GLOBAL FITNESS
INSTITUTE

Learner Guide

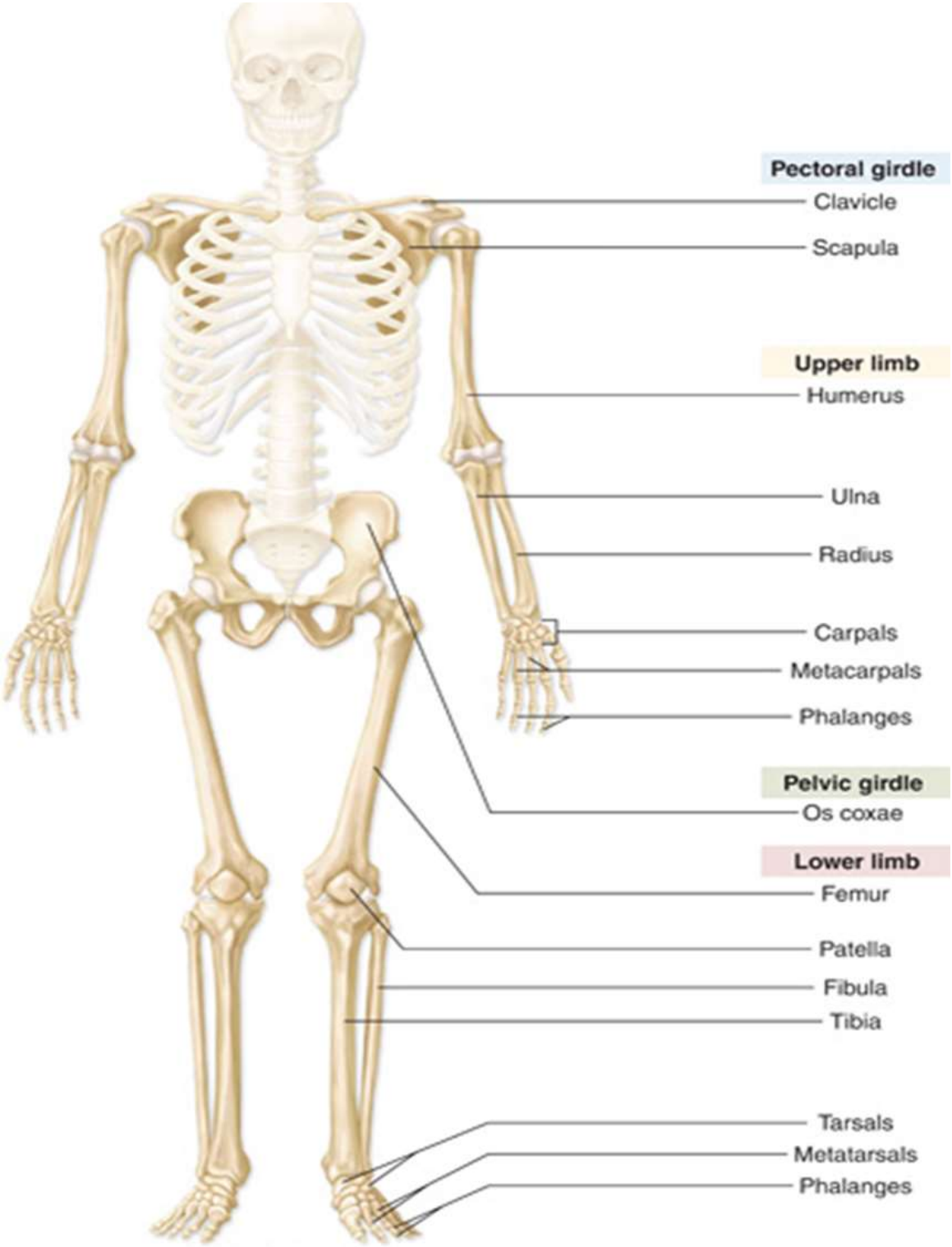
HLTAAP002 Confirm physical health status

The Body Systems:

BODY SYSTEM	COMPONENTS	FUNCTION
SKELETAL	Bones and parts of joints, such as cartilage	support, protection, movement, calcium storage and blood cell formation
MUSCULAR	Skeletal (voluntary), cardiac (involuntary) and smooth (involuntary)	Movement, maintenance of body posture, heat production
NERVOUS	Nerves, brain and spinal cord	Fastest communication system of the body, uses electrical impulses to send messages around the body
DIGESTIVE	Mouth, oesophagus, stomach, intestine, pancreas and liver	Digestion of food and the maintenance of adequate fuel supply
ENDOCRINE	Pituitary and other glands	Regulates the body's chemistry at rest and during activity
URINARY	Kidney, bladder and ducts	Removes metabolic wastes from the body
CARDIOVASCULAR (circulatory)	Heart, arteries, veins and capillaries	Pumps and transports blood throughout the body
RESPIRATORY	Nose, pharynx, larynx, Lungs, bronchi, alveoli	Takes in oxygen from the atmosphere and rids the body of wastes
LYMPHATIC	Lymphatic vessels, lymphoid tissues and organs	Transportation, immunity (body defence)
INTEGUMENTARY	Skin and its parts including sweat and oil glands, hair and nails	Protection, body temperature regulation, holds receptors, helps to make vit D (essential for calcium absorption)

The Skeletal System

This system is made up of bones and joints. There are 206 bones and more than 200 joints in the normal adult skeleton.



Functions

The major functions of the skeleton are:

SUPPORT: Provides a framework for the body
Supports soft tissue
Provides a point of attachment for muscle

PROTECTION: Protects internal organs from injury
E.g. Vertebrae protect the spinal cord, skull protects the brain, and pelvis protects the internal organs

MOVEMENT: Bones serve as levers to which muscles are attached

STORAGE: Bones store several minerals
E.g., calcium, phosphorous, and small amounts of magnesium, sodium and chlorine

HAEMOPOIESIS: Blood cell formation, red marrow in certain bones is able to produce blood cells, predominantly in the marrow of long bones

Structure:

The skeletal system consists of two main parts, the axial skeleton and the appendicular skeleton.

- The AXIAL skeleton consists of the bones of the head (skull)face, neck (hyoid bone and cervical vertebrae), and trunk (ribs, sternum, vertebrae and sacrum)
- It forms the major axis of the body as it is the rigid, supportive structure of the body.
- It also protects many of the vital internal organs.

The APPENDICULAR skeleton consists of the bones of the limbs, including those forming the pectoral (shoulder) and pelvic girdles

- Pectoral girdle and the arm – scapula, clavicle, humerus, radius, ulna, carpals, metacarpals and phalanges (fingers)
- Pelvic girdles and the legs- the ilium, ischium, pubis, femur, patella, fibula, tibia, tarsals, metatarsals, and phalanges (toes)
- The major role of this skeleton is movement

CHARACTERISTICS OF A TYPICAL VERTEBRA:

- Centrum (vertebral body): Thick anterior portion.
- Neural (vertebral) arch: An arch that arises from the posterior surface of the body. Formed by the pedicles and lamina.
- Intervertebral disc: A fibrocartilaginous disc that separates adjacent centra.
- Vertebral foramen: Hole surrounded by the posterior centrum and the vertebral arch.
- Vertebral canal: Formed by adjacent vertebral foramina, through which the spinal cord passes.
- Transverse processes: Lateral projections from each neural arch.
- Spinous process: A midline posterior projection of vertebral arch.
- Pedicle: Portion of the vertebral arch between the centrum and the transverse process.
- Lamina: Portion of the vertebral arch between the transverse and spinous processes.
- Articulating processes: Superior (2) and inferior (2) projections from the vertebral arch which connect adjacent vertebrae and prevent anterior posterior movement of the column.
- Intervertebral foramina: Holes located between the pedicles of adjacent vertebrae, through which spinal nerves pass.

VERTEBRAL COLUMN:

Cervical (7) C1-C7, Thoracic (12) T1-T12, Lumbar (5 fused) L1-L5, Sacral (5 fused) S1-S5 & Coccyx

IDENTIFYING FEATURES OF REGIONAL VERTEBRAE:

CERVICAL VERTEBRAE (Cx)

- Transverse foramina: Openings in the transverse processes to allow for passage of vertebral arteries/veins.
- Bifurcated spinous processes: C2-C6 have a split in their spinous processes.
- Vertebra prominens: C7. Named because of its long spinous process.
- Atlas: C1. Articulates with the occipital condyles of the skull, has no spinous process. It is ring-like, consisting of anterior and posterior arches.
- Axis: C2. It has a vertical projection called the dens around which the atlas rotates.

THORACIC VERTEBRAE (Tx)

- Spinous processes: Longer processes with downward projections.
- Facets and demifacets: Articular facets for the ribs on the transverse processes and centra (except T11 and T12).

LUMBAR VERTEBRAE (Lx)

- Centra: Larger and heavier than other regions.
- Spinous processes: Short and blunt compared to other regions.
- Articular processes: Face inward and outward rather than anterior and posterior to help prevent rotation in this region.

The lumbar vertebrae are lager and heavier due to them supporting more body weight than other vertebrae

SACRAL VERTEBRAE (Sx)

- Median sacral crest: Fused spinous processes on the posterior surface.
- Alae: Fused transverse processes which articulate with the pelvic bones.
- Sacral foramina: Continuation of the intervertebral foramina.
- Sacral promontory: Superior edge of the anterior border of S1.

COCCYGEAL VERTEBRAE

- Forms the coccyx which articulates with the apex of the sacrum.
- Generally speaking, the body starts with 4 coccygeal vertebrae however, some may break off due to damage so generally left with 1 or 2.

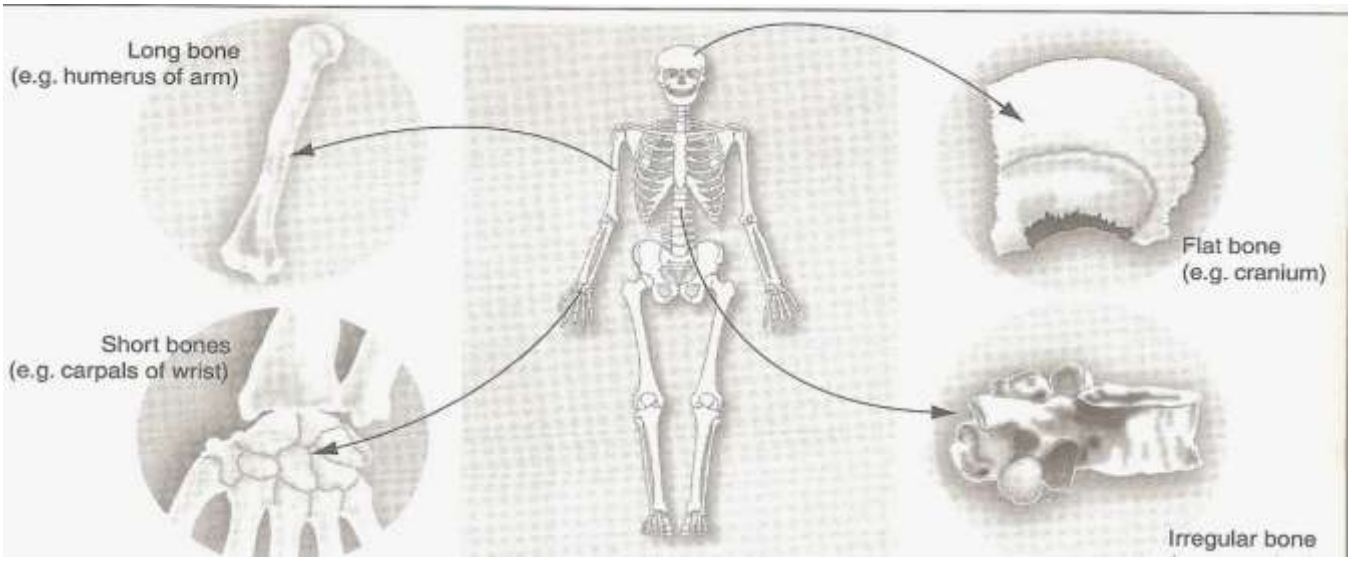
Composition & Types of bone:

Bones are made up of mineral salts, and a protein structure called collagen.
Bones are composed of 2 different types of bone tissue, compact bone and spongy bone

- COMPACT BONE also known as dense bone, tightly compacted tissue, which provides strength for weight bearing.
- SPONGY BONE also known as cancellous bone, is of honeycombed appearance, strong yet lightweight

Bones are usually divided into 5 categories depending on their shape. These categories are long and short bones, flat bones, sesamoid bones and irregular bones.

- LONG BONES are tubular (eg, the humerus in the arm, femur, phalanges)
- SHORT BONES are cuboidal and are found only in the ankle and the wrist (eg, tarsus and carpal)
- FLAT BONES usually serve protective functions (eg, the flat bones of the skull that protect the brain, ribs, pelvis, scapula)
- SESAMOID BONES develop in certain tendons, and are found where tendons cross the ends of long bones in the limbs, protect tendons from excessive wear (patella or the kneecap)
- IRREGULAR BONES have various shapes (eg, the vertebrae and face)



Joints:

The joints in our body can be classified into 3 different kinds of articulations, based on the amount of movement that is allowed.

Kind of joint	Movement	Description

Synarthroses or FIBROUS	No movement	- Fibrous connective tissue - Grows between bones e.g. sutures of skull
Amphiarthroses or CARTILAGINOUS	Slight movement	- Cartilage connects - Articulating bones, e.g. symphysis pubis and joints between the bodies of the vertebrae
Diarthroses or SYNOVIAL	Free movement	- most joints belong to this class, e.g. hip, knee, shoulder and elbow

FREELY MOVEABLE JOINTS (SYNOVIAL)

As most of the joints that allow human movement can be classified into this category, we will examine them closer.
Features:

Articular cartilage – found as a lining at the ends of the bone, provides protection as a spongy cushion for the joint and reduces friction. Made up of hyaline cartilage, which is also found between the ribs and sternum
Joint capsule – made up of fibrous connective tissue, lined with synovial membrane, adds stability to joint, and stops substances entering or leaving the joint
Synovial membrane – lines the internal surfaces of the joint other than the hyaline cartilage, composed of loose connective tissue, secretes a lubricating fluid called synovial fluid
Synovial fluid – lubricates the joint, released as a response to movement and warmth, decreases the wear and tear on the joint structures
Ligaments – strong fibrous tissue that join bone to bone, control movement, relatively inelastic
Menisci - pads of fibrocartilage found in the knee that act as shock absorbers and decrease stress on the bones

There are 6 different types of synovial joints

- BALL AND SOCKET – most freely moving of the synovial joints, permit circular movement in most directions/3 planes eg, shoulder (glenohumeral) and hip (iliofemoral)
- HINGE – only permit movement in one plane, like a hinge on a door, eg, elbow (humeroulna), fingers (metocarpalphalangeal, interphalangeal)
- PIVOT – occur where a ring of bone rotates around a bony prominence on another bone, allows movement in only one directional plane, eg, C1 and C2 in the neck (atlantoaxial), radius and ulna in forearm (radioulna)
- SADDLE – only example of a saddle joint is the thumb (carpometacarpal) allows movement in all directional planes, including the unique combined movement of thumb opposition
- GLIDING – also referred to as plane, least freely moving of all synovial joints, surfaces glide slightly over each other, eg, carpals of the feet and hands (intercarpal)
- CONDYLOID – also referred to as ellipsoidal, involves the condyle of one bone fitting into the depression of another bone. Eg, lateral wrist (radiocarpal)

Bone growth:

Bones begin their formation at week 8 in the embryo. After birth, bones continue to form and grow until they reach adult size. Genetics, lifestyle, exercise, illness, injury, hormonal secretions and

nutrition all effect bone formation and growth. All bones derive from mesenchyme which is an embryonic connective tissue

Bone growth occurs in the area of the bone known as the epiphyseal (or growth) plate, located at the end of the shaft

Bones are formed through a process of ossification (skull is the last bone to ossify). There is intramembranous ossification and endochondral ossification. Intramembranous ossification is the formation of bone within fibrous membranes eg, kneecap, collar bone, skull. Endochondral ossification is the formation of bone within cartilaginous tissue. Bone is a continually changing structure, in fact between 5 – 7 % of bone mass is recycled every week.

Factors affecting bone growth

Injury

- Fractures to bones and particularly to the epiphyseal growth plates can inhibit bone growth.

Diet

- A diet high in calcium & phosphorus is required for strong bones.
- The combination of foods is very important in bone growth. For example, an over-consumption of soft drinks, particularly those high in caffeine, extracts calcium from bones.

Exercise

- Weight-bearing exercise is recommended at least 2 x per week to maximise bone density. Weight-bearing activities include weight training, swimming, circuit training & activities that lift the body weight such as push-ups.

Disease

- Osteopenia is a condition where bones weaken, resulting in an increased risk of fracture.
- Osteoporosis means ‘porous bones’. The body draws on reserves of calcium in the bone when the diet contains insufficient amounts of calcium. This results in poor bone density.
- Osteoarthritis is as a result of degeneration of the joint cartilage causing pain, swelling & loss of movement in the joint.

SKELETAL LANDMARKS.

Crest: A sharp, prominent, bony ridge.
Condyle: A rounded prominence that articulates with another bone.(from the Greek Kondulos meaning knuckle) eg. Distal end of femur has lateral and medial condyles forming part of the knee joint
Epicondyle: A small projection located on or above a condyle.
Facet: A smooth, nearly flat articular surface. (think 'face' – from the French facette)
Fissure: A narrow cleft-like passage.
Foramen: A hole.
Fossa: A depression, often used as an articular passage.
Fovea: A pit.
Head: Usually the larger end of a bone separated from the shaft by the neck.
Line: A slight bony ridge.
Meatus: A canal or passage.
Process: A prominence or projection.
Ramus: A projected part of elongated process.
Spine: A slender pointed projection.
Sulcus: A groove.
Trochanter: A large, somewhat blunt process.
Tubercle: A nodule, or small, rounded process. (may be helpful to think of a tuber – the thickened portion of a plant – eg. Onion or beetroot)
Tuberosity: A broad process, larger than a tubercle.

MAJOR JOINTS & THEIR MOVEMENTS!

JOINT	ARTICULATING BONES	STRUCTURAL/ JOINT TYPE	FUNCTIONAL MOVEMENTS
Skull	Cranial + facial bones	Fibrous ; suture	No movement
Temporomandibular	Temporal bone + mandible	Synovial ; modified hinge	Gliding &uniaxial rotation, slight lateral movement, elevation, depression, protraction and retraction of mandible
Atlanto-occipital	Occipital bone + atlas	Synovial ; condyloid	Biaxial, flexion and extension, abduction and adduction, circumduction of head on neck
Atlantoaxial	Atlas (C1) + axis (C2)	Synovial ; pivot	Uniaxial, rotation of head
Intervertebral	b/w adjacent vertebral bodies	Cartilaginous	Slight movement
Intervertebral	b/w articular processes	Synovial ; plane	Gliding
Vertebrocostal	Vertebrae + ribs	Synovial ; plane	Gliding of ribs
Sternoclavicular	Sternum + clavicle	Synovial ; shallow saddle	Multiaxial; allows clavicle to move in all axes
Sternocostal	Sternum + rib 1	Cartilaginous	No movement
Sternocostal	Sternum + ribs 2-7	Synovial ; double plane	Gliding
Acromioclavicular	Acromion of scapula + clavicle	Synovial ; plane	Gliding, rotation of clavicle on scapula

Shoulder (glenohumeral)	Scapula + humerus	Synovial ; ball & socket	Multiaxial, flexion and extension, abduction and adduction, circumduction, rotation of humerus
Elbow	Ulna and radius + humerus	Synovial ; hinge	Uniaxial, flexion, extension of arm
Radioulnar (proximal)	Radius + ulna	Synovial ; pivot	Uniaxial, rotation of radius around long axis of forearm to allow pronation and supination
Radioulnar (distal)	Radius + ulna	Synovial ; pivot	Uniaxial, rotation
Wrist (radiocarpal)	Radius + proximal carpals	Synovial ; condyloid	Biaxial, flexion and extension, abduction and adduction, circumduction of hand
Intercarpal	Adjacent carpals	Synovial ; plane	Gliding
Carpometacarpal of digit 1	Carpal + metacarpal 1	Synovial ; saddle	Biaxial, flexion and extension, abduction and adduction, circumduction, opposition of metacarpal 1
Carpometacarpal of digits 2-5	Carpal(s) + metacarpal(s)	Synovial ; plane	Gliding of metacarpals
Knuckle (metacarpophalangeal)	Metacarpal + proximal phalanx	Synovial ; condyloid	Biaxial, flexion and extension, abduction and adduction, circumduction of fingers
Finger (interphalangeal)	Adjacent phalanges	Synovial ; hinge	Uniaxial, flexion and extension of fingers
Sacroiliac	Sacrum + coxal bone	Synovial ; plane	Little movement (pregnancy)
Pubic symphysis	Pubic bones	Cartilaginous	Slight movement (pregnancy)
Hip (coxal)	Hip bone + femur	Synovial ; ball & socket	Multiaxial, flexion and extension, abduction and adduction, rotation, circumduction of thigh
Knee (tibiofemoral)	Femur + tibia	Synovial ; modified hinge	Biaxial, flexion and extension of leg, some rotation
Knee (femoropatellar)	Femur + patella	Synovial ; plane	Gliding of patella
Tibiofibular	Tibia + fibula (proximally)	Synovial ; plane	Gliding of fibula
Tibiofibular	Tibia + fibula (distally)	Fibrous	Slight “give” during dorsiflexion
Ankle	Tibia + fibula (with talus)	Synovial ; hinge	Uniaxial, dorsiflexion and plantar flexion of foot
Intertarsal	Adjacent tarsals	Synovial ; plane	Gliding, inversion and eversion of foot
Tarsometatarsal	Tarsal(s) + metatarsal(s)	Synovial ; plane	Gliding of metatarsals
Metatarsophalangeal	Metatarsal and proximal phalanx	Synovial ; condyloid	Biaxial, flexion and extension, abduction and adduction, circumduction of great toe
Toe (interphalangeal)	Adjacent phalanges	Synovial ; hinge	Uniaxial, flexion and extension of toes

ANATOMICAL DIRECTION:

- Superior – above, towards the head

E.g. Eyes superior to the nose

- Inferior – below, towards the feet

E.g. Hand inferior to the shoulder

- Anterior – towards the front of the body

E.g. Sternum anterior to the heart

- Posterior – towards the back of the body

E.g. Spine is posterior to the stomach

- Medial – towards the midline of the body

E.g. Nose in medial to the ears

- Lateral – towards the side of the body, away from the midline

E.g. Eyes are lateral to the nose

- Proximal – towards or nearest the trunk, towards the attachment point of the limb. Refer to limbs only

E.g. Shoulder is proximal to the elbow

- Distal – away from or farthest from the trunk. Refer to limbs only

E.g. Elbows are distal to the shoulders

- Superficial – closer to the body's surface

E.g. Skin is superficial to the organs

- Deep – further in from the body's surface, towards the inside of the body

E.g. Muscles are deep to the skin

Planes, Direction & Movement:

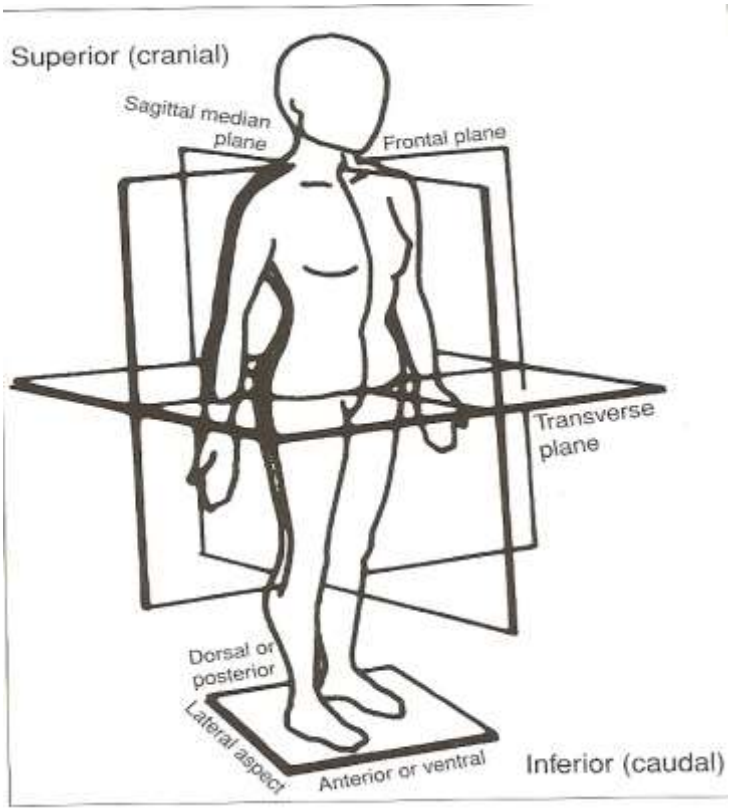
The scientific way to break the body into pieces + describe movement

- Median plane – midline dividing the body into left and right halves

- Sagittal plane – divides the body into left and right portions
  Runs parallel to the median plane
  Joint actions are flexion and extension

- Frontal plane – divides the body into front and back
  Joint actions are adduction and abduction

- Transverse plane – also referred to as a horizontal plane/cross sectional plane
  Divides the body into upper and lower parts
  Transverse sections are at right angles to the body or body segments
  Joint actions are rotation, horizontal flexion and extension



THE SKELETAL SYSTEM OF THE LOWER EXTREMITY

THE PELVIC GIRDLE

The pelvic girdle has many bony landmarks which you can use to assist you in determining what muscles you are on and what you are treating. The pelvis is the transmission point from the lower limb to the rest of the body for energy passing from the feet up through to the spine and head and vice versa.

INNOMINATE BONE - HIP BONE

The innominate is a large, irregularly shaped bone formed by the union of three bones: the ilium, the ischium and the pubis. Before puberty these bones are separated by cartilage, but begin to fuse at years 15-17 at the acetabulum to form one hip bone. By age 23 fusion is complete. The acetabulum is a cup shaped socket on the lateral aspect for articulation with the head of the femur.

ILIUM

The ilium is a fan shaped bone that extends upwards from the acetabulum and it articulates with the sacrum.

- Iliac crest: The superior margin of the ilium. It has internal and external lips and is easily palpable. A tubercle is located on the external lip about 5cm posterior to the ASIS. Place your hands on your waistline and push down – you are pushing down onto your iliac crests.
- Anterior superior iliac spine: A rounded projection at the anterior end of the iliac crest. This is the pointy part of the hip that you can feel at the front – you can palpate this on yourself.
- Anterior inferior iliac spine: A rounded projection just below the anterior superior spine.
- Posterior superior iliac spine: A sharp projection at the posterior end of the iliac crest. These are the bony points you can feel just above where the bottom cheeks begin.

- Posterior inferior iliac spine: A projection just below the posterior superior spine. Not palpable.
- Greater sciatic notch: A deep notch just below the PSIS which provides passage for the sciatic nerve, other nerves and vessels and the piriformis muscle.
- Auricular surface: Surface that articulates with the lateral mass of the sacrum.
- Gluteal surface: The outer surface of the ilium containing three arched lines - posterior, anterior and inferior. The origins of the three gluteal muscles are located between these lines.
- Arcuate line: A slight ridge on the internal surface of the ilium that extends forward and downward from the top of the sacrum to the pecten of the pubis. It forms the internal margins of the pelvic inlet.
- Iliac fossa: The smooth, concave internal surface of the ilium above the arcuate line.

ISCHIUM

The ischium forms the posterior-inferior part of the hip bone and acetabulum. It is roughly an L shaped bone which passes inferior to the acetabulum, then turns anteriorly to join the pubis.

- Ischial spine: A triangular projection from the posterior border behind the acetabulum.
- Ischial tuberosity: A roughened enlargement on the posterior, inferior margin. These are your bum bones or sit bones. These are the bones you can feel when someone sits on your lap.
- Lesser sciatic notch: A small indentation that separates the ischial spine and tuberosity. It transmits the tendon of obturator internus muscle, as well as nerves and blood vessels.
- Ischial ramus: A flattened anterior projection that arises from the tuberosity. It joins with the inferior ramus of the pubis to form the lower border of the obturator foramen.

PUBIS

The pubis forms the anterior-inferior portion of the hip bone and acetabulum and consists of a body and two rami.

- Pubic symphysis: The midline fibrocartilaginous joint between the bodies of both pubic bones.
- Pubic tubercle: A projection from the superior ramus, just lateral to the pubic symphysis.
- Pubic crest: A ridge that extends medially from the pubic tubercle to the pubic symphysis.
- Pecten: A ridge that extends upward and laterally along the superior ramus from the pubic tubercle to the arcuate line.
- Obturator crest: A rounded ridge along the inferior border of the superior ramus from the pubic tubercle to the acetabulum.
- Superior ramus: Elongated process that extends anteriorly from the acetabulum to form the upper border of the obturator foramen.
- Inferior ramus: A projection that passes downward and backward from the pubic symphysis to join with the ischial ramus to form the lower border of the obturator foramen.
- Pubic arch: Formed by the convergence of the inferior rami.
- Obturator foramen: A large opening in the inferior region of the hip bone that allows the passage of the obturator nerve and vessels and is partially covered by the obturator membrane.

PELVIC CAVITIES

Pelvic brim or inlet: The boundary of the opening that leads to the true pelvis formed by the sacral promontory, arcuate lines and the superior margin of the pubic symphysis.

Pelvic outlet: The lower margin of the true pelvis bounded by the coccyx and the lower parts of the hip bones.

False pelvis: The expanded space above the pelvic inlet, which is actually a portion of the abdomino-pelvic cavity.

True pelvis: The smaller cavity below the pelvic inlet.

SEXUAL DIFFERENCES IN THE PELVIS:

CHARACTERISTIC	FEMALE PELVIS	MALE PELVIS
general structure	more delicate	more massive
anterior iliac spines	more widely separated	less widely separated
pelvic inlet	larger; circular	heart shaped
pelvic outlet	wider; ischial tuberosities further apart	narrower
Pubic arch	> 90 degrees	< 90 degrees
obturator foramen	triangular	oval
acetabulum	faces more anteriorly	faces laterally

FEMUR

The femur is the longest and heaviest bone in the body. It extends from the hip joint where its head articulates with the acetabulum, to the knee joint, where its condyles articulate with the tibia. It articulates via a ball and socket joint with the acetabulum. The bone is smooth anteriorly and therefore does not have many muscles attaching at the front.

Proximal end:

- Head: Smooth and forms about 2/3 of a sphere. Articulates with the acetabulum
- Fovea (Pit): A pit on the head where the ligamentum teres (or ligament of the head of the femur) is attached. The ligamentum teres helps to hold the head of the femur into the acetabulum. There is also an artery running through here which feeds the femur
- Nutrient foramen: Small hole where the supplying vessels enter. Directed superiorly.
- Neck: A narrowing which connects the head to the shaft.
- Trochanters:
  Greater - a large lateral projection from the junction of the head and shaft.
  Lesser - projects from the junction of the head and shaft in a posterior-medial direction.
- Intertrochanteric crest: A crest that runs between the two trochanters posteriorly.
- Intertrochanteric line: A line the runs between the two trochanters anteriorly.
- Quadrate tubercle: The midpoint of the intertrochanteric crest.
- Trochanteric fossa: A depression on the medial surface of the greater trochanter.

Shaft:

Gluteal tuberosity: A roughened area on the posterior shaft, extending from below the greater trochanter to the lateral lip of the linea aspera.

Spiral line:	The continuation of the intertrochanteric line below the lesser trochanter, extending as far as the medial lip of the linea aspera.
Linea aspera:	A longitudinal ridge that extends along the middle third of the posterior surface of the shaft. It has a medial and lateral lip.

Distal end:

Supracondylar ridges:	The medial and lateral ridges that are formed by the divergence of the linea aspera at its distal end.
Condyles:	Rounded medial and lateral enlargements that articulate with the tibia.
Epicondyles:	Roughened prominences on the lateral surfaces of the condyles which provide attachments for the collateral ligaments.
Adductor tubercle:	A small projection just above the medial epicondyle at the termination of the medial supracondylar ridge.
Popliteal surface/fossa:	A smooth, triangular area of the posterior surface bounded above by the supracondylar ridges.
Intercondylar notch:	A U-shaped depression that separates the condyles
Patella surface:	A smooth anterior surface above the condyles which articulates with the patella when the knee is extended. Coated with hyaline cartilage

PATELLA

The largest sesamoid (a bone embedded in tendon) bone in the body. It articulates with the femoral condyles via two facets. It is embedded in the quadriceps femoris tendon.

Base:	Superior border.
Apex:	Inferior pole.

THE LEG

The inferior part of the lower limb, between the knee and ankle joints. Bones of the leg are the tibia and fibula whose shafts are connected by a strong band called the interosseous membrane.

TIBIA

The second largest bone of the skeleton on the antero-medial side of the leg.

Condyles:	Flattened enlargements at the proximal end of the shaft which articulate with the femoral condyles.
Plateau:	Flat, superior surfaces (medial and lateral) of the tibia
Intercondylar eminence:	Vertical projection from the superior surface, between the medial and lateral tibial plateaus.
Tibial tuberosity:	A midline projection from the anterior surface just below the condyles where the patella tendon attaches.
Shaft:	Body of the tibia which is triangular in section.
Soleal line:	A rough diagonal ridge on the posterior surface of the proximal part of the body.
Nutrient foramen:	Largest in the skeleton. Located on the posterior surface in the superior third
Borders:	Anterior, interosseous and medial borders.
Surfaces:	Medial, lateral and posterior surfaces.
Interosseous membrane:	Strong, fibrous membrane connecting the interosseous borders of the tibia and fibula.

Medial malleolus:	A downward projection from the medial side of the distal tibia which articulates with the talus.
Fibular notch:	Lower, lateral aspect which articulates with the fibula.

FIBULA

A long pin-like bone lying lateral to the tibia. Its main function is to provide sites for muscle attachment. It has little or no function in weight bearing, but acts like a brace for the tibia and its malleolus helps the talus remain in its socket.

Head:	Prominent, expanded portion which articulates with the proximal tibia.
Facet on head:	On superior surface of the head which articulates with the inferior surface of the lateral condyle of the tibia.
Neck:	Slightly constricted part of the shaft immediately below the head.
Shaft:	Thin body of the fibula.
Interosseous border:	Sharp border of the shaft of the fibula, on the medial side.
Nutrient foramen:	Small, in middle third on the posterior surface.
Lateral malleolus:	Triangular expansion at the distal end which articulates with the talus and the distal tibia.

THE FOOT

The foot consists of the tarsals, metatarsals and phalanges. The medial border of the foot is straigh

THE TARSALS

Consists of 7 tarsal bones arranged in proximal and distal rows with the navicular bone interposed between the two rows on the medial side. The tarsal bones are:

1.	Talus	Proximal row
2.	Calcaneus	Proximal row
3.	Medial or first cuneiform	Distal row
4.	Intermediate of second cuneiform	Distal row
5.	Lateral or third cuneiform	Distal row
6.	Cuboid	Distal row
7.	Navicular	Distal row

Talus:

Articulates with the inferior and lateral surfaces of the tibia, the medial fibular, the superior calcaneus and the navicular.

Head:	Rounded anteromedial portion with a medial and lateral aspect.
Neck:	Slightly constricted part between the head and body.
Body:	Articulates with the tibia and fibula and can be palpated anteriorly and posteriorly.

Calcaneus:

The largest and strongest bone of the foot. It articulates with the talus superiorly and the cuboid anteriorly.

Sustentaculum tali:	A shelf that projects from the superior surface on the medial side to help support the talus.
Peroneal tubercle:	An oblique ridge on the lateral surface under which passes the tendon of peroneus longus.

The Cuneiforms:

Articulate with the navicular posteriorly and the base of the appropriate metatarsal anteriorly. The third cuneiform also articulates with the cuboid.

Cuboid:
Most lateral bone in the distal row of the tarsus. Articulates posteriorly with the calcaneus, anteriorly with the bases of the fourth and fifth metatarsals and medially with the third cuneiform and navicular bones. It contains a groove for the tendon of peroneus longus muscle.

Navicular:
Located between the head of the talus and the three cuneiform bones and also articulates with the cuboid laterally.

Navicular tuberosity: Roughened area on the medial aspect.

The tarsals and metatarsals provide spring when ambulating. You need to use the whole foot to get the best spring from it. The navicular is susceptible to stress fractures because of its location as it is squashed on movement. The blood supply to it is relatively poor so it takes a long time to heal if injured.

THE METATARSALS.
Five long bones connecting the tarsals to the phalanges numbered 1 to 5 from the medial side. Each has a base (proximal), shaft and head (distal). The bases articulate with the three cuneiforms and cuboid bones and the heads articulate with the proximal phalanges. The second metatarsal is the longest bone. The heads of the metatarsals are weight bearing. On the lateral surface of the fifth metatarsal there is a tuberosity.

The metatarsals help the foot to mould to the contour of the terrain.

THE PHALANGES
There are 14 phalanges; 2 in the great toe (proximal and distal) and 3 in toes 2 to 5 (proximal, middle and distal). Each has a base (proximal), shaft and head (distal).

Being able to use the toes is essential in being able to walk and run. Shoes inhibit the function of the foot – they absorb the shock that the foot normally would, therefore the foot can atrophy and lose the absorptive ability. Shoes decrease the proprioceptive ability of the foot and the atrophy that follows may be a contributing factor in foot, ankle, knee and leg problems. This can be improved through treatment and exercise.

TIBIOFIBULAR JOINTS.

The tibia and fibula articulate at their proximal and distal ends. Movement at the proximal joint is not possible without movement at the distal joint.

PROXIMAL TIBIOFIBULAR JOINT.
This is a plane type of synovial joint between the head of the fibula and the lateral tibial condyle. It is important to note that biceps femoris (one of the hamstring muscles) attaches to the head of the fibula as does the lateral collateral ligament (a ligament of the knee).

Structure involved:

1. Articular surfaces
2. Fibrous capsule
3. Synovial capsule
4. Anterior ligament
5. Posterior ligament

1. ARTICULAR SURFACES.

A flat facet on the medial side of the head of the fibula articulates with a facet on the posterior lateral aspect of the lateral tibial condyle.

2. FIBROUS CAPSULE.

Much thicker anteriorly than posteriorly. The capsule is strengthened by intrinsic ligaments anteriorly and posteriorly.

Attachments: Margins of the articular facets on the tibia and fibula.

3. SYNOVIAL CAPSULE.

The inner surface of the fibrous capsule is lines by synovial membrane that is occasionally continuous with that of the knee joint, via an extension of the knee synovial capsule called the popliteus bursa.

4. ANTERIOR LIGAMENT OF THE HEAD OF THE FIBULA.

Attachments:
Proximal: Anterior surface of the lateral tibial condyle.
Distal: Anterior surface of the head of the fibula.

5. POSTERIOR LIGAMENT OF THE HEAD OF THE FIBULA.

Attachments:
Proximal: Posterior surface of the lateral tibial condyle.
Distal: Posterior surface of the head of the fibula.

CRURAL INTEROSSEOUS MEMBRANE.
Connects the interosseous borders of the tibia and fibula, giving attachment to muscles on the anterior and posterior surfaces. Its fibres are mostly oblique and descend laterally, with some fibres descending medially.

DISTAL TIBIOFIBULAR JOINT.
This is a fibrous syndesmosis joint between the inferior ends of the tibia and fibula. Whilst the fibula is not a weight bearing bone, if it is broken stability of the ankle may be jeopardised. The strength of the ankle joint is highly dependent on the stability of this articulation.

Structures involved:
1. Articular surfaces
2. Interosseous ligament
3. Anterior and posterior tibiofibular ligaments
4. Transverse tibiofibular ligament.

1. ARTICULAR SURFACES.

The rough, convex triangular area on the medial surface on the inferior end of the fibula articulates with a facet on the inferior end of the tibia. A small superior projection of synovial capsule of the ankle joint extends upwards to the inferior part of the distal tibiofibular joint.

2. INTEROSSEOUS LIGAMENT.

A strong ligament which is continuous superiorly with the interosseous membrane. It is the largest and strongest bond between the inferior ends of the bones.

3. ANTERIOR AND POSTERIOR TIBIOFIBULAR LIGAMENTS.

These ligaments extend from the fibular notch of the tibia to the anterior and posterior surfaces of the lateral malleolus respectively. The posterior ligament is stronger than the anterior ligament.

4. TRANSVERSE TIBIOFIBULAR LIGAMENT.

This is the inferior, deep part of the posterior tibiofibular ligament. It is a strong band that closes the posterior angle between the tibia and fibula.

TALOCRURAL (ANKLE) JOINT.

This is a hinge synovial joint located between the inferior ends of the tibia and fibula and the superior part of the talus.

Structures involved:

1. Articular surfaces
2. Articular capsule
3. Medial or deltoid ligament
4. Lateral ligaments of the ankle

1. ARTICULAR SURFACES.

The lower end of the tibia, the tibial malleolus, the fibular malleolus and the transverse tibiofibular ligament form a deep recess (socket, mortise) in which the body of the talus fits.

2. ARTICULAR CAPSULE.

The fibrous capsule is thin anteriorly and posteriorly, but is supported on both sides by the strong collateral ligaments. The synovial capsule lines the fibrous capsule and occasionally projects superiorly into the distal tibiofibular ligaments. The capsule is superficial either side of the tendo calcaneus.

Attachments:

Proximal: Borders of the articular surfaces of the tibia and the malleoli.
Distal: Superior articular surface of the talus and the dorsum of the neck of the talus.

3. MEDIAL OR DELTOID LIGAMENT.

This is a strong, triangular band that attaches the medial malleolus to the tarsus. It consists of four parts named according to their bony attachments:

1. Tibionavicular ligament
2. Anterior tibiotalar ligament
3. Posterior tibiotalar ligament
4. Tibiocalcannean ligament

Attachments:

Apex: Margins and tip of the medial malleolus.
Base: Talus, navicular and calcaneus.

4. LATERAL LIGAMENTS OF THE ANKLE.

There are three ligaments that attach the lateral malleolus to the talus and calcaneus which are not as strong as the medial ligament. It is possible to perform more inversion than eversion of the ankle joint. The ligaments are:

1. Anterior talofibular ligament:

   A flat band that extends from the lateral malleolus to the neck of the talus and is not very strong. An inversion sprain of the ankle will generally rupture this ligament if the sprain is severe enough.

2. Posterior talofibular ligament:

   A thick and fairly strong ligament that attaches the malleolar fossa to the

   posterior aspect of the talus.

3. Calcaneofibular ligament:

   A round cord that passes from the lateral malleolus to the lateral aspect of the calcaneus. In a very severe inversion sprain a patient may rupture this ligament as well.

Once the ligaments of the ankle are damaged, they generally stay damaged and this can lead to a loss of proprioception at the ankle. If a patient can enhance proprioception through specific exercises, then ankle strength can be improved.

STABILITY OF THE ANKLE JOINT

During dorsiflexion, the ankle is very strong because it is supported by strong ligaments and several tendons held firm by strong retinacula and the articular surfaces are strongest in this position.

During plantarflexion, the ankle is relatively unstable because the talus moves anteriorly in the mortise, causing the malleoli come together decreasing its grip on the talus.

THE NERVE SUPPLY OF THE ANKLE

The articular nerves are derived from:

1. Tibial nerve
2. Deep peroneal nerve

JOINTS OF THE FOOT

The joints of the foot involve the tarsals, metatarsals and phalanges. The most important joints are the subtalar, talocalcaneo-navicular and the calcaneocuboid joints. The other joints are small and so tightly joined by ligaments that only slight movements occur between them.

SUBTALAR JOINT

This is a synovial joint involving the inferior surface of the body of the talus and the superior surface of the calcaneus. It is surrounded by a weak fibrous capsule, which is supported by medial, lateral and posterior talocalcaneal ligaments and anteriorly by the interosseous talocalcanean ligament. The main movements at this joint are inversion and eversion.

TALOCALCANEO-NAVICULAR JOINT.

This is synovial ball and socket joint between the head of the talus, the posterior surface of the navicular and the articular surface of the calcaneus. It is part of the transverse tarsal joint. It has a fibrous capsule that is strengthened posteriorly, inferiorly and on the dorsum by ligaments.

CALCANEOCUBOID JOINT

This articulation is a synovial joint between the anterior calcaneus and the posterior cuboid that is part of the transverse tarsal joint. Its capsule is strengthened on its plantar and dorsal aspects by ligaments.

TRANSVERSE TARSAL JOINT

The talocalcaneo-navicular and the calcaneocuboid joints are separated from each other, but together form the transverse tarsal joint as they lie in the same transverse plane. Movements occurring at this joint are inversion and eversion.

TARSOMETATARSAL JOINTS

These articulations are plane synovial joints that permit sliding or gliding movements only. The 3 cuneiforms and the cuboid articulate with the bases of the metatarsal bones and are attached by dorsal, plantar and interosseous ligaments.

INTERMETATARSAL JOINTS

These articulations between the bases of the metatarsal bones are plane synovial joints that permit gliding or sliding movements. Ligaments are found on the dorsal, plantar and interosseous aspects of the joints.

METATARSOPHALANGEAL JOINTS

These are condyloid synovial joints between the heads of the metatarsals and the bases of the proximal phalanges. They permit flexion, extension, some abduction and adduction and circumduction. The first metatarsophalangeal joints is the largest due to the size of the first metatarsal head and the 2 sesamoid bones found in the tendons of flexor hallucis brevis muscle. The fibrous capsules of these joints are strengthened by collateral ligaments.

INTERPHALANGEAL JOINTS.

The interphalangeal joints are between the head of one phalanx and the base of the one distal to it. They are hinge synovial joints permitting flexion and extension.

JOINTS OF THE PELVIS.

1. Lumbosacral
2. Sacrococcygeal
3. Sacroiliac
4. Pubic symphysis

1. LUMBOSACRAL JOINT

L5 and S1 vertebrae articulate anteriorly via an intervertebral joint formed by the disc between them and posteriorly via two synovial joints between their articulating processes. The L5 vertebra is attached to the ilium and sacrum by the strong iliolumbar ligaments (from L4/L5 TPs to ilium and sacrum).

2. SACROCOCCYGEAL JOINT.

A secondary cartilaginous joint in which fibrocartilage and ligaments join the articulating bones: i.e. the apex of the sacrum and the base of the coccyx. A thin fibrocartilaginous disc lies between the bones and anterior and posterior ligaments stabilise the joint. This joint is slightly moveable during defecation and moves considerably when giving birth.

3. SACROILIAC JOINTS. (SIJ)

The SIJs are strong weight bearing synovial joints which possess very little movement. This provides stability and allows the transference of weight from the body to the hip bones (innominates).

Bones: The articulating surfaces of the sacrum and ilium.
Ligaments:

1. Interosseous sacroiliac ligaments.
   Short, strong bundles of fibres that help suspend the sacrum between the two ilia

2. Posterior sacroiliac ligaments.
   Consist of short transverse fibres and long vertical fibres which blend with the sacrotuberous ligaments.

3. Anterior sacroiliac ligaments.
   Consist of a thin, wide sheet of transverse fibres on the anterior and inferior surfaces of the SIJ's.

4. PUBIC SYMPHYSIS. (also called symphysis pubis)

This is a median, secondary cartilaginous joint between the bodies of the two pubic bones. The articular surfaces are covered by hyaline cartilage and separated by a thick, fibrocartilage interpubic disc. The joint is strengthened superiorly by the superior pubic ligament, inferiorly by the arcuate ligament and anteriorly by the tendinous fibres of the rectus abdominus and external oblique muscles. It acts like a coupling device between both innominate bones – movement occurring here also created movement at the sacrum (SIJ) and vice versa – implications for the muscles surrounding the region. Eg. In pregnancy, the symphysis pubis becomes unstable as the pelvis expands to accommodate the growing foetus, this in turn can make the SIJs unstable which may result in back problems following childbirth.

Important Ligaments

1. Sacrotuberous ligament
Runs from the sacrum to the ischial tuberosity. It helps to prevent the sacrum from flexing too much – moving anteriorly and posteriorly – as can occur in pregnancy. Also provides attachment points for some of the gluteal muscles. It can often be useful to release this ligament when treating gluteal/hip related problems.

2. Sacrospinous ligament
Runs from the sacrum to the ischial spine. Together with the sacrotuberous ligament they create the greater and lesser sciatic foramen (when in place).

THE HIP JOINT.

A ball and socket joint (multidirectional) between the head of the femur and the acetabulum. The connective tissue surrounding the joint are vital in its stability.

Structures involved:

1. Articular surfaces
2. Acetabular labrum
3. Synovial capsule
4. Fibrous capsule
5. Iliofemoral ligament
6. Pubofemoral ligament
7. Ischiofemoral ligament
8. Ligament of the head of the femur

1. ARTICULAR SURFACES.

The head of the femur is covered in hyaline cartilage except for the fovea, where the ligament of the head attaches. The cartilage is thicker centrally and thinner at the periphery. The acetabular cartilage is an incomplete ring (C-shaped). The gap is called the acetabular notch. There is no cartilage centrally. This area is non-articular and called the acetabular fossa. It is occupied by a fat pad covered with synovial membrane.

2. ACETABULAR LABRUM.

The femoral head is not very congruent with the acetabulum therefore the acetabulum has a lip to make it deeper – the acetabular labrum. This is a fibrocartilaginous rim that attaches to the margin of the acetabulum, the cavity of which it deepens. It bridges the acetabular notch as the transverse acetabular ligament, thus forming a complete circle. The free edge of the labrum closely embraces the head of the femur and assists in holding it in place. A tear of the labrum results in much pain and stability problems.

3. SYNOVIAL CAPSULE.

This capsule lines the internal surface of the fibrous capsule and is reflected from it on the neck of the femur. It forms a sleeve for the ligament of the head of the femur, lines the acetabular fossa, covers the fatty pad in the acetabular notch and is attached to the edges of the acetabular fossa and transverse acetabular ligament. It forms the obturator externus bursa, which protects the tendon of obturator externus muscle, by protruding inferior to the fibrous capsule posteriorly.

4. FIBROUS CAPSULE.

The fibrous capsule forms a cylindrical sleeve that encloses the hip joint and most of the neck of the femur.

Attachments:

Proximally: The acetabulum, beyond the labrum.
Distally: It surrounds the neck of the femur, helping to hold the femoral head in the acetabulum.

5. ILIOFEMORAL LIGAMENT.

A very strong ligament that lies in front of the joint and blends with the capsule. It is Y shaped and prevents overextension (hyperextension) of the hip by screwing the head of the femur into the acetabulum, leading to increased joint stability.
Attachments:

Proximally: AIIS and the acetabular rim.
Distally: Intertrochanteric line of the femur.

6. PUBOFEMORAL LIGAMENT.

This large ligament strengthens the anterior and inferior parts of the hip joint capsule and blends with the medial part of the iliofemoral ligament. It arises from the pubic part of the acetabular rim and prevents over-abduction of the hip joint.

7. ISCHIOFEMORAL LIGAMENT.

This ligament reinforces the posterior aspect of the fibrous capsule of the hip joint. It tends to screw the femoral head medially into the acetabulum during extension of the thigh, thereby preventing overextension (hyperextension).

Attachments:

Proximally: Ischial portion of the acetabular rim.
Distally: The neck of the femur, medial to the base of the greater trochanter.

You will notice that there are no ligaments present which prevent hyperflexion because there is generally no possibility of posterior dislocation – the leg is stopped by the body (accident circumstances may be the exception).

8. LIGAMENT OF THE HEAD OF THE FEMUR. (Ligamentum teres)

This ligament is located within the fibrous capsule (intracapsular) and is surrounded by a sleeve of synovial membrane. It is about 3.5cm long and of little importance in strengthening the hip joint. Usually it contains a small artery to the head of the femur, which is a branch of the obturator artery. This ligament is stretched when the flexed thigh is adducted or laterally rotated. Rupture can result in blood or fusion in the joint cavity because of the artery located within it.

Attachments:

Proximally: Margins of the acetabular notch and to the transverse acetabular ligament.
Distally: The fovea of the head of the femur.

STABILITY OF THE HIP JOINT.

The hip joint is a very strong articulation surrounded by very powerful muscles. The articulating bones are connected by a dense fibrous capsule, which is strengthened by competent intrinsic ligaments, particularly the iliofemoral ligament. The muscles are the number 1 thing in hip support.

NERVE SUPPLY OF THE HIP JOINT.

The articular nerves are derived from:

1. The femoral nerve.
2. The obturator nerve.
3. The sciatic nerve.
4. The superior gluteal nerve.

THE KNEE JOINT.

This joint consists of three articulations: between the patella and femur (patellofemoral joint) and between the medial and lateral femoral and tibial condyles. It is a hinge type of synovial joint which permits some rotation.

Structure involved:

1. Articular surfaces
2. Fibrous capsule
3. Patella ligament
4. Lateral collateral ligament
5. The medial collateral ligament
6. Oblique popliteal ligament
7. Arcuate popliteal ligament
8. Synovial capsule
9. Associated bursae
10. Anterior cruciate ligament
11. Posterior cruciate ligament
12. Medial meniscus
13. Lateral meniscus

1. ARTICULAR SURFACES.

The articular surfaces are:

1. The large, curved femoral condyles
2. The flattened, superior part of the tibial condyles (tibial plateaus)
3. The facets of the patella

The knee is relatively weak mechanically because of the configurations of its articulating surfaces and relies on the ligaments that bind the femur to the tibia for strength.

2. FIBROUS CAPSULE.

The fibrous capsule is strong, especially where it is thickened by 5 intrinsic ligaments.

Attachments:

Proximal: Just above the articular margins of the femoral condyles. It is deficient on the lateral condyle, which allows the tendon of popliteus to leave the joint and pass to the tibia.

Distal:
1. Articular margin of the tibia, except where the tendon of popliteus crosses the bone.
2. Head of the fibula.

3. PATELLAR LIGAMENT.

A strong, thick band, which is a continuation of the quadriceps femoris muscle. It is also continuous with the fibrous capsule. Its deep surface is separated superiorly from the synovial membrane by the infrapatellar fat-pad and inferior from the tibia by the deep infrapatellar bursa.

4. LATERAL (FIBULA) COLLATERAL LIGAMENT.

A 5cm, round cord which passes superficial to the popliteus muscle. It is fused with the capsule superiorly (intrinsic part), but separated from it by fatty tissue inferiorly (extrinsic part).

Attachments:

Proximal: Lateral femoral epicondyle.

Distal: Head of the fibula.

5. MEDIAL (TIBIAL) COLLATERAL LIGAMENT.

A strong, flat band, 8-9cm long which is continuous with the fibrous capsule and partly continuous with the tendon of adductor magnus. Its deep fibres are firmly attached to the medial meniscus.

Attachments:

Proximal: Medial femoral epicondyle.

Distal: Medial tibial condyle and superior part of the medial surface of the tibia.

6. OBLIQUE POPLITEAL LIGAMENT.

A broad band which is the expansion of the semimembranosus muscle. It strengthens the capsule posteriorly.

Attachments:

Proximal: Central part of the posterior aspect of the fibrous capsule and lateral femoral condyle.

Distal: Posterior aspect of the medial tibial condyle.

7. ARCUATE POPLITEAL LIGAMENT.

A Y shaped band of fibres located deep to plantaris and superficial to popliteus. It also strengthens the fibrous capsule posteriorly.

Attachments:

Stem: Head of the fibula.
Branches: Intercondylar area of the tibia and the posteriorly aspect of the lateral femoral condyle.

8. SYNOVIAL CAPSULE.

More extensive than any other joint, thus the knee has the largest joint cavity in the body. It lines the inner surface of the fibrous capsule and the articulating bones to the edges of the cartilages.

9. ASSOCIATED BURSAE.

A. Suprapatellar (Quadriceps) Bursa.

A large, superior extension of the synovial capsule between the femur and the quadriceps tendon. It extends about 8cm superior to the base of the patella and facilitates free movement of the quadriceps tendon over the distal femur. It is held in place by articularis genus.

B. Popliteus Bursa.

An extension of the synovial capsule found between the tendon of popliteus and the lateral tibial condyle. The bursa opens into the lateral part of the joint cavity, inferior to the lateral meniscus.

C. Anserine Bursa.

This bursa separates the tendons of Pes Anserinus (Sartorius, Gracilis, Semitendinosus) from the medial part of the tibia and the medial collateral ligament.

D. Gastrocnemius Bursa.

This extension of the synovial capsule lies between the tendon of the medial head of gastrocnemius and the posterior aspect of the medial femoral condyle.

E. Semimembranosus Bursa.

Frequently, this bursa is a prolongation of the gastroc. bursa and communicates with the knee joint cavity. It is located between the medial head of gastroc and the semimembranosus tendon.

F. Subcutaneous Prepatellar Bursa.

Found between the skin and the anterior surface of the patella and allows free movement of the skin over the patella during flexion and extension of the leg.

G. Subcutaneous Infrapatellar Bursa.

Located between the skin and the tibial tuberosity. It allows the skin to glide over the tibial tuberosity and the tibial tuberosity to with stand pressure when kneeling.

H. Deep Infrapatellar Bursa.

A small bursa that lies between the patellar ligament and the anterior surface of the tibia, superior to the tibial tuberosity. It is separated from the knee joint by the infrapatellar fat-pad.

10. ANTERIOR CRUCIATE LIGAMENT.

The weaker of the two intra-articular cruciates. It prevents posterior displacement of the femur on the tibia and hyperextension of the knee joint (stops the tibia from moving anteriorly). When the knee is flexed to 90 degrees, the tibia cannot be pulled anteriorly because of this ligament.

Attachments:

Femur: Posterior part of the medial margin of the lateral femoral condyle.
Tibia: Anterior part of the intercondylar area of the tibia.

11. POSTERIOR CRUCIATE LIGAMENT.

This strong, intra-articular ligament prevents anterior displacement of the femur on the tibia or posterior displacement of the tibia when the knee is flexed. It also helps prevent hyperflexion of the knee joint. In weight bearing, it is the main stabilising factor on the femur (eg - walking downhill).

Attachments:

Femur: Anterior part of the lateral surface of the medial femoral condyle.
Tibia: Posterior part of the intercondylar area of the tibia.

MENISCI.

The medial and lateral menisci are crescent shaped plates of fibrocartilage on the articular surface of the tibia, which act as shock absorbers. The menisci deepen the articular surfaces of the tibia for articulation with the femoral condyles. Their superior surfaces are concave to receive the rounded femoral condyles and their inferior surfaces are flatter, to accommodate the tibial plateaus. They are smooth and slightly moveable, allowing them to fill the gaps between the femur and the tibia during movement. The capsular fibres that attach the thick, convex margins of the menisci to the deep surface of the fibrous capsule and tibial condyles are called the coronary ligaments. A slender fibrous band called the transverse ligament of the knee joint, joins the anterior edges of the two menisci.

12. MEDIAL MENISCUS.

A C-shaped cartilage that is thicker posteriorly than anteriorly and is firmly attached to the medial collateral ligament.

Attachments:

Anterior: Anterior intercondylar area of the tibia, anterior to the anterior cruciate ligament.
Posterior: Posterior intercondylar area, anterior to the posterior cruciate ligament and between the attachments of the posterior cruciate ligament and the lateral meniscus.

13. LATERAL MENISCUS.

This meniscus is smaller and more freely moveable than the medial meniscus, but covers a larger area of articular surface. The popliteus tendon and bursa separates the lateral meniscus from the lateral collateral ligament. A strong tendinous slip called the posterior meniscofemoral ligament, joins the lateral meniscus to the posterior cruciate ligament and the medial femoral condyle.

Attachments:

Anterior:	Anterior intercondylar area of the tibia.
Posterior:	Posterior intercondylar area of the tibia.

STABILITY OF THE KNEE JOINT.

The stability of the knee joint depends upon the strength of the surrounding muscles and ligaments, particularly the quadriceps femoris muscle. Although the knee is a very strong joint, especially when extended, its function is commonly impaired due to injury. When the knee bends or extends, tension is placed on the cruciate ligaments to help keep the knee stable. In flexion, the hamstring muscles try to pull the knee posteriorly therefore the posterior cruciate ligament tenses. Conversely in extension, the quadriceps try to pull it anteriorly so the anterior cruciate tenses up. Therefore most ACL injuries occur when the knee is going into extension, combined with rotation, causing the ligament to rupture. The PCL generally only ruptures when the tibia is forced posteriorly very strongly (eg in a car accident).

The “unhappy triad” – this relates to the functional relationship between the medial collateral ligament, medial meniscus and ACL. The knee has to twist internally when walking or running and when extra rotation is added, there is a lot of strain on the MCL. If it tears, generally the medial meniscus tears also. If both of these tear, the only structure supporting the knee in the extended rotated position is the ACL. If there is enough force, this too will tear. More often than not, if the ACL is torn, so will the others (if it is a rotational injury).

NERVE SUPPLY OF THE KNEE JOINT.

The articular nerves are branches of:

1. Obturator nerve
2. Femoral nerve
3. Tibial nerve
4. Common peroneal nerve

EXTRA NOTES ON THE LEGS AND FEET

This information helps to put some of what you have learned so far together and needs to be thought about when you are studying muscles and looking at treating patient injuries. It is in note format and is just designed to give you ideas and help you think about relationships between structures.

Joints and bones direct the movement of muscles. Joint, muscular and nerve flexibility are all factors in movement and may or may not occur together

Pelvic Tilt

On posterior tilt of the pelvis, the quadriceps are lengthened, the hamstrings are shortened and the gluteus max is shortened. It also results in slight external rotation of the hip in this position.

On anterior tilt of the pelvis, the quads are shortened and the hamstrings are lengthened. The psoas is also shortened. The femurs naturally tend to internally rotate with this pelvic position. The femurs are affected by pelvic tilt because of the way the acetabulum lines up with the head of the femur.
Muscles can be shortened and loose or lengthened and loose as well as shortened and contracted or lengthened and contracted. Pelvis position will give you some clues as to which muscles to target in your treatments.

For example, a patient may present with chronically tight hamstrings with decreased flexibility. On examination you may find that the pelvis is anteriorly tilted and by treating the psoas muscle, you actually decrease the tension on the hamstrings by allowing the pelvis to return to a more neutral position. This results in decreased 'tight' sensation in the hamstrings and leads to greater flexibility in this area.

Knee Positions

Genu valgum (knocked knees) and genu varum (bow legs).
Both of these are conditions at the tibiofemoral joint and are structural which can result from either congenital or environmental factors (eg. riding a horse).
Genu valgum – increased chance of medial ligament damage and pronation of the feet. There is increased compression on the lateral side and the person is more susceptible to the 'unhappy triad'. The medial hamstrings are lengthened and shortened laterally. The ITB is likely to be tight. There is more internal rotation of the femur and an increased anterior pelvic tilt.
Genu varum – generally the pelvis will be posteriorly tilted and the femurs externally rotated. There is increased compression on the medial side of the knee.

If the problem is structural then you cannot cure it however by releasing the correct hip rotators, the legs may actually straighten up to some extent.

Part of the ITB is also attached to the patella. When this is tight, it pulls on the patella, along with the 3 quads pulling laterally. The vastus medialis obliquus tries to balance this alone – it will be important in patella tracking problems to give patients VMO strengthening exercises to help combat this problem.

Anatomical Axis vs Mechanical Axis

Anatomical axis – orientation of the femur
Mechanical axis – line of knee to the hip.
The skeleton likes to be aligned – alignment create congruency and stability – head over sacrum; hips over knees; knees over ankles – creates compression and stability.
There is a discrepancy between anatomical and mechanical axes and they are different from male to female.

The male knee and hip are straighter with a smaller Q-angle (quadriceps angle) than the female knee and hip. If this angle increases (as in genu valgum) then there is a lot of lateral pull on the patella. In the crural region, the peroneals shorten as the foot naturally wants to evert with the knee in this position.

Foot Positions

Calcaneovalgus and calcaneovarus.

Calcaneovalgus is where the ankles are angled in – the calcaneus is angled medially when the foot is looked at from posteriorly. Generally this results in more pronation(eversion) and is generally found in people with Genu valgum.

Calcaneovarus is where the ankles are angled out – the calcaneus is angled laterally when the foot is looked at from posteriorly. Generally results in inversion and is generally found in people with Genu varum.

Calcaneovalgus results in shortened lateral crural muscles because the foot is already everted to some extent. If the muscles are shortened for some length of time they can become ineffective. The flexors of the foot will be on stretch.

In general, eversion will also result in some dorsiflexion and inversion will result in some plantar flexion. There can be similar complaints with both conditions because in the valgus state the flexors are stretched and overloaded and in varum the flexors are shortened in a constant tightened state.

THE POPLITEAL FOSSA

The popliteal fossa is the diamond shaped depression of the posterior knee. Its boundaries are formed by:

Superolaterally:	Biceps Femoris
Superomedially:	Semimembranosus
Inferolaterally:	Lateral, proximal head of gastrocnemius
Inferomedially:	Medial, proximal head of gastrocnemius
Roof:	Skin and fascia
Floor:	Popliteal surface of femur; oblique popliteal ligament; and popliteus fascia of popliteus

Contents of the Popliteal Fossa:

1. Small saphenous vein
2. Popliteal arteries and veins
3. Tibial and common fibular (peroneal) nerves
4. Posterior cutaneous nerves of thigh
5. Popliteal lymph nodes and lymphatic vessels

JOINTS OF THE UPPER EXTREMITY.

1. Sternoclavicular joint
2. Acromioclavicular joint
3. Glenohumeral joint
4. Elbow joint
5. Superior radio-ulnar joint
6. Middle radio-ulnar joint
7. Inferior radio-ulnar joint
8. Radiocarpal joint
9. Intercarpal joints
10. Carpometacarpal & intercarpal jts
11. Metacarpophalangeal joints
12. Interphalangeal joints.

1. STERNOCLAVICULAR (SC) JOINT.

A saddle type synovial joint, allowing slight movement in many directions.

Articular Surfaces

The medial epiphysis (end) of the clavicle articulates with the shallow socket formed by the manubrium and 1st costal cartilage. The articular surfaces are separated by a strong, thick, fibrocartilaginous articular disc.

Articular Capsule

Formed by the outer, tough fibrous capsule and the inner, fluid-lined synovial capsule. It surrounds the entire joint and is reinforced by 3 extra-articular, intrinsic ligaments (external to the joint but blended with the joint capsule):

Anterior sternoclavicular ligament: strengthens anteriorly.
Posterior sternoclavicular ligament: strengthens posteriorly.
Interclavicular ligament: strengthens superiorly. Runs between the 2 clavicles to the manubrium.

The costoclavicular ligament is extra-articular and extrinsic to the capsule. It runs between the 1st rib and its costal cartilage and the inferomedial aspect of the clavicle. It strengthens the joint laterally.

Stability

Bony structures are incongruent and there's not much supporting muscle, so this joint relies on its ligamentous support and its disc, which deepens the socket leading to increased stability. (Similar to the menisci of the knee). Because there are not many muscles surrounding the joint, once the ligaments are damaged, the joint becomes unstable. When the joint is damaged it can pop up and is often called a 'piano key' injury.

Blood and Nerve Supply

Articular branches of the internal thoracic and suprascapular arteries. Branches of the medial supraclavicular nerve and the nerve to subclavius.

2. ACROMIOCLAVICULAR (AC) JOINT.

A plane synovial joint, allowing slight rotary, anterior and posterior movements of the acromion on the clavicle.

Articular Surfaces

Acromion end of clavicle articulates with the acromion of scapula. The surfaces are covered with fibrocartilage, and separated by an incomplete wedge-shaped articular disc.

Articular Capsule

Contains a loose fibrous capsule lined internally by a synovial membrane. The intrinsic acromioclavicular ligament strengthens the AC joint superiorly. However the integrity of the joint is enhanced by the extrinsic coracoclavicular ligament that consists of the trapezoid and conoid ligaments.

Stability

No muscles connect the articulating bones to move the AC joint. Thus, this joint is never being muscularly stabilized, but is always being pulled apart by the thoracoappendicular muscles.

Blood and Nerve Supply

Supplied by the suprascapula and thoracoacromial arteries, and supraclavicular, lateral pectoral and axillary nerves.

3. GLENOHUMERAL JOINT.

A ball and socket, synovial joint allowing flexion, extension, abduction, adduction, circumduction, and medial and lateral rotation.

Articular Surfaces

Humeral head articulates with the shallow glenoid cavity of the scapula that is deepened slightly by the glenoid labrum, but still accepts only about a third of the humeral head. The long head of biceps tendon is continuous with the glenoid labrum. The socket is not particularly deep but it allows lots of mobility – stability gives way to mobility.

Articular Capsule

A fibrous capsule surrounds the glenohumeral joint and lined internally by a synovial membrane. Three glenohumeral ligaments wrap (radiating laterally) to reinforce mostly the anterior part of the articular capsule. The transverse humeral ligament runs obliquely over the bicipital groove from the lesser to greater tubercle of the humerus to secure the synovial sheath and tendon of the biceps brachii. The coracohumeral ligament is a strong fibrous band that passes from the coracoid process to the anterior aspect of the greater tubercle of the humerus.

The coracoacromial arch is an extrinsic, protective structure formed by the smooth inferior aspect of the acromion and the coracoid process of the scapula, with the coracoacromial ligament spanning between them. This can cause supraspinatus impingement during certain movements and other inflammation responses.

The rotator cuff muscles have associated bursae; the subscapularis bursa (located between the tendon of the subscapularis and the neck of the scapula, and the subacromial bursa (located between the deltoid, the supraspinatus tendon, and the fibrous capsule of the glenohumeral joint.

Stability

Because of its highly flexible nature, the glenohumeral joint is also very unstable. Most of the injuries attributed to the shoulder come from the rotator cuff and ligaments, which are the front line defenses for absorbing force. The tendons of the 4 rotator cuff muscles either fuse with or are very close to the glenohumeral fibrous capsule. When the supraspinatus is overused and results in tendonitis, it can impinge on the subacromial bursa resulting in bursitis. This leaves little space to move the arm resulting in impingement syndrome. This is where a patient has a ‘painful arc’. The person experiences pain between 60° and 120° of abduction. This can happen if the upper trapezius is not lifting the acromion sufficiently or if the humerus is not dropping prior to lifting the arm – the Latissimus dorsi should pull down slightly on the humerus to help create space under the coracoacromial arch.

Blood and Nerve Supply

Supplied by the anterior and posterior circumflex humeral arteries and branches of the suprascapular artery. Innervated by suprascapular, axillary and lateral pectoral nerves. If the humerus is fractured through the surgical neck, there is a danger of a loss of blood supply to the joint and arm.

4. ELBOW JOINT.

A hinge type synovial joint allows flexion and extension. It includes 3 articulations:

1. Humeroulnar articulation: articulation of the trochlea (humerus) and the trochlear notch (ulna).
2. Radiohumeral articulation: articulation of the capitulum (humerus) and the radial head.
3. Superior radio-ulnar articulation (discussed separately).

Articular Surfaces

The humeroulnar and radiohumeral joints possess an articular capsule lined internally with a synovial membrane. The lateral (radial) collateral ligament connects the lateral epicondyle of the humerus with the Annular ligament which encircles and holds the head of the radius in the radial notch of the ulna.

The medial (ulnar) collateral ligament extends from the medial epicondyle of the humerus to the coronoid process and olecranon of the ulna - it consists of three bands:

1. Anterior cordlike band: the strongest.
2. Posterior fanlike band: the weakest.
3. Oblique band: deepens the socket for the trochlea of the humerus.

Associated bursae include the subcutaneous bursa (located in the connective tissue over the olecranon; the subtendinous bursa (located between the olecranon and the triceps tendon); the radio-ulnar bursa (located between the extensor digitorum, radiohumeral joint and the supinator; and the bicipitoradial bursa or biceps bursa (located between the biceps tendon and the anterior part of the radial tuberosity). The joint has a bony end feel on extension and a soft end feel on flexion as the muscles of the arm stop the movement.

Stability

One of the most stable joints in the body. The humeroulnar and radioulnar articulations are most stable when the elbow is flexed at 90^0 at the forearm is mid-way between pronation and supination. What is the carrying angle? Why do females tend to have a larger carrying angle?

Blood and Nerve Supply

Anastomosing arteries around the elbow supply blood and innervation is supplied by the musculocutaneous, ulnar and radial nerves.

5. SUPERIOR (PROXIMAL) RADIO-ULNAR JOINT.

A pivot type synovial joint allowing pronation and supination of the forearm.

Articular Surfaces

The radial head articulates with the radial notch of the ulna and is positioned by the annular ligament. The annular ligament is lined with a synovial membrane which continues distally as a sacciform recess on the neck of the radius. This arrangement allows the radius to rotate or "twist" inside the annular ligament, next to the radial notch of the ulna, without tearing the synovial capsule. The radial head can pop out in children, dislocating out from the annular ligament. This is particularly true when children are lifted or pulled forcefully by their arms.

Blood and Nerve supply

Blood supplied by the anterior and posterior interosseous arteries, and innervation by musculocutaneous, ulnar and radial nerves.

6. MIDDLE RADIO-ULNAR JOINT.

The interosseous membrane connects the radius and ulna from 2-3cm distal to the radial tuberosity to the distal ends of the bones. The interosseous membrane is a strong, fibrous band that stabilises the forearm and provides muscle attachment sites for the deep forearm muscles.
The oblique cord is a strong, fibrous band that extends from the tuberosity of the ulna to the tuberosity of the radius. Its fibres run at right angles to the fibres of the interosseous membrane.

7. INFERIOR (DISTAL) RADIO-ULNAR JOINT.

A pivot type synovial joint allowing pronation and supination of the forearm.

Articular Surfaces

The rounded head of the ulna articulates with the ulnar notch on the medial side of the distal end of the radius. A fibrocartilaginous articular disc ("triangular ligament") binds the ends of the ulna and radius together to form its main uniting structure.

In the articular capsule the fibrous capsule encloses the distal radioulnar joint but is deficient superiorly. The synovial membrane extends superiorly between the radius and ulnar to form the sacciform recess. Anterior and posterior ligaments reinforce the joint.

Stability

A relatively stable joint, but like the proximal radioulnar joint, it can be dislocated or subluxed.

Blood and Nerve Supply

Blood and innervation supplied by the anterior and posterior interosseous arteries and nerves.

8. RADIOCARPAL JOINT (WRIST JOINT).

A condyloid synovial joint allowing flexion, extension, abduction (radial deviation), adduction (ulna deviation) and circumduction.

Articular Surfaces

Articulation of the distal end of the radius and the articular disc of the radioulnar joint with the proximal row of carpal bones, except the pisiform (from lateral to medial: scaphoid, lunate and triquetrum). The joint is encased in a fibrous capsule internally lined by a synovial membrane.

The structural integrity of the wrist joint is strengthened by the palmar radiocarpal ligaments (extend from the radius to the two rows of carpals); the dorsal radiocarpal ligaments (similar to palmar); ulnar collateral ligament (extends from the ulnar styloid process to the triquetrum); and the radial collateral ligament (extends from the radial styloid process to the scaphoid).

Stability of the joint

A lot of movement at the wrist is supplemented by intercarpal activity. When the carpals and radioulnar joints are aligned they are relatively stable. However, during abduction-adduction or extension-flexion, they become inherently unstable due to the complex interaction of the radioulnar-intercarpal motion.

Blood and Nerve Supply

Blood supplied by the dorsal and palmar carpal arches (from the radial and ulna arteries), and innervated by the median, ulnar and radial nerves.

9. INTERCARPAL JOINTS.

Plane synovial joints that allow gliding and sliding. The mid-carpal joint is between the proximal and distal rows. The carpal bones are connected by dorsal, palmar and interosseous ligaments.

Blood and Nerve Supply

Blood supplied from branches from the palmar arches of arteries (radial and ulnar arteries), and innervation is from the anterior and posterior interosseous nerves and the deep and dorsal branches of the ulnar nerve.

10. CARPOMETACARPAL AND INTERMETACARPAL JOINTS

Plane synovial joints that allow gliding and sliding movements. The articular bones are united by dorsal, palmar and interosseous ligaments.

The carpometacarpal joint of the thumb is a saddle synovial joint between the trapezium and the 1st metacarpal, allowing flexion, extension, abduction, adduction, circumduction and opposition.

Blood and Nerve Supply

Blood supplied from branches from the deep palmar arches (radial and ulnar arteries), and innervation is from the anterior and posterior interosseous nerves and the deep and dorsal branches of the ulnar nerve.

11. METACARPOPHALANGEAL JOINTS.

Condyloid synovial joints allowing flexion, extension, abduction, adduction and circumduction. The fibrous capsules are strengthened by collateral, palmar and deep transverse ligaments (hold the heads of the metacarpals together).

Blood and Nerve Supply

Blood supplied by the digital arteries (radial and ulnar arteries), and innervation from the digital nerves (median and ulnar nerves).

12. INTERPHALANGEAL JOINTS.

Hinge synovial joints allowing flexion and extension only. They are strengthened by the extensor expansions dorsally.

Blood and Nerve Supply

Blood supplied by the digital arteries (radial and ulnar arteries), and innervation by the digital nerves (median and ulnar nerves).

THE MUSCULAR SYSTEM

→ The muscular system consists of approximately 640 skeletal muscles.
→ Skeletal muscle produces movement for exercise, help with maintaining posture and stabilising joints so that exercises can be performed correctly
→ Muscular system also responsible for permitting the essential body functions (heart, breathing, digestion)
→ Approximately 40% of body mass is made up of muscle tissue
→ There are 3 different types of muscle: smooth muscle, cardiac muscles and skeletal muscle

Characteristics: all muscle tissue exhibits 4 main characteristics:

- Excitability : muscles are capable of receiving and responding to a stimulus by nerves and hormone
- Contractility : capacity of the muscle to contract or shorten forcefully
- Extensibility : muscles can be stretched to their resting length and beyond to a limited degree, without causing damage to the muscle
- Elasticity : once stretched, a muscle can return to its original resting size and shape, much like an elastic band

MUSCLE NUTRITION

Muscle is composed of:
Water 75%
Protein 20%
Minerals 5% (calcium) and Glycogen and Fat

Contraction of the muscle is caused by nerve impulses. These impulses bring about a chemical change in the muscle that causes it to contract. Food in the form of glycogen is essential to supply muscles with the energy they need to contract.

ATP cellular energy gets used during exercise of the muscles of the body. For ATP to be available the muscle cells must have a constant supply of oxygen and glycogen. After contraction muscle tissue produces wastes that must be removed. Carbon dioxide is delivered to the lungs and we breath it out, Water is used for the body or expelled as waste through he urine. This occurs in what is called aerobic respiration.

Muscle fatigue occurs when the body cannot supply enough oxygen and glycogen to muscle cells for the work they are doing. This is when the muscle converts to anaerobic respiration. The muscle cells can produce ATP without the presence of oxygen but it cannot maintain the work for long and other by-products are produced such as lactic and pyruvic acids that the body must then remove

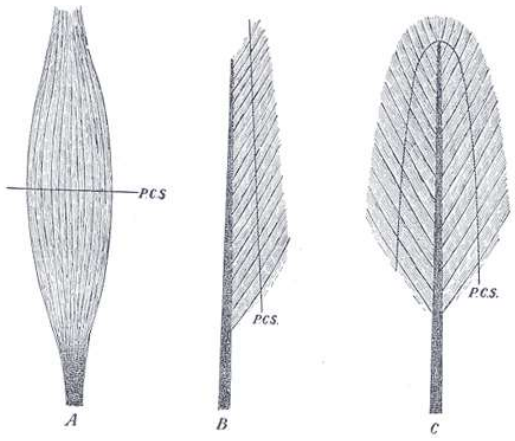
Types of muscle:

SMOOTH MUSCLE – also referred to as visceral muscles, an involuntary muscle, very elastic in nature and initiates sustained slow contractions that can be very powerful, only type of muscle that is NOT STRIATED
Eg. Walls of the arteries, muscles of the digestive system
Smooth muscle is involuntary, a person can not directly tell the muscle what to do. Smooth muscle tissue is commonly found in hollow organs such as the stomach, the bladder, and the respiratory passages. Smooth muscles tissue main function is to propel objects down a certain path. Smooth muscle tissue is spindle shaped. Smooth muscle tissue is arranged in sheets or layers.

CARDIAC MUSCLE – Cardiac muscle tissue is only found in the heart. The heart is entirely made up of cardiac muscle. Cardiac muscle tissue is responsible for pumping blood throughout the heart. Cardiac muscle tissue is protected by a connective tissue. This tissue is arranged in a figure eight formation. Cardiac muscle is straited and is involuntary.

SKELETAL MUSCLE- Skeletal muscle tissue is always connected to bones. Skeletal muscle tissue is long, and somewhat thin. Skeletal muscle tissue is the longest type of muscle tissue in the body. This tissue is the strongest and hardest working in the body. Skeletal muscle tissue is also known as straited muscle tissue, because of its straitions. Straitions are fibers of muscle tissue that cross over each fiber causing an appearance of crisscrossing thought the muscle. Skeletal muscle tissue is the only type of muscle tissues that is voluntary. These muscle cells are small and very fragile. Even though its cells are fragile skeletal muscle tissue is very strong due to a sheath that covers every skeletal muscle fiber.

The muscles vary extremely in their form. In the limbs, they are of considerable length, especially the more superficial ones; they surround the bones, and constitute an important protection to the various joints. In the trunk, they are broad, flattened, and expanded, and assist in forming the walls of the trunk cavities. Hence the reason of the terms, long, broad, short, etc., used in the description of a muscle.



There is considerable variation in the arrangement of the fibers of certain muscles with reference to the tendons to which they are attached. In some muscles the fibers are parallel and run directly from their origin to their insertion; these are the fusiform (A) muscles, in which the fibers are not quite parallel, but slightly curved, so that the muscle tapers at either end. Secondly, in other muscles the fibers are convergent; arising by a broad origin, they converge to a narrow or pointed insertion. This arrangement of fibers is found in the triangular muscles.

Thirdly, in some muscles the fibers are oblique and converge, like the plumes of a quill pen, to one side of a tendon which runs the entire length of the muscle; such muscles are termed unipennate (B). A modification of this condition is found where oblique fibers converge to both sides of a central tendon; these are called bipennate (C), and an example is afforded in the Rectus femoris. Finally, there are muscles in which the fibers are arranged in curved bundles in one or more planes, as in the Sphincters.

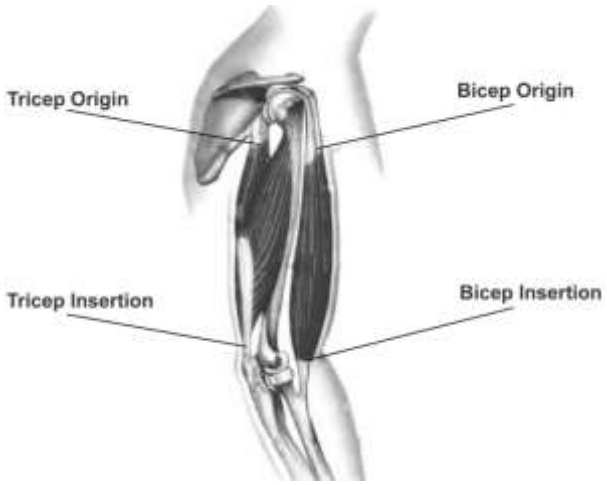
The arrangement of the fibers is of considerable importance in respect to the relative strength and range of movement of the muscle. Those muscles where the fibers are long and few in number have great range, but diminished strength; where, on the other hand, the fibers are short and more numerous, there is great power, but lessened range.

The names applied to the various muscles have been derived: (1) from their situation, as the Tibialis, Radialis, Ulnaris (2) from their direction, as the Rectus abdominis, Transversus abdominis; (3) from their uses, as Flexors, Extensors, Abductors, etc.; (4) from their shape, as the Deltoideus, Rhomboideus; (5) from the number of their divisions, as the Biceps and Triceps; (6) from their points of attachment, as the Sternocleidomastoideus.

In the description of a muscle, the term origin is meant to imply its more fixed or central attachment; and the term insertion the movable point on which the force of the muscle is applied.

To carry out a movement a definite combination of muscles is called into play, and the individual has no power either to leave out a muscle from this combination or to add one to it. One (or more) muscle of the combination is the chief moving force; when this muscle passes over more than one joint other muscles (synergic muscles) come into play to inhibit the movements not required; a third set of muscles (fixation muscles) fix the limb—i. e., in the case of the limb-movements—and also prevent disturbances of the equilibrium of the body generally.

Example:



Individual Muscles

The Muscles of the Neck.

The muscles of the neck may be arranged into the following groups:

Superficial Cervical
Lateral Cervical
Supra- and Infrahyoid
Anterior Vertebral
Lateral Vertebral

a. The Superficial Cervical Muscle

The Superficial Fascia of the neck is a thin lamina investing the Platysma

The Platysma is a broad sheet arising from the fascia covering the upper parts of the Pectoralis major and Deltoideus; its fibers cross the clavicle, and proceed obliquely upward and medialward along the side of the neck.

The Cervical Muscles

The lateral muscles are:
Trapezius and Sternocleidomastoideus

The investing portion of the fascia is attached behind to the ligamentum nuchæ and to the spinous process of the seventh cervical vertebra. It forms a thin investment to the Trapezius, and at the anterior border of this muscle is continued forward as a rather loose areolar layer, covering the posterior triangle of the neck, to the posterior border of the Sternocleidomastoideus, where it begins to assume the appearance of a fascial membrane.

Along the hinder edge of the Sternocleidomastoideus it divides to enclose the muscle, and at the anterior margin again forms a single lamella, which covers the anterior triangle of the neck, and reaches forward to the middle line, where it is continuous with the corresponding part from the opposite side of the neck. In the middle line of the neck it is attached to the symphysis menti and the body of the hyoid bone.

Above, the fascia is attached to the superior nuchal line of the occipital, to the mastoid process of the temporal, and to the whole length of the inferior border of the body of the mandible. Opposite the angle of the mandible the fascia is very strong, and binds the anterior edge of the Sternocleidomastoideus firmly to that bone. Between the mandible and the mastoid process it ensheathes the parotid gland—the layer which covers the gland extends upward under the name of the parotideomasseteric fascia and is fixed to the zygomatic arch. From the part which passes under the parotid gland a strong band extends upward to the styloid process, forming the stylomandibular ligament.

The Sternocleidomastoideus (Sternomastoid muscle) passes obliquely across the side of the neck. It is thick and narrow at its central part, but broader and thinner at either end. It arises from the sternum and clavicle by two heads. The medial or sternal head is a rounded fasciculus, tendinous in front, fleshy behind, which arises from the upper part of the anterior surface of the manubrium sterni, and is directed upward, lateralward, and backward. The lateral or clavicular head, composed of fleshy fibers, arises from the superior border and anterior surface of the medial third of the clavicle; it is directed almost vertically upward.

Nerves.—The Sternocleidomastoideus is supplied by the accessory nerve and branches from the anterior divisions of the second and third cervical nerves.

Actions.—When only one Sternocleidomastoideus acts, it draws the head toward the shoulder of the same side, assisted by the Splenius and the Obliquus capitis inferior of the opposite side. At the same time it rotates the head so as to carry the face toward the opposite side. Acting together from their sternoclavicular attachments the muscles will flex the cervical part of the vertebral column. If the head be fixed, the two muscles assist in elevating the thorax in forced inspiration.

The Muscles of the Trunk.

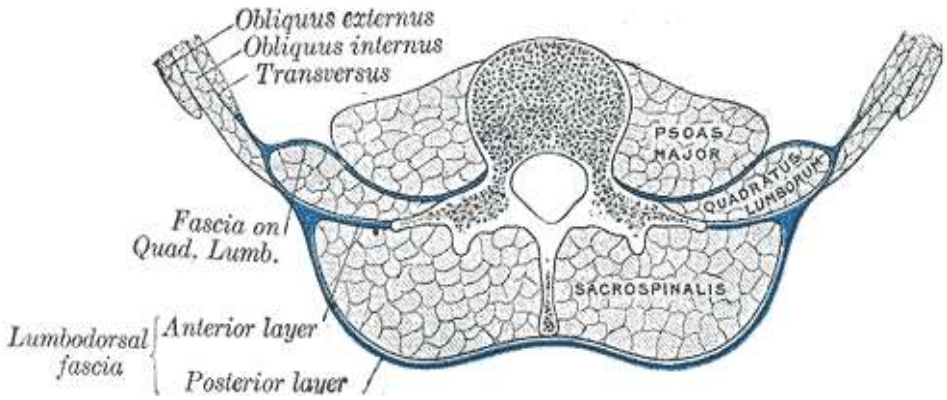
The muscles of the trunk may be arranged in six groups

Deep Muscles of the Back	Suboccipital Muscles	Muscles of the Thorax
Muscles of the Abdomen	Muscles of the Pelvis	Muscles of the Perineum

The Deep Muscles of the Back

The deep or intrinsic muscles of the back consist of a complex group of muscles extending from the pelvis to the skull. They are:

Splenius capitis
Splenius cervicis
Sacrospinalis.
Semispinalis.
Multifidus.
Rotatores
Interspinales
Intertransversarii



The Lumbodorsal Fascia —The lumbodorsal fascia is a deep investing membrane which covers the deep muscles of the back of the trunk. Above, it passes in front of the Serratus posterior superior and is continuous with a similar investing layer on the back of the neck—the nuchal fascia.

In the thoracic region the lumbodorsal fascia is a thin fibrous lamina which serves to bind down the Extensor muscles of the vertebral column and to separate them from the muscles connecting the vertebral column to the upper extremity. It contains both longitudinal and transverse fibers, and is attached, medially, to the spinous processes of the thoracic vertebræ; laterally to the angles of the ribs.

In the lumbar region the fascia (lumbar aponeurosis) is in two layers, anterior and posterior. The posterior layer is attached to the spinous processes of the lumbar and sacral vertebræ and to the

supraspinal ligament; the anterior layer is attached, medially, to the tips of the transverse processes of the lumbar vertebræ and to the intertransverse ligaments, below, to the iliolumbar ligament, and above, to the lumbocostal ligament.

The Splenius cervicis (Splenius colli) arises by a narrow tendinous band from the spinous processes of the third to the sixth thoracic vertebræ; it is inserted, by tendinous fasciculi, into the posterior tubercles of the transverse processes of the upper two or three cervical vertebræ.

Actions.—The Splenii of the two sides, acting together, draw the head directly backward, assisting the Trapezius and Semispinalis capitis; acting separately, they draw the head to one side, and slightly rotate it, turning the face to the same side. They also assist in supporting the head in the erect position.

The Sacrospinalis (Erector spinæ) lies in the groove on the side of the vertebral column. They are covered in the lumbar and thoracic regions by the lumbodorsal fascia, and in the cervical region by the nuchal fascia. This large muscular and tendinous mass varies in size and structure at different parts of the vertebral column.

The Longissimus dorsi is the intermediate and largest of the continuations of the Sacrospinalis. In the lumbar region, where it is as yet blended with the Iliocostalis lumborum, some of its fibers are attached to the whole length of the posterior surfaces of the transverse processes and the accessory processes of the lumbar vertebræ, and to the anterior layer of the lumbodorsal fascia. In the thoracic region it is inserted, by rounded tendons, into the tips of the transverse processes of all the thoracic vertebræ, and by fleshy processes into the lower nine or ten ribs between their tubercles and angles.

The Muscles of the Shoulder

In this group are included:

Deltoideus
Subscapularis
Supraspinatus
Infraspinatus
Teres minor
Teres major

The Deltoideus (Deltoid muscle) is a large, thick, triangular muscle, which covers the shoulder-joint in front, behind, and laterally. It arises from the anterior border and upper surface of the lateral third of the clavicle; from the lateral margin and upper surface of the acromion, and from the lower lip of the posterior border of the spine of the scapula, as far back as the triangular surface at its medial end. From this extensive origin the fibers converge toward their insertion, the middle passing vertically, the anterior obliquely backward and lateralward, the posterior obliquely forward and lateralward; they unite in a thick tendon, which is inserted into the deltoid prominence on the middle of the lateral side of the body of the humerus.

This muscle is remarkably coarse in texture, and the arrangement of its fibers is somewhat peculiar; the central portion of the muscle consists of oblique fibers; these arise in a bipenniform manner from the sides of the tendinous intersections, generally four in number, which are attached above to the acromion and pass downward parallel to one another in the substance of the muscle. The oblique fibers thus formed are inserted into similar tendinous intersections, generally three in

number, which pass upward from the insertion of the muscle and alternate with the descending septa.

Nerves.—The Deltoideus is supplied by the fifth and sixth cervical through the axillary nerve.

Actions.—The Deltoideus raises the arm from the side, so as to bring it at right angles with the trunk. Its anterior fibers, assisted by the Pectoralis major, draw the arm forward; and its posterior fibers, aided by the Teres major and Latissimus dorsi, draw it backward.

The Subscapularis is a large triangular muscle which fills the subscapular fossa, and arises from its medial two-thirds and from the lower two-thirds of the groove on the axillary border of the bone. Some fibers arise from tendinous laminæ which intersect the muscle and are attached to ridges on the bone; others from an aponeurosis, which separates the muscle from the Teres major and the long head of the Triceps brachii. The fibers pass lateralward, and, gradually converging, end in a tendon which is inserted into the lesser tubercle of the humerus and the front of the capsule of the shoulder-joint. The tendon of the muscle is separated from the neck of the scapula by a large bursa, which communicates with the cavity of the shoulder-joint through an aperture in the capsule.

Actions.—The Subscapularis rotates the head of the humerus inward; when the arm is raised, it draws the humerus forward and downward. It is a powerful defence to the front of the shoulder-joint, preventing displacement of the head of the humerus.

The Supraspinatus occupies the whole of the supraspinatous fossa, arising from its medial two-thirds, and from the strong supraspinatous fascia. The muscular fibers converge to a tendon, which crosses the upper part of the shoulder-joint, and is inserted into the highest of the three impressions on the greater tubercle of the humerus; the tendon is intimately adherent to the capsule of the shoulder-joint.

The Infraspinatus is a thick triangular muscle, which occupies the chief part of the infraspinatous fossa; it arises by fleshy fibers from its medial two-thirds, and by tendinous fibers from the ridges on its surface; it also arises from the infraspinatous fascia which covers it, and separates it from the Teretes major and minor. The fibers converge to a tendon, which glides over the lateral border of the spine of the scapula, and, passing across the posterior part of the capsule of the shoulder-joint, is inserted into the middle impression on the greater tubercle of the humerus. The tendon of this muscle is sometimes separated from the capsule of the shoulder-joint by a bursa, which may communicate with the joint cavity.

The Teres minor is a narrow, elongated muscle, which arises from the dorsal surface of the axillary border of the scapula for the upper two-thirds of its extent, and from two aponeurotic laminæ, one of which separates it from the Infraspinatus, the other from the Teres major. Its fibers run obliquely upward and lateralward; the upper ones end in a tendon which is inserted into the lowest of the three impressions on the greater tubercle of the humerus; the lowest fibers are inserted directly into the humerus immediately below this impression. The tendon of this muscle passes across, and is united with, the posterior part of the capsule of the shoulder-joint.

The Teres major is a thick but somewhat flattened muscle, which arises from the oval area on the dorsal surface of the inferior angle of the scapula, and from the fibrous septa interposed between the muscle and the Teres minor and Infraspinatus; the fibers are directed upward and lateralward, and end in a flat tendon, about 5 cm. long, which is inserted into the crest of the lesser tubercle of the humerus. The tendon, at its insertion, lies behind that of the Latissimus dorsi, from which it is separated by a bursa, the two tendons being, however, united along their lower borders for a short distance.

Actions.—The Supraspinatus assists the Deltoideus in raising the arm from the side of the trunk and fixes the head of the humerus in the glenoid cavity. The Infraspinatus and Teres minor rotate the head of the humerus outward; they also assist in carrying the arm backward. One of the most important uses of these three muscles is to protect the shoulder-joint, the Supraspinatus supporting it above, and the Infraspinatus and Teres minor behind. The Teres major assists the Latissimus dorsi in drawing the previously raised humerus downward and backward, and in rotating it inward; when the arm is fixed it may assist the Pectorales and the Latissimus dorsi in drawing the trunk forward.

The Muscles and Fascia of the Arm

The muscles of the arm are:

Coracobrachialis
Biceps brachii
Brachialis
Triceps brachii

The Coracobrachialis the smallest of the three muscles in this region, is situated at the upper and medial part of the arm. It arises from the apex of the coracoid process, in common with the short head of the Biceps brachii, and from the intermuscular septum between the two muscles; it is inserted by means of a flat tendon into an impression at the middle of the medial surface and border of the body of the humerus between the origins of the Triceps brachii and Brachialis. It is perforated by the musculocutaneous nerve.

The Biceps brachii (Biceps; Biceps flexor cubiti) is a long fusiform muscle, placed on the front of the arm, and arising by two heads, from which circumstance it has received its name.

The short head arises by a thick flattened tendon from the apex of the coracoid process, in common with the Coracobrachialis.
The long head arises from the supraglenoid tuberosity at the upper margin of the glenoid cavity, and is continuous with the glenoidal labrum. This tendon, enclosed in a special sheath of the synovial membrane of the shoulder-joint, arches over the head of the humerus; it emerges from the capsule through an opening close to the humeral attachment of the ligament, and descends in the intertubercular groove; it is retained in the groove by the transverse humeral ligament and by a fibrous prolongation from the tendon of the Pectoralis major.

The Brachialis (Brachialis anticus) covers the front of the elbow-joint and the lower half of the humerus. It arises from the lower half of the front of the humerus, commencing above at the insertion of the Deltoideus, which it embraces by two angular processes. Its origin extends below to within 2.5 cm. of the margin of the articular surface. It also arises from the intermuscular septa, but more extensively from the medial than the lateral; it is separated from the lateral below by the Brachioradialis and Extensor carpi radialis longus. Its fibers converge to a thick tendon, which is inserted into the tuberosity of the ulna and the rough depression on the anterior surface of the coronoid process.

Actions.—The Coracobrachialis draws the humerus forward and medialward, and at the same time assists in retaining the head of the bone in contact with the glenoid cavity. The Biceps brachii is a flexor of the elbow and, to a less extent, of the shoulder; it is also a powerful supinator, and serves to render tense the deep fascia of the forearm by means of the lacertus fibrosus given off from its tendon. The Brachialis is a flexor of the forearm, and forms an important defence to the elbow-joint. When the forearm is fixed, the Biceps brachii and Brachialis flex the arm upon the forearm, as in efforts of climbing.

The Triceps brachii (Triceps; Triceps extensor cubiti) is situated on the back of the arm, extending the entire length of the dorsal surface of the humerus. It is of large size, and arises by three heads (long, lateral, and medial), hence its name.

The long head arises by a flattened tendon from the infraglenoid tuberosity of the scapula, being blended at its upper part with the capsule of the shoulder-joint; the muscular fibers pass downward between the two other heads of the muscle, and join with them in the tendon of insertion.
The lateral head arises from the posterior surface of the body of the humerus, between the insertion of the Teres minor and the upper part of the groove for the radial nerve, and from the lateral border of the humerus and the lateral intermuscular septum; the fibers from this origin converge toward the tendon of insertion.
The medial head arises from the posterior surface of the body of the humerus, below the groove for the radial nerve; it is narrow and pointed above, and extends from the insertion of the Teres major: it also arises from the medial border of the humerus and from the back of the whole length of the medial intermuscular septum. Some of the fibers are directed downward to the olecranon, while others converge to the tendon of insertion.
The tendon of the Triceps brachii begins about the middle of the muscle: it consists of two aponeurotic laminæ, one of which is subcutaneous and covers the back of the lower half of the muscle; the other is more deeply seated in the substance of the muscle.
The long head of the Triceps brachii descends between the Teres minor and Teres major, dividing the triangular space between these two muscles and the humerus into two smaller spaces, one triangular, the other quadrangular. The triangular space contains the scapular circumflex vessels; it is bounded by the Teres minor above, the Teres major below, and the scapular head of the Triceps laterally. The quadrangular space transmits the posterior humeral circumflex vessels and the axillary nerve; it is bounded by the Teres minor and capsule of the shoulder-joint above, the Teres major below, the long head of the Triceps brachii medially, and the humerus laterally.

Actions.—The Triceps brachii is the great extensor muscle of the forearm, and is the direct antagonist of the Biceps brachii and Brachialis. When the arm is extended, the long head of the muscle may assist the Teres major and Latissimus dorsi in drawing the humerus backward and in adducting it to the thorax. The long head supports the under part of the shoulder-joint. The Subanconæus draws up the synovial membrane of the elbow-joint during extension of the forearm.

The Muscles of the Forearm

The antibrachial or forearm muscles may be divided into a volar and a dorsal group

The Volar Antibrachial Muscles—These muscles are divided for convenience of description into two groups, superficial and deep.

The Superficial Group

- Pronator teres
- Flexor carpi radialis
- Palmaris longus
- Flexor carpi ulnaris
- Flexor digitorum sublimis

The muscles of this group take origin from the medial epicondyle of the humerus by a common tendon; they receive additional fibers from the deep fascia of the forearm near the elbow, and from the septa which pass from this fascia between the individual muscles

The Pronator teres has two heads of origin—humeral and ulnar. The humeral head, the larger and more superficial, arises immediately above the medial epicondyle, and from the tendon common to the origin of the other muscles; also from the intermuscular septum between it and the Flexor carpi radialis and from the antibrachial fascia.

The ulnar head is a thin fasciculus, which arises from the medial side of the coronoid process of the ulna, and joins the preceding at an acute angle. The median nerve enters the forearm between the two heads of the muscle, and is separated from the ulnar artery by the ulnar head. The muscle passes obliquely across the forearm, and ends in a flat tendon, which is inserted into a rough impression at the middle of the lateral surface of the body of the radius.

The Flexor carpi radialis lies on the medial side of the preceding muscle. It arises from the medial epicondyle by the common tendon; from the fascia of the forearm; and from the intermuscular septa between it and the Pronator teres laterally, the Palmaris longus medially, and the Flexor digitorum sublimis beneath.

The Palmaris longus is a slender, fusiform muscle, lying on the medial side of the preceding. It arises from the medial epicondyle of the humerus by the common tendon, from the intermuscular septa between it and the adjacent muscles, and from the antibrachial fascia.
The Flexor carpi ulnaris lies along the ulnar side of the forearm. It arises by two heads, humeral and ulnar, connected by a tendinous arch, beneath which the ulnar nerve and posterior ulnar recurrent artery pass. The humeral head arises from the medial epicondyle of the humerus by the common tendon; the ulnar head arises from the medial margin of the olecranon and from the upper two-thirds of the dorsal border of the ulna by an aponeurosis, common to it and the Extensor carpi ulnaris and Flexor digitorum profundus; and from the intermuscular septum between it and the Flexor digitorum sublimis.

The Flexor digitorum sublimis is placed beneath the previous muscle; it is the largest of the muscles of the superficial group, and arises by three heads—humeral, ulnar, and radial. The humeral head arises from the medial epicondyle of the humerus by the common tendon, from the ulnar collateral ligament of the elbow-joint, and from the intermuscular septa between it and the preceding muscles. The ulnar head arises from the medial side of the coronoid process, above the ulnar origin of the Pronator teres. The radial head arises from the oblique line of the radius, extending from the Variations.—Absence of radial head, of little finger portion; accessory slips from ulnar tuberosity to the index and middle finger portions; from the inner head to the Flexor profundus; from the ulnar or annular ligament to the little finger.

The Deep Group
Flexor digitorum profundus
Flexor pollicis longus
Pronator quadratus

The Flexor digitorum profundus is situated on the ulnar side of the forearm, immediately beneath the superficial Flexors.

The Flexor pollicis longus is situated on the radial side of the forearm, lying in the same plane as the preceding.

The Pronator quadratus is a small, flat, quadrilateral muscle, extending across the front of the lower parts of the radius and ulna.

Actions.—These muscles act upon the forearm, the wrist, and hand. The Pronator teres rotates the radius upon the ulna, rendering the hand prone; when the radius is fixed, it assists in flexing the

forearm. The Flexor carpi radialis is a flexor and abductor of the wrist; it also assists in pronating the hand, and in bending the elbow.
The Flexor carpi ulnaris is a flexor and adductor of the wrist; it also assists in bending the elbow. The Palmaris longus is a flexor of the wrist-joint; it also assists in flexing the elbow. The Flexor digitorum sublimis flexes first the middle and then the proximal phalanges; it also assists in flexing the wrist and elbow. The Flexor digitorum profundus is one of the flexors of the phalanges. After the Flexor sublimis has bent the second phalanx, the Flexor profundus flexes the terminal one; but it cannot do so until after the contraction of the superficial muscle. It also assists in flexing the wrist. The Flexor pollicis longus is a flexor of the phalanges of the thumb; when the thumb is fixed, it assists in flexing the wrist. The Pronator quadratus rotates the radius upon the ulna, rendering the hand prone.

The Dorsal Antibrachial Muscles—These muscles are divided for convenience of description into two groups, superficial and deep

The Superficial Group
Brachioradialis. Extensor carpi radialis longus Extensor carpi radialis brevis
Extensor digitorum communis Extensor digiti quinti proprius Extensor carpi ulnaris Anconæus.

The Brachioradialis (Supinator longus) is the most superficial muscle on the radial side of the forearm

The Extensor carpi radialis longus (Extensor carpi radialis longior) is placed partly beneath the Brachioradialis.

The Extensor carpi radialis brevis (Extensor carpi radialis brevior) is shorter and thicker than the preceding muscle, beneath which it is placed.

The Extensor digitorum communis arises from the lateral epicondyle of the humerus, by the common tendon; from the intermuscular septa between it and the adjacent muscles, and from the antibrachial fascia. It divides below into four tendons, which pass, together with that of the Extensor indicis proprius, through a separate compartment of the dorsal carpal ligament, within a mucous sheath.

The Extensor digiti quinti proprius (Extensor minimi digiti) is a slender muscle placed on the medial side of the Extensor digitorum communis, with which it is generally connected. It arises from the common Extensor tendon by a thin tendinous slip, from the intermuscular septa between it and the adjacent muscles. Its tendon runs through a compartment of the dorsal carpal ligament behind the distal radio-ulnar joint, then divides into two as it crosses the hand, and finally joins the expansion of the Extensor digitorum communis tendon on the dorsum of the first phalanx of the little finger.

The Extensor carpi ulnaris lies on the ulnar side of the forearm.

The Anconæus is a small triangular muscle which is placed on the back of the elbow-joint, and appears to be a continuation of the Triceps brachii. It arises by a separate tendon from the back part of the lateral epicondyle of the humerus; its fibers diverge and are inserted into the side of the olecranon, and upper fourth of the dorsal surface of the body of the ulna.

The Deep Group
- Supinator
- Abductor pollicis longus
- Extensor pollicis brevis
- Extensor pollicis longus
- Extensor indicis proprius

The Supinator (Supinator brevis) is a broad muscle, curved around the upper third of the radius. It consists of two planes of fibers, between which the deep branch of the radial nerve lies.

The Abductor pollicis longus (Extensor oss. metacarpi pollicis) lies immediately below the Supinator and is sometimes united with it. It arises from the lateral part of the dorsal surface of the body of the ulna below the insertion of the Anconæus, from the interosseous membrane, and from the middle third of the dorsal surface of the body of the radius.

The Extensor pollicis brevis (Extensor primi internodii pollicis) lies on the medial side of, and is closely connected with, the Abductor pollicis longus. It arises from the dorsal surface of the body of the radius below that muscle, and from the interosseous membrane.

The Extensor pollicis longus (Extensor secundi internodii pollicis) is much larger than the preceding muscle, the origin of which it partly covers. It arises from the lateral part of the middle third of the dorsal surface of the body of the ulna below the origin of the Abductor pollicis longus, and from the interosseous membrane. It ends in a tendon, which passes through a separate compartment in the dorsal carpal ligament, lying in a narrow, oblique groove on the back of the lower end of the radius.

The Extensor indicis proprius (Extensor indicis) is a narrow, elongated muscle, placed medial to, and parallel with, the preceding. It arises, from the dorsal surface of the body of the ulna below the origin of the Extensor pollicis longus, and from the interosseous membrane.

Actions.—The muscles of the lateral and dorsal aspects of the forearm, which comprise all the Extensor muscles and the Supinator, act upon the forearm, wrist, and hand; they are the direct antagonists of the Pronator and Flexor muscles. The Anconæus assists the Triceps in extending the forearm. The Brachioradialis is a flexor of the elbow-joint, but only acts as such when the movement of flexion has been initiated by the Biceps brachii and Brachialis. The action of the Supinator is suggested by its name; it assists the Biceps in bringing the hand into the supine position. The Extensor carpi radialis longus extends the wrist and abducts the hand. It may also assist in bending the elbow-joint; at all events it serves to fix or steady this articulation. The Extensor carpi radialis brevis extends the wrist, and may also act slightly as an abductor of the hand. The Extensor carpi ulnaris extends the wrist, but when acting alone inclines the hand toward the ulnar side; by its continued action it extends the elbow-joint. The Extensor digitorum communis extends the phalanges, then the wrist, and finally the elbow. The Extensor indicis proprius extends the index finger, and by its continued action assists in extending the wrist.

The Anterior Muscles of the lower leg

Tibialis anterior Extensor hallucis longus Extensor digitorum longus Peronæus tertius

The Tibialis anterior (Tibialis anticus) is situated on the lateral side of the tibia; it is thick and fleshy above, tendinous below. It arises from the lateral condyle and upper half or two-thirds of the lateral surface of the body of the tibia; from the adjoining part of the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septum between it and the Extensor digitorum longus.

The Extensor hallucis longus (Extensor proprius hallucis) is a thin muscle, situated between the Tibialis anterior and the Extensor digitorum longus. It arises from the anterior surface of the fibula for about the middle two-fourths of its extent, medial to the origin of the Extensor digitorum longus; it also arises from the interosseous membrane to a similar extent.

The Extensor digitorum longus is a penniform muscle, situated at the lateral part of the front of the leg. It arises from the lateral condyle of the tibia; from the upper three-fourths of the anterior surface of the body of the fibula; from the upper part of the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septa between it and the Tibialis anterior on the medial, and the Peronæi on the lateral side.

The Peronæus tertius is a part of the Extensor digitorum longus, and might be described as its fifth tendon. The fibers belonging to this tendon arise from the lower third or more of the anterior surface of the fibula; from the lower part of the interosseous membrane; and from an intermuscular septum between it and the Peronæus brevis.

Actions.—The Tibialis anterior and Peronæus tertius are the direct flexors of the foot at the ankle-joint; the former muscle, when acting in conjunction with the Tibialis posterior, raises the medial border of the foot, i. e., inverts the foot; and the latter, acting with the Peronæi brevis and longus, raises the lateral border of the foot, i. e., everts the foot. The Extensor digitorum longus and Extensor hallucis longus extend the phalanges of the toes, and, continuing their action, flex the foot upon the leg. Taking their fixed points from below, in the erect posture, all these muscles serve to fix the bones of the leg in the perpendicular position, and give increased strength to the ankle-joint.

The Posterior Muscles of the lower leg

The muscles of the back of the leg are subdivided into two groups—superficial and deep. Those of the superficial group constitute a powerful muscular mass, forming the calf of the leg. Their large size is one of the most characteristic features of the muscular apparatus in man, and bears a direct relation to his erect attitude and his mode of progression.

The Superficial Group

Gastrocnemius Soleus
Plantaris

The Gastrocnemius is the most superficial muscle, and forms the greater part of the calf. It arises by two heads, which are connected to the condyles of the femur by strong, flat tendons. The medial and larger head takes its origin from a depression at the upper and back part of the medial condyle and from the adjacent part of the femur. The lateral head arises from an impression on the side of the lateral condyle and from the posterior surface of the femur immediately above the lateral part of the condyle. Both heads, also, arise from the subjacent part of the capsule of the knee. Each tendon spreads out into an aponeurosis, which covers the posterior surface of that portion of the muscle to which it belongs.

The Soleus is a broad flat muscle situated immediately in front of the Gastrocnemius. It arises by tendinous fibers from the back of the head of the fibula, and from the upper third of the posterior surface of the body of the bone; from the popliteal line, and the middle third of the medial border of the tibia; some fibers also arise from a tendinous arch placed between the tibial and fibular origins of the muscle, in front of which the popliteal vessels and tibial nerve run.

Tendo Calcaneus (tendo Achillis).—The tendo calcaneus, the common tendon of the Gastrocnemius and Soleus, is the thickest and strongest in the body. It is about 15 cm. long, and begins near the middle of the leg, but receives fleshy fibers on its anterior surface, almost to its lower end. Gradually becoming contracted below, it is inserted into the middle part of the posterior surface of the calcaneus, a bursa being interposed between the tendon and the upper part of this surface.

The Plantaris is placed between the Gastrocnemius and Soleus. It arises from the lower part of the lateral prolongation of the linea aspera, and from the oblique popliteal ligament of the knee-joint.

Actions.—The muscles of the calf are the chief extensors of the foot at the ankle-joint. They possess considerable power, and are constantly called into use in standing, walking, dancing, and leaping; hence the large size they usually present. In walking, these muscles raise the heel from the ground; the body being thus supported on the raised foot, the opposite limb can be carried forward. In standing, the Soleus, taking its fixed point from below, steadies the leg upon the foot and prevents the body from falling forward. The Gastrocnemius, acting from below, serves to flex the femur upon the tibia, assisted by the Popliteus. The Plantaris is the rudiment of a large muscle which in some of the lower animals is continued over the calcaneus to be inserted into the plantar aponeurosis. In man it is an accessory to the Gastrocnemius, extending the ankle if the foot be free, or bending the knee if the foot be fixed.

The Deep Group

Popliteus.
Flexor digitorum longus
Flexor hallucis longus
Tibialis posterior

The Popliteus is a thin, flat, triangular muscle, which forms the lower part of the floor of the popliteal fossa.

The Flexor hallucis longus is situated on the fibular side of the leg. It arises from the inferior two-thirds of the posterior surface of the body of the fibula, with the exception of 2.5 cm. at its lowest part; from the lower part of the interosseous membrane; from an intermuscular septum between it and the Peronæi, laterally, and from the fascia covering the Tibialis posterior, medially.

The Flexor digitorum longus is situated on the tibial side of the leg. At its origin it is thin and pointed, but it gradually increases in size as it descends.

The Tibialis posterior (Tibialis posticus) lies between the two preceding muscles, and is the most deeply seated of the muscles on the back of the leg. It begins above by two pointed processes, separated by an angular interval through which the anterior tibial vessels pass forward to the front of the leg

Actions.—The Popliteus assists in flexing the leg upon the thigh; when the leg is flexed, it will rotate the tibia inward. It is especially called into action at the beginning of the act of bending the knee, inasmuch as it produces the slight inward rotation of the tibia which is essential in the early stage of this movement. The Tibialis posterior is a direct extensor of the foot at the ankle-joint; acting in conjunction with the Tibialis anterior, it turns the sole of the foot upward and medialward, i.e., inverts the foot, antagonizing the Peronæi, which turn it upward and lateralward (evert it). In the sole of the foot the tendon of the Tibialis posterior lies directly below the plantar calcaneonavicular ligament, and is therefore an important factor in maintaining the arch of the foot.

The Flexor digitorum longus and Flexor hallucis longus are the direct flexors of the phalanges, and, continuing their action, extend the foot upon the leg; they assist the Gastrocnemius and Soleus in extending the foot, as in the act of walking, or in standing on tiptoe.

In consequence of the oblique direction of its tendons the Flexor digitorum longus would draw the toes medialward, were it not for the Quadratus plantæ, which is inserted into the lateral side of the tendon, and draws it to the middle line of the foot. Taking their fixed point from the foot, these muscles serve to maintain the upright posture by steadying the tibia and fibula perpendicularly upon the talus

The Anterior Femoral Muscles

Sartorius
Quadriceps femoris
Rectus femoris
Vastus lateralis
Vastus medialis
Vastus intermedius
Articularis genu

The Sartorius, the longest muscle in the body, is narrow and ribbon-like; it arises by tendinous fibers from the anterior superior iliac spine and the upper half of the notch below it. It passes obliquely across the upper and anterior part of the thigh, from the lateral to the medial side of the limb, then descends vertically, as far as the medial side of the knee, passing behind the medial condyle of the femur to end in a tendon.

The Quadriceps femoris (Quadriceps extensor) includes the four remaining muscles on the front of the thigh. It is the great extensor muscle of the leg, forming a large fleshy mass which covers the front and sides of the femur. It is subdivided into separate portions, which have received distinctive names. One occupying the middle of the thigh, and connected above with the ilium, is called from its straight course the Rectus femoris. The other three lie in immediate connection with the body of the femur, which they cover from the trochanters to the condyles. The portion on the lateral side of the femur is termed the Vastus lateralis; that covering the medial side, the Vastus medialis; and that in front, the Vastus intermedius.

The Rectus femoris is situated in the middle of the front of the thigh; it is fusiform in shape, and its superficial fibers are arranged in a bipenniform manner, the deep fibers running straight down to the deep aponeurosis. It arises by two tendons: one, the anterior or straight, from the anterior inferior iliac spine; the other, the posterior or reflected, from a groove above the brim of the acetabulum.

The Vastus lateralis (Vastus externus) is the largest part of the Quadriceps femoris. It arises by a broad aponeurosis, which is attached to the upper part of the intertrochanteric line, to the anterior and inferior borders of the greater trochanter, to the lateral lip of the gluteal tuberosity, and to the upper half of the lateral lip of the linea aspera; this aponeurosis covers the upper three-fourths of the muscle, and from its deep surface many fibers take origin.

The Vastus medialis (Vastus internus) arises from the lower half of the intertrochanteric line, the medial lip of the linea aspera, the upper part of the medial supracondylar line, the tendons of the Adductor longus and the Adductor magnus and the medial intermuscular septum.

The Vastus intermedius (Crureus) arises from the front and lateral surfaces of the body of the femur in its upper two-thirds and from the lower part of the lateral intermuscular septum.

The tendons of the different portions of the Quadriceps unite at the lower part of the thigh, so as to form a single strong tendon, which is inserted into the base of the patella, some few fibers passing over it to blend with the ligamentum patellæ.

Actions.—The Sartorius flexes the leg upon the thigh, and, continuing to act, flexes the thigh upon the pelvis; it next abducts and rotates the thigh outward. When the knee is bent, the Sartorius assists the Semitendinosus, Semimembranosus, and Popliteus in rotating the tibia inward. Taking its fixed point from the leg, it flexes the pelvis upon the thigh, and, if one muscle acts, assists in rotating the pelvis. The Quadriceps femoris extends the leg upon the thigh. The Rectus femoris assists the Psoas major and Iliacus in supporting the pelvis and trunk upon the femur. It also assists in flexing the thigh on the pelvis, or if the thigh be fixed it will flex the pelvis. The Vastus medialis draws the patella medialward as well as upward.

The Medial Femoral Muscles

Gracilis
Adductor longus
Adductor magnus
Pectineus.
Adductor brevis

The Gracilis is the most superficial muscle on the medial side of the thigh. It is thin and flattened, broad above, narrow and tapering below.

The Pectineus is a flat, quadrangular muscle, situated at the anterior part of the upper and medial aspect of the thigh

The Adductor longus the most superficial of the three Adductores, is a triangular muscle, lying in the same plane as the Pectineus.

The Adductor brevis is situated immediately behind the two preceding muscles. It is somewhat triangular in form, and arises by a narrow origin from the outer surfaces of the superior and inferior rami of the pubis, between the Gracilis and Obturator externus.

The Adductor magnus is a large triangular muscle, situated on the medial side of the thigh. It arises from a small part of the inferior ramus of the pubis, from the inferior ramus of the ischium, and from the outer margin of the inferior part of the tuberosity of the ischium.

Actions.—The Pectineus and three Adductores adduct the thigh powerfully; they are especially used in horse exercise, the sides of the saddle being grasped between the knees by the contraction of these muscles.
In consequence of the obliquity of their insertions into the linea aspera, they rotate the thigh outward, assisting the external Rotators, and when the limb has been abducted, they draw it medialward, carrying the thigh across that of the opposite side. The Pectineus and Adductores brevis and longus assist the Psoas major and Iliacus in flexing the thigh upon the pelvis. In progression, all these muscles assist in drawing forward the lower limb. The Gracilis assists the Sartorius in flexing the leg and rotating it inward; it is also an adductor of the thigh. If the lower extremities be fixed, these muscles, taking their fixed points below, may act upon the pelvis, serving to maintain the body in an erect posture; or, if their action be continued, flex the pelvis forward upon the femur.

The Muscles of the Gluteal Region

Glutæus maximus
Glutæus medius
Glutæus minimus
Tensor fasciæ latæ
Piriformis
Obturator internus
Gemellus superior
Gemellus inferior
Quadratus femoris
Obturator externus

The Glutæus maximus, the most superficial muscle in the gluteal region, is a broad and thick fleshy mass of a quadrilateral shape, and forms the prominence of the nates. Its large size is one of the most characteristic features of the muscular system in man, connected as it is with the power he has of maintaining the trunk in the erect posture.

The Glutæus medius is a broad, thick, radiating muscle, situated on the outer surface of the pelvis. Its posterior third is covered by the Glutæus maximus, its anterior two-thirds by the gluteal aponeurosis, which

The Glutæus minimus, the smallest of the three Glutæi, is placed immediately beneath the preceding. It is fan-shaped, arising from the outer surface of the ilium, between the anterior and inferior gluteal lines, and behind, from the margin of the greater sciatic notch.

The Tensor fasciæ latæ (Tensor fasciæ femoris) arises from the anterior part of the outer lip of the iliac crest; from the outer surface of the anterior superior iliac spine, and part of the outer border of the notch below it, between the Glutæus medius and Sartorius; and from the deep surface of the fascia lata.

The Piriformis is a flat muscle, pyramidal in shape, lying almost parallel with the posterior margin of the Glutæus medius. It is situated partly within the pelvis against its posterior wall, and partly at the back of the hip-joint.

The Obturator internus is situated partly within the lesser pelvis, and partly at the back of the hip-joint.

The Gemelli are two small muscular fasciculi, accessories to the tendon of the Obturator internus which is received into a groove between them.

The Gemellus superior, the smaller of the two, arises from the outer surface of the spine of the ischium, blends with the upper part of the tendon of the Obturator internus, and is inserted with it into the medial surface of the greater trochanter. It is sometimes wanting.

The Gemellus inferior arises from the upper part of the tuberosity of the ischium, immediately below the groove for the Obturator internus tendon.

The Quadratus femoris is a flat, quadrilateral muscle, between the Gemellus inferior and the upper margin of the Adductor magnus; it is separated from the latter by the terminal branches of the medial femoral circumflex vessels.

The Obturator externus is a flat, triangular muscle, which covers the outer surface of the anterior wall of the pelvis.

Actions.—When the Glutæus maximus takes its fixed point from the pelvis, it extends the femur and brings the bent thigh into a line with the body. Taking its fixed point from below, it acts upon the pelvis, supporting it and the trunk upon the head of the femur; this is especially obvious in standing on one leg. Its most powerful action is to cause the body to regain the erect position after stooping, by drawing the pelvis backward, being assisted in this action by the Biceps femoris, Semitendinosus, and Semimembranosus.
The Glutæus maximus is a tensor of the fascia lata, and by its connection with the iliotibial band steadies the femur on the articular surfaces of the tibia during standing, when the Extensor muscles are relaxed. The lower part of the muscle also acts as an adductor and external rotator of the limb.
The Glutæi medius and minimus abduct the thigh, when the limb is extended, and are principally called into action in supporting the body on one limb, in conjunction with the Tensor fasciæ latæ. Their anterior fibers, by drawing the greater trochanter forward, rotate the thigh inward, in which action they are also assisted by the Tensor fasciæ latæ.

The Tensor fasciæ latæ is a tensor of the fascia lata; continuing its action, the oblique direction of its fibers enables it to abduct the thigh and to rotate it inward. In the erect posture, acting from below, it will serve to steady the pelvis upon the head of the femur; and by means of the iliotibial band it steadies the condyles of the femur on the articular surfaces of the tibia, and assists the Glutæus maximus in supporting the knee in the extended position. The remaining muscles are powerful external rotators of the thigh. In the sitting posture, when the thigh is flexed upon the pelvis, their action as rotators ceases, and they become abductors, with the exception of the Obturator externus, which still rotates the femur outward.

The Posterior Femoral Muscles (Hamstring Muscles)

Biceps femoris
Semitendinosus
Semimembranosus

The Biceps femoris (Biceps) is situated on the posterior and lateral aspect of the thigh. It has two heads of origin; one, the long head, arises from the lower and inner impression on the back part of the tuberosity of the ischium, by a tendon common to it and the Semitendinosus, and from the lower part of the sacrotuberous ligament; the other, the short head, arises from the lateral lip of the linea aspera, between the Adductor magnus and Vastus lateralis, extending up almost as high as the insertion of the Glutæus maximus.

The Semitendinosus, remarkable for the great length of its tendon of insertion, is situated at the posterior and medial aspect of the thigh.

The Semimembranosus, so called from its membranous tendon of origin, is situated at the back and medial side of the thigh.

Actions.—The hamstring muscles flex the leg upon the thigh. When the knee is semiflexed, the Biceps femoris in consequence of its oblique direction rotates the leg slightly outward; and the Semitendinosus, and to a slight extent the Semimembranosus, rotate the leg inward, assisting the Popliteus. Taking their fixed point from below, these muscles serve to support the pelvis upon the head of the femur, and to draw the trunk directly backward, as in raising it from the stooping position or in feats of strength, when the body is thrown backward in the form of an arch. As already indicated, complete flexion of the hip cannot be effected unless the knee-joint is also flexed, on account of the shortness of the hamstring muscles.

Muscles in Summary- Origin & Insertion

Neck	Origin	Insertion	Action	Notes
Sternocleidomastoid	Manubrium of sternum, medial 1/3 of clavicle	Mastoid processes of temporal bone	Unilaterally- Lateral flexion to same side and rotation to opposite side Bilaterally- flexion of head and neck	Laying prone - Turn head to side and have client lift head toward ceiling; SCM's will pop out
Platysma	Fascia covering superior part of pectoralis major and deltoid	Edge of mandible, skin of lower part of face	Assists in depressing mandible and tightens the fascia of neck depresses lower lip.	
Scalenes-anterior , medius, posterior	Anterior- transverse processes C3-C6 Middle- transverse processes of C2-C7 Posterior- Transverse processes of C5-C7	Anterior- first rib Middle- first rib Posterior- second rib	Bilaterally – elevate ribs during inhalation Unilaterally- with rib fixed, laterally flexes the neck, rotates head and neck to opposite side Anterior- flexes the neck	Brachial plexus and subclavian artery pass between the middle and anterior scalene.
Longissumus Capitis	C3-C6 transverse processses	Base of occipital bone	Flexion of head	
Splenius capitis	Spinous processes of C7-T3	Mastoid process of temporal bone and superior nuchal line of occiput	Bilaterally- extends neck and head Unilaterally- rotates the head to the same side	Palpate between trapezius and SCM above levator scapula. Wrap around deeper neck muscles.
Splenius cervicis	Spinous processes of T3-T6	Transverse processes of C1-C4	Bilaterally-extends neck	

			Unilaterally- Rotates head to same side	
Suprahyoids	Styloid process, underside of mandible	Hyoid bone	Elevate hyoid and tongue, depress mandible	Important in chewing, swallowing and speaking.
Infrahyoids	Manubrium, superior border of scapula	Hyoid bone, thyroid cartilage	Depresses (pulls downward) hyoid bone and thyroid cartilage	
Head				
Sub occipital muscles				
Occipitofrontalis	Galea aponeurotica (broad sheath of connective tissue that stretches across the cranium) Skin over eyebrows Superior nuchal line of occiput	Galea aponeurotica Skin over eyebrows Superior nuchal l ine of occiput	Raises eyebrows and wrinkles forehead Anchors and retracts the galea posteriorly	Creates expression of "Surprise"
Temporalis	Lateral surface of the temporal bone (temporal fossa and temporal fascia)	Mandible (coronoid process and ramus)	Elevates and retracts mandible; Clenches teeth	Active in TMJ problems, tooth grinding and headaches
Masseter	Zygomatic arch	Ramus and angle of mandible	Elevates mandible in chewing, Closes jaw and assists in protraction. Clenches teeth.	Strongest muscle in proportion to its size.
Buccinator	Maxilla, mandible	Lips	Maintains cheeks near teeth and food in position for chewing	
Pterygoids –lateral	Upper head: from	Front of neck of mandibular	Protrudes mandible, pulls articular disc	Active in TMJ, tooth grinding

	infratemporal surfce of greater wing of sphenoid Lower head: from lateral surface of lateral ptergoid plate	condyle and capsule of mandibular joint	forward, assists in rotary motion while chewing.	and headaches
Pterygoids- medial	Medial surface of lateral pterygoid plate and pyramidal process of palatine bone, small slip from tuberosity of maxilla	Lower and back part of medial surface of ramus and angle of mandible	Protracts and elevates lower jaw, assists in rotary motion while chewing.	Active in TMJ, tooth grinding and headaches.
Orbicularis oculi	Medial portions of orbit	Skin of eyelids	Closes the eye	
Orbicularis oris	Maxilla, mandible, lips, buccinatior	Mucous membranes, muscles inserting into lips	Closes lips	
Chest and trunk				
Muscle	Origin	Insertion	Action	Notes
Intercostals	Inferior border of the rib above	Superior border of the rib below	External Intercostals: draw the ventral part of the ribs upward, increasing thoracic cavity space Internal Intercostals: draw the ventral part of the ribs downward, decreasing the space of the thoracic cavity	Stabilize the rib cage and assist in respiration. Meat of spare ribs.
Pectoralis major	Sternal ½ of clavicle, sternum to 7th rib, aponeurosis of external oblique muscle.	Crest of greater tubercle of humerus: Lateral lip of bicipital grove.	Clavicular (upper) fibers- flexion of humerus Sternocostal (middle and lower) fibers- extension of humerus returning from flexion Adduction, medial	Forms the anterior wall of axilla. Upper and lower fibers are work in opposite actions making

			rotation	it an antagonist to itself. Triggerpoints may cause pain, swelling and congestion of lymphatic fluids in breast tissue.
Pectoralis minor	Third, fourth and fifth ribs	Coracoid process of scapula	Tilts scapula forward, depresses and abducts scapula,	Pulls shoulder forward when rhomboids are weak
Diaphragm	Sternal: inner part of ziphoid process Coastal- inner surface of lower 6 ribs Lumbar- upper 2-3 lumbar vertebrae	Central tendon	Draws central tendon down during inspiration, increases volume of thoracic cavity (increases diameters)	Forms floor of thoracic cavity.
Rectus abdominis	Crest of the pubis, pubic symphysis	Cartilage of the 5th, 6th and 7th ribs and ziphoid process	Flexes the vertebral column	Sometimes origin and insertion are reversed
External obliques	Lower eight ribs (5-12)	Anterior part of iliac crest, abdominal aponeurosis to linea alba	Bilaterally- flexes thorax and compresses abdominal contents Unilaterally- laterally flexes spine and rotates spine to opposite side	Interdigitates with serratus anterior. Place hands on hips as if you were reaching into pants pockets to follow directions of fibers (obliquely downward and medialward)
Internal obliques	Lateral inguinal ligament, anterior iliac crest, thoracolumbar aponeurosis	Cartilage of lower 3-5 ribs (7-12), abdominal aponeurosis to linea alba	Bilaterally- flexes the thorax, compresses abdominal contents Unilaterally- laterally flexes spine and rotates trunk to same side	Place hands over abdomen with fingertips on the anterior-superior iliac spine, your fingertips will

				follow the direction of the fibers (obliquely upward and medialward)
Transverse abdominis	Lateral inguinal ligament, anterior iliac crest, thoracolumbar fascia, cartilage of lower 6 ribs (7-12)	Abdominal aponeurosis to linea alba	Compresses abdominal contents	Deepest layer of abdominals: runs horizontally medialward
Quadratus lumborum	Posterior iliac crest, iliolumbar ligament	Last rib, transverse processes of L1-L4	Bilaterally- extends the spine Unilaterally- lateral flexion of lumbar spine With spine fixed- elevates hip (hikes hip up). Holds 12th rib against the pull of the diaphragm Accessory breathing muscle. Spinal stabilizer	Composed of three groups of fibers: Iliocostal fibers run from medial upper crest of ilium and iliolumbar ligament upward to 12th rib (vertical) Iliolumbar fibers run from the ilium to the transverse processes of L1-L4 Lumbocostal fibers fun from the 12th rib to transverse processes of lumbar vertebrae
Shoulder and arm				
Muscle	Origin	Insertion	Action	Notes
Deltoid	Lateral one-third of clavicle, acromion and spine of scapula	Deltoid tuberosity of humerus	Abduct the shoulder joint Posterior fibers extend and laterally rotate shoulder. Anterior fibers flex and	Origin is identical to the insertion of the trapezius.

			medially rotate the shoulder.	
Supraspinatus "Rotator cuff"	Supraspinatus fossa of scapula	Greater tubercle of humerus – superior facet	Abducts the humerus; stabilizes head of humerus in glenoid cavity. Medially rotates humerus, draws it forward and down when arm is raised.	Deep to trapezius-runs underneath the acromion.(only rotator cuff muscle that doesn't rotate)
Infraspinatus "Rotator cuff"	Infraspinous fossa of scapula	Greater tubercle of humerus – middle facet	Laterally rotate, adducts, extends the shoulder. Stabilizes head of humerus in glenoid cavity	Attaches just posterior to the supraspinatus on the greater tubercle. Works with teres minor.
Teres Minor " Rotator cuff"	Superior half of lateral border of scapula	Greater tubercle of humerus, lowest facet	Laterally rotates, adducts, extends the shoulder, stabilizes head of humerus in glenoid cavity	
Subscapularis "Rotator Cuff"	Subscapular fossa of the scapula	Lesser tubercle of the humerus	Medially rotates shoulder joint, stabilizes head of humerus in glenoid cavity.	Most often the culprit in "frozen shoulder"
Teres Major	Inferior angle of scapula	Medial lip of bicipital grove of humerus	Adducts and medially rotates humerus and draws it back.	
Serratus Anterior	Outer surface of ribs 1-8	Anterior medial border of scapula	Abducts and upwardly rotates scapula, holds scapula against thoracic wall	Lower fibers interdigitate with the external obliques. Weakness causes winged scapula. Tightness may cause "a stitch in the side"
Coracobracialis	Corocoid process of scapula	Middle of medial shaft of humerus	Flexes and adducts the humerus	
Biceps Brachii	Short head-Coracoid	Tuberosity of the radius and	Flexes elbow, supinates forearm,	

	process of scapula Long head- Supraglenoid tubercle of scapula	aponeurosis of biceps brachii	flexes shoulder joint	
Triceps Brachii	Long head- Infraglenoid tubercle of scapula Lateral head- Posterior surface of proximal half of humerus Medial head- Posterior surface of distal half of humerus	All heads- olecranon process of ulna	Long head- Extends and adducts the shoulder All heads- Extend the forearm (elbow)	
Subclavius	First rib and cartilage	Inferior, lateral aspect of clavicle	Elevates first rib, stabilizes sternoclavicular joint, draws clavicle down	Underneath the clavicle.
Brachialis	Distal half of the anterior surface of humerus	Tuberosity and coronoid process of ulna	Flexes the elbow	
Bracioradialis	Lateral supracondylar ridge of humerus	Styloid process of radius	Flexes forearm (handshake position)	
Pronator teres	Medial epicondyle of humerus, coronoid process of ulna	Middle of lateral surface of radius	Pronates the forearm Assists in flexion of the elbow	Resisted pronation
Forearm and hand				
Extensor digitorum	Common extensor tendon from lateral epicondyle of humerus	Dorsal surface of middle and distal phalanges 2-5 (four fingers)	Extends four fingers, assists in extension of the wrist	
Pronator quadratus				

Palmaris longus	Medial epicondyle of humerus	Palmar aponeurosis	Flexion of hand and wrist	Flex wrist against resistance to find tendon. May be absent in one or both sides in some people.
Flexor digitorum superficialis	Medial epicondyle of humerus, coronoid process of ulna, proximal radius	Four tendons into the middle phalanges of fingers 2-5, palmar surface	Flexes the middle and proximal phalanges of fingers 2-5, flexion of the wrist and forearm.	Median nerve and ulnar artery are under origin
Flexor carpi radialis	Medial epicondyle of humerus	Base of 2nd to base of 3rd metacarpal bone	Flexes and abducts the wrist, pronation of the forearm and flexion of the elbow	
Flexor carpi ulnaris	Medial epicondyle of humerus, medial olecranon and proximal posterior ulna	Pisiform bone	Flexes and adducts the wrist and flexes the elbow	
Extensor carpi radialis longus	Lateral supracondylar ridge of humerus	Base of 2nd metacarpal bone dorsal side	Extends and abducts the wrist, flexes the elbow	
Extensor carpi radialis brevis	Lateral epicondyle of humerus	Dorsal surface of base of 3rd metacarpal bone	Extends and assists in abduction of the wrist	
Extensor carpi ulnaris	Lateral epicondyle of humerus, posterior border of ulna	Base of 5th metacarpal bone, ulnar side	Extends and adducts the wrist	Tendon runs through a groove between the head of the ulna and the styloid process of ulna
Flexor digitorum profundus	Anterior and medial surfaces of proximal ¾ of ulna	Four tendons into bases of distal phalanges on anterior surface	Flexes distal interphalangeal joints of four fingers, flexes proximal interphalageal and metacarpopphalangeal	

			joints	
Flexor pollicus longus	Anterior surface of radius, deep to flexors	Distal phalange of thumb	Flexes thumb	
Supinator	Lateral epicondyle of humerus, posterior ulna	Proximal anterior shaft of humerus	Supinates forearm	
Extensor pollicus longus and brevis	Posterior surface of radius and ulna, deep to extensors	Brevis – proximal phalange of thumb Longus- distal phalange of thumb	Extends the thumb	
Opponens pollicis	Palmar retinaculum, trapezium	1st metacarpal anterior surface	Opposition of thumb to each digit. Rotates 1st metacarpal so the thumbnail faces the ceiling when the hand is resting palm up.	

Thigh	Origin	Insertion	Action	Notes
Posterior thigh				
(Hamstrings)				
Biceps Femoris	Long head -Ischial tuberosity Short head- lateral lip of linea aspera	Head of the fibula	Flex knee, extend hip, tilt pelvis posteriorly, laterally rotates femur	
Semitendinosus	Ischial tuberosity	Proximal, medial condyle of the tibia	Flex knee, extend hip, tilt pelvis posteriorly, medially rotate of flexed knee	superficial, stringy, tendonus attachment
Semimembranosus	Ischial tuberosity	Posterior medial condyle of the tibia	Flex knee, extend hip, tilt pelvis posteriorly, medially rotate flexed knee	deeper, broader, most medial
Anterior Thigh				
Sartorius	Anterior superior iliac spine	Upper medial shaft of tibia	assists flexion, abduction, lateral	cross-legged flexion: the

			rotation of hip, assists flexion, medial rotation of knee	tailors muscle
Quadriceps				
Rectus femoris	anterior inferior iliac spine, ilium on upper margin of acetabulum	patella, patellar ligament to tibial tuberosity	extension of knee, assists flexion of hip	only hip flexor of quad group
Vastus medialis	linea aspera on posterior femur	patella, patellar ligament to tibial tuberosity	extension of knee	
Vastus lateralis	linea aspera on posterior femur	patella, patellar ligament to tibial tuberosity	extension of knee	
Vastus intermedius	anterior and lateral femoral shaft	patella, patellar ligament to tibial tuberosity	extension of knee	
Medial thigh				
Pectineus	superior ramus of pubis	pectineal line of femur	flexes hip, adducts thigh, medially rotates the thigh	
Adductor longus	anterior pubis just inferior to pubic tubercle	linea aspera on posterior femur	adduction of hip, assists in flexion and medial rotation of hip	
Adductor brevis	anterior pubis	linea aspera on posterior femur	adduction of the hip, assists in flexion and medial rotation of hip	
Adductor magnus	inferior pubic ramus, ischial ramus, ischial tuberosity	proximal 1/3 of linea aspera of posterior femur, adductor tubercle	adduction of hip, assists in flexion of hip, posterior fiber assists in extension of hip	assist hamstrings
Gracilis	anterior pubis	medial proximal tibia	adduction of hip, assists in flexion and medial rotation of flexed knee	crosses knee and hip
Leg, ankle, foot, posterior thigh				
Gastrocnemius	medial epicondyle of femur, lateral epicondyle of femur	calcaneus via achilles tendon	plantarflexion of foot at ankle, flexion of knee	crosses knee and ankle
Soleus	upper fibula, soleal line of tibia	calcaneus via achilles tendon	plantarflexes foot	deep to gastrocnemius, but wider than gastroc; strong contractions pump blood

				from leg to heart
Plantaris	above the lateral head of gastrocnemius on femur	calcaneus via achilles tendon	weak plantarflexion of the foot at ankle	may be absent in approx. 10% of people
Popliteus	lateral femoral condyle	posterior tibial surface above soleal line	laterally rotates femur, flexes the knee, unlocks knee from and extended position	deepest muscle of posterior knee
Tibialis posterior	proximal posterior tibia, interosseous membrane, medial fibula	navicular, cuneiform, cuboid bones and bases of 2nd -4th metatarsals	inverts the foot, plantar flexes the ankle	tendons under flexor retinaculum
Flexor digitorum longus	lower 2/3 of tibia	4 outer phalanges plantar surface, along side ankle	plantarflexes and inverts foot, flexes toes 2-5	
Flexor hallicus longus	inferior 2/3 of posterior fibula	plantar surface of big toe	flexes big toe, weak plantarflexion of the ankle, inversion of foot	
Anterior leg				
Tibialis anterior	lateral tibia, proximal lateral surface of tibia, interosseous membrane	medial cuneiform, first metatarsal	inversion of foot, dorsiflexion of ankle	
Extensor digitorum longus	lateral tibial condyle, fibula	dorsal surface of phalanges 2-5	extension of toes 2-5, dorsiflexion of the ankle, eversion of the foot	
Extensor hallicus longus	medial aspect of the fibula, interosseous membrane	diatal phalanx of big toe	extends the big toe, dorsiflexion of the ankle, inversion of the foot	
Lateral leg				
Peroneus longus	upper lateral fibula	medial cuneiform, plantar surface of cuboid, base of 1st metatarsal	eversion and abduction of foot, weak plantarflexion of foot	
Peroneus brevis	lower, lateral 2/3 of fibula	fifth metatarsal	eversion and abduction of foot, weak plantarflexion of foot	

Pelvis	Origin	Insertion	Action	Notes

Gluteus maximus	Posterior ilium, sacrum coccyx	Femur (greater trochanter) and Iliotibial band	Forceful extension of the hip, lateral rotation of extended hip, abduct hip (IT band), lower fibers (inserting on trochanter) adduct hip, External rotation	stabilizes knee
Gluteus medius	Ilium between posterior and anterior gluteal lines (below crest)	Greater trochanter of femur	Abducts and rotates thigh medially (internally), abducts, flexes and extends the hip	stabilizes pelvis
Gluteus minimus	Posterior ilium between anterior and inferior gluteal lines	Anterior surface of greater trochanter of femur	Abducts and medially (internally) rotates thigh, stabilizes pelvis on femur	stabilizes pelvis
Tensor fascia latae	Anterior iliac crest (posterior to anterior superior iliac spine)	Iliotibial band which continues to attach to lateral condyle of tibia	Flexes, internally: rotates and abducts thigh, prevents collapse of extended knee in walking	
Psoas major	Lumbar vertebrae, T12-L5 Bodies and transverse processes	Lesser trochanter of femur	Flexion of hip When femur is stabilized it may increases the lordotic curve in the lumbar spine and rotates the pelvis downward. Alternate theory: acting with posterior transversospinalis act to erect (lift or straighten) the spine	Provides support for the spine and maintains disc space when functioning properly.
Iliacus	Iliac fossa	Lesser trochanter of the femur	Flexes, laterally rotates and	

			adducts the hip With femur fixed, acts in rotating pelvis anteriorly	
Piriformis	Anterior surface of the sacrum	Greater trochanter of femur	External rotation of femur Adducts the thigh when the hip is flexed With femur fixed, bilaterally moves pelvis backward (decreasing lordosis); unilaterally medially rotates pelvis	
Deep lateral rotators (Superior and Inferior Gemelli, Obturator Internus and Externus, Quadratus femoris)	Ischium, obturator foramen	Trochanter	Laterally rotate thigh, stabilize hip	

MYOFASCIA

CONNECTIVE TISSUE SHEATHS

Within an intact muscle, the individual muscle fibres are wrapped by several different layers of connective tissue. Each muscle fibre is surrounded by a fine sheath of areolar connective tissue called the endomysium.

Several ensheathed muscle fibres are then gathered together side by side into bundles of muscle cells (also known as muscle fibres) called fascicles, and each fascicle is bound by a collagenic sheath referred to as the perimysium.

The fascicles are in turn bound together by an even coarser “overcoat” of dense fibrous connective tissue called the epimysium, which surrounds the entire muscle.

FASCIA

External to the epimysium is the deep fascia, a still coarser sheet of fibrous connective tissue that binds muscles into functional groups, and extends to wrap other structures as well.

These connective tissue sheaths are continuous with one another as well as with the tendons that join muscles to bones. Thus, when muscles contract, they pull on their sheaths, which in turn transmit the force to the bone to be moved.

Also, like all body cells, skeletal muscle fibres are soft and fragile, so the connective tissue sheaths serves as a source of support to reinforce the muscle, as well as providing it with elasticity. Furthermore, it provides the necessary entry and exit routes for blood vessels and nerves the supply nutrients and innervation to the respective muscle.

Keeping this in mind, we will have a brief look at 'shin splints'. As the muscles of the calf expand with increased exercise, the fascia can't expand as quickly therefore it tightens up, creating greater tension on the periosteum resulting in shin pain. More appropriately this is known as tibial periostitis (inflammation of the periosteum).

Shortening of the myofascia can limit its functional length, thereby reducing its strength and ability to contract therefore intervention with soft tissue techniques can be argued as being appropriate for treatment. Because fascia is everywhere, remember that when you work on one area, you can have an influence elsewhere – something that you should remain aware of. Think and look globally, act locally initially and then globally where appropriate.

ARRANGEMENT OF FASCICLES

Different arrangement of fascicles within the muscle allow for different expressions of force characteristics. It is important to know the arrangement of fascicles to apply the appropriate massage techniques.

- PARALLEL – fast contracting but tend to be relatively weak.
  - ⇒ Straplike- sartorius
  - ⇒ Fusiform- biceps

- PENNATE – allows more fibres per area so is stronger but with a slower contraction. The fibres are arranged in a feather-like arrangement (penna) attaching obliquely to a central tendon that runs the length of the muscle.
  - ⇒ Unipennate- extensor digitorum longus
  - ⇒ Bipennate- rectus femoris
  - ⇒ Multipennate- deltoid

- CONVERGENT (RADIANT)- pectoralis major – allows a large range of movement.

- CIRCULAR- muscles around eyes, mouth and anus

CARDIOVASCULAR SYSTEM

The cardiovascular system of the human body has one distinct job; that is to pump the blood to the different parts of the body. The central organ in this system is the heart. It is made up of cardiac tissue and its job is to pump the blood. It first pumps the blood to the lungs to get oxygen, and then to the various parts of the body for distribution. The blood travels through a series of arteries and veins. The difference between the two is that arteries carry oxygenated blood from the heart to the body, and the veins return the oxygen-free blood back to the heart. The circulatory is not complex, but it does an imperative job for the body.

The cardiovascular system is a complex system with one central organ: the heart. The heart is the body's pacemaker. It pumps oxygen-rich blood to the different parts of the body. The blood's journey through the body is an extensive trip through highways of veins, arteries, and capillaries.

The heart is somewhat centrally located. Two thirds of the heart is on the left side of the sternum. It is the size of your fist, weighing in at a whopping pound and a half. Although it appears small, its importance cannot be understated.

The heart is divided into four chambers: the left and right atria, and the left and right ventricle. The atria are on the upper half of the heart, and the ventricles make up the lower portion. The dividing wall between the left and right sides is the septum. There are four valves of the heart, which control the blood flow.

The object of the blood is to circulate oxygen for the growth and development of cells. The blood is composed of red and white blood cells, platelets, lymph, plasma, and water. The red blood cells contain hemoglobin, which is the chemical compound that carries the oxygen. The white blood cells are part of the immune system. Platelets are used when blood clots, to stop the bleeding. The platelets emit the blot clotting substance, fibrinogen, into its active form, fibrin. Lymph is the interstitial fluid in the blood. The plasma is the remaining portion of the blood, the mixture of glucose and water in which the blood cells is suspended.

Blood enters the heart in the left atrium, from the superior and inferior vena cava. The superior vena cava is the vein that collects the blood returning from the upper body, and the inferior vena cava returns blood from the lower body. The deoxygenated blood of these two veins enters the heart in the right atrium during the systole part of the heartbeat. In this phase of the heartbeat the atria are filling up and the ventricles are contracting in order to pump the blood. The pulmonary and aortic valves open to allow the blood to leave the ventricles.

During the diastole part of the heartbeat, the atria contract to pump the blood into the ventricles. To allow the blood to leave the atria and enter the ventricles, the tricuspid and mitral valves of the heart open to allow the blood to pass through. Both of these phases of the heartbeat take a combined eight tenths of a second.

New blood entering the right atrium is pumped by the tricuspid valve, to the right ventricle. Then, the pulmonary valve opens to the pulmonary artery. This artery has to carry the blood to the lungs to get oxygen. This is the only artery in the body that carries deoxygenated blood.

Once the blood reaches the lungs, carbon dioxide is diffused into the lungs. Carbon dioxide is a cell's waste product after using oxygen. Then the blood must get its oxygen. This is where the circulatory system and the respiratory system intertwine.

The oxygen in the lungs is diffused through the alveoli sacs and then through the wall of the lungs into the bloodstream. The blood carries the oxygen to the various cells in the body. To get the oxygen to the actual cells, the arteries branch off into smaller arterioles.
These even branch off to capillaries, the smallest of blood vessels. Their walls are extremely thin and elastic. In these vessels, the red blood cells must travel single file to pass through. The oxygen is released from the hemoglobin and diffuses across the capillary wall. It then travels to a nearby cell and enters through the cell membrane. Once inside the cell, the oxygen molecule travels into the mitochondrial matrix where it plays a role in ATP synthesis.

The carbon dioxide that returns to the blood is taken back to the lungs through the capillaries. These then fork into venules, which then fork into veins. The veins carry the carbon dioxide along with the blood back to the heart. This completes the cycle of the circulatory system

The blood
The blood is made of many components. They include the following:

Red blood cells
- RBCs are biconcave discs that contain haemoglobin (made of iron).
- The haemoglobin transports oxygen.
- RBCs have a lifecycle of approximately 120 days.
- They are produced in the bone marrow.

White blood cells
- Fight infection.
- Produced in the bone marrow and lymph tissue.

Platelets
- Clot blood by sticking to wounds or foreign particles.
- They are also formed in the bone marrow.

Plasma
- Liquid section of blood that makes up approximately 55% of the blood.
- It contains water, nutrients (including glucose, lipids, amino acids), hormones & waste products.

The blood vessels
Arteries
- Carry blood away from heart.
- The blood is pushed through the arteries at a high pressure caused by the heart beat. The elastic walls expand with each heart beat, creating a pulse.
- Common areas to measure heart rate are the carotid pulse located at the neck and the radial pulse at the wrist.

Veins
- Carry blood to heart.
- Have thinner walls and are less elastic than arteries.
- Most venous blood has to travel against gravity back to the heart. The blood is pumped back to the heart by use of the following:
    - Even the smallest muscular contractions and changes in thoracic pressure compress and relax the veins.
    - The valves that only allow blood flow in 1 direction.
- Venous pooling is when blood pools in the veins. This may occur when an individual stands quickly after lying horizontally or stopping immediately after vigorous exercise. A cool down is recommended to prevent venous pooling.
- Varicose veins are caused by long periods of time standing, causing the blood to pool, damaging valves.

Capillaries
- They have permeable and thin walls 1 cell thick that enable the movement of O2, CO2 & nutrients by the process of diffusion.

- They surround structures in clusters called capillary networks. These include the alveoli, muscles, joints and internal organs.
- The capillaries can expand, or vasodilate when larger amounts of O2 are required. They can also vasoconstrict to redirect blood to areas of need.

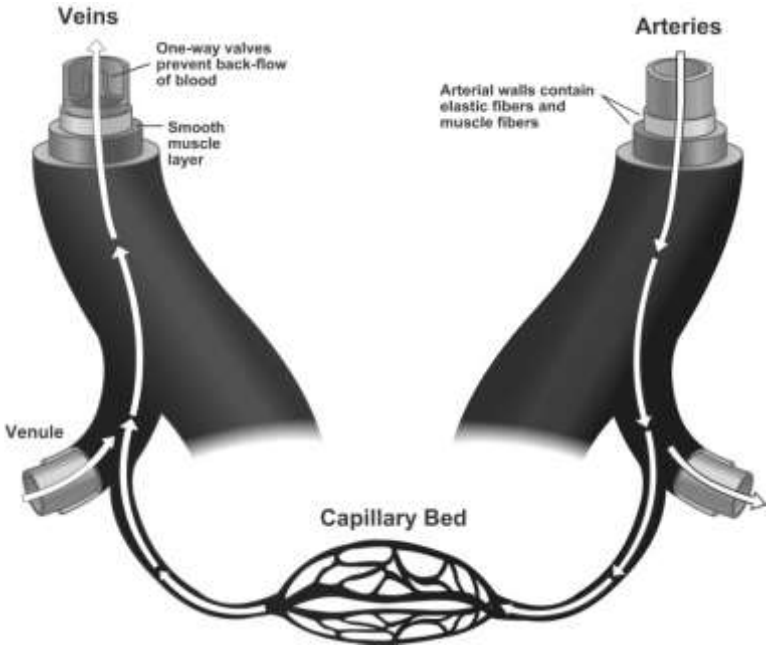
THE 2 CLOSED CIRCUITS

Pulmonary circuit

- Carries blood from the heart to the lungs & back again.

A summary includes:

Right Lung → Heart ← Left Lung



Systemic circuit

Carries blood from the heart to all parts of the body (except lungs) & back again.

A summary includes:

Muscles ← Heart → Muscles of upper body of lower body

THE PATHWAYS OF OXYGEN AND CARBON DIOXIDE

Nasal cavity: warms & filters air ↓ Pharynx: back of throat
↓ Larynx: air passes over voice box, creating speech ↓ Trachea: delivers air to lungs ↓ Bronchus: both the right & left bronchus deliver air to each lung

↓
Bronchioles: small branches that deliver oxygen to the alveoli
↓
Alveoli: tiny air sacs that are surrounded by capillaries. Both have semi-permeable, microscopic walls 1 cell thick, allowing for oxygen to diffuse from a high concentration in the alveoli to a low concentration in the capillaries.
↓
Lung Capillaries: semi-permeable blood vessels with walls that are 1 cell thick. The oxygen diffuses from a high concentration in the alveoli to a low concentration in the capillaries containing blood. The blood is composed of RBC's made up of haemoglobin that the oxygen attaches to.
↓
Pulmonary vein: the blood vessel that transports oxygenated blood to the heart (it is the only vein with oxygenated blood)
↓
Left Atrium: the chamber of the heart that receives oxygenated blood from lungs
↓
Left ventricle: the muscular chamber of the heart that pumps blood to the aorta, where it is sent to the rest of the body
↓
Aorta: the largest artery that pumps blood to other arteries of the body
↓
Arteries & arterioles: blood vessels that carry oxygenated blood away from the heart
↓
Muscle Capillaries: smallest blood vessels that are semi-permeable with walls that are 1 cell thick, allowing for oxygen to diffuse from a high concentration in the muscle to a low concentration into the muscle cell
↓
Myoglobin: chemical found inside the muscle cell that extracts oxygen from the haemoglobin in the blood & takes it to the mitochondria
↓
Mitochondria: powerhouse of the cell where oxygen is used to make energy aerobically. Waste products produced are carbon dioxide and water.
↓

Muscle Capillaries: smallest blood vessels that are semi-permeable and 1 cell thick, allowing for CO_2 & H_2O to diffuse from a high concentration in the muscle cell to a low concentration in the blood
↓
Veins & venules: the blood vessels that deliver deoxygenated blood back to the heart
↓
Vena Cava: the largest vein that receives blood from the body & transports it to the heart
↓
Right atrium: chamber of the heart that receives deoxygenated blood from the body
↓
Right ventricle: the chamber of the heart that pumps blood to the lungs
↓
Pulmonary artery: the blood vessel that delivers the blood to the lungs (it is the only artery with deoxygenated blood)
↓
Lung Capillaries: tiny blood vessels that are semi-permeable & 1 cell thick that allow for the diffusion of CO_2 & H_2O from a high concentration in the capillaries to a low concentration in the alveoli. At the same time, O_2 is diffusing from a high concentration in the alveoli to a low concentration in the capillaries. The waste products are breathed out of the respiratory system.
↓

BASIC PARAMETERS OF THE CIRCULATORY SYSTEM

Heart Rate (HR)

- The number of times the heart beats in 1 minute.
- Measured in beats per minute (bpm)
- Measured at a pulse. The most commonly measured pulses are the carotid pulse located at the neck or the radial pulse at the wrist.

What are some factors that affect heart rate?
Exercise Gender Temperature Eating Laughing Smoking Body position Medication

Stroke volume (SV)

- The amount of blood pumped by the heart in 1 beat. Measured in millilitres (ml).

Cardiac Output (Q)

- The amount of blood pumped by the heart in 1 minute. Measured in millilitres per minute.

Blood pressure

Reflects pressure within the heart and arterial system, Measured in millimetres of mercury (mmHg).
Systolic pressure: Pressure in the walls of the arteries during contraction of the heart.
Diastolic pressure: Pressure in the walls of the arteries during relaxation of the heart.

Resting blood pressure ratings table:

CLASSIFICATION	SYSTOLIC (mmHg)	DIASTOLIC (mmHg)
Optimal	<120	<80
Normal	120-129	80-84
Normal high	130-139	85-89
Hypertension	>140	>90

RESPIRATORY SYSTEM

The respiratory system supplies the body with oxygen, Air is inhaled through the nose or mouth. It then travels into the pharynx, passes through the larynx, and down the trachea. The trachea branch and air reaches the lungs where it will diffuse into the blood via the alveoli.

The nose is the only organ of the respiratory system that resides outside of the body. As we breathe, air enters the body through the nostrils or external nares. The area inside the nose is known as the nasal cavity. The nasal septum divides the nasal cavity medially. The olfactory receptors are located in the mucosa in a small area on the roof of the nasal cavity (see the special senses under the nervous system). The respiratory mucosa lines the nasal cavity. This mucosa helps warm air entering the body. It also helps moisten the air and trap invading pathogens.

The walls of the nasal cavity are uneven. There are three mucous covered projections that stick out into the nasal cavity. These lobes are known as conchae. These projections help increase the area that the mucosa can affect. The nasal cavity is separated from the oral cavity by a palate of bone. Anteriorly, where the palate is supported lies the hard plate. The unsupported area of the palate houses the soft plate.

The nasal cavity is surrounded by the paranasal sinuses. These sinuses are located in the maxillary, ethmoid, sphenoid, and frontal bones. The sinus chambers help lighten the weight of the skull. The sinus chambers also act as resonance chambers for vocalization. The sinus cavities also secrete mucous for the nasal cavity.

The pharynx is the muscular passageway that provides a means of transportation for air and food. The pharynx, also known as the throat, is about 13 cm. long.

Air enters the pharynx through its superior portion, the nasopharynx. Air then descends from the nasopharynx to the oropharynx, to the laryngopharynx. From the laryngopharynx air enters the larynx. Food travels the same way, through the nasopharynx to the laryngopharynx, but instead of entering the larynx, it enters the esophagus. Since the auditory tubes from the ear open into the nasopharynx, the mucosae of each regoin are continuos. Since the mucosae is continuos ear infections may proceed after a sore throat. Tonsils, clusters of lymphatic tissue, are also found in the pharynx. The pharyngeal tonsils, also called the adenoids, are found in the nasopharynx. The palatine tonsils are located in the oropharynx. The lingual tonsils are located at the base of the tongue.

The larynx, also known as the voice box, routes food and air to its proper destination. The larynx is made up of eight hyaline cartilages and a flap of elastic cartilage, the epiglottis. The epiglottis' job is to prevent food from entering the superior opening of the larynx, and traveling down the trachea. Breathing opens the epiglottis and allows free passage of air to the lungs. The larynx is pulled in an upward direction while swallowing, causing the epiglottis to " tip " and close over the opening of the larynx. When the epiglottis is closed, it forces food to be pushed down the esophagus. If something beside air enters the larynx, a cough occurs. A coughs' purpose is to repel any foreign substance, beside air, from entering the trachea. The mucous membrane of the larynx form the vocal folds. When expelled by air, the vocal folds vibrate. This vibration allows human's the ability of speech. The glottis is the thin passageway between the vocal folds. The largest of the hyaline cartilages is the thyroid cartilage. The thyroid cartilage, also called the Adams apple, protrudes anteriorliy.

The trachea, also called the windpipe, is about 10-12 cm. The trachea's walls are covered with ciliated mucousa. The cilia are always beating in the opposite direction of the incoming air. The cilia also send dust pathogens up the trachea so that it may be swallowed and digested.

The trachea is quite rigid due to the fact that its walls are made up of c-shaped hyaline cartilage. The open part of the rings allow the esophagus to expand when one swallows a large amount of food. The opposite ends keep the trachea open.

The division of the trachea form the right and left bronchi. Each of the bronchi run obliquely, before entering the hilius of the lungs. The right primary bronchi is wider, straighter, and shorter that the left primary bronchi. When air enters the bronchi, it is warm, humidified, and cleansed of all pathogens.

The lungs are the primary organs of the respiratory system. The lungs occupy the thoracic cavity. The apex, the superior portion of the lung, is located below the clavicle. The base of the lungs are the section that rest upon the diaphragm. Each lung is subdivided into lobes. The right lung is characterized by three lobes; the left lung is characterized by two lobes.

The surface of the lungs is covered by a visceral serosa known as the visceral, or pulmonary, pleura. Each wall of the thoracic cavity is covered by the parietal pleura. Each pleural membrane forms a secretion known as the pleural fluid. The pleural fluid allows the lungs to slide over the thoracic wall during respiration.

The pleural mucosae can slide from one another, and side to side, but they resist being pulled apart. Due to the characteristics of the pleural mucosae, the lungs rest quite tightly in the thorax wall.

When the primary bronchi enter the lungs, they divide into smaller branches. After the continuous shortening of size, the primary bronchi become the bronchioles. The terminal bronchioles divide to become the respiratory zone structures. The respiratory zone structures eventually divide to become the alveoli. The respiratory zone houses the transfusion of air to blood. The respiratory zone also contains the alveoli, the alveolar sacs, the alveolar ducts, and the respiratory bronchioles. The remaining area of the lungs are known as the conducting zone structures. The conducting zone structures contain all the passages to and from the respiratory zone. Within the lung there are millions of alveoli. The alveoli are responsible for the transfusion of oxygen to blood.

Gaseous Exchange

Oxygen is a gas that is exchanged for another gas, carbon dioxide. This occurs by a process called diffusion.
In this process, the gases move from a high to a low concentration. The gases are able to move into and out of the capillaries due to their microscopically thin walls.

Gaseous exchange occurs in the following places:

Lungs
The O2 moves from a high concentration in the alveoli to a low concentration in the lung capillaries.
The CO2 moves from a high concentration in the lung capillaries to a low concentration in the alveoli.

Muscles
The O2 moves from a high concentration in the muscle capillaries to a low concentration into the muscle.

The CO2 moves from a high concentration in the muscle to a low concentration in the muscle capillaries.

O2 uptake
O2 enters the body through the respiratory system. O2 diffuses from the alveoli into the blood at the lungs.

O2 transport
O2 is transported in the blood by attaching to haemoglobin. The O2 travels in the blood to the heart, where it is pumped to the body. During exercise, blood flow increases to the working muscles.
Once the oxygenated blood arrives at the muscles, it diffuses from the blood into the muscle.

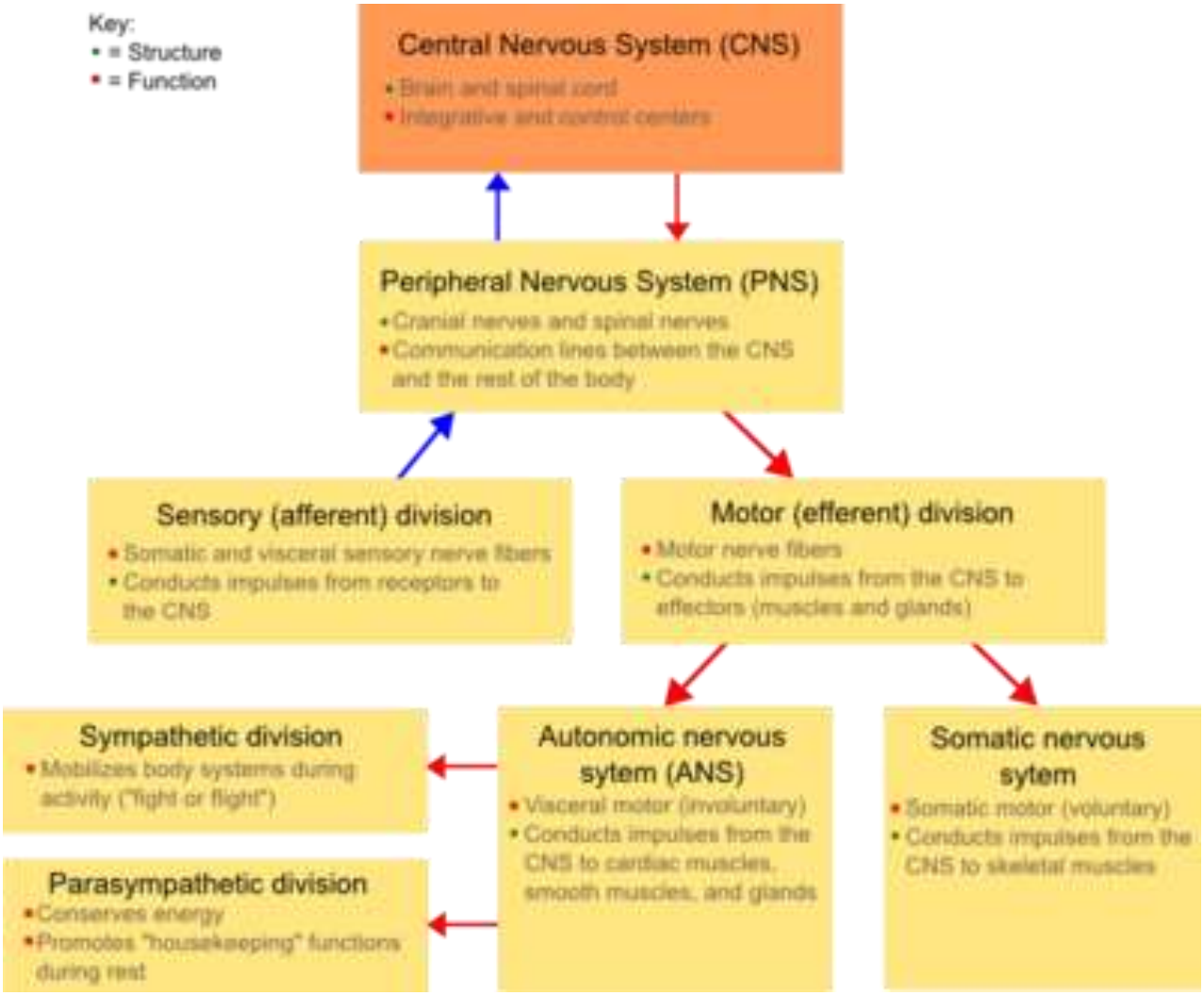
O2 extraction
Myoglobin inside the muscle extracts O2 from the haemoglobin. Myoglobin transports the O2 to the mitochondria.
The mitochondria uses the O2 to make ATP in the aerobic energy system.

NERVOUS SYSTEM

The nervous system is the master controlling and communicating system of the body. Every thought, action, and emotion reflects its activity. The nervous system is by far the most rapid acting and complex system of the body. The cells of the nervous system communicate by means of electrical signals, which are rapid, specific, and usually cause almost immediate responses.

The nervous system is but one single system, but for convenience we divide it into two parts: the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS consists of the brain and the spinal cord which are located in the dorsal body cavity. The CNS is the command center of the nervous system. It interprets incoming signals and responds to them based on past experiences, reflexes, and current conditions. The PNS is the part of the nervous system that is not part of the CNS. It consists mainly of the nerves that extend from the brain and the spinal cord. These nerves are called the cranial nerves and the spinal nerves, respectively. These peripheral nerves serve as the communications link from the body to the CNS.

The PNS can then be farther divided into two functional subdivisions. The sensory division is the division that contains the nerve fibers that carry impulses to the CNS from sensory receptors that are located throughout the body. There are two types of sensory fibers. The somatic afferents convey information from the skin , skeletal muscles, and joints. The visceral afferents convey impulses from the visceral organs. The other division of the PNS is the motor division. This division transports messages from the CNS to organs, muscles, and glands. The motor system can also be divided farther in to two parts. The somatic nervous system is composed of motor nerve fibers that connect the CNS to the skeletal muscles and is often referred to as the voluntary nervous system. The autonomic nervous system consists of nerve fibers that regulate the activity of smooth muscles, cardiac muscles, and glands. Since we usually cannot consciously control these activities, it is generally referred to as the involuntary nervous system.

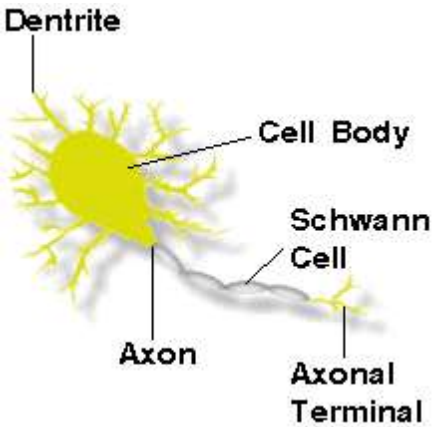


In the nervous system there are two main types of cells in the nervous system: neurons and supporting cells. Neurons provide a pathway for messages traveling to and from the brain and spinal coed. Supporting cells provide structural reinforcement, protection, insulation, and generally assist neurons.

Neurons are specialized cells for transporting signals from location to location. There are many different types of neurons. However, all neurons share common characteristics. First of all, they all share large cell bodies, and they all have fiber-like extensions called processes. Processes increase the distance which the cells can conduct messages. There are two types of processes: dendrites and axons.

Dendrites convey signals towards the cell body. Axons, conversely, conduct signals away from the cell body. Dendrites, in general, are short and numerous and branch extensively. Most neurons have only a single axon which is usually very long. Axons stem from the axon hillock which is a cone-shaped region of the cell body. Schwann cells are arranged along the length of the axon. All together these Schwann cells form an insulating layer which is called the myelin sheath.

Axons can be branched and each branch can terminate in hundreds or thousands of small branchlets called telodendria which end in a small bulbous end called the synaptic knob. Synaptic knobs relay messages to other cells via neurotransmitters. Between the synaptic knobs are gaps called synapses.



In the central nervous system supporting cells are called glial cells, glial roughly means glue. Astrocytes are glial cells that line capillaries in the brain and contribute too the blood-brain

barrier. The blood-brain barrier restricts the passage of most substances into the brain. It helps prevent dangerous fluctuations in the chemical environment of the central nervous system.

In the body, cells usually carry a negative charge. Nervous cells are able to alter their charge in order to conduct signals. Cells that are able to do this are called excitable cells. Neurons are able to alter their charge largely due to ions. Neuron plasma membranes have an abundance of sodium potassium pumps. These pumps actively transport Na+ out of the cell and K+ into the cell. This generate steep gradients of these ions. Na+ is then more concentrated outside the cell and K+ is more concentrated on the inside of the cell. This in turn polarizes the cell, meaning that there is a difference in the electrical charge between the outside of the cell and the inside of the cell.

The unstimulated, polarized state of a neuron is called the resting potential, which is usually about -70 millivolts. When the cell is stimulated gated ion channels in the membrane open and allow Na+ to enter the cell. This depolarizes the cell meaning that it is now more positive on the inside. If the stimulus is powerful enough, more Na+ gates open which causes complete depolarization or an action potential. This in turn opens K+ gates and the K+ on the inside of the cell moves out.

This causes repolarization of the cell which is accomplished by restoring the original membrane polarization. Soon after these gates open the Na+ gates close. When the K+ gates finally close, more K+ has exited the cell than necessary to reestablish the original polarization. This makes the membrane become hyperpolarized. During the refractory period, K+ and Na+ return to there original sides of the membrane. During this period the neuron is not able to respond to a new stimulus.

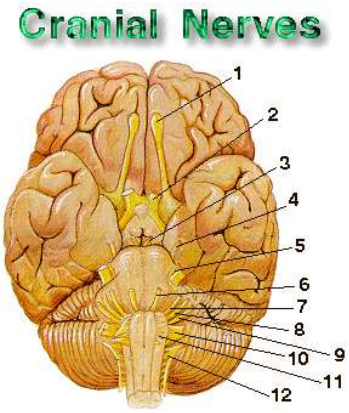
Cells in which a signal begins are called pre-synaptic cells. Cells which receive the signal are called post-synaptic cells. There are two types of synapses: electrical and chemical. An electrical synapse allows the action potential to spread directly from the pre-synaptic to the post-synaptic cells. Chemical synapses allows for cells that so not have an electrical connection to spread their action potential. This happens by converting the electrical signal to a chemical signal that then travels across the synapse and is then converted back to an electrical signal on the other side of the synapse. These chemicals are called Neurotransmitters.

At the present time there are about ten molecules that are known to be neurotransmitters. Dozens more are good candidates and the list of possibilities is growing. Acetylcholine is the most common neurotransmitter. This chemical triggers the contraction of a muscle cell at the junction of the motor neuron and a skeletal muscle cell.

Biogenetic amines are derived from amino acids. Biogenetic amines commonly function as neurotransmitters within the central nervous system. Dopamine and serotonin are biogenetic amines that affect sleep, mood, attention, and learning. An imbalance of these transmitters can be associated with mental illness. For example Schizophrenia is tied to an excess of dopamine. Psychoactive drugs like LDS induce hallucinations by binding the receptors for certain neurotransmitters. Gamma amino butyric acid (GABA) is believed to be the transmitter at inhibitory synapses in the brain. The brain has hundreds times more GABA than any other neurotransmitter.

The peripheral nervous system is composed of two systems: the afferent nervous system and the efferent nervous system. The afferent nervous system is the part of the PNS that deals with senses, that is it brings information into the brain from the sensory receptors. The efferent nervous system is the part of the PNS that deals with carrying the signals from the CNS to the body.

There are 12 pair cranial nerves and 31 pairs of spinal nerves in humans. These nerves connect the PNS to the CNS. Most contain both afferent and efferent neurons; however, the olfactory (smell) and optic (sight) contain only afferent neurons.



1. Olfactory Bulb
2. Optic Nerve
3. Oculomotor Nerve
4. Trochlear Nerve
5. Trigeminal Nerve
6. Abducens Nerve
7. Facial Nerve
8. Vestibulocochlear Nerve
9. Glossopharyngeal Nerve
10. Vagus Nerve
11. Accessory Nerve
12. Hypoglossal Nerve

CRANIAL NERVES.

It is not necessary for you to know all 12 of the Cranial Nerves, however they are all listed here for your information. It IS important for you to know CNV, VII, X and XI and at least one feature of their distribution. The defining feature of Cranial nerves is that they exit the cranial cavity through foramina or fissures rather than from the spinal cord.

No.	Name	Distribution
I	Olfactory	Olfaction (smell).
II	Optic	Vision.
III	Occulomotor	Eye muscles, lens and pupils.
IV	Trochlear	Eye muscles.
V	Trigeminal	Cornea, some facial skin, tongue, muscles of mastication. (Masseter and Temporalis)
VI	Abducens	Eye muscles.
VII	Facial	Muscles of facial expression (Frontalis, occipitalis); tongue; salivary, lacrimal and mucus glands.
VIII	Vestibulocochlear	Equilibrium; hearing.
IX	Glossopharyngeal	Pharyngeal muscles; parotid salivary glands; tongue; pharynx; middle ear cavity; carotid sinus.
X	Vagus	Muscles of pharynx and larynx; thoracic and abdominal organs; tongue.
XI	Accessory	Trapezius and sternocleidomastoid muscles.
XII	Hypoglossal	Muscles of the tongue.

Voluntary contractions of the skeletal muscles are controlled by the somatic nervous system. These motor neurons mainly respond to external stimuli and a conscious decision is made to move the muscles. Reflexes are automatic reactions to a stimulus. In most cases reflexes are controlled by the spinal cord and the brain stem.

THE CENTRAL NERVOUS SYSTEM (CNS)

The CNS consists of the brain and spinal cord that are enclosed in the cranium and vertebral canal respectively. The CNS is the integrative and control centre of the nervous system. It receives sensory input from the peripheral nervous system (PNS) and formulates responses to this input and also carries out higher mental functions like thinking and learning. The entire CNS is covered by three layers of connective tissue called the meninges. The meninges are composed of the dura mater (outermost), the arachnoid (middle) and the pia mater (innermost). Cerebrospinal fluid (CSF) circulates between the CNS and the meninges.

THE BRAIN.

The brain is formed by the cerebrum, which has right and left cerebral hemispheres, the cerebellum and the brain stem.

The Cerebrum.

Has an outer surface of grey matter that is comprised mainly of nerve cell bodies and unmyelinated nerve cell fibres. The surface layer is called the cerebral cortex and is the highest centre in the brain. Deep inside each cerebral hemisphere are several additional structures of grey matter called the basal ganglia (involved in regulation of stereotyped activity such as arm swing while walking. Disorders may result in too much or too little movement eg. Parkinson's Disease). The grey matter of the cortex is separated from the basal ganglia by white matter, which is composed of tracts of myelinated nerve fibres. The cerebral hemispheres are divided into lobes – association areas.

- Temporal lobe – allows us to hear – interprets sound
- Occipital lobe – responsible for sight
- Parietal lobe – proprioception/kinesthetic awareness – gives us sense of where we are in the environment. As a practitioner you may need to help the patient's brain become aware of a new position. For example, poor posture can be improved by manually placing the patient in the new position. The brain then notes that change and it may then be easier for the patient to remember that position in future.
- Frontal lobe – logical thinking (high level)

The Cerebellum. (Little brain)

Composed of two lateral cerebellar hemispheres connected in the midline. It co-ordinates the activities of the skeletal muscles through sensory information carried to it from receptors for proprioception, equilibrium and balance around the body. It also receives some sensory information concerning touch, vision and sound. A person with cerebellar damage experiences muscular weakness, loss of muscle tone and co-ordination. Although the cerebellum can communicate with the cerebral cortex, it is also able to mediate certain responses without having them reach the conscious level. It ensures movement is smooth giving unconscious awareness of limb positions.

The Brain Stem.

Formed by the mid-brain, the pons and the medulla oblongata. The medulla oblongata is continuous with the spinal cord. The brain stem controls many vital functions including heart rate, respiration, dilation and constriction of blood vessels, swallowing and vomiting.

THE SPINAL CORD

Below the level of the medulla, the CNS continues as the spinal cord. The spinal cord performs two main functions:

1. Conducts nerve impulses to and from the brain.
2. It processes sensory information in a limited manner, initiating spinal reflexes without input from higher brain centres.

The spinal cord passes through the vertebral canal and extends from the foramen magnum to the level of L1 or L2. Thirty-one pairs of spinal nerves arise from the spinal cord and pass through the intervertebral foramina of the vertebral column. Each portion of the cord that gives rise to a pair of spinal nerves is called a spinal segment. The roots of the lower spinal nerves pass some distance inferiorly before reaching the appropriate intervertebral foramen. At the end of the spinal cord, the mass of descending lumbar and sacral spinal roots has the appearance of a horse's tail and is called the cauda equina.
The inside of the spinal cord contains the grey matter, with the white matter surrounding this. The grey matter is shaped like an H and is comprised of two dorsal horns (sensory nerves) and two ventral horns (somatic motor nerves). These give rise to a dorsal and ventral nerve root (pl.= rami) which in turn give rise to the spinal nerve. In the thoracic and upper lumbar regions there are also two lateral horns that give rise to visceral motor nerves (innervate the organs) – think about the location of organ systems in the body and relate that to the reason why the Lx and Tx spinal cord has the visceral component . The cell bodies of the sensory nerves are located outside the spinal cord within enlargements of the dorsal root. These enlargements lie in the intervertebral foramina and are called the dorsal root ganglia (ganglion - singular).

The white matter of the spinal cord completely surrounds the grey matter and is composed of myelinated axons which travel in three directions:

1. Up the cord to the brain or higher levels of the cord.
2. Down the cord from higher levels of the cord or the brain.
3. Across the cord, transmitting impulses from one side of the cord to the other.

The Spinal Reflex Arc.

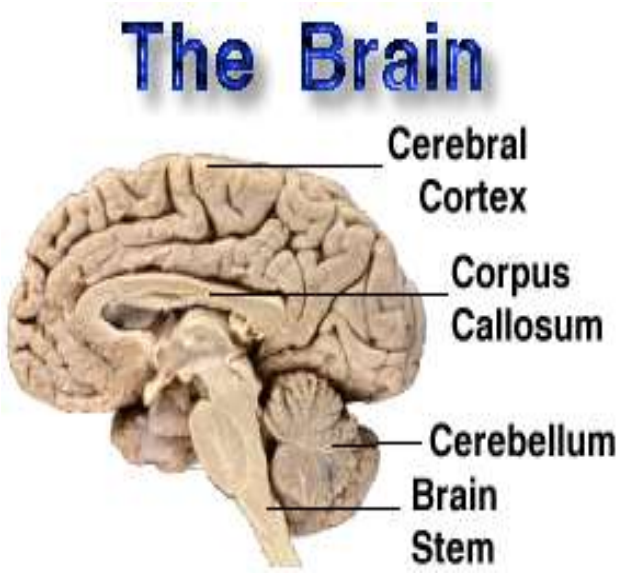
Some sensory neurons synapse, through an interneuron, with motor neurons in the ventral horn of the grey matter at the same level at which they enter the cord. Other impulses travel only 1 or 2 levels up or down the cord before synapsing with a motor neuron. The neural pathway by which sensory impulses from receptors reach effectors without travelling to the brain are called spinal reflex arcs. The presence of spinal reflex arcs makes possible automatic, stereotypes reactions to stimuli.

The reflex pathway is as follows:

1. Receptor on the peripheral end of a sensory nerve.
2. Sensory or afferent neuron which carries the impulse to the spinal cord.
3. Synapse with a motor neuron, usually via an interneuron.
4. Motor or efferent neuron which transmits the impulse from the cord to an effector.
5. Effector muscle or organ, which responds to the efferent nerve impulse.

This is also why it is important to have your patient relaxed when you treat them

The nervous system that controls smooth and cardiac muscle is the autonomic nervous system. This system regulates the internal environment and it is generally involuntary. The autonomic nervous system contains two subdivisions: the sympathetic and the parasympathetic nervous systems. The Sympathetic nervous system and the parasympathetic nervous system have opposite effects when they act upon the same organ. The parasympathetic nervous system enhances activities and is able to conserve energy. Conversely the sympathetic nervous system increases energy expenditures and prepares the individual for action.



The spinal cord is a long bundle of white nerve matter that resides in the middle of the spinal column. This serves as the link between the brain and the body. It also serves as the center from which reflexes stem from.

The brain is much more complex than the spinal cord. It has many divisions within it. These are the brain stem, the cerebellum, the cerebrum.

The brain stem is the core for most of the life systems commands such as breathing and heartbeat. It is the most primitive of the brain divisions and the process that are contained within it cannot be consciously controlled.

The cerebellum is the next most advanced of the brain divisions. It controls balance and the coordination of muscles to obtain movement.

The cerebral cortex is by far the most advanced part of the brain. This is where conscious though takes place. The cerebellum itself can be divided into the left and right hemispheres. It can also be divided into the parts that control specific functions such as hearing and sight. The right hemisphere, generally, is the artistic side of the brain. People who are right brained (their right hemisphere is dominate over the left) are into art, music, and abstract thinking. Left brained people are very logical. They excel in math and physics and other logical thought processes.

The two hemispheres are connected by the corpus callosum which is the means for the two hemisphere to communicate with each other. However, it has been proved by scientific experiment that both hemispheres with function normally if the corpus callosum is severed.

SPINAL NERVES.

Spinal nerves contain both sensory and motor nerve fibres. After passing through the intervertebral foramina, each spinal nerve divides into 2 branches: a dorsal ramus and a ventral ramus. The dorsal rami pass posteriorly to supply the skin and muscles of the back. The ventral rami are longer and their distribution varies in different body regions. In the cervical, lumbar and sacral regions, the ventral rami of successive spinal nerves unite to form plexuses (networks) that give rise to the nerves supplying the skin, muscles and joints of the upper and lower limbs. It is important to note that in the cervical region of the spine, the spinal nerves are named for the number of the vertebra below which is why we have spinal nerves C1 to C8 but only 7 cervical vertebrae. At T1 the nomenclature changes and the spinal nerves are then named for the vertebra above where they exit the spinal canal (see pg 70-72).

PLEXUSES AND PERIPHERAL NERVES.

The peripheral nerves are formed by the intermixing of the ventral rami of the spinal nerves in plexuses and have specific names. Peripheral nerves supply the skin and underlying muscles of the limbs. The main nerve plexuses, all of which are paired, are the cervical, brachial and lumbosacral plexuses.

The Cervical Plexus.

Formed by the ventral rami of the first 4 spinal nerves and is situated opposite the upper 4 cervical vertebrae, deep to the internal jugular vein and the sternocleidomastoid and anterior to the scalenus medius and the levator scapulae. Branches from the plexus supply the muscles and skin of the head, neck, shoulder, chest and diaphragm. Cranial nerves X (vagus), XI (accessory) and XII (hypoglossal) interconnect with the cervical plexus.

The Brachial Plexus.

Formed by the ventral rami of spinal nerves C5 to T1 and usually includes parts of C4 and T2 spinal nerves. The brachial plexus extends downwards and laterally, passing behind the clavicle to enter the axilla.

THE AUTONOMIC NERVOUS SYSTEM (ANS)

The ANS is part of the efferent division of the peripheral nervous system. It is composed entirely of visceral motor (efferent) neurons that innervate and thus regulate the activity of cardiac muscle, smooth muscle and glands of the body.

This system is normally an involuntary system that functions below the conscious level. The ANS is structurally and functionally an integral part of the body's single nervous system. (i.e.: many of the nerve fibres of the ANS travel in the spinal nerves and certain cranial nerves.)

The efferent pathways of the ANS that run from the CNS to the effectors are composed of two neurons:

1. Preganglionic (presynaptic) neuron - cell body in the CNS.
2. Postganglionic (postsynaptic) neurons - cell body outside CNS.

The axon of the preganglionic neuron travels to an autonomic ganglion located outside the CNS, where it synapses with the postganglionic neurons. The axons of postganglionic neurons generally form networks called autonomic plexuses, which then travel to the various effectors. This two neuron chain differs from the somatic nervous system, where a single motor unit travels from the CNS to the structure innervated.

The ANS can be separated structurally and functionally into two divisions:

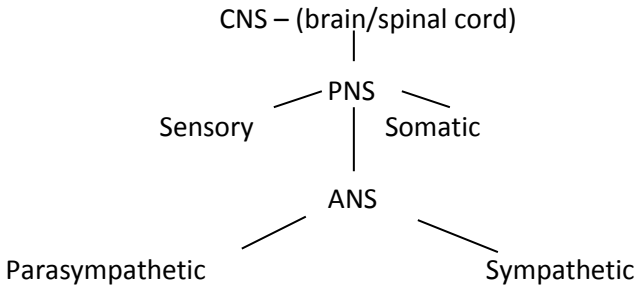
Sympathetic division (used in emergency or stress situations).
Parasympathetic division (used to conserve and restore body resources).

EFFECTS OF THE ANS.

STRUCTURE	SYMPATHETIC	PARASYMPATHETIC STIMULATION

	STIMULATION	
Heart	Increase rate	Decreases rate
Lungs	Dilates bronchioles Inhibits gland secretion	Constricts bronchioles Stimulates gland secretion
Salivary glands	Secretion of viscous fluid	Secretion of watery fluid
Stomach	Decreased motility Secretion inhibition	Increased motility Secretion stimulation
Intestine	Decreased peristalsis Secretion inhibition	Increased peristalsis Secretion stimulation
Pancreas (exocrine)		Secretion stimulation
Liver	Increased glucose release	
Eye	Dilates pupil	Constricts pupil
Sweat glands	Secretion stimulation	
Adrenal medulla	Secretion stimulation	
Urinary bladder	Relaxation	Contraction
Blood vessels of skin	Constriction	

Schematic Summary



It is important to realise that the nervous system is not discreet – it is continuous with the circulatory and lymphatic systems and is surrounded by connective tissue. It is also important to note that you are able to override reflexes through treatment, for example stretching a muscle. This overrides the contraction response when the muscle reaches stretch.

Short, possibly helpful glossary

Viscera – internal organs of the body

Somatic – pertaining to muscle

Cerebral – of the brain

Cephalic – of the head

Afferent – towards the CNS

Efferent – away from the CNS

NERVOUS CONTROL OF MUSCULAR CONTRACTION

For movement to occur, a message is transmitted from the brain, via the spinal cord & nerves and then on to the muscle. Nerves are made up of bundles of neurons, or nerve cells.
The neurons that transmit impulses to muscles are called motor neurons.

Motor Neurons

- The motor neuron consists of a cell body that directs the neuron's activities, branches that pick up the impulse called dendrites and an axon that transmits the message to the muscle.
- The terminal ends of the axon are known as motor end plates.

Motor Unit

- A single motor neuron joins with many muscle fibres.
- The motor neuron & the number of muscle fibres that it innervates is called a motor unit.
- All muscle fibres will respond when the motor neuron is activated.

- The muscle fibres will either not respond to an impulse, or respond once the impulse reaches a certain intensity & frequency (Maughan et.al. 2004 p24).
- A motor neuron in the eye may stimulate 4 muscles compared to a back extensor that may stimulate 2000 muscle fibres (Watkins, 1999).
- The force produced by muscles can increase by:
- Increasing the number of motor units recruited
- Increasing the frequency at which the motor units are stimulated
- For example: When a light load is lifted by the back extensors, few motor units are activated at a low frequency. When a heavy load is lifted, more motor units are activated at a higher frequency.

THE PERIPHERAL NERVOUS SYSTEM OF THE LOWER LIMB

THE LUMBOSACRAL PLEXUS.

The nerves of each lumbosacral plexus supply the skin and muscles of the buttocks, pelvis, lower abdomen and lower limbs. The plexus is divided into two sections which are connected by a lumbosacral trunk of nerves:

1. The lumbar plexus.
2. The sacral plexus.

THE LUMBAR PLEXUS.

Each lumbar plexus is formed from the ventral rami of lumbar nerves 1-3 and most of the 4th lumbar nerve and some fibres from the twelfth thoracic nerve. It lies within the posterior part of psoas major, in front of the lumbar TP's.

Formation of the Lumbar Plexus.

The first lumbar nerve receives a branch from the last thoracic nerve and splits into upper and lower branches. The upper, larger branch splits into the iliohypogastric and ilio-inguinal nerves. The lower smaller branch unites with a branch from the second lumbar nerve to form the genitofemoral nerve.

The rest of the second, the third and part of the fourth lumbar nerves divide into ventral and dorsal branches. The ventral branches of the 2nd, 3rd and 4th lumbar nerves unite to form the obturator nerve. The dorsal branches of the 2nd and 3rd nerves each divide into a smaller and larger part. The smaller parts unite to form the lateral femoral cutaneous nerve. The larger parts unite with the

dorsal branch of the 4th nerve to form the femoral nerve. The accessory obturator nerve, when it exists, arises from the ventral branches of the 3rd and 4th nerves.

Main Branches of the Lumbar Plexus.

NERVE	SPINAL NERVES INVOLVED	DISTRIBUTION
Iliohypogastric	T12, L1	Skin & muscles of lower back, hip & lower abdomen.
Ilioinguinal	L1	Skin of upper medial thigh & external genitalia. Muscles of lower abdominal wall.
Genitofemoral	L1, 2	Skin of anterior thigh, almost to the knee & external genitalia.
Lateral femoral cutaneous	L2, 3	Skin of lateral thigh.
Femoral	L2, 3, 4	Skin of anterior & medial thigh, leg & foot through anterior femoral cutaneous and saphenous branches. Muscles sartorius, iliopsoas, quadriceps femoris & pectineus.
Obturator	L2, 3, 4	Skin of medial thigh. Muscles adductors longus, magnus & brevis, gracilis, pectineus & obturator externus.

The Lumbosacral Trunk.

The lumbosacral trunk comprises a part of the ventral ramus of the 4th lumbar nerve and the whole ventral ramus of the 5th lumbar nerve. It appears at the medial side of psoas major and descends over the pelvic brim anterior to the sacro-iliac joint, where it joins with the ventral ramus of the 1st sacral nerve.

THE SACRAL PLEXUS.

The sacral plexus is formed by the lumbosacral trunk, the ventral rami of the 1st, 2nd and 3rd sacral nerves and part of the 4th sacral nerve, the remainder of which joins the coccygeal plexus. The nerves forming the sacral plexus converge towards the greater sciatic foramen and unite without much interlacement to form an upper, large and lower, small band.

Formation of the Sacral Plexus.

The Upper Band.

Formed by the union of the lumbosacral trunk with the 1st, 2nd and greater part of the 3rd sacral nerves and is continued into the sciatic nerve, which is comprised of the tibial and common peroneal nerves. The tibial nerve is formed from the ventral rami of the upper band and the common peroneal nerve is formed by the dorsal rami of the upper band. Smaller nerves originating from the upper band include the superior and inferior gluteal nerves, the posterior femoral cutaneous nerve and the nerve to piriformis.

The Lower Band.

Formed by the smaller part of the 3rd sacral nerve joining with the portion of the 4th sacral nerve that is concerned with the sacral plexus, plus a small contribution from the 2nd sacral nerve. The main nerve from the lower band is the pudendal nerve.

Main Branches of the Sacral Plexus.

NERVE	SPINAL NERVES INVOLVED	DISTRIBUTION
Superior gluteal	L4, 5, S1	Muscles gluteus medius, minimus and tensor fascia lata.
Inferior gluteal	L5, S1, 2	Muscles gluteus maximus
Posterior femoral cutaneous	S1, 2, 3	Skin on posterior thigh.
Pudendal	S2, 3, 4	Skin & muscles of peroneum & external genitalia.
Sciatic		Skin of posterior leg & sole of foot.
Tibial: Sural, and Medial & lateral plantar	L4, 5, S1, 2, 3	Muscles hamstring group, flexor digitorum longus, flexor hallucis longus, tibialis posterior, popliteus & foot intrinsics.
		Skin of anterior leg & dorsum of foot.
Common peroneal: Superficial & deep peroneal	L4, 5, S1, 2	Muscles peroneals, tibialis anterior, extensor hallucis longus, extensor digitorum longus & brevis.

PATHWAYS OF THE MAIN NERVES

Femoral:
Pierces the psoas major muscle and runs inferolaterally within it to emerge between the psoas major and iliacus muscles, just superior to the inguinal ligament. It passes under the inguinal ligament lateral to the femoral vessels (V.A.N.), outside the femoral sheath. It descends through the femoral triangle, then divides into several terminal branches, including the saphenous nerve that passes through the adductor canal and becomes superficial by passing between the sartorius and gracilis. It passes antero-inferiorly to supply the skin and fascia of the anterior and medial knee, leg and foot.

Obturator:
Descends through the psoas major muscle leaving its medial border at the pelvic inlet. It pierces the psoas fascia, crosses the SIJ and enters the true pelvis. It leaves the pelvis through the obturator foramen and enters the medial thigh. The accessory obturator nerve when it exists lies medial to psoas major. Once in the medial thigh compartment, it sends branches to the adductor muscles.

Sciatic:
Leaves the pelvis via the greater sciatic foramen, passing over, under or through the piriformis, about half way between the ischial tuberosity and the greater trochanter. It passes superficial to the obturator internus, quadratus femoris and adductor magnus muscles. The most common place for the tibial and common peroneal nerves to separate is at mid thigh, but it can occur more proximally.

Tibial:
Descends through the middle of the popliteal fossa and at the distal border of popliteus passes deep to soleus, then centrally down the posterior calf. It then curves medially and passes posterior to the medial maleollus between the posterior tibial vein and flexor hallucis longus tendon (Tom, Dick And Very Naughty Harry). It branches in the medial and lateral plantar nerves of the sole of the foot.

The sural nerve is a cutaneous branch of the tibial that arises in the popliteal fossa and passes between the heads of gastrocnemius and enters the foot posterior to the lateral maleollus.

Common Peroneal:
Follows the medial border of the biceps femoris tendon along the popliteal fossa. It passes superficial to the lateral head of gastroc. Then winds around the neck of the fibula to the lateral compartment of the leg. Deep to peroneus longus muscle the CP nerve divides into the superficial peroneal nerve, which travels distally in the lateral compartment and the deep peroneal nerve, which continues on to the anterior compartment and passes deep to the anterior leg muscles.

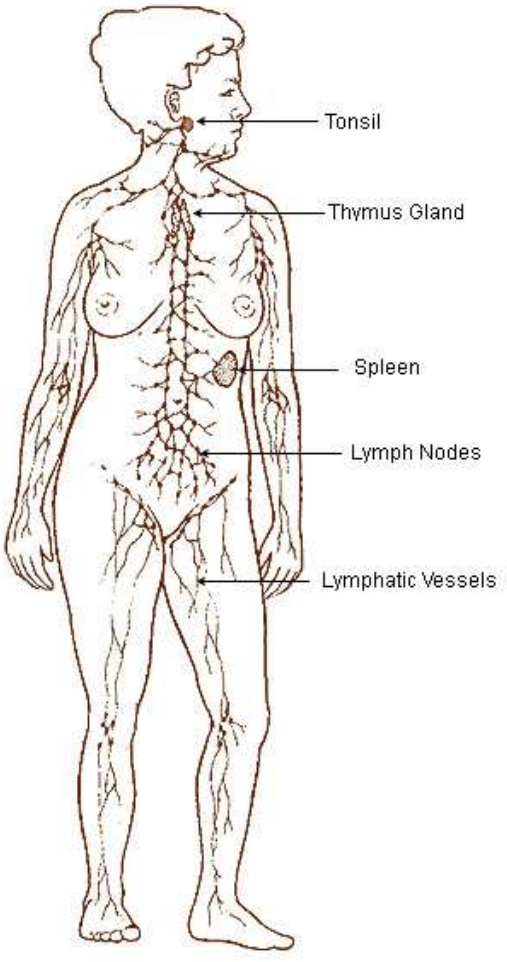
Figure 6.15 shows the innervation of the lower limb including lumbar and sacral plexuses.

THE COCCYGEAL PLEXUS.

Formed by a small descending branch from the ventral ramus of the 4th sacral nerve, the ventral ramus of the 5th sacral nerve and the coccygeal nerves.

LYMPHATIC SYSTEM

The lymphatic system in vertebrates is a network of conduits that carry a clear fluid called lymph. It also includes the lymphoid tissue through which the lymph travels. Lymphoid tissue is found in many organs, particularly the lymph nodes, and in the lymphoid follicles associated with the digestive system such as the tonsils. The system also includes all the structures dedicated to the circulation and production of lymphocytes, which includes the spleen, thymus, bone marrow and the lymphoid tissue associated with the digestive system.



The dissolved constituents of the blood do not directly come in contact with the cells and tissues in the body, but first enter the interstitial fluid, and then the cells of the body. Lymph is the fluid that is formed when interstitial fluid enters the conduits of the lymphatic system. The lymph is not pumped through the body like blood, but is moved mostly by the contractions of skeletal muscles.

The lymphatic system has three interrelated functions. It is responsible for the removal of interstitial fluid from tissues. It absorbs and transports fatty acids and fats as chyle to the circulatory system. The last function of the lymphatic system is the transport of antigen presenting cells (APCs), such as dendritic cells, to the lymph nodes where an immune response is stimulated.

The study of lymphatic drainage of various organs is important in diagnosis, prognosis, and treatment of cancer. The lymphatic system, because of its physical proximity to many tissues of the body, is responsible for carrying cancerous cells between the various parts of the body in a process called metastasis. The intervening lymph nodes can trap the cancer cells. If

they are not successful in destroying the cancer cells the nodes may become sites of secondary tumors.

Diseases and other problems of the lymphatic system can cause swelling and other symptoms. Problems with the system can impair the body's ability to fight infections

Diseases of the lymphatic system

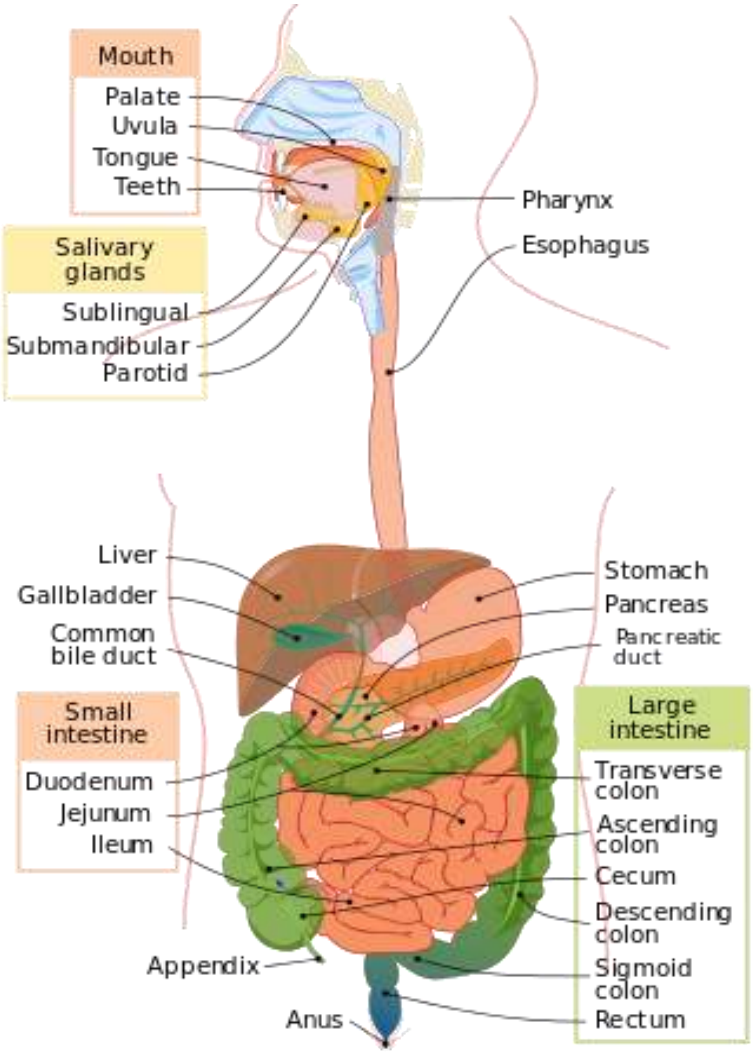
Lymphedema is the swelling caused by the accumulation of lymph fluid which may occur if the lymphatic system is damaged or has malformations. It usually affects the limbs, though face, neck and abdomen may also be affected.

An estimated 170 million people develop lymphedema, which progresses in three stages:
Stage 1: Pressing the swollen limb leaves a pit that takes a while to fill back in. Because there is little fibrosis (hardening) it is often reversible. Elevation reduces swelling.

Stage 2: Pressure does not leave a pit. Elevation does not help. If left untreated, the limb becomes fibrotic.
Stage 3: This stage of lymphedema is often called elephantiasis. It is generally only in the legs after lymphedema that has gone long untreated. While treatment can help a little, it is not reversible.

THE DIGESTIVE SYSTEM

The digestive system is one of the most complex systems of the body. The digestive system provides the body's means of transforming food to energy. Food first enters the digestive system through the mouth, goes through multiple organs, until they are transformed into enzymes, glucose, and other nutrients that the body can use.



The Digestive tract

The mouth and teeth are the first organs of the digestive tract. The teeth are bones whose primary purpose is to grind food in to easy bits that the body can digest. In the mouth, a base known as saliva helps begin to separate the chemical make up of food.

There are certain organs that are located in the mouth, such as the uvula, the tongue, and the frenulum (the organ that connects the tongue to the base of the mouth). The walls of the inner cheeks are lined with mucous which help protect the food from bacteria, and also protect the cheeks form saliva.

The Pharynx is the passage way through which many tubes run from the mouth and the nose to the upper body. Some of these tubes are the nasopharynx, which runs oxygen to the lungs, and the oropharynx, which also runs oxygen to the lungs.

The esophagus runs from the pharynx to the diaphragm, to the top of the stomach. The esophagus is really a large muscle which pushes food down to the stomach. The walls of the esophagus are lined with four layers of thin tissue. These membranes are, the mucosa, the submucosa, the muscularis externa, and the serosa

The stomach is a J- shaped muscle. The stomach acts as a churn. There are two sphincters, circular muscles that act as valves that are placed outside organs, surrounding the two openings of the stomach. Chemical breakdown of food begins in the stomach.

The constant churning helps allow digestion in the stomach improve. There are several of acids located in the stomach. One of these acids is known as gastric juice. Gastric juice is manufactured in gastric glands located in the stomach. With gastric juice and other acids being mixed with the food, it breaks down and become a creamy substance known as chyme. After being transformed into chyme , food leaves a sphincter to the small intestine

The small intestine is the primary organ of the of the digestive tract. In the small intestine, chyme is finally mixed for its passage to cells. The small intestine may be subdivided into three segments. A sphincter is located at the top of the small intestine. The first segment of the small intestine is known as the deudodenum. The second segment of the small intestine is known as the jejunum. The final segment of the small intestine is known as the ileum. Most of food digestion through acids and bases occurs in the small intestine. Since the small intestine can only process a small amount of chyme, the spchinter located outside of the small intestine regulates the amount of food that passes through the small intestine. Bile helps digest the chyme furthermore. Bile, an enzyme that helps digest food, is manufactured in the liver.

In addition to digesting chyme, the small intestine is responsible for absorbing the processed food into the bloodstream, so that energy can be deriven from the food. This absorption takes place through anatomical structures known as villi. Villi are structures ,that act as valves, that allow solids liquids and/or acids to pass through one structure to another. Through these Villi, all the useful nutrients that are located in chyme pass through the small intestine into the bloodstream. The undigested chyme, or not useful nutrients then pass to the large intestine.

The large intestine stretches from a valve that rests between the bottom of the small intestine and the top of the large intestine, to the anus. The main job of the small intestine is to digest any undigested chyme, and to rid the body of any unneeded wastes by sending it to the anus. The large intestine has many subdivisions such as the cecum, the appendix, the colon, the rectum, and the canal.

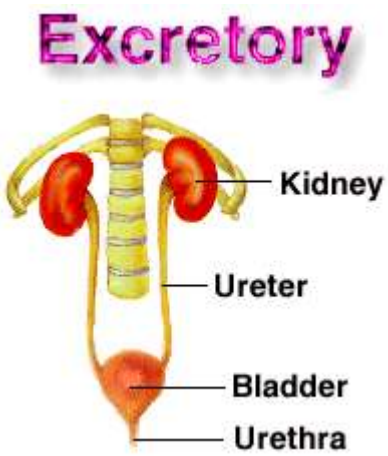
Diseases of the Digestive system

There are a number of diseases and conditions affecting the gastrointestinal system, including:

- Cholera
- Colorectal cancer
- Diverticulitis
- Enteric duplication cyst

- Gastroenteritis, also known as "stomach flu";an inflammation of the stomach and intestines
- Giardiasis
- Inflammatory bowel disease
- Irritable bowel syndrome
- Pancreatitis
- Peptic ulcer disease

THE EXCRETORY SYSTEM



The excretory system, or urinary system, is composed of multiple organs. The main organ of the urinary system is the kidney. The kidney performs dual tasks of filtering out wastes and purifying blood. The main function of the kidneys is to filter out wastes. Other organs in the urinary system include; the urinary bladder, the ureters, and the urethra. The ureters are two tubes that transport urine from the kidneys to the urinary bladder. The urinary bladder is a large hollow muxcle sac that holds urine. The urethra is a tube that transports urine from the bladder to an opening outside the body.

The kidneys are responsible for purifying the blood. They are one of the best examples of homeostatic organas, organs responsible for maintaining a balance of elements. They work muck like sanitation workers filtering and disposing of wastes from the blood. The kidneys are protected by floating ribs located in the mid back. They are small dark red, bean-shaped organs. Due to the placement of the liver, the right kidney is a bit lower than the left.

The kidney is enclosed by a transparent, fiberous, renal capsule. A mass of fat, known as the adipose capsule encases each kidney, and provides some protection. The kidney can be divided into three regoins, the renal cortex, the renal medulla, and the renal pelvis. The renal cortex is the light colored, outer region of the kidney. The renal medulla is the darker, reddish-brown region.

The primary function of the kidneys is to clean the blood, resulting in a large amount of blood being continuously present in the kidneys. Some one quarter of the body's blood enters the kidneys per minute. The renal artery is the large arterial vessal which enters the kidneys then branches off to segmented arteries. This vessel brings in oxygenated blood from the heart. The renal vein is the large vessel by which cleansed blood exits the kidney.

Nephrons are small structural units that are responsible for the formation of urine. There are millions of nephrons in each kidney. A nephron is made up of two parts, the glomerus, and the renal tubule. At the end of the renal tubule, there is a cup shaped region. This region is known as Bowmans capsule. Urine is formed when the nephrons participate in a three-step process. The three processes are filtration, reabsorption, and secretion.

During this process, the glomerus acts as a filter. Filtration is a passive, non-selective process. The glomerus forms a filtrate. The filtrate is made up of blood plasma with out blood proteins. The blood plasma forms a filtrate membrane that doesn't allow blood proteins or plasma to pass through. This filtrate allows wastes, such as Nitrogen and Carbon Dioxide to pass through.

Though the filter membrane contains many wastes, it also houses some useful substances. These substances, such as proteins, may be reabsorbed into the blood stream. The process of useful substances moving from the filtrate membrane, to the blood stream is known as tubular reabsorption. Tubular reabsorption begins when the filtrate enters the convuluted tube. Tubule cells act like transporters and move useful substances from the filtrate to the extracellular space. There are two ureters that run from the hilius of each kidney to the posterior are of the bladder. The ureters job is to transport the freshly collected urine from the kidneys to the bladder. Layers of muscle tissue line the walls of the ureters. These muscles help "push" urine from the kidneys to the bladder. When urine has entered the bladder, ther are a number of valve-like mucosa that prevent urine from traveling up the ureters.

The urinary bladder is a large hollow, muscular organ that temporarily holds urine. The urinary bladder is located retroperitoneally in the pelvis, and is posterior to the pubic symphysis. There are three openings in the bladder, two of them are for the ureters, and one is for the urethra. The triangular base of the bladder is known as the trigone. Most infections of the bladder occur at the trigone. The male prostate gland is located in the bladder near the urethra's opening. The walls of the bladder are made up of three layers of muscle tissue. Collectively, these muscles are known as the detrosur muscle. As urine collects in the bladder the walls of the bladder expand and rise. The urethra is a narrow, hollow passageway that flows from the bladder to the to an opening outside the body. At the junction of the bladder and urethra, smooth muscle forms the internal urethral sphincter. The internal urethral sphincter is an involuntary muscle that prevents urine from flowing up the urethra to the bladder. At the end of the urethra is the external urethral sphincter. This sphincter is voluntary and regulates urine flowing from the bladder to an opening outside the body.

ENDOCRINE SYSTEM

Next to the nervous system the endocrine system is the system that controls the body. However, the endocrine system uses hormones to stimulate the metabolic activities of the cells. These hormones are released into the blood stream. Tissue response to hormones usually occur after a lag time of seconds or days. Once started the responses tend to be much more prolonged than those that are induced by the nervous system.

The organs of the endocrine system are small and unimpressive. The endocrine glands of the body include the pituitary, thyroid, parathyroid, adrenal, pineal, and thymus.

Hormones are chemical compounds that regulate metabolic function of cells in the body. There are two types of hormones: amino acid-based hormones and steroids. Most hormones are amino acid-based. Steroid hormones are synthesized from cholesterol. Only the gonadal hormones and adrenocortical hormones are steroids.

A hormone is a chemical that is synthesized and secreted by a group of specialized cells that are called glands. Glands are classified in two ways: exocrine or endocrine. Exocrine glands use ducts to transport their secretions. Endocrine glands, on the other hand, don’t use ducts to transport their hormones. Instead they secrete into the blood stream for distribution.

Another key component of the endocrine system is the receptors for the hormones on the surface of the cell membrane. Receptors are composed of proteins and imbedded in the cell membrane just like other proteins.

There are over 50 hormones in the human body, and they can be grouped together by their chemical structure. Steroids are produced from cholesterol. Peptides are chains of amino acids. Other hormones are derived from amino acids.

Several glands comprise the endocrine system. The hypothalamus integrates the endocrine system and the nervous system. It receives signals from the brain and the peripheral nerves. It then initiates the endocrine system. The cells that comprise the hypothalamus are called nuerosecretory cells. The cells are able to receive a nerve impulse just like a nerve cell would, but instead of passing it on to another cell they trigger the release of hormones in the blood stream.

The pituitary is sometimes referred to as the master gland. However, most of the time the pituitary receives orders from the hypothalamus. There are two lobes on the pituitary. The posterior lobe, called the neurhypophysis, stores hormones manufactured by the hypothalamus and secretes them

on command. The anterior lobe, called the adenohypophysis, is able to produce it's own hormones which act on other glands.

The thyroid gland is located on the front surface of the trachea. It has two lobes, and it produces two hormones: Triiodothyronine (T3) and Thyroxine (T4). Both T3 and T4 have the same effect on the target cell, but T3 is usually most active. The thyroid also regulates metabolism. The thyroidal secretions are controlled by both the hypothalamus and the pituitary.

The pancreas secretes insulin, a hormone that regulates glucose in take of the cells. A deficiency in this hormone results in diabetes mellitus. Insulin regulates the blood sugar levels by stimulating cells to take in glucose. It also stimulates the synthesis of protein and fat storage.

The adrenal medulla is the gland behind the fight-or-flight reaction. It secretes two hormones: epinephrine and norepinephrine. (Epinephrine is also known as adrenaline.) Epinephrine secretion is triggered by stress, both positive and negative stress. It increases the rate and the stroke volume of the heart.

The testis and ovaries secrete hormones that are grouped into three major categories: androgens, estrogens, and progestins. All three are found in both males and females, but each in varying amounts.

Androgens are primarily produces by the testis. Testosterone is the primary hormone in this group. Androgens stimulate the maintenance and development of the male reproductive system.

Estrogens are the female equivalent of Androgens. They maintain the female reproductive system and trigger the development of female second sex characteristics. Progestins maintain and prepare the uterus for growth and development of an embryo.

IMMUNE SYSTEM

The Immune system is the body's main defense against all foreign substances. Without the immune system, the human body would die immediately from foreign bacteria. Billions of which rest on the skin.

The skin is the body's first line of defense, it plays a major role in preventing disease by protecting all the organs, blood vessels, and the lymph system. Without the skin, bacteria and viruses could easily enter the blood system. The skin also houses many lymph nodes. Lymph nodes are a part of the lymph system, a network of vessels which transport white blood cells, or phagocytes, throughout the body to combat disease.

Mucous membranes are cells that line all openings of the body. When dust particles enter the body, they get caught in the mucous membranes and are then digested.

Nose hair is the bodies natural air filtration system. Nose hairs capture dust particles keeping them from accumulating in the lungs. A sneeze is the body's way of ridding itself of accumulated dust particles.

The lymph system is made up of T cells, B cells, antibodies, and platelets. When the skin is scratched, platelets travel to the wound. They then try to mend the wound, and stop the bleeding. The T cells are the cells that attack all diseases that enter the body. B cells are the cells that manufacture antibodies. Antibodies are proteins that isolate pathogens, foreign substances, so that T cells can attack and destroy it.

In today's world there are virtually millions upon millions of diseases. Most diseases are caused by viruses or bacteria. Viruses are considered non-living parasites which enter healthy cells, release their own DNA and cause the healthy cell to begin manufacturing other virus bodies. Since viruses are not alive, antibiotics cannot kill them; therefore, most viruses have no cure. When a virus enters the body, antibodies are sent to isolate the virus, then B cells arrive to infiltrate and finally kill the virus.

Bacteria on the other hand is a living parasite. It performs the same functions as a virus, but it is considered a living parasite. Since bacteria is living, antibiotics can be used to kill it. There are three types of bacteria, bacilla, cocci, and spirili. Bacilli bacteria are rod shaped and usually appear alone, only occasionally found in groups. Cocci are spherical bacteria that occur in chains of cells, singularly, or in clusters that resemble a bunch of grapes. Spirili are spiral shaped bacteria, they are curved, and resemble a comma. Bacteria is considered deadly due to the fact that it can reproduce very quickly.

In today's medical world, most attention has been directed toward deadly viruses that the body cannot kill. The most deadly virus is known as AIDS, or acquired immune deficiency syndrome. The aids virus is one of the more peculiar viruses. It infiltrates the body and conquers the T cells. When the T cell has been infected, it begins to produce AIDS cells. These new AIDS cells then attack all of the remaining B cells until all of the B cells are dead. With no means of defense, the body then becomes terminally infected and dies.

THE INTEGUMENTARY SYSTEM

The integumentary system, commonly called the skin, wraps the body and serves several purposes. First it offers protection to the underlying layers from the sun. It also serves in body temperature regulation. The skin is also home to millions of nerves that respond to temperature, touch, pressure, and pain.

The skin has two layers: the epidermis and the dermis. The epidermis is the upper layer of the skin. It has up to five layers, called strata. Under the epidermis is the dermis.

This layer connects the skin to the underlying tissue. It is in the dermis that hair follicles and sweat glands reside.

Fingerprints are a result of dermal ridges which produce looped and whirled ridges on the epidermis. This gives the fingers and toes extra gripping ability.

Skin color is determined by three pigments: melanin, carotene, and hemoglobin. However, only melanin is made in the skin. Melanin can be gradated into many different shades. It is this ability of Melanin that gives different races different skin coloration.

Exposure to sunlight can also cause a temporary change in the color of melanin. Carotene has a yellow-orange color and is primarily found in the palms and the soles. Hemoglobin gives fair-skinned people a pink hue to their skin due to the lack of melanin in the epidermis, which makes it almost transparent.

Hair on other mammals serves them to keep them warm. However, the sparse covering of hair on the human body serves other purposes. It is able to sense insects on the skin before they are able to sting. The hair on the head serves to control and prevent heat loss as well as guard against sunlight and physical trauma.

Hair is produced by hair follicles in the skin. These follicles are heavily vascularized and are surrounded by nerve fibers. Goose bumps occur when small muscles pull the follicles upright producing a bump on the surface of the skin.

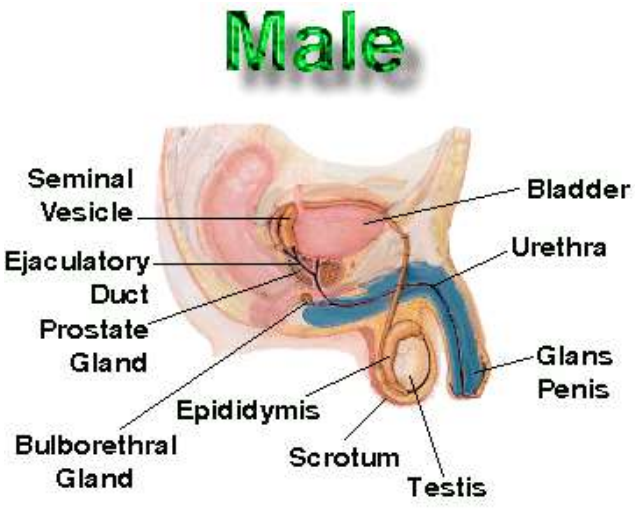
Sweat glands are distributed throughout the skin. Their basic function is to cool the body. This is accomplished by evaporation. Evaporation of sweat off of the body dissipates body heat.

REPRODUCTIVE SYSTEM

The reproductive system is the system that allows for the continuation of the human species. This system is different in both males and females. The role of the male's reproductive system is to manufacture sperm and then to deliver them to the female's reproductive tract where fertilization may occur. The role of the female's reproductive system is basically the same except that it goes further if the sperm meets an egg. If fertilization occurs the female reproductive system is designed to nurture and care for the cell that will soon grow into a baby.

The sperm is produced in the males testis and then travels through a series of ducts to reach the body exterior. The eggs are produced in the ovary of a female. When a egg is to be expelled or ovulated a "blister forms on the exterior of the ovary. When the "blister" bursts the egg is collected by the ends of the fallopian tubes and travels through the fallopian tubes where it can be fertilized by a single sperm.

If an egg is fertilized it travels down into the uterus where it embeds in the wall of the uterus. There it divides rapidly and the cells begin to specialize into the different organs of a pregnancy. Some of the cells form the amniotic sac while some form the placenta and the umbilical cord. Only a small number of these cells will eventually form the fetus.



Male Reproduction:

The scrotum and the penis are the male genitalia. The male gonads, called testis, are tightly coiled tubes surrounded by tissue. It is in these tubes where sperm forms. The male gonads are located outside of the body since sperm productions can only occur at about two degrees Celsius lower than normal body temperature. After the sperm are produced they mature and are stored in the epididymus.

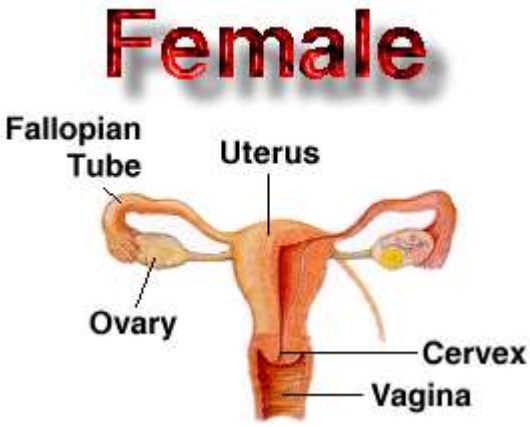
The male reproductive system also contains three sets of glands that add secretions to the semen. Sixty percent of semen is secreted by the seminal vesicles. They lie behind and below the bladder and empty directly into the ejaculatory duct. The fluid secreted is clear yet thick. It contains mucus, amino acids, and fructose. The fructose provides energy for the sperm.

The prostate gland surrounds the beginning of the urethra in which it secretes its products. Prostatic fluid is milky, thin, and alkaline in order to balance the acidity of any urine remaining in the urethra and the acidity of vaginal fluids. Bulbourethral glands lie along the urethra below the prostate. Although their specific function is still unknown, they do secrete a viscous fluid before ejaculation.

Three layers of spongy tissue comprise the human penis. When sexually aroused, this tissue fills with blood from the arteries, while the veins are sealed. This produces an erection.

The shaft of the penis is covered in relatively thick skin. The head, or glans penis, is covered with thinner skin. This results in extra sensitivity in the glans penis area.

Female reproduction:



Ovaries, the female gonads, are located below the digestive system in the abdominal cavity. Inside each ovary are many follicles which consist of a single egg cell and one or more layers of follicle cells. Follicle cells protect and nourish the egg cells. A woman is born with about 400,000 follicles and cannot produce more.

Ovulation is the process in which an egg is expelled from a follicle. The egg is expelled directly into the abdominal cavity and is picked up by the fallopian tubes. Inside the fallopian tubes are cilia which sweep the egg into the uterus. At the neck of the uterus is the cervix which leads into the vagina. The vagina has very thin walls, much thinner than those of the uterus.

At the end of the vagina are two pairs of folded skin, the libia minora and the libia majora. At the top of the libia is glans clitoris, a small bulb of erectile tissue. Like glans penis, glans clitoris is very sensitive to stimuli.

Before fertilization can occur, the sperm must reach the egg. Each egg is only viable for 12 to 48 hours and some sperm can survive for as long as 72 hours, but most can only retain their fertilizing power for 12 to 48 hours. Therefore in order to produce offspring, sex must occur no more than 72 hours before ovulation or no later than 24 hour after.

The moment of ejaculation, millions of sperm are propelled into the female's reproductive tract. Some sperm immediately leak out of the vagina. The rest then are able to propel themselves up through the vagina towards the cervix. As they travel many are killed by the acidity of the vaginal fluids. The few sperm that are able to make it to the cervix are then exposed to contractions of the uterus that cause a washing machine effect in the uterine cavity. Here thousands of sperm are

hunted down and killed by phagocytes which recognize them as “non-self.” Of the millions of sperm that are ejaculated, only a few thousand are able to reach the egg.

When the sperm reaches the egg, it cannot immediately fertilize it. Instead it must wait in order to allow their membranes to become capacitated, or weakened. This is facilitated by the cervical mucus, and in the following 6-8 hours the sperm are gradually capacitated.

After capacitation has occurred, a reaction called the acrosomal reaction can occur. This reaction releases enzymes in the area surrounding the egg therefore weakening the intracellural cement that surrounds the egg. Once weakened a single sperm is allowed to penetrate the egg and fertilize it.

The Special Senses

Sight

Sight or vision is the ability of the brain and eye to detect electromagnetic waves within the visible range (light) interpreting the image as "sight." There is disagreement as to whether this constitutes one, two or three senses. Neuroanatomists generally regard it as two senses, given that different receptors are responsible for the perception of colour (the frequency of photons of light) and brightness (amplitude/intensity - number of photons of light). Some argue that stereopsis, the perception of depth, also constitutes a sense, but it is generally regarded as a cognitive (that is, post-sensory) function of brain to interpret sensory input and to derive new information. The inability to see is called blindness.

Hearing

Hearing or audition is the sense of sound perception. Since sound is vibrations propagating through a medium such as air, the detection of these vibrations, that is the sense of the hearing, is a mechanical sense akin to a sense of touch, albeit a very specialized one. In humans, this perception is executed by tiny hair fibres in the inner ear which detect the motion of a membrane which vibrates in response to changes in the pressure exerted by atmospheric particles within a range of 20 to 22000 Hertz, with substantial variation between individuals. Sound can also be detected as vibrations conducted through the body by tactition. Lower and higher frequencies than that can be heard are detected this way only. The inability to hear is called deafness.

Taste

Taste or gustation is one of the two main "chemical" senses. There are at least four types of taste that "buds" (receptors) on the tongue detect, and hence there are anatomists who argue that these constitute five or more different senses, given that each receptor conveys information to a slightly different region of the brain. The inability to taste is called ageusia.

The four well-known receptors detect sweet, salt, sour, and bitter, although the receptors for sweet and bitter have not been conclusively identified. The umami receptor detects the amino acid glutamate, a flavour commonly found in meat and in artificial flavourings such as monosodium glutamate.

Note that taste is not the same as flavour; flavour includes the smell of a food as well as its taste.

Smell

Smell or olfaction is the other "chemical" sense. Unlike taste, there are hundreds of olfactory receptors, each binding to a particular molecular feature. Odour molecules possess a variety of features and thus excite specific receptors more or less strongly. This combination of excitatory signals from different receptors makes up what we perceive as the molecule's smell. In the brain, olfaction is processed by the olfactory system. Olfactory receptor neurons in the nose differ from most other neurons in that they die and regenerate on a regular basis. The inability to smell is called anosmia. Some neurons in the nose are specialized to detect pheromones.

Touch

Touch, also called mechanoreception or somatic sensation, is the sense of pressure perception, generally in the skin. There are a variety of nerve endings that respond to variations in pressure (e.g., firm, brushing, and sustained). The inability to feel anything or almost anything is called anesthesia. Paresthesia is a sensation of tingling, pricking, or numbness of a person's skin with no apparent long term physical effect.

Balance and acceleration

Balance, equilibrioception, or vestibular sense is the sense which allows an organism to sense body movement, direction, and acceleration, and to attain and maintain postural equilibrium and balance. The organ of equilibrioception is the vestibular labyrinthine system found in both of the inner ears. Technically this organ is responsible for two senses, angular momentum and linear acceleration (which also senses gravity), but they are known together as equilibrioception.

The vestibular nerve conducts information from the three semicircular canals corresponding to the three spatial planes, the utricle, and the saccule. The ampulla, or base, portion of the three semicircular canals each contain a structure called a crista. These bend in response to angular momentum or spinning. The saccule and utricle, also called the "otolith organs", sense linear acceleration and thus gravity. Otoliths are small crystals of calcium carbonate that provide the inertia needed to detect changes in acceleration or gravity.

Temperature

Thermoception is the sense of heat and the absence of heat (cold) by the skin and including internal skin passages. The thermoceptors in the skin are quite different from the homeostatic thermoceptors in the brain (hypothalamus) which provide feedback on internal body temperature.

Kinesthetic sense

Proprioception, the kinesthetic sense, provides the parietal cortex of the brain with information on the relative positions of the parts of the body. Neurologists test this sense by telling patients to close their eyes and touch the tip of a finger to their nose. Assuming proper proprioceptive function, at no time will the person lose awareness of where the hand actually is, even though it is not being detected by any of the other senses. Proprioception and touch are related in subtle ways, and their impairment results in surprising and deep deficits in perception and action.

Pain

Nociception (physiological pain) signals near-damage or damage to tissue. The three types of pain receptors are cutaneous (skin), somatic (joints and bones) and visceral (body organs). It was believed that pain was simply the overloading of pressure receptors, but research in the first half of the 20th century indicated that pain is a distinct phenomenon that intertwines with all of the other senses, including touch.

Thermoregulation

Thermoregulation is an important aspect of human homeostasis. Heat is mainly produced by muscle contractions. Humans have been able to adapt to a great diversity of climates, including hot humid and hot arid. High temperatures pose serious stresses for the human body, placing it in great danger of injury or even death. In order to deal with these climatic conditions, humans have developed physiologic and cultural modes of adaptation.

The skin assists in homeostasis (keeping different aspects of the body constant e.g. temperature). It does this by reacting differently to hot and cold conditions so that the inner body temperature remains more or less constant. Vasodilation and sweating are the primary modes by which humans attempt to lose excess body heat. The brain creates much heat through the countless reactions which occur. Even the process of thought creates heat. In order keep the brain from overheating, the head has a complex system of blood vessels which bring blood to the thin skin on the head which allows heat to escape. The effectiveness of these methods is influenced by the character of the climate and the degree to which the individual is acclimatized.

In hot conditions

1. Sweat glands under the skin secrete sweat (a fluid containing mostly water with some dissolved ions) which travels up the sweat duct, through the sweat pore and onto the

surface of the skin. This causes heat loss by evaporation; however, a lot of essential water is lost.

2. The hairs on the skin lie flat, preventing heat from being trapped by the layer of still air between the hairs. This is caused by tiny muscles under the surface of the skin called erector pili muscles relaxing so that their attached hair follicles are not erect. These flat hairs increase the flow of air next to the skin increasing heat loss by convection. When environmental temperature is above core body temperature, sweating is the only physiological way for humans to lose heat.
3. Arterioles Vasodilation occurs, this is the process of relaxation of smooth muscle in arteriole walls allowing increased blood flow through the artery. This redirects blood into the superficial capillaries in the skin increasing heat loss by convection and conduction.

In cold conditions

1. Sweat stops being produced.
2. The minute muscles under the surface of the skin called arrector pili muscles (attached to an individual hair follicle) contract (piloerection), lifting the hair follicle upright. This makes our hairs stand on end which acts as an insulating layer, trapping heat. This is what also causes goose bumps since humans don't have very much hair and the contracted muscles can easily be seen.
3. Arterioles carrying blood to superficial capillaries under the surface of the skin can shrink (constrict), thereby rerouting blood away from the skin and towards the warmer core of the body. This prevents blood from losing heat to the surroundings and also prevents the core temperature dropping further. This process is called vasoconstriction. It is impossible to prevent all heat loss from the blood, only to reduce it. In extremely cold conditions excessive vasoconstriction leads to numbness and pale skin. Frostbite only occurs when water within the cells begins to freeze, this destroys the cell causing damage.
4. Muscles can also receive messages from the thermo-regulatory center of the brain (the hypothalamus) to cause shivering. This increases heat production as respiration is an exothermic reaction in muscle cells. Shivering is more effective than exercise at producing heat because the animal remains still. This means that less heat is lost to the environment via convection. There are two types of shivering: low intensity and high intensity. During low intensity shivering animals shiver constantly at a low level for months during cold conditions. During high intensity shivering animals shiver violently for a relatively short time. Both processes consume energy although high intensity shivering uses glucose as a fuel source and low intensity tends to use fats. This is why animals store up food in the winter

   The process explained above, in which the skin regulates body temperature is a part of thermoregulation. This is one aspect of homeostasis-the process by which the body regulates itself to keep internal conditions constant.

Normal human temperature

Average core temperature for healthy adults had been considered 37.0 °C , while normal ranges are 36.1 °C to 37.8 °C .

Human temperature variation effects

Hot

- 37°C - Normal body temperature (which varies between about 36.12-37.5°C
- 38°C - Sweating, feeling very uncomfortable, slightly hungry.

- 39°C - Severe sweating, flushed and very red. Fast heart rate and breathlessness. There may be exhaustion accompanying this. Children and people with epilepsy may be very likely to get convulsions at this point.
- 40°C - Fainting, dehydration, weakness, vomiting, headache and dizziness may occur as well as profuse sweating.
- 41°C - (Medical emergency) - Fainting, vomiting, severe headache, dizziness, confusion, hallucinations, delirium and drowsiness can occur. There may also be palpitations and breathlessness.
- 42°C - Subject may turn pale or remain flushed and red. They may become comatose, be in severe delirium, vomiting, and convulsions can occur. Blood pressure may be high or low and heart rate will be very fast.
- 43°C - Normally death, or there may be serious brain damage, continuous convulsions and shock. Cardio-respiratory collapse will likely occur.
- 44°C or more - Almost certainly death will occur; however, patients have been known to survive up to 46.5°C

Cold

- 37°C - Normal body temperature (which varies between about 36-37.5°C
- 36°C - Mild to moderate shivering (it drops this low during sleep). May be a normal body temperature.
- 35°C - (Hypothermia) is less than 35°C - Intense shivering, numbness and bluish/grayness of the skin. There is the possibility of heart irritability.
- 34°C - Severe shivering, loss of movement of fingers, blueness and confusion. Some behavioural changes may take place.
- 33°C - Moderate to severe confusion, sleepiness, depressed reflexes, progressive loss of shivering, slow heart beat, shallow breathing. Shivering may stop. Subject may be unresponsive to certain stimuli.
- 32°C - (Medical emergency) Hallucinations, delirium, complete confusion, extreme sleepiness that is progressively becoming comatose. Shivering is absent (subject may even think they are hot). Reflex may be absent or very slight.
- 31°C - Comatose, very rarely conscious. No or slight reflexes. Very shallow breathing and slow heart rate. Possibility of serious heart rhythm problems.
- 28°C - Severe heart rhythm disturbances are likely and breathing may stop at any time. Patient may appear to be dead.
- 24-26°C or less - Death usually occurs due to irregular heart beat or respiratory arrest; however, some patients have been known to survive with body temperatures as low as 14.2°C.

FOOD, THE FUEL FOR ENERGY

Food is the source of energy for the human body and it also provides nutrients for growth and repair. When food is eaten, this is what happens…

- The food is broken down into soluble chemicals (e.g. glucose) by digestion in the gut.
- The soluble chemicals pass through the gut wall into the blood.
- The blood carries the soluble food chemicals to all of the body's cells, where they will be used for:
    - Energy
    - Growth
    - Repair

Foods are made up of fuel sources that are capable of providing energy. These include:

- Carbohydrates (CHO)
- Fats or Lipids
- Protein

Fat and carbohydrate provide the vast majority of fuel required for energy production in skeletal muscle during all intensities of aerobic exercise in humans. CHO is also consumed during 'anaerobic' (oxygen independent) exercise to sustain work rates performed above an individuals maximal aerobic power (VO_2 max).
CHO is available within the muscle fibre (in the form of glycogen) and from blood glucose (from the breakdown of liver glycogen). Fat is available from triglyceride droplets within the muscle fibre as well as from plasma FFAs from lipolysis. These food fuels break down and provide energy to re-synthesise ATP (Adenosine Triphosphate) with (aerobically) or without oxygen (anaerobically).

Energy is measured in kJ or calories (1 Ca = 4.2 kJ). Fuel sources release the following amounts of energy in kilojules (kJ) per gram of food:

- Fats= 38 kJ/gram
- CHO= 17 kJ/gram
- Pr= 17kJ/gram

CARBOHYDRATES (CHO)

Roles
CHOs are the most readily available source of energy.

Recommended % of total daily intake
The total daily intake should consist of 55-60% of CHO for the average person, 60% for physically active & 70% for those engaged in intense training

Fuel source

- CHOs are used as a fuel source by the anaerobic glycolysis or lactic acid system that does not require oxygen.
- It is also used by the aerobic glycolysis energy system that uses oxygen for a more complete break down of glycogen.
- The glucose enters the blood stream & travels to the cells of the body via the liver.
- If glucose is not required by the body cells, it is stored in the muscle cells and the liver as glycogen. Once these stores are full, excess glucose is converted to adipose tissue and stored in the skin.
- When the glucose in the muscles has been used, the glycogen in the liver is broken down to glucose. This glucose is used as a fuel source for the energy systems.

Food Sources: Glycaemic index

This index is a score out of 100 indicating the rate of digestion and absorption of glucose into the bloodstream Most of the absorption takes place in the intestine.

High glycaemic index (79-100)

- The glucose is released quickly into the bloodstream, causing a rapid rise in blood glucose.
- This rise causes a production of insulin from the pancreas. Insulin is the hormone used to store excess amounts of blood sugar or glucose as glycogen.This release of insulin results in a decrease in blood sugar, an increase in CHO oxidation & fatigue.

Low glycaemic index (0-55)

- The glucose is released into the blood stream slowly.
- This decreases the production of insulin, lessening the likelihood of fatigue.

High GI		Moderate GI		Low GI	
Glucose	100	Corn	59	Apples	39
Carrots	92	Sucrose	59	Butter beans	36
Honey	87	All-Bran ®	51	Kidney beans	29
Corn Flakes	80	Peas	51	Lentils	29
Wholemeal bread	72	White pasta	50	Fructose	20
White rice	72	Oatmeal	49	Peanuts	13
Potatoes	70	Whole-wheat pasta	42	Yoghurt	15
White bread	69	Oranges	40		
Brown rice	66				
Bananas	62				

LIPIDS (Fats)

Roles

Lipids provide energy. They have more energy per gram (38 compared to 17 grams) than CHO & protein.

Other roles of lipids include:

- Protect vital organs
- Thermal insulation
- Transport fat soluble vitamins
- Lipids are a component of cell membranes, hormones, & HDL cholesterol

Recommended % of total daily intake

- The total daily intake should consist of 30% of fat for the average person.
- Over-consumption can lead to obesity & other related diseases.
- Athletes need to take care that they do not consume too many foods high in lipids. Body fat increases energy cost.
- The aesthetic aspects of sports such as gymnastics and body-building & the sports that rely upon weight divisions such as rowing & martial arts insist upon low levels of body fat.

Fuel source

Lipids are only used as a fuel source by the aerobic energy system pathway called aerobic lipolysis.

Common Food sources

Oils-Margarine-Oily fish-Nuts-Dairy products-Avocadoes -Pastries-'Junk' food-Fried foods-Potato chips

Saturated Fatty Acids

They are found mostly in animal products such as beef, pork, chicken, egg yolk, cream, milk, butter and cheese.

Hydrogenated fats contain 'trans' fatty acids. Trans-fatty acids account for thousands of deaths from heart disease and increase the risk of type 2 diabetes. They are found in margarine, commercially baked cakes labeled with 'hydrogenated fat' or 'partially hydrogenated fat' and some deep fried foods

Unsaturated Fatty Acids

They are generally plant products that liquefy at room temperature.

Monounsaturated

Examples include canola oil, olive oil and the oil in avocados & almonds.

Polyunsaturated

Examples include safflower oil, sunflower oil and soybean oil.

Another example of polyunsaturated fats includes omega 3 oils. Examples of these are the oils found in shellfish, salmon, sardines, dark green leafy vegetables, canola, soy and walnut oils.

1-2% of the total energy intake should come from the essential polyunsaturated fatty acid called linoleic acid. This is equivalent to 1Tb per day of a 2500 kCal intake that can be found in fatty fish, plant oils, mayonnaise, salad dressings, whole grains and vegetables

Good Fats vs Bad fats

Lipoproteins

Low density lipoproteins (LDL)
They are made by the liver and consist of 60-80% cholesterol. They are also made of lipids, CHO and alcohol.
They are very dangerous as they adhere readily to the walls of the arteries, damaging & narrowing arteries.

High Density Lipoproteins (HDL)
They are made by the liver and the small intestine and consist of 50% protein, 20% lipids & 20% cholesterol.
They remove cholesterol from the arterial wall and deliver it to the liver where it is broken down.
Foods high in cholesterol include red meat, egg yolks and dairy products such as cream, butter and ice-cream. Plant foods do not contain any cholesterol.
The recommended daily intake of cholesterol is 150-300mg.
Regular aerobic exercise and abstinence from smoking lower LDL and increase HDL.

PROTEIN

Roles
The vital roles of protein include tissue, growth, maintenance & repair.
Proteins form RBC, hormones & enzymes.
Protein, particularly muscle protein, provides energy in the following conditions: starvation, reduced energy intake or very low carbohydrate diets and strenuous exercise.

Recommended % of total daily intake
The total daily intake should consist of 15% of protein for the average person, or 1 gram per kilogram of body weight per day.

- This is achievable by consuming a balanced diet.

Common Food sources

- Meat Poultry Fish Eggs Dairy products Beans Lentils Cereal Breads

Storage of food fuel in the body and recommended proportions in a balanced diet

Food fuel	Stored as	Site(s)	The proportions of essential nutrients contained in a balanced diet
Carbohydrate	Glycogen	Muscles and liver around the body Excess stored as adipose tissue around the body * Glucose occurs in the bloodstream but this is rarely used for muscular contractions. It supplies the brain and energy requirements of the nervous system	55–60
Fat	Fatty acids are broken down to triglycerides	Adipose tissue Muscles around the body	25–30
Protein	Amino acids	Muscles around the body	10–15

Energy consumption and weight management

Energy Intake and Energy Output- The energy balance equation.

Energy Intake (Ein):
Energy is available from the foods we eat. Although foods contain a number of nutrients, energy is provided by proteins, carbohydrates, and fats. Vitamins and minerals in foods, although essential for normal metabolic functions, do not contribute calories to our diets.

A food calorie is the equivalent of 1,000 calories, or 1 kilocalorie. The food calorie is sometimes represented by "Calorie," with a capital C. In keeping with the usual format in nutrition studies, this curriculum supplement uses "calorie" to mean the food calorie. A food calorie (1 kilocalorie) is defined as the amount of energy required to raise the temperature of a liter of water 1ºC at sea level.

Each gram of protein or carbohydrate we consume contributes 4 calories of energy. In contrast, fat provides 9 calories per gram. Interestingly, alcohol has 7 calories per gram. Alcohol-containing products have calories and few nutrients; their consumption may upset both energy balance and nutritional status.

Energy output (Eout):
Total energy expenditure has three major components, which, added together, provide an accurate measure of an individual's daily caloric requirement: the basal metabolic rate (BMR), the energy used for physical activity, and the thermic effect of food.

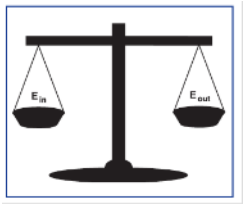
The BMR represents the energy used to carry out the basic metabolic needs of the body.
Energy must be provided for maintaining a heartbeat, breathing, regulating body temperature, and carrying out other activities that we take for granted. Most of our daily energy expenditure, about 60 to 70 percent, is represented by our BMR. A person's actual BMR changes over time.

This depends on a number of factors, including several that distinguish groups of people:
Age—Younger people have higher-than average BMRs. As children grow, their body composition (percent body fat and
muscle mass) changes. As they continue to age, BMR decreases as the percent muscle mass decreases.
Growth—Children and pregnant women have higher-than-average BMRs.
Height—Tall, thin people have higher than- average BMRs.
Body Composition—People with higher than- average or increased muscle mass have higher-than-average BMRs.

Other factors cause variation within individuals:
Fever—Fever increases your BMR.
Stress—Physical stress, such as recovering from an illness, increases your BMR; mental or emotional stress may lead to
lethargy or depression and decrease your BMR.
Inside/Outside Temperature—Both heat and cold raise your BMR.
Fasting—Fasting lowers your BMR.

Physical activity amounts to about 20 to 30 percent of the body's total energy output. Energy expended during physical activity varies with the level and duration of the activity. It is also affected by the age, gender, height, and weight of the individual performing the activity.

The “thermic effect of food” refers to the energy required to digest food. This term indicates what is usually obvious: we must expend some energy to make materials available in the body that will be used for the production of much larger amounts of energy. The thermic effect of food can be estimated as approximately 10 percent of total calories consumed.



The energy balance equation.

The equation for energy balance is Ein = Eout. This means that caloric intake equals caloric output.
It is the desirable condition for adults who are at a healthy weight. One way to understand the concept of energy balance is to use a two-pan balance analogy. On one pan of the balance are weights representing Ein (foods, which contain carbohydrate, protein, fat, and alcohol). On the other pan are weights representing energy expenditures (Eout) as metabolic activities and physical activities (and the thermic effect of food).
If adults consume more calories than are used for metabolic and physical activities, then Ein > Eout, and the extra energy is stored as body fat. They are in a state of positive energy balance. The pan scale would tip to the Ein side.
If adults lose weight (as, for example, with dieting), they are in a state of negative energy balance. In this case, Ein < Eout, and the pan scale would tip to the Eout side.

The Food Guide Pyramid

The Food Guide Pyramid, which is based on the foods Australians typically eat and the nutrients in these foods, is designed to help people choose what and how much to eat from each food group to get needed nutrients, without excessive intake of calories, saturated fat, cholesterol, total fat, and sugar.

The Food Guide Pyramid shows a range of servings for each major food group. This range is based on the caloric needs of the individual. Almost everyone should have at least the lowest number of servings in the ranges.

The Food Guide Pyramid is easily adaptable to ethnic and cultural preferences by including specific types of fruits, vegetables, and grain products. It is also adaptable to vegetarian diets by allowing for meat substitutes, such as beans, soy-based meat substitutes, and eggs.

A balanced diet provides 45 to 65 percent of total daily calories as carbohydrate, most of which should be from complex carbohydrates, such as starches; 10 to 35 percent of daily calories from protein; and no more than 30 percent of calories from fat.

The needs of athletes and other more physically active people may differ in both energy and nutrient intakes, depending on the intensity and duration of their physical activities. People with special needs due to illness or medications should consult a physician and a registered dietitian to create an appropriate plan to meet nutritional demands.

Body-fat composition

Understanding the relationship between energy requirements and desirable body weights should take into account not only the total weight, but also the composition of the weight. This is important because muscle mass and body fat make different demands on daily energy requirements and can have different long-term health consequences.

Considerable variation among individuals in resting metabolic rates is due in part to variation in body composition or, more specifically, to the ratio of muscle to fat tissue in the body. Muscle tissue is more effective than fat at burning calories, expending more than three times as much energy under resting conditions.

Therefore, the ratio of muscle to fat tissue is an important determinant of the total daily energy requirement.
Significant changes in the ratio of muscle tissue to fat tissue occur during adolescence. In females, body fat increases from a mean of 17 percent of body weight to 25 percent of body weight during adolescence. Males, in contrast, experience a decline in body fat, from a mean of 18 percent of body weight to 11 percent of body weight during this period.

Body composition is a much better predictor of one's level of health and risk of disease than is weight. Muscle mass or a measure of body fat is used to assess body composition. Professionals estimate body-fat content using tools and techniques such as circumference measurements (of abdomen, hips); a height and hip-girth chart; the caliper measurement method; and the water-weighing measurement method.

Body mass index (BMI).

BMI expresses the relationship between an individual's weight in kilograms (or pounds divided by 2.2) and height in meters (or inches divided by 39.4).
For adults, the formula is BMI = weight/height2.

For children over two years old and adolescents, the formula is BMI = (weight in kg/height in inches2) × 703.35 BMI is a helpful indicator of obesity and underweight and has two primary uses. It can be used to screen and monitor a population for risks to health or for nutritional disorders. Alternatively, BMI, along with other necessary information, can be used to assess risks to health for an individual.

Scientists and health officials have arrived at the following classifications for adults, based on the effect that body weight has on disease and death:

BMI less than 18.5 underweight
BMI between 18.5 and 24.9 healthy range
BMI between 25 and 29.9 overweight
BMI equal to or over 30.0 obese

Thermic effect of food

Thermic effect of food (also commonly known simply as thermic effect when the context is known), or TEF in shorthand, is the increment in energy expenditure above resting metabolic rate due to the cost of processing food for storage and use. It is one of the components of metabolism along with the resting metabolic rate, and the exercise component.

Another term commonly used to describe this component of total metabolism is the Specific Dynamic Action or SDA. A common number used to estimate the magnitude of the thermic effect of food is about 10% of the caloric intake of a given time period, though the effect varies substantially for different food components. Dietary fat is very easy to process and has very little thermic effect, while protein is hard to process and has a much larger thermic effect.

Raw celery and grapefruit are often claimed to have negative caloric balance (requiring they take more energy to digest than usable energy received from the food), presumably because the thermic effect is greater than the caloric content, due to the high fibre matrix that must be unraveled to access their carbohydrates.

The thermic effect of food is increased by both aerobic training of sufficient duration and intensity and by anaerobic weight training. However, the increase is marginal, amounting to 7-8 cal per hour. The primary determinants of daily TEF are the quantity and composition of the food ingested.

Nutrients and their effect on your body

Nutrient	What it does	Healthiest food source	Overdose	Deficiency
Carbohydrate	Major energy source	Vegetables, fruit, bread, rice, pasta	Put on body fat	Fatigue, weight loss
Protein	Building block for body structures	Fish, poultry, beans, nuts, eggs, meat, milk	Put on body fat	Irritability, lower resistance to infection

Nutrient	What it does	Healthiest food source	Overdose	Deficiency
Fats	Minor energy source	Almonds, peanuts, dairy products, margarine	Put on body fat	Skin disorders, weight loss, fatigue
Minerals				
Iron	Red blood cell formation	Liver, lentils, beans, meat	Nausea, liver damage	Anaemia
Phosphorous	Energy production	Meat, bread	Disrupts your body's chemical balance	Poor bone formation
Calcium	Bone strength	Cheese, sardines, milk, meat	Kidney stones	Soft, brittle bones
Vitamin A	Helps to keep skin clear and smooth; increased resistance to infection (keeps linings of respiratory and alimentary tracts healthy); assists night vision	Margarine, liver, deep yellow, green and red fruit and vegetables	Insomnia, aching limbs; haemorrhages; liver damage	Scaly, dry skin; decreased resistance to disease; poor vision in dim light
Vitamin B1 (thiamine)	Stimulates appetite and digestion; necessary for health of nerves; helps body cells obtain energy from food	All meats, fish and poultry, whole grain cereals, eggs, milk	Excreted	Decreased appetite; weight loss; nervous disorders; fatigue
Vitamin B2 (riboflavin)	Helps in energy production; promotes health of skin, particularly around mouth	Meat and poultry, milk and milk products, eggs, green vegetables, yeast	Excreted	Inflammation of tongue and lips; skin disorders on face
Vitamin B3 (niacin)	Active enzyme	Eggs, milk products, cereals	Flushing, tingling, gout, diabetes	Nerve disorders, headaches
Vitamin B6	Helps in energy production	Vegetables, fruit, bread, rice, pasta	Excreted	Skin disorders; inflammation of the intestinal tract mucosa
Vitamin B12	Important in formation of red blood cells; necessary for health of nerve tissue	Liver, kidney, meat, eggs, milk, cheese	Excreted	Pellagra; anaemia (reduced numbers of red blood cells); nervous system disorders
Vitamin C (ascorbic acid)	Important in strength of blood vessel walls; helps resist infection and heal wounds; important in formation of teeth and bones	Citrus fruits, tomatoes, strawberries, potatoes, leaf vegetables (destroyed by boiling)	Stored	Sore bleeding gums; delayed wound healing, scurvy

Nutrient	What it does	Healthiest food source	Overdose	Deficiency
Vitamin D	Important in formation of strong bones (helps bones use calcium and phosphorus)	Fish and liver oils, milk and milk products (is produced in skin when exposed to sunlight)	Vomiting, artery disease, calcification	Soft, weak bones; enlarged joints; muscle spasms
Vitamin E	Function uncertain	Very widespread in food	Headaches, upset stomach, blurred vision	Nothing proved
Vitamin K	Necessary for production of blood-clotting factor	Green vegetables, tomatoes	Possible rupture of red blood cells	Delayed blood clotting
Water	Transport of other nutrients within the body; heat control in the body	Water	Increased urination	Thirst and dehydration
Fibre	Clears out the digestive system	Apples, pears, cabbage, lettuce, cereals	Diarrhoea	Constipation; bowel cancer

VITAMIN & MINERAL SUPPLEMENTS

- No studies have shown any benefits with consuming vitamin & mineral supplements.
- Adequate levels of vitamins & minerals are consumed in a balanced diet.

Fat Soluble Vitamins
They do not need to be consumed daily as they are stored in the fatty adipose tissue. Consequently, they can be dangerous when eaten in excess.

Vitamin	Dietary sources	Major Functions	Deficiency	Excess
Vitamin A Retinol	• Green vegs • Milk • Butter • Cheese	• Vision • Maintains epitheleal tissue • Bone growth	• Poor vision	• Headaches • Vomiting • Dry skin • Joint & bone pain due to bone swelling • Poor appetite
Vitamin D	• Cod-liver oil • Eggs • Dairy products • Margarine • Fortified milk	• Increases absorption & uptake of Ca & P • Bone growth	• Bone deformities	• Vomiting • Diarrhoea • Weight loss • Kidney damage
Vitamin E	• Green leafy vegs • Nuts • Seeds • Margarine	• Anti-oxidant, preventing cell damage	• Possible anaemia	Only very large amounts are toxic over more than 1 year • Excessive bleeding
Vitamin K	• Green leafy vegs	• Blood clotting	• Severe bleeding	Only toxic with the over use of synthetic Vit K

	• Liver		• Bruising	• Jaundice • Liver damage

Water Soluble Vitamins
Many act as co-enzymes, combining and working with enzymes in chemical reactions.
They are excreted in the urine and therefore are rarely consumed in excess. They must be consumed regularly to avoid deficiencies.

Vitamin	Dietary sources	Major functions	Deficiencies
Vitamin B1 (Thiamin)	• Enriched cereals • Pork • Beef • Seeds • Nuts • Fruit • Vegs • Peas	• Involved in removing CO2	Beri beri: • Mental confusion • Loss of sensation in the arms & legs • Heart failure
Vitamin B2 (Riboflavin)	• Pork • Liver • Enriched cereals • Eggs • Milk • Green, leafy vegs	• Involved in energy metabolism	• Cracked, red lips • Reddening of the eyes
Niacin (B3)	• Liver • Fish • Poultry • Legumes • Peanuts • Grains	• Involved in energy metabolism	Pellagra: • Dermatitis • Diarrhoea • Dementia • Death
Vitamin B6	• Meat • Fish • Poultry • Green & yellow vegs • Bananas • Grains • Cereals • Seeds	• Involved in metabolism of amino acid & glycogen	• Mental confusion • Depression • Convulsions • Muscular twitching • Dermatitis • Kidney stones
Folic Acid	• Green vegs • Legumes • Eggs • Milk • Liver • Whole wheat	• Involved in metabolism of amino acids	• Anaemia • Diarrhoea • Red tongue

	products		
Vitamin B12	• Meat • Fish • Liver • Eggs • Dairy products	• Involved in the metabolism of fatty acids and amino acids • Maintenance of nerve and blood cells	• Anaemia • Numb & tingling hands & feet • Mental confusion • Depression
Biotin	• Egg yolks • Legumes • Vegs • Meats • Liver • Nuts • Watermelon • Strawberries • Bananas • Milk	• Involved in the synthesis of glycogen & fatty acids • Involved in the metabolism of amino acids	• Nausea • Fatigue • Depression • Muscular pain • Dermatitis
Pantothenic Acid	• Meat • Fish • Poultry • Legumes • Milk • Whole grains • Eggs • Sweet potatoes • Yoghurt	• Involved in energy metabolism	• Fatigue • Poor coordination • Nausea • Sleep disturbances (Very rare as it is found in so many foods)
Vitamin C 500-1500mg/day	• Citrus fruits • Kiwi fruit • Green peppers • Tomatoes • Salad greens • Cantaloupe • Broccoli • Cauliflower	• Involved in the synthesis of amino acids, including the formation of collagen. • Forms a structural component of bone, teeth & cartilage • Improves the absorption of iron	Scurvy • Degeneration of bone, teeth & blood vessels • Bruising • Poor wound healing • Bleeding gums • Internal bleeding

Minerals

Mineral	Dietary sources	Major functions	Deficiency	Excess	RDI for athletes
Calcium (Ca)	• Milk • Cheese • Dried legumes • Dark green vegs	• Formation of bone & teeth • Stimulates nerve impulses & muscular contraction • Blood clotting	• Rickets • Osteoporosis • Osteopaenia • Stunted growth • Convulsion	• None reported	Upper limit of 2,500 mg
Phosphorus (P)	• Milk • Cheese • Meat • Yoghurt	• Formation of bone & teeth • Component of energy molecules	Rare • Demineralisation of bones • Joint pain	Rare • Erosion of jaw	Within normal recommendations 4g/d,

	• Fish • Poultry • Grains	• Prevents calcium loss from bone • Balances pH levels			800mg
Potassium (K)	• Leafy vegetables • Potatoes • Bananas • Milk • Meats • Coffee • Tea	• Fluid balance • Balances pH • Nerve transmission	• Muscle cramps & weakness • Irregular heart beat • Loss of appetite • Mental confusion	• Heart failure	Within normal recommendations 2000mg/d
Sodium (Na)	• Salt	• Maintains normal water balance • pH balance • Nerve function	• Mental fatigue • Muscle cramps • Decreased appetite • Diarrhoea • Vomiting • Kidney damage	• High blood pressure (Hypertension)	Within normal recommendations 2400mg Athletes should consume sports drinks containing salt prior to & after heavy sweating
Sulfur (S)	• Consumed with protein	• pH balance • liver function	Unlikely	• Unknown	
Chlorine (Cl)	• Salt • Vegetables • Fruits	• Component of extracellular fluids	Unlikely with adequate dietary intake	• High blood pressure	
Magnesium (Mg)	• Green leafy vegs • Whole grains • Cereals • Nuts • Vegs	• Activates enzymes involved in protein synthesis • Assists in the uptake of Ca	• Poor growth • Irrational behavioural	• Diarrhoea	Within normal recommendations 350mg/d
Iron (Fe)	• Eggs • Meat • Green leafy vegs • Whole grains • Legumes	• A component of haemoglobin & myoglobin • Involved with enzymes in energy metabolism	• Anaemia	• Cirrhosis of the liver • Lethal in excessive amounts	Within normal recommendations 45 mg/d

Flourine (Fl)	• Drinking water • Tea • Seafood	• Strengthens teeth & helps teeth resist decay • May be important in the formation of bones	• Tooth decay	• Flurosis, or rusty coloured stains on the teeth	Within normal recommendations 10mg/d
Zinc (Zn)	• Meats • Milk • Grains	• Component of digestive enzymes • Growth, repair & maintenance of tissues	• Poor growth • Decreased maturation of sex organs	• Nausea • Vomiting • Diarrhoea • Fever	Within normal recommendations 40mg/d
Copper (Cu)	• Liver • Lamb chops • Oysters • Mixed nuts • Drinking water (from copper pipes)	• Component of enzymes involved in iron metabolism & collagen formation	• Anaemia • Poor growth	Rare • Damage to kidneys, liver & brain	Within normal recommendations 10,000 µg/d
Selenium (Se)	• Seafood • Meats • Grains	• Component of enzymes • Works with Vitamin E as an anti-oxidant	Rare • Anaemia	• Diarrhoea • Hair & fingernail loss • Liver damage • Lung damage	Within normal recommendations 400 µg/d
Iodine (I)	• Shellfish • Fish • Dairy products • Vegs	• Component of thyroid hormones	• Goitre • Poor growth & development	• Depress thyroid activity • Bulging eyes • Weight loss • Anxiousness	Within normal recommendations 1,100 µg/d
Chromium (Ch)	• Cereals • Legumes • Whole grains • Meats • Dairy products • Broccoli • Asparagu	• Component of enzymes involved in energy metabolism	Rare • Impaired ability to metabolise glucose	• Inhibition of enzymes • Skin damage • Kidney damage • Diarrhoea • Cramping	Lack of data Dietary sources only

	s • Prunes • Fats • Veg Oils			• Can be fatal	

FLUID INTAKE

Fluid makes up 40-70% of an individual's body mass.

- A sedentary adult in a normal environment requires 2.5 Litres of water per day.
- Roles of fluid or water in the body include:
  - Transport
  - Dilutes waste
  - Lubricates surfaces & membranes
  - Body temperature regulation
  - Used in chemical reactions
  - Water is important to avoid dehydration, which is a major cause of fatigue.

Eating Disorders in Australian Society

A key concept is that energy balance is a long-term, rather than a short-term, goal. Two important consequences of energy imbalance for adolescents are obesity and undernutrition.

Obesity is a chronic metabolic disease resulting from an imbalance between energy intake and energy output. It is caused by the interaction of multiple genetic and environmental factors.
Among these are excessive caloric and food intake, insufficient physical activity, genetic predisposition, family history of obesity, individual metabolism, and behavioral factors. The defining feature is excess body fat. Obesity increases the risk of developing many conditions, including heart disease and stroke, high blood pressure, type 2 (non-insulin-dependent) diabetes, gallstones, sleep apnea, back pain, osteoarthritis of the weight-bearing joints, and some forms of cancer (for example, breast and colon). Fortunately, many of these conditions improve with successful treatment for obesity.

Undernutrition is a complex issue. Individuals may suffer from an insufficient intake of both calories and specific nutrients. In some cases, energy intake may be sufficient, but the diet may be lacking in nutrient content. The diagnosis of undernutrition used to depend on deficits in weight compared with reference standards.
There is great pressure on people to fit in and gain acceptance. People may worry excessively about what others think of them, especially their physical appearance. Unfortunately, emphasis in the media generally is on being thin, and the "ideal" body image is that of today's models and TV and movie stars. Some people may develop eating disorders as a result of complex psychological, environmental, and/or genetic factors.

Eating disorders have both mental and physical components that can have serious medical consequences. However, not all individuals with eating disorders suffer serious medical consequences. Indeed, some individuals may not suffer from any apparent medical problems. These disorders may develop as a means of gaining control, of focusing on something pleasant, of blocking out painful feelings or experiences, or of providing punishment through self-abuse.

Three eating disorders include:

• Anorexia nervosa: This disorder is characterized by significant weight loss resulting from excessive dieting. Because of their obsession to be thin, those suffering from anorexia consider themselves fat, no matter what their weight actually is. They have a powerful and irrational fear of gaining weight and becoming fat. About 1 of every 100 adolescent girls develops anorexia nervosa. Some individuals who have anorexia also binge and purge.

• Binge eating disorder: This disorder is characterized by frequent episodes of uncontrolled eating. About 5 percent of people have this disorder. The binge eater feels out of control, and episodes of overeating are followed by feelings of disgust, guilt, or depression. It is common for episodes of overeating to be followed by bulimic behavior, such as vomiting, using laxatives, or over exercising.

• Bulimia nervosa: This disorder is characterized by behaviors such as vomiting, taking laxatives, or over-exercising after eating to rid the body of the calories consumed. Victims of this disorder also have a fear of being fat, even if their size and body weight are normal. Approximately to 5 of every 100 young women develop bulimia. This condition can develop in those with anorexia nervosa, or it can occur as a separate condition.

Eating disorders may begin at very young ages. Children as young as 8 years of age have voiced complaints about their body size and shape and expressed a fear of being fat. Furthermore, young people in all ethnic and cultural groups may develop eating disorders.

Treatment is complex and requires input from psychological, medical, and nutritional experts, as well as strong support from family and friends. Healthy diet and regular physical activity help children and adults feel better, learn and work more effectively, and avoid developing a variety of risk factors for disease.

Social and technological trends of the 20th century have contributed to the current poor state of diet and physical activity among Australians, most notably innovations in transportation, communication, computer technologies, food processing, and food marketing.

Fewer daily opportunities exist today to burn calories: leisure and workplace activities are increasingly sedentary, motorized travel for all but the shortest distances has become almost universal, and school systems continue to cut back on physical education programs.

At the same time, there are more opportunities to eat each day now than 20 years ago because the marketing and distribution of high-calorie fast foods and snacks has increased, the number of restaurants has increased, and social interactions increasingly involve food and drink.

This combination of poor diet and lack of physical activity is associated with an “epidemic of obesity” in the Australia.

Diseases

A disease or medical condition is an abnormal condition of an organism that impairs bodily functions, associated with specific symptoms and signs. It may be caused by external factors, such as invading organisms, or it may be caused by internal dysfunctions, such as autoimmune diseases.

In human beings, "disease" is often used more broadly to refer to any condition that causes extreme pain, dysfunction, distress, social problems, and/or death to the person afflicted, or similar problems for those in contact with the person. In this broader sense, it sometimes includes injuries, disabilities, disorders, syndromes, infections, isolated symptoms, deviant behaviors, and atypical

variations of structure and function, while in other contexts and for other purposes these may be considered distinguishable categories.it might also be considered to be an infection

Disease

This term broadly refers to any abnormal condition that impairs normal function. it is what people receive when they are ill. It is a abdergin of their mental as well as physical health. Commonly, this term is used to refer specifically to infectious diseases, which are clinically evident diseases that result from the presence of pathogenic microbial agents, including viruses, bacteria, fungi, protozoa, multicellular parasites, and aberrant proteins known as prions. An infection that does not produce clinically evident impairment of normal functioning is not considered a disease.

Pathogens

A pathogen is an infectious agent, or (more commonly) germ, is a biological agent that causes disease or illness to its host. There are several substrates and pathways whereby pathogens can invade a host; the principal pathways have different episodic time frames, but soil contamination has the longest or most persistent potential for harboring a pathogen.

The body contains many natural defenses against some of the common pathogens in the form of the human immune system and by some "helpful" bacteria present in the human body's normal flora. However, if the immune system or "good" bacteria is damaged in any way (such as by chemotherapy, human immunodeficiency virus (HIV), or antibiotics being taken to kill other pathogens), pathogenic bacteria that were being held at bay can proliferate and cause harm to the host. Such cases are called opportunistic infection.

Some pathogens have been responsible for massive numbers of casualties and have had numerous effects on afflicted groups. Of particular note in modern times is HIV, which is known to have infected several million humans globally, along with Severe Acute Respiratory Syndrome (SARS) and the Influenza virus. Today, while many medical advances have been made to safeguard against infection by pathogens, through the use of vaccination, antibiotics, and fungicide, pathogens continue to threaten human life. Social advances such as food safety, hygiene, and water treatment have reduced the threat from some pathogens.

Viral: Some notable pathogenic viruses cause: smallpox, influenza, mumps, measles, chickenpox and rubella. Ebola is another pathogenic virus.

Bacterial: Although the vast majority of bacteria are harmless or beneficial, a few pathogenic bacteria can cause infectious diseases. The most common bacterial disease is tuberculosis. Pathogenic bacteria contribute to other globally important diseases, such as pneumonia, which can be caused by bacteria such as Streptococcus and Pseudomonas, and foodborne illnesses. Pathogenic bacteria also cause infections such as tetanus, typhoid fever, diphtheria, syphilis and leprosy. Bacteria can often be killed by antibiotics.

Fungal: Fungal microbes can cause diseases in humans, animals and crop plants. Fungi most often infect immuno-compromised patients or vulnerable people with a weakend immune system. Most antibiotics cannot be used to treat fungal infections due to the fact that fungi and their hosts both have eukaryotic cells. Most clinical fungicides belong to the azole group.

Transmission of disease

Some diseases such as influenza are contagious and infectious. The micro-organisms that cause these diseases are known as pathogens and include varieties of bacteria, viruses, protozoa and fungi.Infectious diseases can be transmitted by as, by hand to mouth contact with infectious material on surfaces, by bites of insects or other carriers of the disease, and from contaminated water or food (often via faecal contamination), etc. In addition, there are sexually transmitted diseases. In some cases, micro-organisms that are not readily spread from person to person play a role, while other diseases can be prevented or ameliorated with appropriate nutrition or other lifestyle changes. Some diseases such as cancer, heart disease and mental disorders are , in most cases, not considered to be caused by infection (see Non infectious disease), although there are important exceptions. Many diseases (including some cancers, heart disease and mental disorders) have a partially or completely genetic basis and may thus be transmitted from one generation to another.

Illness

Illness and sickness are generally used as synonyms for disease. However, this term is occasionally used to refer specifically to the patient's personal experience of his or her disease In this model, it is possible for a person to be diseased without being ill, (to have an objectively definable, but asymptomatic, medical condition), and to be ill without being diseased (such as when a person perceives a normal experience as a medical condition, or medicalizes a non-disease situation in his or her life). Illness is often not due to infection but a collection of evolved responses, sickness behavior, by the body aids the clearing of infection. Such aspects of illness can include lethargy, depression, anorexia, sleepiness, hyperalgesia, and inability to concentrate

Disorder

In medicine, a disorder is a functional abnormality or disturbance. Medical disorders can be categorized into mental disorders, physical disorders, genetic disorders, behavioral disorders and functional disorders.

The term disorder is often considered more value-neutral and less stigmatizing than the terms disease or illness, and therefore is preferred terminology in some circumstances. In mental health, the term mental disorder is used as a way of acknowledging the complex interaction of biological, social, and psychological factors in psychiatric conditions. However, the term disorder is also used in many other areas of medicine, primarily to identify physical disorders that are not caused by infectious organisms, such as organic brain syndrome.

Medical condition

A medical condition is a broad term that includes all diseases and disorders, but also includes normal situations, such as pregnancy, that might benefit from medical assistance or have implications for medical treatments.

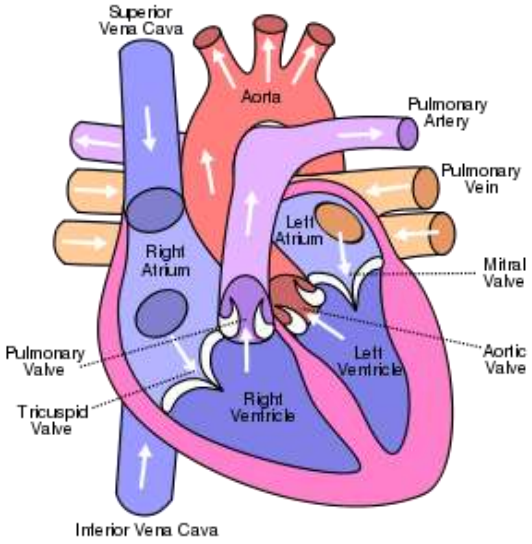
As it is more value-neutral than terms like disease, it is sometimes preferred by people with these conditions. Additionally, the term medical condition is used as a synonym for medical state, where it describes a patient's current state, as seen from a medical standpoint. This usage is seen in statements that describe a patient as being "in critical condition", for example.

Genetic Disorders

A genetic disorder is an illness caused by abnormalities in genes or chromosomes. While some diseases, such as cancer, are due in part to a genetic disorders, they can also be caused by environmental factors.

Common genetically influenced conditions include:

- asthma
- autism
- autoimmune diseases such as multiple sclerosis
- cancers
- cleft palate
- diabetes
- heart disease
- hypertension
- inflammatory bowel disease
- mental retardation
- obesity



Common Problems:

Cardiovascular:

Congestive cardiac failure-

Heart failure (HF) is a condition in which a problem with the structure or function of the heart impairs its ability to supply sufficient blood flow to meet the body's needs. It should not be confused with cardiac arrest.

Common causes of heart failure include myocardial infarction and other forms of ischemic heart disease, hypertension, valvular heart disease and cardiomyopathy. Heart failure can cause a large variety of symptoms such as shortness of breath (typically worse when lying flat, which is called orthopnea), coughing, ankle swelling and reduced exercise capacity. Heart failure is often undiagnosed due to a lack of a universally agreed definition and challenges in definitive diagnosis. Treatment commonly consists of lifestyle measures (such as decreased salt intake) and medications, and sometimes devices or even surgery.

Heart failure is a common, costly, disabling and deadly condition. In developing countries, around 2% of adults suffer from heart failure, but in those over the age of 65, this increases to 6—10%. Mostly due to costs of hospitalization, it is associated with a high health expenditure; costs have been estimated to amount to 2% of the total budget of the National Health Service in the United Kingdom, and more than $35 billion in the United States. Heart failure is associated with significantly reduced physical and mental health, resulting in a markedly decreased quality of life. With the exception of heart failure caused by reversible conditions, the condition usually worsens with time. Although some patients survive many years, progressive disease is associated with an overall annual mortality rate of 10%.

Angina Pectoris-

Angina pectoris, commonly known as angina, is severe chest pain due to ischemia (a lack of blood and hence oxygen supply) of the heart muscle, generally due to obstruction or spasm of the coronary arteries (the heart's blood vessels). Coronary artery disease, the main cause of angina, is due to atherosclerosis of the cardiac arteries. The term derives from the Greek ankhon ("strangling") and the Latin pectus ("chest"), and can therefore be translated as "a strangling feeling in the chest".

It is not common to equate severity of angina with risk of fatal cardiac events. There is a weak relationship between severity of pain and degree of oxygen deprivation in the heart muscle (i.e. there can be severe pain with little or no risk of a heart attack, and a heart attack can occur without pain).

Worsening ("crescendo") angina attacks, sudden-onset angina at rest, and angina lasting more than 15 minutes are symptoms of unstable angina (usually grouped with similar conditions as the acute coronary syndrome). As these may herald myocardial infarction (a heart attack), they require urgent medical attention and are generally treated as a presumed heart attack.

Most patients with angina complain of chest discomfort rather than actual pain: the discomfort is usually described as a pressure, heaviness, tightness, squeezing, burning, or choking sensation. Apart from chest discomfort, anginal pains may also be experienced in the epigastrium (upper central abdomen), back, neck, jaw, or shoulders, following skin dermatomes. Typical locations for radiation of pain are arms (often inner left arm), shoulders, and neck into the jaw. Angina is typically precipitated by exertion or emotional stress. It is exacerbated by having a full stomach and by cold temperatures. Pain may be accompanied by breathlessness, sweating and nausea in some cases. It usually lasts for about 3 to 5 minutes, and is relieved by rest or specific anti-angina medication. Chest pain lasting only a few seconds is normally not angina.

Myocardial ischemia comes about when the myocardia (the heart muscles) receive insufficient blood and oxygen to function normally either because of increased oxygen demand by the myocardia or by decreased supply to the myocardia. This inadequate perfusion of blood and the resulting reduced delivery of oxygen and nutrients is directly correlated to blocked or narrowed blood vessels.

Some experience "autonomic symptoms" (related to increased activity of the autonomic nervous system) such as nausea, vomiting and pallor.

Major risk factors for angina include cigarette smoking, diabetes, high cholesterol, high blood pressure, sedentary lifestyle and family history of premature heart disease.

A variant form of angina (Prinzmetal's angina) occurs in patients with normal coronary arteries or insignificant atherosclerosis. It is thought to be caused by spasms of the artery. It occurs more in younger women.

Cardiac Arrest-

Cardiac arrest, also known as cardiopulmonary arrest or circulatory arrest, is the abrupt cessation of normal circulation of the blood due to failure of the heart to contract effectively during systole.

A cardiac arrest is different from (but may be caused by) a heart attack or myocardial infarction, where blood flow to the still-beating heart, is interrupted (as in cardiogenic shock).

"Arrested" blood circulation prevents delivery of oxygen to all parts of the body. Cerebral hypoxia, or lack of oxygen supply to the brain, causes victims to lose consciousness and to stop normal breathing, although agonal breathing may still occur. Brain injury is likely if cardiac arrest is untreated for more than 5 minutes, although new treatments such as induced hypothermia have begun to extend this time. To improve survival and neurological recovery immediate response is paramount.

Cardiac arrest is a medical emergency that, in certain groups of patients, is potentially reversible if treated early enough. When unexpected cardiac arrest leads to death this is called sudden cardiac death (SCD). The primary first-aid treatment for cardiac arrest is cardiopulmonary resuscitation (commonly known as CPR) which provides circulatory support until availability of definitive medical treatment, which will vary dependent on the rhythm the heart is exhibiting, but often requires defibrillation.

Cardiac arrest is synonymous with Clinical death. All disease processes leading to death have a period of (potentially) reversible cardiac arrest: the causes of arrest are, therefore, numerous. However, many of these conditions, rather than causing an arrest themselves, promote one of the "Reversible causes" , which then triggers the arrest (e.g. choking leads to hypoxia which in turn leads to an arrest). In some cases, the underlying mechanism cannot be overcome, leading to an unsuccessful resuscitation.

Among adults, ischemic heart disease is the predominant cause of arrest. At autopsy 30% of victims show signs of recent myocardial infarction. Other cardiac conditions potentially leading to arrest include structural abnormalities, arrhythmias and cardiomyopathies. Non-cardiac causes include infections, overdoses, trauma and cancer, in addition to many others.

Thrombosis-

Thrombosis is the formation of a blood clot (thrombus) inside a blood vessel, obstructing the flow of blood through the circulatory system. When a blood vessel is injured, the body uses platelets and fibrin to form a blood clot, because the first step in repairing it (hemostasis) is to prevent loss of blood. If that mechanism causes too much clotting, and the clot breaks free, an embolus is formed.

Thromboembolism is a general term describing both thrombosis and its main complication which is embolisation.

When a thrombus occupies more than 75% of surface area of the lumen of an artery, blood flow to the tissue supplied is reduced enough to cause symptoms because of decreased oxygen (hypoxia) and accumulation of metabolic products like lactic acid. More than 90% of obstruction can result in anoxia, the complete deprivation of oxygen, and infarction, a mode of cell death.

In classical terms, thrombosis is caused by abnormalities in one or more of the following (Virchow's triad):

- The composition of the blood (hypercoagulability)
- Quality of the vessel wall (endothelial cell injury)
- Nature of the blood flow

The formation of a thrombus is usually caused by Virchow's triad. To elaborate, the pathogenesis includes: an injury to the vessel's wall (such as by trauma, infection, or turbulent flow at bifurcations); by the slowing or stagnation of blood flow past the point of injury (which may occur

after long periods of sedentary behavior—for example, sitting on a long airplane flight); by a blood state of hypercoagulability (caused for example, by genetic deficiencies or autoimmune disorders).

Dental:

Gingivitis-

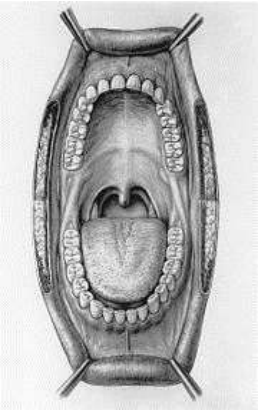
Gingivitis ("inflammation of the gums") (gingiva) around the teeth is a general term for gingival diseases affecting the gingiva (gums). As generally used, the term gingivitis refers to gingival inflammation induced by bacterial biofilms (also called plaque) adherent to tooth surfaces.

The symptoms of gingivitis are as follows:

- Swollen gums
- Mouth sores
- Bright-red, or purple gums
- Shiny gums
- Swollen gums that emit pus
- Severe oral odor
- Gums that are painless, except when pressure is applied
- Gums that bleed easily, even with gentle brushing, and especially when flossing.
- Gums that itch with varying degrees of severity.

Gingivitis can be prevented through regular oral hygiene that includes daily brushing and flossing. Mouth wash is optional, usually using a saline solution (water and salt) or chlorhexidine. Rigorous plaque control programs along with periodontal scaling and curettage also have proved to be helpful. In many countries, such as the United States, mouthwashes containing chlorhexidine are available only by prescription.

Halitosis-



Halitosis, oral malodor, breath odor, mouth odor, foul breath, fege bosta, fetor oris, fetor ex ore, or most commonly bad breath are terms used to describe noticeably unpleasant odors exhaled in breathing – whether the smell is from an oral source or not. Halitosis has a significant impact – personally and socially – on those who suffer from it or believe they do (halitophobia), and is estimated to be the third most frequent reason for seeking dental aid, following tooth decay and periodontal disease

In most cases (85–90%), bad breath originates in the mouth itself. The intensity of bad breath differs during the day, due to eating certain foods (such as garlic, onions, meat, fish, and cheese), obesity, smoking, and alcohol consumption. Because the mouth is exposed to less oxygen and is inactive during the night, the odor is usually worse upon awakening ("morning breath"). Bad breath may be transient, often disappearing following eating, brushing one's teeth, flossing, and rinsing with specialised mouthwash.

Bad breath may also be persistent (chronic bad breath), which is a more serious condition, affecting some 25% of the population in varying degrees.It can negatively affect the individual's personal, social, and business relationships, leading to poor self-esteem and increased stress.

Digestive:

Gastro-intestinal bleeding-

Gastrointestinal bleeding or gastrointestinal hemorrhage describes every form of hemorrhage (loss of blood) in the gastrointestinal tract, from the pharynx to the rectum. It has diverse causes, and a medical history, as well as physical examination, generally distinguishes between the main forms. The degree of bleeding can range from nearly undetectable to acute, massive, life-threatening bleeding.

Initial emphasis is on resuscitation by infusion of intravenous fluids and blood transfusion, treatment with proton pump inhibitors and occasionally with vasopressin analogues and tranexamic acid. Upper endoscopy or colonoscopy are generally considered appropriate to identify the source of bleeding and carry out therapeutic interventions.

Gastrointestinal bleeding can range from microscopic bleeding, where the amount of blood is so small that it can only be detected by laboratory testing (in the form of iron deficiency anemia), to massive bleeding where pure blood is passed and hypovolemia and shock may develop, risking death.

Initial focus in any patient with a form of gastrointestinal hemorrhage is on resuscitation, as any further intervention is precluded by the presence of intravascular depletion or shock.

- Fluid resuscitation: intravenous fluids and blood transfusion may be administered.
- Acid suppression: in an upper GI source, proton pump inhibitors reduce gastric acid production and enhance healing of bleeding lesions.
- Inhibition of fibrinolysis: in ongoing bleeding, tranexamic acid reduces fibrinolysis and may decrease blood product requirements.
- Correction of coagulopathy: if coagulation parameters (e.g. prothrombin time) are deranged, vitamin K or fresh frozen plasma may need to be administered.
- Reduction of portal pressure: if the bleeding is thought to be due to esophageal varices (a complication of cirrhosis of the liver), vasopressin analogues and rarely octreotide may be administered. Rarely, a Sengstaken-Blakemore tube may be inserted to mechanically compress varices.
- Urgent endoscopy: if the bleeding cannot be managed medically an urgent esophagogastroduodenoscopy (EGD/OGD) may identify sources of bleeding. This is a high-risk procedure best performed under safe circumstances in the intensive care unit or operating theatres.
- Surgical intervention: in extreme cases of bleeding, laparotomy may be required to identify the bleeding source.

Gastroenteritis-

Gastroenteritis (also known as gastro, gastric flu, tummy bug in the United Kingdom, and stomach flu, although unrelated to influenza) is inflammation of the gastrointestinal tract, involving both the stomach and the small intestine (see also gastritis and enteritis) and resulting in acute diarrhea. The inflammation is caused most often by an infection from certain viruses or less often by bacteria, their toxins, parasites, or an adverse reaction to something in the diet or medication. Worldwide, inadequate treatment of gastroenteritis kills 5 to 8 million people per year, and is a leading cause of death among infants and children under 5.

At least 50% of cases of gastroenteritis as foodborne illness are due to norovirus. Another 20% of cases, and the majority of severe cases in children, are due to rotavirus. Other significant viral agents include adenovirus and astrovirus.

Different species of bacteria can cause gastroenteritis, including Salmonella, Shigella, Staphylococcus, Campylobacter jejuni, Clostridium, Escherichia coli, Yersinia, and others. Some sources of the infection are improperly prepared food, reheated meat dishes, seafood, dairy, and bakery products. Each organism causes slightly different symptoms but all result in diarrhea. Colitis, inflammation of the large intestine, may also be present.

Risk factors include consumption of improperly prepared foods or contaminated water and travel or residence in areas of poor sanitation. It is also common for river swimmers to become infected during times of rain as a result of contaminated runoff water.[5] The incidence is 1 in 1,000 people.

Gastroenteritis often involves stomach pain or spasms (sometimes to the point of being incapacitated), diarrhea and/or vomiting, with noninflammatory infection of the upper small bowel, or inflammatory infections of the colon.

It usually is of acute onset, normally lasting 1–6 days, in some cases even longer and is self-limiting.

- Nausea and vomiting
- Diarrhea
- Loss of appetite
- Headaches
- Abdominal pain
- Abdominal cramps
- Bloody stools (dysentery - suggesting infection by amoeba, Campylobacter, Salmonella, Shigella or some pathogenic strains of Escherichia coli)
- Fainting and Weakness

The main contributing factors include poor feeding in infants. Diarrhea is common, and may be followed by vomiting. Viral diarrhea usually causes frequent watery stools, whereas blood stained diarrhea may be indicative of bacterial colitis. In some cases, even when the stomach is empty, bile can be vomited up.

A child with gastroenteritis may be lethargic, suffer lack of sleep, run a low fever, have signs of dehydration (which include dry mucous membranes), tachycardia, reduced skin turgor, skin color discoloration, sunken fontanelles, sunken eyeballs, darkened eye circles, glassy eyes, poor perfusion and ultimately shock.

Symptoms occur for up to 6 days on average. Given appropriate treatment, bowel movements will return to normal within a week after that.

Ear health:

Otitis media-

Otitis media is inflammation of the middle ear, or middle ear infection (the word otitis is Greek and it means “inflammation of the ear”, and media means middle).

Otitis media occurs in the area between the ear drum (the end of the outer ear) and the inner ear, including a duct known as the Eustachian tube. It is one of the two categories of ear inflammation that can underly what is commonly called an earache, the other being otitis externa. Diseases other than ear infections can also cause ear pain, including cancers of any structure that shares nerve supply with the ear.

Otitis media has many degrees of severity, and various names are used to describe each. The terminology is sometimes confusing because of multiple terms being used to describe the same condition. A common misconception with ear infection is that sufferers think that a symptom is itchy ear. Although sufferers may feel discomfort, an itchy ear is not a symptom of ear infection.

Hearing impairment-

A hearing impairment is a full or partial decrease in the ability to detect or understand sounds. Caused by a wide range of biological and environmental factors, loss of hearing can happen to any organism that perceives sound. "Hearing impaired" is often used to refer to those who are deaf, although the term is no longer politically correct. In Deaf culture, they prefer the terms Deaf and Hard of Hearing.

Sound waves vary in amplitude and in frequency. Amplitude is the sound wave's peak pressure variation. Frequency is the number of cycles per second of a sinusoidal component of a sound wave. Loss of the ability to detect some frequencies, or to detect low-amplitude sounds that an organism naturally detects, is a hearing impairment.

The International symbol for hearing impairment →

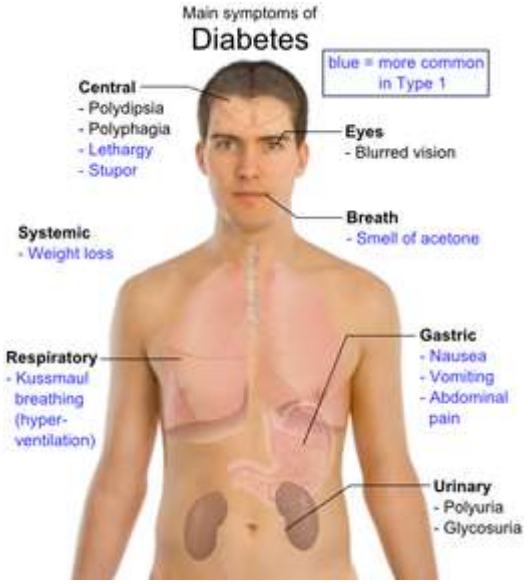
Endocrine system:

Diabetes Mellitus-

Diabetes mellitus, often referred to simply as diabetes, is a syndrome of disordered metabolism, usually due to a combination of hereditary and environmental causes, resulting in abnormally high blood sugar levels (hyperglycemia). Blood glucose levels are controlled by a complex interaction of multiple chemicals and hormones in the body, including the hormone insulin made in the beta cells

of the pancreas. Diabetes mellitus refers to the group of diseases that lead to high blood glucose levels due to defects in either insulin secretion or insulin action in the body.

Diabetes develops due to a diminished production of insulin (in type 1) or resistance to its effects (in type 2 and gestational). Both lead to hyperglycemia, which largely causes the acute signs of diabetes: excessive urine production, resulting compensatory thirst and increased fluid intake, blurred vision, unexplained weight loss, lethargy, and changes in energy metabolism.



All forms of diabetes have been treatable since insulin became medically available in 1921, but there is no cure. The injections by a syringe, insulin pump, or insulin pen deliver insulin, which is a basic treatment of type 1 diabetes. Type 2 is managed with a combination of dietary treatment, exercise, medications and insulin supplementation.

Diabetes and its treatments can cause many complications. Acute complications including hypoglycemia, ketoacidosis, or nonketotic hyperosmolar coma may occur if the disease is not adequately controlled. Serious long-term complications include cardiovascular disease, chronic renal failure, retinal damage, which can lead to blindness, several types of nerve damage, and microvascular damage, which may cause erectile dysfunction and poor wound healing. Poor healing of wounds, particularly of the feet, can lead to gangrene, and possibly to amputation. Adequate treatment of diabetes, as well as increased emphasis on blood pressure control and lifestyle factors such as not smoking and maintaining a healthy body weight, may improve the risk profile of most of the chronic complications. In the developed world, diabetes is the most significant cause of adult blindness in the non-elderly and the leading cause of non-traumatic amputation in adults, and diabetic nephropathy is the main illness requiring renal dialysis in the United States.

Eye:

Myopia-

Myopia, also called nearsightedness or shortsightedness, is a refractive defect of the eye in which collimated light produces image focus in front of the retina when accommodation is relaxed.

Those with myopia see nearby objects clearly but distant objects appear blurred. With myopia, the eyeball is too long, or the cornea is too steep, so images are focused in the vitreous inside the eye rather than on the retina at the back of the eye. The opposite defect of myopia is hyperopia or "farsightedness" or "long-sightedness" — this is where the cornea is too flat or the eye is too short.

Mainstream Eye care professionals most commonly correct myopia through the use of corrective lenses, such as glasses or contact lenses. It may also be corrected by refractive surgery, such as LASIK. The corrective lenses have a negative optical power (i.e. are concave) which compensates for the excessive positive diopters of the myopic eye.

Normal vision

Vision with myopia

Cataracts-

A cataract is a clouding that develops in the crystalline lens of the eye or in its envelope, varying in degree from slight to complete opacity and obstructing the passage of light. Early in the development of age-related cataract the power of the lens may be increased, causing near-sightedness (myopia), and the gradual yellowing and opacification of the lens may reduce the perception of blue colours. Cataracts typically progress slowly to cause vision loss and are potentially blinding if untreated. The condition usually affects both the eyes, but almost always one eye is affected earlier than the other.

A senile cataract, occurring in the aged, is characterized by an initial opacity in the lens, subsequent swelling of the lens and final shrinkage with complete loss of transparency.[2] Moreover, with time the cataract cortex liquefies to form a milky white fluid in a Morgagnian cataract, which can cause severe inflammation if the lens capsule ruptures and leaks. Untreated, the cataract can cause phacomorphic glaucoma. Very advanced cataracts with weak zonules are liable to dislocation anteriorly or posteriorly. Such spontaneous posterior dislocations (akin to the historical surgical procedure of couching) in ancient times were regarded as a blessing from the heavens, because some perception of light was restored in the cataractous patients.

Gastro-intestinal and Intestinal:

Gallstones-

In medicine, gallstones (choleliths) are crystalline bodies formed within the body by accretion or concretion of normal or abnormal bile components.

Gallstones can occur anywhere within the biliary tree, including the gallbladder and the common bile duct. Obstruction of the common bile duct is choledocholithiasis; obstruction of the biliary tree can cause jaundice; obstruction of the outlet of the pancreatic exocrine system can cause pancreatitis.

Cholelithiasis is the presence of stones in the gallbladder or bile ducts: chole- means "bile", lithia means "stone", and -sis means "process".

Gallstones have different appearance, depending on their contents. On the basis of their contents, gallstones can be subdivided into the two following types:

- Cholesterol stones are usually green, but are sometimes white or yellow in color. They are made primarily of cholesterol and account for 80 percent of gallstones.

- Pigment stones are small, dark stones made of bilirubin and calcium salts that are found in bile. They account for 20 percent of gallstones. Risk factors for pigment stones include hemolytic anemia, cirrhosis, biliary tract infections, and hereditary blood cell disorders, such as sickle cell anemia and spherocytosis.

Researchers believe that gallstones may be caused by a combination of factors, including inherited body chemistry, body weight, gallbladder motility (movement), and perhaps diet. Additionally, people with erythropoietic protoporphyria (EPP) are at increased risk to develop gallstones.

Cholesterol gallstones develop when bile contains too much cholesterol and not enough bile salts. Besides a high concentration of cholesterol, two other factors seem to be important in causing gallstones. The first is how often and how well the gallbladder contracts; incomplete and infrequent emptying of the gallbladder may cause the bile to become overconcentrated and contribute to gallstone formation. The second factor is the presence of proteins in the liver and bile that either promote or inhibit cholesterol crystallization into gallstones.

In addition, increased levels of the hormone estrogen as a result of pregnancy, hormone therapy, or the use of combined (estrogen-containing) forms of hormonal contraception, may increase cholesterol levels in bile and also decrease gallbladder movement, resulting in gallstone formation.

No clear relationship has been proven between diet and gallstone formation. However, low-fibre, high-cholesterol diets, and diets high in starchy foods have been suggested as contributing to gallstone formation. Other nutritional factors that may increase risk of gallstones include rapid weight loss, constipation, eating fewer meals per day, eating less fish, and low intakes of the nutrients folate, magnesium, calcium, and vitamin C. On the other hand, wine and whole grain bread may decrease the risk of gallstones.

The common mnemonic for gallstone risk factors refer to the "four F's": fat (i.e., overweight), forty (an age near or above 40), female, and fertile (pre-menopausal); a fifth F, fair is sometimes added to indicate that the condition is more prevalent in Caucasians. The absence of these risk factors does not, however, preclude the formation of gallstones.

Interestingly, a lack of melatonin could significantly contribute to gallbladder stones, as melatonin both inhibits cholesterol secretion from the gallbladder, enhances the conversion of cholesterol to bile, and is an antioxidant, capable of reducing oxidative stress to the gallbladder.

Gallstones usually remain asymptomatic initially. They start developing symptoms once the stones reach a certain size (>8 mm). A main symptom of gallstones is commonly referred to as a gallstone "attack", also known as biliary colic, in which a person will experience intense pain in the upper abdominal region that steadily increases for approximately thirty minutes to several hours. A patient may also encounter pain in the back, ordinarily between the shoulder blades, or pain under the right shoulder. In some cases, the pain develops in the lower region of the abdomen, nearer to the pelvis, but this is less common. Nausea and vomiting may occur.

Diverticulitis-

Diverticulitis is a common digestive disease particularly found in the colon (the large intestine). Diverticulitis develops from diverticulosis, which involves the formation of pouches (diverticula) on the outside of the colon. Diverticulitis results if one of these diverticula becomes inflamed or infected. The colon can become infected with craters of food stuck inside, which causes abdominal pain.

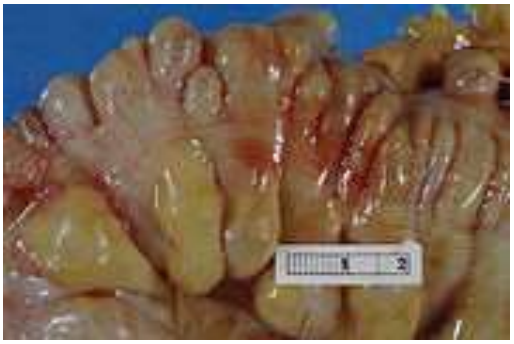
The development of colonic diverticulum is thought to be a result of raised intraluminal colonic pressures. The Sigmoid colon (Section 4) has the smallest diameter of any portion of the colon, and therefore the portion which would be expected to have the highest intraluminal pressure. The assumption that a lack of dietary fiber, particularly non-soluble fiber (also known in older parlance as "roughage") predisposes individuals to diverticular disease is supported within the medical literature.

It is thought that mechanical blockage of a diverticulum, possibly by a piece of feces or food particles, leads to infection of the diverticulum.

There is some evidence that a genetic component may be a causative factor.

Patients often present with the classic triad of left lower quadrant pain, fever, and leukocytosis (an elevation of the white cell count in blood tests). Patients may also complain of nausea or diarrhea; others may be constipated.

Less commonly, an individual with diverticulitis may present with right-sided abdominal pain. This may be due to the less prevalent right-sided diverticula or a very redundant sigmoid colon.



Large bowel (sigmoid colon) showing multiple diverticula. Note how the diverticula appear on either side of the longitudinal muscle bundle (taenium).

Genitourinary:

UTI-

A urinary tract infection (UTI) is a bacterial infection that affects any part of the urinary tract. Although urine contains a variety of fluids, salts, and waste products, it usually does not have bacteria in it. When bacteria get into the bladder or kidney and multiply in the urine, they cause a UTI. The most common type of UTI is a bladder infection which is also often called cystitis. Another kind of UTI is a kidney infection, known as pyelonephritis, and is much more serious. Although they cause discomfort, urinary tract infections can usually be quickly and easily treated with a short course of antibiotics.

- Frequent urination along with the feeling of having to urinate even though there may be very little urine to pass.
- Nocturia: Need to urinate during the night.
- Urethritis: Discomfort or pain at the urethral meatus or a burning sensation throughout the urethra with urination (dysuria).
- Pain in the midline suprapubic region.
- Pyuria: Pus in the urine or discharge from the urethra.
- Hematuria: Blood in urine.
- Pyrexia: Mild fever
- Cloudy and foul-smelling urine
- Increased confusion and associated falls are common presentations to Emergency Departments for elderly patients with UTI.
- Some urinary tract infections are asymptomatic.

Incontinence-

Urinary incontinence (UI) is any involuntary leakage of urine. It is a common and distressing problem, which may have a profound impact on quality of life. Urinary incontinence almost always results from an underlying treatable medical condition. There is also a related condition for defecation known as fecal incontinence.

Patients with incontinence should be referred to a medical practitioner specializing in this field. Urologists specialize in the urinary tract, and some urologists further specialize in the female urinary tract. A urogynecologist is a gynecologist who has special training in urological problems in women. Gynecologists and obstetricians specialize in the female reproductive tract and childbirth and some also treat urinary incontinence in women. Family practitioners and internists see patients for all kinds of complaints and can refer patients on to the relevant specialists.

A careful history taking is essential especially in the pattern of voiding and urine leakage as it suggests the type of incontinence faced. Other important points include straining and discomfort, use of drugs, recent surgery, and illness.

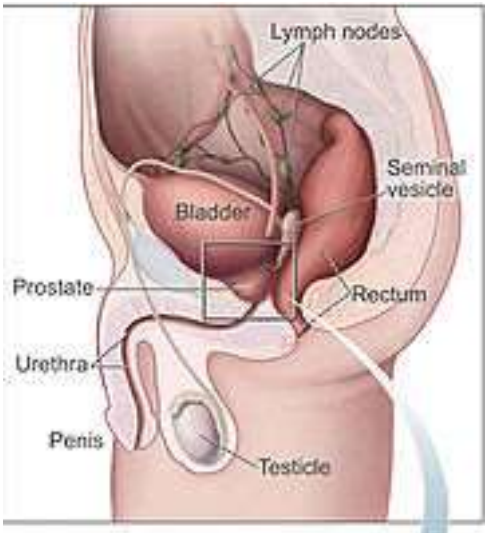
The physical examination will focus on looking for signs of medical conditions causing incontinence, such as tumors that block the urinary tract, stool impaction, and poor reflexes or sensations, which may be evidence of a nerve-related cause.

A test often performed is the measurement of bladder capacity and residual urine for evidence of poorly functioning bladder muscles.

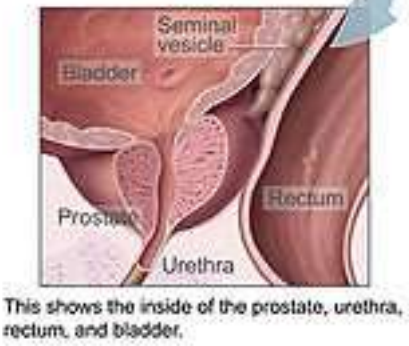
Other tests include:

- Stress test – the patient relaxes, then coughs vigorously as the doctor watches for loss of urine.
- Urinalysis – urine is tested for evidence of infection, urinary stones, or other contributing causes.
- Blood tests – blood is taken, sent to a laboratory, and examined for substances related to causes of incontinence.
- Ultrasound – sound waves are used to visualize the kidneys, ureters, bladder, and urethra.
- Cystoscopy – a thin tube with a tiny camera is inserted in the urethra and used to see the inside of the urethra and bladder.
- Urodynamics – various techniques measure pressure in the bladder and the flow of urine.

Patients are often asked to keep a diary for a day or more, up to a week, to record the pattern of voiding, noting times and the amounts of urine produced



This shows the prostate and nearby organs.



This shows the inside of the prostate, urethra, rectum, and bladder.

Prostatic cancer-

Prostate cancer is a disease in which cancer develops in the prostate, a gland in the male reproductive system. It occurs when cells of the prostate mutate and begin to multiply uncontrollably. These cells may metastasize (spread) from the prostate to other parts of the body, particularly the bones and lymph nodes. Prostate cancer may cause pain, difficulty in urinating, problems during sexual intercourse, erectile dysfunction. Other symptoms can potentially develop during later stages of the disease.

The specific causes of prostate cancer remain unknown. A man's risk of developing prostate cancer is related to his age, genetics, race, diet, lifestyle, medications, and other factors. The primary risk factor is age. Prostate cancer is uncommon in men less than 45, but becomes more common with advancing age. The average age at the time of diagnosis is 70. However, many men never know they have prostate cancer. Autopsy studies of Chinese, German, Israeli, Jamaican, Swedish, and Ugandan men who died of other causes have found prostate cancer in thirty percent of men in their 50s, and in eighty percent of men in their 70s. In the year 2005 in the United States, there were an estimated 230,000 new cases of prostate cancer and 30,000 deaths due to prostate cancer.

Integumentary system:

Impetigo-

Impetigo (sometimes impetaigo) is a superficial bacterial skin infection most common among children 2 to 6 years old. People who play close contact sports such as rugby, American football and wrestling are also susceptible, regardless of age. While not as common in adults, impetigo is more frequent in individuals with poor hygiene or limited access to showers or bathing facilities. It is also known as school sores.

Diagnosis- Impetigo generally appears as honey-colored scabs formed from dried serum, and is often found on the arms, legs, or face.

Transmission- The infection is spread by direct contact with lesions or with nasal carriers. The incubation period is 1–3 days. Dried streptococci in the air are not infectious to intact skin. Scratching may spread the lesions.

Dermatitis-

Dermatitis is a blanket term meaning any "inflammation of the skin" (e.g. rashes, etc.). There are several different types of dermatitis. The different kinds usually have in common an allergic reaction to specific allergens. The term may be used to refer to eczema, which is also known as dermatitis eczema or eczematous dermatitis. A diagnosis of eczema often implies childhood or atopic dermatitis, but without proper context, it means nothing more than a "rash".

Burns-

A burn is a type of injury that may be caused by heat, cold, electricity, chemicals, light, radiation, or friction. Burns can be highly variable in terms of the tissue affected, the severity, and resultant complications. Muscle, bone, blood vessel, and epidermal tissue can all be damaged with subsequent pain due to profound injury to nerves. Depending on the location affected and the degree of severity, a burn victim may experience a wide number of potentially fatal complications including shock, infection, electrolyte imbalance and respiratory distress. Beyond physical complications, burns can also result in severe psychological and emotional distress due to scarring and deformity. It is generally accepted that a burn affecting more than one percent of the body surface, (approximately area of the casualty's palm) should be assessed by a medical practitioner.

Musculoskeletal system:

Soft tisse injury-

Soft tissue injury is damage of the soft tissue of the body. This is sort of like bruising. These types of injuries are a major source of pain and disability. The four fundamental tissues that are affected are the epithelial, muscular, nervous and connective tissues.

Soft tissue injuries include sprains, strains, subluxation, repetitive stress injury, carpal tunnel syndrome, etc.

The standard approach to managing soft tissue injuries is to obtain a good medical history and perform a thorough physical examination. X-ray investigation can be used to assess the possibility of fracture or dislocation.

Nerve conduction studies may also be used to localize nerve dysfunction (e.g., carpal tunnel syndrome), assess severity, and help with prognosis. Electrodiagnosis also helps differentiate between myopathy and neuropathy.

Ultimately, the best method of imaging soft tissue is magnetic resonance imaging (MRI), though it is cost-prohibitive and carries a high false positive rate.

Management of soft tissue injuries consists of protecting the injured tissue; resting it with splints, braces, or tape; ice; compression; and elevation and referral. An easy mnemonic for remembering these steps is RICER – Rest, Ice, Compression, Elevation Referral. Use of a cold compression wrap combines ice and compression. Referral - see a doctor or physiotherapist to gain knowledge about the extent of the injury.

Fracture-

In orthopedic medicine, fractures are classified in various ways.

- Closed fractures are those in which the skin is intact, while open (compound) fractures involve wounds that communicate with the fracture, or where fracture hematoma is exposed, and may thus expose bone to contamination. Open injuries carry a higher risk of infection; they require antibiotic treatment and usually urgent surgical treatment (debridement). This involves removal of all dirt, contamination, and dead tissue.
- Simple fractures are fractures that only occur along one line, splitting the bone into two pieces, while multi-fragmentary fractures (formerly called comminuted) involve the bone

splitting into multiple pieces. A simple, closed fracture is much easier to treat and has a much better prognosis than an open, comminuted fracture.

Other considerations in fracture care are displacement (fracture gap) and angulation. If angulation or displacement is large, reduction (manipulation) of the bone may be required and, in adults, frequently requires surgical care. These injuries may take longer to heal than injuries without displacement or angulation.

Another type of bone fracture is a compression fracture. It usually occurs in the vertebrae, for example when the front portion of a vertebra in the spine collapses due to osteoporosis (a medical condition which causes bones to become brittle and susceptible to fracture, with or without trauma).

Other types of fracture are:

- Complete fracture - A fracture in which bone fragments separate completely.
- Incomplete fracture - A fracture in which the bone fragments are still partially joined.
- Linear fracture - A fracture that is parallel to the bone's long axis.
- Transverse fracture - A fracture that is at a right angle to the bone's long axis.
- Oblique fracture - A fracture that is diagonal to a bone's long axis.
- Spiral fracture - A fracture where at least one part of the bone has been twisted.
- Compacted fracture - A fracture caused when bone fragments are driven into each other.

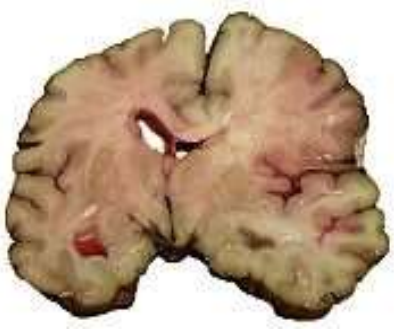
Bone tissue itself doesn't contain nociceptors. Still, bone fracture is very painful, for several reasons:

- Breaking in the continuity of the periosteum, with or without similar discontinuity in endosteum, as both contain multiple nociceptors.

- Edema of nearby soft tissues caused by bleeding of torn periosteal blood vessels evokes pressure pain.

- Muscle spasms trying to hold bone fragments in place

First aid for fractures includes stabilizing the break with a splint in order to prevent movement of the injured part, which could sever blood vessels and cause further tissue damage. Waxed cardboard splints are inexpensive, lightweight, waterproof and strong. Compound fractures are treated as open wounds in addition to fractures.



Nervous system:

Stroke (Cerebrovascular accident)-

A stroke is the rapidly developing loss of brain function(s) due to disturbance in the blood supply to the brain. This can be due to ischemia (lack of blood supply) caused by thrombosis or embolism or due to a hemorrhage. As a result, the affected area of the brain is unable to function, leading to inability to move one or more limbs on one side of the body, inability to understand or formulate speech, or inability to see one side of the visual field. In the past, stroke was referred to as cerebrovascular accident or CVA, but the term "stroke" is now preferred.

A stroke is a medical emergency and can cause permanent neurological damage, complications, and death. It is the leading cause of adult disability in the United States and Europe. In the UK, it is the second most common cause of death, the first being heart attacks and third being cancer. It is the number two cause of death worldwide and may soon become the leading cause of death worldwide.Risk factors for stroke include advanced age, hypertension (high blood pressure), previous stroke or transient ischemic attack (TIA), diabetes, high cholesterol, cigarette smoking and atrial fibrillation.High blood pressure is the most important modifiable risk factor of stroke.

The traditional definition of stroke, devised by the World Health Organization in the 1970s, is a "neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours". This definition was supposed to reflect the reversibility of tissue damage and was devised for the purpose, with the time frame of 24 hours being chosen arbitrarily. The 24-hour limit divides stroke from transient ischemic attack, which is a related syndrome of stroke symptoms that resolve completely within 24 hours. With the availability of treatments that, when given early, can reduce stroke severity, many now prefer alternative concepts, such as brain attack and acute ischemic cerebrovascular syndrome (modeled after heart attack and acute coronary syndrome respectively), that reflect the urgency of stroke symptoms and the need to act swiftly.

A stroke is occasionally treated with thrombolysis ("clot buster"), but usually with supportive care (speech and language therapy, physiotherapy and occupational therapy) in a "stroke unit" and secondary prevention with antiplatelet drugs (aspirin and often dipyridamole), blood pressure control, statins, and in selected patients with carotid endarterectomy and anticoagulation.

Stroke symptoms typically start suddenly, over seconds to minutes, and in most cases do not progress further. The symptoms depend on the area of the brain affected. The more extensive the area of brain affected, the more functions that are likely to be lost. Some forms of stroke can cause additional symptoms: in intracranial hemorrhage, the affected area may compress other structures. Most forms of stroke are not associated with headache, apart from subarachnoid hemorrhage and cerebral venous thrombosis and occasionally intracerebral hemorrhage.

Dementia-

Dementia is the progressive decline in cognitive function due to damage or disease in the body beyond what might be expected from normal aging. Although dementia is far more common in the geriatric population, it may occur in any stage of adulthood. This age cutoff is defining, as similar sets of symptoms due to organic brain dysfunction are given different names in populations younger than adult.

Dementia is a non-specific illness syndrome (set of signs and symptoms) in which affected areas of cognition may be memory, attention, language, and problem solving. Higher mental functions are affected first in the process. Especially in the later stages of the condition, affected persons may be disoriented in time (not knowing what day of the week, day of the month, or even what year it is), in place (not knowing where they are), and in person (not knowing who they are or others around them). Dementia, though treatable, is incurable.

Symptoms of dementia can be classified as either reversible or irreversible, depending upon the etiology of the disease. Less than 10 percent of cases of dementia are due to causes which may presently be reversed with treatment. Causes include many different specific disease processes, in the same way that symptoms of organ dysfunction such as shortness of breath, jaundice, or pain are attributable to many etiologies. Without careful assessment of history, the short-term syndrome of delirium can easily be confused with dementia, because they have many symptoms in common.

Some mental illnesses, including depression and psychosis, may also produce symptoms which must be differentiated from both delirium and dementia.

Proper differential diagnosis between the types of dementia (cortical and subcortical - see below) will require, at the least, referral to a specialist, e.g. a geriatric internist, geriatric psychiatrist, neurologist, neuropsychologist or geropsychologist. However, there exist some brief tests (5–15 minutes) that have reasonable reliability and can be used in the office or other setting to screen cognitive status for deficits which are considered pathological. Examples of such tests include the abbreviated mental test score (AMTS), the mini mental state examination (MMSE), Modified Mini-Mental State Examination (3MS),the Cognitive Abilities Screening Instrument (CASI),and the clock drawing test.An AMTS score of less than six (out of a possible score of ten) and an MMSE score under 24 (out of a possible score of 30) suggests a need for further evaluation. Scores must be interpreted in the context of the person's educational and other background, and the particular circumstances; for example, a person highly depressed or in great pain will not be expected to do well on many tests of mental ability.

It appears that the regular moderate consumption of alcohol (beer, wine, or distilled spirits) and a Mediterranean diet may reduce risk.A study has shown a link between high blood pressure and developing dementia.

Reproductive system:

Obstetric emergencies-

The main emergencies include:

- Ectopic pregnancy is when an embryo implants in the Fallopian tube or (rarely) on the ovary or inside the peritoneal cavity. This may cause massive internal bleeding.
- Pre-eclampsia is a disease which is defined by a combination of signs and symptoms that are related to maternal hypertension. The cause is unknown, and markers are being sought to predict its development from the earlist stages of pregnancy.

Some unknown factors cause vascular damage in the endothelium, causing hypertension and proteinuria. If severe, it progresses to fulminant pre-eclampsia, with headaches, epigastric pain and visual disturbances. This is a prelude to eclampsia, where a convulsion occurs, which can be fatal.

- Placental abruption where the patient can bleed to death if not managed appropriately.
- Shoulder dystocia where one of the fetus' shoulders becomes stuck during vaginal birth, especially in macrosomic babies of diabetic mothers.

Respiratory system:

Bronchospasm-

Bronchospasm or a bronchial spasm is a sudden constriction of the muscles in the walls of the bronchioles. It is caused by the release (degranulation) of substances from mast cells or basophils under the influence of anaphylatoxins. It causes difficulty in breathing which can be very mild to severe.

Bronchospasms appear as the feature of asthma, chronic bronchitis, anaphylaxis, as a possible side-effect of the drug pilocarpine (which is used to treat illness resulting from the ingestion of deadly nightshade as well as other things) and also as a side effect for beta blockers (used to treat hypertension) and other drugs.

Bronchospasms are one of several conditions associated with cold housing.

Some of the things that can cause bronchospasms are consuming foods, taking medicines or getting insect bites or stings when one is allergic to them.

A few of the more common allergens are foods such as eggs, milk, peanuts, tree and other nuts, fish, especially shellfish, soy and wheat; insect bites and stings, especially bee stings; and other medicines, especially penicillin and its derivatives.

The over activity of the bronchioles' muscle is a result of exposure to a stimulus which under normal circumstances would cause little or no response. The resulting constriction and inflammation causes a narrowing of the airways and an increase in mucus production; this reduces the amount of oxygen that is available to the individual causing breathlessness, coughing and hypoxia.

Bronchospasms are a serious potential complication of placing a breathing tube during general anesthesia. When the airways spasm or constrict in response to the irritating stimulus of the breathing tube, it is difficult to maintain the airway and the patient can become apnic.

Upper respiratory tract infection-

Upper respiratory tract infections, (URTI or URI), are the illnesses caused by an acute infection which involves the upper respiratory tract: nose, sinuses, pharynx or larynx.

Acute upper respiratory tract infections include rhino-sinusitis (Common cold), sinusitis, pharyngitis/tonsillitis,ear infection, laryngitis and sometimes bronchitis. Symptoms of URTI's commonly include nasal congestion, cough, running nose, sore throat, fever, facial pressure and sneezing. Onset of the symptoms usually begins after 1-3 days after exposure to a microbial pathogen, most commonly a virus. The duration of the symptoms is typically 7 to 10 days but may persist longer.

Up to 15% of acute pharyngitis cases may be caused by bacteria, commonly Group A streptococcus in Streptococcal pharyngitis ("Strep Throat"). Generally, patients with strep throat start with a sore throat as their first symptom and usually do not have runny nose or cough or sneezing.

Pain and pressure of the ear caused by a middle ear infection (Otitis media) and the reddening of the eye caused by Viral Conjunctivitis are often associated with upper respiratory infections.

Influenza (the flu) is a more systemic illness which can also involve the upper respiratory tract.

Upper RT (including URTIs, Common cold)	Head	sinuses: Sinusitis nose: Rhinitis (Vasomotor rhinitis, Atrophic rhinitis, Hay fever) · Nasal polyp · Deviated septum · Rhinorrhea tonsil: Tonsillitis · Adenoid hypertrophy · Peritonsillar abscess

	Neck	pharynx: Pharyngitis (Strep throat) larynx: Laryngitis · Croup · Laryngospasm · vocal folds: Vocal fold nodule · epiglottis: Epiglottitis trachea: Tracheitis · Tracheal stenosis

Drug types, possible adverse effects and appropriate actions

DRUG TYPE	POSSIBLE CONSEQUENCE FOR MASSAGE	APPROPRIATE ACTIONS
angiotensin converting enzyme (ACE) inhibitor	mild postural hypotension; giddiness; potential to faint	advise to stand up slowly; be prepared for fainting
angiotensin II receptor antagonist	mild postural hypotension; giddiness; potential to faint	advise to stand up slowly; be prepared for fainting
anti-anxiety drugs	sedation	warn of danger in driving after massage
anticontractile drugs	reduced muscle spasm	no action
antiepileptic drugs	sedation	warn of danger in driving after massage
antihistamines	dry hot skin	hydrating oils; gentle massage
	sedation	warn of danger in driving after massage
anti-inflammatory analgesics	reduced pain response	control intensity of massage
antipsychotic drugs	involuntary movements	reassure patient
antispastic drugs (acting on muscle)	reduced muscle spasm	no action
antispastic drugs (CNS acting)	reduced muscle spasm	no action
	sedation	warn of danger in driving after massage
β -adrenoceptor agonists	muscle tremor	reassure patient; no other action
β -adrenoceptor antagonists	mild postural hypotension; giddiness; potential to faint	advise to stand up slowly; be prepared for fainting
benzodiazepines	sedation	warn of danger in driving after massage
calcium channel blockers	mild postural hypotension; giddiness; potential to faint	advise to stand up slowly; be prepared for fainting
corticosteroids (inhaled)	nil	no action

DRUG TYPE	POSSIBLE CONSEQUENCE FOR MASSAGE	APPROPRIATE ACTIONS
corticosteroids (oral)	wasting of muscle protein; reduced bone strength; skin wasting and possible fungal infection	take particular care to control intensity of massage; use hydrating oils; take precautions for infected skin
corticosteroids (topical)	thinning of skin, possible fungal infection of skin	control intensity of massage; use hydrating oils; take precautions for infected skin
insulin	hypoglycaemic episode: faintness, clammy skin, tremor	oral glucose or sucrose (jelly beans, one or two candy bars or two bananas); in emergency call ambulance
lithium (antimanic)	acne	skin infection control
	tremor	reassure patient
nitrates	severe postural hypotension with potential to faint	advise to stand up slowly; be prepared for fainting
oral hypoglcaemic drugs	hypoglycaemic episode: faintness, clammy skin, tremor	oral glucose or sucrose (one or two candy bars or two bananas); in emergency call ambulance
phenothiaxines	muscle stiffness	be aware that muscle stiffness and movement is neuronal in origin and not ameliorated by massage
phenothiazines	tremor	reassure patient
	dry hot skin	hydrating oils; gentle massage
phenothiazines	extrapyramidal syndrome: tremor, akinesia, twitching, stiffness, spasms	reassure patient; syndrome is CNS in origin and massage will palliate only
phenothiazines	postural hypotension; giddiness; potential to faint	advise to stand up slowly; be prepared for fainting
	sedation	warn of danger in driving after massage
psychostimulants	low therapeutic doses no problem; high illicit doses cause excitement, palpitations, tremor, chorea, psychotic episode	reassure patient; emergency procedures if required
reversible inhibitors of monoamine oxidase (RIMA)	no common marked adverse effects	no action
selective serotonin reuptake inhibitors (SSRI)	dizziness, nervousness, tremor	reassure patient
St John's wort	occasional serotonin syndrome (confusion, tremor, diarrhoea)	seek medical help
thiazide diuretic	postural hypotension; giddiness; potential to faint	advise to stand up slowly; be prepared for fainting
tricyclic anti-depressants	dry hot skin	hydrating oils; gentle massage
	sedation	warn of danger in driving after massage

Short glossary of commonly used terms

Acute-signs and symptoms happen quickly, last a short amount of time and then disappear.

Adhesion- Abnormal adherence of collagen fibers within connective tissue to surrounding structures following trauma or stress; as a result of surgery. Restrict the normal elasticity of these structures as well as the transfer of electrolytes and other fluids.

Autonomic Nervous System- The body system that regulates involuntary body functions such as action of glands, smooth muscles and the heart. It consists of the sympathetic and parasympathetic nervous system.

Atrophy- Wasting away or decrease in size of something, due to disease or other factors such as nutrition or lack of use.

Chronic- disease or condition that develops slowly and lasts for a long time.

Connective tissue- The most abundant type of tissue in the body, providing support, structure, framework, space, stabilization and scar formation; binds structures together.

Contraindications- factors that indicate that the treatment is not advised, unless further evaluation by a physician can recommend a treatment plan.

Friction- circular or transverse technique that focuses on the underlying tissue.

Golgi Tendon Receptors- receptors in the tendons that sense tension; found mostly near the junction of tendons and muscles. It will trigger a central nervous system response which will inhibit muscular contraction when the tendon is in danger of tearing due to excessive tension.

Hyperemia- an excess of blood in an area or body part; usually indicated by red, flushed color or heat in the area.

Hyperesthesia- Unusual sensitivity to sensory stimulus, hyper irritalbility, or increased muscular sensitivity to pain.

Hypertonicity- Excess muscle tone

Hypertrophy- An increased size in muscle or thickening of muscle tissue in response to increases stress.

Inflammation- characterized by pain, heat, redness, swelling; usually as a result of an injury or infection.

Ischemia- Local and temporary decrease in blood flow to an area.

Mechanical Effect- based on structural changes in the tissue; primary effects created manually; as a direct result of the application of the technique.

Myofascial- affecting the connective tissue of the body

Muscle spasm- a non-voluntary contraction of the motor unit of a muscle; usually causing a contraction without shortening the muscle; can be a result of mental, physical, emotional, chemical stress.

Peristalsis- Successive muscular contractions along the wall of a hollow muscular structure such as the movement of food through the intestine and colon.

Proprioceptor- a receptor located in muscles, tendons or joints that provides information about body movement an position.

Reflexive effect- secondary effects that occur as a result of the massage technique but we do not cause directly or manually.

Scar tissue- tissue that results from healing of wounds; It is composed of collagenous fibers which will restrict normal elasticity of tissue involved.

Aerobic exercise: An activity that uses the large muscles and involves increased breathing and heart rate over an extended period of time, usually a minimum of 20 minutes.

Anorexia nervosa: A serious psychological disorder most often affecting young women and characterized by refusal to eat. Those affected exert extreme discipline over their eating habits and are usually obsessed about food. They carefully plan their meals and are fearful of overindulging.

Appetite: A learned behavior and an emotional or mental desire for food that may be brought about by the sight or smell of food or by thinking of a pleasurable food or meal eaten in the past.

Basal metabolic rate (BMR): A measure of the energy necessary for maintaining basic functions, such as breathing, heart rate, and digestion.

Binge eating disorder: A condition characterized by frequent episodes of uncontrolled eating.

The binge eater feels out of control, and episodes of overeating are followed by feelings of disgust, guilt, or depression. It is common for episodes of overeating to be followed by bulimic behavior, such as vomiting, using laxatives, or over-exercising.

Body mass index (BMI): A measure relating body weight to height. It is derived from a person's weight (in kilograms) divided by their height (in meters) squared.

Bulimia nervosa: An eating disorder aimed at averting weight gain. It is characterized by behaviors such as vomiting, taking laxatives, or over exercising after eating to rid the body of the calories consumed.

Calorie: A unit of energy. In nutrition, calorie is used instead of the more precise scientific term kilocalorie. A kilocalorie is the amount of energy required to raise the temperature of a liter of water 1 ºC at sea level. The common usage of the word calorie is understood to refer to a kilocalorie when referring to food energy.

Diabetes: A chronic disease associated with abnormally high concentrations of the sugar glucose in the blood. It may be due to inadequate production of insulin (a hormone made by the pancreas that lowers blood glucose) or inadequate sensitivity of body cells to the action of insulin. The major complications of diabetes include dangerously elevated blood sugar, abnormally low blood sugar due to diabetes medications, and disease of the blood vessels, which can damage the eyes, kidneys, nerves, and heart.

Energy: As used in this curriculum supplement, it is the potential work value found in foods, measured in calories, and the work value found in animals after they eat foods.

Energy balance: A condition determined by both energy intake and energy output. Energy balance is achieved when energy intake equals energy output. This is the desired condition for healthy adults.

Hunger: The uneasy or painful sensation caused by lack of food. It may be defined as a consequence of a sequence of events that leads up to and follows a lack of adequate food intake.

Hypothesis: A testable statement that predicts an outcome.

Metabolism: The sum of all chemical reactions occurring in the body.

Negative energy balance: A condition in which energy output exceeds energy intake. This condition results in weight loss.

Nutrition: The process by which food is assimilated and used for growth and maintenance.

Obesity: A chronic metabolic disease characterized by having a high amount of body fat. Individuals traditionally have been considered obese if they are more than 20 percent over their ideal weight. That ideal weight must take into account a person's height, age, sex, and build.

Obesity in adults (not children and adolescents) has been defined more precisely by the National Institutes of Health as having a BMI of 30 or higher (a BMI of 30 is about 30 pounds overweight for a woman who is 5'4" tall).

Osteoarthritis: A type of arthritis caused by breakdown of cartilage with eventual loss of the cartilage of the joints. Arthritis is a joint disorder characterized by inflammation. Cartilage is a protein that serves as a “cushion” between the bones of the joints.

Osteoporosis: A disease characterized by a reduction in bone mass due to depletion of calcium and bone protein.

Overweight: A condition in which one is too heavy for one’s height. The National Institute of Health defines overweight in adults (not children and adolescents) as having a body mass index (BMI) of 25 to 29. Body weight comes from fat, muscle, bone, and body water. Overweight does not always mean “overfat.”

Positive energy balance: A condition in which energy intake exceeds energy output for basal metabolic rate (BMR) and physical activities. Children, adolescents, and teenagers should be in positive energy balance. For these age groups, energy intake in excess of energy used for BMR and physical activities is used for growth or may be stored for use at a later time.

Thermic effect of food: The energy needed to digest food.

Under nutrition: Inadequate nutrition due to not enough or poor assimilation of food.