

ANNEX I**Anatomy and physiology**

To provide adequate medical care on board ship there is no need to have a detailed knowledge of anatomy (structure of the body) or of physiology (function of bodily systems). Nevertheless the information provided in this Annex could be useful when examining a patient or obtaining and acting on radio medical advice.

The principal bones of the skeleton and the main muscles of the body are illustrated in Figures I.1 and I.2. The position of the organs in the chest and abdomen is depicted in Plates 14 and 15.

The bone structure

The skeleton, which consists of bones and cartilages, provides a rigid framework. The separate bones and cartilages are held together firmly at the joints by strong bands of connective tissue (the ligaments). Each bone is enveloped in a very tough adherent sheath of fibrous tissue. Between the sheath and the bone surface is a layer of bone-forming cells which can produce new bone in the event of a fracture.

The shaft of a typical long bone has a thick wall of dense bone which forms a hollow cylinder enclosing a central canal containing bone marrow. At each end the shaft is expanded to make the joint surface. These surfaces are covered by a smooth layer of cartilage to permit movements without causing friction.

Voluntary muscles

These form the bulk of the fleshy parts of the body. They are fixed to the bones by blending with the sheaths of fibrous tissue surrounding the bones. Some are attached directly to a wide area of bone surface but others taper to form a strong cord (tendon or leader) which is attached at a specific place on a bone. Muscles, and especially those of the limbs, are arranged in two opposing groups. Contraction of one group in response to an impulse through the nerve supply must be accompanied by simultaneous relaxation of the opposing group, or movement will not take place. These movements are under conscious control.

Involuntary muscles

These are found in the stomach and intestines, in the heart and blood vessels, and also in other internal organs of the body. They continue to work throughout life as part of natural body function outside the control of personal will.

ANNEX I**Anatomy and physiology**

Bone structure
 Voluntary muscles
 Involuntary muscles
 Circulatory system
 Breathing system
 Digestive system
 Urinary system
 Nervous system
 Skin

ANNEX II**Anatomical drawings**

The skeleton
 Main voluntary muscles
 Organs of chest and abdomen

Circulatory system

Blood

The body contains about 5 litres of blood which consists basically of four constituents: plasma; red cells; white cells; and platelet cells.

The plasma is the liquid component of the blood which circulates to all the tissue cells throughout the body. It distributes food, water, salts and heat and collects waste products which are subsequently excreted.

The red cells predominate and give the blood its colour. This colour is derived from a complex iron compound (haemoglobin) which is the main oxygen carrier.

The white cells give protection against infection by attacking and killing bacteria and also by producing substances which are necessary for building up resistance to further infections.

The main purpose of platelets is to assist in the blood clotting mechanism.

The heart and blood vessels

The heart is a thick-walled muscular pump about the size of a clenched fist. It is divided in the mid line into two sides which do not communicate. Each side has an upper and lower chamber which communicate through a main heart valve. The separate chambers are each served by a major blood vessel that either brings blood to the chamber or carries it away. See Plate 15.

The right side receives venous blood which, having been circulated around the body, has given up its oxygen and collected carbon dioxide. This blood is pumped through the lungs where it is replenished with oxygen and discards the carbon dioxide. As purified blood, it returns to the left side to be pumped through the arteries to all parts of the body.

The blood vessels form a closed system of tubes. The arteries, which have to take the full force of the pumping pressure, have thick walls containing muscle fibres and elastic tissue. Each heart beat widens the bore of the arteries to accommodate the surge of blood. Between beats the bore is returned to normal by the action of the muscle fibres and elastic tissue. Where an artery runs close to the body surface, the changing pressures can be felt as a pulse.

The arteries penetrate to all parts of the body, dividing and sub-dividing until they narrow to form very thin-walled vessels (capillaries). The capillaries then join with the venous network which returns the blood to the heart (Figure I.2). The size of veins increases until the heart is reached.

The capillary system is vital to the life of all tissues. The thin capillary vessel wall allows nutrients, oxygen, heat and beneficial chemical substance to enter the cells and, most important, waste products to be passed out into the blood.

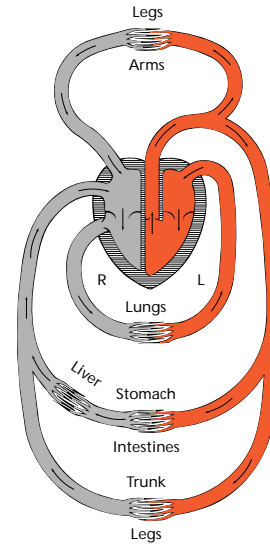


Figure I.1 The heart and the various circulations, diagrammatic



Figure I.2 Capillaries

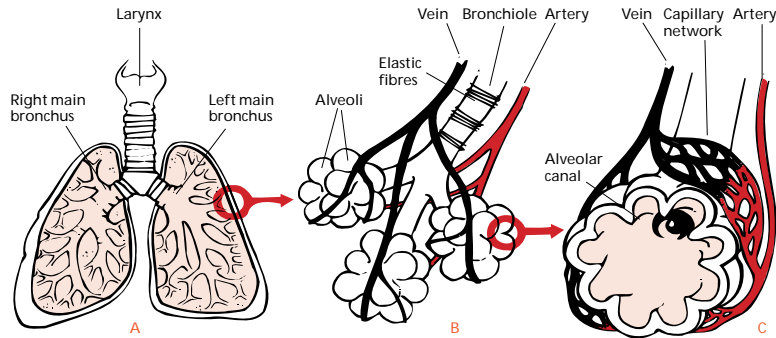
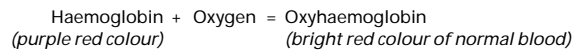


Figure 1.3 Lungs, bronchi, and alveoli

Breathing system

Every time a breath is taken in, the air (20% oxygen) passes through the nose or mouth and then past the larynx or voice box into the windpipe (trachea) which is about 12.5 cm long. At its lower end the windpipe divides into two main tubes called bronchi (Figure 1.3).

The main air passage in each lung (the bronchus) divides into successively smaller branches which carry inhaled air to all parts of the lung. Each small branch terminates by forming a cluster of very tiny air sacs (the alveoli). A fine network of blood vessels covers the surface of every air sac thereby permitting gas exchange by diffusion. Oxygen from the inspired air passes through the thin tissues to combine with the haemoglobin of the red blood cells. Waste gases, mainly carbon-dioxide, pass from blood into the air sacs and are expelled on breathing out.



Whenever the blood is insufficiently oxygenated, as in pneumonia, the purple red hue of the blood shows as a blue tinge of the lips.

Each lung is covered by a lubricated lining called the pleura. The inner side of the chest wall is also covered by a similar lining. These two layers of pleura are in contact and slide smoothly over one another during breathing.

The act of breathing is mainly due to the diaphragm moving up and down. The diaphragm is a large dome-shaped muscle which separates the chest from the abdominal cavity. When the diaphragm muscle contracts, its dome becomes flattened and draws down the lungs, causing air to enter them; when it relaxes the lungs become smaller and the air in them is expelled. The muscles of the abdomen also help in breathing. When they tighten up, they press the abdominal contents up against the diaphragm and help in expelling air from the lungs; when they relax, they assist the diaphragm in drawing down the lungs as breathing in takes place.

The normal rate of breathing at rest is 16–18 times a minute. This rate increases considerably with exertion and also with certain diseases, especially those affecting the heart and lungs.

Digestive system

The abdomen is a cavity shut off from the chest by the diaphragm. The cavity is lined by a sheath of membrane (the peritoneum) which also enfolds some of the abdominal organs. The sheath secretes fluid which keeps the abdominal contents moist and prevents friction.

The digestive tract

This is a passage consisting of the gullet (oesophagus), the stomach, the small intestine, the large intestine, the rectum and the anus.

The gullet is a straight muscular tube which joins the throat to the stomach. It passes down through the back of the chest cavity and goes through an opening in the diaphragm to connect with the upper part of the stomach.

The stomach is a J shaped pouch. It enlarges when food or liquid is consumed. The lower part of the stomach is narrow where it joins with the first part (duodenum) of the small intestine.

The small intestine is a narrow-bore coiled tube, roughly 7.5 metres long, which occupies most of the central part of the abdominal cavity. The internal surface of the wall bears a large number of very small folds which project inwards to increase the surface area in contact with the contents of the intestine. The small intestine joins with the large intestine in the right lower quarter of the abdomen.

The large intestine is a wide-bore tube, roughly 1.5 metres long, which arches upwards and across the abdominal cavity before descending the left side to join with the rectum.

The rectum is roughly 150 mm long and is continuous at its lower end with the very short anal canal which opens to the exterior.

The digestive process

Digestion is the physical and chemical breakdown of food into useful products which are then absorbed by the capillaries of the blood vessels serving the gut. The unwanted residue of food is excreted as faeces.

The digestive tract walls contain involuntary muscle which by contractions moves the contents through the entire length until they reach the rectum where they are stored as faeces prior to evacuation. At certain places such as the entrance and exit to the stomach and at the anus, circular bands of muscle capable of constriction (sphincters) act as valves to shut off the flow.

The physical breakdown of food is accomplished by chewing, by the churning actions of the gut and by the addition of special digestive juices to the food. This begins in the mouth when food is mixed with saliva which contains enzymes. In the stomach, acid gastric juice is secreted by the stomach walls and acts on the food which may be retained there for several hours before passing through the duodenum. Small ducts from the bile system of the liver and also from the pancreas open into the duodenum. These ducts provide juices which are partly designed to neutralise the acid from the stomach juice and thus allow the enzymes secreted by the duodenal walls to act more efficiently. The churning of the gut then ensures a thorough mixing of food and digestive juices throughout the length of the small intestine where most of the chemical breakdown takes place. The main functions of the large intestine are to re-absorb water from the food residue and to reduce the bulk of the faeces.

The liver

The abdominal veins drain into the liver and carry to it the useful products which have been absorbed during the digestive process. One of the main liver functions is to act as a chemical factory which processes these products into substances necessary for nutrition.

Urinary system

The kidneys are located at the back of the upper part of the abdominal cavity, one on each side of the spine (see Plate 14). They are embedded in fat to cushion them from injury.

The main kidney function is to remove water and certain harmful waste products from the blood and, by this filtering process, to form urine. They control total body water and the concentration of various chemical substances in the blood. The kidneys also play an important part in maintaining a steady level of blood pressure.

The urine is carried downward from the kidneys to the urinary bladder by tubes of small calibre (the ureters); one tube for each kidney. The urinary bladder is a muscular bag situated in the front part of the cavity formed by the pelvic bones. The bladder acts as a reservoir where urine collects until it is expelled by voluntary muscular contractions through a tube (the urethra) which leaves from the bladder base.

The male urethra measures 18 to 20 cm from the bladder to the external opening at the end of the penis. A knowledge of this length is important when passing a catheter. The female urethra is much shorter, being about 4 cm in length. It runs embedded in the upper vaginal wall to the external opening just above the vaginal orifice.

Nervous system

Cerebro-spinal nervous system

This consists of the brain, spinal cord and the associated nerves. The brain is in the cavity of the skull. It is the co-ordinating centre for the nervous system, processing incoming information from nerves concerned with sight, smell, taste, hearing, sensation etc. and controlling various parts of the body, particularly muscles by way of out going (motor nerves). Higher functions include intellect, memory, personality etc.

The spinal cord emerges from the base of the brain and leaves the skull into the bony vertebral canal. It is protected by vertebrae throughout its length, and nerves emerge at regular intervals. These nerves control muscles and transmit sensation back through the spinal column to the brain.

Sympathetic nervous system

This is a fine network of nerves not under direct voluntary control influencing the function of various organs, especially gut, bladder, blood vessels and heart.

Skin

This protects and covers the body. It consists of two layers. The outer layer is hard and contains no blood vessels or nerves. This outer layer protects the inner layer, where there are sensitive nerve endings numerous sweat glands and the roots of the hair.

Sweat consists of water, salt and some impurities from the blood. The evaporation of the sweat cools the body, and helps to regulate its temperature.

ANNEX II

Anatomical drawings

FRONT VIEW OF SKELETON

- Cranium (skull)
- Orbit (eye socket)
- Mandible (lower jaw)
- Clavicle (collar bone)
- Head of humerus articulating with scapula (shoulder joint)
- Humerus (upper arm bone)
- Ulna (inner bone of forearm)
- Radius (outer bone of forearm)
- Carpal bones (small hand bones of wrist joint)
- Metacarpal bones (long bones of the hand)
- Phalanges (bones of the thumb and fingers)
- Sternum (breast bone)
- Ribs
- Costal cartilages (non-bony attachments of ribs to the breast bone)
- Floating ribs (not attached to the breast bone)
- Ilium (bone of the pelvis)
- Ischium (bony part underlying the buttocks)
- Pubis (joining the two pelvis bones)
- Head and neck of femur forming part of hip joint
- Femur (thigh bone)
- Patella (knee cap)
- Tibia (shin bone)
- Fibula
- Tarsal bones (small bones of the foot)
- Metatarsal bones (long bones of the foot)
- Phalanges (bones of the toes)

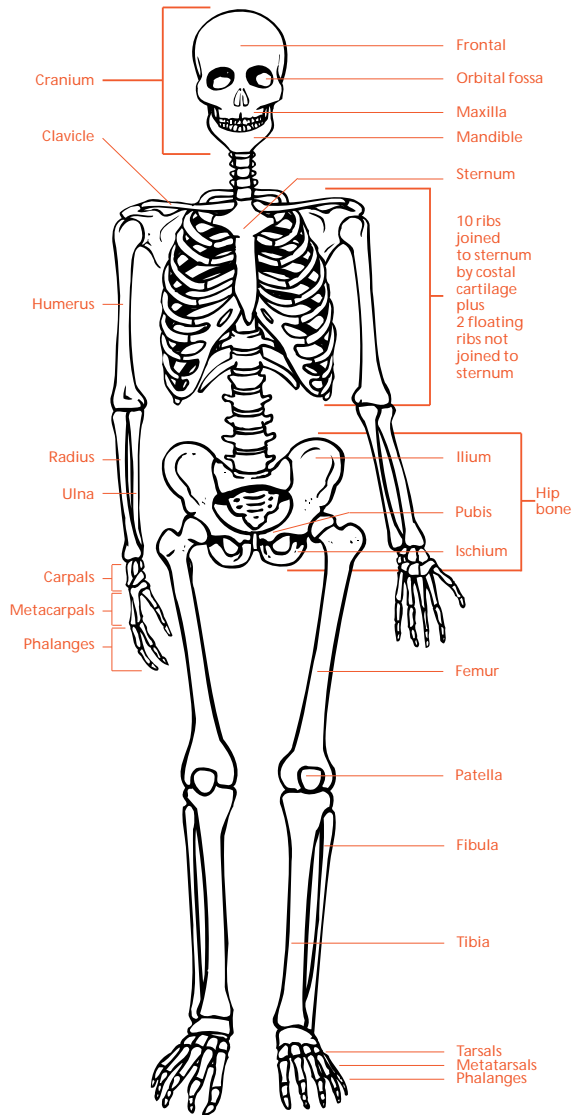


Figure I.1 The skeleton (front)

BACK VIEW OF SKELETON
includingParietal and occipital
bones (part of cranium)Vertebral column (spinal
column)

Scapula (shoulder-blade)

Sacrum (base of the spine)

Coccyx (small bones at the
base of the spine – tail
bone)

Os calcis (the heel)

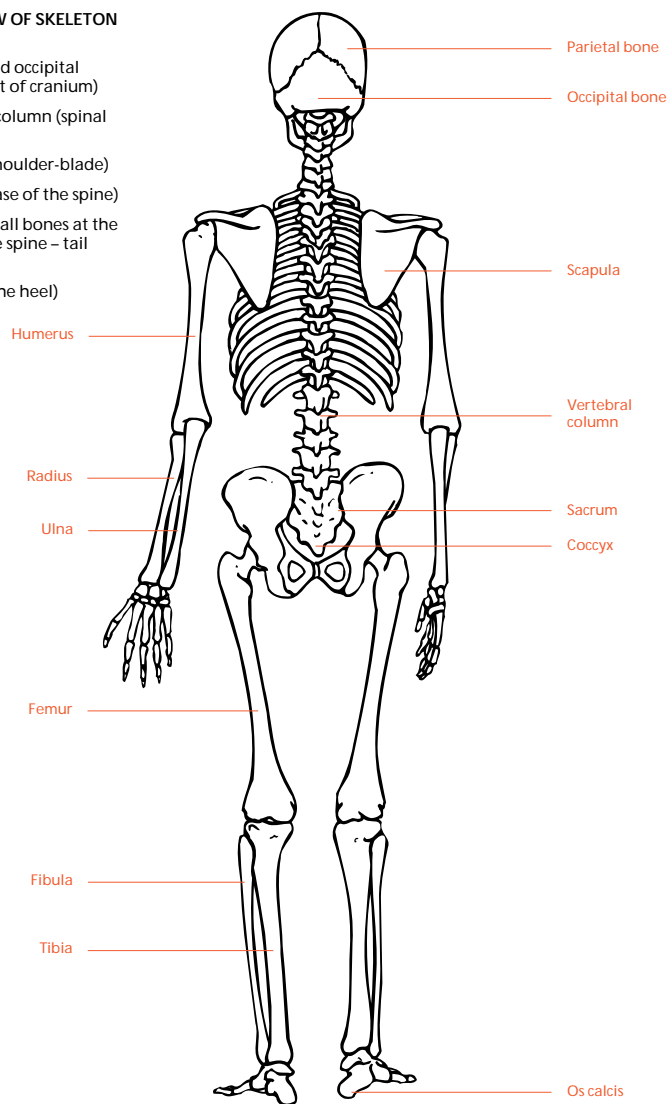


Figure 1.2 The skeleton (rear)

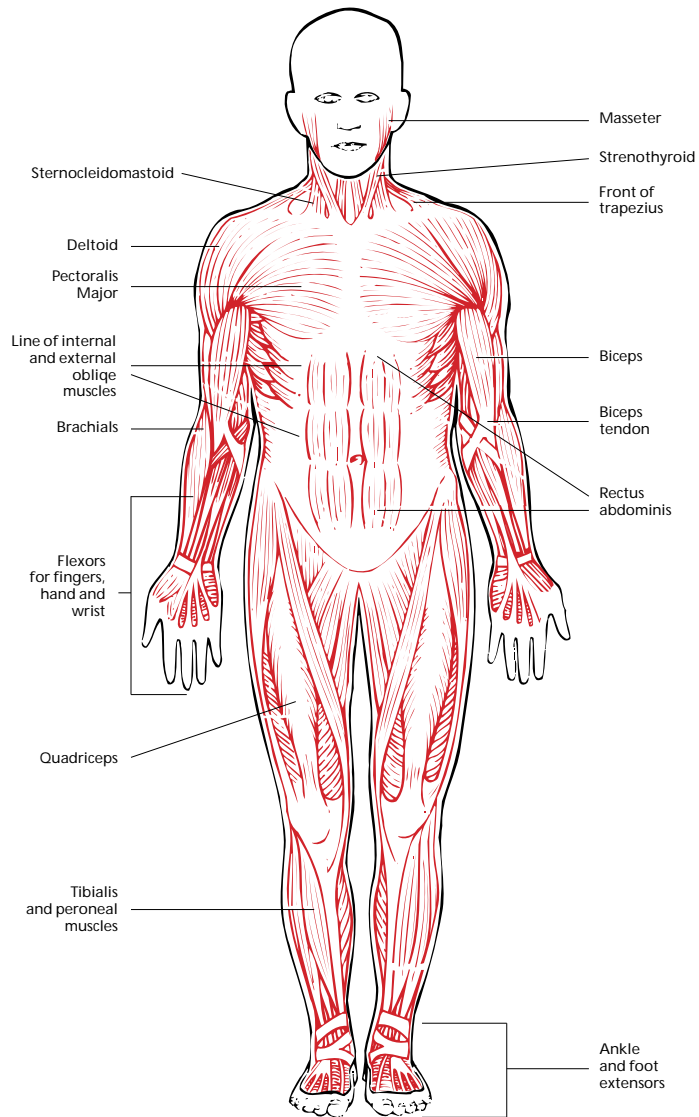


Figure II.3 Main voluntary muscles (front)

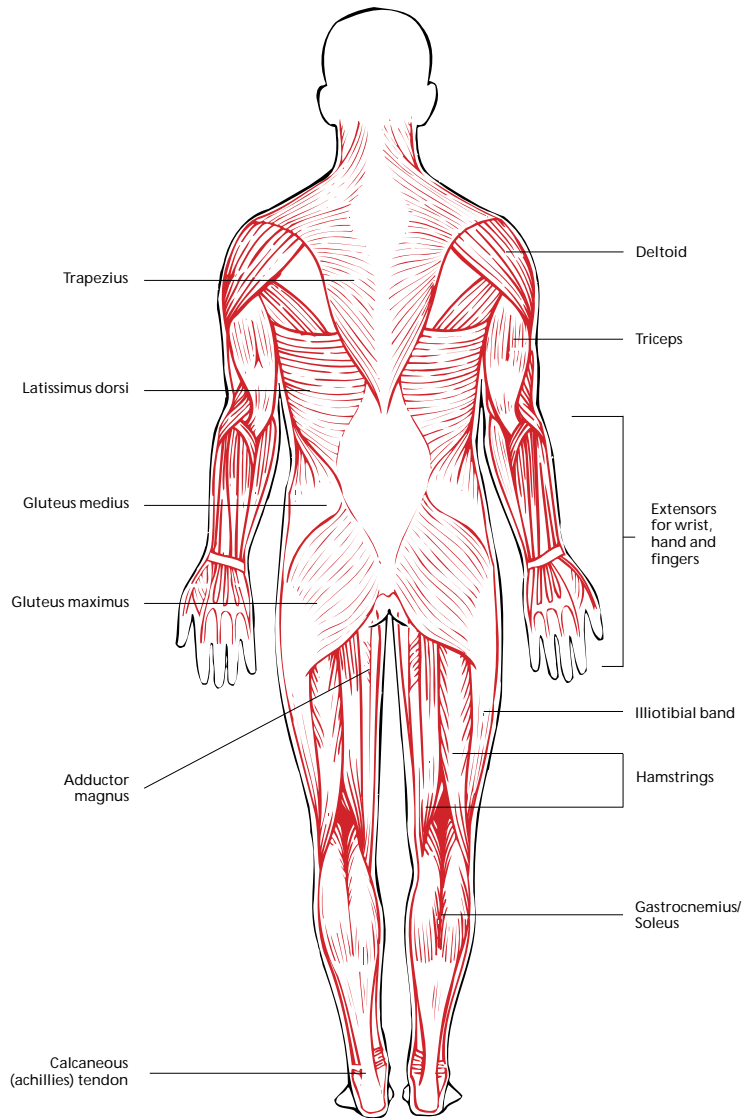


Figure II.4 Main voluntary muscles (rear)

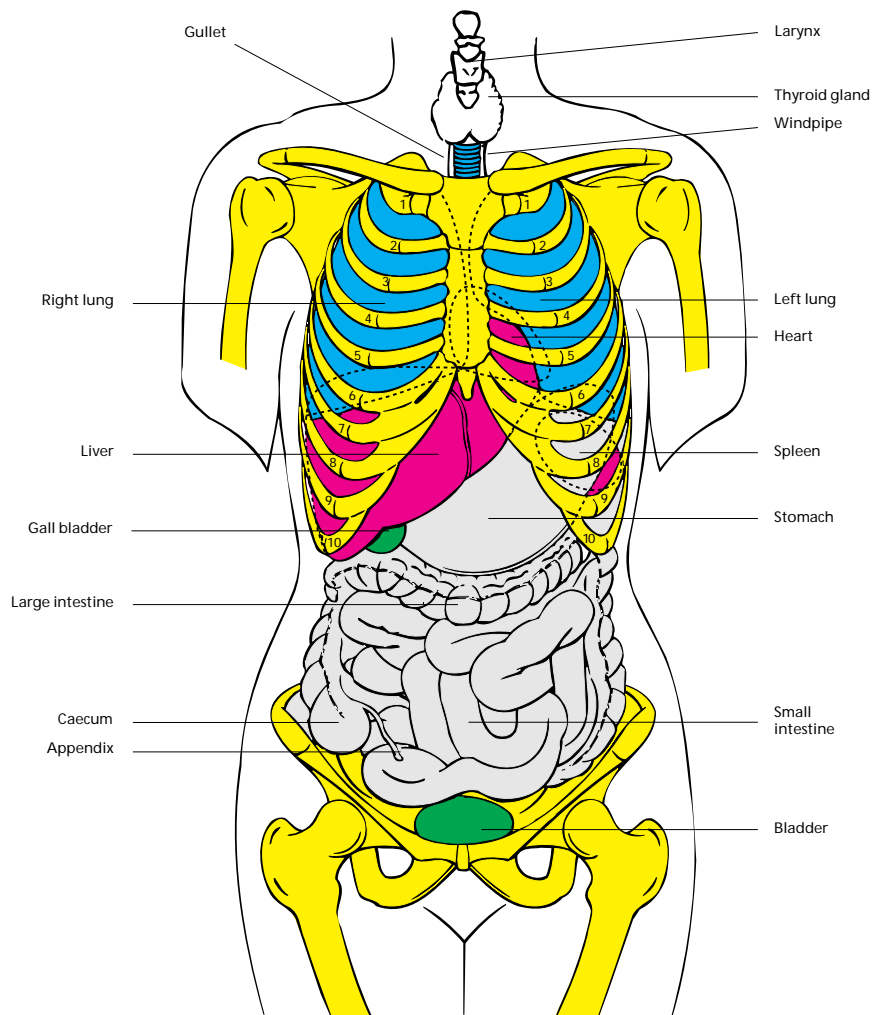


Plate 13 Organs of chest and abdomen (front)

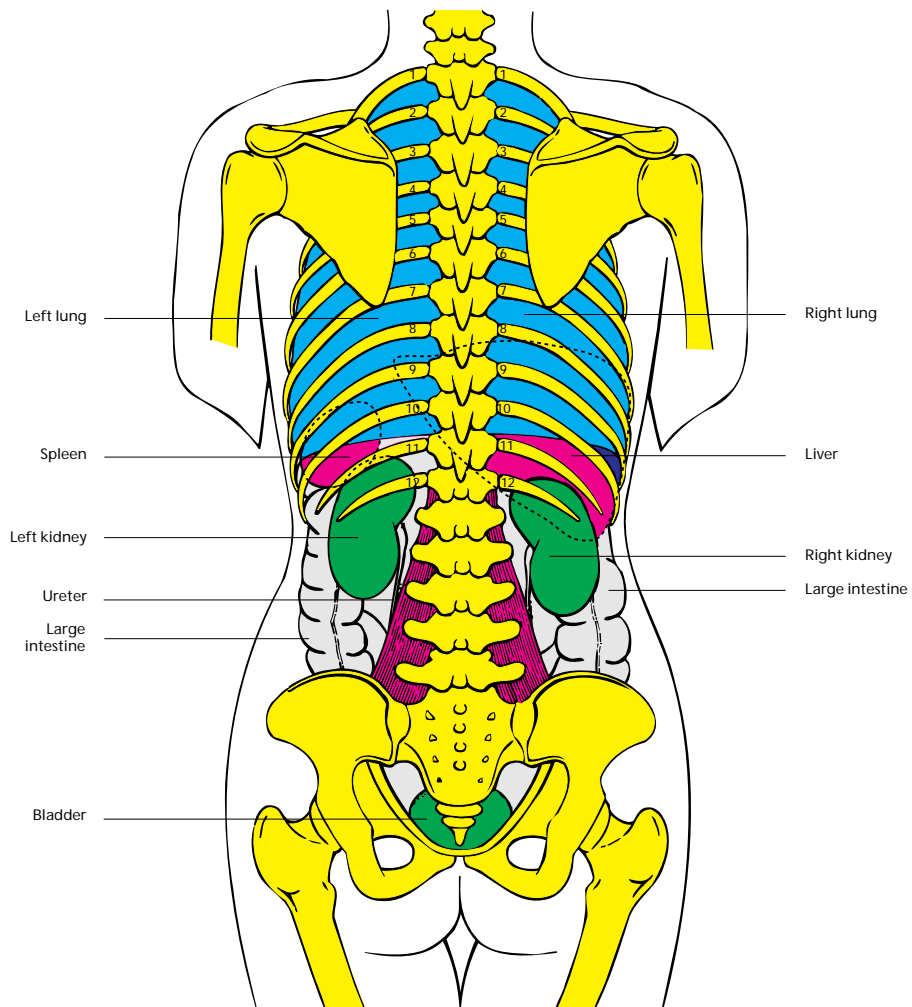


Plate 14 Organs of chest and abdomen (rear)

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