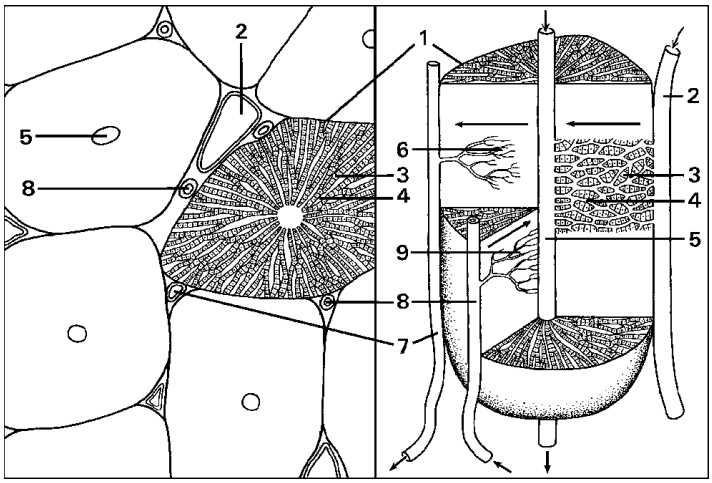
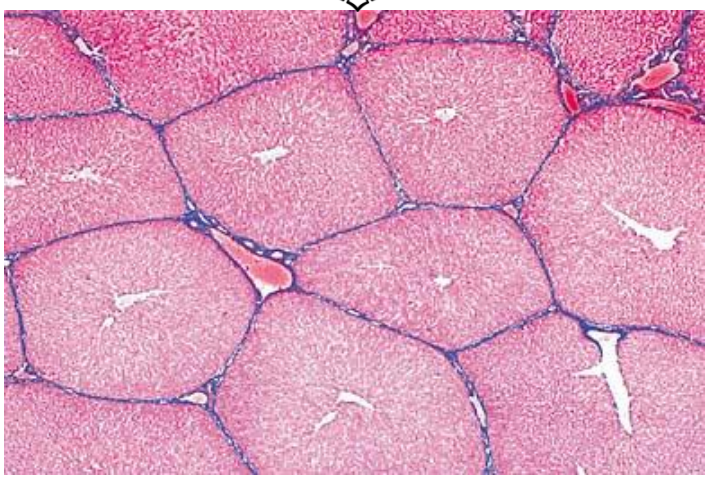




Liver of pig, t.s.

The embryonic development of the liver starts in the region of the anterior intestinal portal with a ventral evagination from the gut entoderm. The liver is the biggest gland of humans. It weighs about 1,5 kg in the adult. Well protected by the ribs, it produces about 1000 ml of bile a day, detoxicates the blood, functioning as the cemetery of the red blood corpuscles, it decomposes the erythrocytes to the bile color, it furthermore synthesizes glycogen and specific proteins and stores them together with up to 20% (1,25 liter) of our blood. All the blood coming from the digestive tract, the spleen and the pancreas passes through the liver. Being the main chemical laboratory of the body it consumes 12% of its oxygen. That is why blood coming from the liver has the temperature of 41° C.

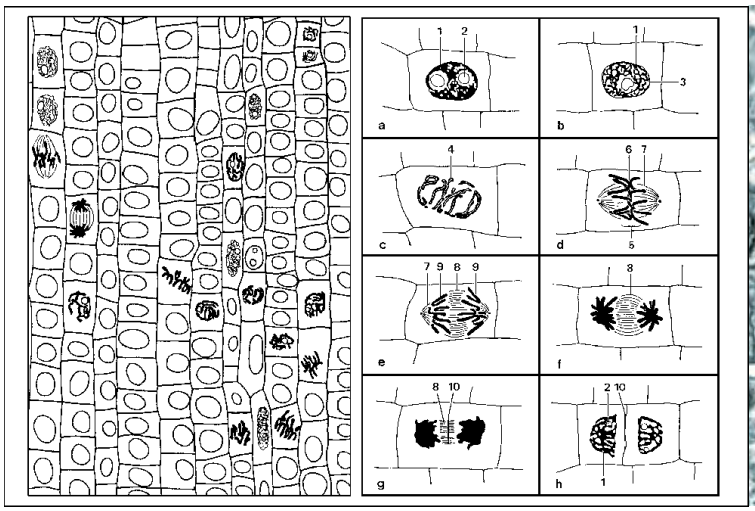
The human liver has the same structure as the liver of the pig. The microstructure of our liver was not completely understood before the forties of this century: 1–2 mm long oval **liver lobules (1)** are the structural units. They are covered by branches of the **portal vein (2)** which transport venous blood from the intestine. **Hepatic sinusoids (4)** extending between **hepatic cords (3)** connect the portal vein with the **central liver vein (5)**. The cords take food substances from the blood to synthesize body substances. They detoxicate substances such as alcohol. Bile is produced from decomposition products of the erythrocytes, collected in the **bile canaliculi (6)**, conducted to the peripheral **bile ducts (7)** and finally stored in the gall bladder. Decomposition, synthesis, detoxication and storing consume great quantities of energy, which are produced by the oxidation of organic compounds. The **liver artery (8)** advances the required oxygen and glucose to the liver. The artery is connected with the liver vein by **capillaries (9)**. This is a common capillary system connecting an artery with a vein. It should not be mixed up with the special system connecting the portal vein with the liver vein.

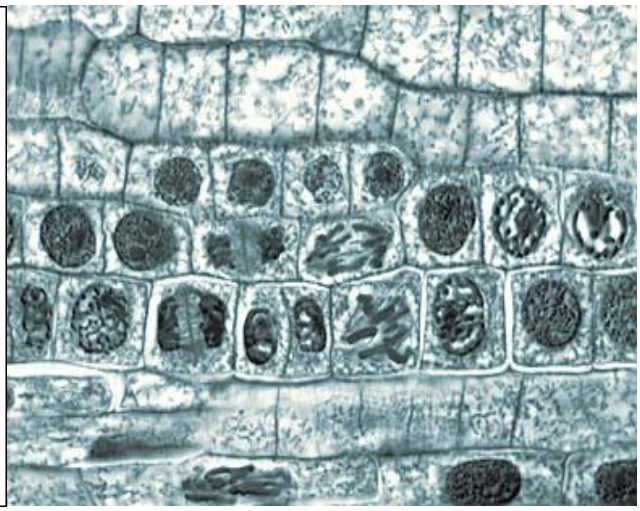
All of this makes perfectly clear that any injury of the liver by rupture, stab, shooting etc. is extremely dangerous, that any reduction of its function e.g. by poisonous substances as alcohol has serious consequences for the whole body.

If bile is not drained off due to an inflammation of the liver it finally passes into the blood stream and causes jaundice. If liver lobules are seriously damaged by some poisonous substance they are substituted by connective tissue. This subsequently results in the lethal hepatic cirrhosis.

The left picture shows a transverse section of liver lobules, the right one a spatial reconstruction of a lobule.

Tecnical data sheet of As114d





Allium cepa, onion, root tips, l.s. showing all stages of mitosis

Cells multiply by division which simultaneously is a division of the nucleus, a mitosis.

In mitosis the nuclear substance is distributed among the daughter cells in such a way that each of them receives identical genetic material, i.e. the same number of chromosomes.

The various mitotic phases are found in the longitudinal sections of the onion root tip. To get a good specimen, the root tip should be fixed shortly after midnight when most mitoses are going.

Part of a section is reproduced in the picture. The picture shows the nuclei as the student sees them under the normal microscope when using a medium to higher magnification.

Root tip l.s. shows stages of mitosis

Every cell division is preceded by nuclear division. First, the chromosomes in the nucleus become visible. They can be darkly stained, using special dyes; hence the name (Greek: chroma = colour; soma = body). The chromosomes split lengthways into two halves which are then equally distributed between the two opposite poles of the cell. Such nuclear division is known as mitosis. It takes, on average, two hours, and is divided into several stages - prophase, metaphase, anaphase and telophase. Towards the end of nuclear division, a dividing wall is formed between the two poles. The stage between two mitoses is called interphase.

a. I n t e r p h a s e. The nucleus is covered by the nuclear membrane (3) which encloses the chromatin reticulum or network (1) together with the two nucleoli (2). The nucleus is in a metabolically active phase, controlling the formation and decomposition of enzymes, but first of all the duplication of the genetic material by duplicating the chromatids. In interphase the nucleus is in its active form.

b. P r o p h a s e I. The chromatin reticulum becomes denser, the nucleoli have disappeared.

c. P r o p h a s e I I. The chromosomes appear as distinct structures. They are split longitudinally to form two chromatids which lie close together. The nuclear membrane (3) has disappeared.

d. M e t a p h a s e. The chromosomes arrange to form the equatorial plate (5) in the centre of the cell. The two daughter chromosomes formed by the longitudinal division of the mother chromosome are still connected by the kinetochore (6). This occupies a different place in different pairs of chromosomes thus forming segments of different length. The lengths of these segments and the total length are both characteristic of every chromosome. The number of chromosomes and their structure are the same in all cells of a species, and thus they are characteristic of every species . Spindle fibers (7) are attached to the kinetochore. They converge at the poles of the cell. Now the kinetochore divides.

e. A n a p h a s e I. The spindle fibers contract. Simultaneously the fibers (8) between the daughter kinetochores push the two chromosomes apart. These consequently move quickly to the poles. The daughter chromosomes which originated by „longitudinal division“ usually move to opposite poles (9).

f. L a t e a n a p h a s e , e a r l y t e l o p h a s e .

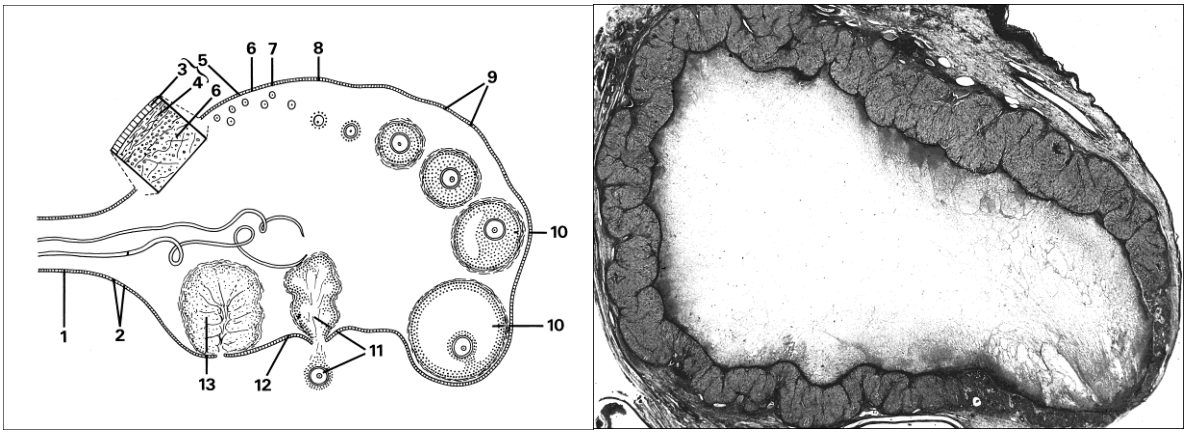
g. T e l o p h a s e I. The chromosomes have arrived at their destination. They now elongate and lose their shape. Beginning with condensations of the central fibers in the equatorial plate the dividing wall (10) gradually forms in the equator of the cell.

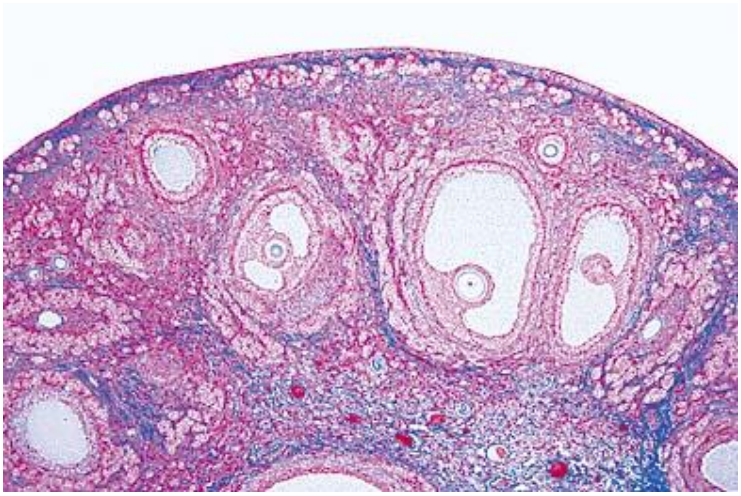
h. T e l o p h a s e I I. The chromosomes change their shape and reconstruct their chromatine network. The nucleoli reappear. The dividing wall (10) grows to the cell walls and separates the two daughter cells. By forming the nuclear membrane the nucleus regains its active form, in contrast to its transport form from prophase to the telophase, The telophase essentially is a reversed prophase.

Tecnical data sheet of Ma431d

Ma431d Ovary of cat, t.s. for general study, shows primary, secondary and Graafian follicles

Ma434dOvary, sec. selected to show Corpus luteum





Ma431d Ovary of cat, t.s. for general study, shows primary, secondary and Graafian follicles

The rabbit's ovary, though being smaller than the human one, has the same structure and hence is better suited for microscopic mounts.

The human ovary is an ovoid organ, somewhat flattened on its sides. It weighs 4–7 g and is suspended from the posterior wall of the abdominal cavity by the **mesovarium (1)**, by the suspensory and the ovarian ligament. The ovary is supplied by a number of **spirally arranged vessels (2)**. Its **cortex (5)** consists of an **epithelium (3)** of cuboidal cells and a layer of **fibers (4)** continuing into the **medulla (6)**.

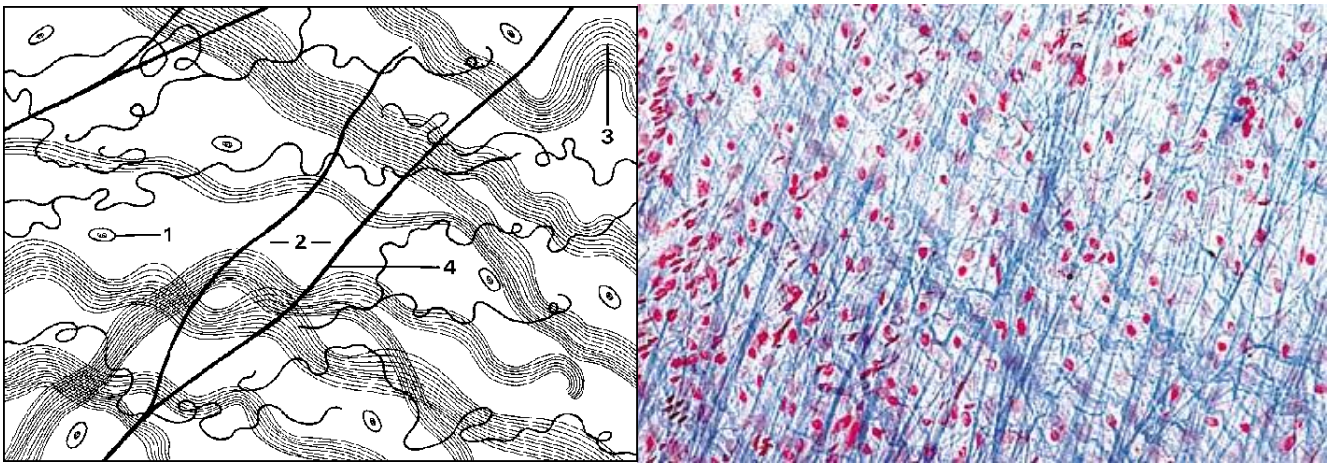
Here, close to the cortex, primary oocytes develop from primordial germ cells. These have migrated from the coecal entoderm by way of the entodermal gut and dorsal mesentery into the epithelium of the genital ridge, the initial stage of the ovary.

In oogenesis, the development of the female reproductive cells, the following phases are distinguished:

- **Reproductive phase**: mitotic divisions of the primordial germ cells result in the formation of 400 000 to 1 million primary oocytes before birth. They remain in the prophase of the first meiotic division until in puberty the
- **phase of growth** begins. Mitoses have stopped. The egg cell grows in size due to the production of yolk material by the nourishing cells. During puberty the first meiotic division ends, the second division starts but is not ended for the time being. A
  - **primary follicle (8)** develops consisting of one layer of follicular cells and a primary oocyte. It soon becomes a
  - **secondary follicle (9)** with several layers of follicular cells and a secondary oocyte due to the action of follicle stimulating hormone FSH secreted into the blood stream by the hypophysis (see series 763: Hormones III). Now the follicular diameter is 0,2 mm. It develops into a
  - **Graafian or tertiary follicle (10)** by the formation of follicular fluid. The mature Graafian follicle attains a size of 1,5–2 cm. Its egg has a diameter of 0,11–0,14 mm. It produces estradiol which stimulates the production of luteinizing hormone LH in the hypophysis. When a certain ratio of LH : FSH is attained the **follicle ruptures (11)**. The
- **phase of maturation** is terminated with the second meiotic division. The luteinizing hormone now stimulates the

– **development of the corpus luteum**, the transformation of the follicular wall (12) into the corpus luteum (13).

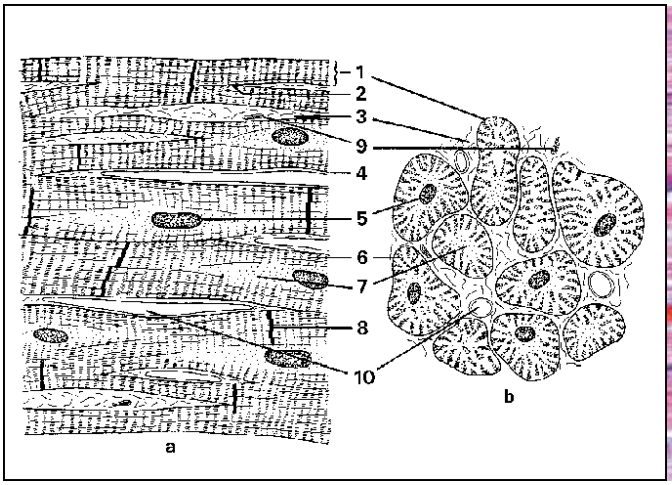
Tecnical data sheet of Ho121e

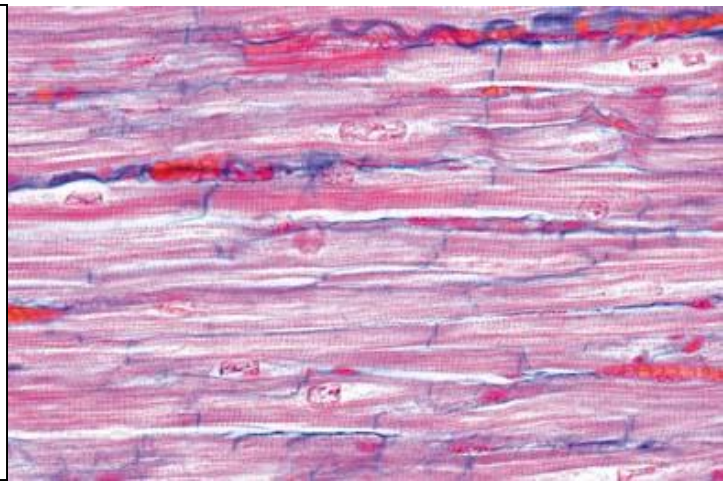


Ho121e Areolar connective tissue, human w.m.

Cells belonging to the same kind constitute a tissue. Different tissues constitute an organ. Several cooperating organs constitute a system of organs, and all of these systems make up an organism.
Connective tissues are characterized by relatively few and in some types movable **cells (1)** and a large amount of **intercellular substance (2)** containing various types and arrangements of fibers. We distinguish embryonic from adult connective tissues. The latter ones are subdivided into connective tissues proper (with soft intercellular substance), cartilage (with firm yet flexible and even elastic intercellular substance) and bone (rigid due to the deposition of calcium salts in the matrix).
Loose connective tissue without fibers generally connects organs movable against each other (e. g. muscles). It also composes the subcutis. – **Areolar connective tissue** (our example) contains wavy **bundles of collagenous fibers (3)**. They can be straightened but are non-extensible. Upon boiling they yield gelatin. **Elastic fibers (4)** branch and anostosome freely. They are highly elastic, allowing 40–140 % extension, and are not affected by boiling. Areolar connective tissue constitutes the dermis (leather!) and the capsule of organs. – In **dense connective tissue**, constituting **tendons and ligaments**, the collagenous fibers are closely packed. – **Adipose tissue** is a modified type of fibrillar connective tissue.

Tecnical data sheet Ho156e

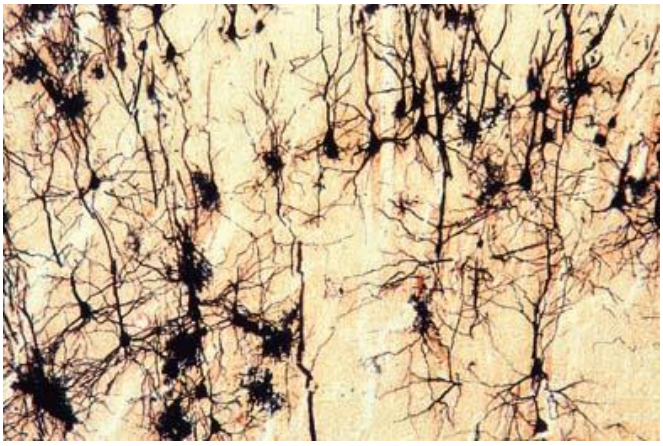


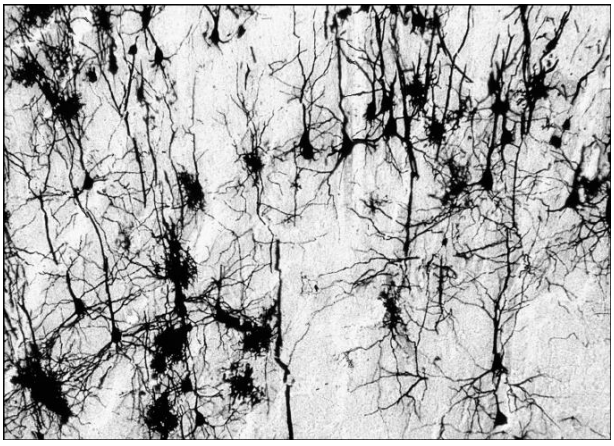


Ho156e Heart (cardiac) muscle, human l.s. and t.s.

The **muscle fibers (1)** composing the vertebrate heart **adjoin (2)** in an irregular manner to form a network which, in mammals, is partly subdivided by **connective tissue (3)** into bundles. These wind about the heart, particularly in the ventricle, in long spirals, the various layers coursing in different directions making the wall of the heart tough and most resistant. Hence, a section of the myocardium shows groups of fibers cut longitudinally, transversally, and obliquely.
Similar to skeletal muscle fibers, each cardiac fiber is enclosed by **sarcolemma (4)** composed of plasmolemma and a basement membrane consisting of a basal lamina of amorphous material and a reticular lamina. The quite large and oval shaped **nuclei (5)** are found in the central portion of the fiber, and there is only one, occasionally two of them per cell. Similar to skeletal muscle fibers, the fibers contain myosin and actin myofilaments forming bundles commonly known as **myofibrils (6)**. These course more irregularly than in skeletal muscles and branch frequently becoming confluent with those of an adjacent myofibril. **Longitudinal sections (a)** show that they diverge around the nucleus leaving a **paler staining zone (7)** at each pole of the nucleus. In **transection (b)** the groups of myofibrils are arranged in concentric bands. The **sarcoplasm (7)** of the cell shows best in the paler staining zone around the nucleus. It contains the usual cell organelles (endoplasmic reticulum, mitochondria, characterized by numerous cristae and much more abundant than in skeletal muscle, Golgi complex, tubules, but also fat droplets and glycogen, stored energy). Peculiar of cardiac muscles are the **intercalated discs (8)**, often step-like cross bands of the fibers. These discs are specialized cell junctions with a complex pattern and with a variety of structural characteristics. The fibers are surrounded by a net of reticular and fine collagenous fibers corresponding to the endomysium of skeletal muscles. Some **nuclei of fibrocytes (9)** show in the connective tissue of (a) and (b) as well as an extensive plexus of **blood** and **lymph capillaries (10)** which surround and supply the muscle fibers.
Due to its function, the cardiac muscle is much more supplied with blood than skeletal muscles. Branches of sympathetic (accelerating) and parasympathetic (retarding) nerves follow the connective tissue pathway and terminate in fine endings on the muscle fibers.

Tecnical data sheet Ho512f

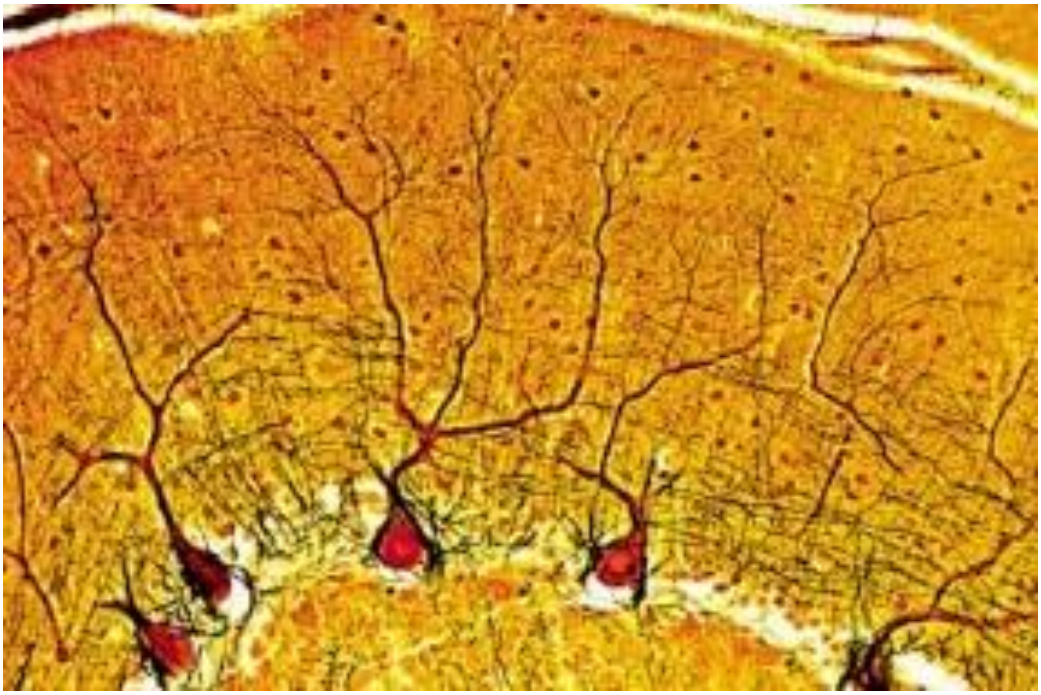




Ma512f Cerebral cortex, t.s. stained by Golgi's silver method to show the pyramid cells

Pyramidal cells are typical of the cerebral cortex as are Purkinje cells of the cerebellar one. The picture shows about a dozen of pyramidal cells. Their characteristic, long apical dendrite is usually directed to the surface of the brain where it is connected with other neurons. Numerous dendrites are given off from the basal corners of the cell body, whereas the very long axon proceeds from the base opposite to the apical dendrite (s. fig. 4d and 6b). The pyramidal axons constitute the pyramidal tract of the white matter in the spinal cord. It transmits impulses for voluntary movement from the cerebral cortex to motor neurons in the anterior horn of the gray matter. Centrally in the lower half of the picture, an axon runs vertically downward. Apart from pyramidal cells, other kinds of cells, e.g. glia cells, show particularly in the left half of the picture.

The slide shown with our picture was treated according to the method of the Italian histologist **GOLGI** (Pavia 1844 – 1926, Nobel prize 1906). His technique of silver impregnation shows neurons with all of their processes and thus started modern research of the nervous system, especially of the brain. The nervous tissue is soaked in a solution of potassium carbonate and osmic acid and then treated with silver nitrate. According to their chemistry, silver chromite is precipitated on the neurons blackening the cell bodies and all of the processes. – Although several other techniques of staining nervous tissue have been developed since (comp. fig. 2c, 2d, 5b and 7a), the Golgi method is still indispensable for showing the whole neuron (s. fig. 6a).



Ma515f Cerebellum, t.s. stained by Golgi's silver method to show the Purkinje cells

Characteristic of the cerebellar cortex and its functions are the **Purkinje cells**. They have a most conspicuous structure and were discovered by JOHANNES EVANGELISTA RITTER VON PURKINJE (1787–1869, professor at the universities of Breslau and Prague). Similar to an espalier tree the Purkinje **dendrites (1)** branch fan-like within the molecular layer in a plane at right angles to the long axis of the cerebellar fold. The **axon (3)**, arising from the opposite pole of the **cell body (2)**, extends through the white substance to one of the cerebellar nuclei. A **collateral (4)** branches off the axon. The cerebellar cortex contains about 15 millions Purkinje cells.
The cerebellum has two entrances: through the mossy fibers and through the climbing fibers, but only on exit, through the Purkinje axon. All neurons of the cortex except the **granule cells (5)** have an inhibitory function. That is why an input is extinguished already within 0,1 sec, and the cerebellar region is ready to receive the next input. Due to this automatic „clearing" quick movements are possible.
Programs, formed by earlier experiences, are stored in the cerebellar cortex. They are called upon by the input and have an inhibitory function by association with the Purkinje cells. Thus an unrestrained building up of the cerebrocortical pyramid cells is checked efficiently. Figuratively spoken: Just as much of a crude block is carved away to leave the desired sculpture. So the build up of cerebrocortical associations are influenced by the Purkinje-function (Detailed information in given in the color slide series 856: The human brain).