MICROSCOPIC MORPHOLOGY AND HISTOLOGY OF THE HUMAN MENINGES pdf

1: Histology and Morphology of the Brain Subarachnoid Trabeculae

Microscopic morphology and histology of the human meninges. Weller RO(1). Author information: (1)Clinical Neurosciences, Southampton University School of Medicine, Mail Point , Southampton General Hospital, Southampton SO16 6YD, UK. row@www.enganchecubano.com The meninges comprise the dura mater and the leptomeninges (arachnoid and pia mater).

Dura mater The dura mater Latin: The dura mater, the outermost part, is a loosely arranged, fibroelastic layer of cells, characterized by multiple interdigitating cell processes, no extracellular collagen, and significant extracellular spaces. The middle region is a mostly fibrous portion. It consists of two layers: It contains larger blood vessels that split into the capillaries in the pia mater. It is composed of dense fibrous tissue, and its inner surface is covered by flattened cells like those present on the surfaces of the pia mater and arachnoid mater. The dura mater is a sac that envelops the arachnoid mater and surrounds and supports the large dural sinuses carrying blood from the brain toward the heart. The dura has four areas of infolding: Falx cerebri , the largest, sickle-shaped; separates the cerebral hemispheres. Starts from the frontal crest of frontal bone and the crista galli running to the internal occipital protuberance. Tentorium cerebelli , the second largest, crescent-shaped; separates the occipital lobes from cerebellum. The falx cerebri attaches to it giving a tentlike appearance. Falx cerebelli , vertical infolding; lies inferior to the tentorium cerebelli, separating the cerebellar hemispheres. Diaphragma sellae , smallest infolding; covers the pituitary gland and sella turcica. Arachnoid mater Main article: Arachnoid mater The middle element of the meninges is the arachnoid mater , so named because of its spider web -like appearance. It cushions the central nervous system. This thin, transparent membrane is composed of fibrous tissue and, like the pia mater, is covered by flat cells also thought to be impermeable to fluid. The shape of the arachnoid does not follow the convolutions of the surface of the brain and so looks like a loosely fitting sac. In particular, in the region of the brain a large number of fine filaments called arachnoid trabeculae pass from the arachnoid through the subarachnoid space to blend with the tissue of the pia mater. The arachnoid is composed of an outermost portion arachnoid barrier cell layer with tightly packed cells and no extracellular collagen; that is why it is considered to represent an effective morphological and physiological meningeal barrier between the cerebrospinal fluid and subarachnoid space and the blood circulation in the dura. The arachnoid barrier layer is characterized by a distinct continuous basal lamina on its inner surface toward the innermost collagenous portion of the arachnoid reticular layer. Pia mater The pia mater Latin: It is a very thin membrane composed of fibrous tissue covered on its outer surface by a sheet of flat cells thought to be impermeable to fluid. The pia mater is pierced by blood vessels to the brain and spinal cord, and its capillaries nourish the brain. Leptomeninges The arachnoid and pia mater together are sometimes called the leptomeninges, literally "thin meninges". Because the arachnoid is connected to the pia by cob-web like strands, it is structurally continuous with the pia, hence the name pia-arachnoid or leptomeninges. They are responsible for the production of beta-trace. Subarachnoid space The subarachnoid space is the space that normally exists between the arachnoid and the pia mater , which is filled with cerebrospinal fluid. The dura mater is attached to the skull , whereas in the spinal cord , the dura mater is separated from the bone vertebrae by a space called the epidural space , which contain fat and blood vessels. The arachnoid is attached to the dura mater, while the pia mater is attached to the central nervous system tissue. When the dura mater and the arachnoid separate through injury or illness, the space between them is the subdural space. There is a subpial space underneath the pia mater that separates it from the glia limitans. Clinical significance There are three types of hemorrhage involving the meninges: A subdural hematoma is a hematoma collection of blood located in a separation of the arachnoid from the dura mater. The small veins that connect the dura mater and the arachnoid are torn, usually during an accident, and blood leaks into this area. An epidural hematoma may arise after an accident or spontaneously. Other medical conditions that affect the meninges include meningitis usually from fungal , bacterial , or viral infection and meningiomas that arise from the meninges, or from

meningeal carcinomatoses tumors that form elsewhere in the body and metastasize to the meninges. In other animals In fish , there is a single membrane the primitive meninx. In amphibians , reptiles and birds , the meninges include a thick outer dura mater and a thick inner secondary meninx. Mammals retain the dura mater, and the secondary meninx divides into the arachnoid and pia mater.

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2: morphology | Definition & Examples | www.enganchecubano.com

Download Citation on ResearchGate | Microscopic morphology and histology of the human meninges | The meninges comprise the dura mater and the leptomeninges (arachnoid and pia mater).

Structure[edit] It is interposed between the two other meninges, the more superficial and much thicker dura mater and the deeper pia mater , from which it is separated by the subarachnoid space. The delicate arachnoid layer is attached to the inside of the dura and surrounds the brain and spinal cord. It does not line the brain down into its sulci folds , as does the pia mater , with the exception of the longitudinal fissure , which divides the left and right cerebral hemispheres. Cerebrospinal fluid CSF flows under the arachnoid in the subarachnoid space. The arachnoid mater makes arachnoid villi , small protrusions through the dura mater into the venous sinuses of the brain, which allow CSF to exit the subarachnoid space and enter the blood stream. The arachnoid mater and dura mater are very close together throughout the cranium and spinal canal all the way to S2, where the two layers fuse into one and end in the filum terminale , which attaches to the coccygeal end of the spinal canal. Similarly, the dura in this situation is called the pachymeninx. There are two subdivisions of arachnoid mater surrounding the subarachnoid space , the dorsal layer and the ventral layer. The dorsal layer covers internal cerebral veins and fixes them to the surrounding tela choroidea. The ventral layer of arachnoid membrane, on the other hand, is a direct anterior extension of this arachnoid envelope that the dorsal layer forms over the pineal region. Cerebrospinal fluid and Subarachnoid space CSF circulates in the subarachnoid space between arachnoid and pia mater. Cerebrospinal fluid is produced by the choroid plexus inside the ventricles of the brain, which are in direct communication with the subarachnoid space so the CSF can flow freely through the nervous system. Its electrolyte levels, glucose levels, and pH are very similar to those in plasma, but the presence of blood in cerebrospinal fluid is always abnormal. Meninges Diagrammatic section of scalp. The arachnoid mater lies under the dura mater , and arteries and veins run on top of it. Spinal dura mater opened, arachnoid mater visible. The medulla spinalis and its membranes. Spinal membranes and nerve roots. Meninges and superficial cerebral veins. For that reason some meningiomas can appear as completely inside the brain. The Distribution of arachnoid membrane within the velum interpositum". Acta neurochirurgica SeptVol Issue 9, page

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3: Meninges | Morphology of Nervous System

A number of intermediate layers of arachnoid mater are loosely adherent to the pari- Histology of Human Meninges 29 etal arachnoid and form sheets over the surface of the spinal cord enveloping nerve roots and arteries, par- ticularly on the dorsal aspect of the cord (figure 5a and 5b) [35].

Fixation histology Chemical fixatives are used to preserve tissue from degradation, and to maintain the structure of the cell and of sub-cellular components such as cell organelles e. For electron microscopy, the most commonly used fixative is glutaraldehyde , usually as a 2. These fixatives preserve tissues or cells mainly by irreversibly cross-linking proteins. The main action of these aldehyde fixatives is to cross-link amino groups in proteins through the formation of methylene bridges -CH2- , in the case of formaldehyde, or by C5H10 cross-links in the case of glutaraldehyde. This process, while preserving the structural integrity of the cells and tissue can damage the biological functionality of proteins, particularly enzymes , and can also denature them to a certain extent. This can be detrimental to certain histological techniques. Further fixatives are often used for electron microscopy such as osmium tetroxide or uranyl acetate. However, extraction and analysis of nucleic acids and proteins from formalin-fixed, paraffin-embedded tissues is possible using appropriate protocols. It is often used after surgical removal of tumors to allow rapid determination of margin that the tumor has been completely removed. Processing - dehydration, clearing, and infiltration[edit] The aim of tissue processing is to remove water from tissues and replace with a medium that solidifies to allow thin sections to be cut. For light microscopy, paraffin wax is most frequently used. Since it is immiscible with water, the main constituent of biological tissue, water must first be removed in the process of dehydration. Samples are transferred through baths of progressively more concentrated ethanol to remove the water. This is followed by a hydrophobic clearing agent such as xylene to remove the alcohol, and finally molten paraffin wax , the infiltration agent, which replaces the xylene. Paraffin wax does not provide a sufficiently hard matrix for cutting very thin sections for electron microscopy. Instead, resins are used. Epoxy resins are the most commonly employed embedding media, but acrylic resins are also used, particularly where immunohistochemistry is required. Again, the immiscibility of most epoxy and acrylic resins with water necessitates the use of dehydration, usually with ethanol. Embedding[edit] OCT embedding [13] optimal cutting temperature compound After the tissues have been dehydrated, cleared, and infiltrated with the embedding material, they are ready for external embedding. During this process the tissue samples are placed into molds along with liquid embedding material such as agar, gelatine, or wax which is then hardened. This is achieved by cooling in the case of paraffin wax and heating curing in the case of the epoxy resins. The acrylic resins are polymerised by heat, ultraviolet light, or chemical catalysts. The hardened blocks containing the tissue samples are then ready to be sectioned. Because formalin-fixed, paraffin-embedded FFPE tissues may be stored indefinitely at room temperature, and nucleic acids both DNA and RNA may be recovered from them decades after fixation, FFPE tissues are an important resource for historical studies in medicine. Embedding can also be accomplished using frozen, non-fixed tissue in a water-based medium. Pre-frozen tissues are placed into molds with the liquid embedding material, usually a water-based glycol, OCT, TBS, Cryogel, or resin, which is then frozen to form hardened blocks. Microtome For light microscopy, a steel knife mounted in a microtome is used to cut 4- micrometer -thick tissue sections which are mounted on a glass microscope slide. For transmission electron microscopy, a diamond knife mounted in an ultramicrotome is used to cut nanometer -thick tissue sections which are mounted on a 3-millimeter-diameter copper grid. Then the mounted sections are treated with the appropriate stain. Sections can be cut through the tissue in a number of directions. For pathological evaluation of tissues, vertical sectioning, cut perpendicular to the surface of the tissue to produce a cross section is the usual method. Horizontal also known as transverse or longitudinal sectioning, cut along the long axis of the tissue, is often used in the evaluation of the hair follicles and pilosebaceous units. Frozen section procedure Fixed or unfixed tissue may be frozen and sliced using a

microtome mounted in a refrigeration device known as a cryostat. The frozen sections are mounted on a glass slide and may be stained to enhance the contrast between different tissues. Unfixed frozen sections can also be used for studies requiring enzyme localization in tissues and cells. It is necessary to fix tissue for certain procedures such as antibody linked immunofluorescence staining. Frozen sectioning can also be used to determine if a tumour is malignant when it is found incidentally during surgery on a patient. Sample of a trachea coloured with hematoxylin and eosin Main article: Staining Example of staining [14] in light microscopy: Staining is employed to give both contrast to the tissue as well as highlighting particular features of interest. Where the underlying mechanistic chemistry of staining is understood, the term histochemistry is used. Hematoxylin, a basic dye, stains nuclei blue due to an affinity to nucleic acids in the cell nucleus; eosin, an acidic dye, stains the cytoplasm pink. Uranyl acetate and lead citrate are commonly used to impart contrast to tissue in the electron microscope. There are many other staining techniques that have been used to selectively stain cells and cellular components. One of these techniques involves marking peripheral tumors or surgical margins, in which a certain color of dye is applied to the posterior border of a sample, another to the anterior, etc. Other compounds used to color tissue sections include safranin , Oil Red O , Congo red , Fast green FCF , silver salts, and numerous natural and artificial dyes that usually originated from the development of dyes for the textile industry. Histochemistry refers to the science of using chemical reactions between laboratory chemicals and components within tissue. A commonly performed histochemical technique is the Perls Prussian blue reaction, used to demonstrate iron deposits in diseases like hemochromatosis. Histology samples have often been examined by radioactive techniques. In historadiography , a slide sometimes stained histochemically is X-rayed. More commonly, autoradiography is used to visualize the locations to which a radioactive substance has been transported within the body, such as cells in S phase undergoing DNA replication which incorporate tritiated thymidine , or sites to which radiolabeled nucleic acid probes bind in in situ hybridization. For autoradiography on a microscopic level, the slide is typically dipped into liquid nuclear tract emulsion, which dries to form the exposure film. Individual silver grains in the film are visualized with dark field microscopy. Recently, antibodies have been used to specifically visualize proteins, carbohydrates, and lipids. This process is called immunohistochemistry , or when the stain is a fluorescent molecule, immunofluorescence. This technique has greatly increased the ability to identify categories of cells under a microscope. Other advanced techniques, such as nonradioactive in situ hybridization, can be combined with immunochemistry to identify specific DNA or RNA molecules with fluorescent probes or tags that can be used for immunofluorescence and enzyme-linked fluorescence amplification especially alkaline phosphatase and tyramide signal amplification. Fluorescence microscopy and confocal microscopy are used to detect fluorescent signals with good intracellular detail. Digital cameras are increasingly used to capture histological and histopathological image Common laboratory stains[edit].

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4: Histology - Infogalactic: the planetary knowledge core

The arachnoid mater is one of the three meninges, the protective membranes that cover the brain and spinal www.enganchecubano.com arachnoid mater is a derivative of the neural crest mesectoderm in the embryo.

Fixation histology Chemical fixatives are used to preserve tissue from degradation, and to maintain the structure of the cell and of sub-cellular components such as cell organelles e. For electron microscopy, the most commonly used fixative is glutaraldehyde , usually as a 2. These fixatives preserve tissues or cells mainly by irreversibly cross-linking proteins. The main action of these aldehyde fixatives is to cross-link amino groups in proteins through the formation of methylene bridges -CH2- , in the case of formaldehyde, or by a C5H10 cross-links in the case of glutaraldehyde. This process, while preserving the structural integrity of the cells and tissue can damage the biological functionality of proteins, particularly enzymes , and can also denature them to a certain extent. This can be detrimental to certain histological techniques. However, extraction, amplification and analysis of these nucleic acids from formalin-fixed, paraffin-embedded tissues is possible using appropriate protocols. It is often used after surgical removal of tumors to allow rapid determination of margin that the tumor has been completely removed. Processing - dehydration, clearing, and infiltration The aim of Tissue Processing is to remove water from tissues and replace with a medium that solidifies to allow thin sections to be cut. For light microscopy, paraffin wax is most frequently used. Since it is immiscible with water, the main constituent of biological tissue, water must first be removed in the process of dehydration. Samples are transferred through baths of progressively more concentrated ethanol to remove the water. This is followed by a hydrophobic clearing agent such as xylene to remove the alcohol, and finally molten paraffin wax , the infiltration agent, which replaces the xylene. Paraffin wax does not provide a sufficiently hard matrix for cutting very thin sections for electron microscopy. Instead, resins are used. Epoxy resins are the most commonly employed embedding media, but acrylic resins are also used, particularly where immunohistochemistry is required. Again, the immiscibility of most epoxy and acrylic resins with water necessitates the use of dehydration, usually with ethanol. Embedding OCT embedding Optimal Cutting Temperature compound After the tissues have been dehydrated, cleared, and infiltrated with the embedding material, they are ready for external embedding. During this process the tissue samples are placed into molds along with liquid embedding material such as agar, gelatine, or wax which is then hardened. This is achieved by cooling in the case of paraffin wax and heating curing in the case of the epoxy resins. The acrylic resins are polymerised by heat, ultraviolet light, or chemical catalysts. The hardened blocks containing the tissue samples are then ready to be sectioned. Embedding can also be accomplished using frozen, non-fixed tissue in a water-based medium. Pre-frozen tissues are placed into molds with the liquid embedding material, usually a water-based glycol, OCT, TBS, Cryogel, or resin, which is then frozen to form hardened blocks. For transmission electron microscopy, a diamond knife mounted in an ultramicrotome is used to cut nanometer -thick tissue sections which are mounted on a 3-millimeter-diameter copper grid. Then the mounted sections are treated with the appropriate stain. Sections can be cut through the tissue in a number of directions. For pathological evaluation of tissues, vertical sectioning, cut perpendicular to the surface of the tissue to produce a cross section is the usual method. Horizontal also known as transverse or longitudinal sectioning, cut along the long axis of the tissue, is often used in the evaluation of the hair follicles and pilosebaceous units. Frozen section procedure Fixed or unfixed tissue may be frozen and sliced using a microtome mounted in a refrigeration device known as a cryostat. The frozen sections are mounted on a glass slide and may be stained to enhance the contrast between different tissues. Unfixed frozen sections can also be used for studies requiring enzyme localization in tissues and cells. It is necessary to fix tissue for certain procedures such as antibody linked immunofluorescence staining. Frozen sectioning can also be used to determine if a tumour is malignant when it is found incidentally during surgery on a patient. Sample of a trachea coloured with hematoxylin and eosin Staining Example of staining in light microscopy: Carmine staining of a monogenean

parasitic worm Biological tissue has little inherent contrast in either the light or electron microscope. Staining is employed to give both contrast to the tissue as well as highlighting particular features of interest. Where the underlying mechanistic chemistry of staining is understood, the term histochemistry is used. Hematoxylin, a basic dye, stains nuclei blue due to an affinity to nucleic acids in the cell nucleus; eosin, an acidic dye, stains the cytoplasm pink. Uranyl acetate and lead citrate are commonly used to impart contrast to tissue in the electron microscope. There are many other staining techniques that have been used to selectively stain cells and cellular components. One of these techniques involves marking peripheral tumors or surgical margins, in which a certain color of dye is applied to the posterior border of a sample, another to the anterior, etc. Other compounds used to color tissue sections include safranin , Oil Red O , Congo red , Fast green FCF , silver salts, and numerous natural and artificial dyes that usually originated from the development of dyes for the textile industry. Histochemistry refers to the science of using chemical reactions between laboratory chemicals and components within tissue. A commonly performed histochemical technique is the Perls Prussian blue reaction, used to demonstrate iron deposits in diseases like hemochromatosis. Histology samples have often been examined by radioactive techniques. In historadiography , a slide sometimes stained histochemically is X-rayed. More commonly, autoradiography is used to visualize the locations to which a radioactive substance has been transported within the body, such as cells in S phase undergoing DNA replication which incorporate tritiated thymidine , or sites to which radiolabeled nucleic acid probes bind in in situ hybridization. For autoradiography on a microscopic level, the slide is typically dipped into liquid nuclear tract emulsion, which dries to form the exposure film. Individual silver grains in the film are visualized with dark field microscopy. Recently, antibodies have been used to specifically visualize proteins, carbohydrates, and lipids. This process is called immunohistochemistry , or when the stain is a fluorescent molecule, immunofluorescence. This technique has greatly increased the ability to identify categories of cells under a microscope. Other advanced techniques, such as nonradioactive in situ hybridization, can be combined with immunochemistry to identify specific DNA or RNA molecules with fluorescent probes or tags that can be used for immunofluorescence and enzyme-linked fluorescence amplification especially alkaline phosphatase and tyramide signal amplification. Fluorescence microscopy and confocal microscopy are used to detect fluorescent signals with good intracellular detail. Digital cameras are increasingly used to capture histological and histopathological image Common laboratory stains.

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5: Microscopic morphology and histology of the human meninges.

The embryogenesis of the meninges varies across vertebrate species. The human meningeal development is still a matter of great controversy. Although comparative embryologic and anatomic studies have demonstrated that main developmental landmarks are conserved among the species, these findings should be cautiously extrapolated to the human embryonic development (1).

Be able to identify tissues in the nervous system nerves, cell bodies and ganglia, and white vs. Describe the organization and understand some of the basic functions of regions of the: Examine the cross section of the lumbar spinal cord in slide At low magnification, differentiate inner gray from outer white matter and identify dorsal and ventral horns of the gray matter. You should also identify the dorsal and ventral horns in Slide N stained with Masson trichrome. In these slides, dorsal happens to be "up," but you should be able to tell dorsal and ventral horns based on morphology and the cells present rather than the orientation. The perikarya of large somatic motor neurons Webscope located in the ventral horn of the cord innervate the skeletal muscles of the limbs and trunk, which are embryologically derived from somites hence, somatic muscles. Why are perikarya of dorsal horn neurons smaller than those in the ventral horn? Answer Neurons in the dorsal horn are essentially interneurons that project to other regions of the CNS e. Remember that the perikaryon is the metabolic support center for each neuron, so, therefore, motor neurons require much larger perikarya. Slide 66a Webscope Imagescope shows a section of thoracic spinal cord. In addition to the dorsal and ventral horns, two structures especially obvious in the thoracic cord are the dorsal nucleus of Clarke and the lateral extension of the ventral horn. The dorsal nucleus of Clarke a WebScope is in the dorsal horn and contains relatively large, multipolar neurons that receive proprioceptive information from dorsal root ganglion cells that are innervated by muscle spindles in the trunk and lower limb. The lateral extension of the ventral horn contains relatively large, multipolar visceral motor neurons of the intermediolateral cell column that extends from levels T1 through L2 of the spinal cord. Note that sacral levels of the cord levels S also contain visceral motor neurons in the lateral horn, but these are parasympathetic. Many neurons in the spinal cord may appear shrunken and surrounded by an empty space due to poor fixation. Cells that are well preserved show features characteristic of most neurons: The delicate meshwork of dendritic processes and nerve fibers axons lying between cells in the gray matter is called the neuropil. The white matter contains nerve fibers axons entering and exiting the gray matter, and traveling up and down the spinal cord, linking it to the brain. Nervous tissue contains two basic categories of cells: Both neurons and glia have fine processes projecting from the cell body, which generally cannot be resolved in the light microscope without special staining techniques. Astrocytes in the CNS provide metabolic support for neurons and play an important role in maintaining the blood-brain barrier see Slide astrocytes below. Oligodendrocytes another type of glial cell are responsible for the myelination of CNS axons. Recall thatSchwann cells are the glial cells responsible for myelination in the peripheral nervous system. Myelin is lipid-rich, and on gross inspection appears white. The other major glial cell type you should know about are microglia which are small cells derived from blood monocytes. Because of the difficulty of discerning each glial cell type by routine light microscopy, you will not be required to identify glial cells in HE-stained sections by light microscopy, but you should be aware of their functions. Neurons Slide 65 and Glial Cells Neurons are characterized by a large cell body or perikaryon containing a large, pale active, euchromatic nucleus with a prominentnucleolus. One or more cell processes may also be seen emerging from the neuronal perikaryon. Review diagrams illustrating the morphology of neurons in your textbooks. The dendrites receive neural input from other neurons viasynapses or they are specialized to receive sensory stimuli , and they transmit neural information toward the perikaryon Law of Dynamic Polarization. A single axon often called a nerve fiber leaves the perikaryon and transmits neural signals to other neurons or to the effectororgan e. Ependymal cells, which are uniquely located lining the ventricles of the brain the central canal of the spinal cord, are one notable exception. Use the virtual slide of the hippocampal region to study the

ependymal cell lining of the choroid plexus. Also note these columnar cells lining the ventricles of the brain. Slide astrocytes, Gold-staining Webscope Imagescope Go to a lighter stained area of the slide, which is in focus, and look for typical star-shaped cells, which represent astrocytes. Many of these astrocytes send out processes that contact and wrap around nearby capillaries, which are also clearly recognizable as tube-shaped segments. Still deeper is the white matter Webscope of the cerebellum, which contains nerve fibers, neuroglial cells, small blood vessels, but no neuronal cell bodies. Examine the boundary between molecular and granule cell layers. Here you will see the Purkinje cell bodies Webscope. In these slides you will not be able to discern the amazing dendritic tree that extends from the Purkinje cell bodies into the molecular layer, nor will you be able to see their axons, which extend down through the granular layer into deeper parts of the cerebellum. The dendritic tree and axon of each Purkinje cell can only be seen in thicker sections stained with special silver stains. Nonetheless, it is loosely stratified into layers containing scattered nuclei of both neurons and glial cells. Typically one or more sulci infoldings will extend inward from one edge of the section. Examine the gray matter on each side of the sulcus using first low and then high power. Neurons of the cerebral cortex are of varying shapes and sizes, but the most obvious arepyramidal cells. As the name implies, the cell body is shaped somewhat like a pyramid, with a large, branching dendrite extending from the apex of the pyramid toward the cortical surface, and with an axon extending downward from the base of the pyramid. In addition to pyramidal cells, other nuclei seen in these sections may belong to other neurons or to glial cells also present in the cortex. You may be able to see subtle differences in the distribution of cell types in rather loosely demarcated layers. There are 6 classically recognized layers of the cortex: Outer plexiform molecular layer: Deep to the gray matter of the cerebral cortex is the white matter that conveys myelinated fibers between different parts of the cortex and other regions of the CNS. Review the organization of gray and white matter in cerebral cortex vs. Above the temporal ventral or inferior horn of the lateral ventricle the lateral geniculate nucleus is present. Lateral to this structure is the tail of the caudate. The medial surface of the section is the posterior portion of the thalamus and a small portion of the cerebral peduncle. Look at the margins of the ventricle at higher magnification and note that it is entirely lined by ependymal cells. Just medial to the right of the tail of the caudate, note the choroid plexus NPN Webscope , which consists of highly convoluted and vascularized villi covered by ependymal cells which are specialized for the production of cerebrospinal fluid, or CSF. Later in this sequence, you will learn how the hippocampus and dentate gyrus function in what is known as the "limbic system" to integrate inputs from many parts of the nervous system into complicated behaviors such as learning, memory, and social interaction. For now, focus just on the morphology of these regions and observe the presence of three distinct layers rather than the six layers found in the cerebral cortex evolutionarily speaking, the three-layered organization is considered to be "older," so this type of cortex is also known as "archicortex" whereas the "newer" six-layered cerebral cortex is "neocortex". In the hippocampus orientation Image , observe: In the dentate gyrus orientation Image , observe: The "hilus" is the region where the head of hippocampus abuts the dentate gyrus. The multipolar neurons in this area are known as "mossy cells" NPN Webscope and they primarily receive input from mossy fibers of the granule cells of the dentate gyrus and then relay those signals back to other cells in the dentate. In terms of clinical significance, the pyramidal cells of the hippocampus are particularly vulnerable to damage in severe circulatory failure and by anoxia of persistent severe seizures. You may see small calcific bodies in part of the hippocampus, which occur as a normal part of the aging process. Calcific bodies are present in the choroid plexus, another common site of accumulation as the years pass. In this electron micrograph, note some of the features you saw in ventral horn motor neurons with the light microscope, such as the large, pale nucleus, prominent nucleolus, Nissl bodies, dendrites and axon. Adjacent to the neuron, note myelinated axons of various sizes and also that there are no spaces between cell processes. All spaces are occupied either by the processes of neurons or glia or by capillaries these capillaries are somewhat swollen here because the tissue was fixed by perfusion.

MICROSCOPIC MORPHOLOGY AND HISTOLOGY OF THE HUMAN MENINGES pdf

6: The cerebellum | Morphology of Nervous System

Meninges The meninges, the cerebrospinal membranes, invest the brain and spinal cord, the optic nerve, and also the first portions of the cranial and spinal nerve roots. There are three cerebrospinal membranes: pia mater, the innermost; arachnoid, the intermedial; dura mater, the outermost.

Meningothelial cells MECs play a central role in the maintenance of cerebrospinal fluid CSF homeostasis and in physiological and pathophysiological processes within the subarachnoid space SAS linking them to optic nerve ON pathologies. Still, not much is known about their structural properties that might enable MECs to perform specific functions within the ON microenvironment. For closer characterization of the structural properties of the human MEC layer in the arachnoid, we performed immunohistological analyses to evaluate the presence of cellâ€”cell interaction markers, namely, markers for tight junctions JAM1, Occludin, and Claudin 5 , gap junctions Connexin 26 and 43 , and desmosomes Desmoplakin as well as for water channel marker aquaporin 4 AQP4 in retrobulbar, midorbital, and intracanalicular human ON sections. However, no immunopositivity was found for Desmoplakin. The presence of these proteins emphasizes the important function of MECs within the ON microenvironment as part of the meningeal barrier. Beyond this barrier function, the expression of these proteins by MECs supports a broader role of these cells in signal transduction and CSF clearance pathways within the ON microenvironment. Introduction The optic nerve ON connects the eye to the brain. A variety of ON degenerations such as glaucoma, papilledema, and optic neuritis are associated with damage of the ON resulting in vision loss. A novel concept supports the idea of a possible influence of the ON microenvironment and therefore the meninges as part of this environment in the pathogenesis of these diseases. The meninges consist of three different layers, the dura mater, the arachnoid, and the pia mater. These layers form the subdural space between dura and arachnoid, as well as the subarachnoid space SAS between arachnoid and pia mater. There is strong evidence that the cellular element of the meninges, the meningothelial cells MECs which cover the arachnoid, the pia, and the inner wall of the dura mater as well as the trabeculae and septae within the SAS in the brain and the ON contribute to the homeostasis of the ON microenvironment 2 â€” 4. Yet, until now, MECs have only been poorly characterized and not much is known about their function within the ON microenvironment. It is generally accepted that these cells provide a barrier function between CSF and the brain as well as the neuronal tissue. For this barrier to be efficient, MECs have to form a tight interconnected cellular network. Consequently, a structural hallmark of the MEC layer is cellâ€”cell interaction markers including tight junctions, gap junctions but also desmosomes 5 , 6. Desmosomes, on the other hand, are known to be important with regards to contact inhibition as well as cellâ€”cell adhesion 7. Recent research on MECs demonstrated that these cells not only possess passive barrier function but also seem to be actively involved in a variety of physiological and pathophysiological processes within the SAS. MECs have been shown to react to stimuli such as pressure and oxidative stress with the secretion of cytokines and proteins thus actively contributing to CSF composition 8. Furthermore, MECs have been shown to be highly active phagocytes that are able to ingesting large amounts of bacteria, implicating them in inflammatory processes and antimicrobial host defense 4 , 9. With regards to their involvement in eye disease, Pache and Meyer also showed that an enhanced proliferation of MECs and the formation of cell nests are found in ON sections of glaucoma patients compared to healthy controls To this end, we evaluated MECs in retrobulbar, midorbital, and intracanalicular human ON sections of seven patients for the presence of cellâ€”cell interaction markers including tight junctions, gap junctions, and desmosomes as well as aquaporin 4 AQP4 water channels. Materials and Methods Human Tissue Samples The orbital and canalicular portions of both ONs were obtained postmortem after removal of the orbital roof and opening the optic channels. The ONs were removed within The cause of death in the seven donors was heart failure three donors , dissecting thoracic aortic aneurysm one donor , dissecting infrarenal aortic aneurysm one donor , metastatic small cell lung cancer one donor , and oropharyngeal cancer one donor. The

ONs were measured in length and diameter and were sectioned into three segments: Coronal as well as sagittal sections were prepared and histologically processed. Semiquantitative assessment of marker expression was performed by two blinded observers, the level of immunopositivity was graded between 0 no expression , 1 low , 2 intermediate , and 3 high. This study was designed and performed in accordance with the Declaration of Helsinki. Written informed consent was obtained as part of the agreement for autopsy. Immunohistochemistry Optic nerve samples including the bulbar, midorbital, and intracanalicular segments were formalin fixed and paraffin embedded. Slides with ON sections were stained with the following antibodies: The extent of cellâ€”cell interaction markers was semiquantitatively determined by eye scale ranging from 1 to 3. To evaluate specificity of immunohistochemistry staining procedure, control staining absence of primary antibody for each marker was performed on coronal sections of human meninges retrobulbar portion of the ON Figure S1 in Supplementary Material. Results For a better understanding of the anatomy of meninges and their cellular component, MECs within the ON, cellâ€”cell contacts were analyzed by immunohistochemistry. To this end, coronal and sagittal sections at retrobulbar, midorbital, and intracanalicular locations of the ON from 14 human eyes left and right eyes of seven donors were obtained and stained for the tight junction markers such as Claudin 5, Occludin, and JAM1, the gap junction markers such as Connexin 26 and Connexin 43 as well as the desmosomal marker such as Desmoplakin. As shown in Figure 1 , Claudin 5 was found in the arachnoidea and to some extent in the subarachnoidal area. Similarly, Occludin Figure 1 , panel 2 and JAM1 Figure 1 , panel 3 immunopositivity was found in the arachnoidal and subarachnoidal locations. These data are consistent with the expression of tight junctions between MECs. As for gap junctions, Connexin 26 and Connexin 43 immunoreactivity was found in the arachnoid and in subarachnoidal locations along the entire ON Figure 1 , panels 4 and 5. Interestingly, the desmosomal marker Desmoplakin was not detected in any location along the ON Figure 1 , panel 6. To confirm these findings, sagittal sections from locations along the ON were also analyzed by immunohistochemistry Figure 2. As in the coronal sections, the tight junction markers, such as Claudin 5, Occludin, and JAM1, were found in the arachnoid and in subarachnoidal locations along the ON. Similarly, immunopositivity for the gap junction markers, such as Connexin 26 and 43, was found retrobulbar, midorbital, and intracanalicular. Coronal sections of human meninges including the retrobulbar, midorbital, and intracanalicular part of the optic nerve stained for cellâ€”cell interaction markers of tight junctions JAM1, Occludin, and Claudin 5 , gap junctions Connexin 26 and 43 , and desmosomes Desmoplakin. A representative staining of one patient is shown. Sagittal sections of human meninges including the retrobulbar, midorbital, and intracanalicular part of the optic nerve stained for cellâ€”cell interaction markers of tight junctions JAM1, Occludin, and Claudin 5 , gap junctions Connexin 26 and 43 , and desmosomes Desmoplakin. To assess intra-patient variability of cellâ€”cell contact expression, the level of immunopositivity of each marker protein was compared between samples from 14 ONs from 7 different patients again at retrobulbar, midorbital, and intracanalicular locations. Following independent assessment by two blinded observers, the level of immunopositivity was graded between 0 no expression , 1 low , 2 intermediate , and 3 high. As shown in Figure 3 , Claudin 5 expression is low to intermediate in all samples analyzed. Similarly, Connexin 26 is consistently low between the samples. As for Occludin, JAM1, and Connexin 43, expression differs between samples with Occludin showing a trend toward mainly high expression. As for Desmoplakin, no immunoreactivity was detected in all 14 samples analyzed. Semiquantitative assessment of the coronal and sagittal sections of human meninges including the retrobulbar, midorbital, and intracanalicular part of the optic nerve stained for cellâ€”cell interaction markers of tight junctions JAM1, Occludin, and Claudin 5 , gap junctions Connexin 26 and 43 , and desmosomes Desmoplakin. Scale for expression evaluation ranging from 0 no immunopositivity to 3 high immunopositivity. To further assess our findings, immunopositivity of markers of cellâ€”cell contact was evaluated on the patient, eye, location, and sample level. Figure 4 summarizes our findings for each left and right eyes of each patient. Comparison of expression levels of cellâ€”cell interaction markers of tight junctions JAM1, Occludin, and Claudin 5 , gap junctions Connexin 26 and 43 , and desmosomes Desmoplakin with

regard to patient sample for coronal and sagittal sections. For each patient, left and right eyes were compared. So far, identification of cellâ€”cell contacts between MECs in the ON underlines the role of meninges in barrier formation. However, biological barriers serve not only to separate but also to allow selective exchange between two compartments. As shown in Figure 5 , AQP4 immunoreactivity was found in the arachnoid and subarachnoidal locations in retrobulbar, midorbital, and intracanalicular locations. Aquaporin expression seemed to vary between different patients Figure 5 B ; however, individual analysis Figure 5 C revealed similar expression levels between samples from the same patient. AQP4 immunoreactivity was found as well in the ON tissue where it is known to be expressed in astrocytes. A Coronal and sagittal sections of human meninges including the retrobulbar, midorbital, and intracanalicular part of the optic nerve ON stained for water channel marker aquaporin 4 AQP4. A representative staining of one patient is depicted. B Semiquantitative assessment of the coronal and sagittal sections of human meninges stained for AQP4. C Comparison of expression levels of AQP4. Marker levels between different samples of a given patient were not apparently different. Discussion The meninges cover and protect the brain, the spinal cord, and the ON form mechanical injury and provide a space for CSF. They also play a role in supplying blood to the brain. Our evaluation of MECs within human ON sections applying immunohistochemistry demonstrated expression of tight junction markers, gap junction markers, and AQP4 water channels. Regarding tight junction markers, we found expression of Claudin 5, occluding and JAM1 within the meninges of the ON sections in all patients. The presence of tight junctions within the meninges of the brain is well known and has been previously described in electron microscopy studies. These studies revealed that in brain meninges such junctions are found especially in cells at the border of the arachnoid with the dura affirming their function of restricting diffusion of solutes across intercellular spaces and thereby posing a physical barrier to CSF 5. Concerning gap junction markers in the ON meninges, we found immunopositivity for Connexin 26 and Gap junctions are specialized intercellular junctions that facilitate cellâ€”cell communication by acting as a selective transporter of small molecules and ions between cells. It has been previously shown that cells expressing gap junctions can act as a bystander to neighboring cells by distributing toxic load via these junctions, thus limiting the impact of toxic substances on the single cell level It is therefore conceivable that MECs might act in a similar fashion by taking up waste substances from the CSF shuttling them along the MEC layer toward the glymphatic network. Although the presence of desmosomes has been described within the MEC layer in the brain 6 , we did not find Desmoplakin immunopositivity within the arachnoid layer in the ON. The ON is a white matter tract of the brain extending into the orbit via the optic canal; therefore, the presence of such a system in the ON has been suspected. There has been increasing evidence of the existence of lymphatic structures in murine and also human dura mater of the brain and the ON 1 , 13 â€” The first histological evidence for a paravascular pathway within the ON has been shown in a recent publication. In addition to cellâ€”cell interaction markers, we therefore investigated the ON meninges for the presence of water channel marker AQP4. Aquaporins are membrane proteins that have been mainly implicated in epithelial fluid transport All subjects gave written informed consent in accordance with the Declaration of Helsinki. AN made intellectual contributions and participated in analyses of the results. HK and PM made intellectual contributions and supervised the work. Conflict of Interest Statement The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. Acknowledgments The authors gratefully acknowledge Ms. Myriam Vonlanthen and Ms. Petra Hirschmann for their technical assistance. Supplementary Material The Supplementary Material for this article can be found online at https: Lymphatic capillaries in the meninges of the human optic nerve. J Neuroophthalmol 19 4:

MICROSCOPIC MORPHOLOGY AND HISTOLOGY OF THE HUMAN MENINGES pdf

7: Human Structure Virtual Microscopy

The meninges comprise the dura mater and the leptomeninges (arachnoid and pia mater). Dura forms an outer endosteal layer related to the bones of the skull and spine and an inner layer closely.

Morphology refers to the size, shape, and arrangement of cells. The observation of microbial cells requires not only the use of microscopes but also the preparation of the cells in a manner appropriate for the particular kind of microscopy. During the first decades ofâ€¦ Historical background Evidence that prehistoric humans appreciated the form and structure of their contemporary animals has survived in the form of paintings on the walls of caves in France, Spain, and elsewhere. During the early civilizations of China, Egypt, and the Middle East , as humans learned to domesticate certain animals and to cultivate many fruits and grains, they also acquired knowledge about the structures of various plants and animals. Aristotle was interested in biological form and structure, and his Historia animalium contains excellent descriptions, clearly recognizable in extant species , of the animals of Greece and Asia Minor. He was also interested in developmental morphology and studied the development of chicks before hatching and the breeding methods of sharks and bees. Galen was among the first to dissect animals and to make careful records of his observations of internal structures. His descriptions of the human body , though they remained the unquestioned authority for more than 1, years, contained some remarkable errors, for they were based on dissections of pigs and monkeys rather than of humans. In an Italian physiologist, Marcello Malpighi , the founder of microscopic anatomy, demonstrated the presence of the small blood vessels called capillaries , which connect arteries and veins. The existence of capillaries had been postulated 30 years earlier by English physician William Harvey , whose classic experiments on the direction of blood flow in arteries and veins indicated that minute connections must exist between them. Between and , Dutch microscopist Antonie van Leeuwenhoek used the recently invented microscope to describe red blood cells , human sperm cells, bacteria , protozoans , and various other structures. Cellular componentsâ€”the nucleus and nucleolus of plant cells and the chromosomes within the nucleusâ€”and the complex sequence of nuclear events mitosis that occur during cell division were described by various scientists throughout the 19th century. Organographie der Pflanzen â€”; Organography of Plants, â€”05 , the great work of a German botanist, Karl von Goebel , who was associated with morphology in all its aspects, remains a classic in the field. British surgeon John Hunter and French zoologist Georges Cuvier were early 19th-century pioneers in the study of similar structures in different animalsâ€”i. Cuvier in particular was among the first to study the structures of both fossils and living organisms and is credited with founding the science of paleontology. A British biologist, Sir Richard Owen , developed two concepts of basic importance in comparative morphologyâ€”homology, which refers to intrinsic structural similarity, and analogy , which refers to superficial functional similarity. One of the major thrusts in contemporary morphology has been the elucidation of the molecular basis of cellular structure. Techniques such as electron microscopy have revealed the complex details of cell structure, provided a basis for relating structural details to the particular functions of the cell, and shown that certain cellular components occur in a variety of tissues. Studies of the smallest components of cells have clarified the structural basis not only for the contraction of muscle cells but also for the motility of the tail of the sperm cell and the hairlike projections cilia and flagella found on protozoans and other cells. Studies involving the structural details of plant cells, although begun somewhat later than those concerned with animal cells, have revealed fascinating facts about such important structures as the chloroplasts , which contain chlorophyll that functions in photosynthesis. Attention has also been focused on the plant tissues composed of cells that retain their power to divide meristems , particularly at the tips of stems, and their relationship with the new parts to which they give rise. The structural details of bacteria and blue-green algae , which are similar to each other in many respects but markedly different from both higher plants and animals, have been studied in an attempt to determine their origin. Morphology continues to be of importance in taxonomy because morphological features characteristic of a particular species are used to

identify it. As biologists have begun to devote more attention to ecology , the identification of plant and animal species present in an area and perhaps changing in numbers in response to environmental changes has become increasingly significant. Fundamental concepts Homology and analogy Homologous structures develop from similar embryonic substances and thus have similar basic structural and developmental patterns, reflecting common genetic endowments and evolutionary relationships. In marked contrast, analogous structures are superficially similar and serve similar functions but have quite different structural and developmental patterns. The arm of a human, the wing of a bird, and the pectoral fins of a whale are homologous structures in that all have similar patterns of bones, muscles, nerves, and blood vessels and similar embryonic origins; each, however, has a different function. The wings of birds and those of butterflies, in contrast, are analogous structuresâ€”i. Although such structures serve similar functions, they have quite different evolutionary origins and developmental patterns. The terms homology and analogy are also applied to the molecular structures of cellular constituents. Because the hemoglobin molecules from different vertebrate species contain remarkably similar sequences of amino acids , they may be termed homologous molecules. In contrast, hemoglobin and hemocyanin, the latter of which is present in crab blood, are described as analogous molecules because they have a similar function oxygen transport but differ considerably in molecular structure. Corresponding similarities occur in the structures of other proteins from different speciesâ€”e. Body plan and symmetry The bodies of most animals and plants are organized according to one of three types of symmetry: A spherically symmetrical body is similar throughout and can be cut in any plane through the centre to yield two equal halves. A few of the simplest plants and animals are spherically symmetricalâ€”e. Radially symmetrical bodies, such as those of starfishes and mushrooms, have a distinguishable top and bottom and usually have a cylindrical shape, with the body parts radiating from the central axis. A starfish can be cut into two equal halves by any plane that includes the line, or axis, running through its centre from top to bottom. The anterior, or oral, end usually contains the mouth; a posterior, or aboral, end may have an anus. In the bilaterally symmetrical body of higher animals including humans, only a cut from head to foot exactly in the centre divides the body into equivalent halves. An anterior, or head, end and a posterior, or tail, end can be distinguished; and the dorsal, or back, side can be distinguished from the ventral, or belly, side. But because some internal organs of humans are not symmetrical e. A few organismsâ€”amoebas, slime molds, and certain spongesâ€”with an irregular form, or one that changes as the organism moves, have no plane of symmetry. Morphological basis of classification The features that distinguish closely related species of plants and animals are usually superficial differences such as colour, size, and proportion. In contrast, the major divisions, or phyla, of the plant and animal kingdoms are distinguished by characteristics that, though usually not unique to a single division or phylum, occur in unique combinations in each. One morphological feature useful in classifying animals and in determining their evolutionary relationships is the presence or absence of cellular differentiationâ€”i. Some multicellular animals have only two embryonic cell, or germ , layers: Other animals have these, in addition to a mesoderm , which lies between the ectoderm and endoderm. Animals may have one of two types of body cavity. The bodies of the Coelenterata invertebrates such as the jellyfish and other primitive many-celled animals consist of a double-walled sac surrounding a single cavity with a mouth. Higher animals have two cavities, and their bodies are constructed on a so-called tube-within-a-tube plan. An inner tube, or digestive tract, is lined with endoderm and opens at each end to form the mouth and the anus. An outer tube, or body wall, is covered with ectoderm. Between the two tubes a second cavity, or coelom, lies within the mesoderm and is lined by it. Another major distinguishing morphological feature of animal phyla is the presence or absence of segmentation. The members of several phyla have bodies characterized by the presence of a row of segments, or body units, of the same fundamental structure. Segmented animals include the vertebrates, the annelids invertebrates such as the earthworm , and the arthropods invertebrates such as insects ; in some segmented animals such as humans and most vertebrates, however, the segmental character of the body is obscured. An evolutionary tendency in many animal phyla has been the progressive differentiation of the anterior end to

form a head with conspicuous sense organs and an accumulation of nervous tissues, a brain ; the tendency is called cephalization. Some morphological structures are found only in one phylum; for example, only the Coelenterata have stinging cells nematocysts , the Echinodermata invertebrates such as starfishes have a peculiar water vascular system , and only the Chordates e. Like animals, plants may be either single-celled or composed of many kinds of specialized cells. The bodies of most of the lower plants, such as algae and fungi, comprise the least-differentiated and least-specialized type of plant cells, parenchyma cells. The embryonic tissues of higher plants, unlike those of animals, remain extremely active throughout the life of the plant. In addition, the different types of cells characteristic of the body of higher plants arise from meristems, specific regions in the plant body where cells divide and enlarge. In all but the simplest forms, the plant body is composed of various types of cells associated in more or less definite ways to form systems of units called tissue systemsâ€”e. The arrangement of the components of the vascular system is a distinguishing morphological feature of various plant groups. The character and relative extent of the two phases in the life history of a plantâ€”the sexual phase, or gametophyte , and the sporophyte â€”vary considerably among the plant groups and are useful in distinguishing them. Areas of study Anatomy The best known aspect of morphology, usually called anatomy, is the study of gross structure, or form, of organs and organisms. It should not be inferred however, that even the human body, which has been extensively studied, has been so completely explored that nothing remains to be discovered. It was found only in , for example, that the nerve to the pineal gland , which lies on the upper surface of the brain of mammals, is a branch from the sympathetic nerves; the sympathetic nerves receive nerve impulses from a small branch of the nerves that transmit impulses from the eye to the brain optic nerves. Thus the pineal gland responds by a very indirect route to quantitative changes in the environmental lighting and secretes appropriate amounts of the substance it forms, the hormone melatonin. Detailed comparisons of the morphological features of different animals, called comparative anatomy , provide strong arguments for the evolutionary relationships among different species. In the course of evolution , animals and plants tend to undergo adaptive morphological changes that enable them to survive under certain environmental conditions. As a result, animals only remotely related evolutionarily may come to resemble each other superficially because of common adaptations to similar environments , a phenomenon known as convergent evolution. Structural similaritiesâ€”streamlined shape, dorsal fins, tail fins, and flipper-like forelimbs and hindlimbs, for exampleâ€”have evolved in such varied animal groups as the dolphins and porpoises, both of which are mammals ; the extinct ichthyosaurs, which were reptiles; and both the bony and cartilaginous fishes. In a like manner, the mole, an insectivore, and the gopher, a rodent, have both evolved shovellike forelimbs, an adaptation for digging. An opposite phenomenon, divergent evolution, occurs when animals originally closely related adapt to different environments and come to be superficially quite different. Although sea lions and seals, for example, are carnivores and thus closely related to bears, cats, and dogs, their adaptations to an aquatic existence have resulted in morphological characteristics distinct from those of the terrestrial carnivores. In the course of mammalian evolution, many features have changed to permit specific animal groups to adapt to particular environmentsâ€”e. Careful study of adaptive morphological aspects has permitted inferences about the course of the evolutionary history of various animals and of their successive adaptations to changing environments. The present-day Australian tree-climbing kangaroos , for example, are the descendents of a ground-dwelling marsupial , from whom evolved forms that began to live in trees and eventually developed limbs adapted to tree climbing. But the events may have occurred in the reverse sequence; that is, specialized limbs may have evolved before the animal adopted an arboreal mode of life. In any event, some of the tree-dwelling kangaroos subsequently left the trees, became readapted to life on the ground i. Careful comparisons of the feet of the many kinds of living Australian marsupials reveal the stages in this complicated process of adaptation and re-adaptation. Changes in genes mutations constantly occur and may cause a decrease in size and function of an organ. On the other hand, a change in the environment or in the mode of life of a species may make an organ unnecessary for survival. As a result, many plants and animals contain organs or parts of organs that are useless, degenerate, undersized, or

lacking some essential part when compared with homologous structures in related organisms. The human body, for instance, has more than such organsâ€”e. The parts of a seed plant include roots, stems, leaves, and reproductive organs in the flowers. The evolution of specialized conducting tissues called xylem and phloem has enabled seed plants to survive on land and to attain large sizes. Roots anchor the plant, enable it to maintain an upright position, and absorb water, minerals, and other nutrients from the soil. The roots of plants such as carrots, beets, and yams serve as sites for food storage. The stem links the roots with the leaves, where photosynthesis occurs, and its xylem and phloem are continuous with those of root and leaf. The stem supports leaves, flowers, and fruits. Each year, the stems of woody plants add a layer of xylem and phloem, the annual ring , the width of which varies with climatic conditions. A leaf consists of a petiole stalk , by which it is attached to the stem, and a blade, typically broad and flat, that contains bundles, or veins, of xylem and phloem on the undersurface. The flower contains pollen -producing anthers and egg-producing ovules. After fertilization the base of the flower, or ovary , enlarges and forms the fruit, which is a mature ovary containing seeds, or mature ovules. The bodies of ferns and mosses also are composed of roots, stems, and leaves, but those of lower plants such as mushrooms and kelps are much more simple and lack true roots, stems, and leaves. Histology A major trend in the evolution of both plants and animals has resulted in the specialization of cells and a division of labour among them.

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8: Central Nervous System | histology

Be able to identify tissues in the nervous system (nerves, cell bodies and ganglia, and white vs. gray matter in the spinal cord, cerebellum, and cerebrum).

Submit manuscript at https: Priority will be given to the studies that clearly articulate their relevance to the anatomical community. Focal areas of the journal include: Manuscripts with novel methods or synthetic perspective on the anatomical system, studies that describes anatomy are welcome, if they communicate clearly on the broader functional or evolutionary significance. Articles covering bioinformatics and the functional anatomical understanding will also be considered. The Journal also publishes original research articles on macroscopic anatomy , histological development , Morphological Sciences , Cell and Molecular Biology , Macroscopic Human Anatomy , and Microscopic Human Anatomy. Morphology Applied to other Sciences like phonology, syntax, and semantics , the acquisition and processing of morphological information , mental lexicon, and morphological variation and change, models of morphology, morphological typology, the position of morphology in the architecture of the human language, and the evolution of language. The Journal accepts original manuscripts in the form of research article, review article, short communication, case report, letter-to-the-Editor and Editorials for publication. All the published articles are open access and can be accessed online without any subscription charges. The journal extensively enhances the worldwide visibility of the scholars that contribute their research work. The Editorial Manager System helps in maintaining the quality of the peer review process and enables the authors to track the review and publication process in an automated way. Experts in the field of Morphology and Anatomy take up the review process under the guidance of Editor-in-Chief. Approval of at least two independent reviewers and the editor is mandatory for the acceptance of the manuscript for publication. Anatomical Sciences Anatomy is the identification and description of the structures of living things. Anatomy is a branch of biology and medicine which can be divided into three broad areas: Anatomy is inherently tied to embryology, Comparative anatomy, Evolutionary biology, phylogeny, as these are the processes by which anatomy is generated over immediate embryology and long evolution timescales. Comparative Embryology Embryology is the branch of biology that is concerned with the development of gametes sex cells , fertilization, and development of embryos and fetuses. It is the science dealing with the formation, development, structure, and functional activities of embryos. Embryology is the study of congenital disorders that occur before birth. Comparative embryology is the branch of embryology that compares and contrasts embryos of different species. It is used to show how all animals are related. Many things are compared such as whether or not the organism has a notochord or gill arches. Many components go into comparative embryology, and much information about the developmental similarities between species can be taken from its study, from which many conclusions can be drawn. General Anatomy General Anatomy or Comparative anatomy is the study of similarities and differences in the anatomy of different species. Two major concepts of comparative anatomy are: They may or may not serve the same function. An example is the forelimb structure shared by cats and whales. They usually perform the same or similar purposes. An example is the streamlined torpedo body shape of porpoises and sharks. So even though they evolved from different ancestors, porpoises and sharks developed analogous structures as a result of their evolution in the same aquatic environment. It addresses the origin and evolution of embryonic development; how modifications of development and developmental processes lead to the production of novel features, such as the evolution of feathers, the role of developmental plasticity in evolution; how ecology impacts development and evolutionary change; and the developmental basis of homoplasy and homology. Phylogenetic Tree A phylogenetic tree or evolutionary tree is a branching diagram that shows the inferred evolutionary relationships among various biological species or other entities-their phylogeny-based upon similarities and differences in their physical or genetic characteristics. A phylogenetic tree, also known as a phylogeny, is a diagram that depicts the lines of evolutionary descent of different species, organisms, or genes

from a common ancestor. Phylogenies are useful for organizing knowledge of biological diversity, for structuring classifications, and for providing insight into events that occurred during evolution. Furthermore, because these trees show descent from a common ancestor, and because much of the strongest evidence for evolution comes in the form of common ancestry, one must understand phylogenies in order to fully appreciate the overwhelming evidence supporting the theory of evolution. Surface Anatomy Surface anatomy also known as superficial anatomy and visual anatomy is the study of the external features of the body. It deals with anatomical features that can be studied by sight, without dissection. It is a branch of gross anatomy, along with endoscopic and radiological anatomy. Surface anatomy is a descriptive science. In particular, in the case of human surface anatomy, these are the form and proportions of the human body and the surface landmarks which correspond to deeper structures hidden from view, both in static pose and in motion. Macroscopic Anatomy It is the study of the structure of the body and its parts without the use of a microscope. There are many ways to approach gross anatomy: Many advanced courses in anatomy stress a regional approach, because it emphasizes the spatial relationships between structures already familiar to students. Organ systems are groups of organs that function together in a coordinated manner. For example, the heart, blood, and blood vessels form the cardiovascular system, which distributes oxygen and nutrients throughout the body. Introductory texts present systemic anatomy because that approach clarifies functional relationships among the component organs. The human body has 11 organ systems, and we will introduce them later in the chapter. Because developmental anatomy considers anatomical structures over such a broad range of sizes from a single cell to an adult human , techniques used in it are similar to those used in both microscopic anatomy and gross anatomy. The most extensive structural changes occur during the first 2 months of development. Microscopic Anatomy The study of the structure of cells, tissues, and organs of the body as seen with a microscope. Microscopic anatomy deals with structures that cannot be seen without magnification. The boundaries of microscopic anatomy are established by the limits of the equipment used. With a light microscope, you can see basic details of cell structure; with an electron microscope, you can see individual molecules that are only a few nanometers across. Tissue Sciences A tissue is one of the building blocks of an organism--either animal or plant. An organism is comprised of tissues, which are made up of individual cells. The study of tissues is a field known as histology. Histology is the study of the microscopic anatomy microanatomy of cells and tissues of plants and animals. It is commonly performed by examining cells and tissues under a light microscope or electron microscope, the specimen having been sectioned cut into a thin cross section with a microtome , stained, and mounted on a microscope slide. Histological studies may be conducted using tissue culture, where live human or animal cells are isolated and maintained in an artificial environment for various research projects. The ability to visualize or differentially identify microscopic structures is frequently enhanced through the use of histological stains. Histology is an essential tool of biology and medicine. Morphological Sciences Morphology is a branch of biology dealing with the study of the form and structure of organisms and their specific structural features. This includes aspects of the outward appearance shape, structure, colour, pattern, size , i. Vertebrate Anatomy All vertebrates have a similar basic body plan and at some point in their lives, mostly in the embryonic stage , share the major chordate characteristics; a stiffening rod, the notochord; a dorsal hollow tube of nervous material, the neural tube; pharyngeal arches; and a tail posterior to the anus. The spinal cord is protected by the vertebral column and is above the notochord and the gastrointestinal tract is below it. Nervous tissue is derived from the ectoderm, connective tissues are derived from mesoderm, and gut is derived from the endoderm. At the posterior end is a tail which continues the spinal cord and vertebrae but not the gut. The mouth is found at the anterior end of the animal, and the anus at the base of the tail. The defining characteristic of a vertebrate is the vertebral column, formed in the development of the segmented series of vertebrae. In most vertebrates the notochord becomes the nucleus pulposus of the intervertebral discs. However, a few vertebrates, such as the sturgeon and the coelacanth retain the notochord into adulthood. Jawed vertebrates are typified by paired appendages, fins or legs, which may be secondarily lost. The limbs of vertebrates are considered to be homologous because the

same underlying skeletal structure was inherited from their last common ancestor. This is one of the arguments put forward by Charles Darwin to support his theory of evolution. Invertebrate Anatomy Invertebrates constitute a vast array of living organisms ranging from the simplest unicellular eukaryotes such as Paramecium to such complex multicellular animals as the octopus, lobster and dragonfly. By definition, none of these creatures has a backbone. The cells of single-cell protozoans have the same basic structure as those of multicellular animals but some parts are specialised into the equivalent of tissues and organs. Locomotion is often provided by cilia or flagella or may proceed via the advance of pseudopodia, food may be gathered by phagocytosis, energy needs may be supplied by photosynthesis and the cell may be supported by an endoskeleton or an exoskeleton. Some protozoans can form multicellular colonies. Evolutionary Morphology Morphology is a branch of biology dealing with the study of the form and structure of organisms and their specific structural features. Anatomical pathology Commonwealth or Anatomic pathology is a medical specialty that is concerned with the diagnosis of disease based on the macroscopic, microscopic, biochemical, immunologic and molecular examination of organs and tissues. Eidonomy Eidonomy is the study of the external appearance of an organism. It is thus the opposite of anatomy, which refers to internal morphology. While predominant early in the history of biology it is little studied in particular anymore as it is ripe with the effects of convergent evolution. It thus yields less new information about organisms than anatomy, and therefore the external appearance of lifeforms is usually studied as part of general investigations in morphology, e. Cytogenetical Sciences Cytogenetics is an exciting, dynamic field of study which analyzes the number and structure of human and animal chromosomes. Chromosomal abnormalities can happen when egg and sperm cells are being made, during early fetal development, or after birth in any cell in the body. Changes to chromosome structure can disrupt genes, causing the proteins made from disrupted genes to be missing or faulty. Depending on size, location, and timing, structural changes in chromosomes can lead to birth defects, syndromes or even cancer. Protozoology Protozoology is that branch of zoology which is concerned with the group of animals known as the Protozoa. Protozoa are unicellular, heterotrophic eukaryotes that have been studied for more than years, at first as microscopic curiosities, later as organisms causing disease and more recently as important components of ecosystems. Protozoans are common, and they are of particular interest to man because they cause such diseases as malaria, amoebic dysentery, and African trypanosomiasis sleeping sickness. Certain protozoans known as foraminifera, which have an extensive fossil record, are useful to geologists in locating petroleum deposits. Protozoans also serve as experimental organisms in many studies of cell and molecular biology. Developmental Biological Sciences Developmental biology is the study of the process by which animals and plants grow and develop, and is synonymous with ontogeny. In animals most development occurs in embryonic life, but it is also found in regeneration, asexual reproduction and metamorphosis, and in the growth and differentiation of stem cells in the adult organism. In plants, development occurs in embryos, during vegetative reproduction, and in the normal outgrowth of roots, shoots and flowers. Molecular Biology Molecular biology chiefly concerns itself with understanding the interactions between the various systems of a cell, including the interrelationship of DNA, RNA and protein synthesis and learning how these interactions are regulated. Molecular biology is the study of molecular underpinnings of the process of replication, transcription and translation of the genetic material.

MICROSCOPIC MORPHOLOGY AND HISTOLOGY OF THE HUMAN MENINGES pdf

9: The Meninges - Dura - Arachnoid - Pia - TeachMeAnatomy

Human spinal dura and arachnoid, obtained during neurosurgical operations, were studied by transmission electron microscopy. The ultrastructure of spinal meninges largely conformed to the morphology of the cranial meninges, but some minor differences were detected.

This is an open access article distributed under the Creative Commons Attribution License , which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. Abstract The interface between the brain and the skull consists of three fibrous tissue layers, dura mater, arachnoid, and pia mater, known as the meninges, and strands of collagen tissues connecting the arachnoid to the pia mater, known as trabeculae. The space between the arachnoid and the pia mater is filled with cerebrospinal fluid which stabilizes the shape and position of the brain during head movements or impacts. The histology and architecture of the subarachnoid space trabeculae in the brain are not well established in the literature. The only recognized fact about the trabeculae is that they are made of collagen fibers surrounded by fibroblast cells and they have pillar- and veil-like structures. In this work the histology and the architecture of the brain trabeculae were studied, via a series of in vivo and in vitro experiments using cadaveric and animal tissue. In the cadaveric study fluorescence and bright field microscopy were employed while scanning and transmission electron microscopy were used for the animal studies. The results of this study reveal that the trabeculae are collagen based type I, and their architecture is in the form of tree-shaped rods, pillars, and plates and, in some regions, they have a complex network morphology. Introduction Traumatic brain injury TBI , which is mainly due to vehicular collisions, contact sports, falls, or shock wave blasts from improvised explosive devices IEDs , is caused by the relative motion between the brain and the skull. Anatomically the interface between the skull and the brain consists of a series of three fibrous tissue layers, dura mater, arachnoid, and pia mater, and arachnoid trabeculae which are strands of collagen tissue Figure 1. In addition, the space between the arachnoid and pia mater, known as the subarachnoid space SAS , is filled with cerebrospinal fluid CSF which stabilizes the shape and the position of the brain during head movements. Meningeal layers, the SAS, the pia mater, and the arachnoid. The SAS itself has a complex geometry due to the fact that there is an abundance of trabeculae which stretch from the arachnoid subdural to the pia mater. Also, since the pia mater adheres to the surface of the brain and follows all its contours including the folds of the cerebral and cerebellar cortices, the resulting SAS is highly irregular and the associated distribution of CSF within the SAS is very nonuniform. Consequently, this irregular geometry produces a complex CSF flow around the brain, which results in a solid-fluid interaction that damps and stabilizes the movement of the brain when the head is exposed to external loads. Unfortunately, the complicated geometry of the SAS and trabeculae makes it impossible to model all the details of the region. Thus, in many studies [1 â€” 6] the meningeal layers and the subarachnoid region have been simplified as a soft elastic material or, in some cases, as water i. The shortcoming of these approaches is that the hydraulic damping associated with the fluid solid interaction and the mechanical role of the fibrous trabeculae and the CSF in the subarachnoid space have often been ignored. This is borne out by the fact that the subarachnoid space SAS trabeculae play an important role in damping and reducing the relative movement of the brain with respect to the skull, thereby reducing traumatic brain injuries TBI , as was shown by Zoghi-Moghadam and Sadegh [7]. While the functionality of the SAS is understood, the architecture, the histology, and biomechanics of this critical region have not been fully investigated. Consequently, in the modeling of the head, previous investigators have oversimplified this important region, and these simplifications could lead to inaccurate results in a finite element analysis of the brain. However, several validated finite element models e. In addition, there have been a few experimental studies associated with the architecture of the SAS, with one experimental study by Alcolado et al. The result of that work was compared with calcification in psammoma bodies in a normal arachnoid, and there it was concluded that psammoma bodies in the choroid plexus form by a process of dystrophic calcification

associated with arachnoid cells and collagen fibers. In contrast, Frederickson [11] used electron microscopy to study the subdural region within the cranial meninges in guinea pigs, where attention was paid to the fine structure of the arachnoid membrane, dura mater, inner surface of the dura, and outer surface of the arachnoid. This study revealed that the subdural space was not observed in the guinea pig, and it was also concluded that the reason the intermediate cells are located in the light cell layer, next to the dark arachnoid cells, is because of a greater complement of rough endoplasmic reticulum. In addition, the histology of the trabeculae in the optical nerves was studied by Killer et al. The samples were examined within seven hours after death, following qualified consent for necropsy. Scanning electron microscopy SEM and transmission electron microscopy TEM were used to study the anatomy and arrangement of trabeculae within the optic nerves and they were described as having pillar-, septa-, and platelike structures similar to the trabeculae found in a subarachnoid space. The conclusion from this study was that the human optic nerve is not a homogeneous medium and that the SAS is regionally different, particularly in the area closer to the canalicular portion where the trabeculae are more oriented and shaped like pillars. In a recent study by Scott and Coats [13], optical coherence tomography OCT Imaging was used to determine the density and regional variability of arachnoid trabeculae within the SAS. From this study it was concluded that more investigation is needed to study the architecture of the SAS using OCT imaging techniques. The goal of this present study was therefore to investigate the histology and morphology of the SAS of the brain and in particular the SAS trabeculae, which is needed for sophisticated and accurate modeling of TBI. Specifically, in this paper, the histology and the architecture of the brain trabeculae are presented via cadaveric and animal experimental studies. In the first experimental study of the brain a histological sectioning with florescent and bright field illumination was done. In the second set of experimental studies scanning and transmission electron microscopy were used. Material and Methods 2. Cadaveric Experimental Studies The first set of experiments designed to examine the histology and architecture of the SAS was done, by using fluorescence and bright field microscopy, to determine the structure of the SAS associated with a cadaver brain. In this experiment an image of the trabecular architecture of a cadaver was acquired using florescent and bright field microscopy. However, since the cadaveric human brain was already fixed by formaldehyde, the arachnoid had been collapsed onto the pia mater and the CSF had been drained. Several techniques were employed to separate the arachnoid from the pia mater and to recreate and restore the subarachnoid space, which is approximately 2 to 3 mm wide in a human head. The techniques involved several steps that included confining a cortical region of the brain and the injection of Microfil a silicone rubber injection compound from Flowtech, Inc. The Microfil solidified quickly and kept the two layers separated. To inject the Microfil solution into the SAS a fixture was designed to confine the Microfil within the cortex, where the fixture consisted of a clear tube with a key-way on one side to allow for the insertion of the syringe needle. Extreme care was taken during this process since it was necessary to ensure that the solution was injected exactly between the pia mater and the arachnoid. The viscosity of the fluid was also an important factor because if the Microfil that was mixed with the solidifier was too thick it was not possible to inject it between the two layers using a small needle; however, if it were diluted too much it would then just be drained out from between the neighboring cortexes and would not cause the subarachnoid space to open. Figure 2 shows the Microfil injected between the arachnoid and the pia mater to separate and rebuild the SAS of the brain tissue. The samples were then stained using hematoxylin-eosin staining protocol and sliced using a vibratome. It should be noted that since the tissue was already fixed in the formaldehyde the Microfil did not survive the staining procedure and it was washed out during the sample preparation. However, it was possible to see the trabeculae structure and make a distinction between the pia mater and the arachnoid mater. The brain tissue with Microfil fixed in the formalin. A rat was used since it has been shown that there is a similarity in the morphology of the trabeculae of rats and humans [10 , 11 , 13]. Scanning Electron Microscopy SEM To investigate the histology and the architecture of the SAS trabeculae in vitro, experiments were performed using Sprague-Dawley rats that weighted â€” g and were 2 to 3 months old. The objective of this experiment was to fix and solidify the subarachnoid space and the trabeculae while the

animal was alive. A prefixative solution of PBS followed by the fixative solution glutaraldehyde and formaldehyde was injected through the cut ventricle into the ascending aorta of the rat to allow the blood vessels of the SAS to be solidified. The animal was sacrificed and samples of the brain tissue were prepared for the scanning and transmission electron microscopy. The head was cut, the skull was carefully dissected, and the brain was extracted along with the dura mater. The regular protocol of biological sample preparation was used with some adaptations for these types of samples. Cerebral sections were obtained by cutting along a sagittal plane. The samples were then cleaned of the glutaraldehyde solution under a hood, and the sections needed for visualization under the SEM were obtained and washed in distilled water ddH2O. Care was taken to keep the samples constantly wet, and after 5 minutes the samples were rinsed with fresh ddH2O. In total, the samples were washed 5 times with ddH2O, each time for 5 minutes. At the end of this step, none of the glutaraldehyde solution remained in the samples. Next, the samples were placed in a basket and the ddH2O was washed out from the samples by using alcohol at different concentrations. The tube was shaken from time to time to ensure a better penetration of the alcohol within the tissues. The Critical Point Drying CPD technique was also used by immersing the samples in a chamber that was then placed in liquid CO2, rinsing them 7 times for 5â€”10 minutes. Finally, the samples were coated with gold particles just prior to observing them with the SEM. Transmission Electron Microscopy TEM The tissue samples for the TEM study were obtained from the same batch of brain tissue prepared for use with the SEM; however, in this process the specimens had to be only 1 or 2 mm in thickness; therefore it was necessary to choose and cut the tissue samples from a specific location of the brain due to the small physical size of the specimen. Consequently, extracting the tissue from the area surrounding the superior sagittal sinus by cutting the brain along a plane parallel and next to the sagittal plane on both sides of the sinus was decided. The sections were then shortened to be about 1 mm from the top of the brain and were cut into approximately 1 mm sized pieces. The samples were dehydrated and rinsed twice in propylene oxide for 5 minutes. For each concentration the jar containing the resin and the samples was placed on a shaker for three hours. The block sample was transferred to the microtome and its position was adjusted with respect to the diamond knife. The thickness of the sections was set to nm. Once enough sections had been obtained, a moist eyelash was used to create groups of six pieces, and they were transferred onto the shiny side of the small round grids. Subsequently, the samples were stained with uranyl acetate and Reynolds lead citrate and studied using a Philips CM transmission electron microscope at an accelerating voltage of 80 kV. The Fluorescence and Bright Field Result The bright field microscopy image of the subarachnoid space is shown in Figure 3 , where the arachnoid and the pia mater are identified. The figure also shows that there is a gap between the pia mater and the brain which is caused by the injection of the Microfil. The tissue studied under the fluorescence light microscopy is shown in Figure 4 , and here collagen tissues can be clearly seen. From these initial experiments it was determined that the subarachnoid space collapses easily in the absence of CSF, and injection of rubber silicon may rupture the trabeculae. Light microscopic view of subarachnoid, a the arachnoid mater, b SAS, c the pia mater, and d the brain. Trabeculae of cadaveric brain tissue under the fluorescent light. These images allowed the different layers of the meninges, the SAS Figure 5 , the trabecula Figure 6 , and their fine structures Figure 8 to be clearly seen. The high resolution of the SEM permitted the structure of the trabecula to be seen down to the tissue level. Figures 5 to 9 reveal the morphology and architecture of the SAS. SEM micrograph of the dura and arachnoid layer in the rat brain: Specifically, Figure 8 is a close-up of an SEM image of a trabecula that has a platelike shape that spans the arachnoid and pia mater. The voids in the trabecula show the permeable characteristics of a trabecula itself with the voids being approximately 0. Figure 9 shows a further close-up of a trabecula and in this image it is clearly seen that its internal structure consists of collagen fibrils. In addition, Figure 8 , along with Figure 9 , shows the tree-shaped structure of a trabecula where the stem is on the pia mater and the branches merge into the arachnoid mater. Figure 9 is a close-up of a different area of the SAS where the trabecula has a veil-like network structure. This type of structure is seen in the areas where the trabeculae are denser, such as between blood vessels. The SAS appeared to have a more complicated

morphology than is presented in much of the literature [8 , 14 â€” 16]. Instead of being merely rods connecting the pia mater to the arachnoid layer, the trabecula displayed various shapes and organizations. In this work trabeculae were seen to have a variety of forms: However, it was clear that the basic building blocks for the components that make up the SAS were collagen fibrils. Those fibrils were found everywhere within the SAS Figures 8 and 9 and provided the tissue with its structural and permeable characteristics Figure 8. The SEM images and figures shown in Killer et al. In comparison to the SEM, the TEM images allowed different cell layers to be clearly identified; however, the separation between the brain and the SAS was not as clear as in the SEM case; therefore the myelin sheath of the neurons was taken as a reference to locate the brain.

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