CHAPTER 16

ENDOCRINE SYSTEM

GENERAL CONCEPTS

I. Endocrine cells release their secretory products, called hormones, into the surrounding extracellular space. Hormones can affect adjacent cells (**paracrine secretion**) or diffuse into capillaries to be transported in the blood (**endocrine secretion**). Although exposed to all cells, Hormones act only on selected cells, called **target cells**, which express specific receptors to mediate the hormone signal.

II. Endocrine organs are highly vascularized with fenestrated capillaries and, with the major exception of the thyroid gland, their cells do not show polarity. The nervous and endocrine systems combine to coordinate functions of all body systems and are functionally integrated as the neuroendocrine system.

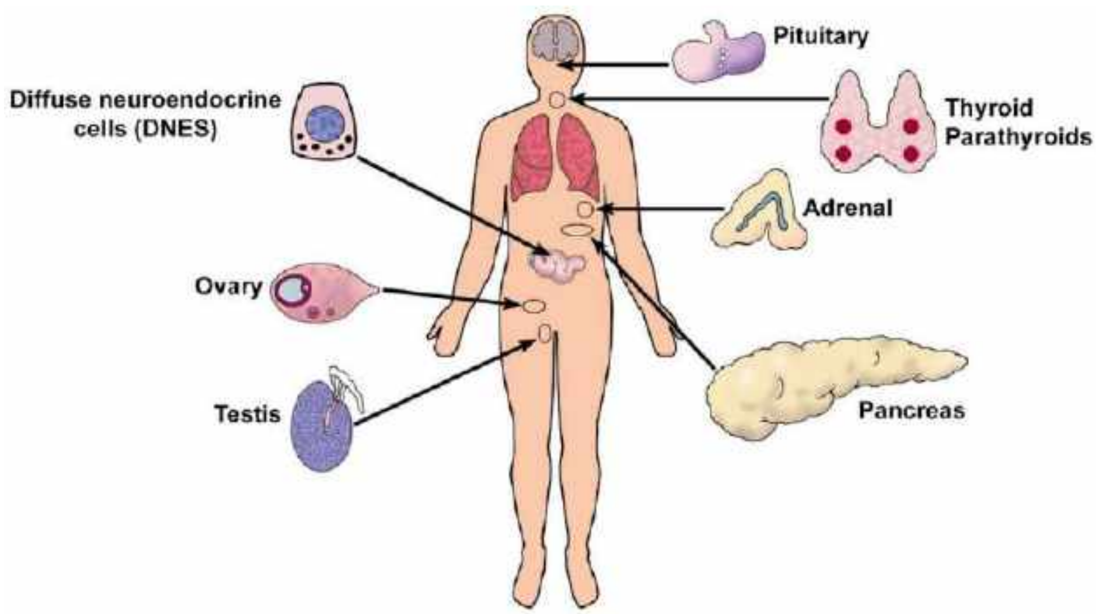

FIGURE 16.1. Components of the endocrine system.

COMPONENTS

I. Individual cells (enteroendocrine cells) ***(images)***

II. Clusters of cells

A. Islets of Langerhans (pancreas)

B. Theca interna (ovary)

C. Interstitial cells (testis)

III. Organs

A. Pituitary

B. Thyroid

C. Parathyroid

D. Adrenal

E. Pineal

HORMONE TYPES

I. Steroids and fatty acid derivatives (cortisol, testosterone)

II. Amino acid derivatives (thyroxine, epinephrine)

III. Peptides and proteins (insulin, growth hormone)

PITUITARY GLAND (HYPOPHYSIS) ***(images)***

ORIGINS OF THE PITUITARY GLAND

I. The pituitary gland consists of two different glands, the adenohypophysis and the neurohypophysis, which are derived embryologically from two distinct tissues.

   A. **Adenohypophysis**

      1. The adenophypophysis develops from a hollow evagination, **Rathke's pouch**, an outgrowth of ectoderm from the roof of the mouth

      2. Rathke's pouch loses its connection with the oral cavity and ascends toward the base of the brain where it contacts the neurohypophysis, growing down from the hypothalamus of the brain.

      3. Subdivisions

         a. **Pars distalis**. Largest subdivision; forms from the anterior wall of Rathke's pouch, constituting >95% of the adenophypophysis

         b. **Pars tuberalis***.* Forms a collar of cells around the infundibulum of the neurohypophysis.

c. **Cystic remnants of Rathke's pouch**. Small cysts persisting from the original cavity of Rathke's pouch

d. **Pars intermedia**. Forms from the posterior wall of Rathke's pouch at the interface of the adenohypophysis with the pars nervosa of the neurohypophysis; these cells also surround small cystic remnants of Rathke's pouch; this subdivision is rudimentary in humans.

B. Neurohypophysis

1. The **neurohypophysis** develops as an outgrowth from the hypothalamus of the diencephalon of the brain, and retains its connection with the brain, abutting the posterior wall of Rathke's pouch.

2. The subdivisions of the neurohypophysis consist of the **infundibulum** and the **pars nervosa**.

II. Pituitary terminology

<table>
<tr><th>Terminology based on embryonic origin</th><th>Pituitary subdivisions</th><th>Clinical terminology</th></tr>
<tr><td rowspan="3">Adenohypophysis</td><td>Pars distalis</td><td rowspan="2">Anterior lobe of pituitary</td></tr>
<tr><td>Pars tuberalis</td></tr>
<tr><td>Pars intermedia</td><td rowspan="3">Posterior lobe of pituitary</td></tr>
<tr><td rowspan="2">Neurohypophysis</td><td>Pars nervosa</td></tr>
<tr><td>infundibulum</td></tr>
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ADENOHYPOPHYSIS

I. Cell types

Hormone(s)	General Cell Type	Specific Cell Type
GH	Acidophil	Somatotrope
Prolactin	Acidophil	Mammotrope
TSH	Basophil	Thyrotrope
FSH/LH	Basophil	Gonadotrope
ACTH	Basophil	Adrenocorticotrope

A. **Chromophils**

1. **Acidophils**. Hormone-containing granules in the cytoplasm stain with acidic dyes, e.g., eosin

    a. **Somatotropes**. Secrete **somatotropin, (growth hormone, GH)** which promotes growth (anabolic)

    b. **Mammotropes**. Secrete **prolactin** which stimulates milk production

2. **Basophils**. Hormone-containing granules in the cytoplasm of these cells stain with basic dyes, e.g., hematoxylin

    a. **Thyrotropes**. Secrete **thyroid stimulating hormone (TSH)** which stimulates thyroid hormone synthesis and release

    b. **Gonadotropes**. Secrete **luteinizing hormone (LH)** and **follicle stimulating hormone (FSH)** that regulate egg and sperm maturation and sex hormone production. Both hormones are secreted in both males and females. In males LH can be referred to as **interstitial cell stimulating hormone (ICSH)**.

    c. **Adrenocorticotropes**. Secrete **adrenocorticotropic hormone (ACTH)** which regulates glucocorticoid secretion by adrenal gland

B. **Chromophobes**

1. Cells with sparse granule content that do not stain with either hematoxylin or eosin

2. May be degranulated cells or reserve, undifferentiated cells

II. Distribution of cell types in the adenohypophysis

A. Pars distalis contains all five cell types

B. Pars tuberalis contains gonadotropes only

C. Pars intermedia contains basophils; however, their secretions in humans are unclear, although ACTH secretion is a possibility.

III. Regulation of adenohypophyseal secretion

A. Adenohypophyseal hormone secretion is regulated by releasing or inhibitory factors **(neurohormones)** produced by neurons in the hypothalamus. Axons from these neurons terminate on a capillary bed located at the base of the hypothalamus in a region called the median eminence and release their neurohormones into these capillaries.

B. The capillaries anastomose into the **hypophyseal portal vessels** which travel down the infundibulum and end in a second capillary network within the adenohypophysis.

C. Hypothalamic factors exit this second capillary plexus and either stimulate or inhibit the secretion of hormones from their target acidophil or basophil cells.

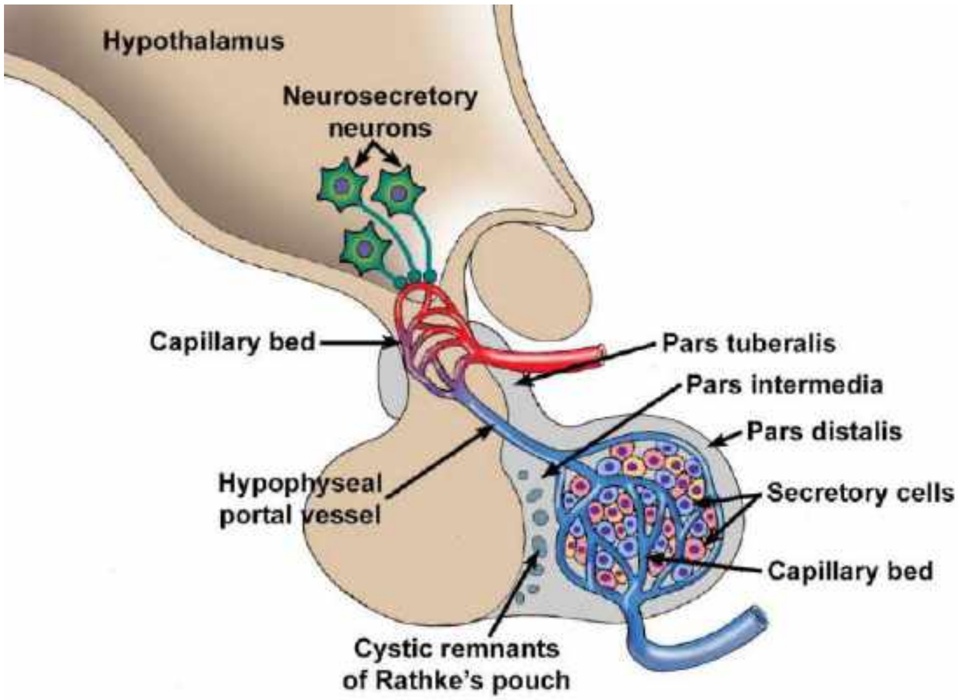


FIGURE 16.2. Structure and regulation of secretion of the adenohypophysis.

NEUROHYPOPHYSIS

I. Components

A. **Infundibulum (hypophyseal stalk)**

1. Extension from the hypothalamus; continuous with the pars nervosa

2. Contains the **hypothalamo-hypophyseal tract** which consists of axons from neurons whose cell bodies are located in the **supraoptic** and **paraventricular nuclei** of the hypothalamus

B. **Pars nervosa**

1. Contains axons and axon terminals of the neurons forming the **hypothalamo-hypophyseal tract**

2. **Herring bodies**. Expanded axon terminals which accumulate secretory granules containing oxytocin or antidiuretic hormone (vasopressin)

    a. **Oxytocin** causes smooth muscle and myoepithelial cell contraction.

    b. **Antidiuretic hormone (ADH)** acts on the kidney tubules to prevent water loss.

3. Also contains "astrocyte-like" cells, called **pituicytes**.

4. No secretory cells are present.

II. Regulation of neurohypophyseal secretion

A. Oxytocin and vasopressin are synthesized by neurons in the hypothalamus, transported down the axons and stored in axons terminals (Herring bodies) in the pars nervosa.

B. Activity in these neurons, in response to physiological signals, causes hormone release (neurosecretion) in a manner similar to release of neurotransmitters.

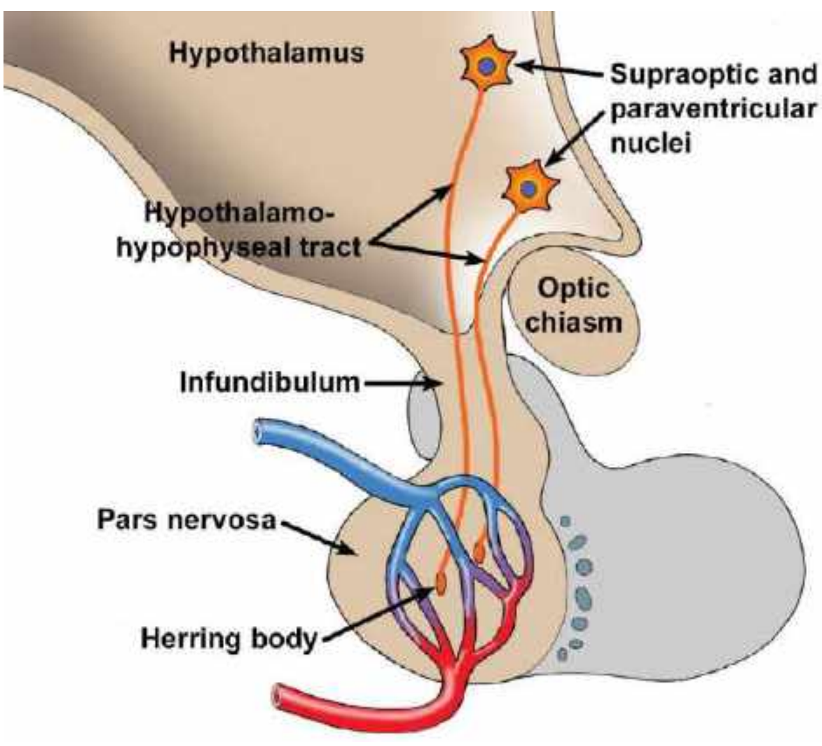


FIGURE 16.3. Structure and regulation of secretion of the neurohypophysis.

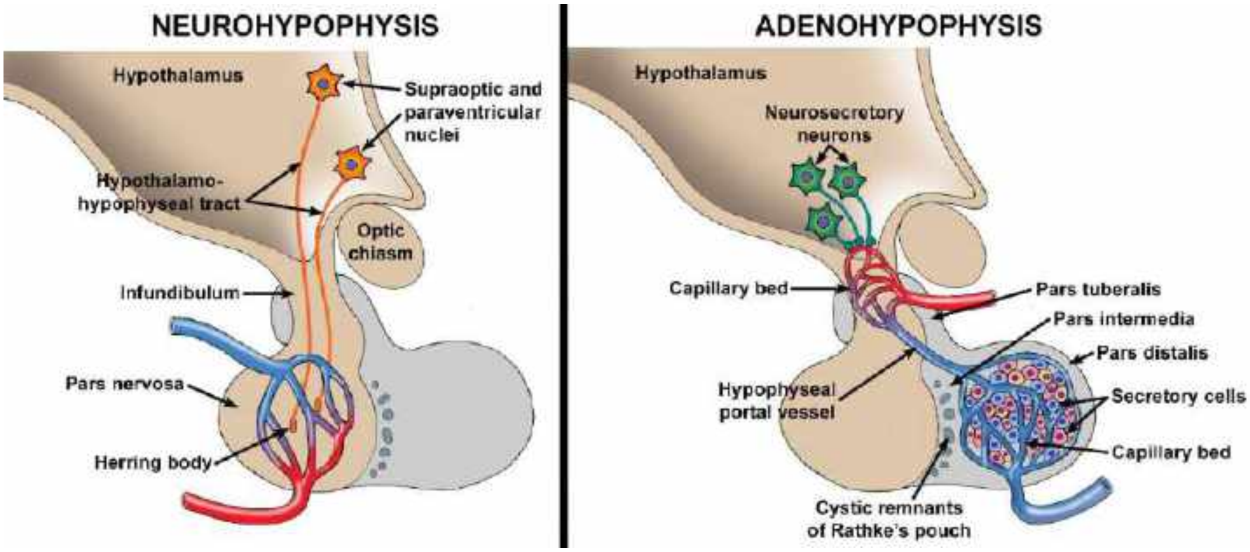


FIGURE 16.4. Comparison of the structure and regulation of secretion of pituitary gland subdivisions.

THYROID GLAND *(images)*

I. The thyroid gland consists of two unique structural and functional subdivisions, the **thyroid follicles** and **parafollicular cells**.

II. **Thyroid follicles**

A. Spherical cysts whose wall is composed of a single layer of follicle cells surrounding a center gel called colloid. Cells have apical and basal surfaces and demonstrate cellular polarity.

B. Follicle cells secrete **thyroglobulin**, a glycoprotein that is stored as colloid in the center of the follicle. The thyroid gland is the only endocrine organ that stores a hormone. When needed, these same follicular cells take up the stored thyroglobulin, transport it across the epithelium and release thyroid hormones into the capillaries surrounding the follicle.

C. Thyroglobulin contains modified tyrosine amino acids that constitute the thyroid hormones, **thyroxine (tetraiodothyronine, T_4)** and **triiodothyronine (T_3)**.

D. Thyroid hormones regulate the basal metabolic rate.

E. The secretion of T_3 and T_4 is controlled by TSH released from the adenohypophysis.

III. **Parafollicular cells (C cells, clear cells)**

A. Are located within the follicular epithelium and in small clusters between follicles

B. Possess secretory granules containing the hormone **calcitonin**, which acts to inhibit bone resorption, lowering blood calcium levels.

C. Belong to the **diffuse neuroendocrine system (DNES)**

D. The secretion of calcitonin is controlled by calcium levels in the blood.

SYNTHESIS AND RELEASE OF THYROID HORMONES

I. Follicle cells synthesize and secrete thyroglobulin from their apical surfaces into the follicle lumen where it is stored. The follicle lumen is an extracellular compartment and, thus, secretion of thyroglobulin constitutes the exocrine secretion of the follicle cells and accounts for the polarity of the cells.

II. The tyrosines of thyroglobulin are iodinated in the follicle lumen and rearranged to form the thyroid hormones (T_3 and T_4), which are modified tyrosines that are retained in the primary structure of thyroglobulin.

III. The iodinated thyrogobulin is resorbed by pinocytosis into the follicle cells where it is hydrolyzed, liberating T3 and T4.

IV. T_3 and T_4 are released from the basolateral surfaces of the follicle cell and enter the blood stream.

V. Active and inactive follicles

A. **Active follicle***.* Follicle cells are cuboidal to columnar and are involved with both secretion and resorption of thyroglobulin.

B. **Inactive follicle***.* Follicle cells are squamous, reflecting the paucity of secretory organelles and the lack of synthetic and uptake activity.

PARATHYROID GLANDS ***(images)***

I. The **parathyroid glands** are four small, spherical glands that are embedded in the posterior surface of the thyroid gland.

II. Cell types

A. **Chief cell**

1. Major cell type, arranged in cords or clumps

2. Small polyhedron-shaped cells with secretory granules visible only with electron microscope

3. Secrete **parathyroid hormone (PTH)** which increases blood calcium levels, through increased osteoclast activity

4. The secretion of PTH is controlled by calcium levels in the blood.

B. **Oxyphil cell**

1. Large cell may appear singly or in clumps

2. Heterochromatic nucleus and abundant eosinophilic cytoplasm, due to numerous mitochondria

3. No secretory granules

4. Function is unclear.

ADRENAL GLANDS ***(images)***

I. Structure

A. Paired glands, each located at the superior pole of a kidney; consist of two distinct subdivisions with different embryological origins

B. Subdivisions

1. **Cortex***.* Derived from mesoderm and constitutes the major steroid-producing gland

2. **Medulla***.* Derived from neural crest and is a major source of epinephrine and norepinephrine neurohormones

C. Surrounded by a dense **capsule**

II. Cortex

A. Composed of steroid-secreting cells, whose features include:

1. Abundant smooth endoplasmic reticulum

2. Mitochondria with **tubular cristae** in the zona fasciculata and the zona reticularis; **shelf-like cristae** in the zona glomerulosa

3. Numerous lipid droplets filled with cholesterol, precursor for steroid hormones

4. Secretion is by diffusion with no hormone storage.

B. Zonation

1. **Zona glomerulosa**

   a. Located immediately beneath the capsule

   b. Cells arranged in round clusters

   c. Secretes **mineralocorticoids, e.g., aldosterone**

2. **Zona fasciculata**

   a. Middle layer, largest cortical zone

   b. Cells arranged in rows perpendicular to the capsule alternating with wide-diameter, fenestrated capillaries

   c. Secretes **glucocorticoids** and **androgens**

   d. The secretion of glucocorticoids is controlled by ACTH released from the adenohypophysis.

3. **Zona reticularis**

   a. Forms deepest layer of the cortex

   b. Cells arranged as anastomosing cords

   c. Same secretions as zona fasciculata, **glucocorticoids** and **androgens**

III. Medulla

A. Composed of **chromaffin cells**

1. Modified adrenergic neurons without axons or dendrites; represent sympathetic ganglion cells

2. Polyhedral cells containing abundant dense-core, secretory granules

B. Chromaffin cells synthesize and release epinephrine and norepinephrine, which are routinely released in small quantities. Under stress, the autonomic nervous system stimulates greater production and release.

PINEAL GLAND (EPIPHYSIS CEREBRI) ***(images)***

I. Structure

A. Small conical-shaped gland; develops from the roof of the diencephalon and remains attached by a short pineal stalk

B. Surrounded by a **capsule** composed of **pia mater**

1. Connective tissue septa derived from the pia mater penetrate the gland and subdivide it into indistinct lobules.

2. Sympathetic axons and blood vessels enter the gland with the septa.

C. Cells

1. **Pinealocytes**

a. Major cell type, represent modified neurons

b. Euchromatic nucleus, spherical to ovoid, with a prominent nucleolus

c. Cytoplasm not evident with conventional stains; however, silver staining reveals that the cell generally has two or more extensions similar to neuronal processes.

d. Processes end in association with capillaries.

e. Secrete **melatonin**, an indoleamine hormone

2. **Interstitial cells**

a. Minor cell type, similar to astrocytes in the brain

b. Nucleus is elongated and more heterochromatic than that of pinealocytes.

c. Possess long processes with intermediate filaments

d. Located among groups of pinealocytes and in the connective tissue septae

D. **Corpora araneacea ("brain sand")**

1. Globular, basophilic accumulations of calcium phosphates and carbonates in the interstitial space

2. Radio-opaque in X-ray images and, thus, often used as indicators of

midline deflection of the brain resulting from pathological conditions

II. Secretion

A. Major hormone secreted is melatonin which regulates diurnal (circadian) light-dark cycles and seasonal rhythms.

B. Melatonin is secreted during darkness; secretion is inhibited by light.

C. Retinal stimulation by light is relayed to the pineal via sympathetic innervation from the superior cervical ganglion.

CHAPTER 19

EYE

GENERAL CONCEPTS

I. The eyes are complex photoreceptive organs located in the bony orbits of the skull. Movement of the eye is accomplished by a set of extrinsic ocular muscles, which insert on the outer surface of the globe.

II. Each eye consists of image-forming structures, a photoreceptive retina, and a fibrous globe to provide support.

III. The eye is protected by an eyelid, a moveable fold of skin that covers the anterior surface of the globe.

EYELID *(images)*

I. Protective covering of the eye.

II. Components

A. Covered on its outer surface by thin skin that possesses eyelashes at the margin of the eyelid

B. **Tarsal plate**. Region of dense fibrous and elastic connective tissues within the eyelid that provide support

C. Contains the **obicularis oculi muscle**

D. **Meibomian glands**. Specialized sebaceous glands embedded in the tarsal plate, whose secretions add to the tear film to reduce evaporation

E. **Palpebral conjunctiva**. Lines the inner surface, consisting of a stratified columnar epithelium with goblet cells; the conjunctiva is reflected onto the globe as the bulbar conjunctiva, which is continuous with the **corneal epithelium**.

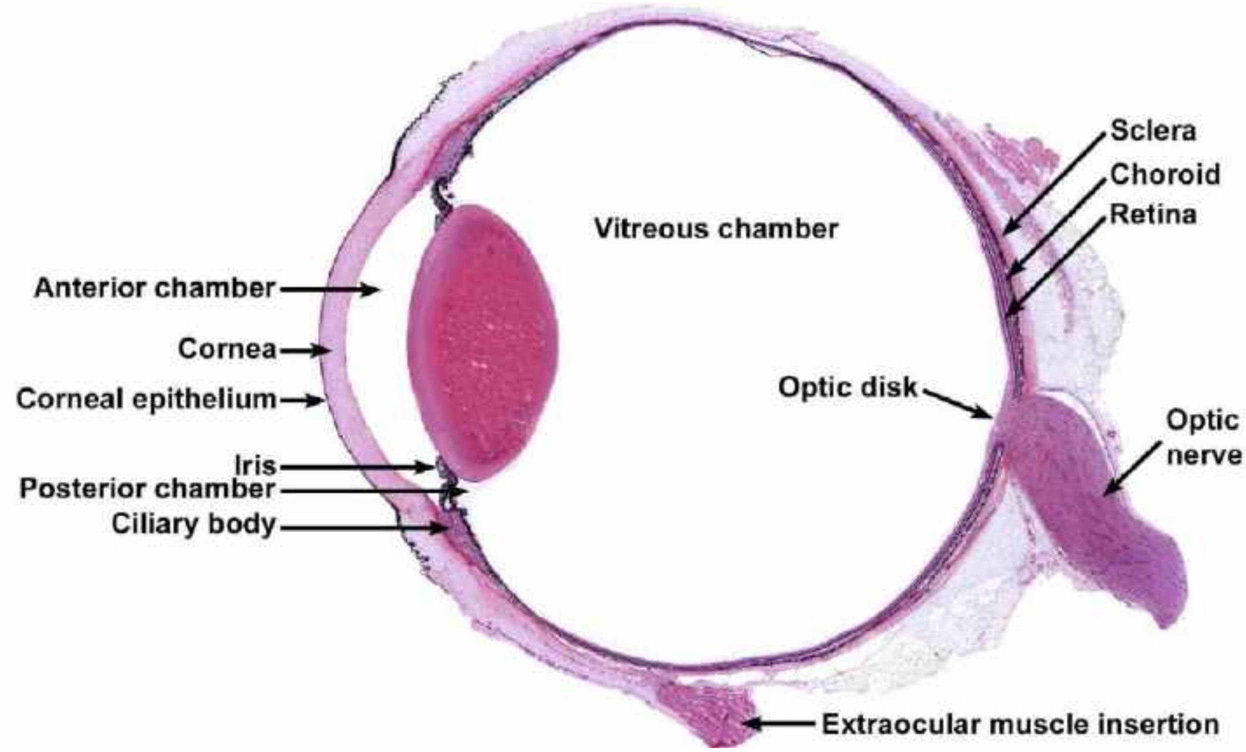


FIGURE 19.1. Midsagittal section of the eyeball.

EYEBALL (GLOBE) *(images)*

I. Composed of three layers or tunics

A. **Fibrous tunic** consisting of the sclera and cornea

B. **Vascular tunic or uveal tract** consisting of the iris, ciliary body, and choroid

C. **Neural tunic** consisting of the retina

II. Contains three chambers

A. **Anterior chamber** is the space between the cornea and the iris, filled with *aqueous humor* fluid.

B. **Posterior chamber** lies between the iris anteriorly and the lens, ciliary body, and zonule fibers posteriorly; filled with aqueous humor

C. **Vitreous chamber** is located behind the lens and is filled with a gelatinous substance called the **vitreous body**.

FIBROUS TUNIC OF THE EYE (OUTER TUNIC)

I. **Sclera**

A. Opaque layer composed of dense, irregular connective tissue; forms the outer layer of the posterior four-fifths of the globe

B. Gives shape and provides support for the globe

C. Provides insertion points for extraocular muscles

II. **Cornea**

A. Anterior continuation of the sclera, covering the anterior one-fifth of the eye

B. Transparent and avascular; transparency results from the ordered arrangement of its collagen fibers and low state of tissue hydration.

C. Convex curvature aids in focusing light (refraction).

D. Layers (anterior to posterior)

1. **Corneal epithelium**. Covers the anterior surface of the cornea; composed of a moist, stratified squamous epithelium that is continuous with the bulbar conjunctiva at the *limbus*

2. **Bowman's membrane**. Acellular collagenous layer beneath the corneal epithelium

3. **Stroma**. Multiple layers of parallel collagen fibers constitute the majority of the cornea. The collagen fibers in each layer are arranged at about right angles to adjacent layers. The highly ordered arrangement of these fibers contributes to the transparency of the cornea.

4. **Descemet's membrane**. Thickened basal lamina of the corneal endothelium

5. **Corneal endothelium**. Simple squamous epithelium covering the posterior surface of the cornea; regulates the hydration state of the stroma

III. **Corneo-scleral junction (limbus)**

A. Transition zone between the cornea and the sclera

B. Bowman's membrane ends and the corneal epithelium thickens at this junction.

C. **Trabecular meshwork***.* Irregular channels in the stroma that are lined by endothelium. Drains the aqueous humor from the anterior chamber to maintain proper intraocular pressure. The channels of the trabecular meshwork merge to form the **canal of Schlemm***,* a ring-like sinus that encircles the limbus and drains into the venous system.

VASCULAR TUNIC (UVEAL TRACT) OF THE EYE (MIDDLE TUNIC)

I. **Choroid**

A. Highly vascular, cellular layer lying inside the sclera; this layer is richly pigmented due to its large number of **melanocytes***.* Its inner portion is the **choriocapillary layer***,* which contains large numbers of small vessels and capillaries and serves a nutritive function for the retina.

B. **Bruch's membrane***.* A thin layer separating the retina from the chori-ocapillary layer; represents the combined basal laminae of the capillary endothelium and the pigment epithelium of the retina and an intervening network of elastic and collagen fibers

II. **Ciliary body**

A. Anterior expansion of the choroid forming a ring that encircles the lens; appears triangular in cross-section

B. Composed of a core of connective tissue and muscle; lined on its vitreal surface by two layers of columnar cells, an inner pigmented epithelium and an outer layer of non-pigmented cells. These two layers of columnar cells form the non-sensory retina and represent the attenuated anterior part of the sensory layer of the retina.

C. **Ciliary processes**

1. Ridge-like extensions from the ciliary body

2. **Zonule fibers***.* Emerge from between the processes and attach to the lens capsule

3. The aqueous humor is produced by the epithelium of the ciliary processes.

D. **Ciliary muscles***.* Smooth muscle fibers that insert on the sclera and ciliary body; contraction of circularly arranged fibers releases tension on the **zonule fibers**, allowing the lens to assume a more spherical shape, thus providing for focusing on near objects (**accommodation**). Contraction of radially oriented smooth muscle fibers results in flattening of the lens, thus providing for focusing on far objects.

III. **Iris**

A. Disc-shaped structure that arises from the anterior margin of the ciliary body; separates anterior and posterior chambers and partially covers the lens

B. Composed of loose connective tissue that is covered on its anterior surface by an incomplete layer of pigment cells and fibroblasts. Its posterior surface is covered by a double layer of pigmented epithelial cells.

C. **Pupil**. Central opening in the iris; its diameter is regulated by contraction of two sets of intrinsic smooth muscle in the iris.

1. **Dilator pupillae muscle**. Derived from the more anterior, pigmented epithelial layer; consists of radially oriented cells whose contraction widens the aperture of the pupil

2. **Constrictor pupillae muscle**. Consists of circularly oriented smooth muscle fibers surrounding the pupil; contraction of these fibers decreases the diameter of the pupil.

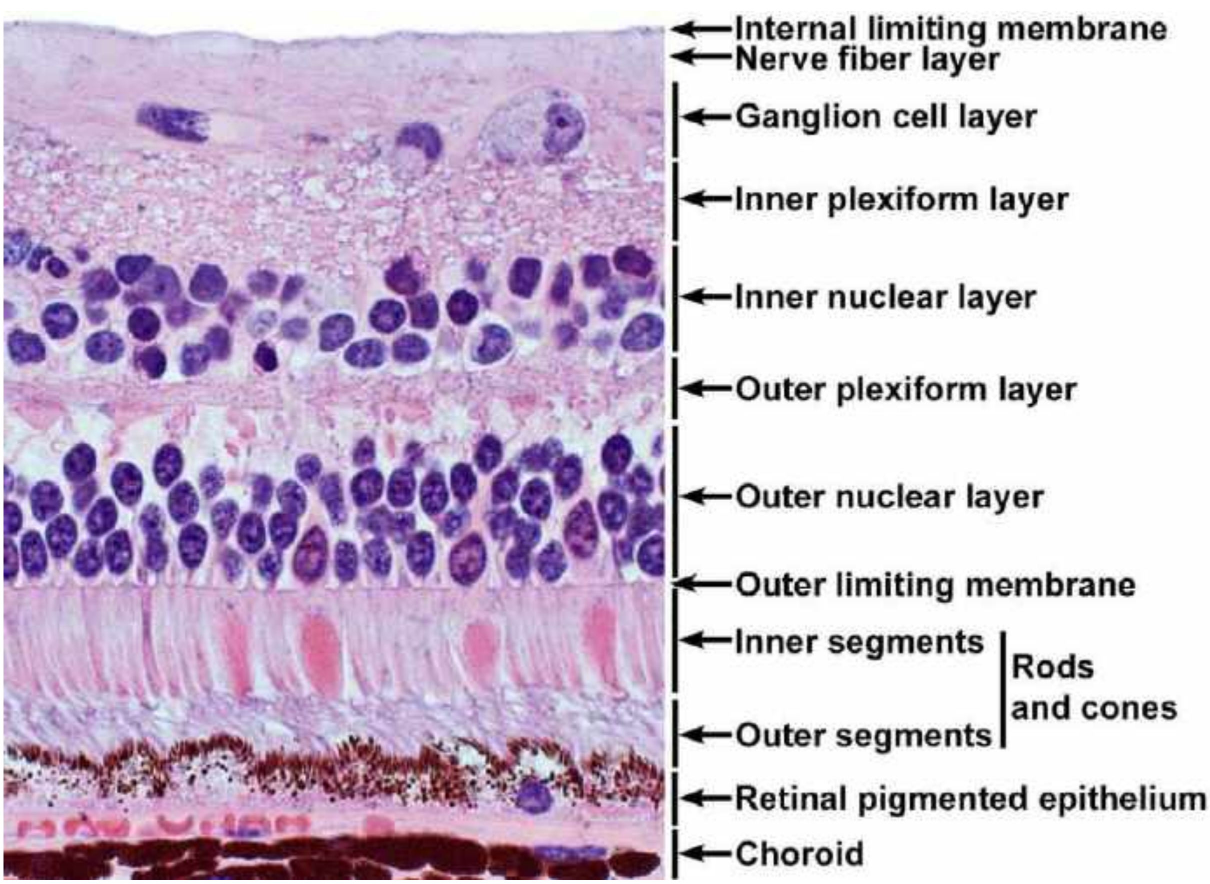


FIGURE 19.2. Layer of the retina

RETINA - INNER TUNIC ***(images)***

I. Inner-most of the three layers, forming a cup-shaped structure. The posterior portion is photosensitive and extends forward to the ciliary body, terminating as the **ora serrata**. The nonphotosensitive anterior portion is reduced in thickness and number of layers and forms the posterior lining of the ciliary body and the posterior lining of the iris.

II. The photosensitive portion contains the photoreceptors, which transduce light into nervous impulses, and neurons, which perform the initial integration of the visual signals.

III. Overview of retinal cytoarchitecture

   A. Basic plan of the **retina** consists of a three-cell pathway

      1. **Rods** and **cones**. Photoreceptors that transduce light energy into neural activity and form the **photoreceptor layer**; their nuclei are located in the **outer nuclear layer**.

      2. **Bipolar cells**. Synapse with rods and cones; nuclei are located in the **inner nuclear layer**.

      3. **Ganglion cells**. Synapse with bipolar cells; cell bodies are located in the **ganglion cell layer**; axons from these cells form the **optic nerve fiber layer** as they pass toward the **optic disc**, head of the optic nerve.

   B. Regions of synaptic integration

      1. **Outer plexiform layer**. Location of synapses of rods and cones with bipolar cells

      2. **Inner plexiform layer**. Location of synapses of bipolar cells and ganglion cells

IV. Layers of the retina–from outer to inner

   A. Composed of 10 layers. The naming of the layers is based on their position relative to the path of neural conduction (from outer to inner), not the path of light (from inner to outer).

   B. **Pigment epithelium**

      1. Cytoplasm contains numerous **melanin granules** to absorb light and reduce reflection

      2. Columnar epithelial cells with apical microvilli whose bases are adherent to

Bruch's membrane

3. Cells form a cylindrical sheath that surrounds the apical tips of the photoreceptors; these sheaths aid in phagocytosis and digestion of membranous discs shed by the photoreceptors.

C. **Photoreceptor layer**

1. Composed of rods and cones

2. Rods are sensitive to low light intensity, outnumber cones and are located throughout the retina

3. Cones are less numerous than rods, sensitive to high intensity light and respond to color. Cones provide greater visual acuity and are concentrated in the **fovea centralis**.

4. **Outer segment**. Contains flattened, membranous discs that contain the visual pigments rhodopsin (rods) and iodopsins (cones).

5. **Inner segment**. Separated from the outer segment by a constriction, contains the major synthetic and energy-producing organelles.

D. **External limiting membrane**. Not a true membrane; formed by adherent junctions of Mueller cells, modified astrocytes, with the photoreceptors

E. **Outer nuclear layer**. Location of the nuclei of rods and cones

F. **Outer plexiform layer**. Region of synaptic contacts between photoreceptor axons and bipolar cell dendrites

G. **Inner nuclear layer**. Location of cell bodies of bipolar cells. Also present are additional neurons, amacrine and horizontal cells.

H. **Inner plexiform layer**. Location of synaptic contacts between bipolar cell axons and ganglion cell dendrites.

I. **Ganglion cell layer**. Location of cell bodies of ganglion cells

J. **Optic nerve fiber layer**. Layer formed by the unmyelinated axons of the ganglion cell axons that pass toward the **optic disc**, the head of the optic nerve, where they exit to form the **optic nerve** (cranial nerve II).

K. **Internal limiting membrane**. Formed by the basal portions of Mueller cells

V. **Fovea centralis**. Region of the retina providing greatest visual acuity, consists entirely of cones; other retinal layers are displaced centrifugally to allow for an unimpeded path for the light to reach the photoreceptors.

VI. **Optic disc** ("blind spot"). Region composed only of axons from retinal ganglion cells as they exit from the retina through the sclera to form the optic nerve

LENS ***(images)***

I. Biconcave, transparent, and elastic

II. Suspended by radially oriented zonule fibers that extend from the ciliay body to insert into the lens capsule

III. Structure of the lens

A. **Lens capsule***.* A thickened basal lamina, produced by the subcapsular epithelium, surrounds the entire lens.

B. **Subcapsular epithelium***.* Simple cuboidal epithelium, present only on the anterior surface of the lens; apical surfaces of the cells are directed toward the center of the lens.

C. **Lens fibers***.* Derived from cells of the subcapsular epithelium primarily in the equatorial region of the lens; lens fibers are highly differentiated cells that lose their organelles and become filled with crystallin proteins.

IV. Contraction of the circularly arranged ciliary muscle releases tension on the zonule fibers, allowing the lens to assume a more spherical shape which provides for focusing on near objects (accommodation). Contraction of the radially oriented ciliary muscles causes the lens to flatten for focusing on distant objects.

CHAPTER 20

EAR

COMPONENTS ***(images)***

I. **External ear**. Receives sound waves, transmitting them to the tympanic membrane

II. **Middle ear**. Transmits movement of the tympanic membrane by three ear ossicles to fluid in the inner ear

III. **Inner ear**. Contains a receptor that responds to these fluid vibrations for the perception of sound. Additional receptors in the inner ear respond to the effects of gravity and motion of the head to maintain equilibrium.

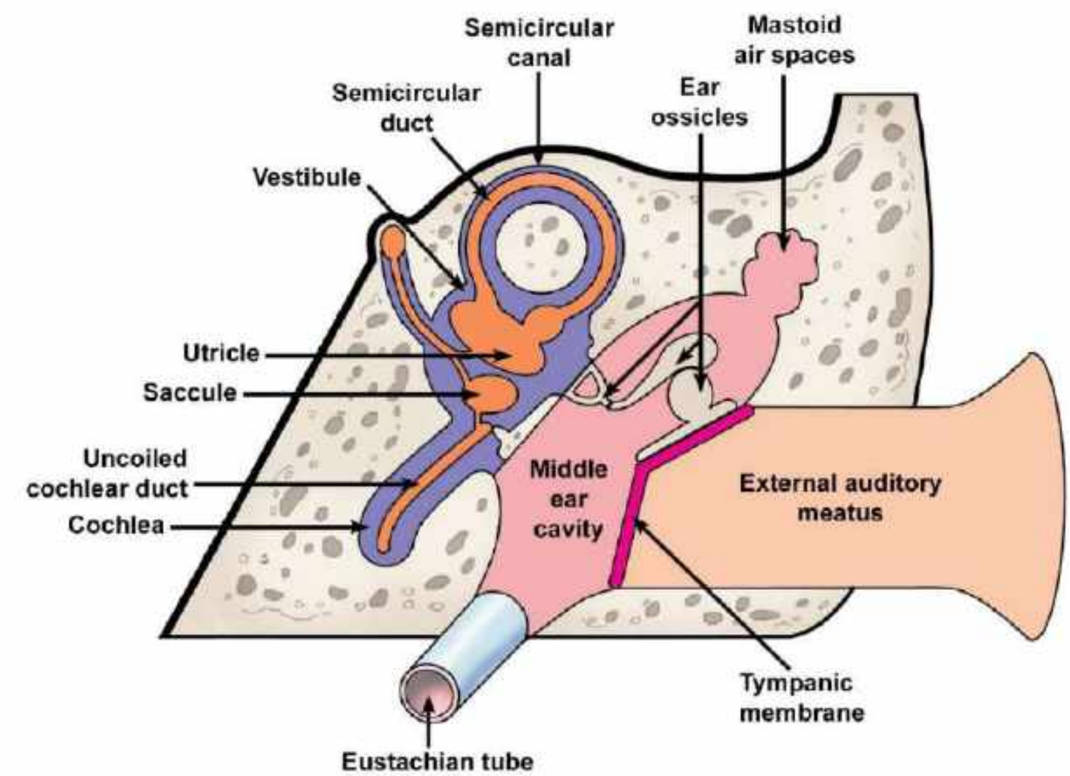


FIGURE 20.1. Schematic illustration of the three subdivisions of the ear embedded in the temporal bone.

EXTERNAL EAR ***(images)***

I. **Auricle** or **pinna**. Shallow appendage on the lateral surfaces of the head that is formed by thin skin covering a framework of elastic cartilage

II. **External auditory meatus**. Short tube leading to the tympanic membrane

A. The thin skin, lining the meatus, possesses ceruminous glands. Their secretions combine with those of adjacent sebaceous glands to form cerumen, a thick, waxy product.

B. Support provided by:

1. Elastic cartilage in the outer portion

2. Temporal bone in the inner portion

III. **Tympanic membrane** (ear drum) separates external from the middle ear.

A. Composition (from exterior to interior). Thin skin, two layers of collagen and elastic fibers with radial then circular arrangements, and a mucous membrane that is continuous with that lining the middle ear

B. Attachment of the malleus, an ear ossicle, to the inner surface pulls the tympanic membrane into a flattened, cone shape.

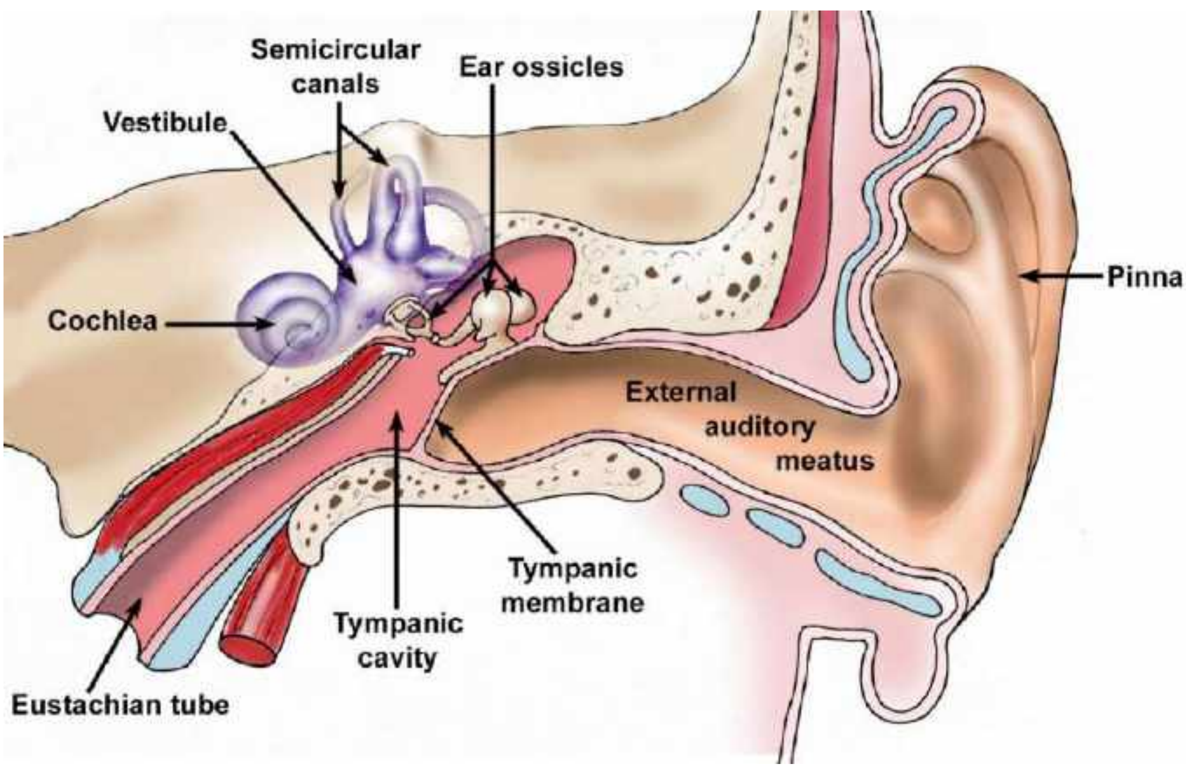


FIGURE 20.2. Coronal section through the skull showing the three subdivisions of the ear in the temporal bone.

MIDDLE EAR (TYMPANIC CAVITY) ***(images)***

I. The **middle ear** or **tympanic cavity** is a cavity within the temporal bone that is bounded by the tympanic membrane laterally and the bony wall of the inner ear medially. It communicates with the mastoid air cells posteriorly, and with the nasopharynx, via the Eustachian tube, anteriorly.

II. Structure

A. Lined by a mucous membrane whose epithelium is predominately simple squamous

B. Ear ossicles, small bones, transmit vibrations from the tympanic membrane to the inner ear.

1. Components

a. **Malleus***.* Attached to the tympanic membrane

b. **Incus***.* Interconnects malleus with stapes

c. **Stapes***.* Footplate of the stapes fits into the oval window of the inner ear

2. Ossicles are connected to each other by ligaments and are covered with mucosa.

3. Small muscles attached to malleus (**tensor tympani**) and stapes (**stapedius**) modulate vibrations of these ossicles.

C. **Eustachian tube** (auditory tube)

1. Connects middle ear with the nasopharynx

2. Is lined by a mucous membrane whose epithelium becomes pseudostratified near the nasopharynx. Cilia associated with this epithelium beat toward the pharynx.

3. Is supported first by bone and then by cartilage and fibrous tissue as it nears the nasopharynx

4. Is usually collapsed but opens during swallowing to equilibrate air pressure

D. **Oval window** and **round window**

1. Openings in the petrous portion of the temporal bone that forms the medial wall of the middle ear

2. The oval window is occupied by the footplate of the stapes.

3. The round window is covered by a membrane that bulges to relieve pressure in the cochlea that originates from motion of the stapes at the oval window.

E. **Mastoid air spaces**, located in the mastoid process of the temporal bone, communicate posteriorly with the middle ear.

INNER EAR *(images)*

I. The **inner ear** is located in the **petrous portion of the temporal bone**.

II. Components

A. **Osseous labyrinth**. Series of interconnected tubular and cavernous spaces in the petrous portion of the temporal bone that are lined with periosteum and filled with perilymph fluid

1. **Vestibule**. Centrally located chamber; communicates with middle ear via the oval window

2. **Semicircular canals**

a. Are three tubular spaces that communicate with and lie posterolaterally to the vestibule

b. Are oriented in three mutually perpendicular planes

c. An enlargement at one end of each canal, adjacent to the vestibule, houses the ampulla of the semicircular ducts.

3. **Cochlea**. An osseous tube that connects with and lies anteromedially to the vestibule

a. Tube is coiled into a spiral shape with 2.5 turns, resembling a snail shell.

b. The tube's spiraling in the temporal bone results in the formation of a central, bony axis for the cochlea called the **modiolus**, which resembles a screw. The threads of the screw project into the cochlea and are called the **osseous spiral lamina**.

c. The modiolus houses the cochlear division of **cranial nerve VIII** and its sensory ganglion, the **spiral ganglion**.

B. **Membranous labyrinth**. Series of interconnected ducts and chambers that are suspended within the osseous labyrinth. Contain the fluid, endolymph. These ducts and chambers contain receptors for hearing and for static and kinetic senses.

1. **Utricle** and **saccule**. Suspended within the vestibule. A receptor, the **macula**, in each of these two chambers responds to stimuli of linear acceleration and gravitational forces.

2. **Semicircular ducts** (three). One duct is suspended in each of the semicircular canals; both ends of each duct connect with the utricle. An enlargement, the **ampulla**, at one end of each duct is located in the enlargement of each semicircular canal and contains a receptor, the **crista ampullaris**, for angular acceleration.

3. **Cochlear duct**. Located in the center of the cochlea. The cochlear duct communicates indirectly with the saccule. The receptor in the cochlear duct, the **organ of Corti**, responds to sound vibrations.

4. **Endolymphatic duct**. Formed by union of small ducts from the utricle and saccule; extends toward the brain where it terminates as an enlargement, the endolymphatic sac, between layers of the meninges. Probably functions to absorb **endolymph**.

C. Sensory innervation is provided by **cranial nerve VIII, the vestibulocochlear nerve**.

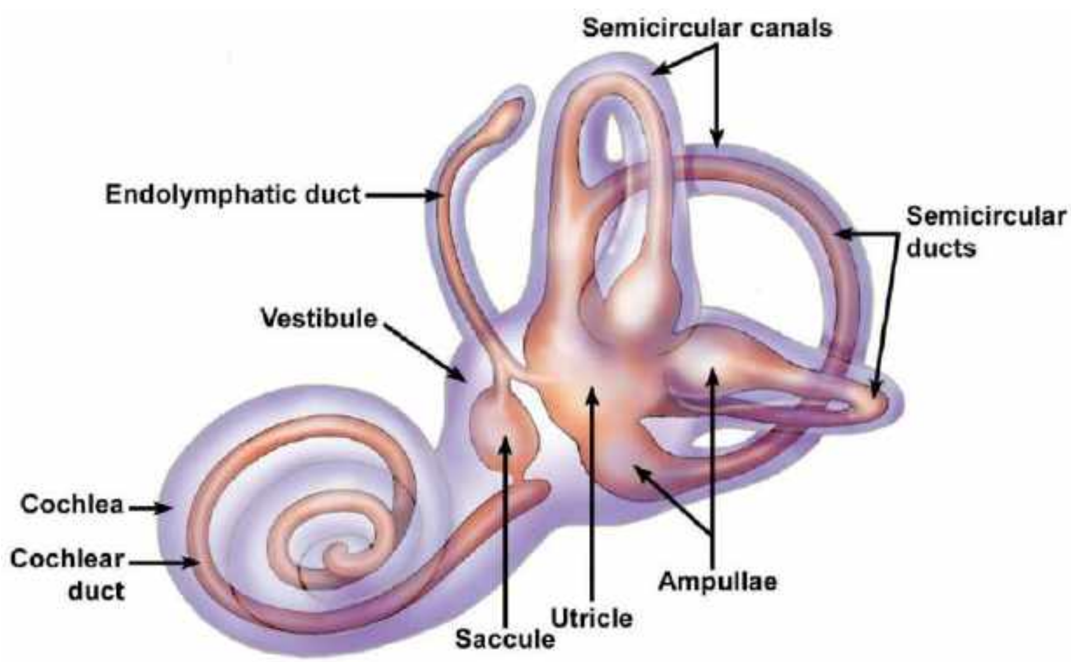


FIGURE 20.3. Inner ear: the membranous labyrinth is suspended in the osseous labyrinth.

III. **Utricle** and **saccule**

A. Portions of the membranous labyrinth that are connected to each other and are suspended in the osseous vestibule

B. **Macula**. Receptor in both the utricle and saccule

1. Thickening in the wall of the utricle and saccule composed of:

a. **Supporting cells**

b. **Hair cells** with stereocilia and a cilium (**kinocilium**) that are embedded in the gelatinous layer

c. **Gelatinous layer** is produced by supporting cells and covers both these and the hair cells.

d. **Otoliths** (**otoconia**). Calcium carbonate crystals that are suspended at the top of the gel

2. Linear acceleration and the force of gravity displace the otoliths, stimulating the stereocilia and kinocilia and initiating a neural, sensory impulse in the vestibular division of cranial nerve VIII.

IV. **Semicircular ducts** (three)

A. Portions of the membranous labyrinth suspended in the osseous semicircular canals; both ends of each semicircular duct connect to the utricle.

B. **Crista ampullaris**. Receptor in the ampullary enlargement of each semicircular duct

1. Ridge-like structure that lies perpendicular to the long axis of each duct. Internal cell structure is similar to that of a macula except:

a. Gelatinous layer, called the **cupula**, is shaped like a cone and extends across the ampulla to the opposite wall, thus spanning the duct.

b. Otoliths are absent.

2. Angular acceleration displaces the cupula that deflects the stereocilia and kinocilia and initiates a neural, sensory impulse in the vestibular division of cranial nerve VIII.

3. Orientation in three distinct planes allows for complex detection of motion.

V. **Cochlear duct**

A. Wedge-shaped duct of the membranous labyrinth suspended in the middle of the tubular, osseous cochlea. Position of the cochlear duct separates the bony cochlea into three subdivisions.

1. **Scala vestibuli***.* This subdivision of the cochlea is continuous with the vestibule and lies above the cochlear duct, separated from it by the vestibular membrane.

2. **Cochlear duct***.* Contains the receptor for sound. The cochlear duct is located in the middle of the cochlea and is continuous with the saccule through a small duct. Its roof is the vestibular membrane separating it from the osseous scala vestibuli. Its floor is formed by the basilar membrane that is continuous with the osseous spiral lamina; both separate the cochlear duct from the scala tympani.

3. **Scala tympani***.* Subdivision of the bony cochlea lying beneath the cochlear duct. The scala tympani is continuous with the scala vestibuli at the **helicotrema***,* located at the tip of the cochlea. The scala tympani terminates at the round window where pressure on the perilymph in this scala, initiated at the oval window and transported through scala vestibuli to scala tympani, is released.

B. **Organ of Corti***.* Receptor for sound in the cochlear duct; positioned on the floor of the cochlear duct, resting on the basilar membrane

1. Structure

a. **Supporting cells***.* Several varieties, including pillar cells that form the boundary of a triangular space called the inner tunnel. Provide support for the hair cells, among other functions.

b. Inner and **outer hair cells***.* Receptor cells located on either side of the inner tunnel possess stereocilia that are embedded in the tectorial membrane.

c. **Tectorial membrane***.* This gelatinous membrane extends over the hair cells and is secreted by the cells of the spiral limbus, resting on the osseous spiral lamina. Stereocilia of the hair cells are embedded in the tectorial membrane.

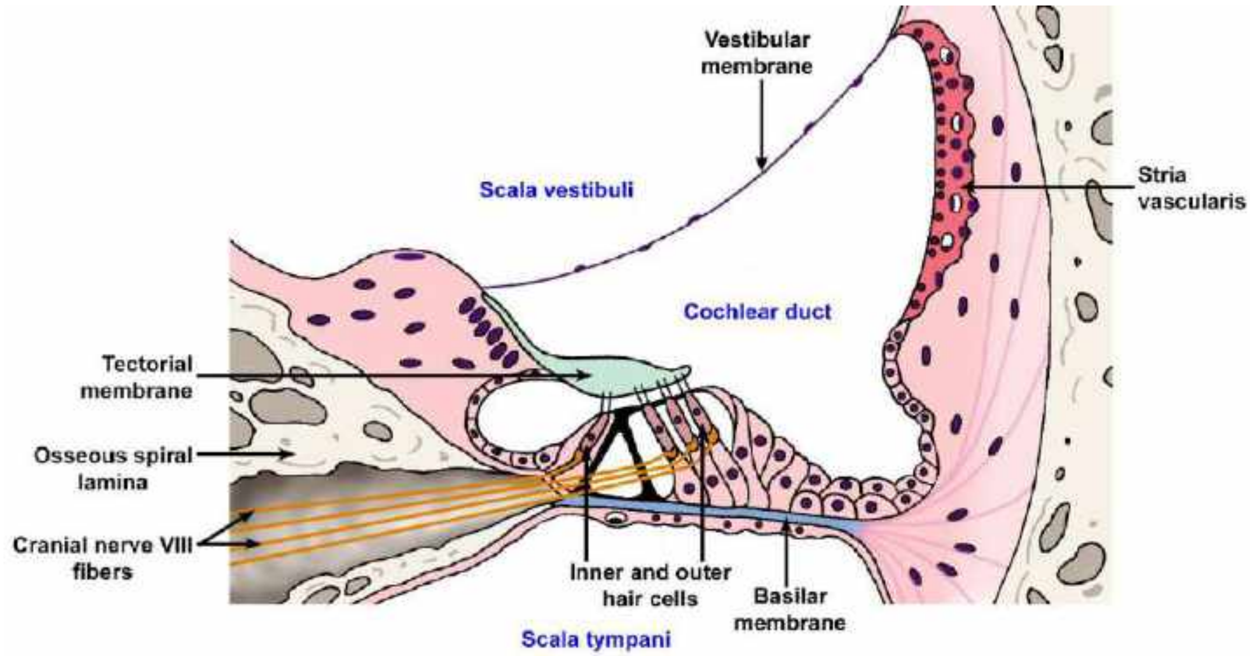


FIGURE 20.4. Cochlear duct, the receptor for sound, is a part of the membranous labyrinth in the inner ear.

2. Functions to discriminate sound

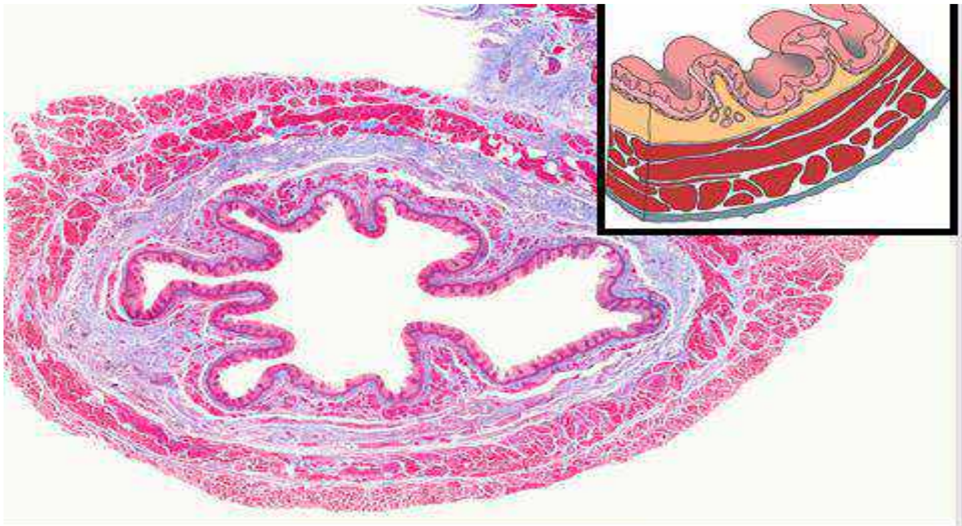
    a. Inward movement of the stapes at the oval window generates pressure on the perilymph in the vestibule that is transmitted into the scala vestibuli.

    b. From the scala vestibuli, pressure is conducted, by deflection of the vestibular membrane, to the endolymph of the cochlear duct and to the basilar membrane. Movement of the basilar membrane into scala tympani and away from the tectorial membrane causes a shearing force on the stereocilia embedded in this membrane and initiates a neural, sensory response in the cochlear division of cranial nerve VIII.

    c. Sound vibrations in the scala vestibuli also continue into the scala tympani at their junction at the **helicotrema**.

    d. Sound vibrations in scala tympani are relieved by the bulging of the round window into the middle ear.

3. **Stria vascularis** is a vascularized epithelium located on the outer wall of the cochlear duct that produces endolymph.

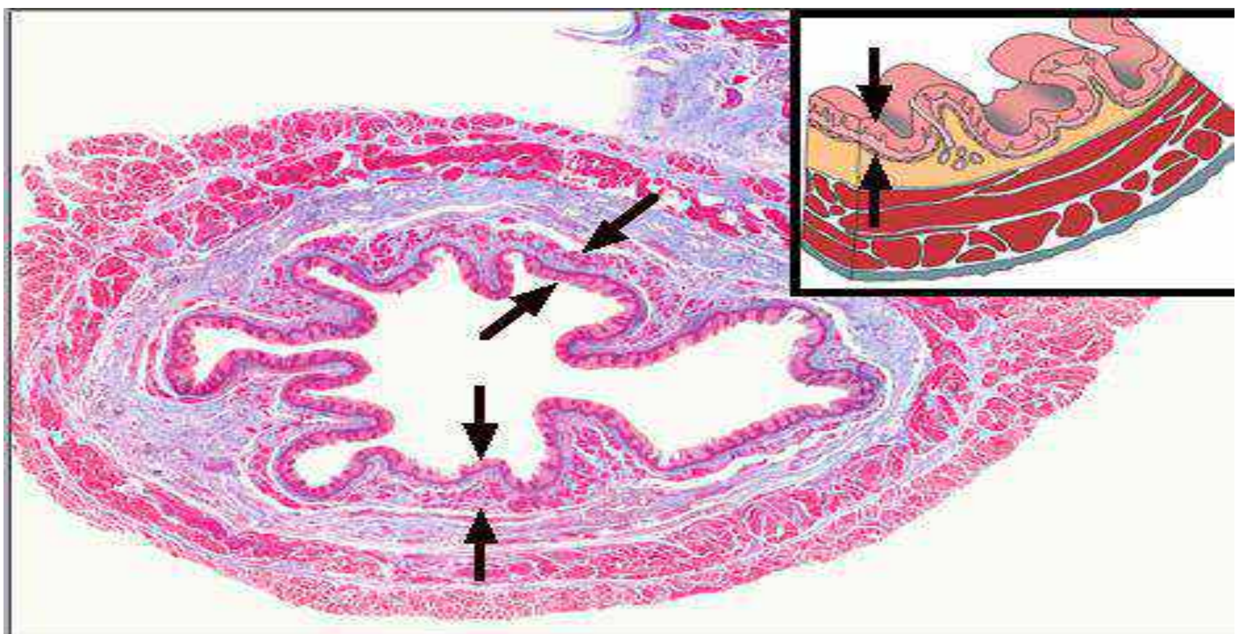


click to identify:

Mucosa >
Submucosa >
Muscularis >
externa
Skeletal muscle
Smooth muscle
Adventitia >

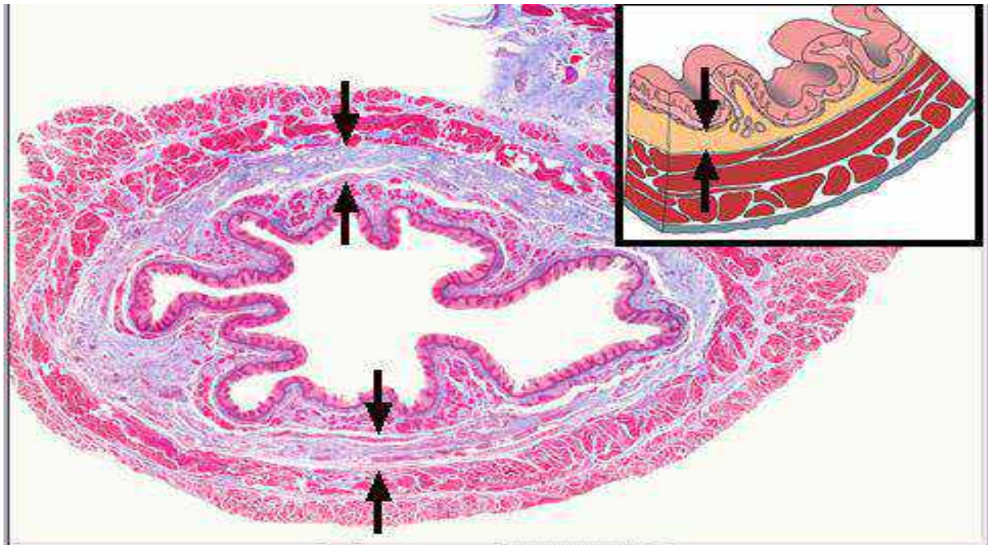
1 of 10

Esophagus: overview -- The esophagus is a muscular tube transporting partially digested food from the pharynx to the stomach. As are all organs opening to the exterior, the esophagus is composed of four tunics: mucosa; submucosa; muscularis externa; and adventitia (because the esophagus does not protrude into an internal body cavity). 10x.



1 of 10

The mucosa of the esophagus is lined with stratified squamous moist epithelium to protect the organ from the partially digested food. Mucous glands are located in the lamina propria in some regions, particularly near the gastro-esophageal junction and sometimes in the upper third.

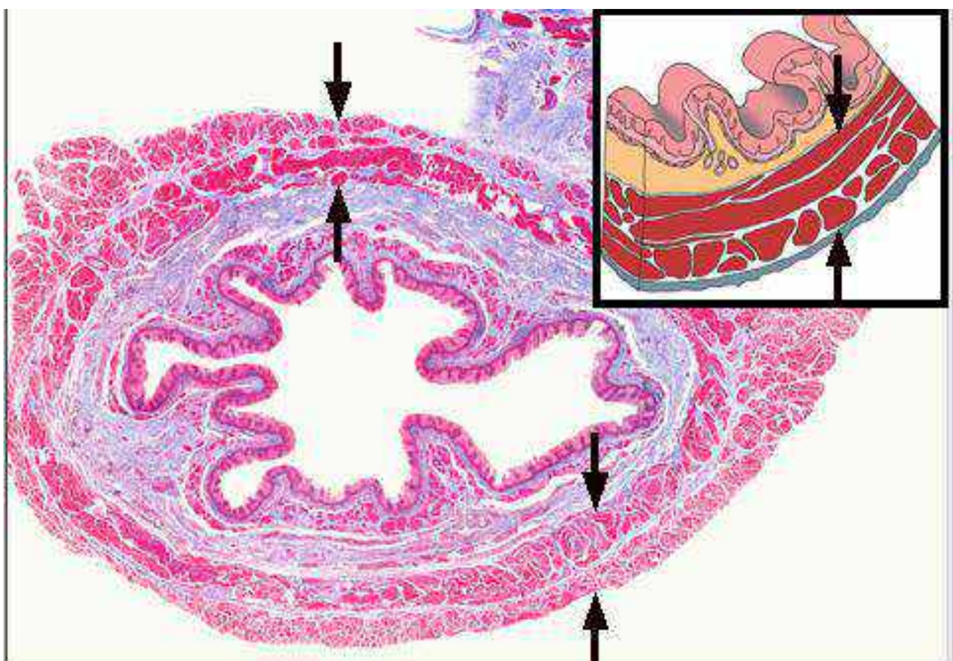


click to identi

Mucosa >
Submucosa >
Muscularis >
externa
Skeletal mu
Smooth mu
Adventitia >

1 of 10

The submucosa possesses compound tubulo-acinar glands, called esophageal glands proper, scattered along the length of the esophagus. These glands, not present in this image, lubricate the esophagus during food transport.

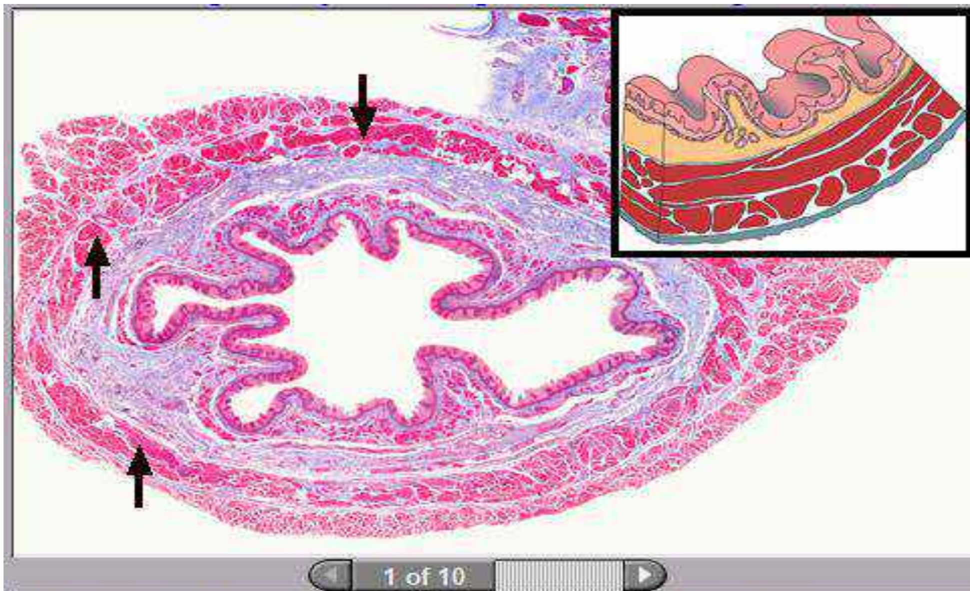


click to identify:

Mucosa >
Submucosa >
Muscularis >
externa
Skeletal muscle
Smooth muscle
Adventitia >

1 of 10

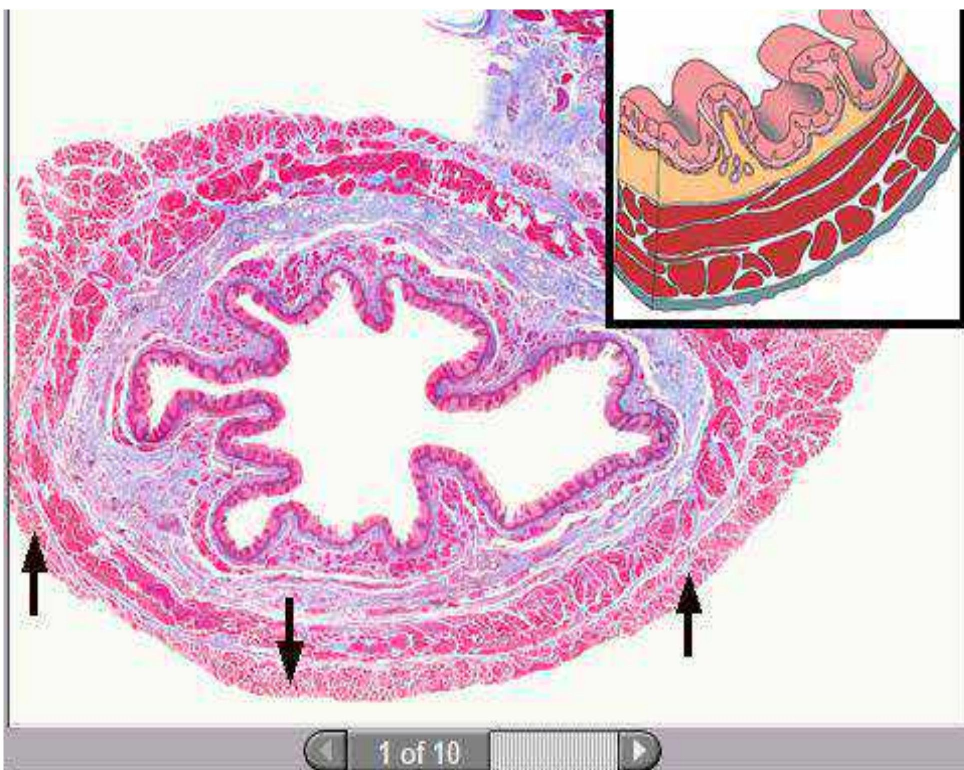
Because swallowing is a voluntary action, muscularis externa in the upper one-third of the esophagus is composed of skeletal muscle. Both skeletal and smooth muscle are located in the muscularis externa in the middle third (shown here), and only smooth muscle is found in this tunic in the lower one-third.



click to identify:

Mucosa >
Submucosa >
Muscularis >
externa
> Skeletal muscle
Smooth muscle
Adventitia >

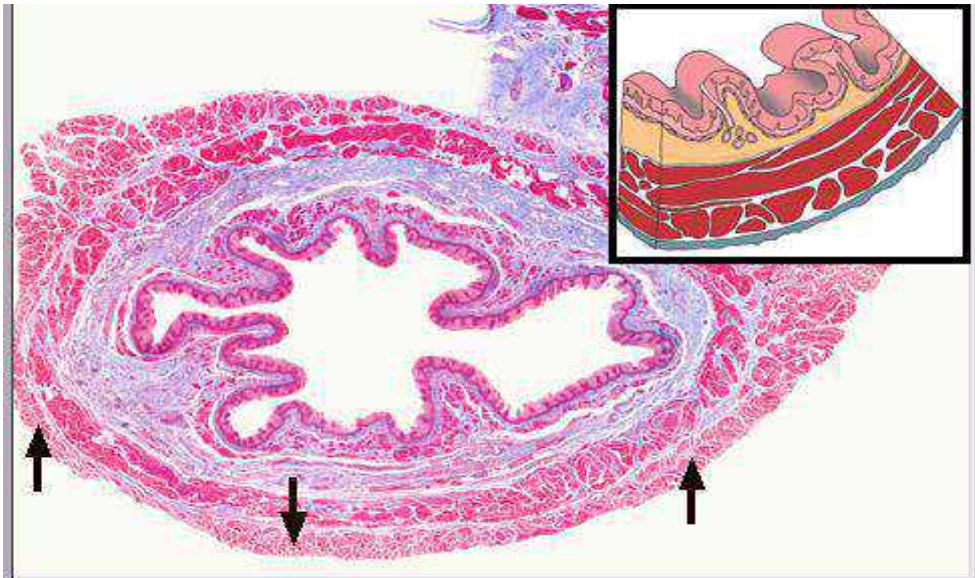
Because swallowing is a voluntary action, muscularis externa in the upper one-third of the esophagus is composed of skeletal muscle. Both skeletal and smooth muscle are located in the muscularis externa in the middle third (shown here), and only smooth muscle is found in this tunic in the lower one-third.



click to identify:

Mucosa >
Submucosa >
Muscularis >
externa
Skeletal muscle
> Smooth muscle
Adventitia >

Because swallowing is a voluntary action, muscularis externa in the upper one-third of the esophagus is composed of skeletal muscle. Both skeletal and smooth muscle are located in the muscularis externa in the middle third (shown here), and only smooth muscle is found in this tunic in the lower one-third.

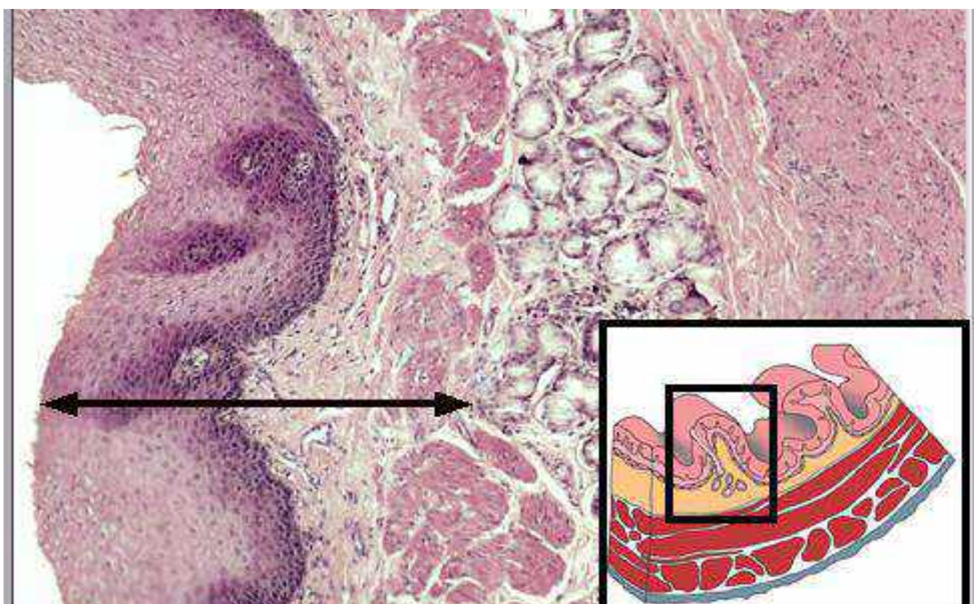


1 of 10

Because swallowing is a voluntary action, muscularis externa in the upper one-third of the esophagus is composed of skeletal muscle. Both skeletal and smooth muscle are located in the muscularis externa in the middle third (shown here), and only smooth muscle is found in this tunic in the lower one-third.

click to identify:

Mucosa >
Submucosa >
Muscularis > externa
Skeletal muscle
› Smooth muscle
Adventitia >

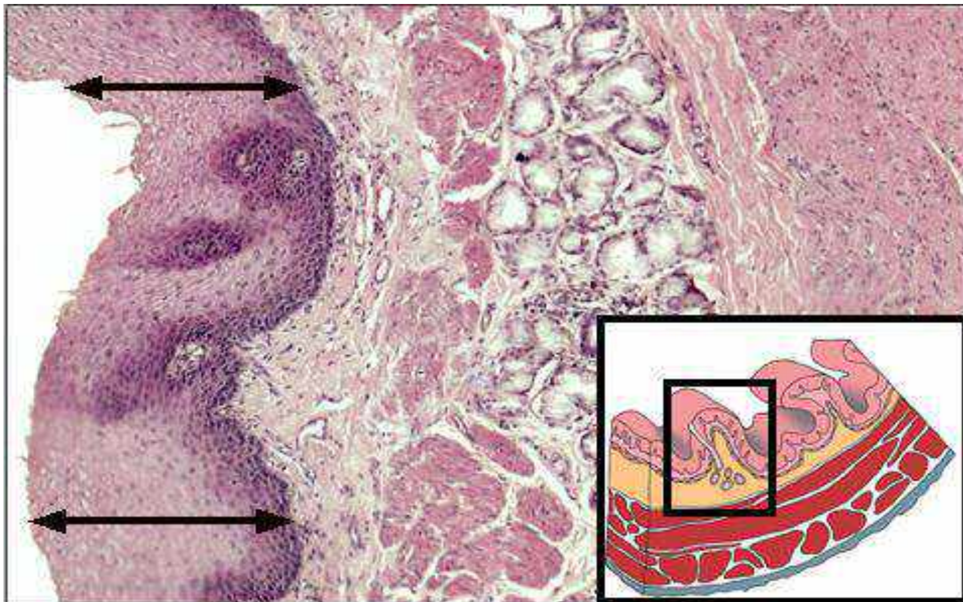


4 of 10

Esophagus -- A thick stratified squamous nonkeratinized epithelium lines the esophagus. The lamina propria underlying the epithelium possesses lymphoid structures and localized mucous glands (not shown here) in the lower third and sometimes in the upper third. Additional tubulo-acinar glands, esophageal glands proper, are located in the submucosa. 100x

click to identify:

› Mucosa
Epithelium
Lamina propria
Muscularis mucosae
Submucosa
Esophageal glands proper
Muscularis externa



4 of 10

click to identify:

- Mucosa
  - Epithelium
  - Lamina propria
  - Muscularis mucosae
- Submucosa
- Esophageal glands proper
- Muscularis externa

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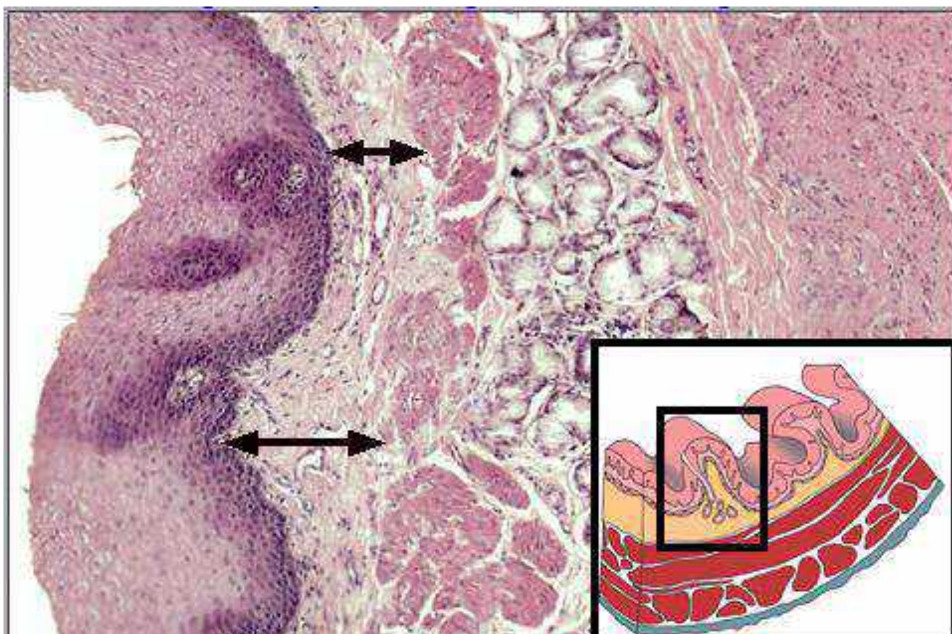

4 of 10

click to identify:

- Mucosa
  - Epithelium
  - Lamina propria
  - Muscularis mucosae
- Submucosa
- Esophageal glands proper
- Muscularis externa

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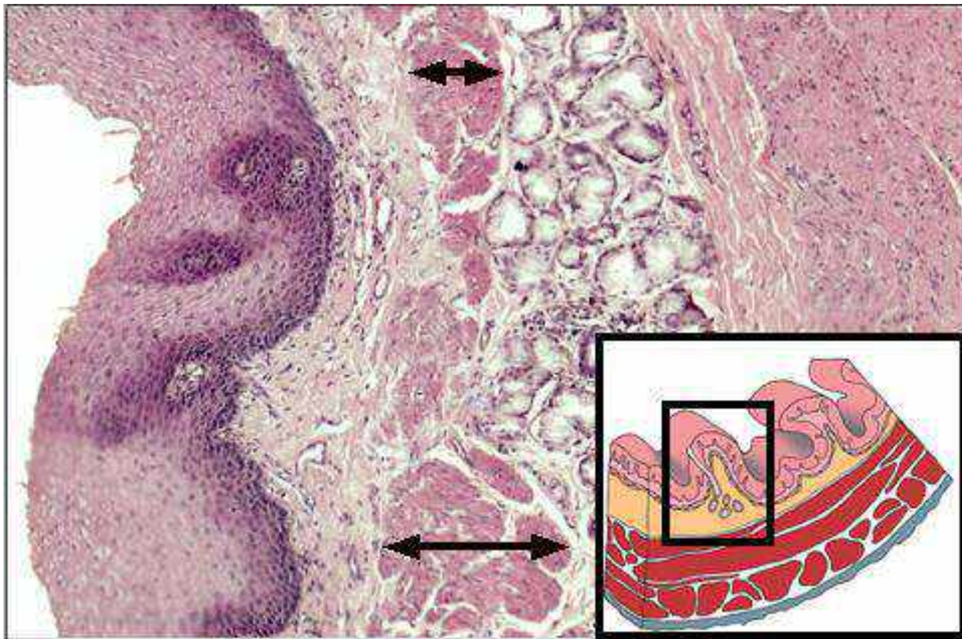

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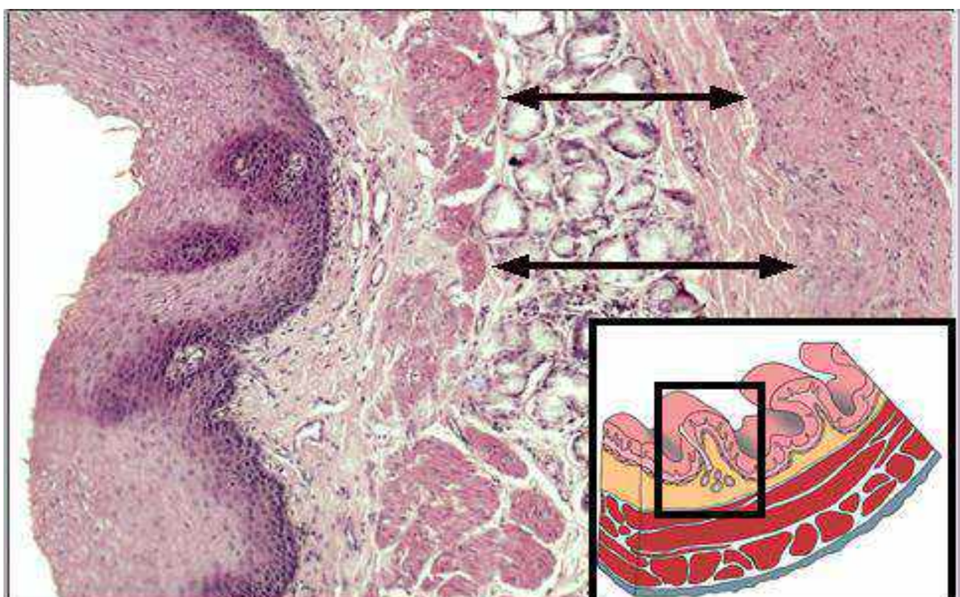
click to identify:

- Mucosa
  - Epithelium
  - Lamina propria
  - › Muscularis mucosae
- Submucosa
- Esophageal glands proper
- Muscularis externa



4 of 10

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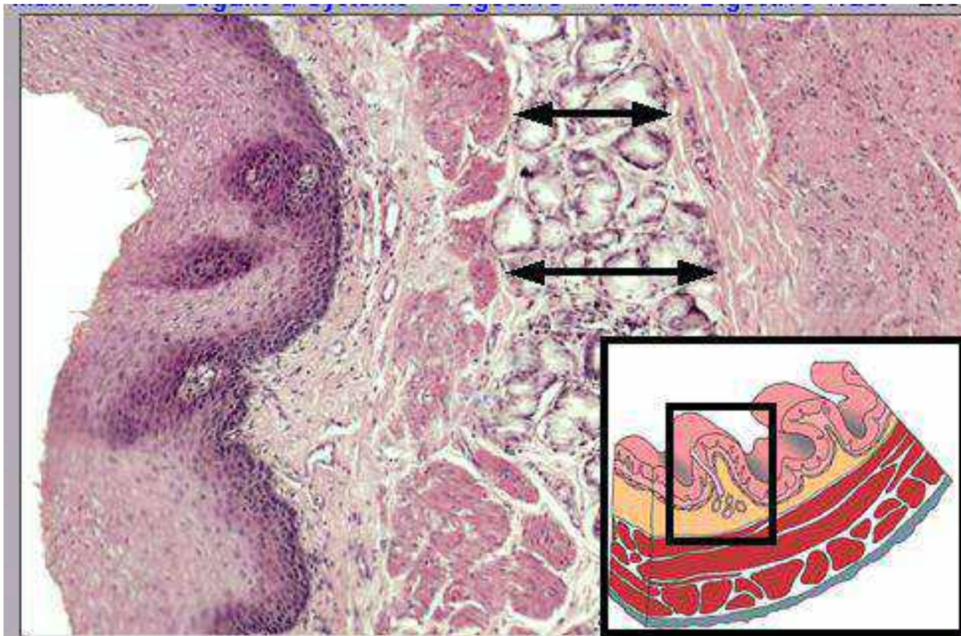
click to identify:

- Mucosa
  - Epithelium
  - Lamina propria
  - Muscularis mucosae
- › Submucosa
- Esophageal glands proper
- Muscularis externa



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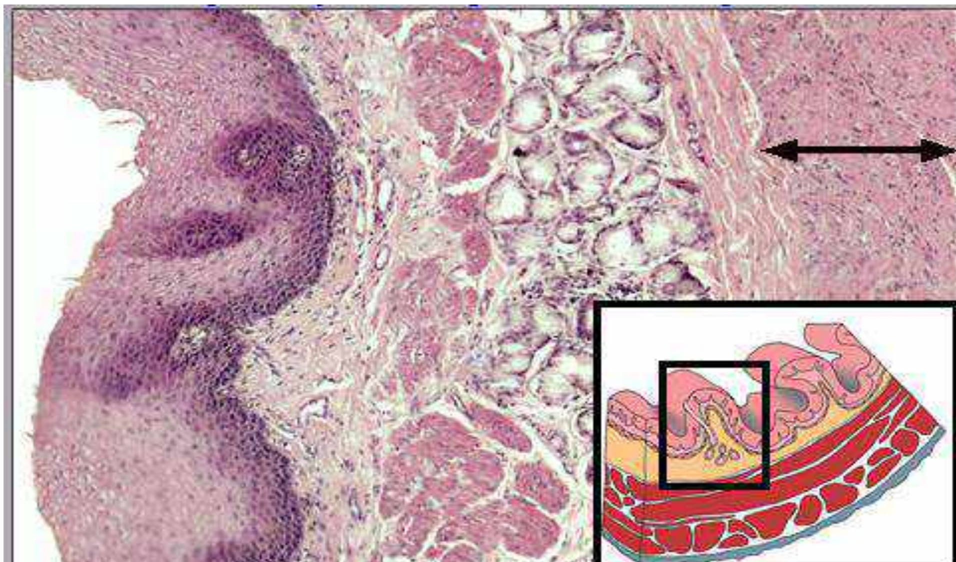
- Mucosa
  - Epithelium
  - Lamina propria
  - Muscularis mucosae
- Submucosa
- › Esophageal glands proper
- Muscularis externa



4 of 10

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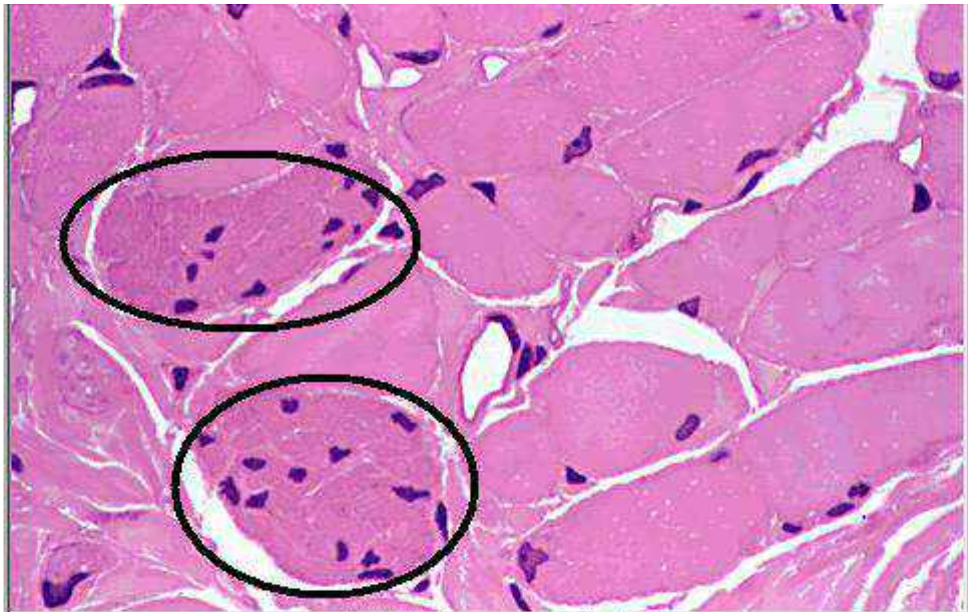
click to identify:

- Mucosa
  - Epithelium
  - Lamina propria
  - Muscularis mucosae
- Submucosa
- Esophageal glands proper
- › Muscularis externa

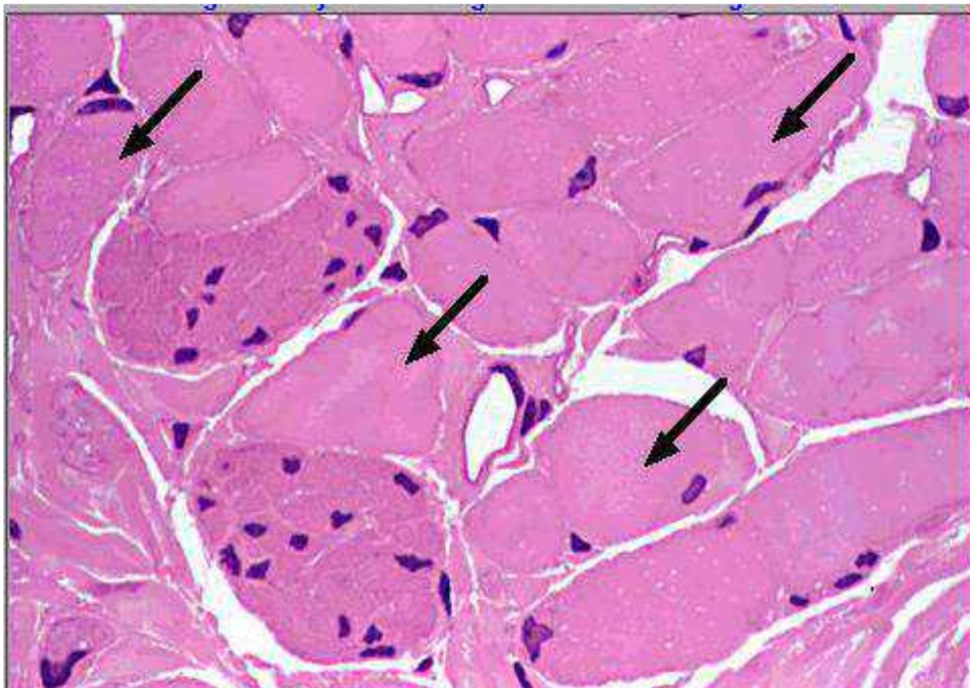


click to identify:

- Smooth muscle fibers
- Skeletal muscle fibers
- Skeletal muscle nuclei
- Smooth muscle nuclei
- Capillary
- Connective tissue

8 of 10

Esophagus -- In the middle part of the muscularis externa of the esophagus, smooth muscle fibers and skeletal muscle fibers occur together. In this field, compare the size of the fibers and location of the nuclei of these two muscle types. 1000x



click to identify:

- Smooth muscle fibers
- Skeletal muscle fibers
- Skeletal muscle nuclei
- Smooth muscle nuclei
- Capillary
- Connective tissue

8 of 10

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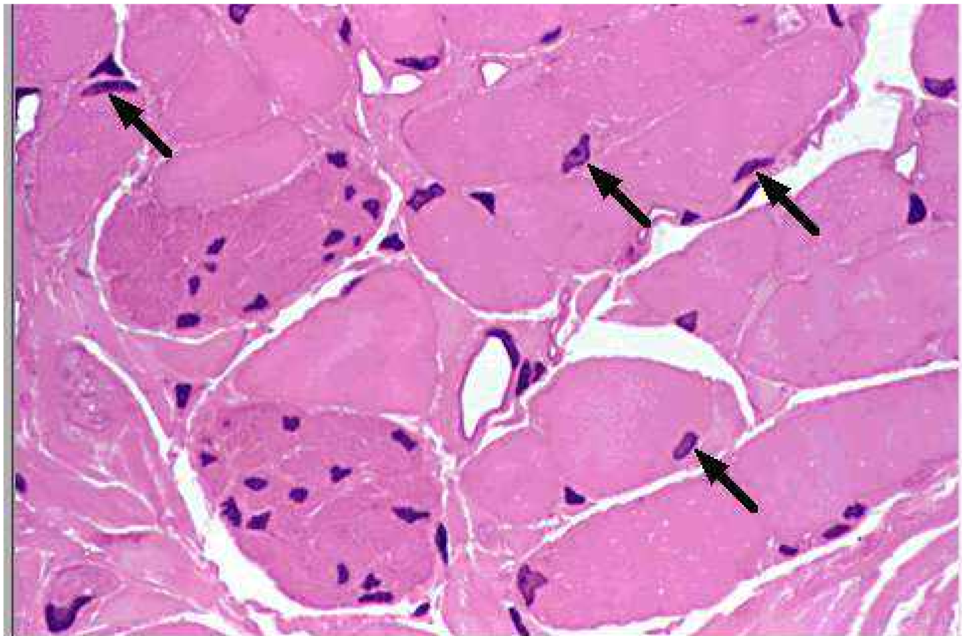

8 of 10

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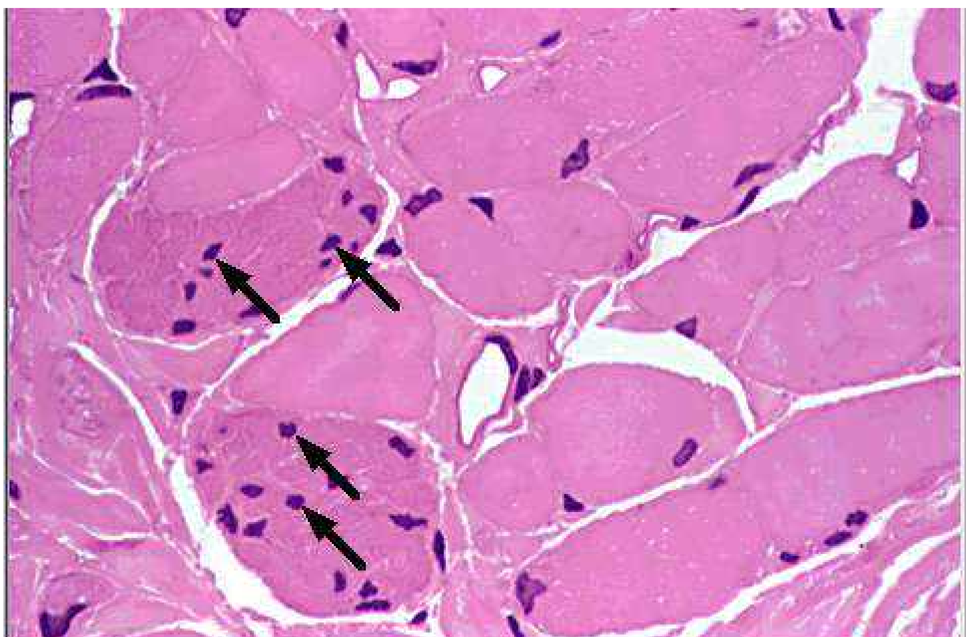
click to identify:

- Smooth muscle fibers
- Skeletal muscle fibers
- › Skeletal muscle nuclei
- Smooth muscle nuclei
- Capillary
- Connective tissue



8 of 10

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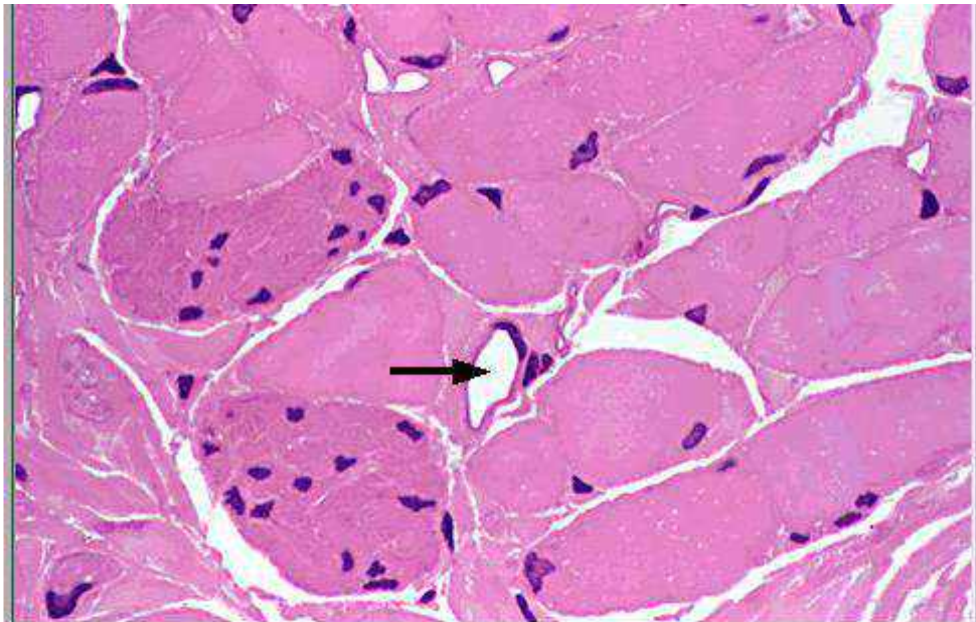
click to identify:

- Smooth muscle fibers
- Skeletal muscle fibers
- Skeletal muscle nuclei
- › Smooth muscle nuclei
- Capillary
- Connective tissue



8 of 10

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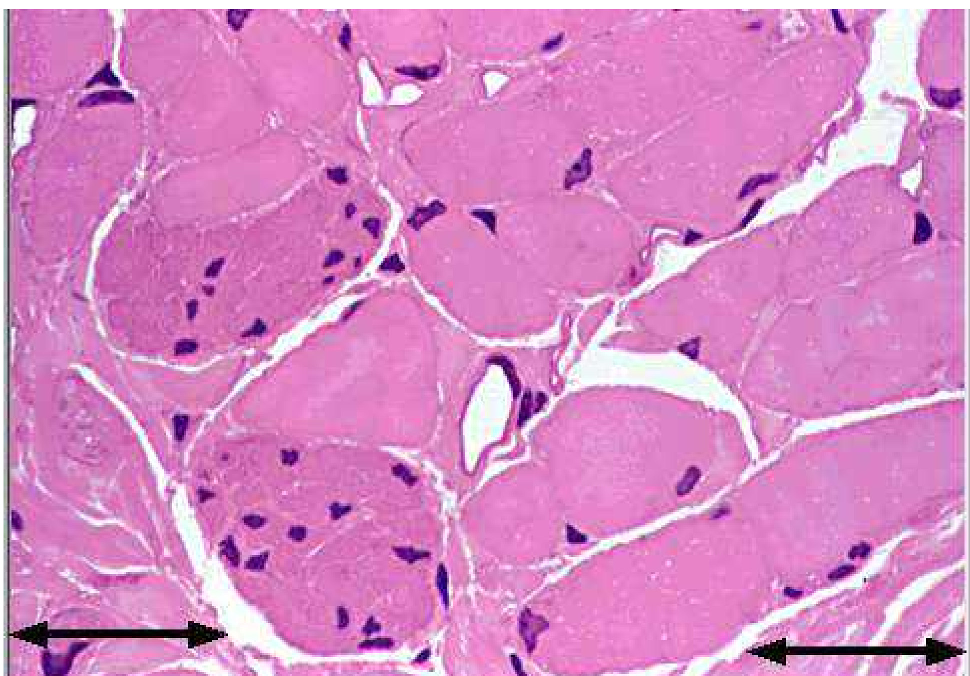
- Smooth muscle fibers
- Skeletal muscle fibers
- Skeletal muscle nuclei
- Smooth muscle nuclei
- Capillary
- Connective tissue



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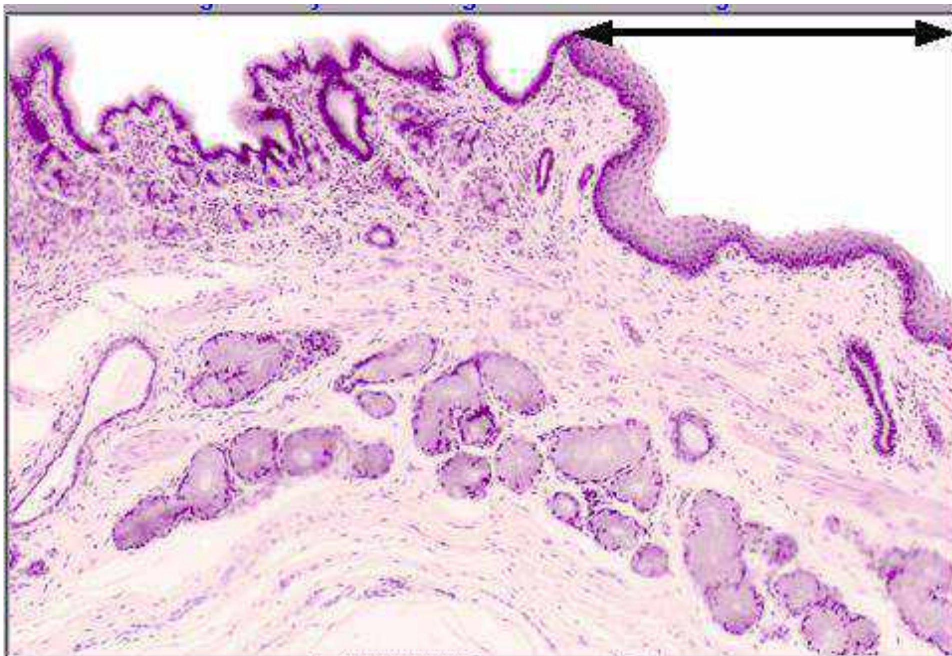
- Smooth muscle fibers
- Skeletal muscle fibers
- Skeletal muscle nuclei
- Smooth muscle nuclei
- Capillary
- Connective tissue

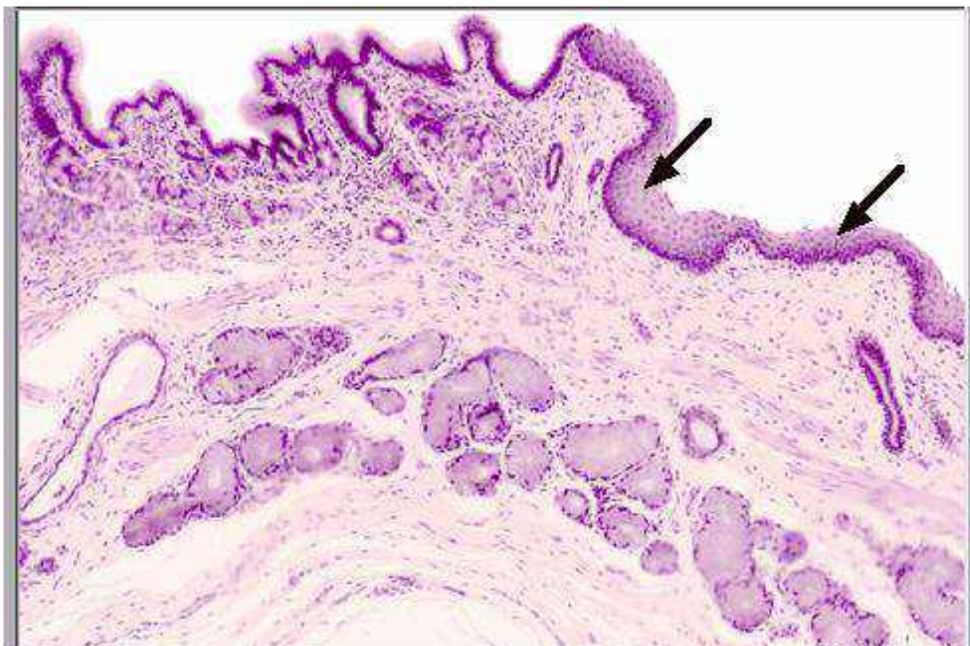


10 of 10

Gastro-esophageal junction -- Stratified squamous moist epithelium (esophagus) changes abruptly to a simple columnar epithelium (sheet gland) of the stomach. Esophageal glands proper, tubulo-acinar glands in the submucosa, continue into the stomach in this section. 100x

click to identify:

- Esophagus
- Stratified squamous epithelium
- Cardiac stomach
- Sheet gland
- Gastric pits
- Cardiac glands
- Lamina propria
- Muscularis mucosae
- Submucosa
- Esophageal glands proper



10 of 10

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- Sheet gland
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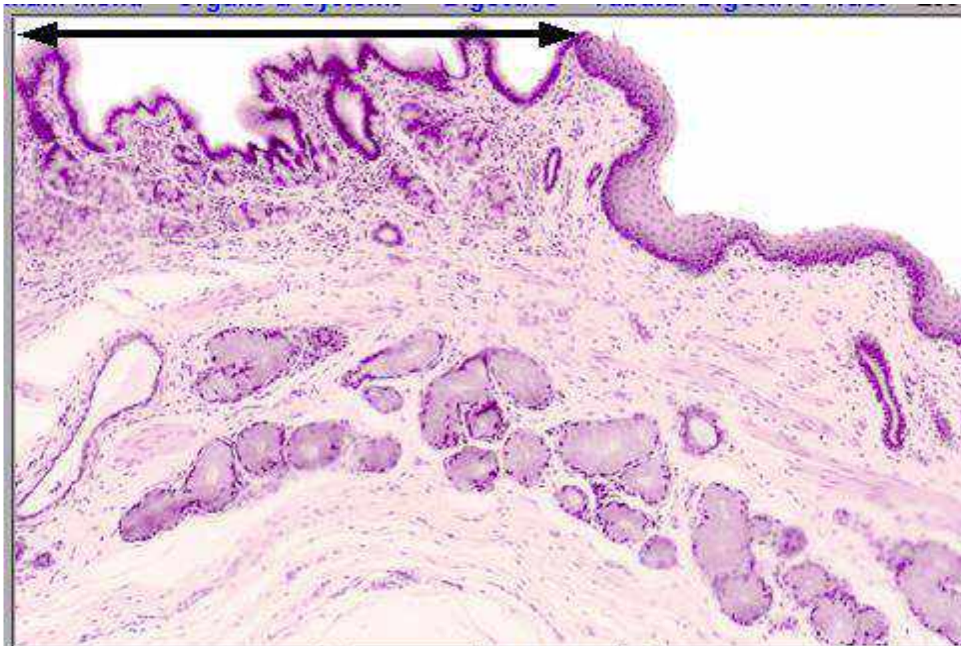
- Cardiac glands
- Lamina propria
- Muscularis mucosae
- Submucosa
- Esophageal glands proper



click to identify:

- Esophagus
- Stratified squamous epithelium
- › Cardiac stomach
- Sheet gland
- Gastric pits
- Cardiac glands
- Lamina propria
- Muscularis mucosae
- Submucosa
- Esophageal glands proper

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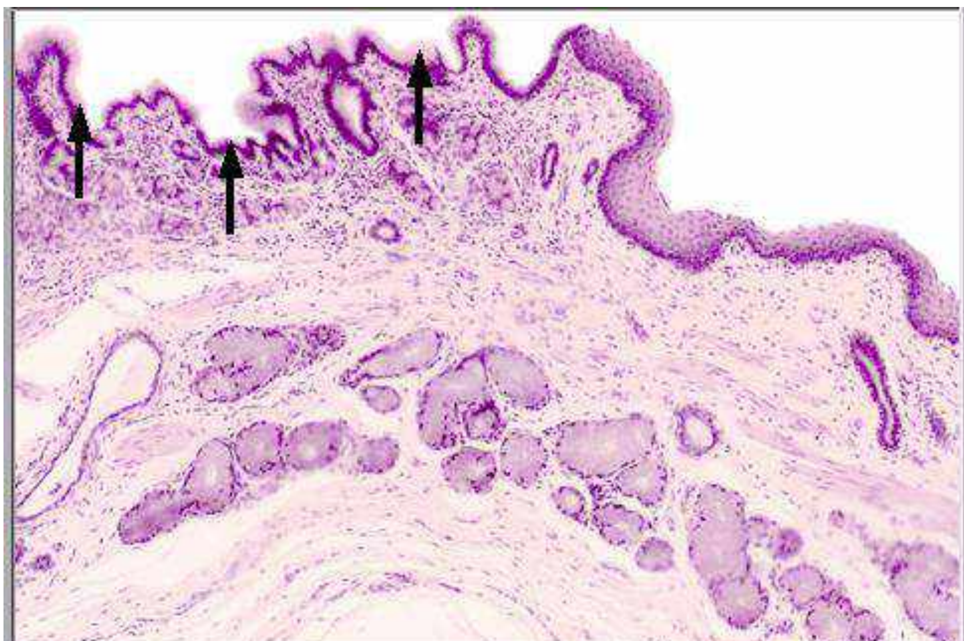

click to identify:

- Esophagus
- Stratified squamous epithelium
- Cardiac stomach
- › Sheet gland
- Gastric pits
- Cardiac glands
- Lamina propria
- Muscularis mucosae
- Submucosa
- Esophageal glands proper

10 of 10

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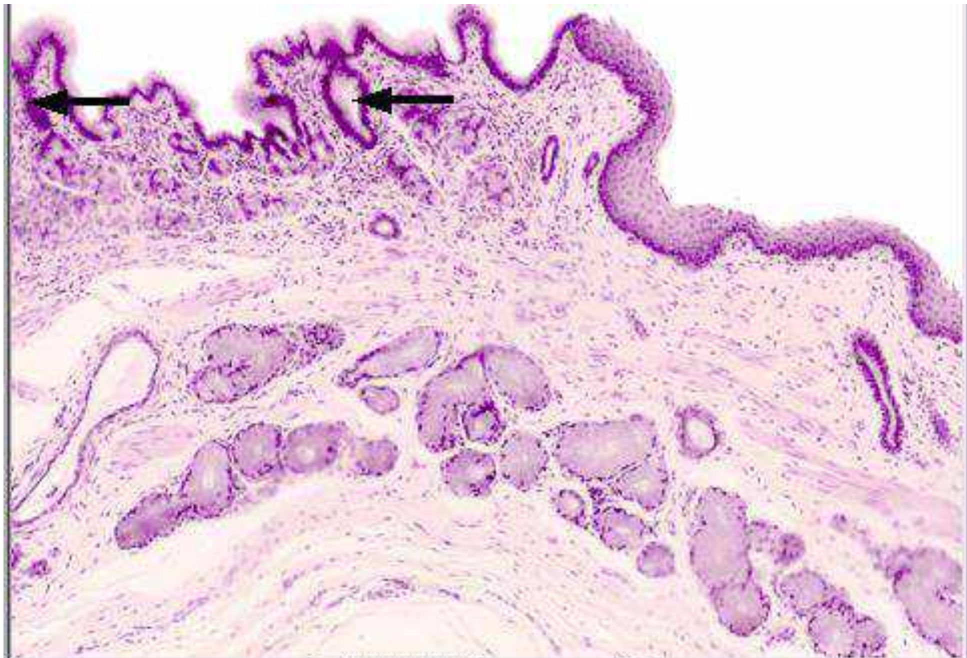

click to identify:

Esophagus
Stratified squamous epithelium
Cardiac stomach
Sheet gland
› Gastric pits
Cardiac glands
Lamina propria
Muscularis mucosae
Submucosa
Esophageal glands proper

10 of 10

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Esophagus
Stratified squamous epithelium
Cardiac stomach
Sheet gland
Gastric pits
› Cardiac glands
Lamina propria
Muscularis mucosae
Submucosa
Esophageal glands proper

10 of 10

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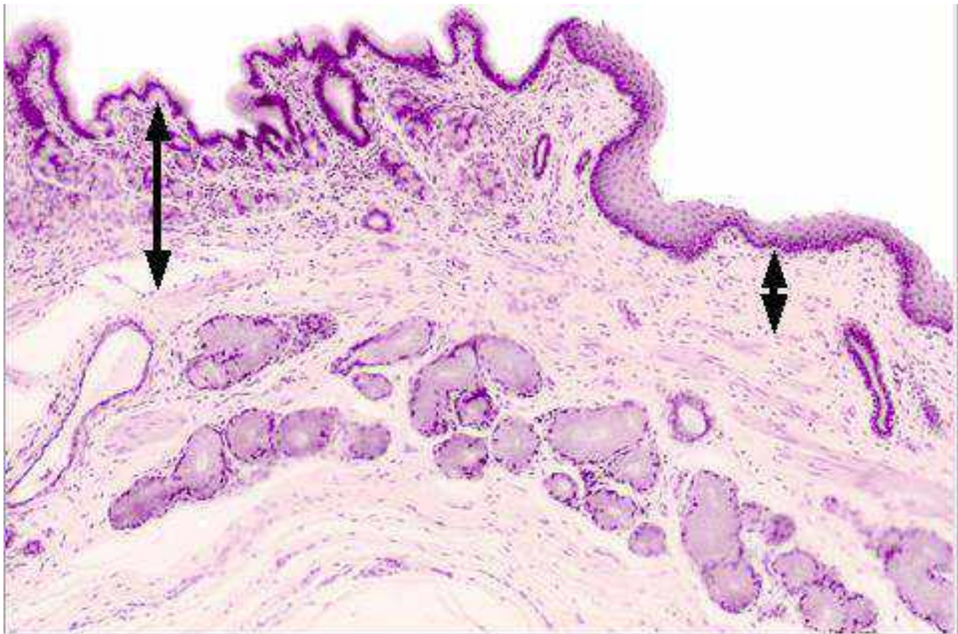
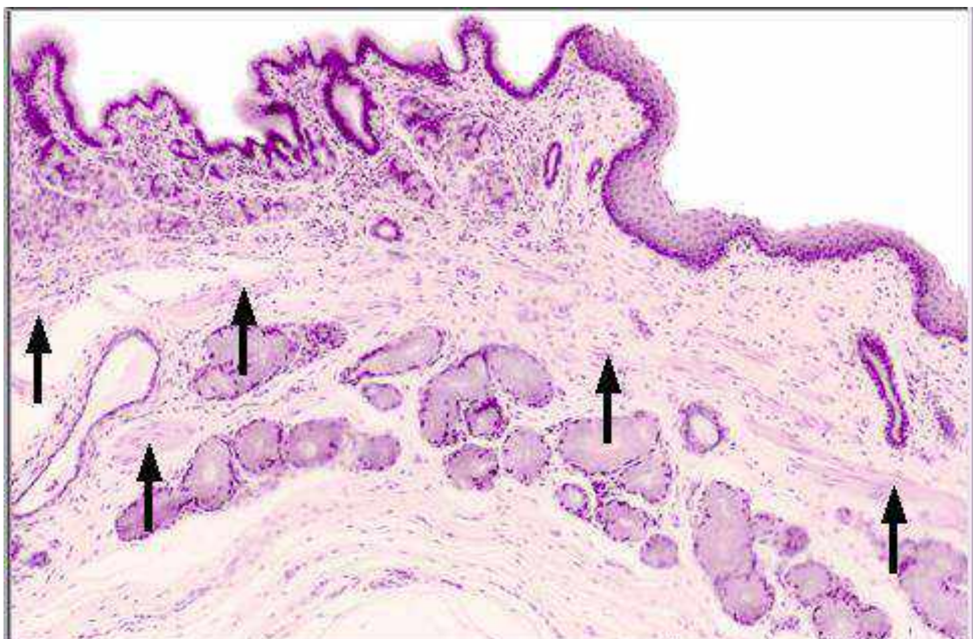


10 of 10

Gastro-esophageal junction -- Stratified squamous moist epithelium (esophagus) changes abruptly to a simple columnar epithelium (sheet gland) of the stomach. Esophageal glands proper, tubulo-acinar glands in the submucosa, continue into the stomach in this section. 100x

click to identify:

- Esophagus
- Stratified squamous epithelium
- Cardiac stomach
- Sheet gland
- Gastric pits
- Cardiac glands
- > Lamina propria
- Muscularis mucosae
- Submucosa
- Esophageal glands proper



10 of 10

Gastro-esophageal junction -- Stratified squamous moist epithelium (esophagus) changes abruptly to a simple columnar epithelium (sheet gland) of the stomach. Esophageal glands proper, tubulo-acinar glands in the submucosa, continue into the stomach in this section. 100x

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- Esophagus
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- Sheet gland
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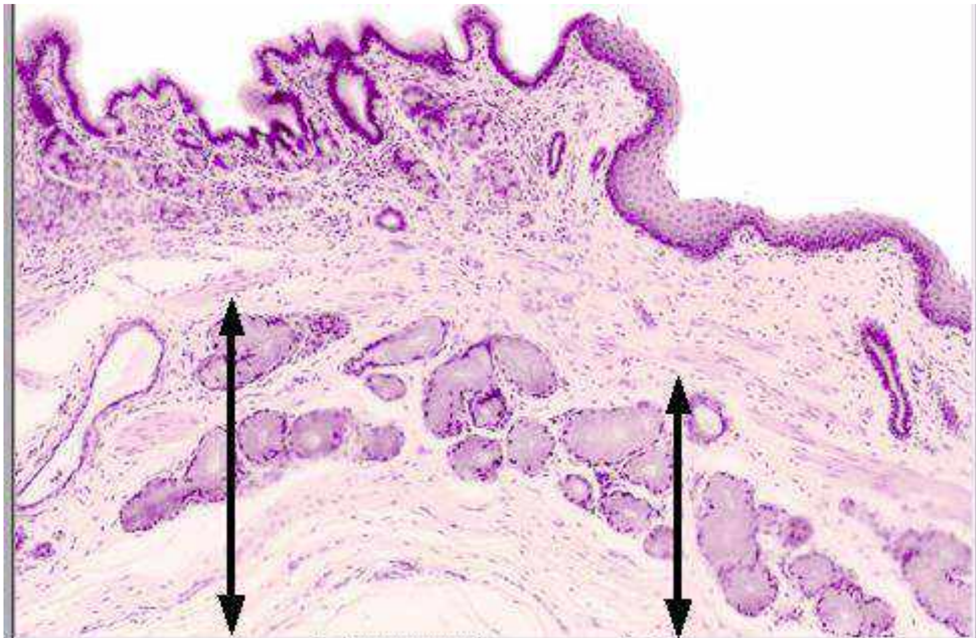

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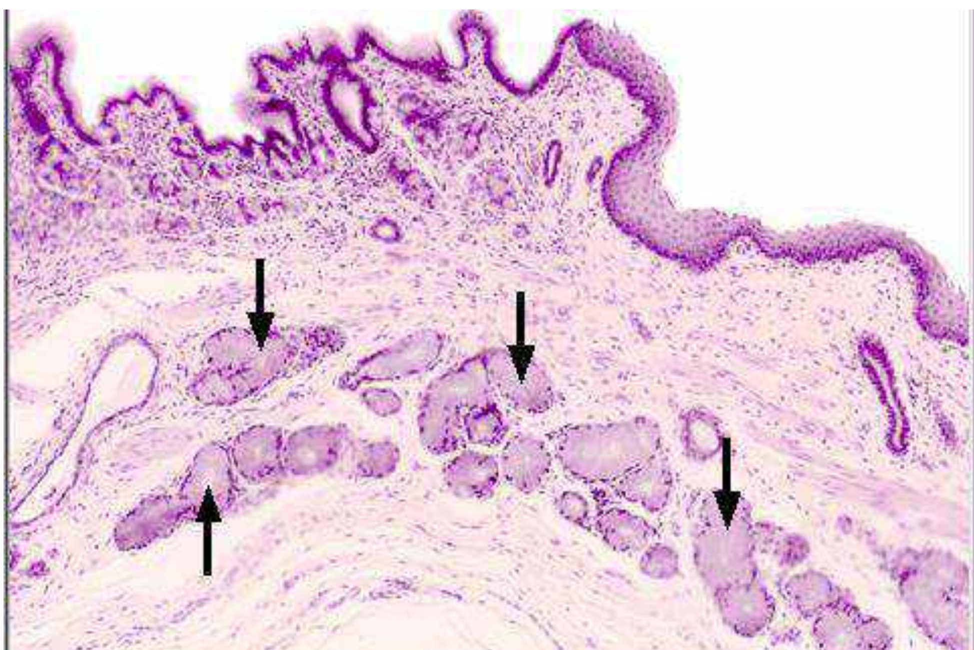

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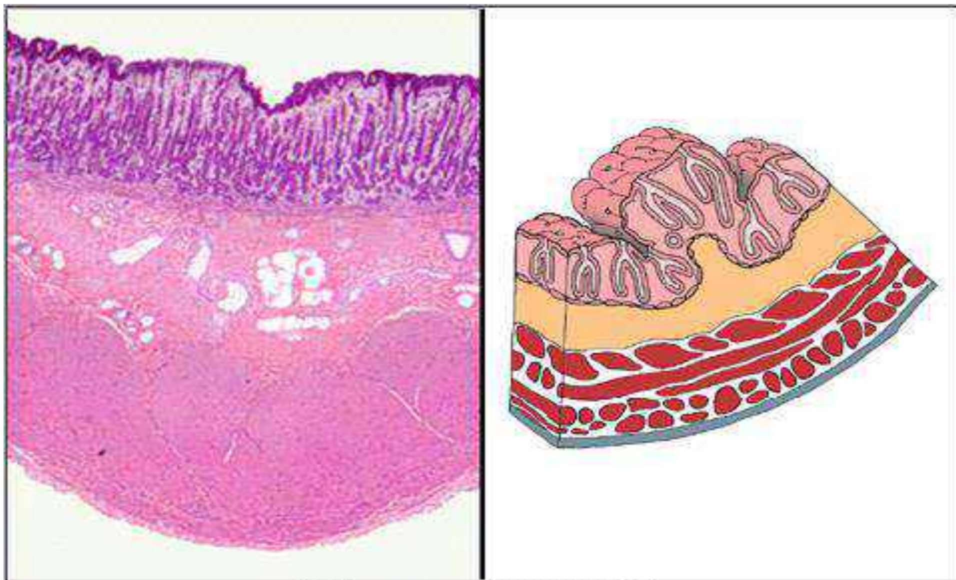
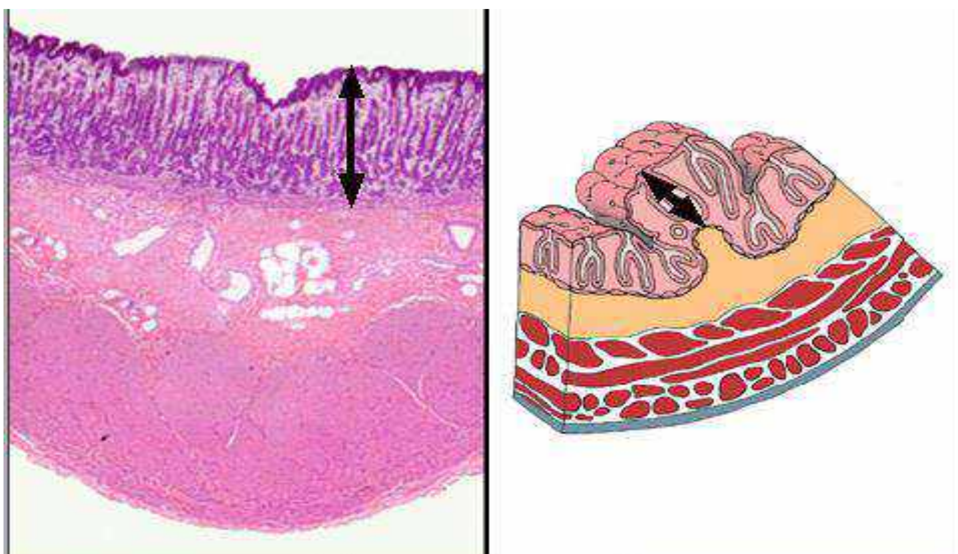


1 of 6

Overview -- The four stomach regions comprise three functional units (cardia, body and fundus, pylorus), each composed of the expected four tunics. The stomach continues digestion by secreting pepsin to aid in protein digestion, by producing an acidic fluid, and by churning via the thick muscularis externa. Hormones secreted by enteroendocrine cells modulate digestion. 10x

click to identify:

- Mucosa >
  - Sheet gland
  - Lamina propria
  - Muscularis mucosae
  - Gastric pits
  - Gastric glands
- Submucosa >
- Muscularis externa
- Serosa



1 of 6

The mucosal epithelium of the stomach is modified to form a sheet gland that invaginates into lamina propria, forming gastric pits. Gastric glands begin at the bases of these pits and extend to muscularis mucosae.

click to identify:

- > Mucosa >
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  - Lamina propria
  - Muscularis mucosae
  - Gastric pits
  - Gastric glands
- Submucosa >
- Muscularis externa
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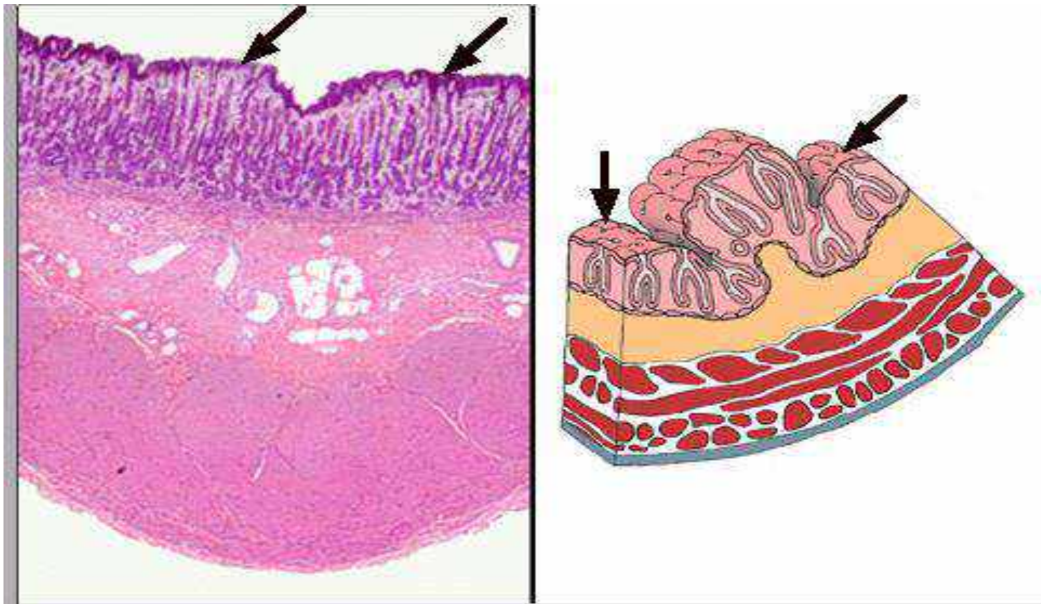

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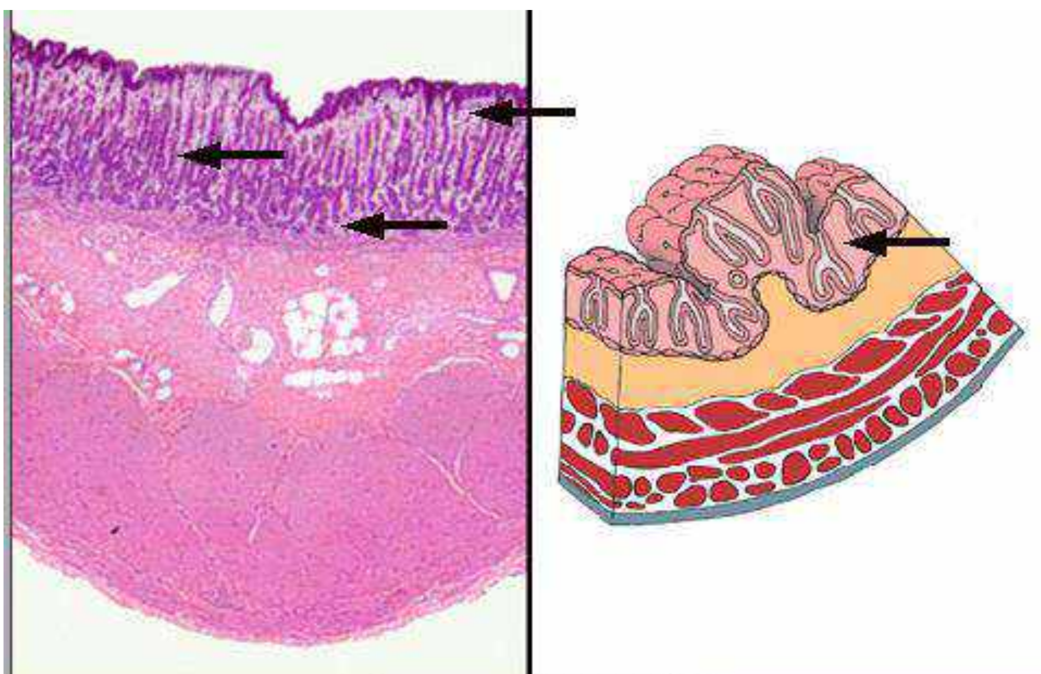

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- Mucosa >
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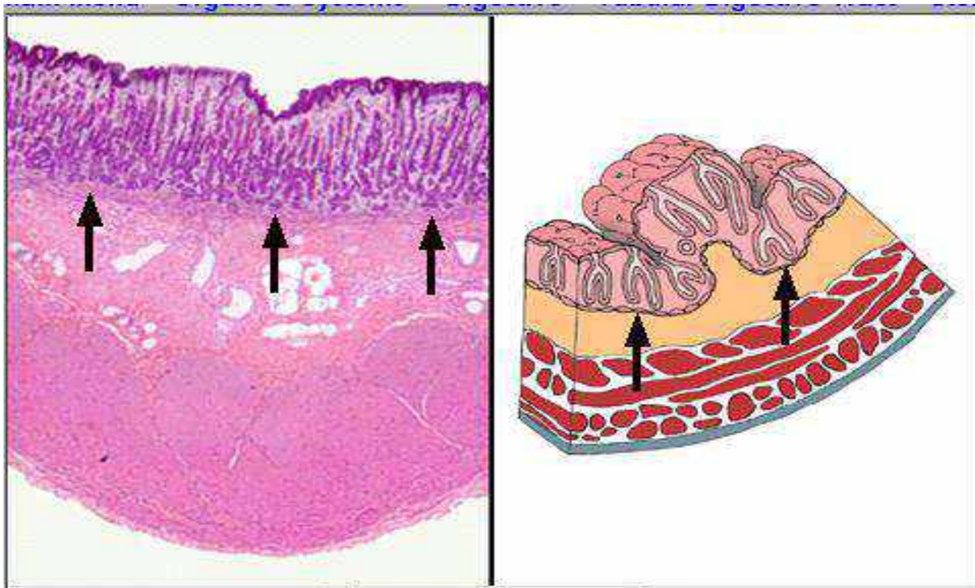

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Mucosa >
Sheet gland
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Muscularis mucosae
Gastric pits
Gastric glands
Submucosa >
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Serosa

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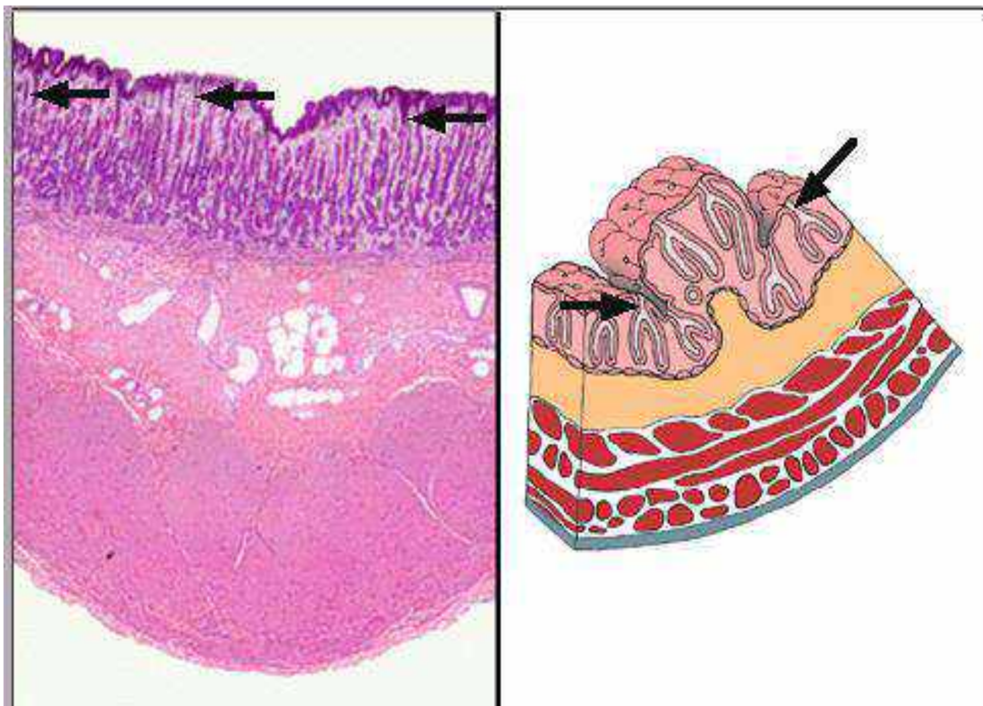

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Sheet gland
Lamina propria
Muscularis mucosae
Gastric pits
Gastric glands
Submucosa >
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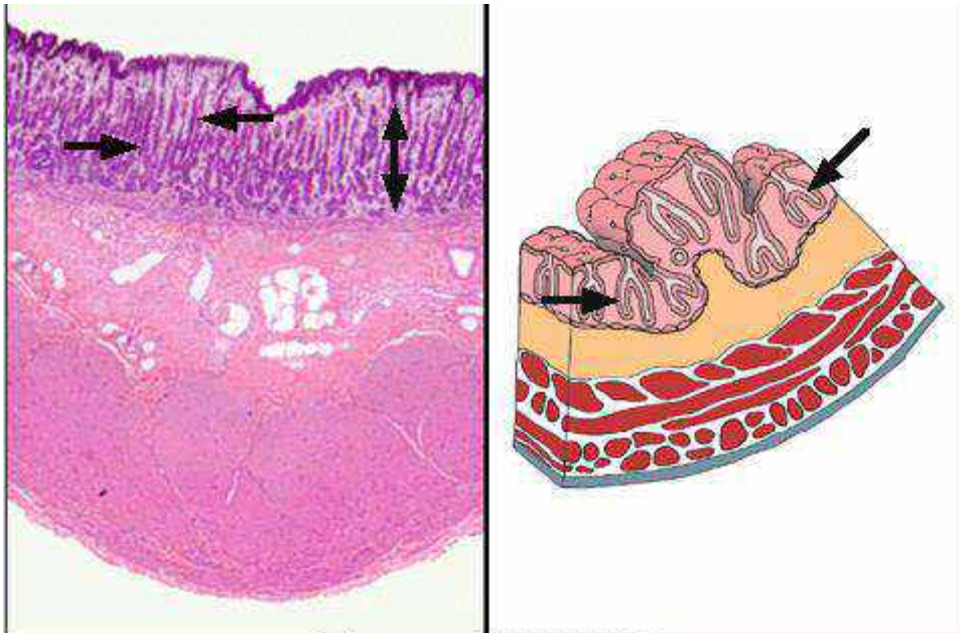

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  - Muscularis mucosae
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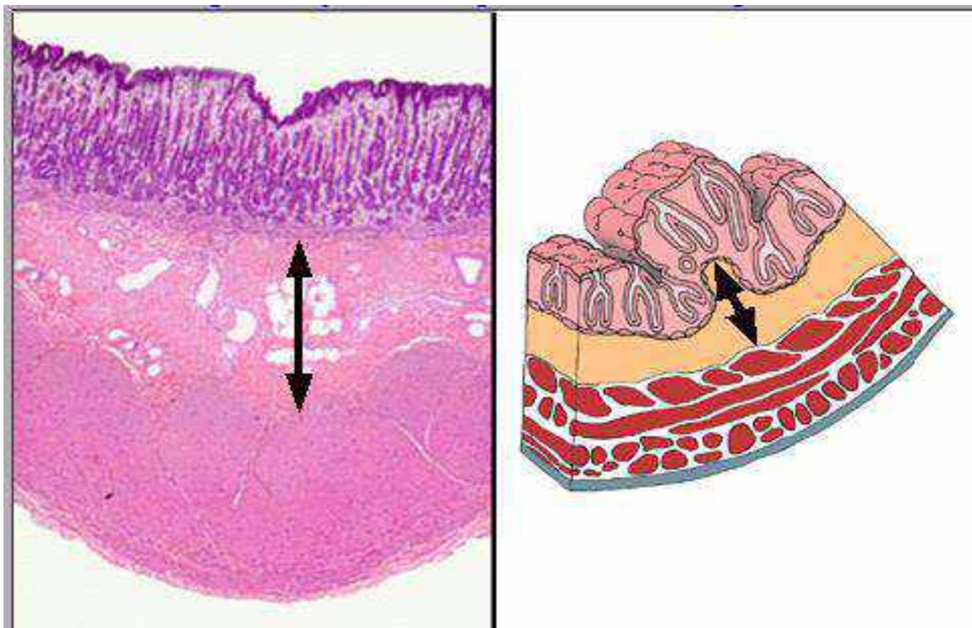
  - › Gastric glands
- Submucosa >
- Muscularis externa
- Serosa



1 of 6

The submucosa is composed of dense connective tissue. Although muscularis externa is composed of three layers of smooth muscle instead of the usual two, the additional internal oblique layer is inconsistently present. The stomach is covered on its exterior surface by an serosa because this organ protrudes into the peritoneal cavity.

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  - Lamina propria
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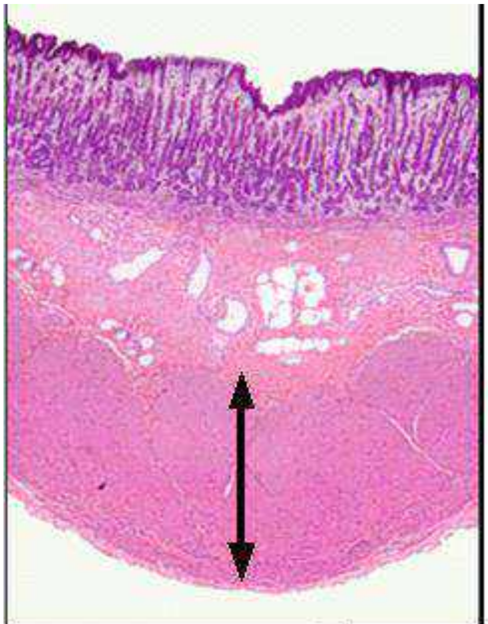
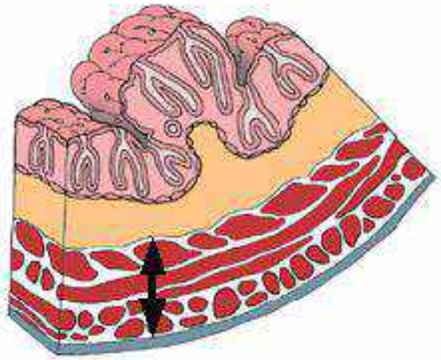
  - Gastric pits
  - Gastric glands
- › Submucosa >
- Muscularis externa
- Serosa





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- Sheet gland
- Lamina propria
- Muscularis mucosae
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Serosa

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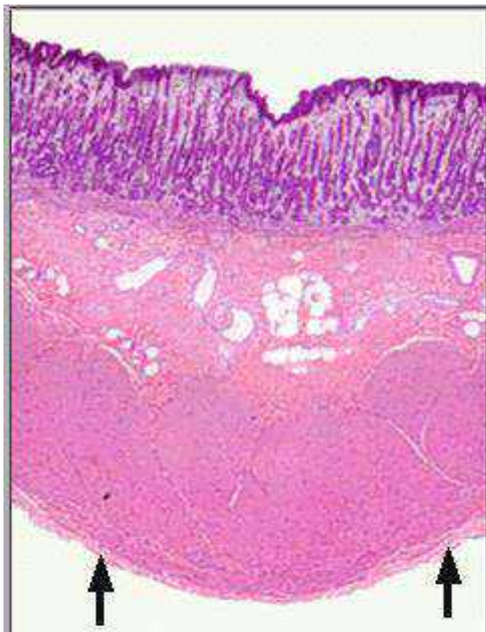

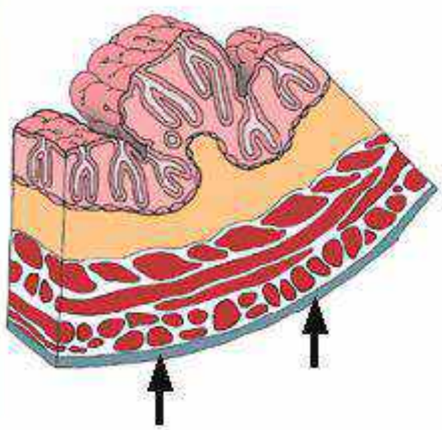

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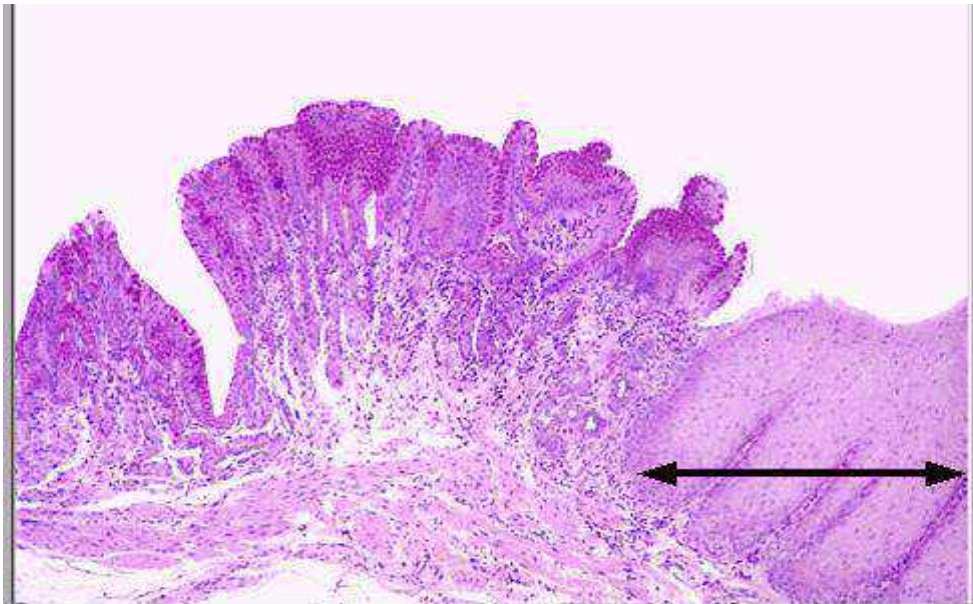
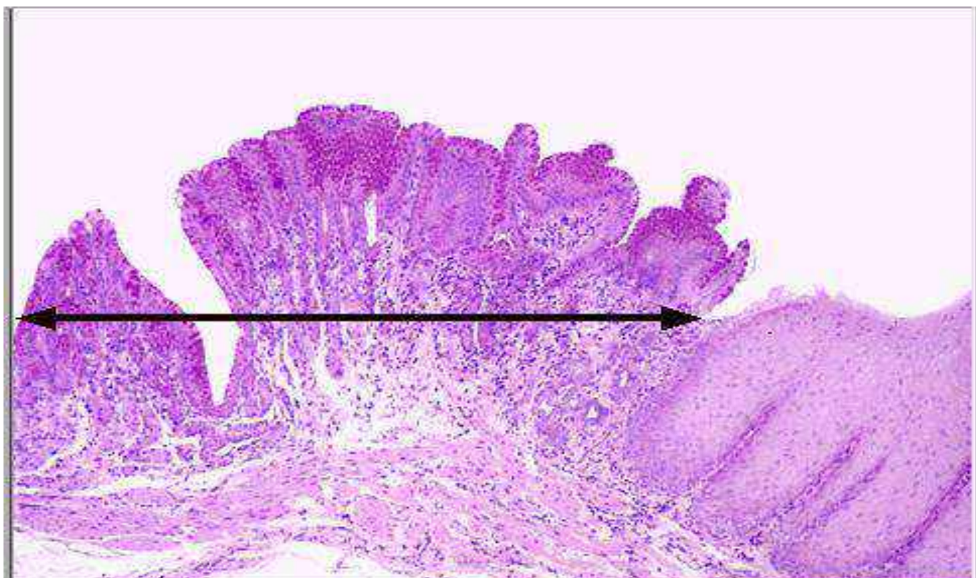


1 of 13

Stomach: cardiac region -- A sharp transition in the epithelium, from stratified squamous moist (esophagus) to simple columnar (stomach), marks the transition of these two organs. The depth of the gastric pits (foveolae) is about equal to the length of the glands in the cardiac region (a diagnostic feature for the cardiac region of the stomach). 40x

click to identify:

- › Esophagus
- Cardiac stomach
- Gastroesophageal junction
- Opening of pits
- Gastric pits
- Cardiac glands



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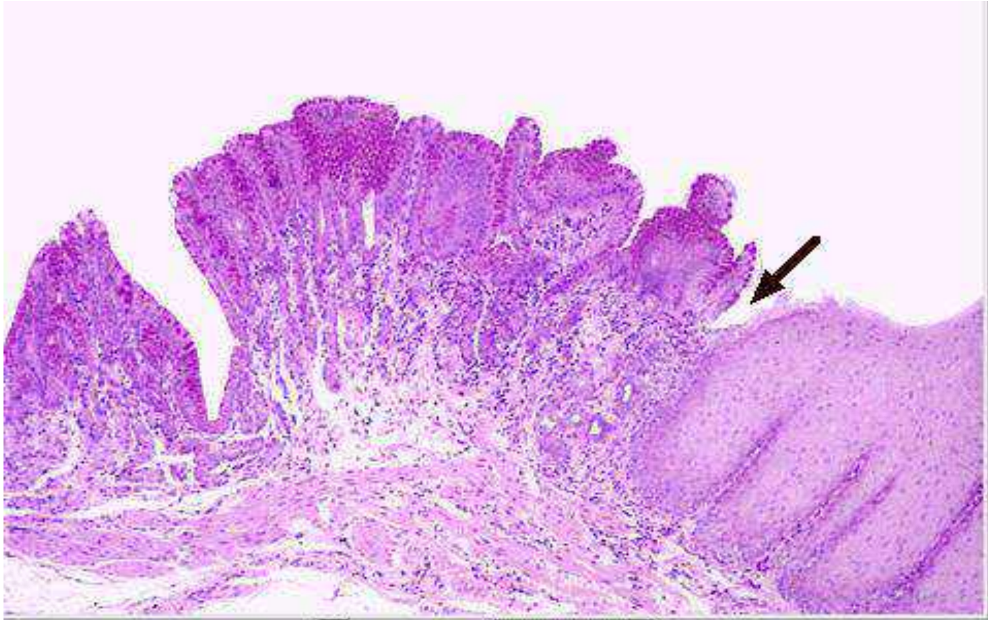

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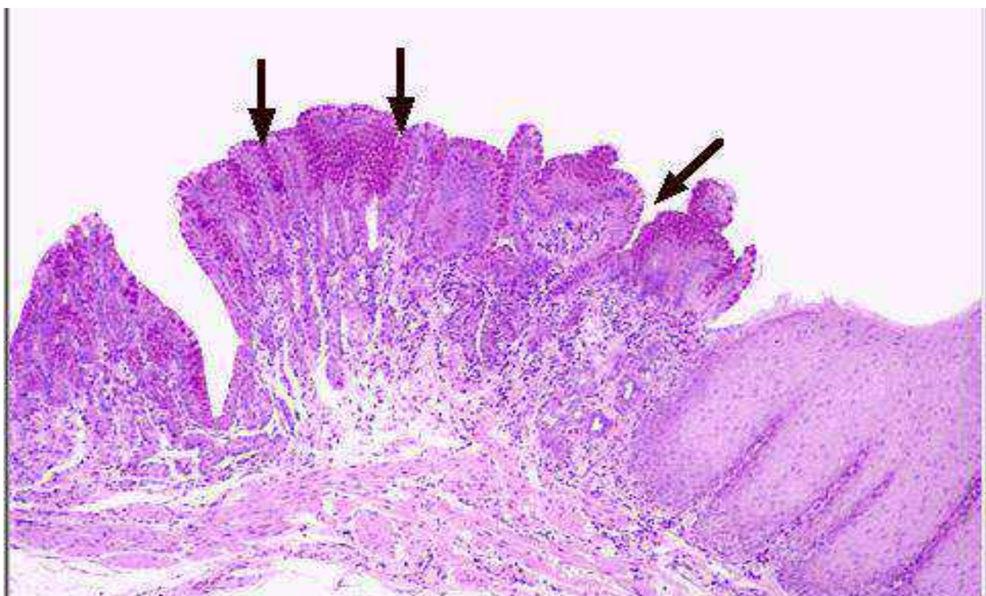

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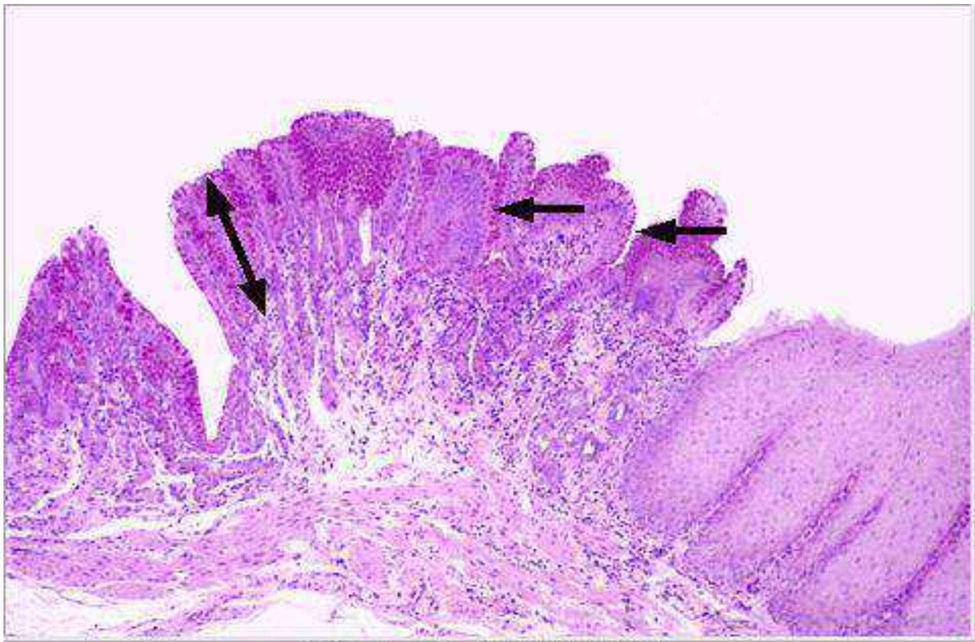

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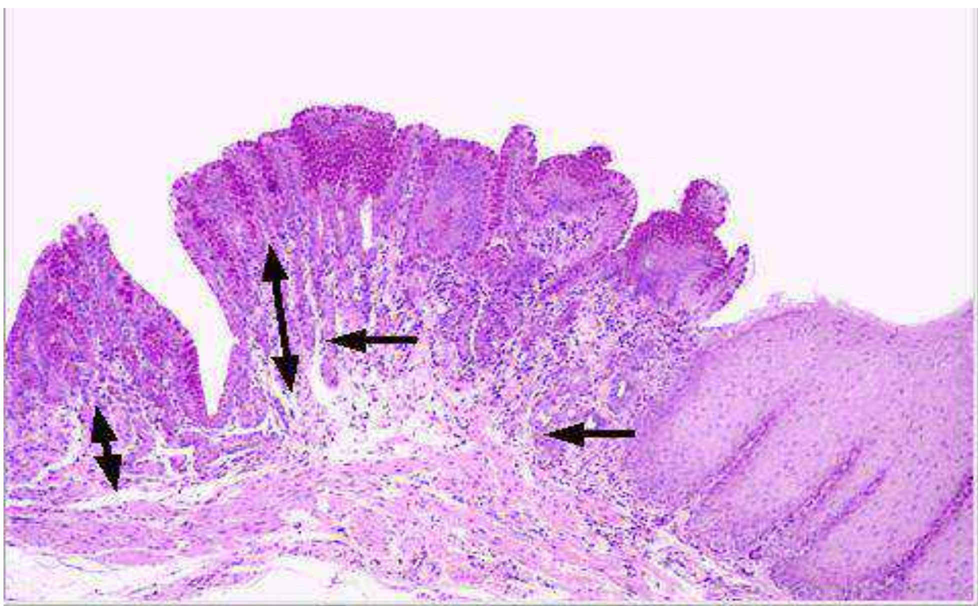

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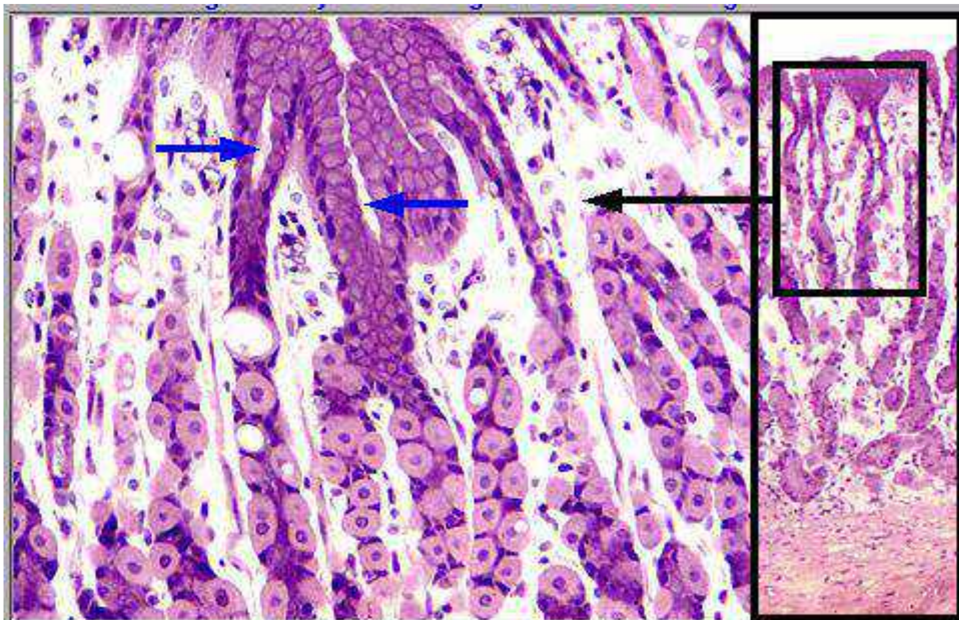
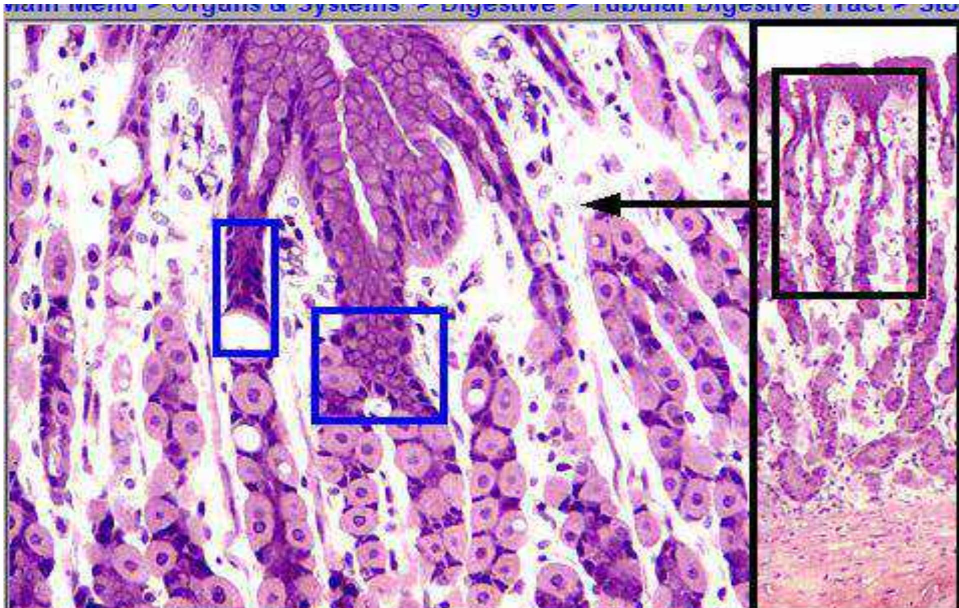


5 of 13

Stomach: fundus and body -- The neck, the first part of fundic glands, contains mucous neck cells (darkly staining cells) and parietal cells. Mucous neck cells secrete a mucus different from that of the surface mucous cells. Parietal (oxyntic) cells, large, spherical and eosinophilic, are responsible for the HCl production in the stomach and also secrete gastric intrinsic factor. 200x, 100x

click to identify:

- Gastric pits
- Necks of glands
- Bodies of glands
- Mucous neck cells
- Parietal cells



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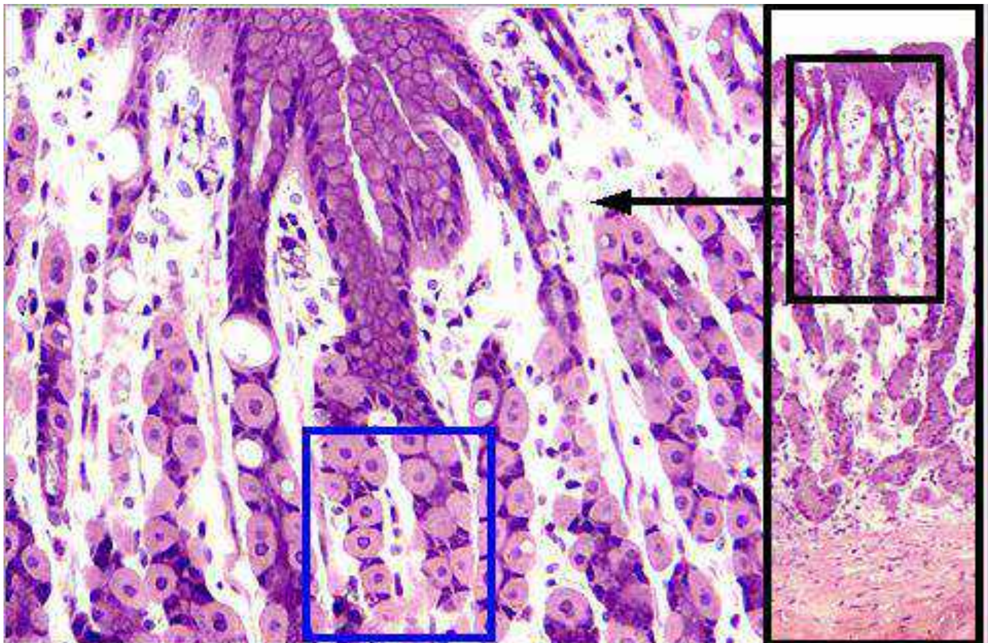

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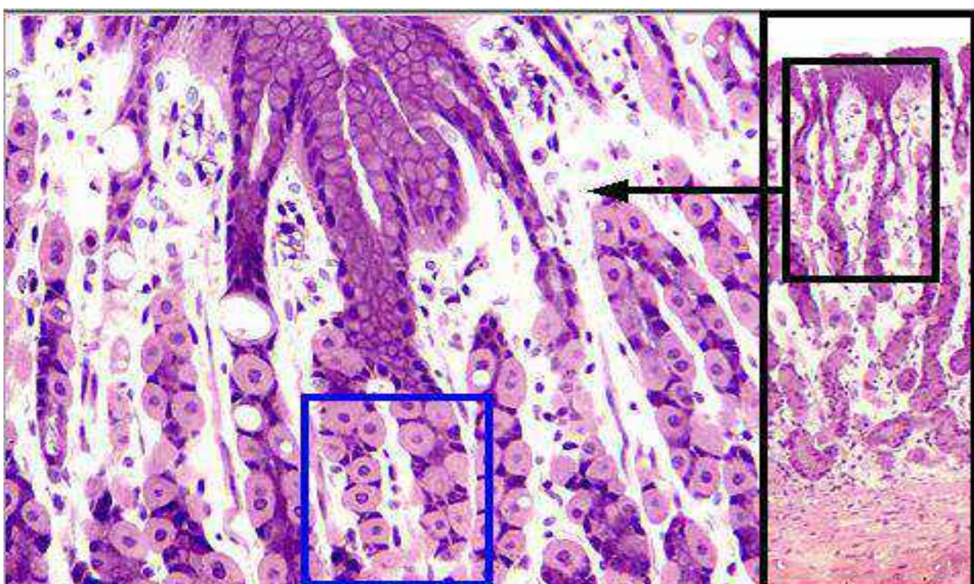

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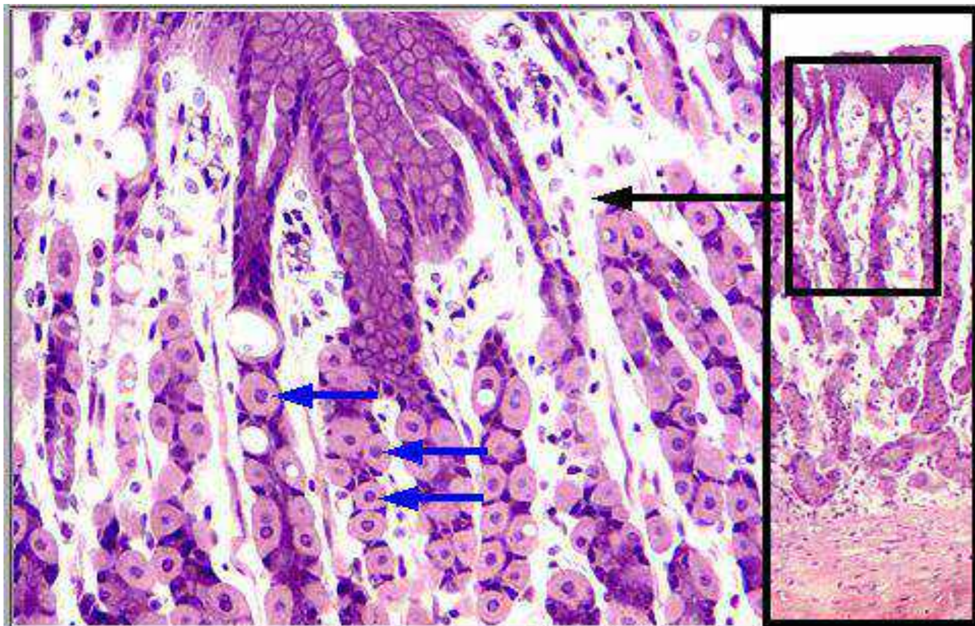

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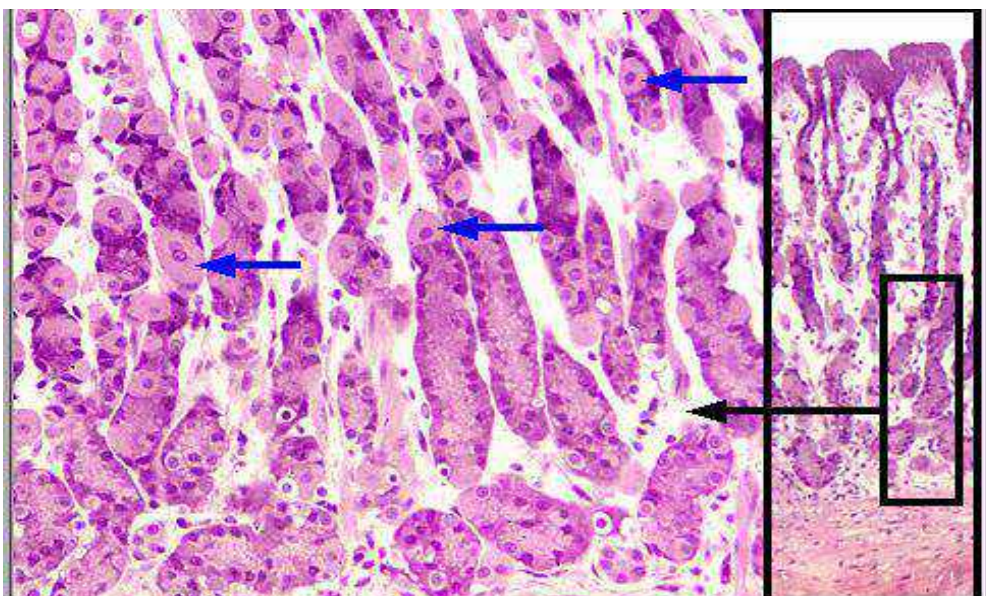
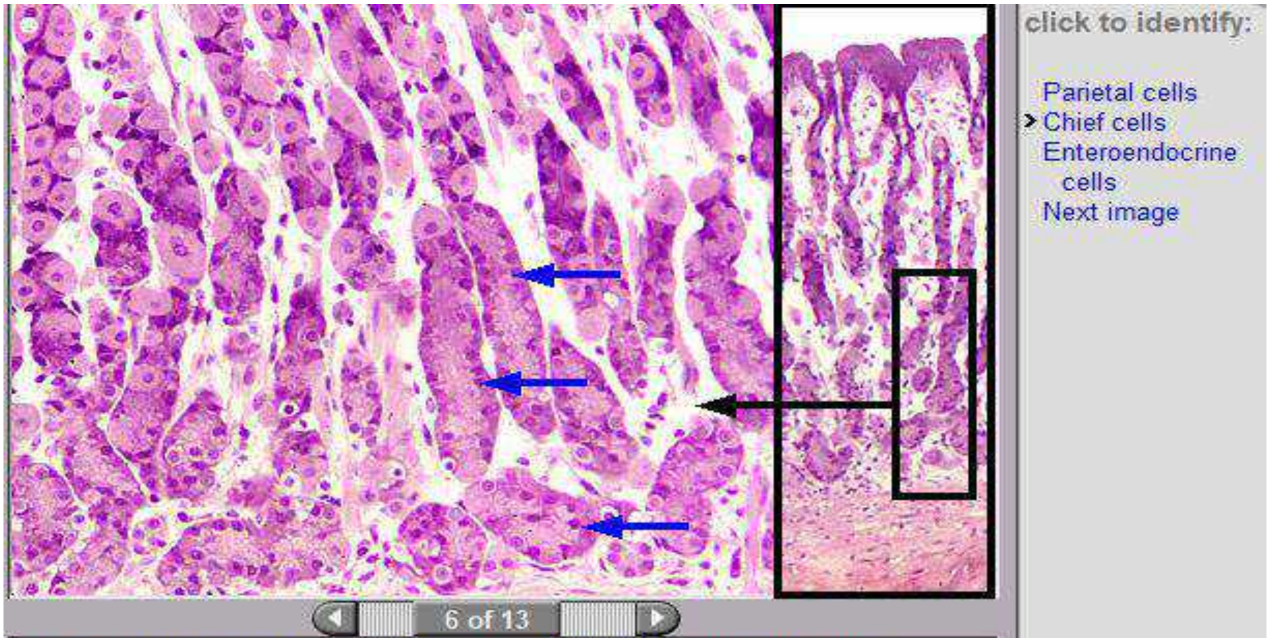


6 of 13

Stomach: fundus and body -- The bases of fundic glands, resting on the muscularis mucosae, are embedded in the loose connective tissue of the lamina propria. Although parietal cells are located here too, chief cells and enteroendocrine cells predominate in this area. 200x

click to identify:

- › Parietal cells
- Chief cells
- Enteroendocrine cells
- Next image



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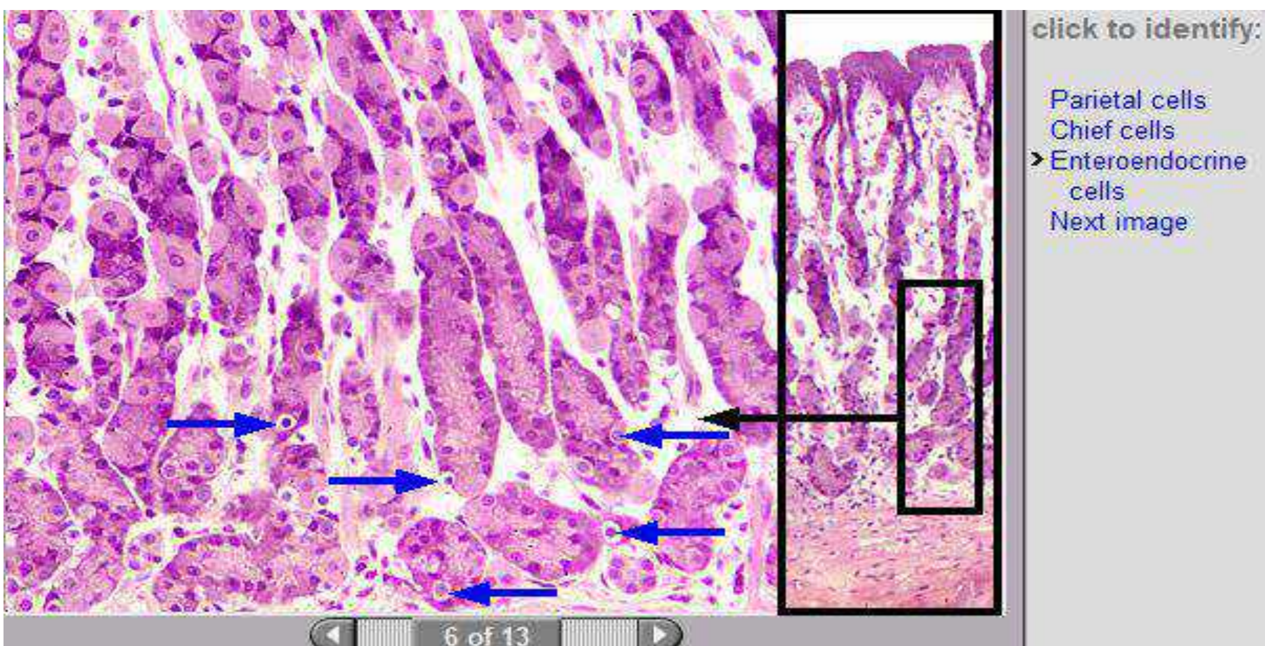

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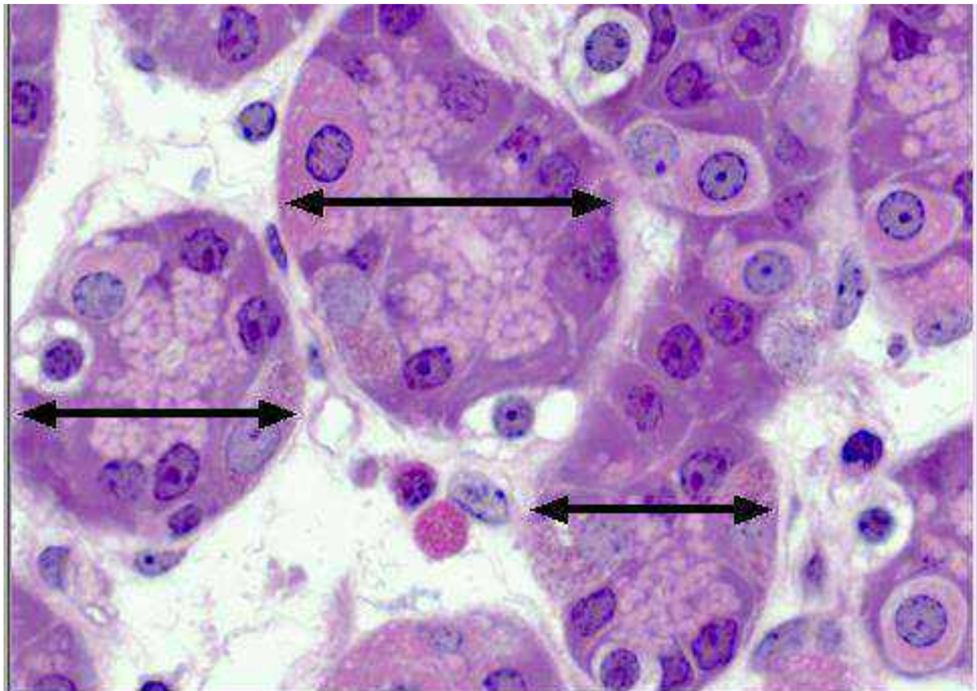
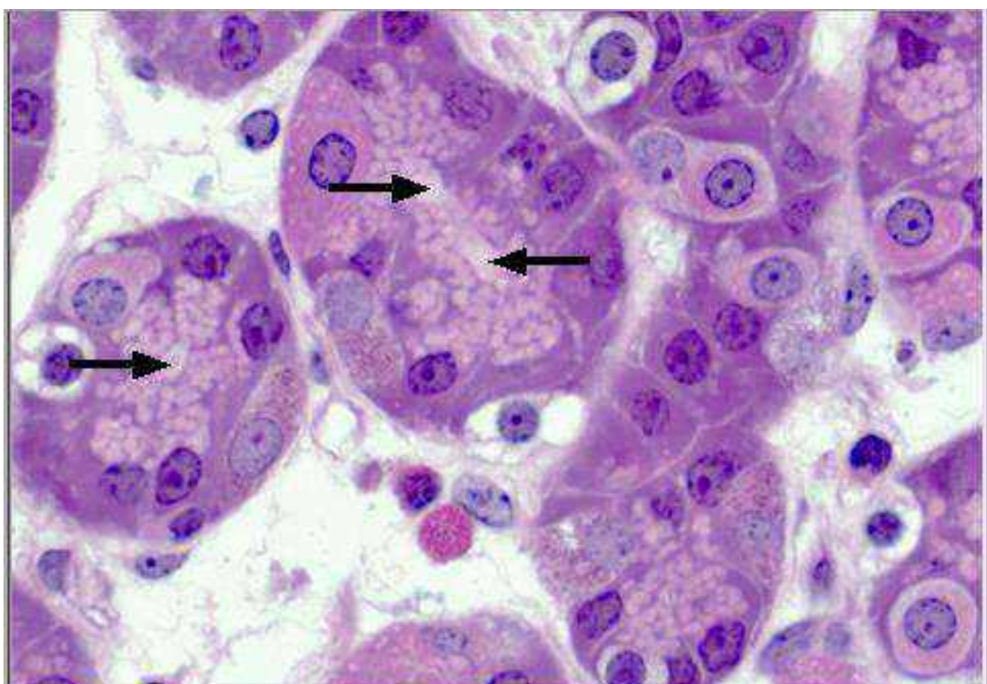


8 of 13

Stomach: fundus and body -- Bases of gastric glands in the fundic region of the stomach demonstrate several cell types. 1000x

click to identify:

- › Fundic glands
- Lumens of glands
- Lamina propria
- Parietal cell >
- Chief cells >
- DNES cells >
- Secretory > granules



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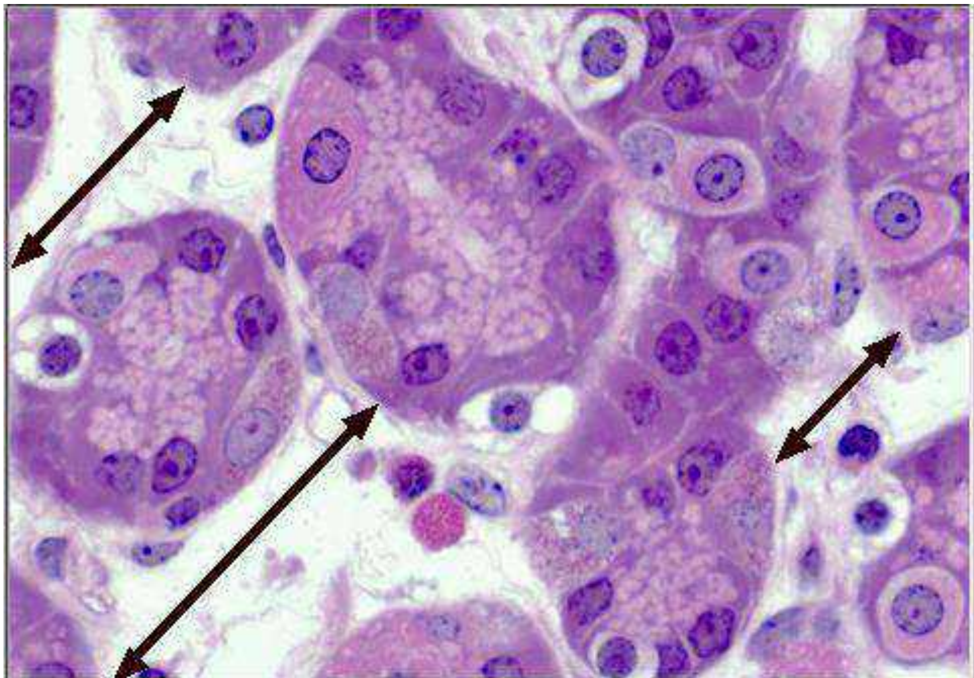

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Fundic glands
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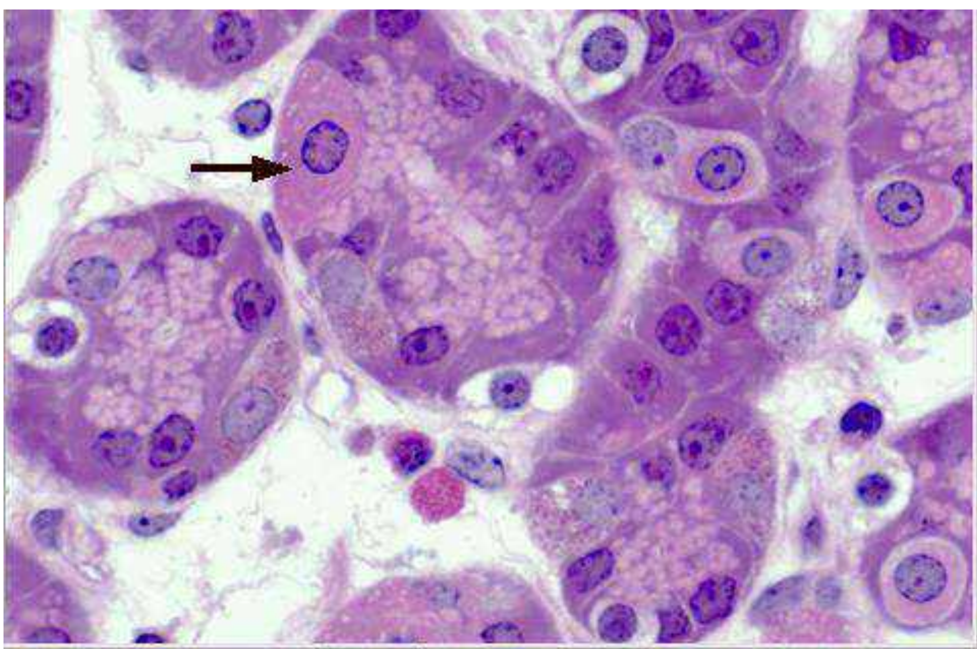
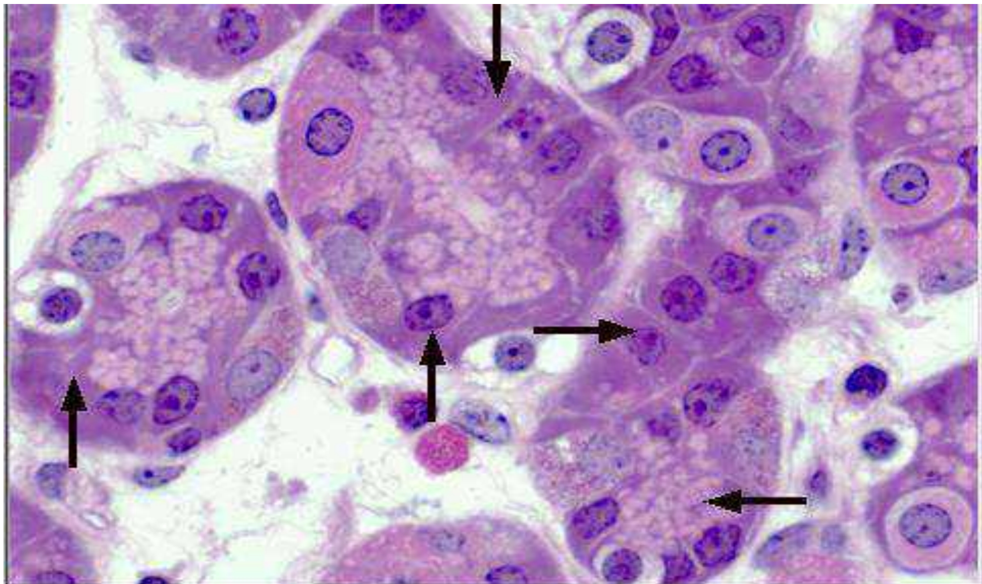


8 of 13

Although more numerous closer to the lumen of the stomach, parietal cells are also seen deep in the glands. They secrete HCl, which aids in digestion, converts pepsinogen into the active pepsin, and is bacteriostatic. Parietal cells resemble fried eggs, with abundant eosinophilic cytoplasm and a centrally located nucleus.

click to identify:

Fundic glands
Lumens of glands
Lamina propria
Parietal cell >
Chief cells >
DNES cells >
Secretory > granules

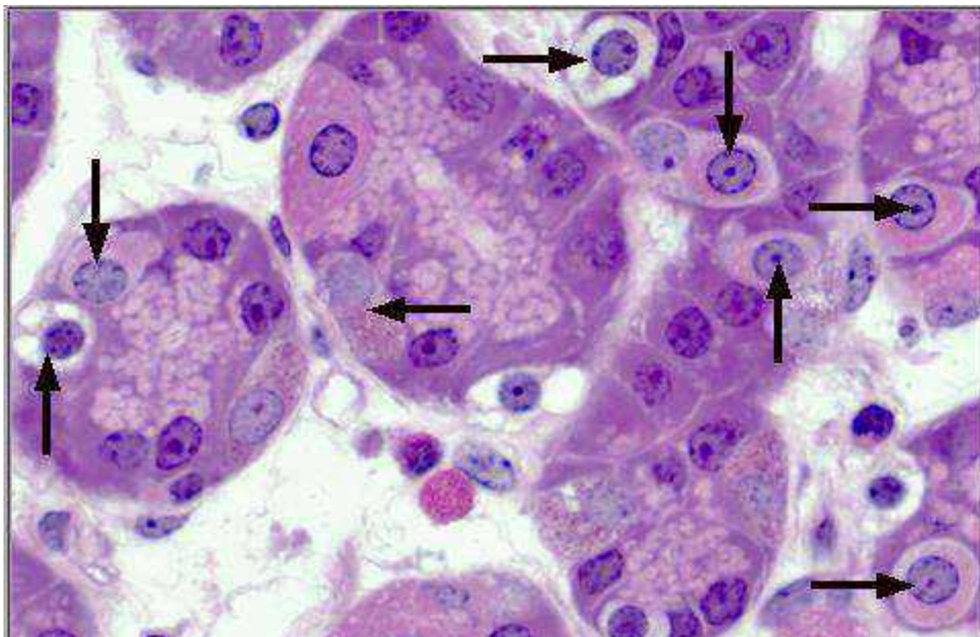


8 of 13

Chief cells secrete the enzyme precursor pepsinogen and, therefore, as protein-secreting exocrine cells, have basally located RER and apically located secretory granules. These cells are most numerous in the bases of the fundic glands, as seen here.

click to identify:

- Fundic glands
- Lumens of glands
- Lamina propria
- Parietal cell >
- Chief cells >
- DNES cells >
- Secretory > granules

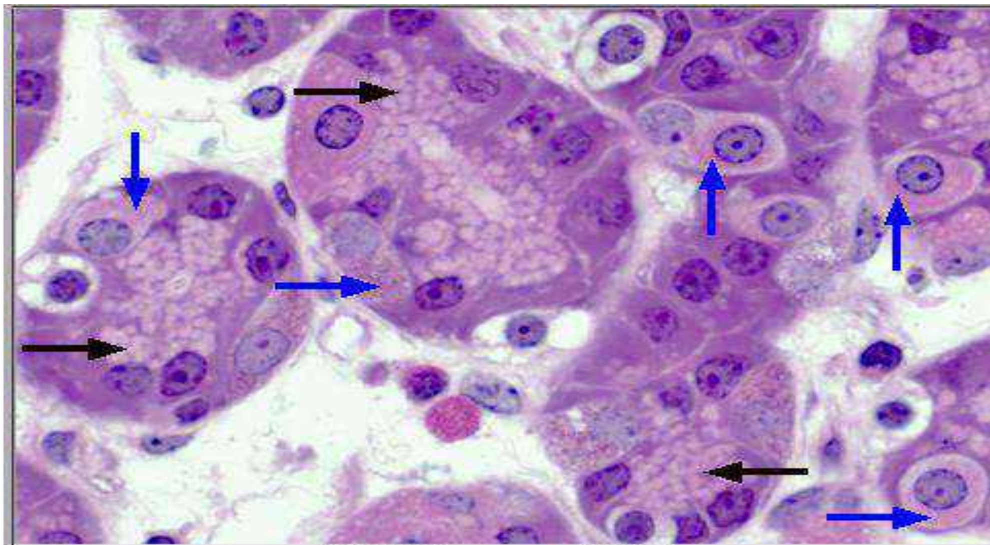


8 of 13

DNES (diffuse neuroendocrine system) cells are called enteroendocrine cells in the digestive system. They do not secrete their hormones into the lumens of the glands but into the surrounding connective tissue. Therefore, these cells are located at the periphery of the glands with their granules positioned away from the lumen and adjacent to the basement membrane.

click to identify:

- Fundic glands
- Lumens of glands
- Lamina propria
- Parietal cell >
- Chief cells >
- DNES cells >
- Secretory > granules

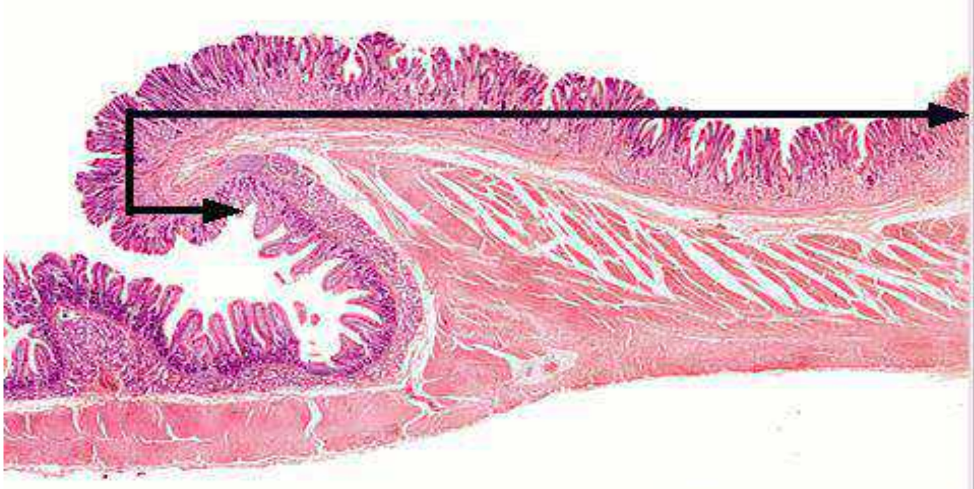


8 of 13

Secretory granules of chief cells (black arrows) lie adjacent to the glandular lumens into which they are released (exocrine secretion). Conversely, the secretory granules (blue arrows) of enteroendocrine cells are located adjacent to the basement membrane of fundic glands because their secretory product is released into the lamina propria (endocrine or paracrine secretion).

click to identify:

- Fundic glands
- Lumens of glands
- Lamina propria
- Parietal cell >
- Chief cells >
- DNES cells >
- › Secretory > granules



12 of 13

Gastro-duodenal junction -- Several criteria differentiate the transition of pyloric stomach to duodenum of the small intestine . As denoted by their names, gastric pits and gastric glands occur only in stomach. Villi, intestinal glands and Brunner's glands are present in the duodenum. The inner circular layer of muscularis externa in stomach is modified to form the pyloric sphincter. 10x

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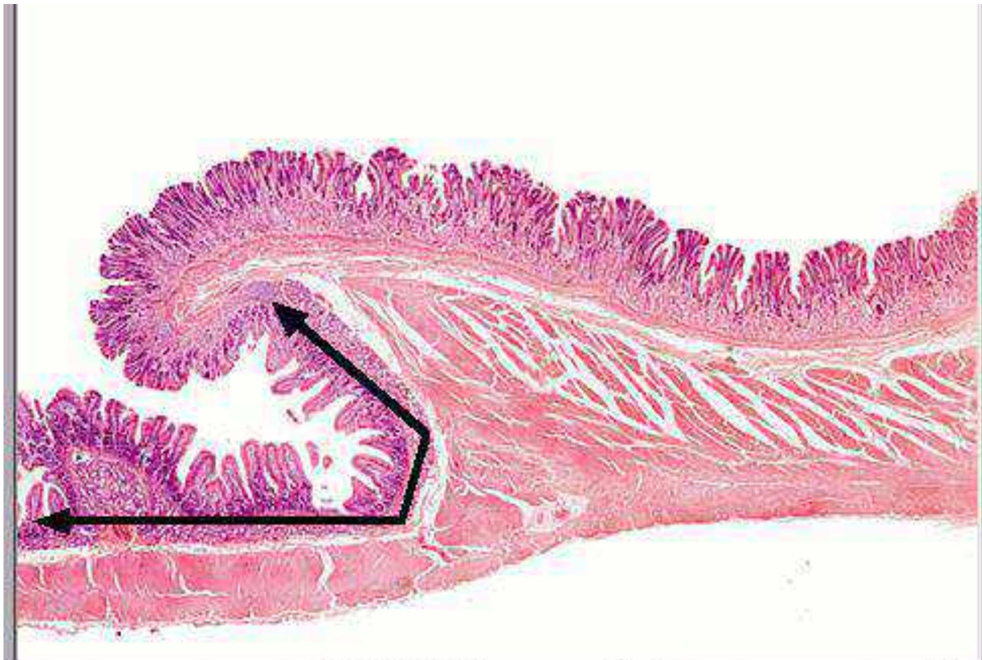
- › Pyloric stomach
- Duodenum
- Gastric pits
- Pyloric glands
- Villi
- Intestinal glands
- Brunner's glands
- Muscularis externa
- Pyloric sphincter



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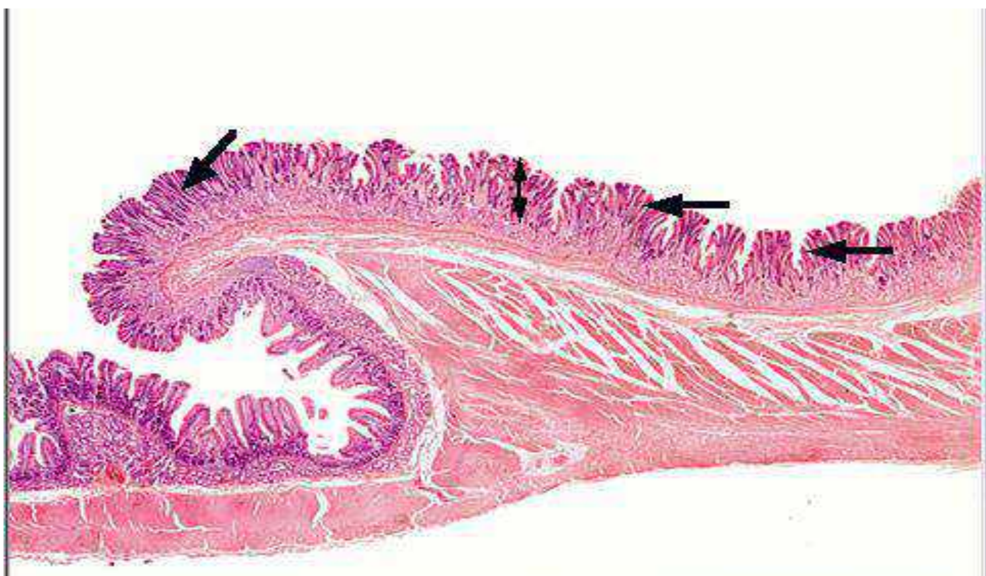

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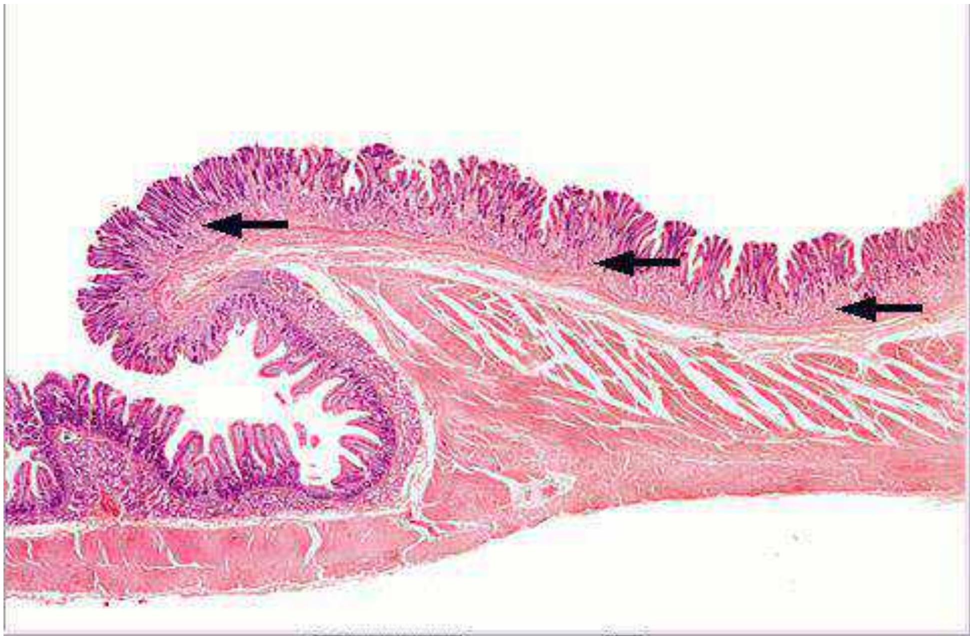

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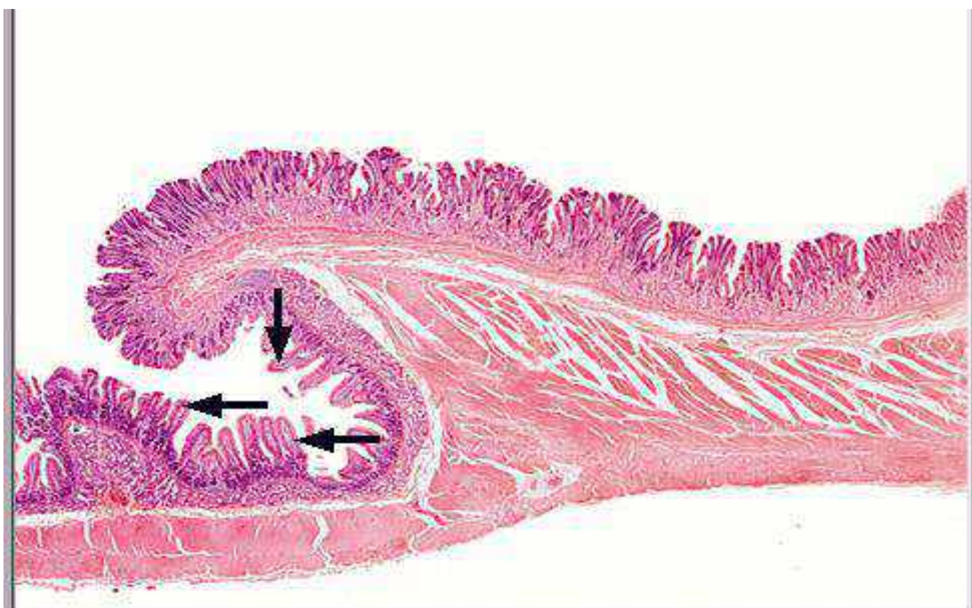

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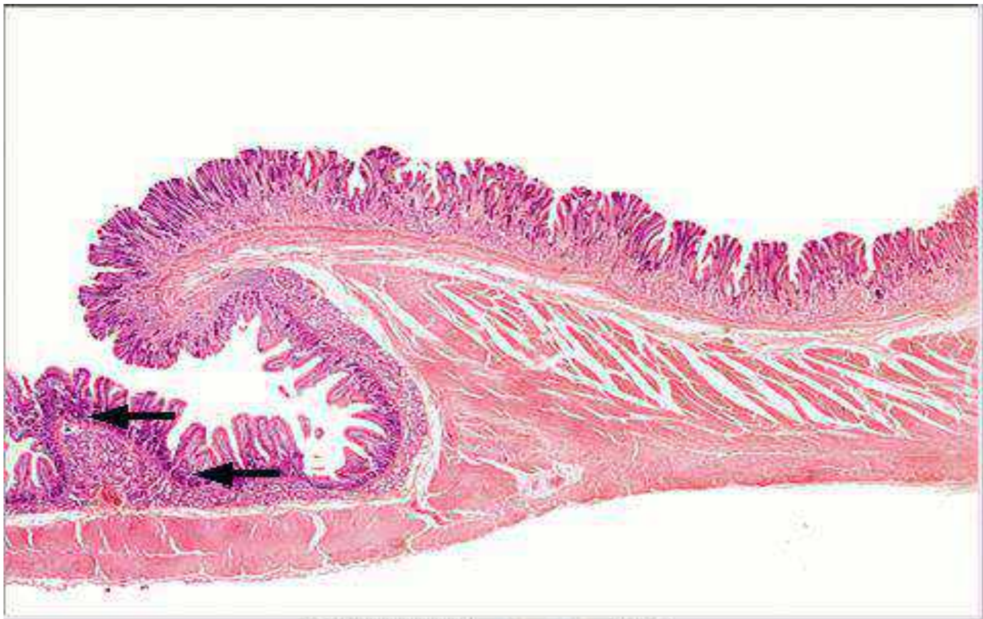

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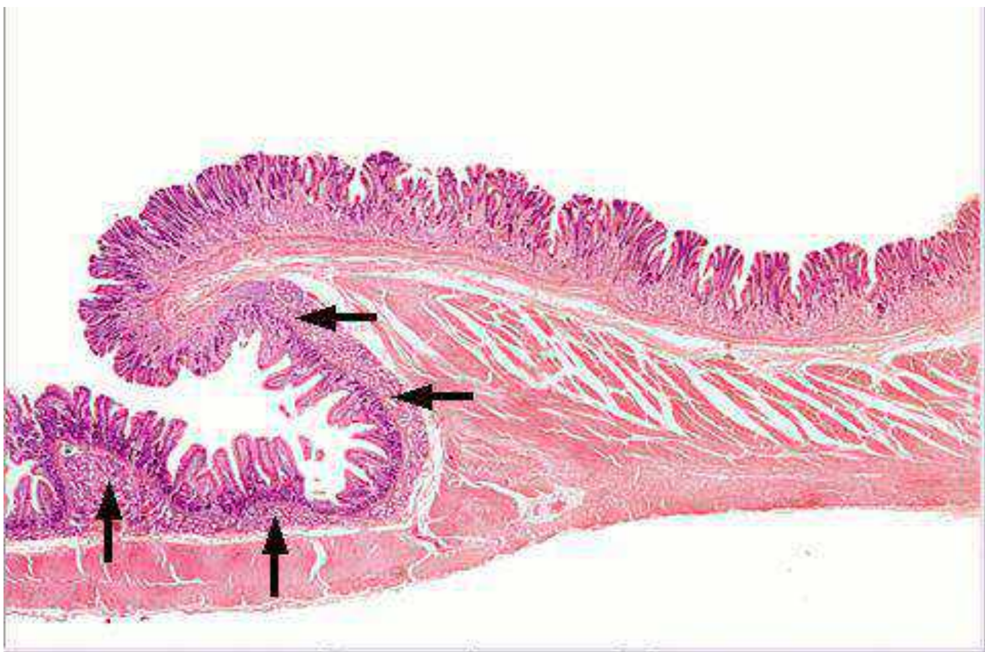

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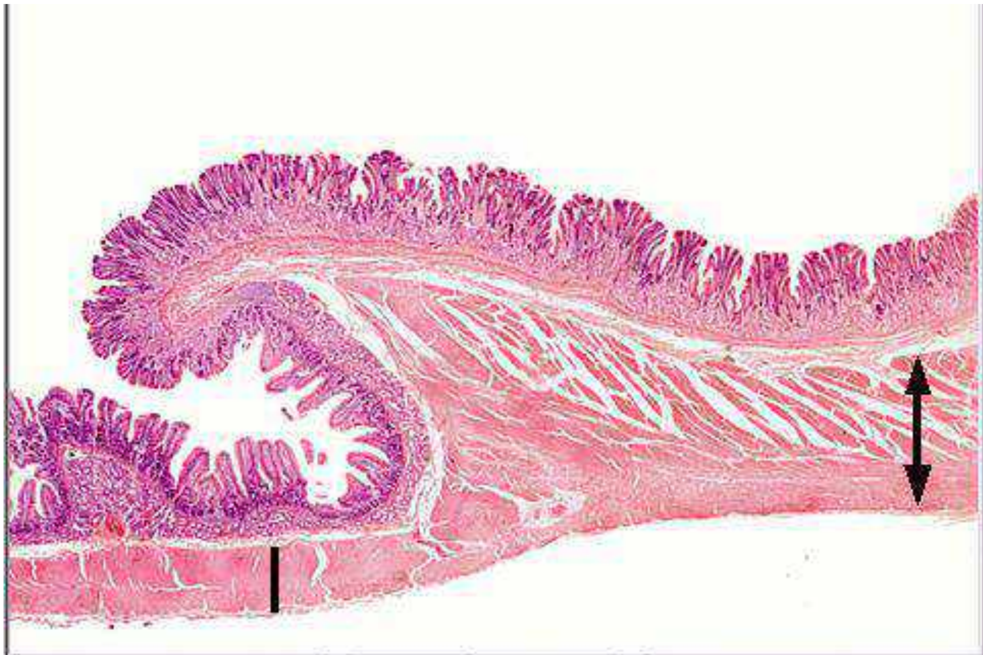

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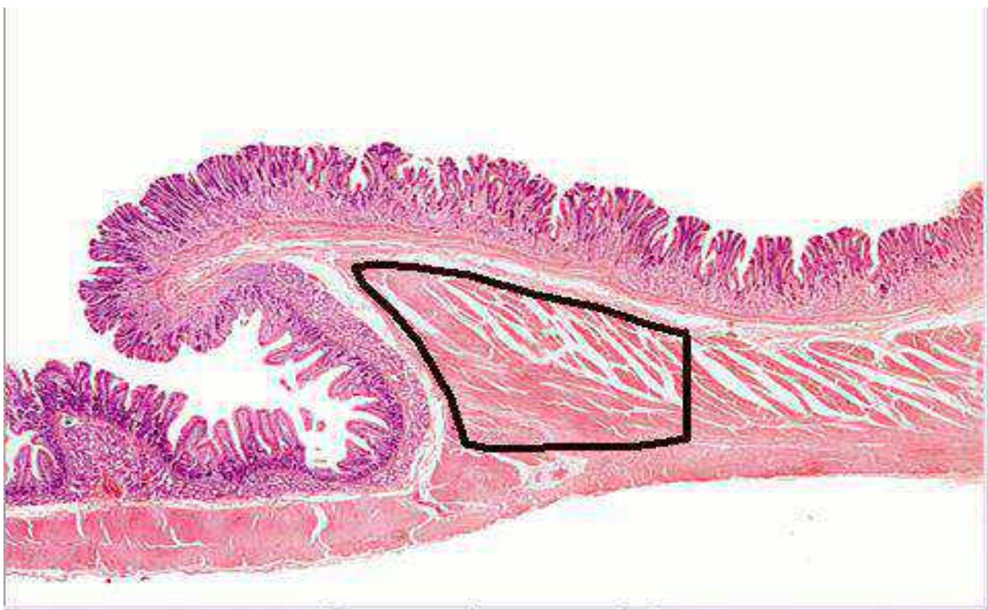

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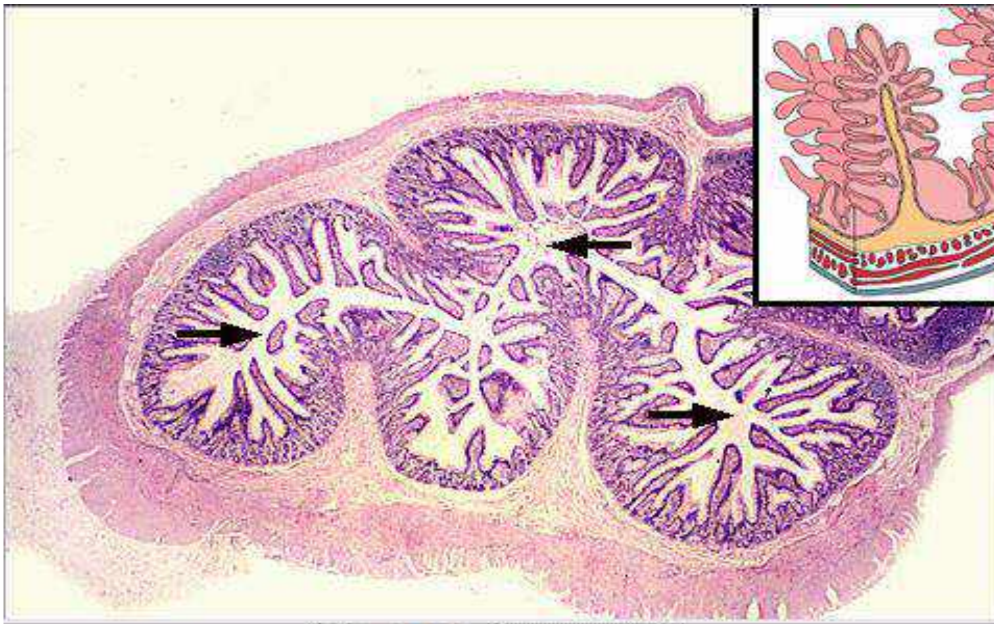
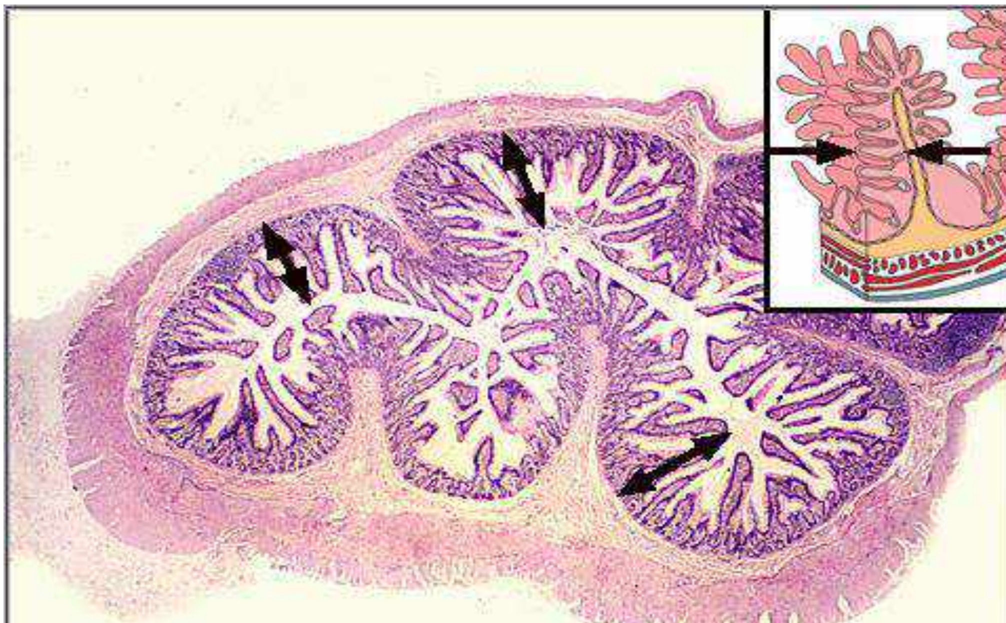


click to identify:

- Lumen
- Mucosa
- Submucosa
- Muscularis > externa
- Serosa >
- Villi >
- Plicae circulares >
- Mesentery >
- Next image

1 of 9

Overview -- Digestion is completed and metabolites are absorbed in the small intestine. The small intestine, composed of a mucosa, submucosa, muscularis externa and usually a serosa, is subdivided into duodenum, jejunum and ileum. The exocrine secretions of the pancreas and liver are released into the duodenum. 10x



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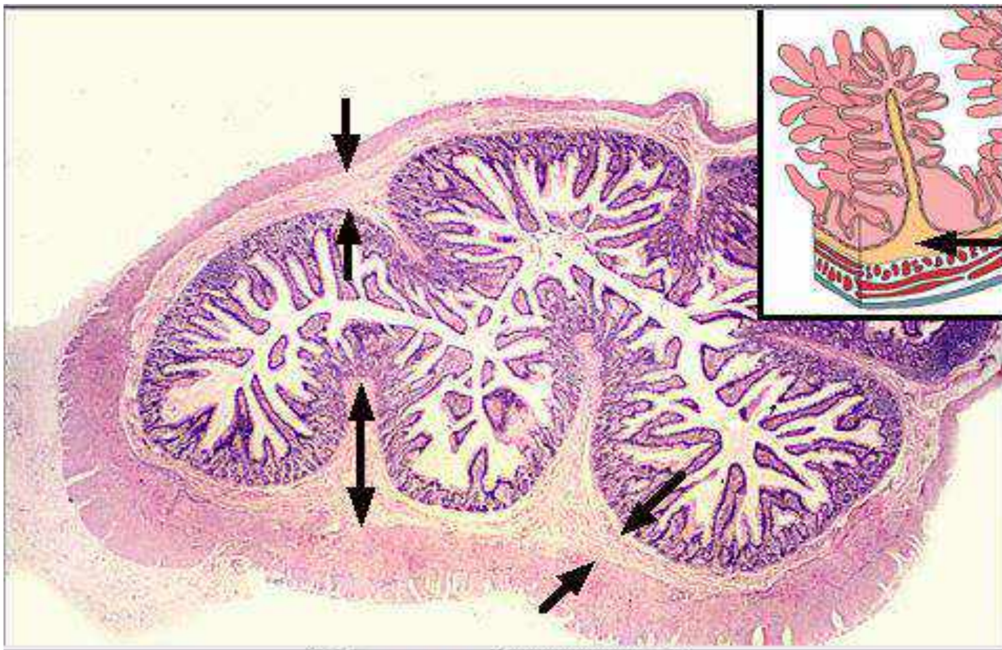

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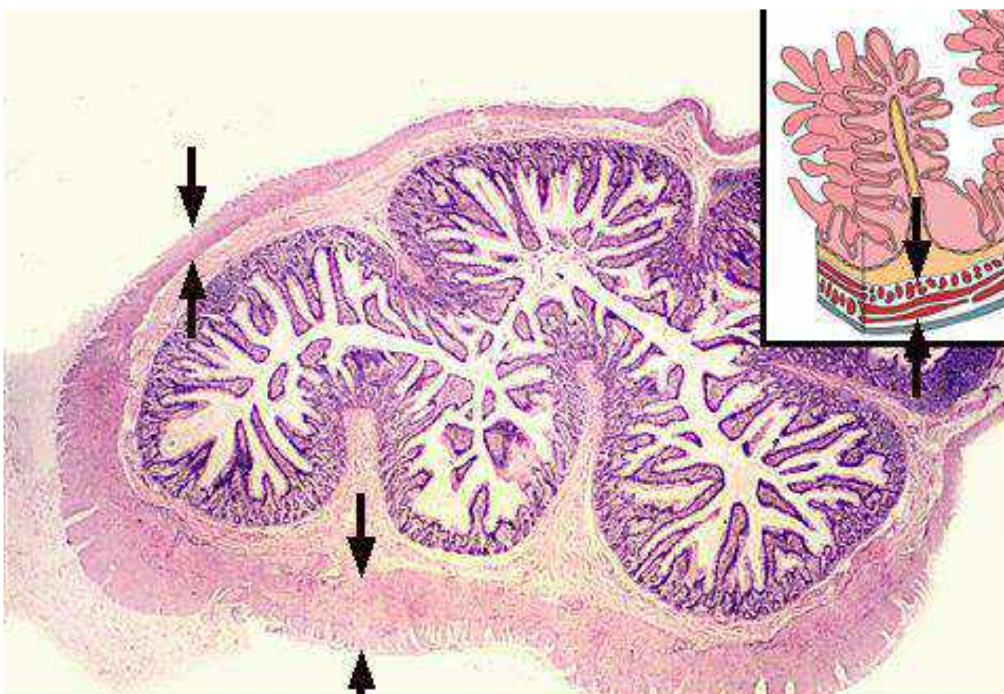
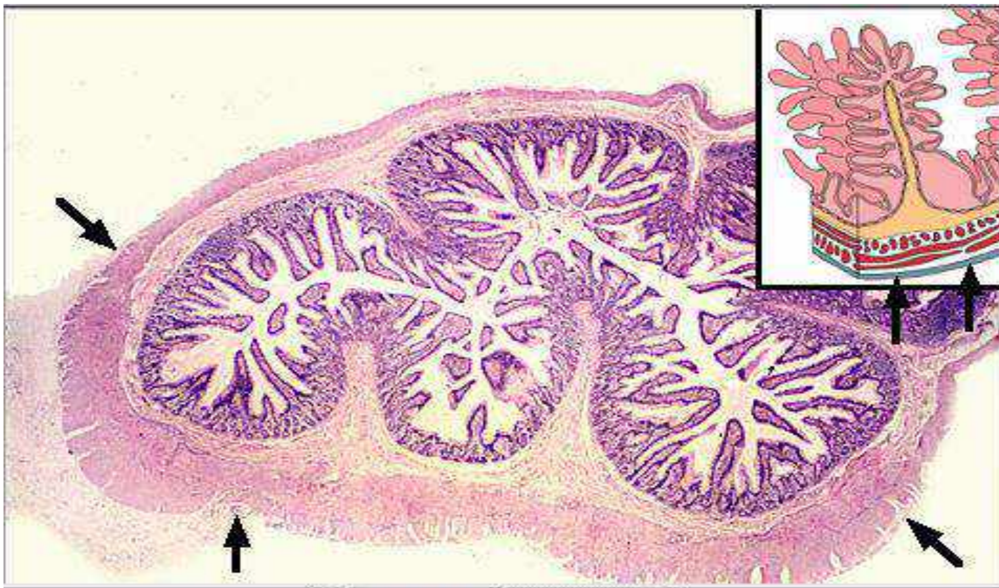


1 of 9

The muscularis externa of the small intestine is composed of inner circular and outer longitudinal layers of smooth muscle.

click to identify:

- Lumen
- Mucosa
- Submucosa
- › Muscularis > externa
- Serosa >
- Villi >
- Plicae circulares >
- Mesentery >
- Next image

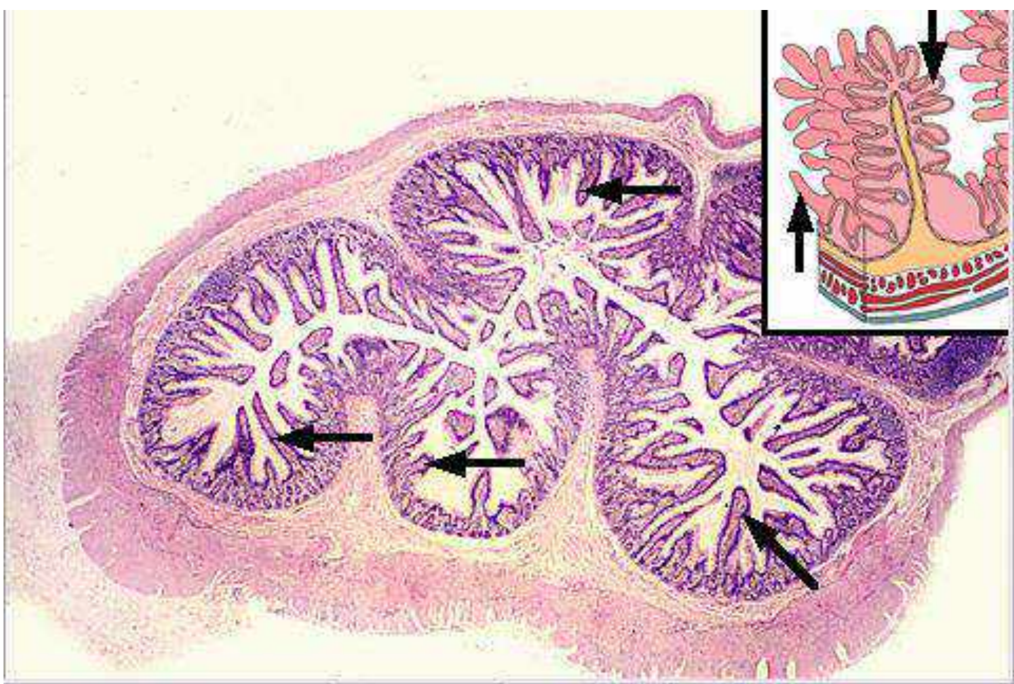


1 of 9

The outermost layer of the small intestine may be either an adventitia (in the part of the duodenum that is retroperitoneal) or a serosa, in the remainder of the duodenum and in the jejunum and ileum (shown here). (See serosa and adventitia in the General Concepts chapter to review where each is present.)

click to identify:

- Lumen
- Mucosa
- Submucosa
- Muscularis > externa
- › Serosa >
- Villi >
- Plicae circulares >
- Mesentery >
- Next image



1 of 9

Villi are finger-like projections from the surface of the small intestine into the lumen of the organ. Villi are composed of a central core of lamina propria covered by its overlying surface epithelium. The presence of villi are diagnostic for the small intestine.

click to identify:

- Lumen
- Mucosa
- Submucosa
- Muscularis > externa
- Serosa >
- › Villi >
- Plicae circulares >
- Mesentery >
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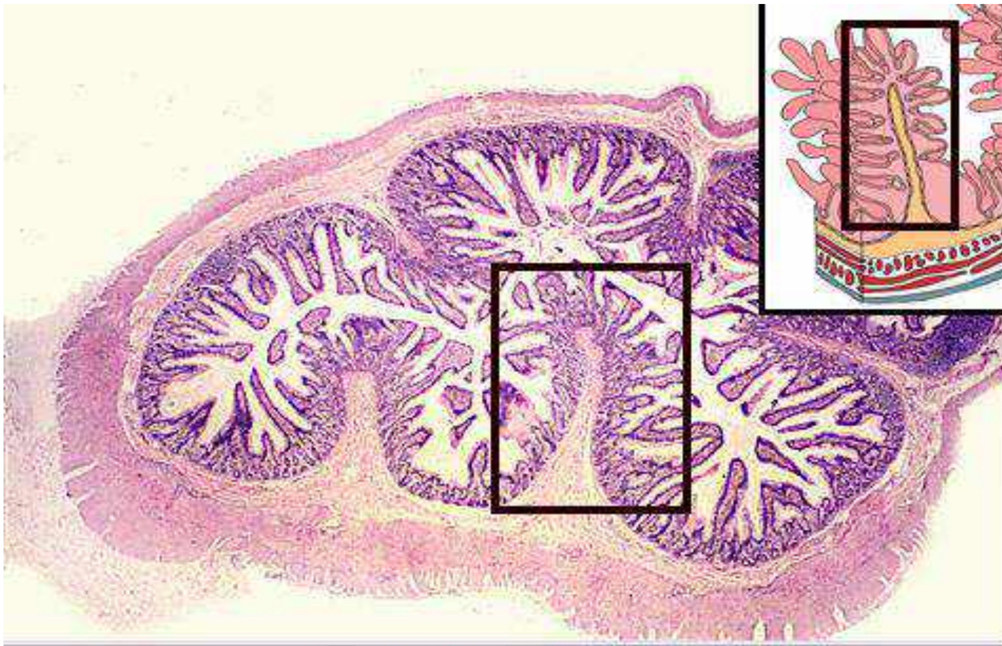

1 of 9

Plicae circulares are circular folds extending around the inner circumference of the small intestine. The central core of each plica, formed by the submucosa, pushes up all the overlying layers. Therefore, the entire mucosa (including villi and glands) overlying the submucosal core is included in each plica.

click to identify:

- Lumen
- Mucosa
- Submucosa
- Muscularis > externa
- Serosa >
- Villi >
- › Plicae circulares >
- Mesentery >
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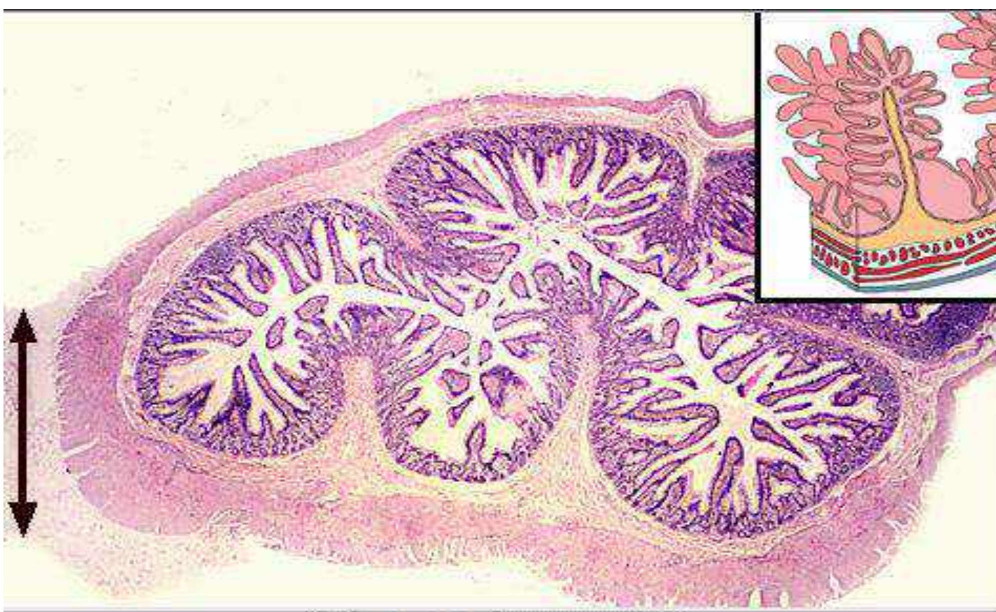

1 of 9

The mesentery suspends most of the small intestine from the dorsal body wall. It is composed of two serosal layers and an intervening layer of loose connective tissue.

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- Lumen
- Mucosa
- Submucosa
- Muscularis > externa
- Serosa >
- Villi >
- Plicae circulares >
- › Mesentery >
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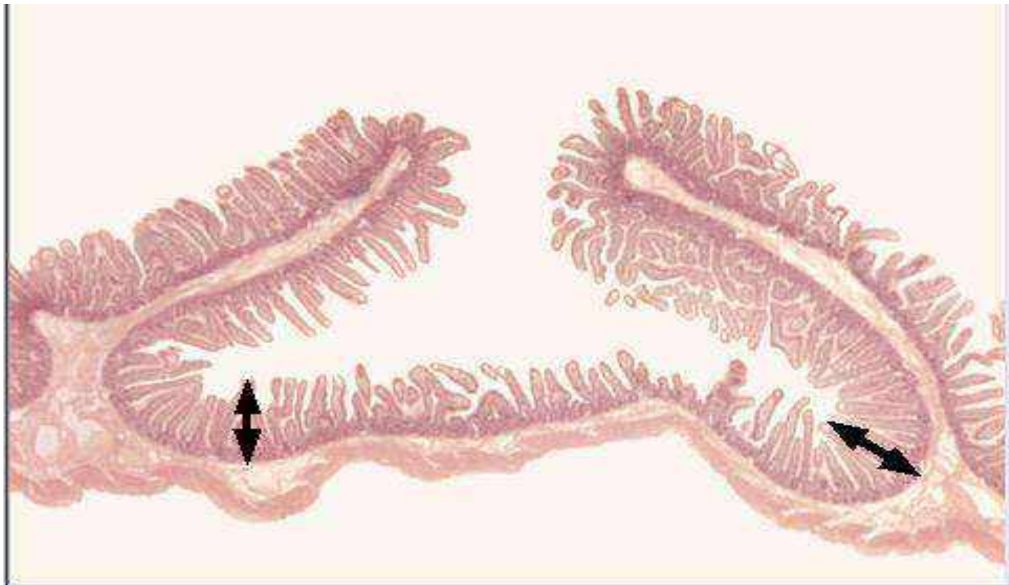
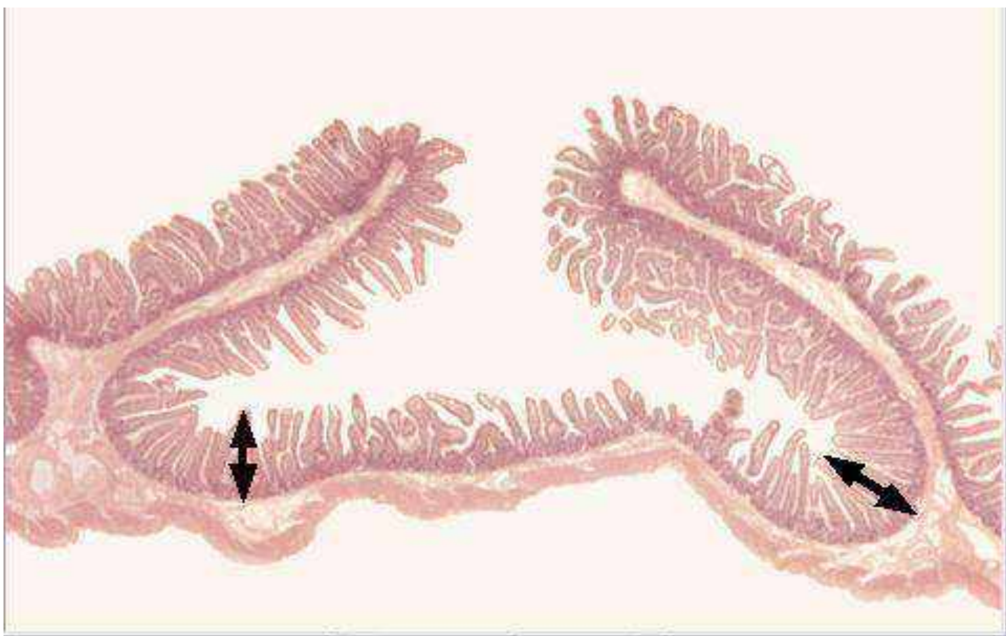


2 of 9

Overview -- A longitudinal section of the small intestine displays the four layers of this organ as well as structures that aid to increase surface area, plicae circulares and villi. Each plica has a core of submucosa that is overlain by all mucosal layers, including villi. Villi have a core of lamina propria covered by the intestinal epithelium, including microvilli. 10x

click to identify:

- Mucosa
- Submucosa
- Muscularis externa
- Serosa
- Villi
- Intestinal glands
- Plicae circulares
- Next image



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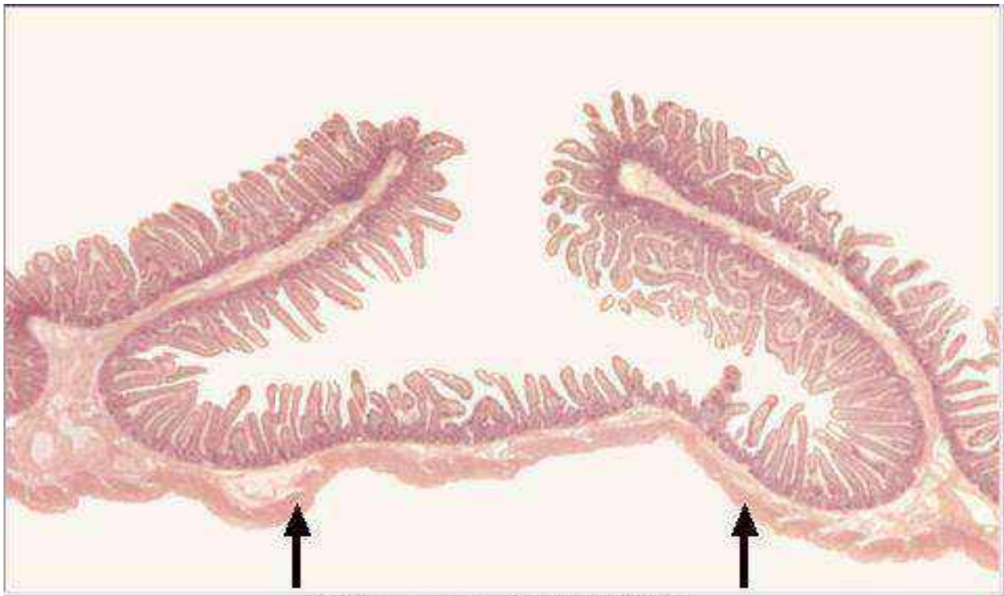

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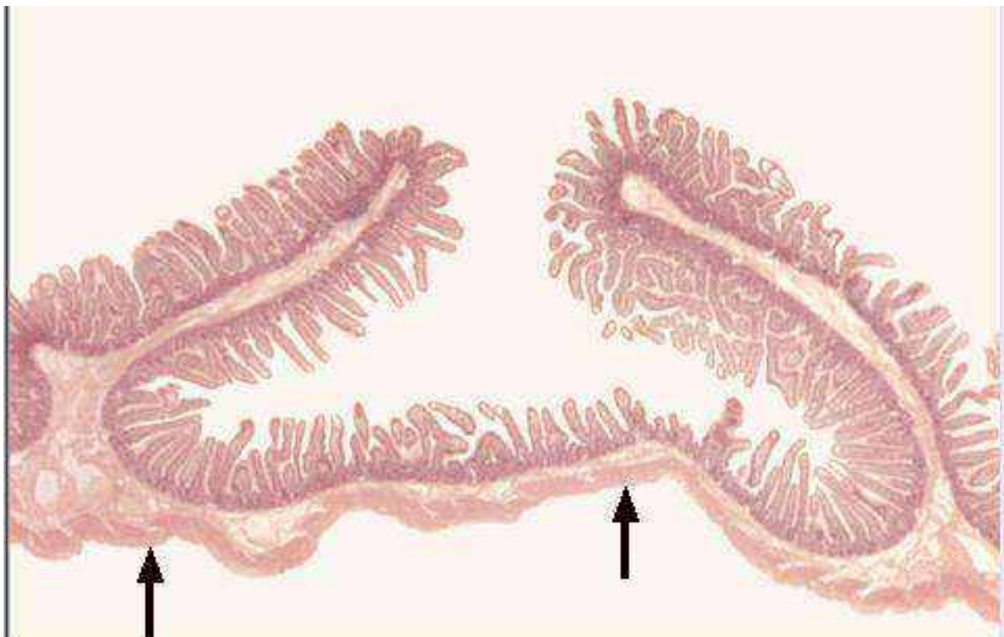

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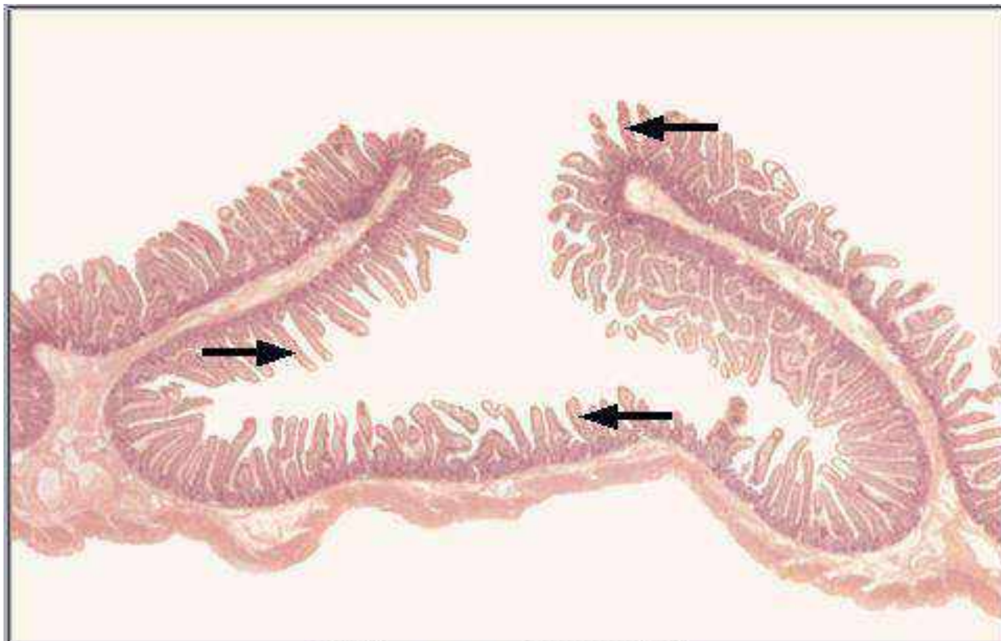

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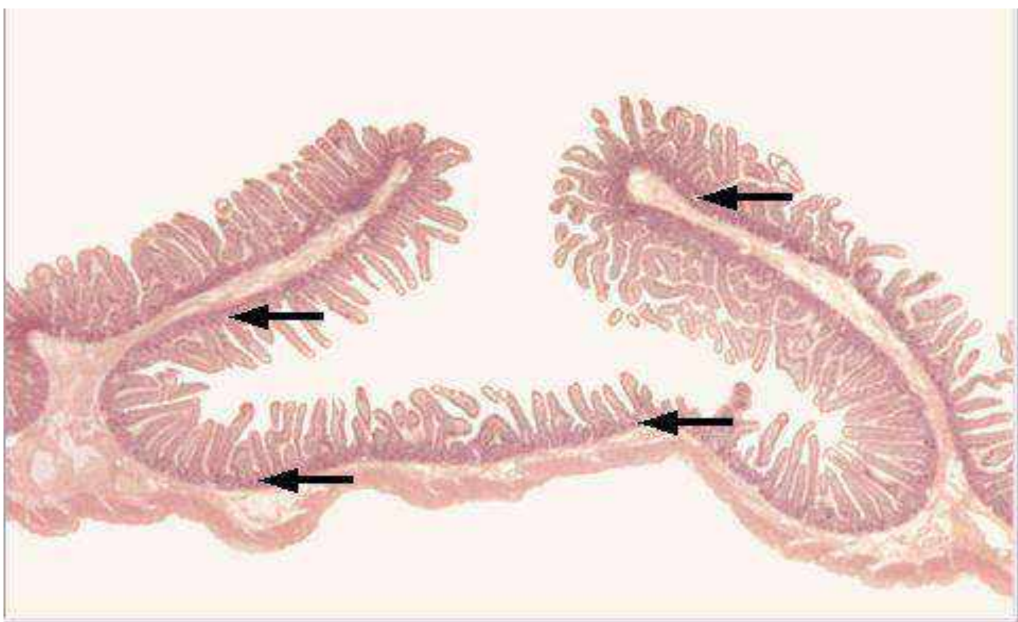

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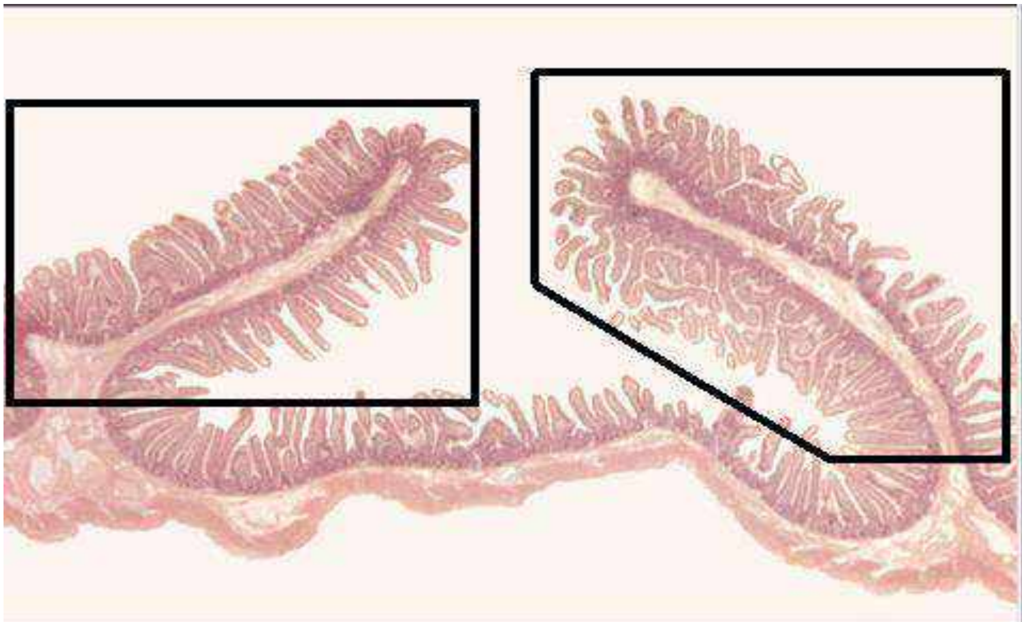

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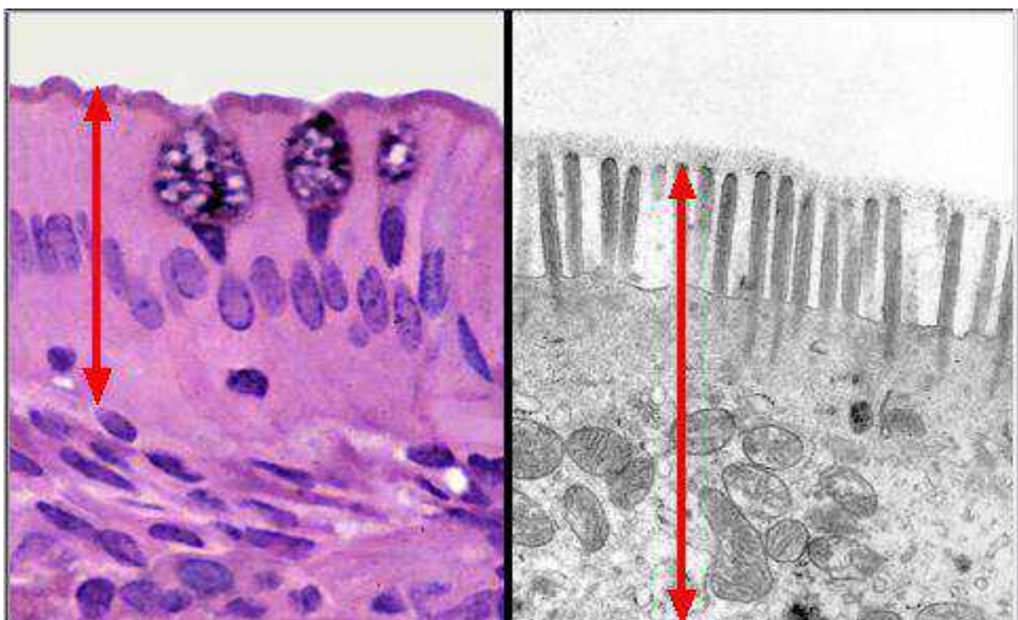
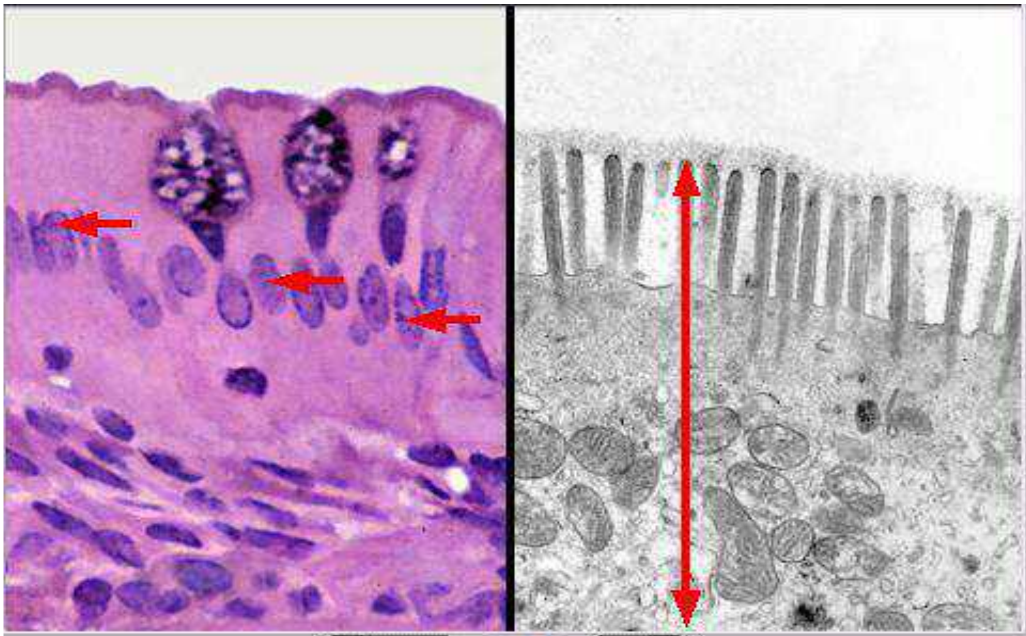


6 of 9

Overview -- The small intestine is lined by a simple columnar epithelium with microvilli and goblet cells. The majority of these epithelial cells are absorptive cells (enterocytes) involved with the uptake of nutrients from ingested food. 1000x, 10,000x

click to identify:

- › Epithelium
- Enterocytes >
- Microvilli
- Glycocalyx
- Goblet cells >
- Lamina propria >

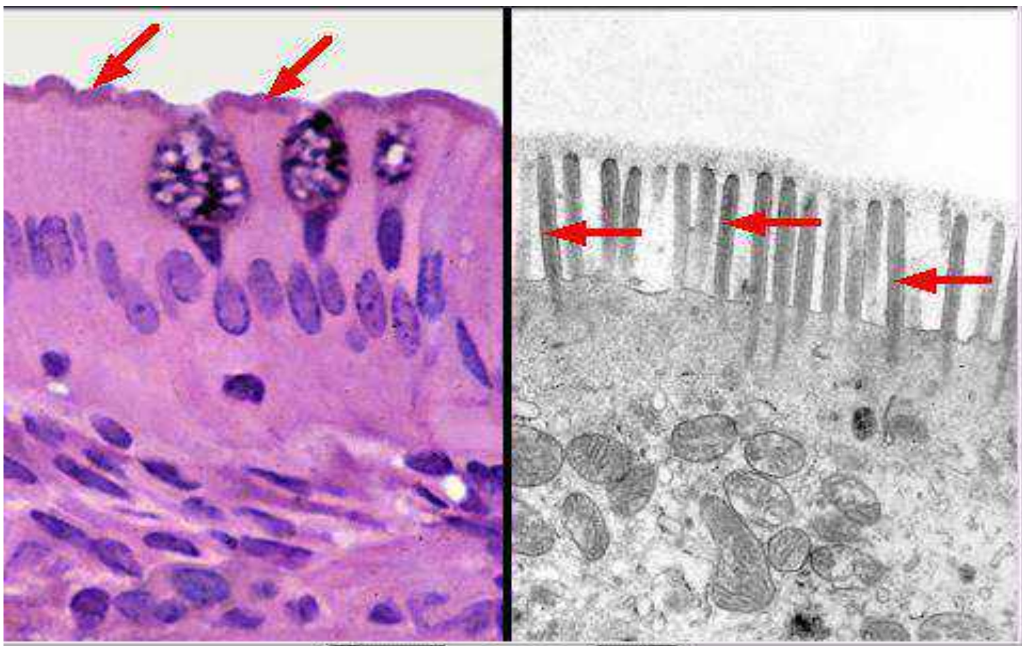


6 of 9

The luminal surfaces of enterocytes, the simple columnar cells of this epithelium, are covered by microvilli that increase the surface area for absorption. A glycocalyx, also located at the extracellular surface, sequesters enzymes important in digestion and in the transport of nutrients.

click to identify:

- Epithelium
- Enterocytes >
- Microvilli
- Glycocalyx
- Goblet cells >
- Lamina propria >



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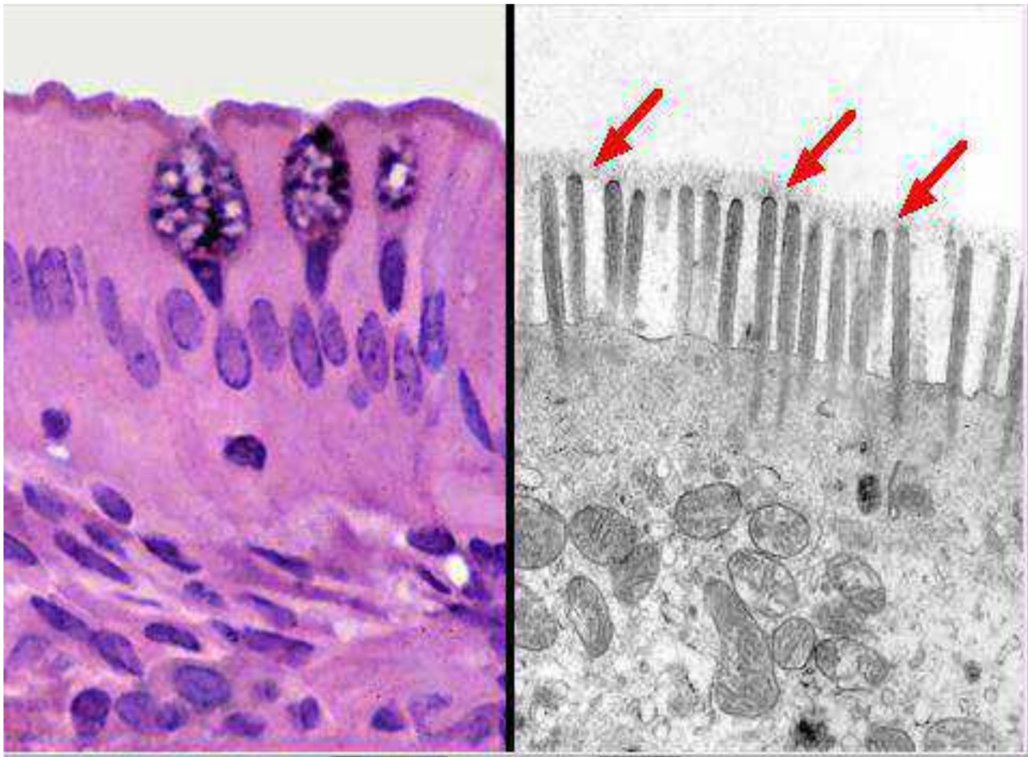
- Enterocytes >
- Microvilli
- Glycocalyx
- Goblet cells >
- Lamina propria >



click to identify:

Epithelium
Enterocytes >
Microvilli
> Glycocalyx
Goblet cells >
Lamina propria >

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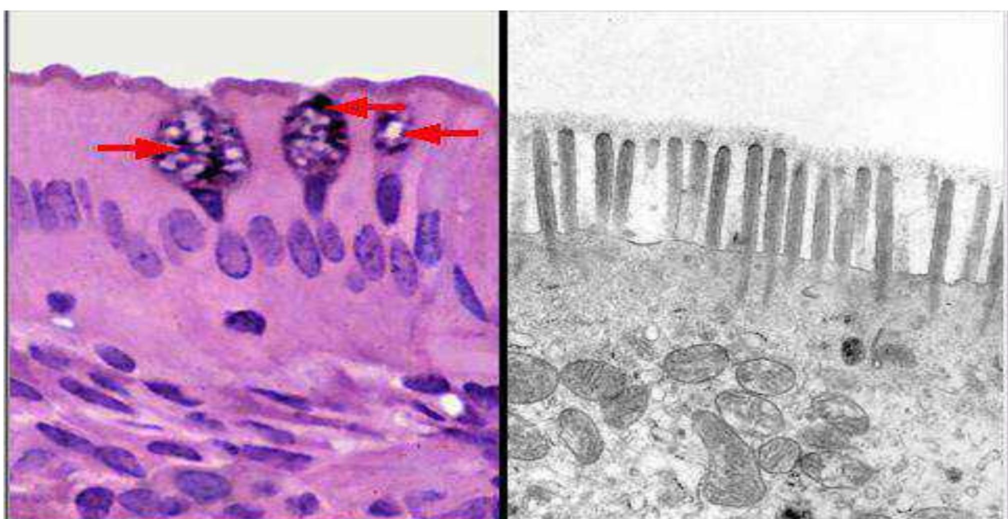
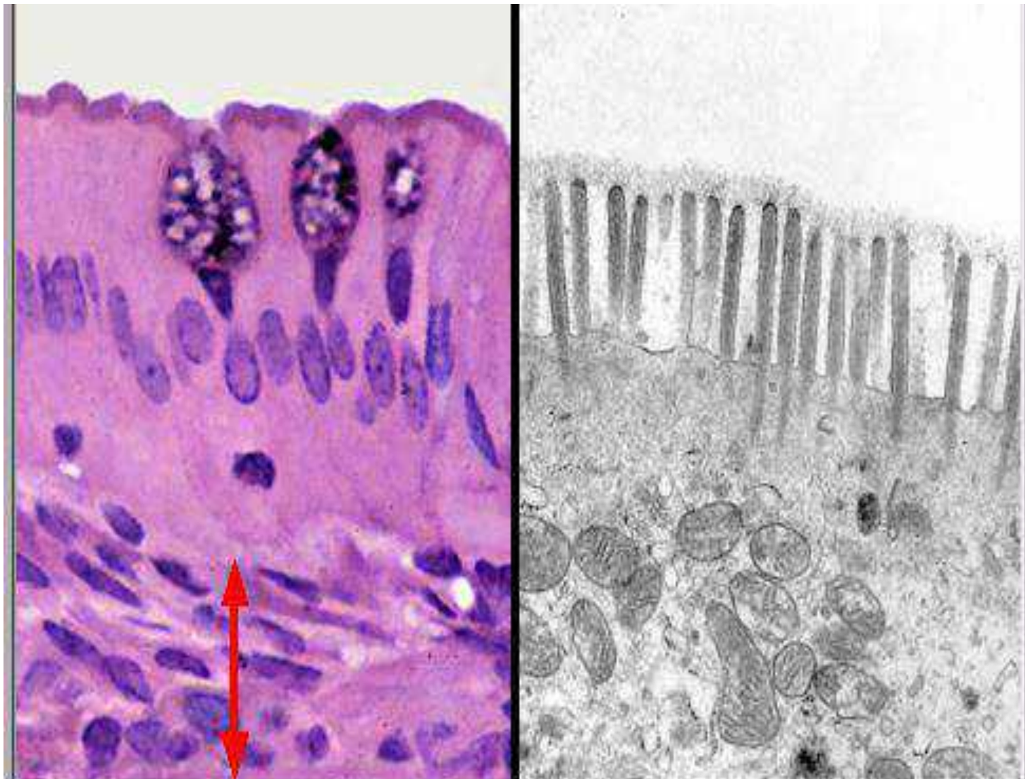


click to identify:

Epithelium
Enterocytes >
Microvilli
Glycocalyx
> Goblet cells >
Lamina propria >

6 of 9

Goblet cells are the second cell type in the epithelium. Mucin droplets produced by these cells accumulate in the bulging apex, while the nucleus and remaining cytoplasm form the "stem" of the each goblet. Goblet cells, found throughout the small and large intestines, produce mucus that lubricates the surface of the intestines.

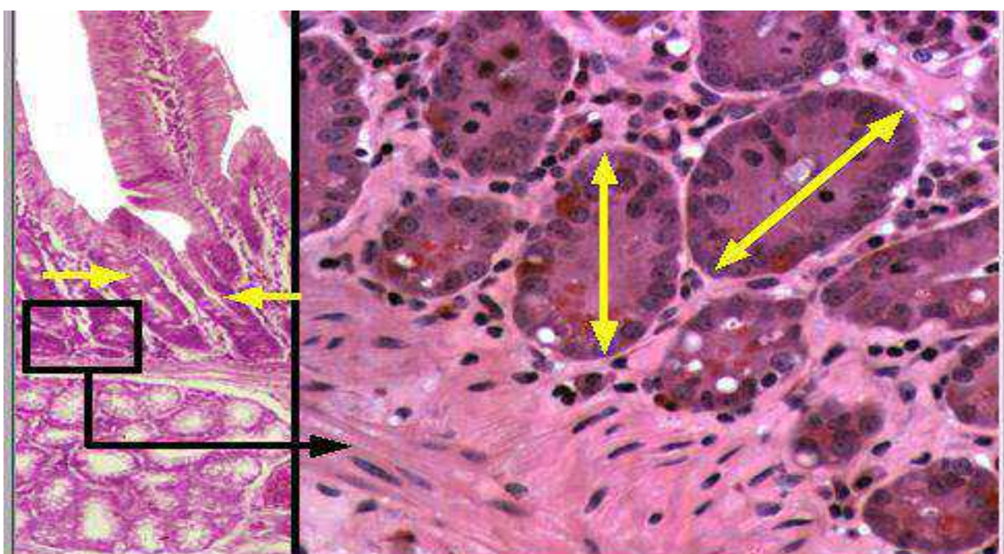


6 of 9

A lamina propria of loose connective tissue underlies the epithelium.

click to identify:

- Epithelium
- Enterocytes >
- Microvilli
- Glycocalyx
- Goblet cells >
- Lamina propria >

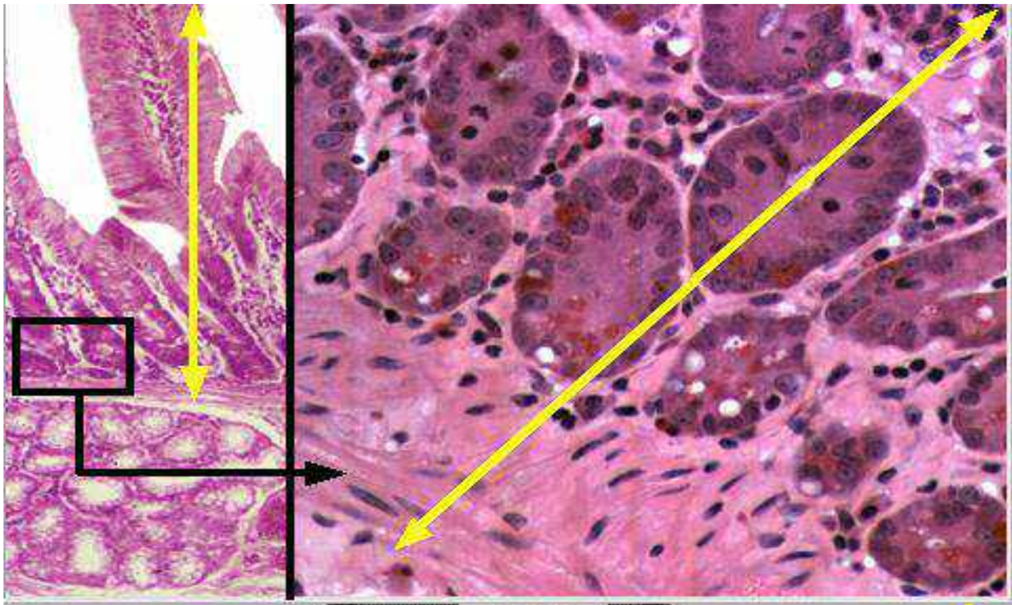


7 of 9

Overview -- Epithelial invaginations into the lamina propria of the small intestine form the intestinal glands, also known as the glands or crypts of Lieberkuhn; the bases of these glands extend down to the muscularis mucosae. Intestinal glands contain goblet cells, some absorptive cells, Paneth cells and enteroendocrine (DNES) cells. 100x, 400x

click to identify:

- Intestinal glands
- Mucosa
- Lamina propria
- Muscularis mucosae
- Submucosa
- Next image



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- Lamina propria
- Muscularis mucosae
- Submucosa
- Next image

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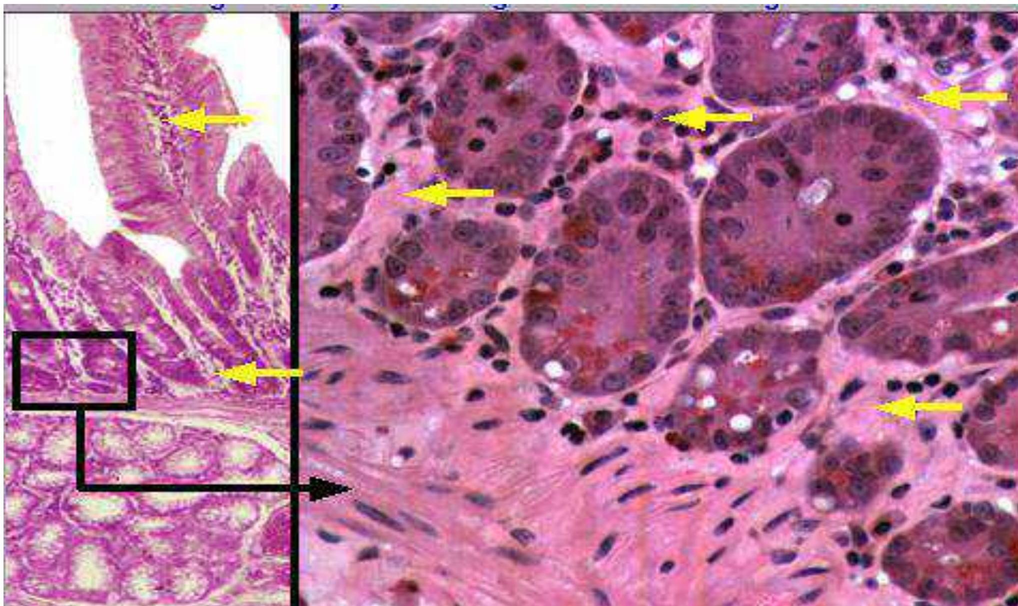

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- Mucosa
- › Lamina propria
- Muscularis mucosae
- Submucosa
- Next image

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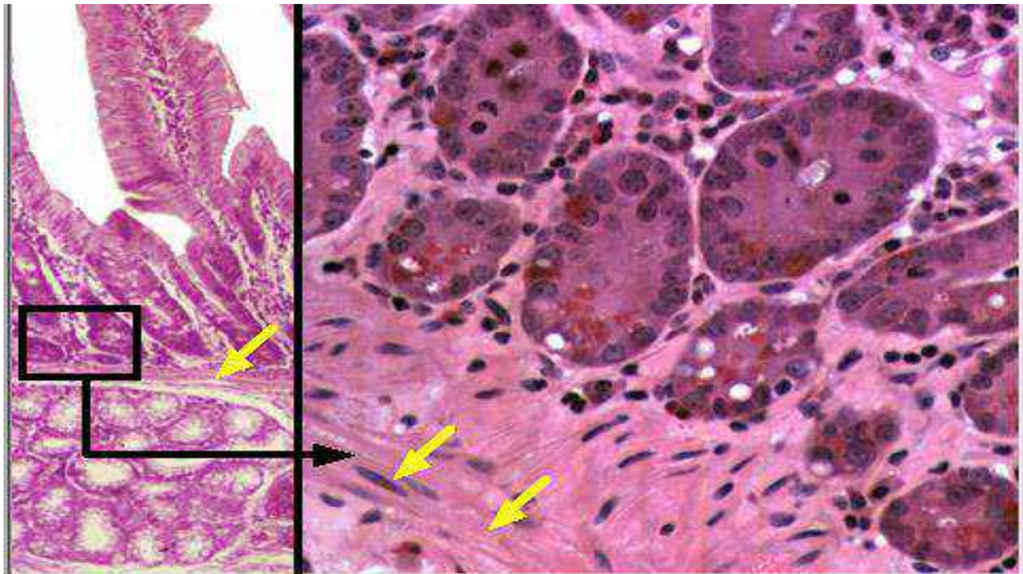

7 of 9

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Intestinal glands
Mucosa
Lamina propria
› Muscularis mucosae
Submucosa
Next image

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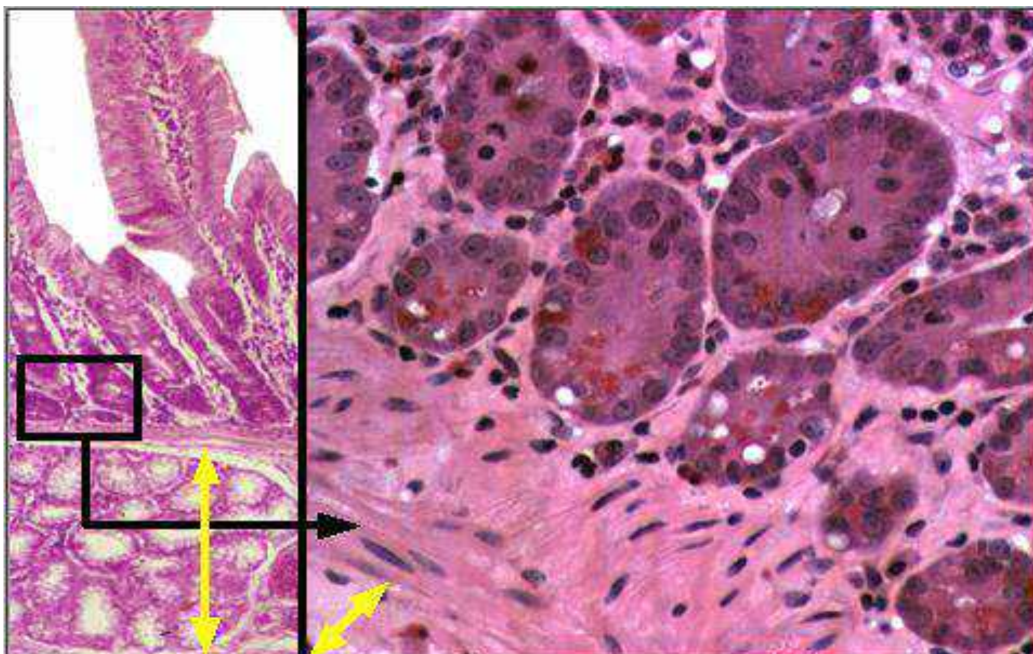

7 of 9

click to identify:

Intestinal glands
Mucosa
Lamina propria
Muscularis mucosae
› Submucosa
Next image

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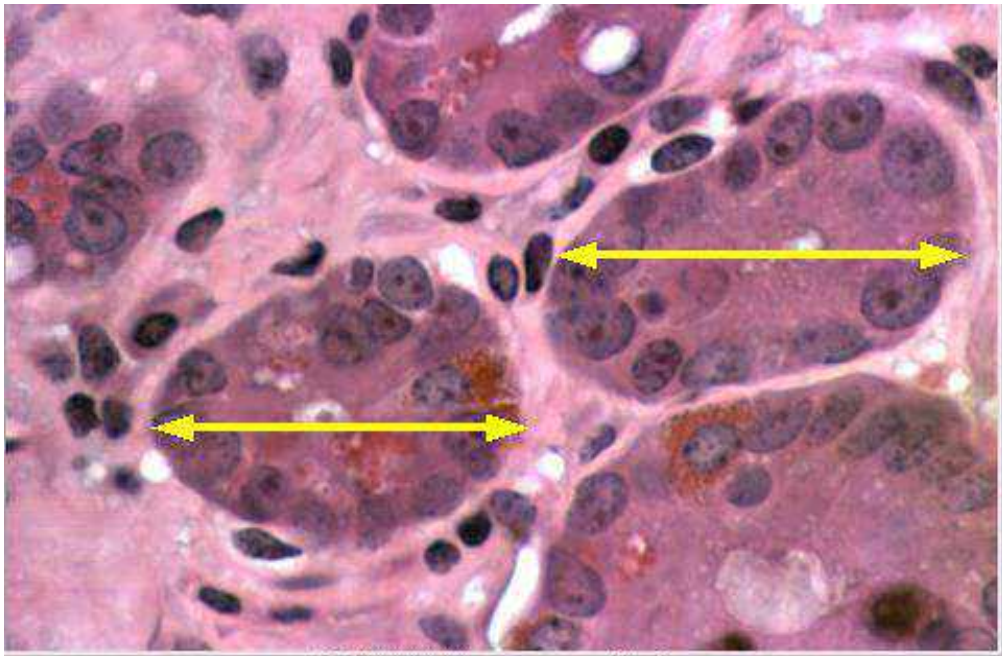
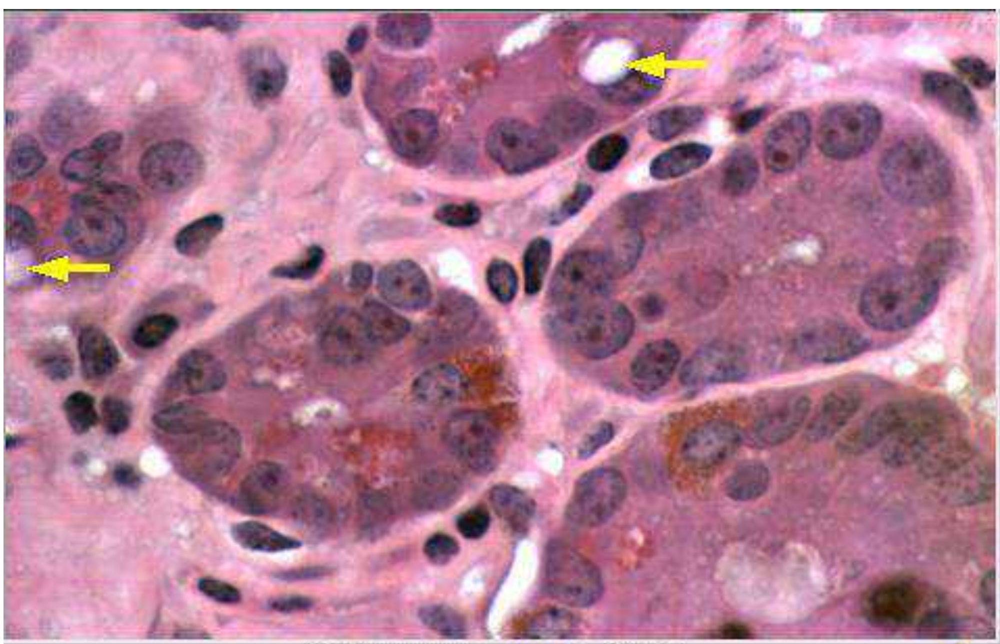


8 of 9

Overview -- Intestinal glands, seen here in cross section, are formed by an epithelium composed of absorptive cells, goblet cells, Paneth cells, precursor cells and enteroendocrine (DNES) cells. 1000x

click to identify:

- > Intestinal glands
- Goblet cells
- Precursor cells >
- Paneth cells >
- Enteroendocrine > cells
- Lamina propria >
- Plasma cell



8 of 9

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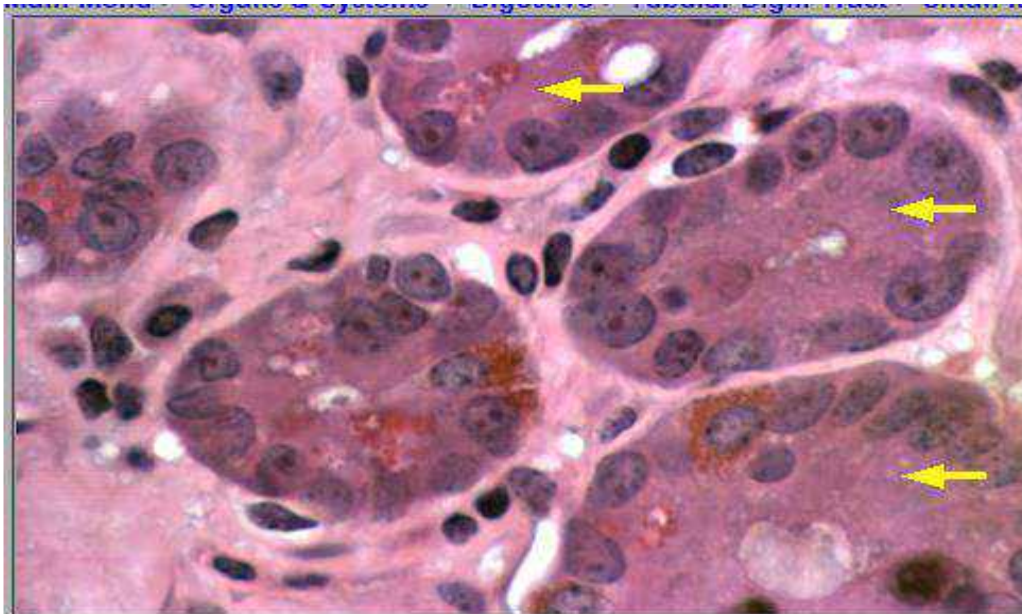
click to identify:

- Intestinal glands
- > Goblet cells
- Precursor cells >
- Paneth cells >
- Enteroendocrine > cells
- Lamina propria >
- Plasma cell

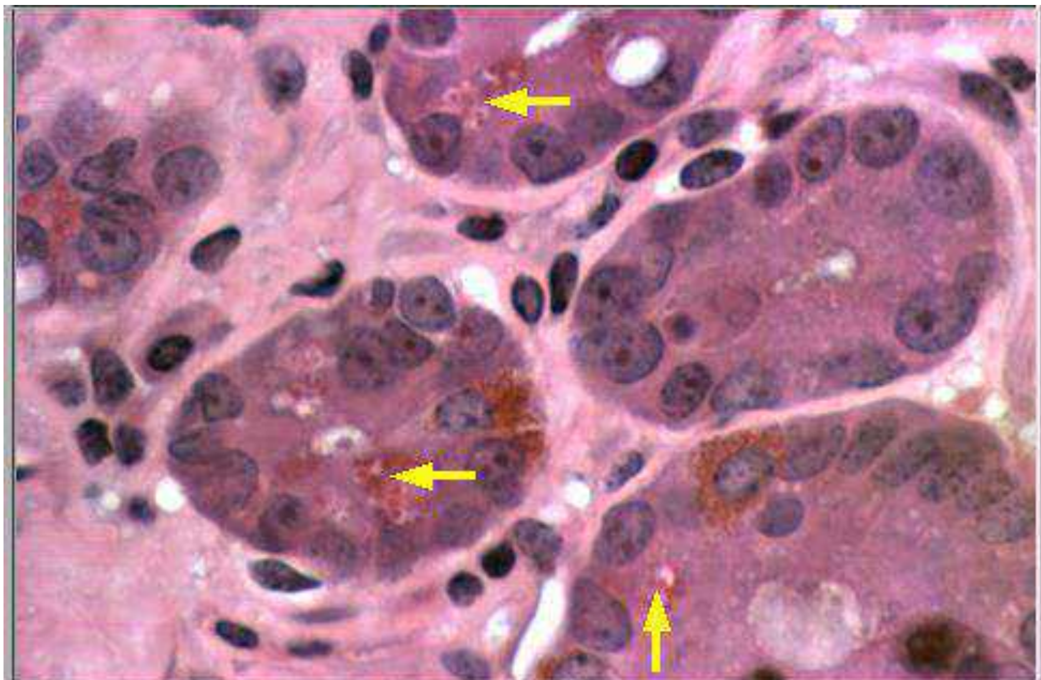


8 of 9

The crypts of Lieberkuhn house precursor cells (stem and intermediate cells) that replenish the supply of both the absorptive and goblet cells. When formed, these differentiated cells migrate up the intestinal glands and villi to be shed from the tips of the villi.

click to identify:

- Intestinal glands
- Goblet cells
- Precursor cells >
- Paneth cells >
- Enteroendocrine > cells
- Lamina propria >
- Plasma cell

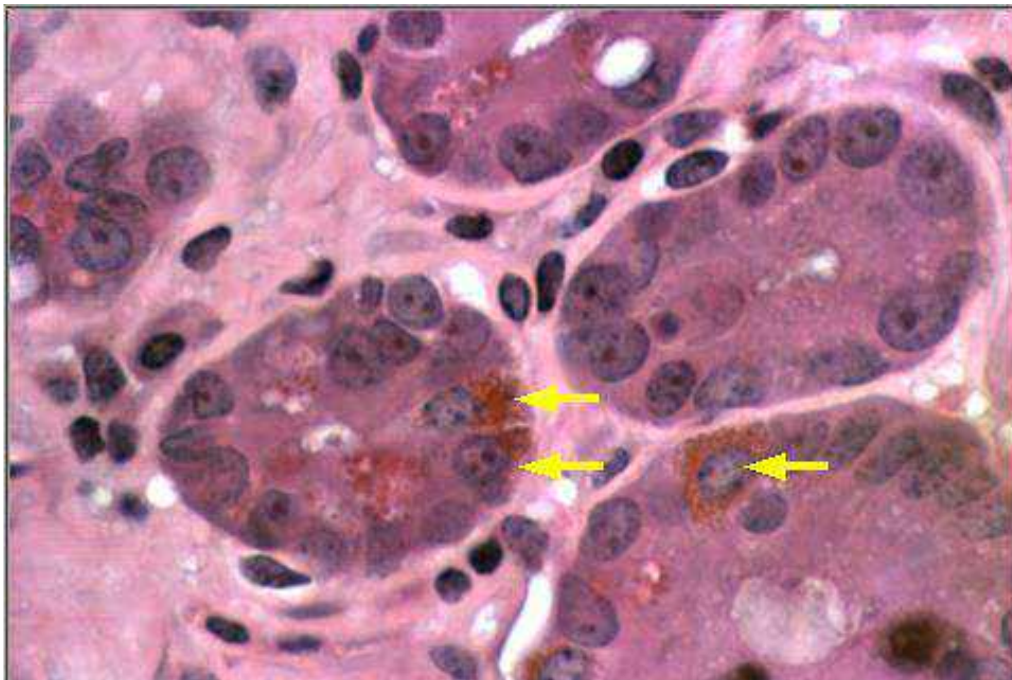


8 of 9

Paneth cells have prominent, eosinophilic granules that face the lumens of the glands. They produce lysozyme, an enzyme that digests bacterial cell walls, and also probably aids in maintenance of healthy intestinal flora.

click to identify:

- Intestinal glands
- Goblet cells
- Precursor cells >
- Paneth cells >
- Enteroendocrine > cells
- Lamina propria >
- Plasma cell

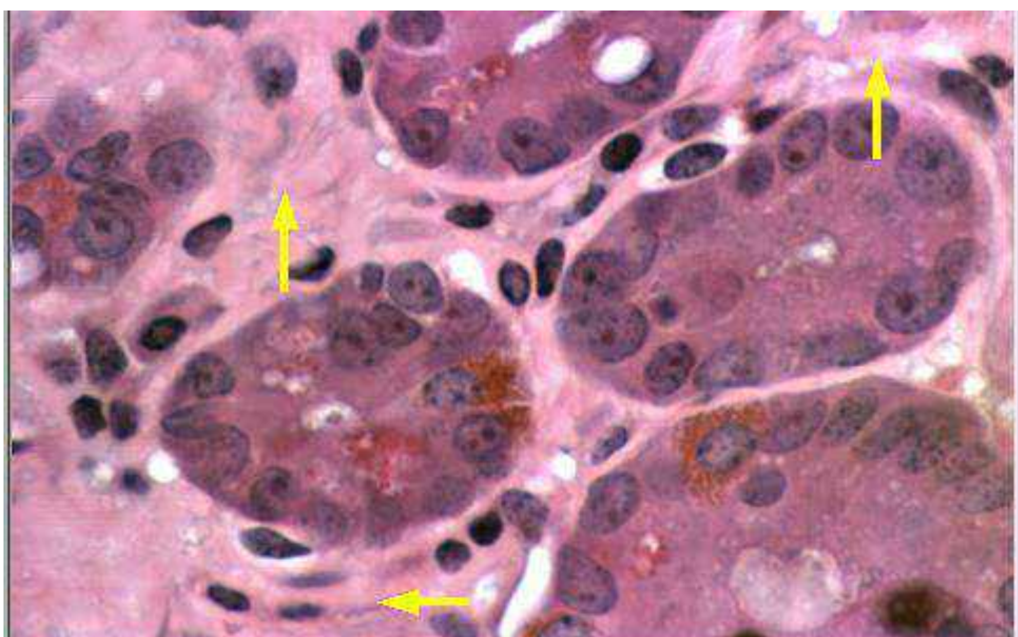


8 of 9

Solitary endocrine cells, enteroendocrine, are also found in the intestinal glands. Because these cells are secreting into the lamina propria, their granules face the basement membrane of the gland rather than the lumen.

click to identify:

- Intestinal glands
- Goblet cells
- Precursor cells >
- Paneth cells >
- › Enteroendocrine > cells
- Lamina propria >
- Plasma cell

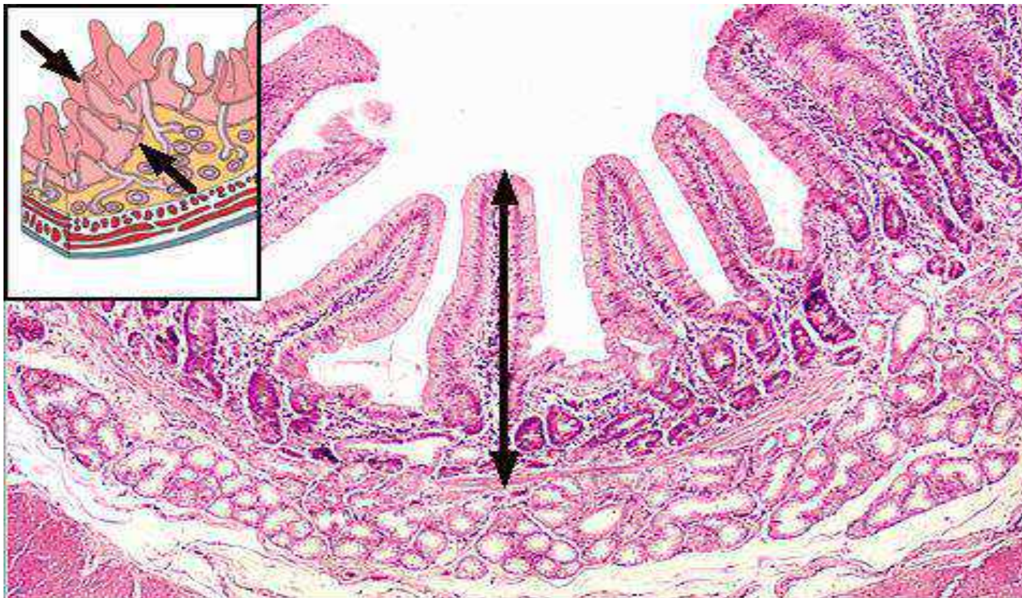


8 of 9

The lamina propria of loose connective tissue surrounds the intestinal glands and possesses a wide variety of cells, such as the immunoresponsive plasma cell seen here.

click to identify:

- Intestinal glands
- Goblet cells
- Precursor cells >
- Paneth cells >
- Enteroendocrine > cells
- › Lamina propria >
- Plasma cell

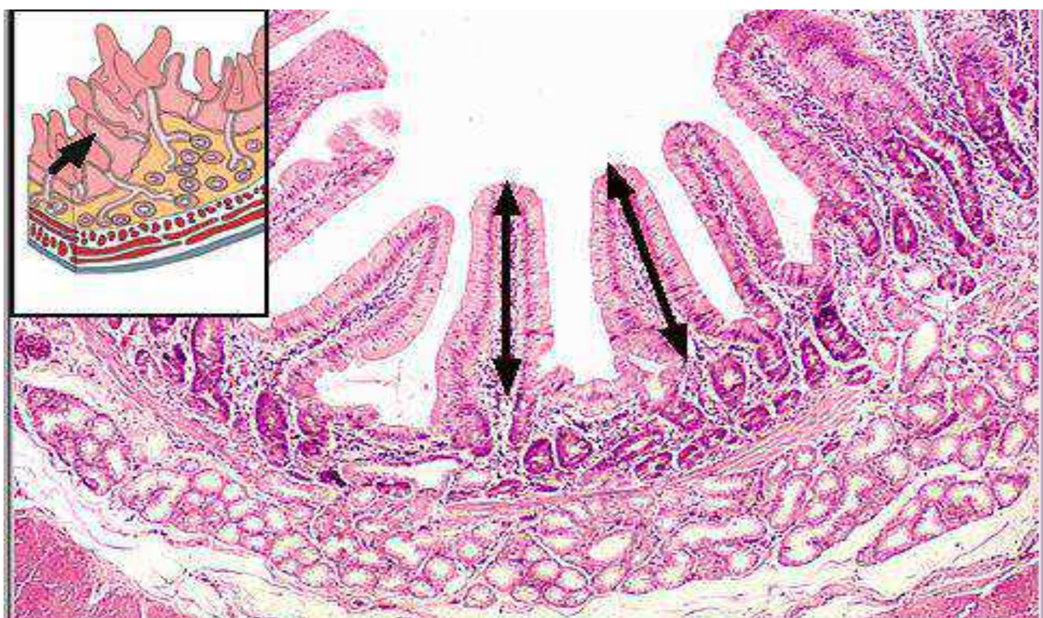


1 of 9

Duodenum -- The duodenum of the small intestine can be differentiated from the remainder of the small intestine primarily by the presence of Brunner's glands in the submucosa. Brunner's glands produce an alkaline mucus that counterbalances the acidity of the chyme entering the duodenum from the stomach. 100x

click to identify:

- › Mucosa
- Villi
- Intestinal glands
- Lamina propria
- Muscularis mucosae
- Submucosa
- Brunner's glands



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- › Villi
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- Lamina propria
- Muscularis mucosae
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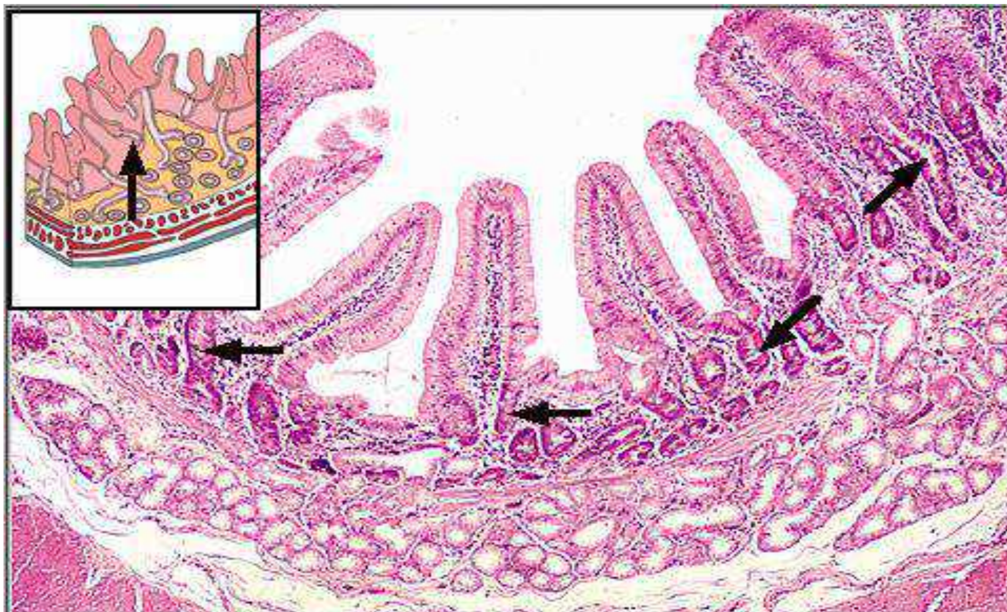
- Brunner's glands



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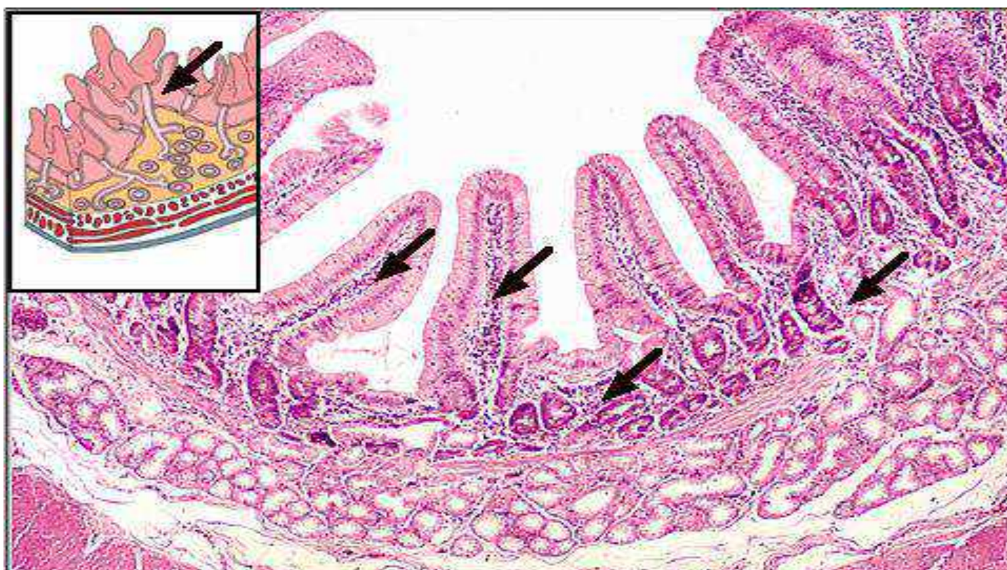

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- Intestinal glands
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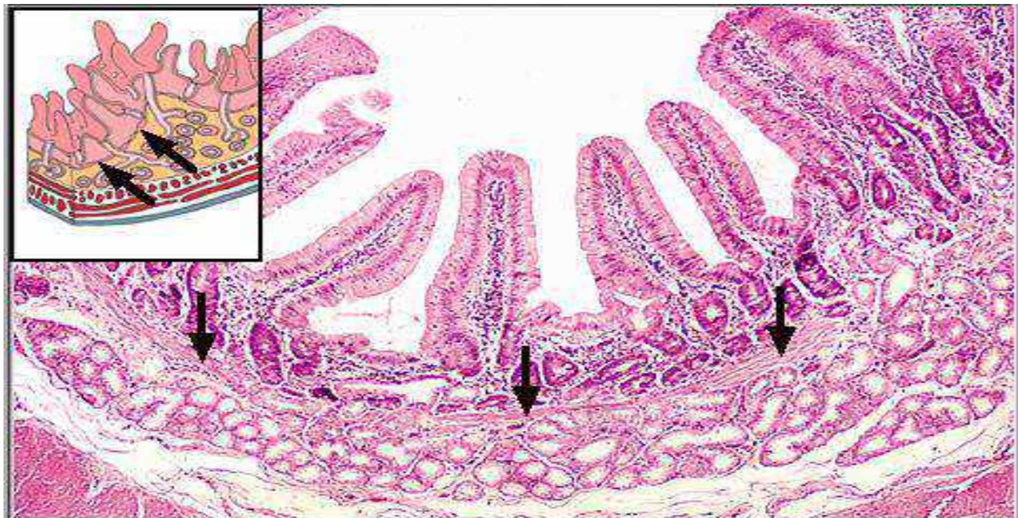
- Muscularis mucosae
- Submucosa
- Brunner's glands



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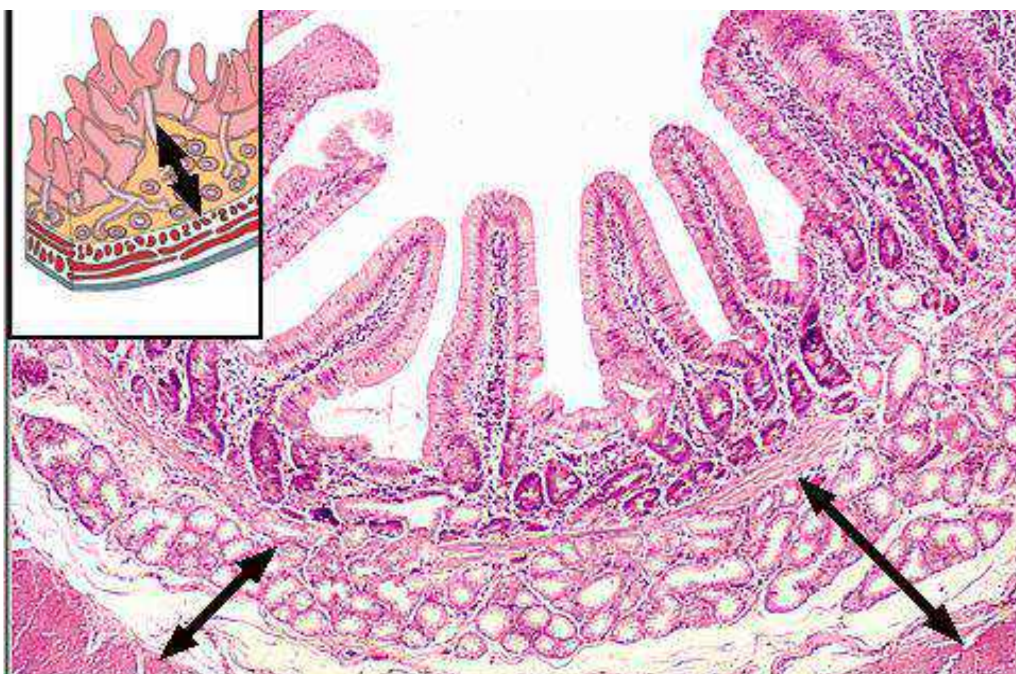
- Villi
- Intestinal glands
- Lamina propria
- › Muscularis mucosae
- Submucosa
- Brunner's glands



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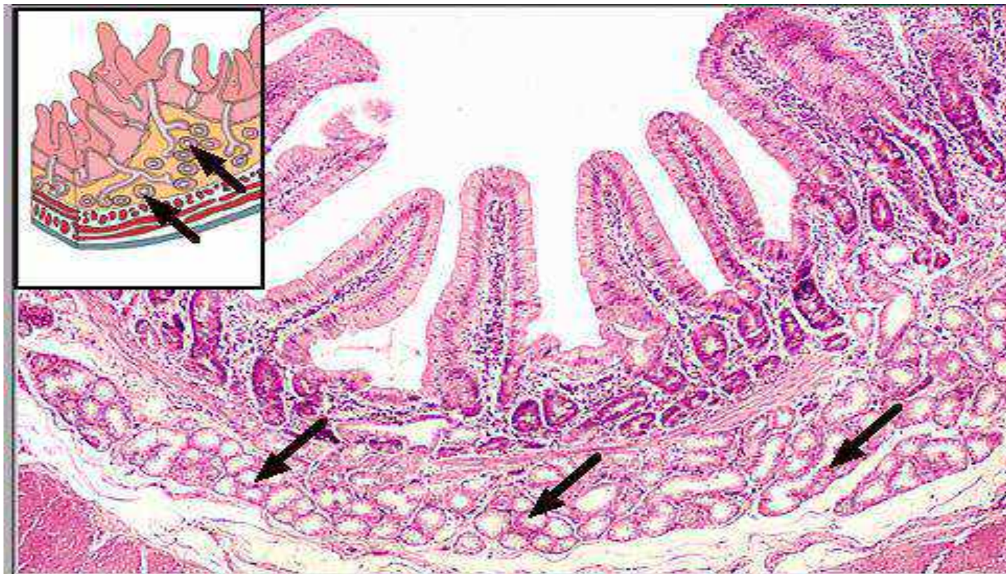

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Submucosa
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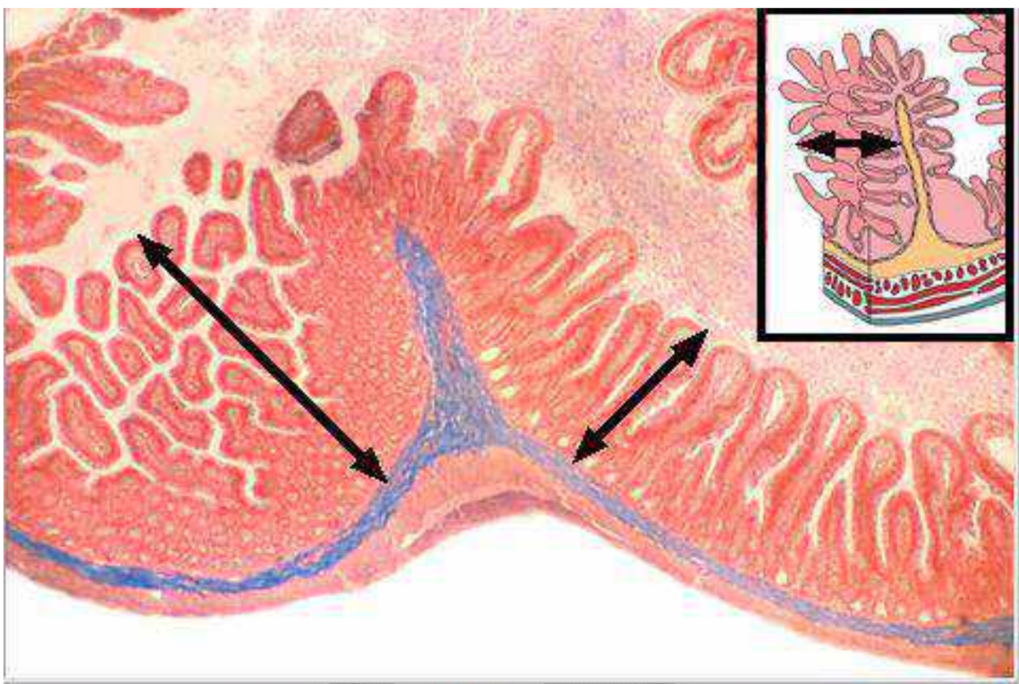
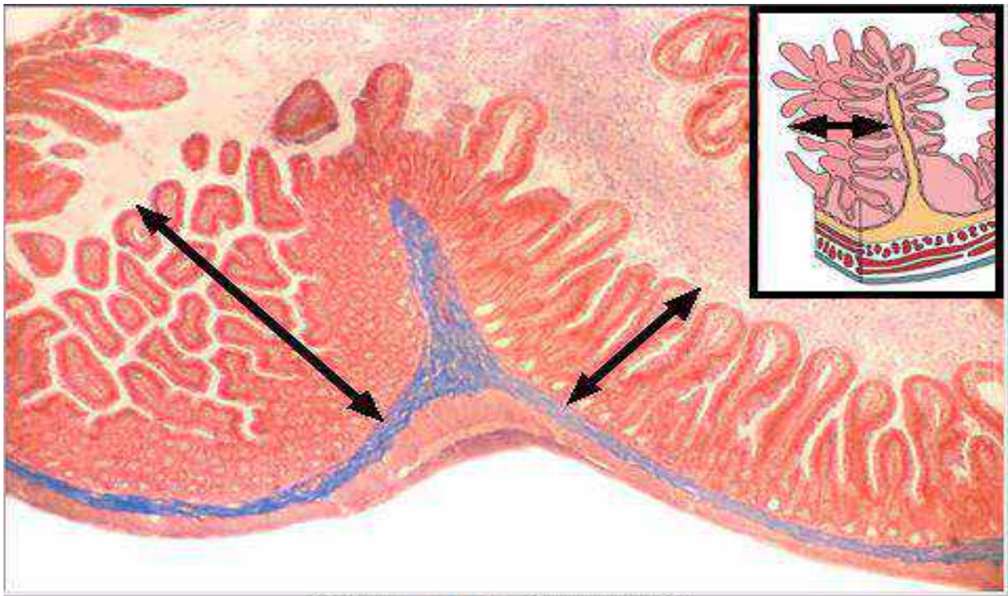


3 of 9

Jejunum or ileum -- The jejunum and ileum (shown here) can be differentiated from the duodenum, primarily by the lack of glands in the submucosa. Villi of the small intestine possess a lacteal that transports absorbed lipids to lymphatic vessels in the submucosa. A plica circularis, a circular fold of submucosa and its overlying mucosa, is centrally located in the image. 40x

click to identify:

› Mucosa
Villi
Intestinal glands
Lamina propria
Lacteals
Submucosa
Muscularis externa
Plica circularis
Next image



click to identify:

- Mucosa
- Villi
- Intestinal glands
- Lamina propria
- Lacteals
- Submucosa
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- Plica circularis
- Next image

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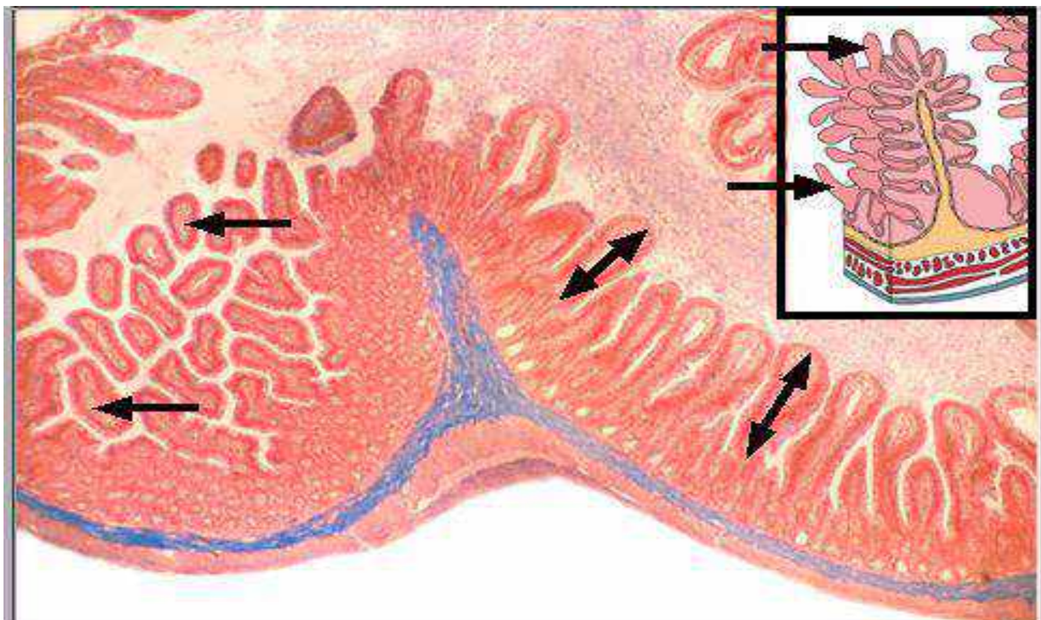

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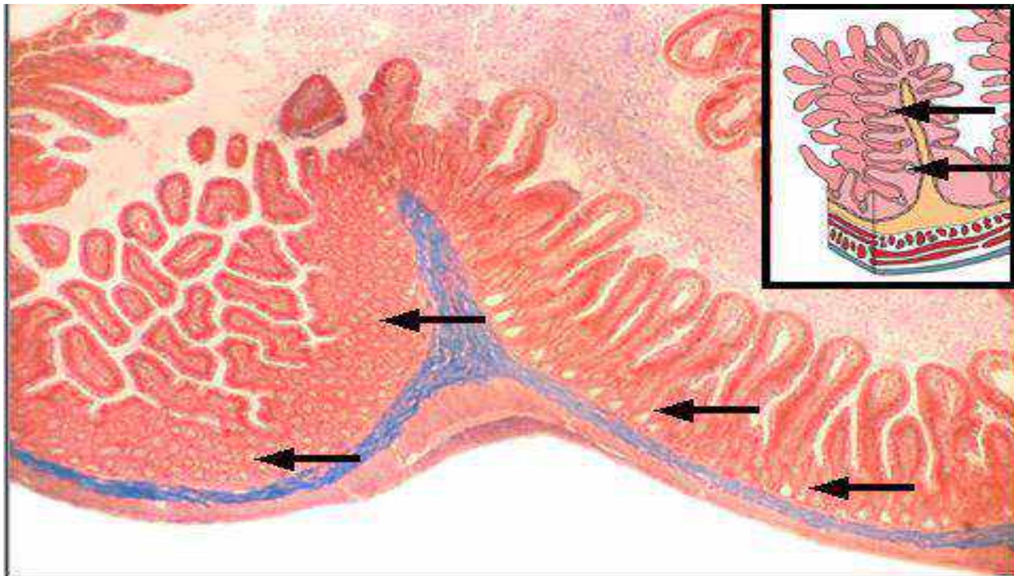

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- Submucosa
- Muscularis externa
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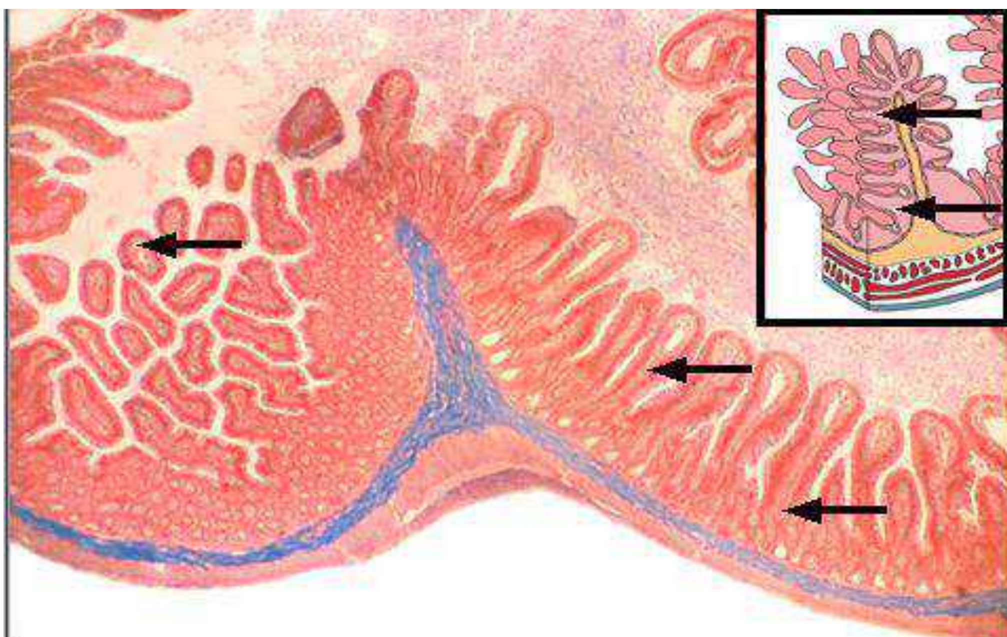

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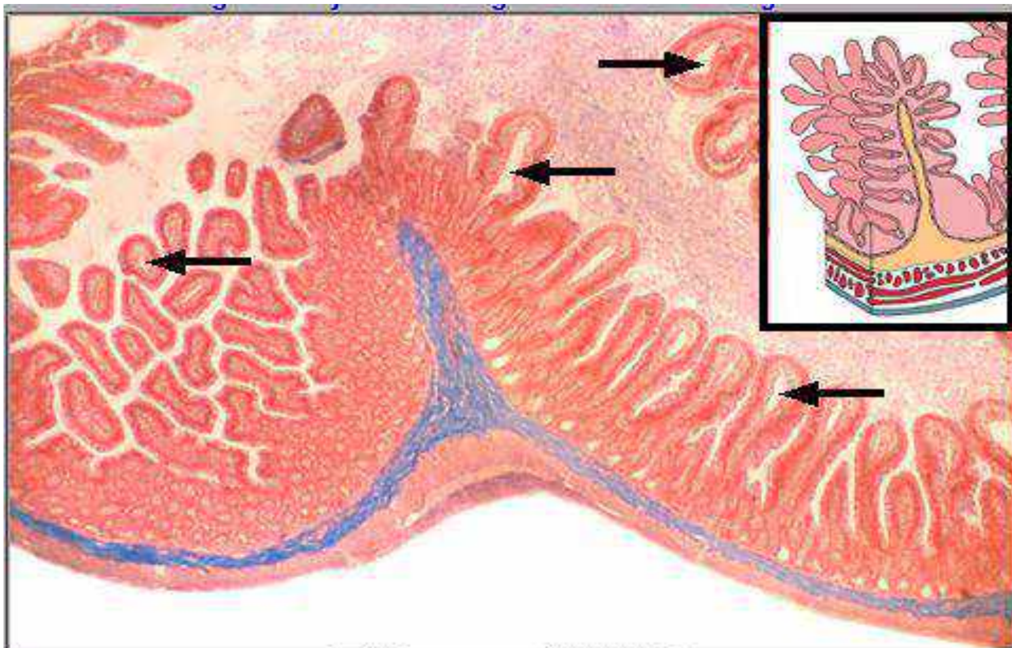

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- › Lacteals
- Submucosa
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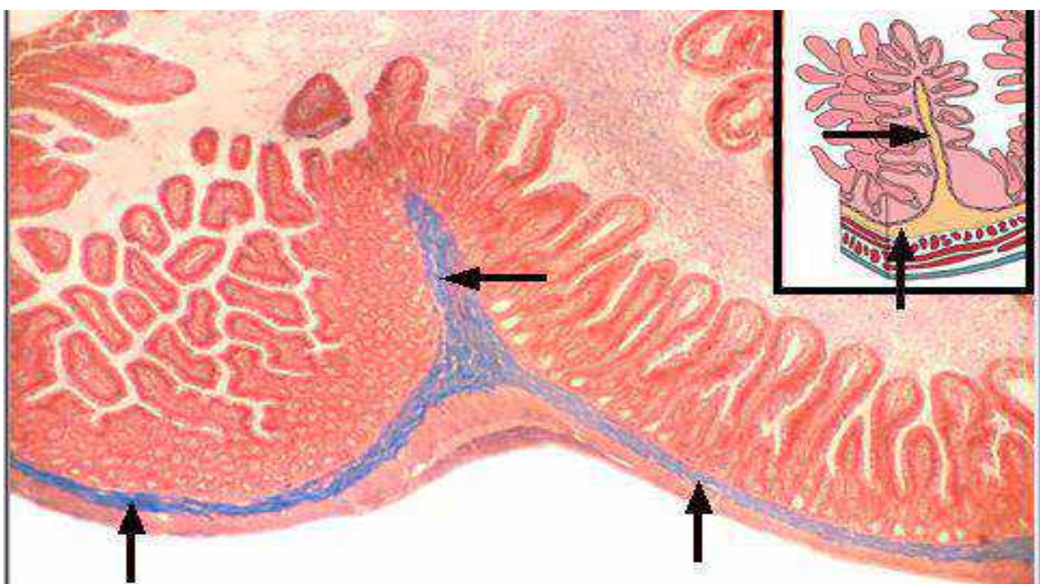

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- Villi
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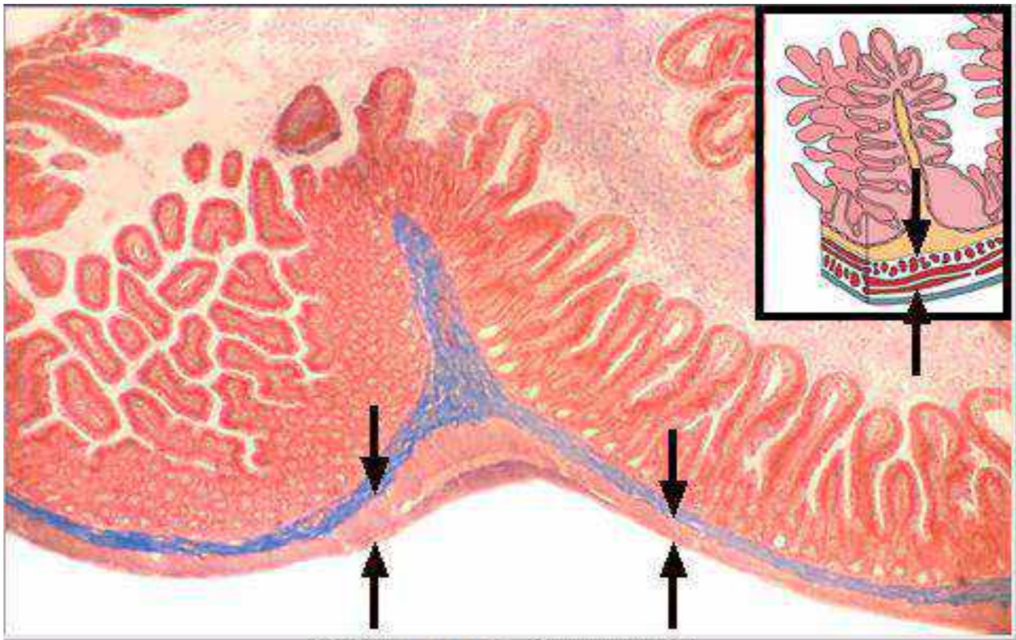
- Next image



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- Lacteals
- Submucosa
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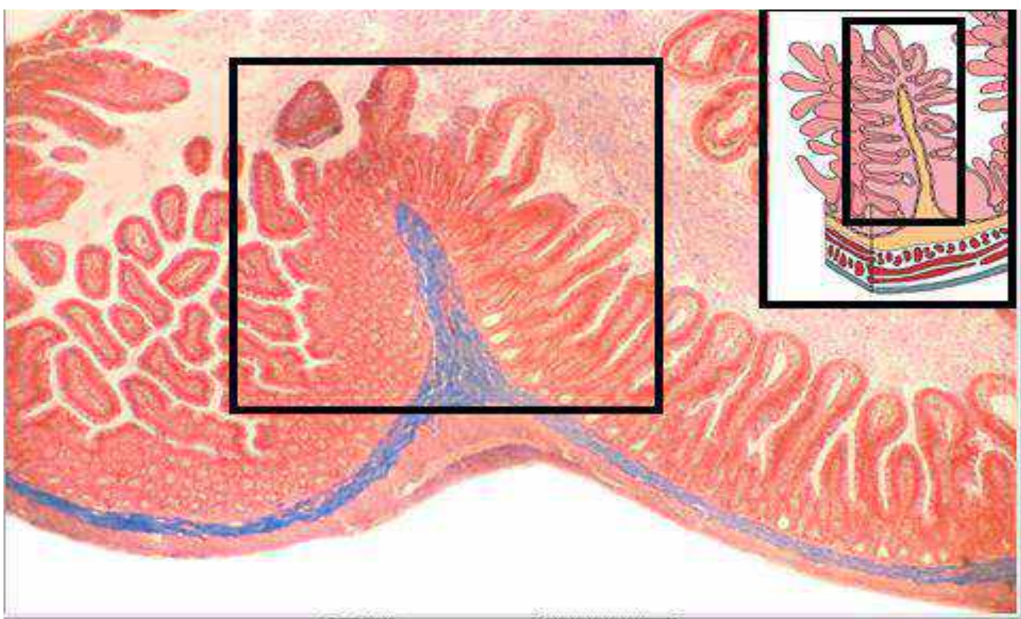

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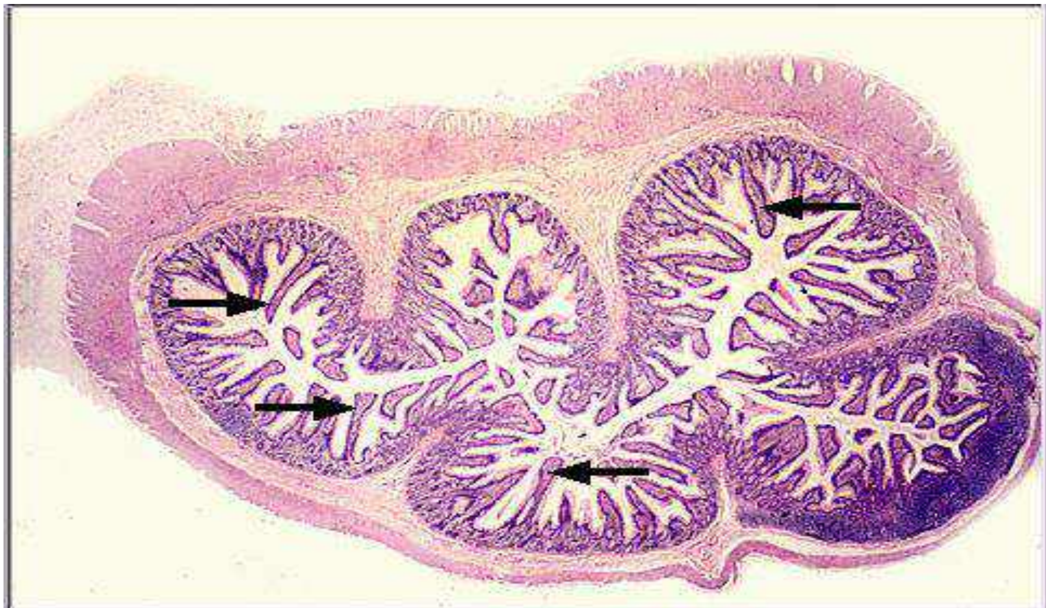
click to identify:

- Mucosa
- Villi
- Intestinal glands
- Lamina propria
- Lacteals
- Submucosa
- Muscularis externa
- › Plica circularis
- Next image

click to identify

- Villi
- Plica circularis
- Peyer's patch
- Mesentery
- Next image

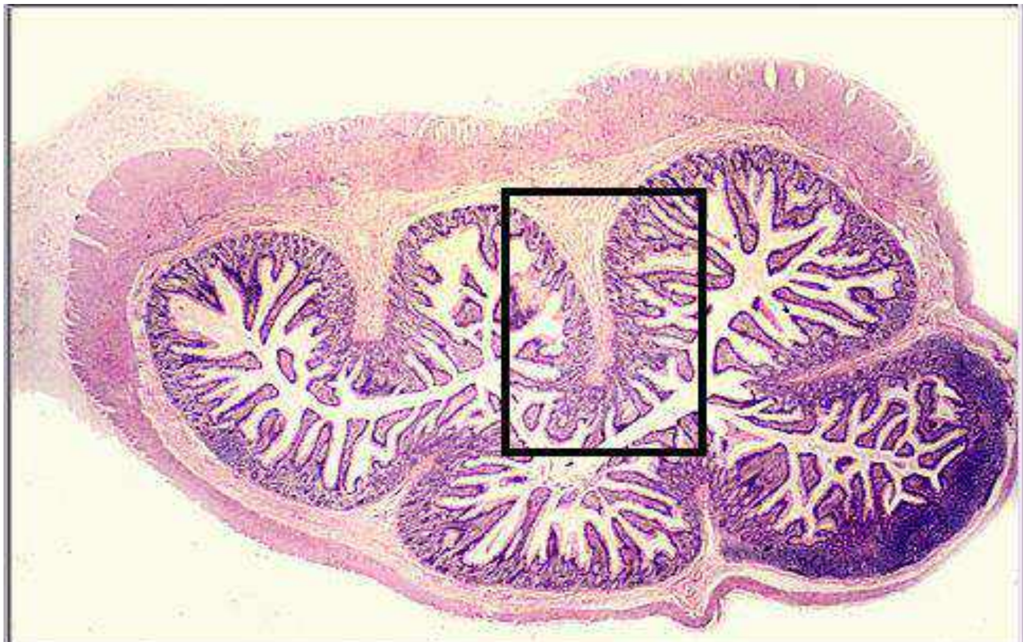


6 of 9

Ileum -- This low magnification image of the ileum shows that the villi of the ileum are tall and are the most finger-like in the small intestine. Diffuse and nodular lymphoid tissues, forming a Peyer's patch, are common in the lamina propria of the ileum on the side opposite the mesentery. Peyer's patches are a part of the mucosa-associated lymphoid tissue (MALT). 10x

click to identify:

- Villi
- Plica circularis
- Peyer's patch
- Mesentery
- Next image



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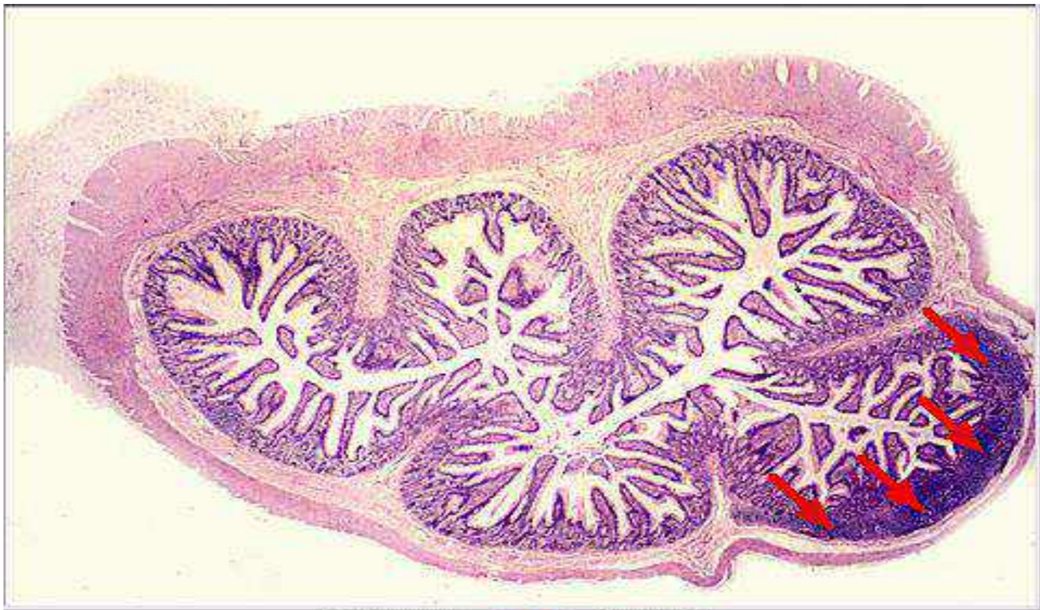

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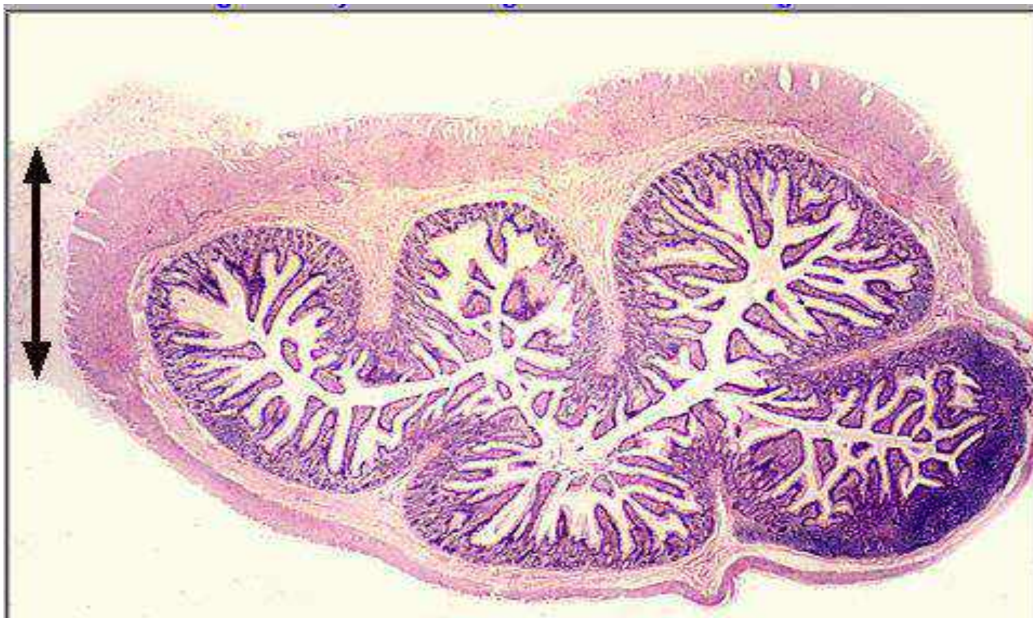
click to identify

- Villi
- Plica circularis
- Peyer's patch
- Mesentery
- Next image



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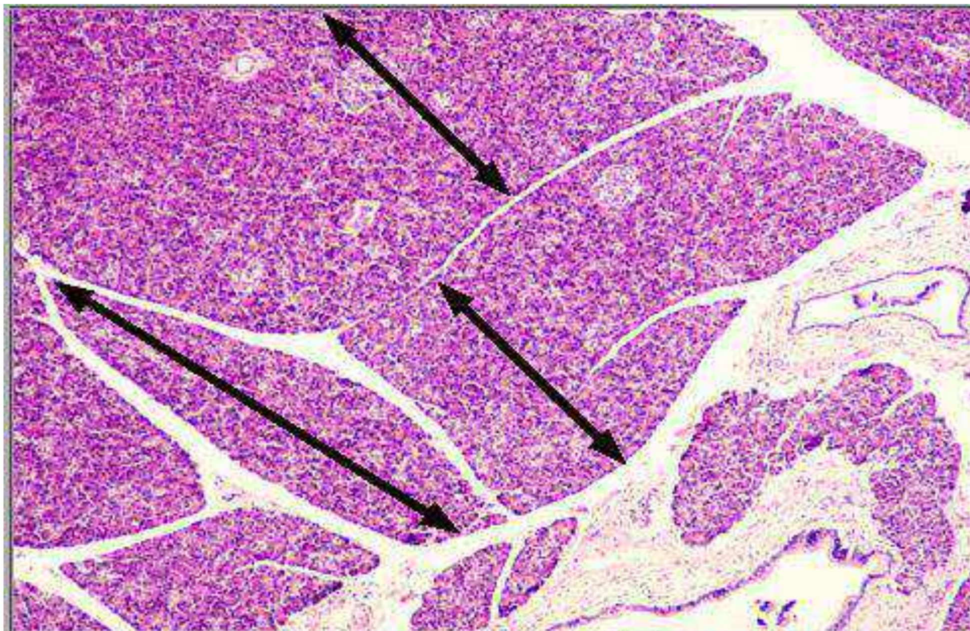
- Next image

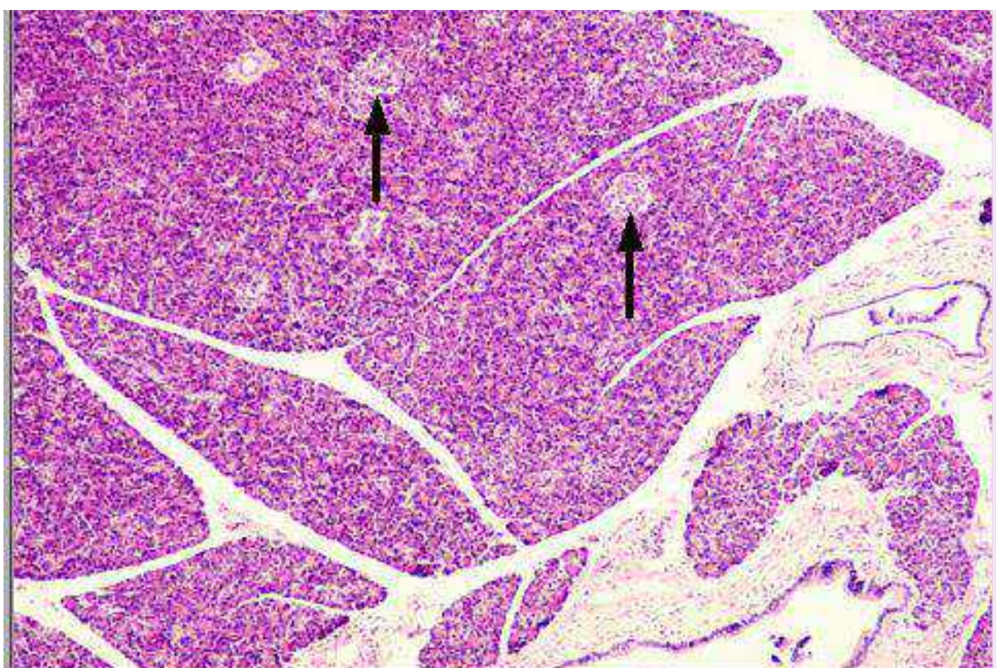


1 of 15

Pancreas -- The pancreas is both an exocrine (compound acinar) and an endocrine (islets of Langerhans) gland. The exocrine pancreas releases alkaline secretions, containing enzymes, into the duodenum that aid in food digestion and neutralize the acidity of chyme leaving the stomach. The islets synthesize hormones that regulate blood glucose levels. 40x

click to identify:

- › Lobules
- Islets of > Langerhans
- Acini >
- Intralobular duct
- Interlobular ducts
- Interlobular CT

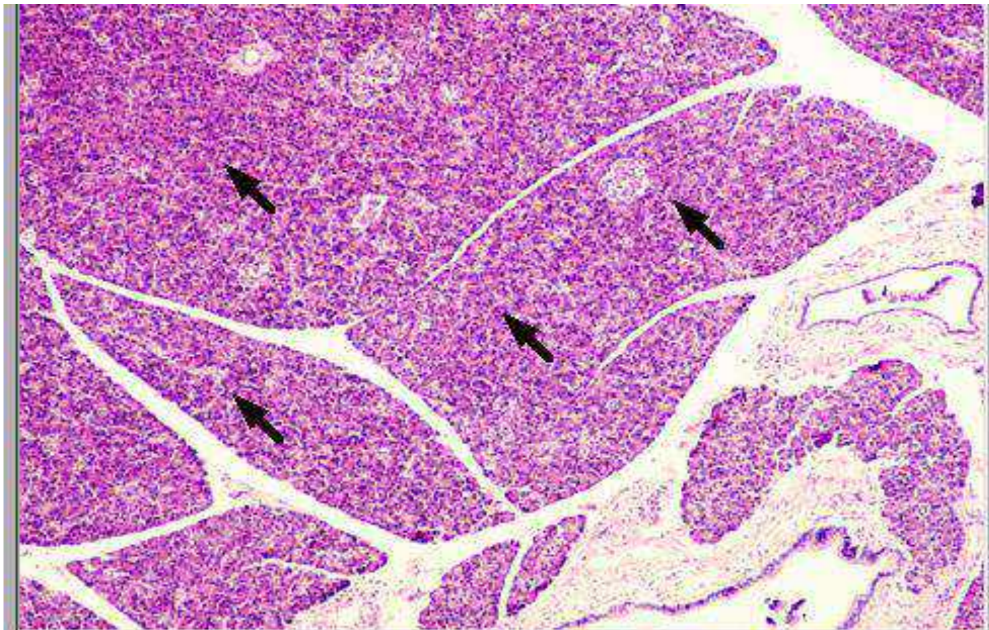


1 of 15

The islets of Langerhans appear as isolated clusters of endocrine-secreting cells surrounded by the exocrine acini. The major secretions of islet cells are insulin and glucagon that regulate blood glucose levels.

click to identify:

- Lobules
- › Islets of > Langerhans
- Acini >
- Intralobular duct
- Interlobular ducts
- Interlobular CT

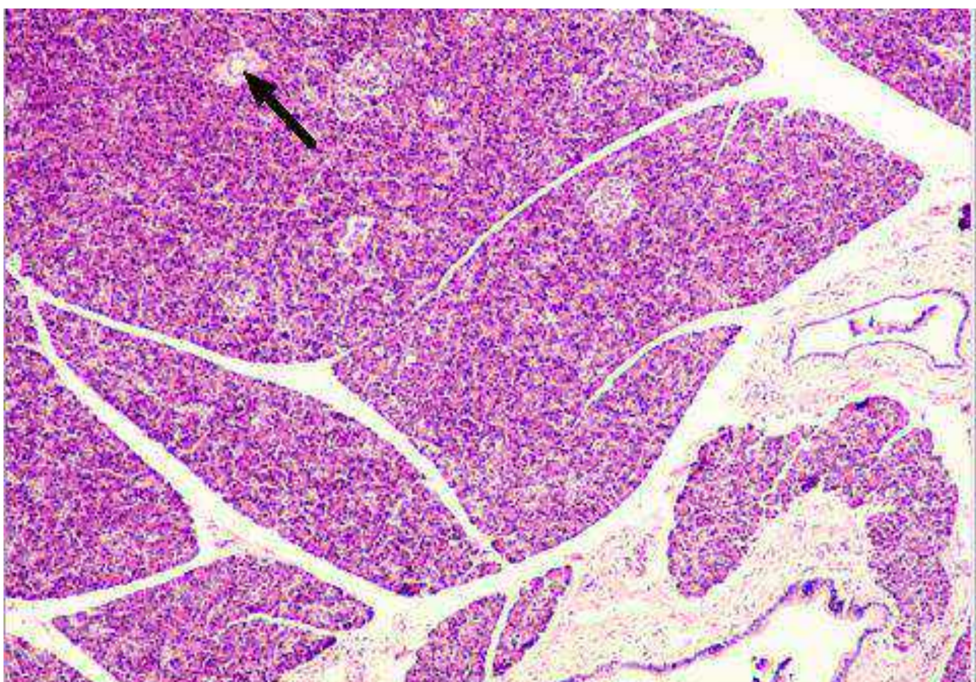


1 of 15

The exocrine pancreas, a compound acinar gland, comprises most of the pancreas. The pancreas has fewer intralobular and interlobular ducts than would be expected for a gland of its size and composition.

click to identify:

- Lobules
- Islets of > Langerhans
- › Acini >
- Intralobular duct
- Interlobular ducts
- Interlobular CT



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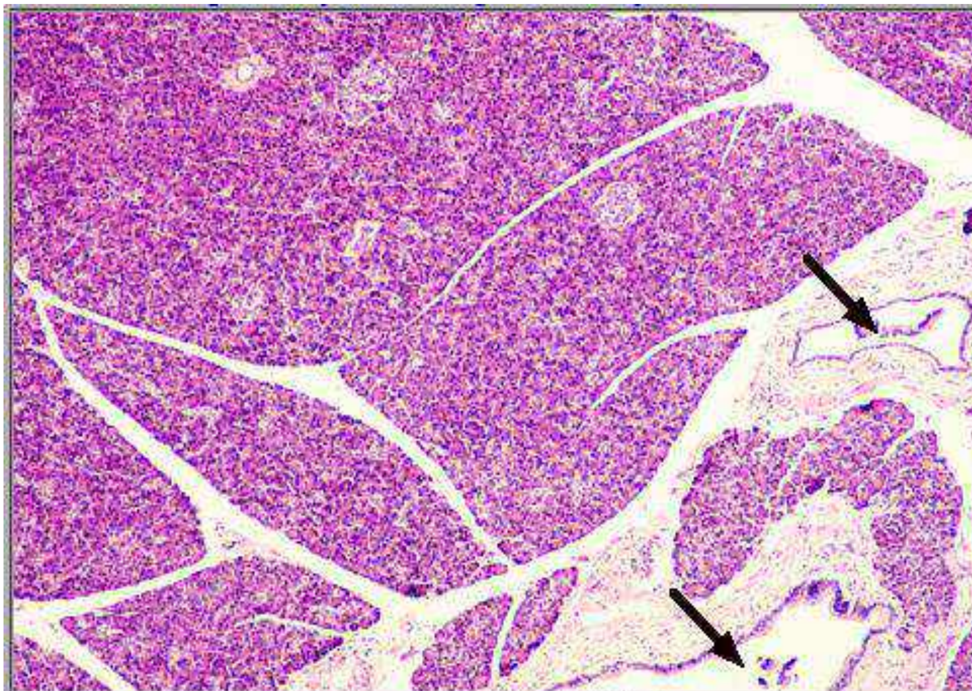
click to identify:

- Lobules
- Islets of > Langerhans
- Acini >
- › Intralobular duct
- Interlobular ducts
- Interlobular CT



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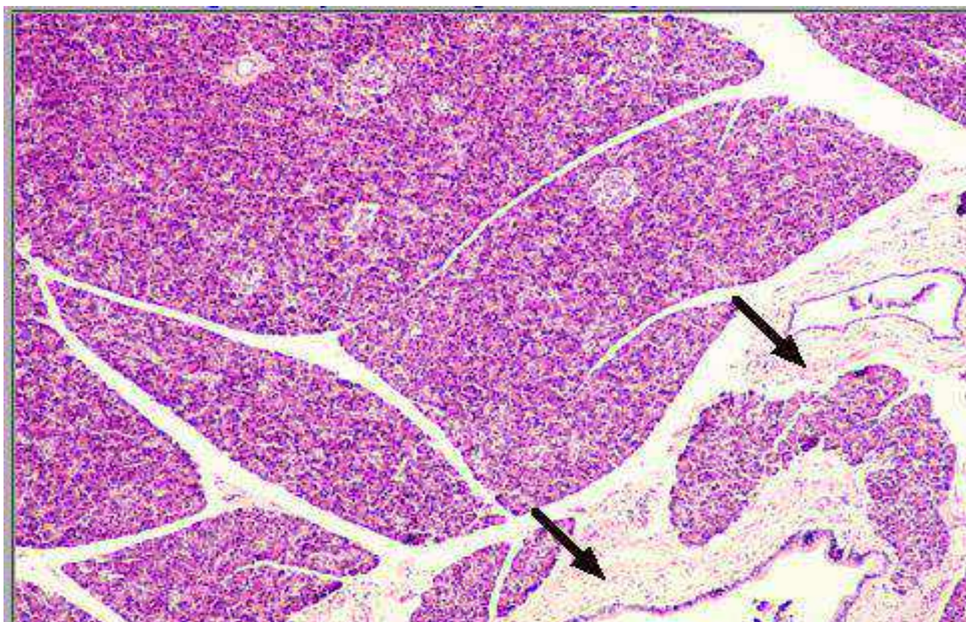
- Islets of > Langerhans
- Acini >
- Intralobular duct
- › Interlobular ducts
- Interlobular CT



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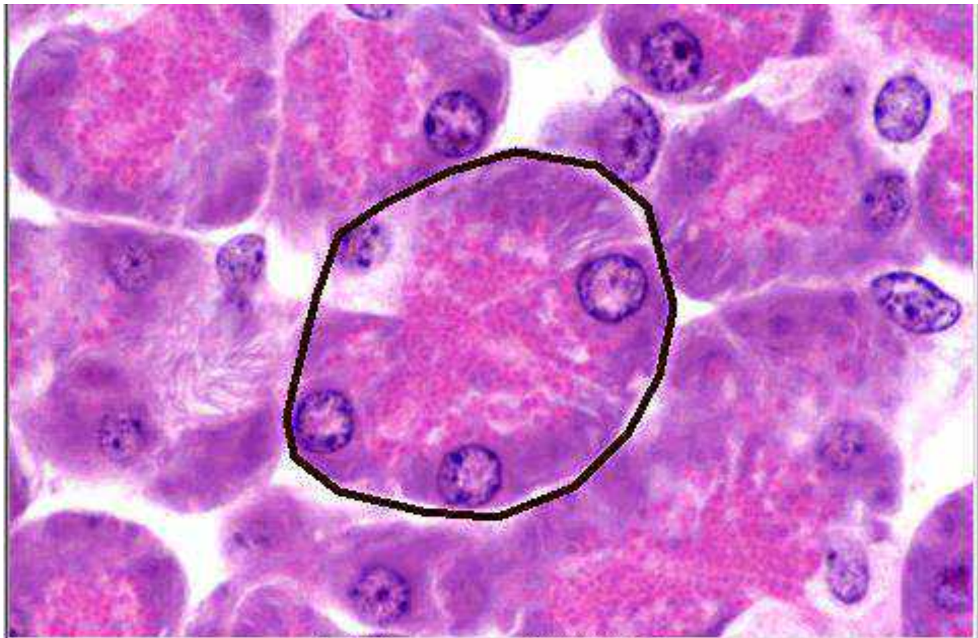
- Lobules
- Islets of > Langerhans
- Acini >
- Intralobular duct
- Interlobular ducts
- › Interlobular CT

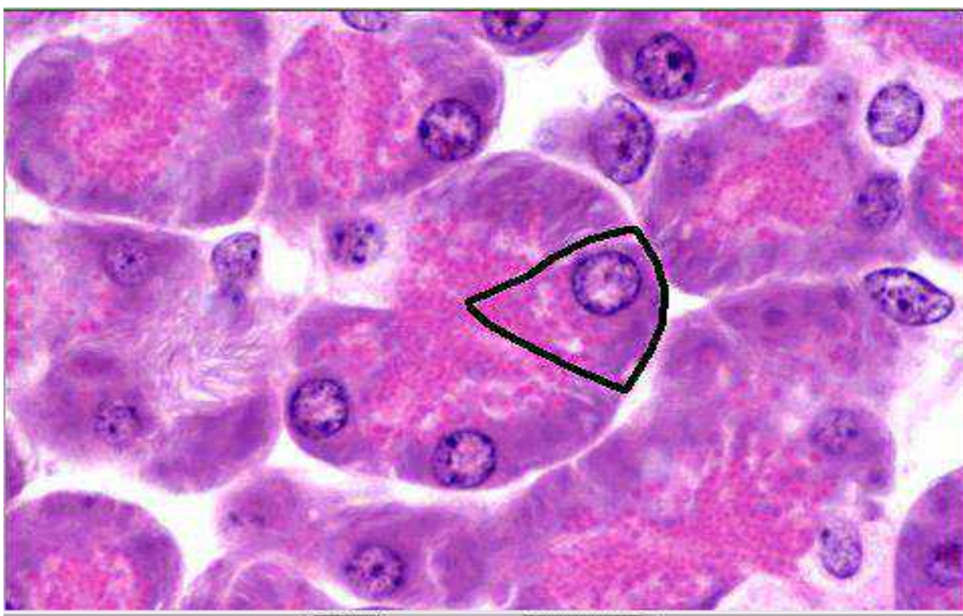


5 of 15

Pancreas -- The enzymes produced by the exocrine pancreas are manufactured in the RER located in the bases of the acinar cells. The product is transported as secretory granules to the apex for release into the acinar lumen. The pancreas is unique in that the duct system begins with centroacinar cells within the acinus. 1000x

click to identify:

> Acinus
Acinar cell
RER
Golgi
Secretory granules
Centroacinar cells

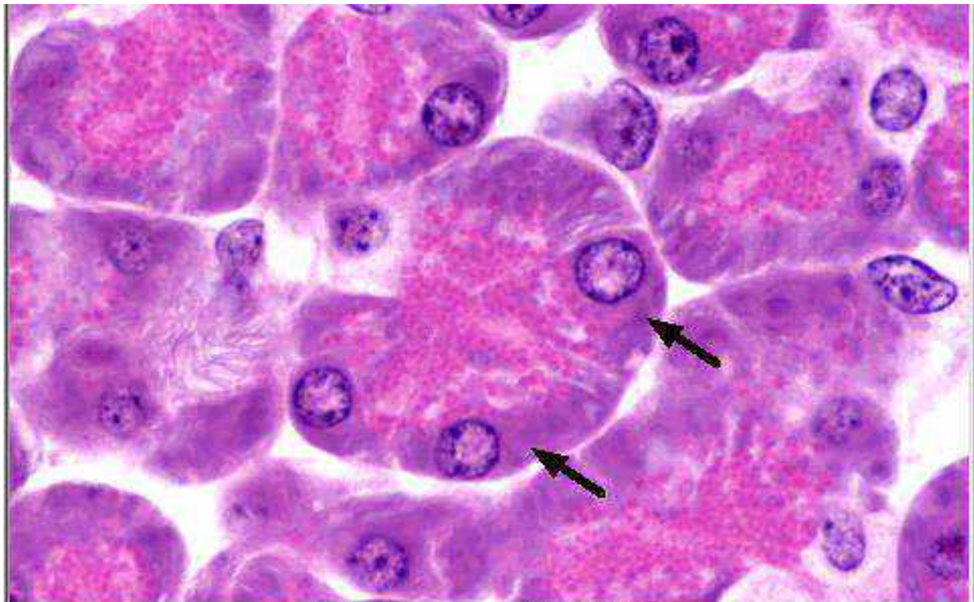


5 of 15

Pancreas -- The enzymes produced by the exocrine pancreas are manufactured in the RER located in the bases of the acinar cells. The product is transported as secretory granules to the apex for release into the acinar lumen. The pancreas is unique in that the duct system begins with centroacinar cells within the acinus. 1000x

click to identify:

Acinus
> Acinar cell
RER
Golgi
Secretory granules
Centroacinar cells



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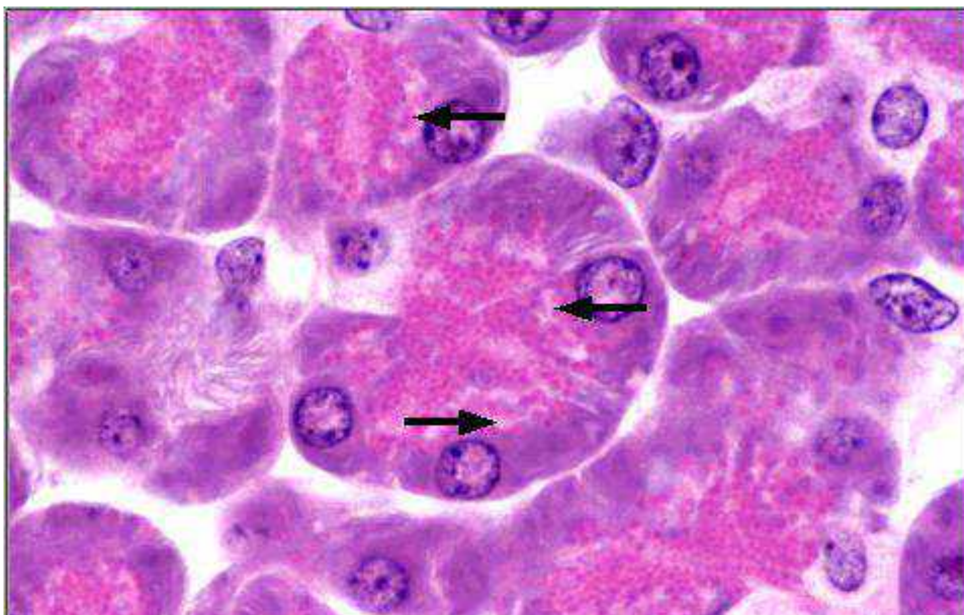
- Acinus
- Acinar cell
- › RER
- Golgi
- Secretory granules
- Centroacinar cells



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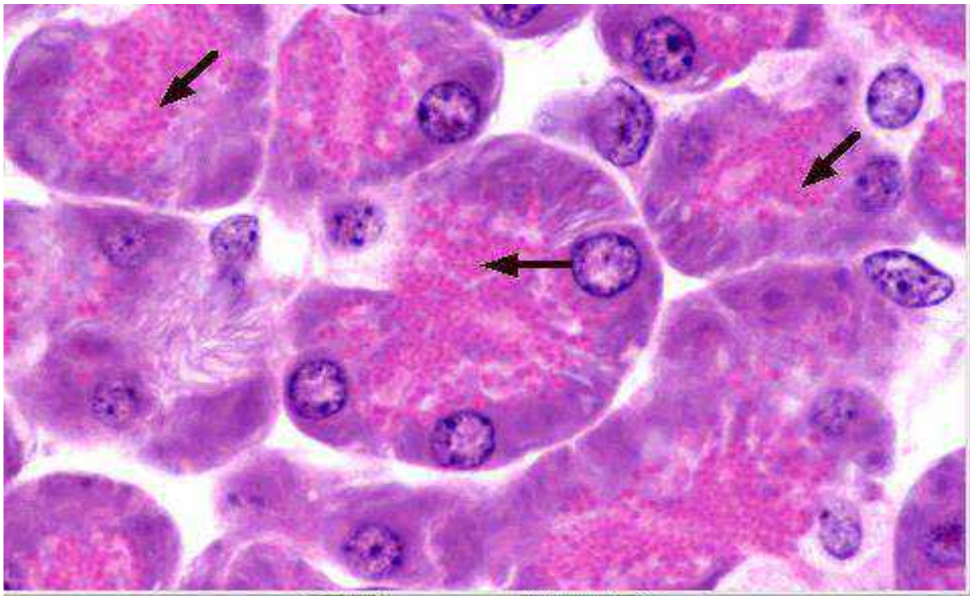

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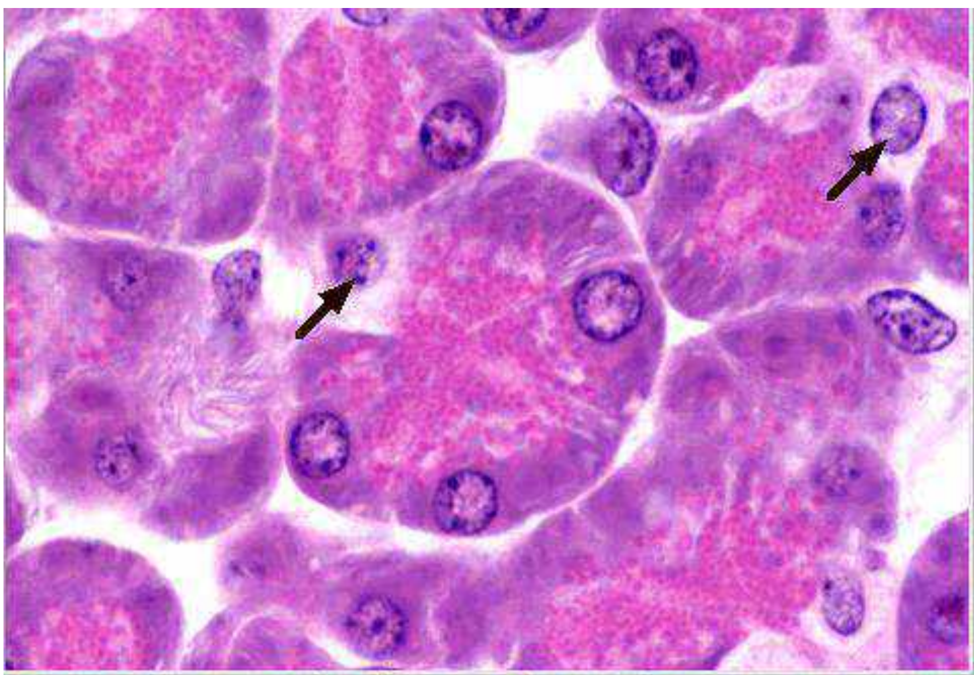

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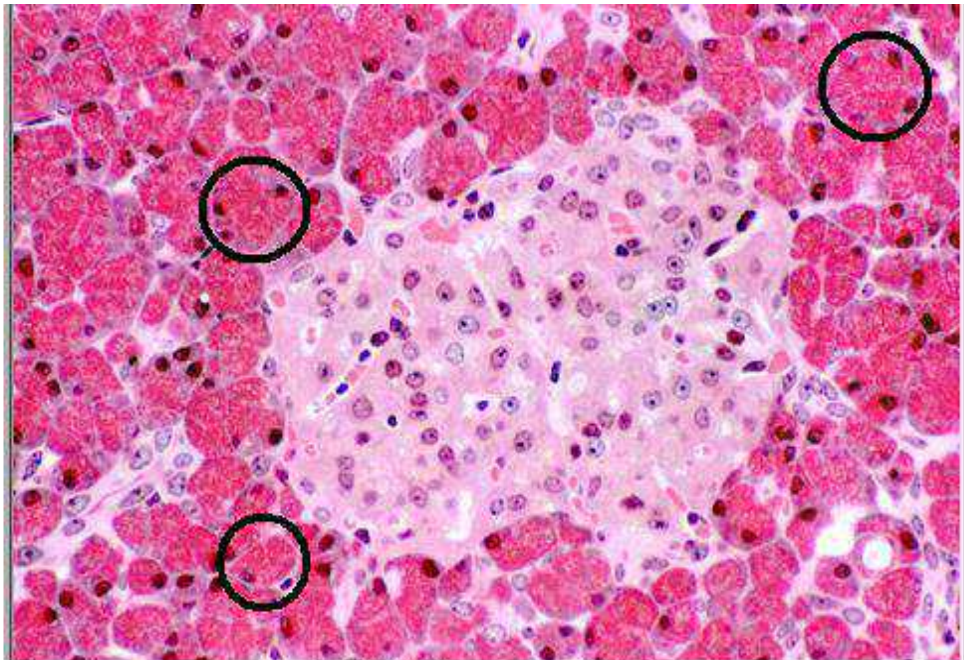
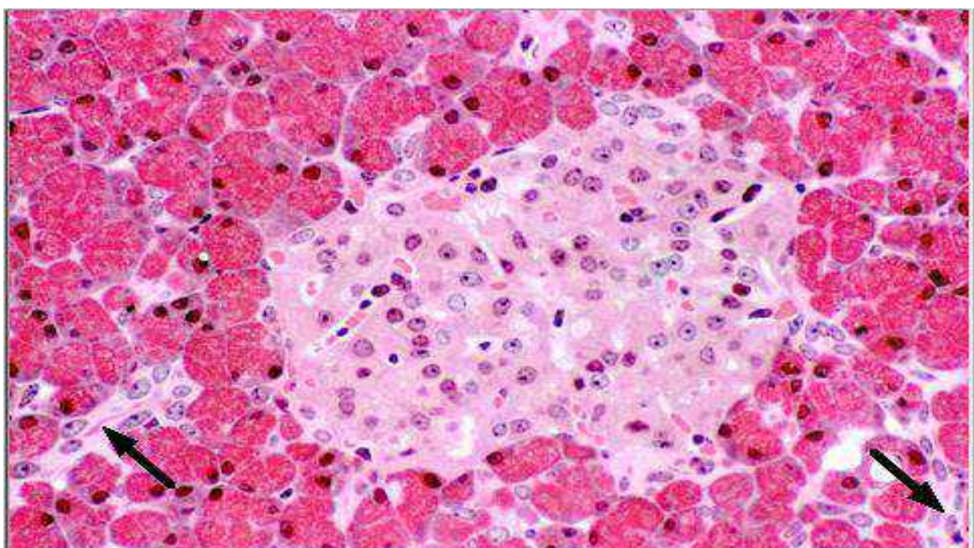


click to identify:

- Serous acini
- Intercalated ducts
- Islet of Langerhans
- Endocrine cells
- Capillaries

12 of 15

Pancreas -- An islet of Langerhans, the endocrine portion of the pancreas, is surrounded by serous acini and intercalated ducts of the exocrine portion. Although individual endocrine cell types cannot be differentiated with this stain, numerous capillaries and the lack of an organized arrangement of the endocrine cells reflect the endocrine characteristics of the islet. 400x



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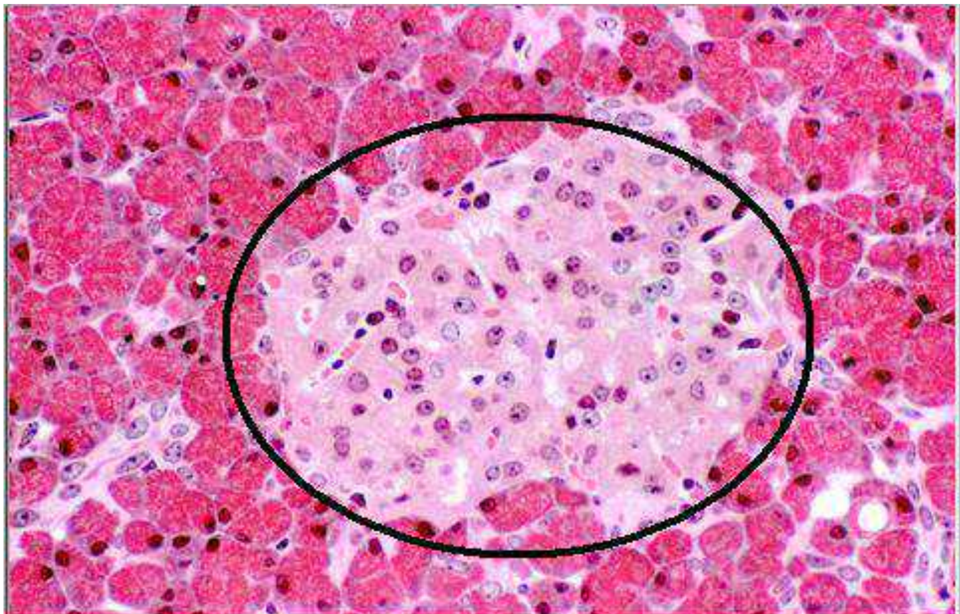

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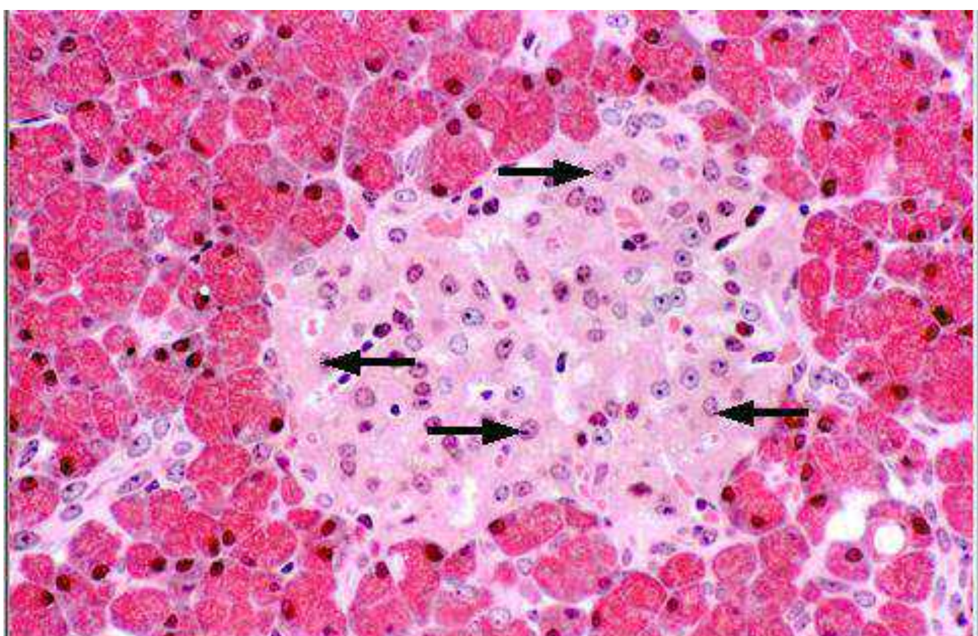

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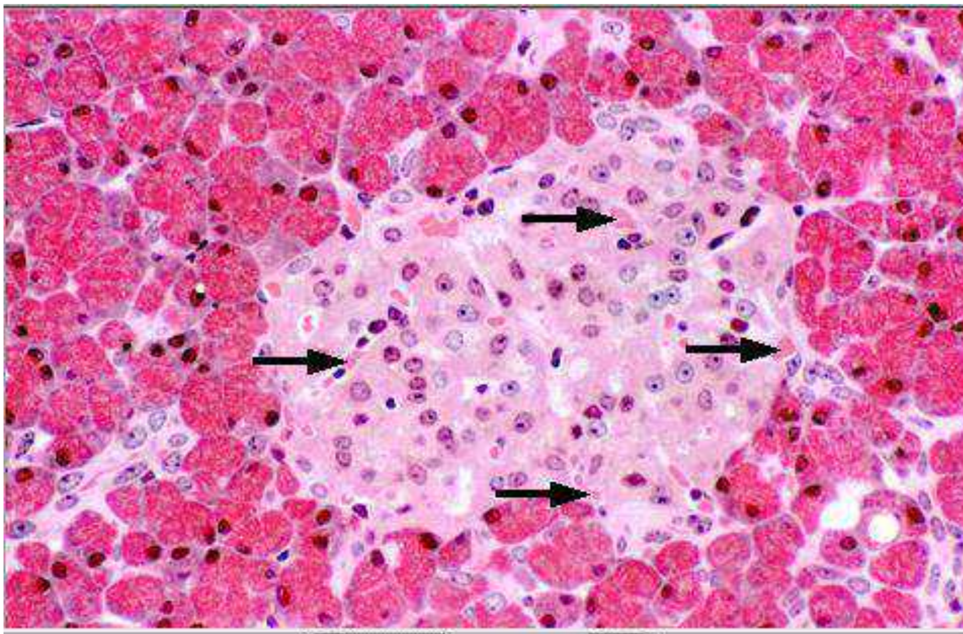

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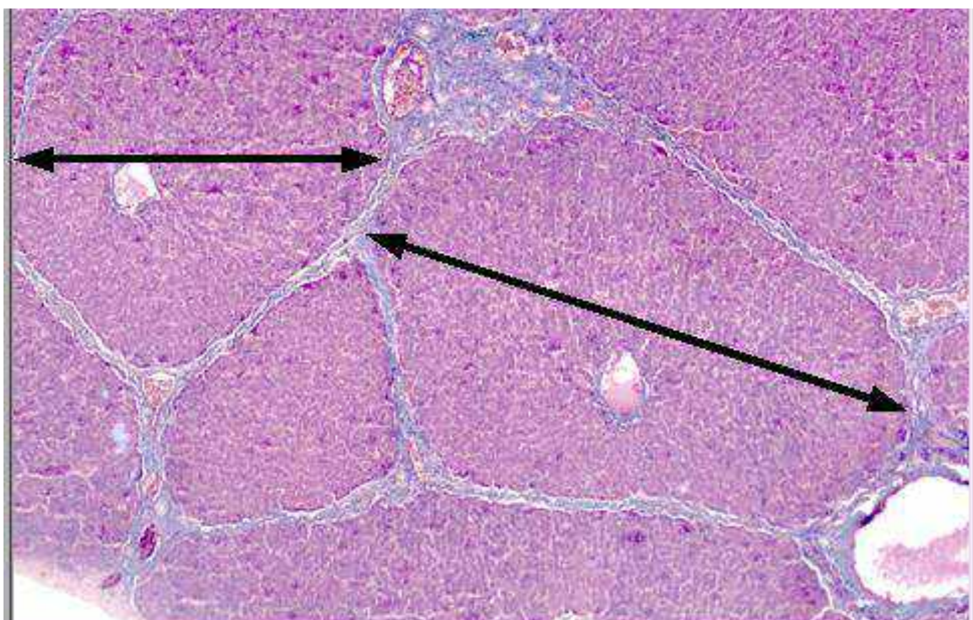
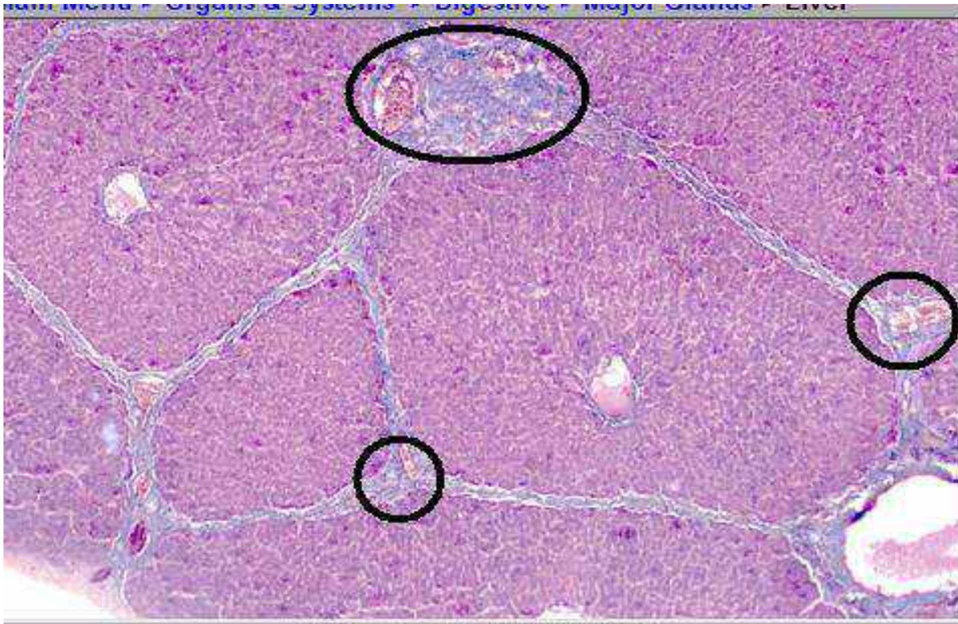


2 of 12

Liver -- The classic liver lobule is more clearly demarcated by connective tissue in a pig than in the human. Blood enters the liver in the hepatic portal vein or hepatic artery; branches of both vessels are located in a portal canal. From these branches, blood enters hepatic sinusoids between plates of hepatocytes and is carried into the central vein. 80x

click to identify:

- Liver lobules
- Portal canals
- Sinusoids
- Central veins
- Hepatocytes
- Connective tissue
- Direction of blood flow



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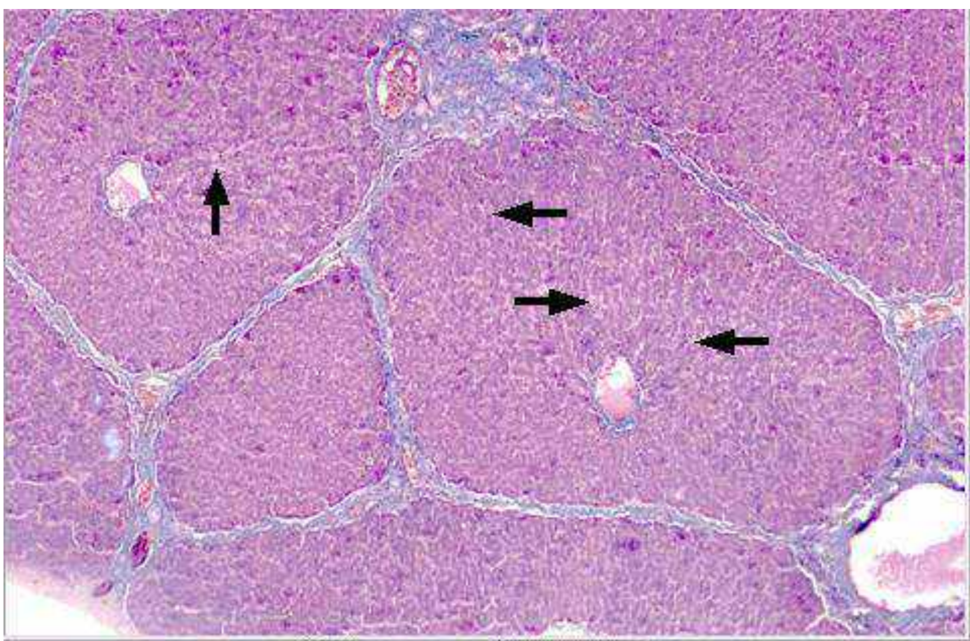

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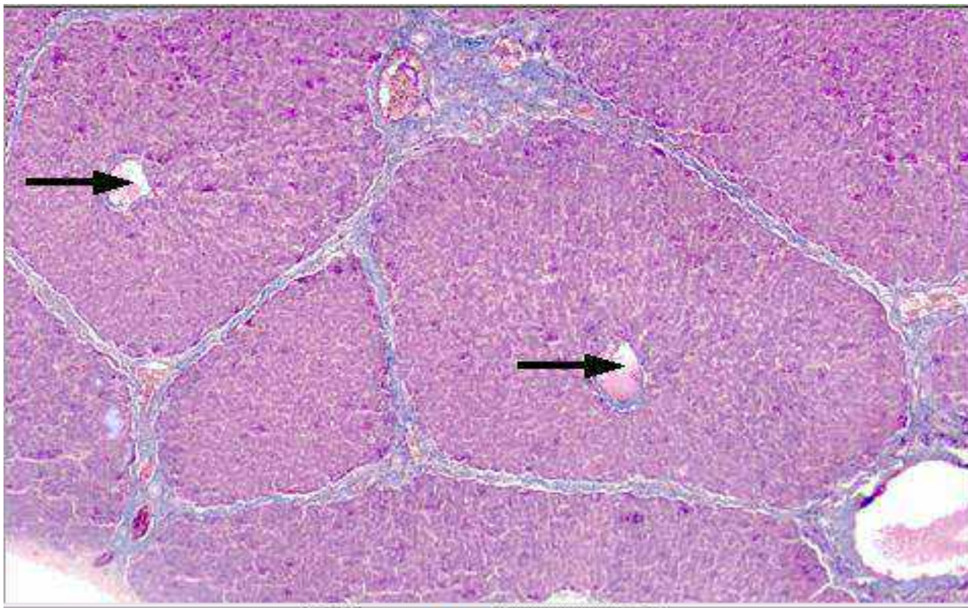

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Portal canals
Sinusoids
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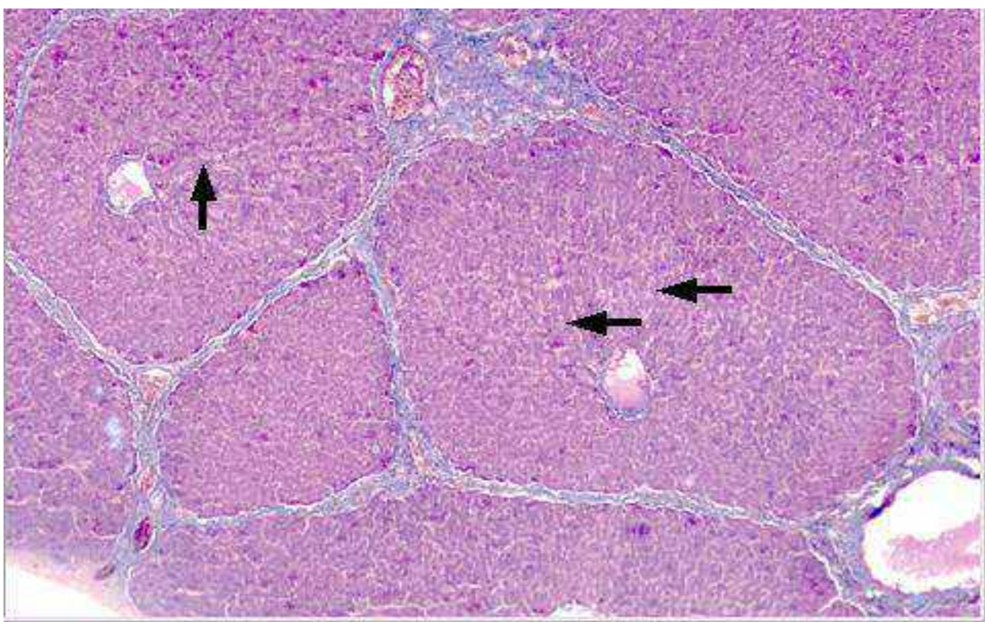
Hepatocytes
Connective tissue
Direction of blood flow



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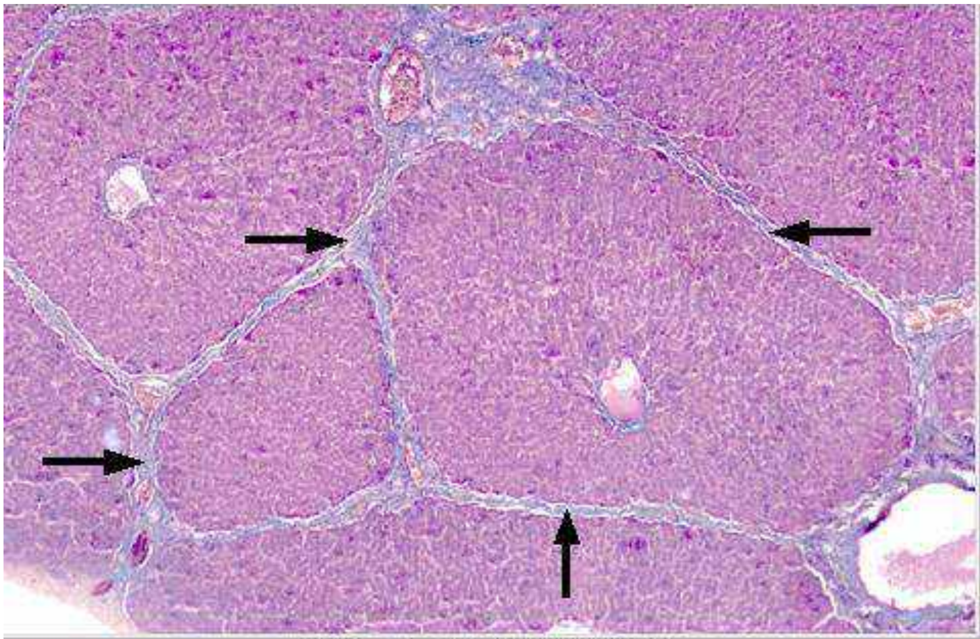

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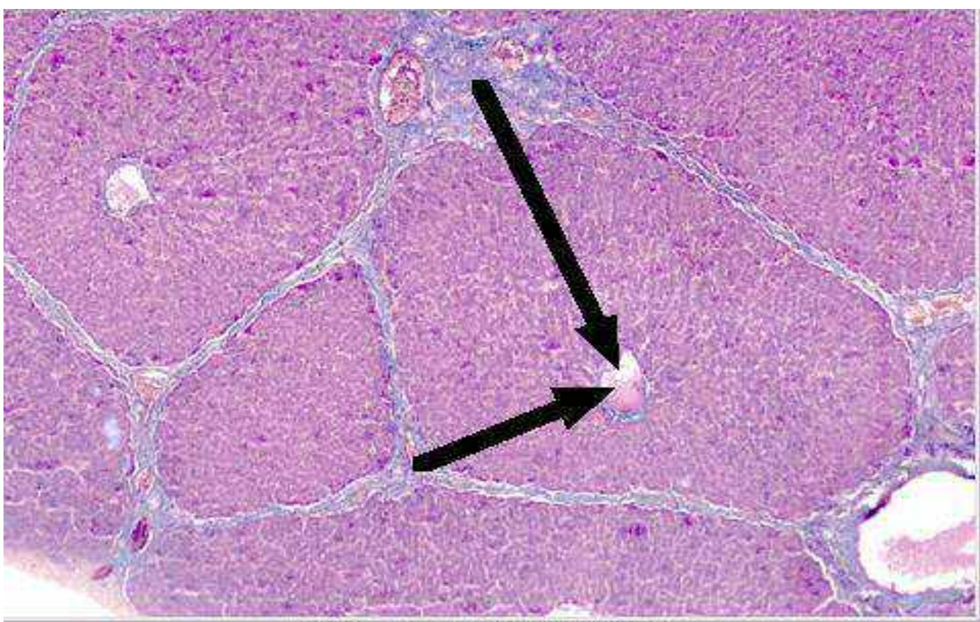

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Portal canals
Sinusoids
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Hepatocytes
Connective tissue
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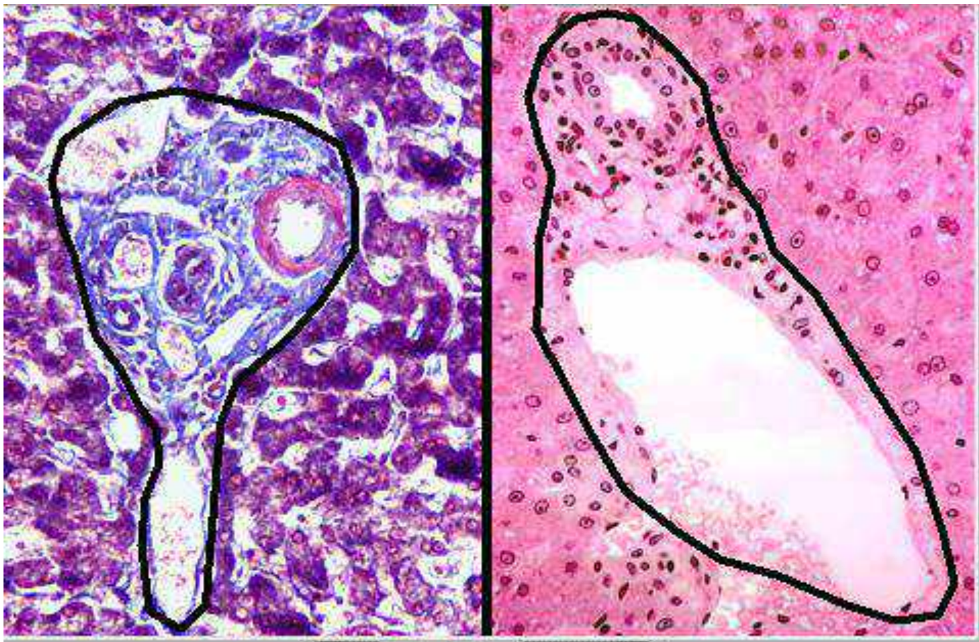
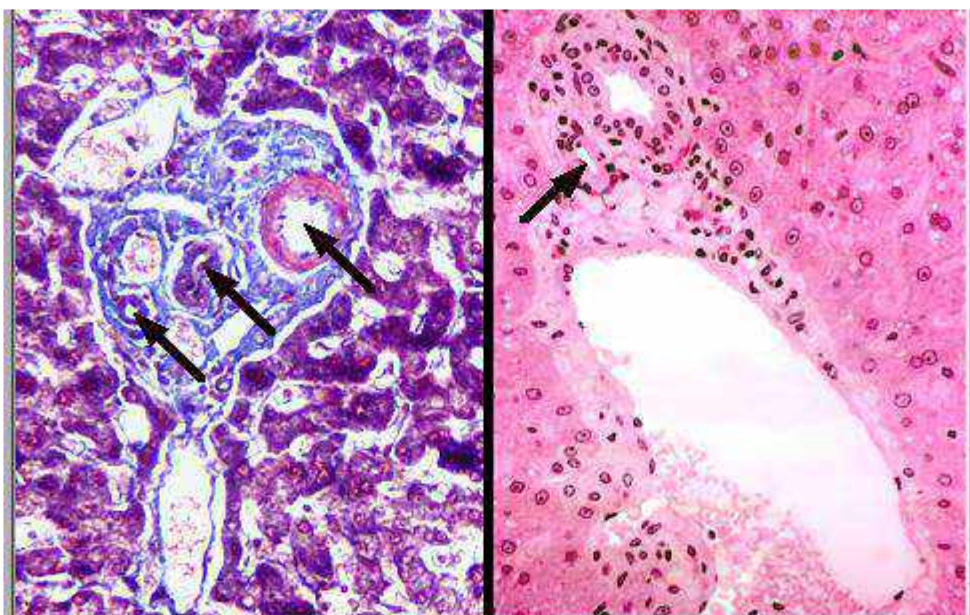


4 of 12

Liver -- Portal canals, located in the interlobular connective tissue surrounding classic lobules, contain the portal triad (branches of the hepatic portal vein, hepatic artery and bile duct) and lymphatic vessels. The left image (pig liver) has been stained with a trichrome stain to differentiate connective tissue from liver parenchyma. 200x, 400x

click to identify:

› Portal canals
Hepatic arteries >
Hepatic portal veins
Bile ducts >
Lymphatic > vessels
Hepatocytes >
Liver sinusoids >

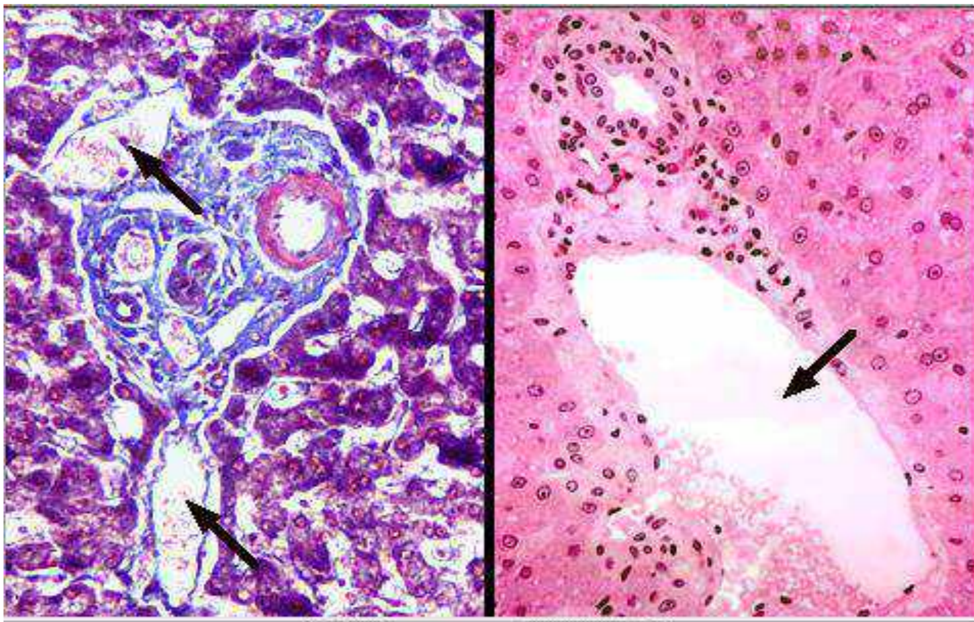


4 of 12

The liver has a dual blood supply. The hepatic artery carries oxygenated blood. The larger hepatic portal vein supplies a much greater volume of blood that is low in oxygen but high in nutrients; this blood comes directly from capillary beds located primarily in digestive organs. Blood flows from branches of these two vessels in the portal canal into liver sinusoids and into the central vein.

click to identify:

Portal canals
› Hepatic arteries >
Hepatic portal veins
Bile ducts >
Lymphatic > vessels
Hepatocytes >
Liver sinusoids >



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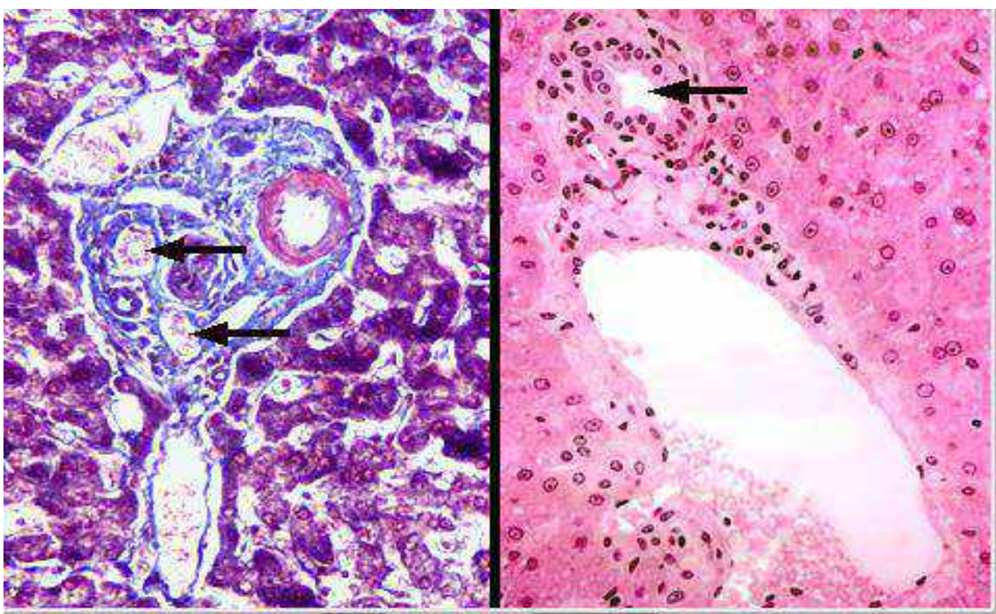
- › Hepatic portal veins
- Bile ducts >
- Lymphatic > vessels
- Hepatocytes >
- Liver sinusoids >



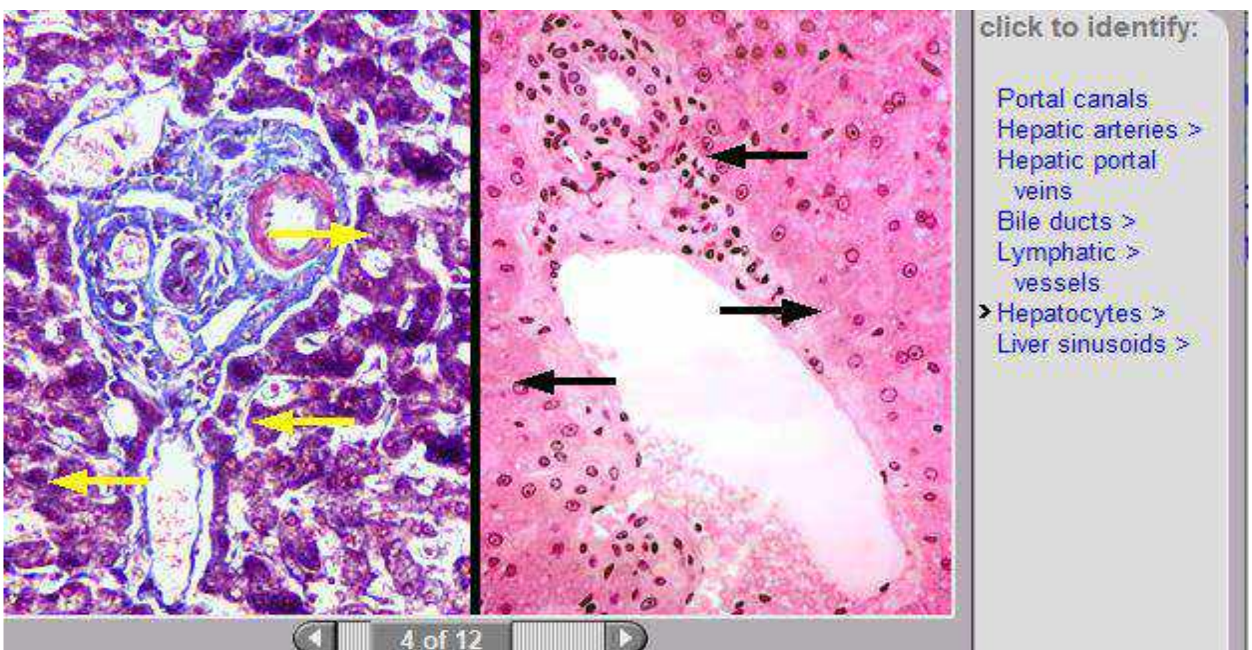
4 of 12

Bile ducts carry bile, the exocrine product, away from the liver lobule to the gall bladder and duodenum. Bile is produced by hepatocytes and released into minute channels, bile canaliculi, located between hepatocytes. Bile canaliculi anastomose and enter the portal canals as bile ducts, formed by simple cuboidal epithelium. Bile flow, therefore, is toward the periphery of the liver lobule.

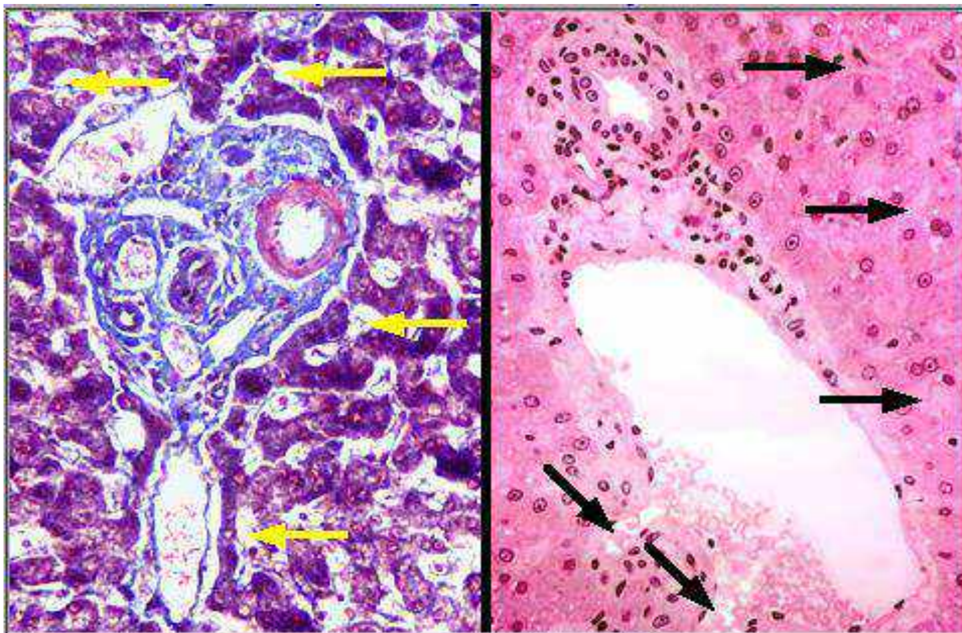
click to identify:

- Portal canals
- Hepatic arteries >
- Hepatic portal veins
- › Bile ducts >
- Lymphatic > vessels
- Hepatocytes >
- Liver sinusoids >

Lymphatic vessels are also located in portal canals.



Hepatocytes, the liver cells, are both endocrine- and exocrine-secreting cells. Their exocrine function is the production of bile, that aids in the digestion of lipids. Their endocrine function is the release of plasma proteins and glucose into the blood stream. Hepatocytes are also involved in a myriad of other functions, including storing metabolites and degrading toxic substances.



4 of 12

Sinusoids, discontinuous capillaries, are located between cords of hepatocytes. Appearing as clear spaces in the left image, sinusoids are filled with blood in the right and, thus, are difficult to distinguish. Two sinusoids are seen exiting from an hepatic portal vein. Sinusoids receive blood from the hepatic artery and hepatic portal vein and drain into the central vein of the lobule.

click to identify:

- Portal canals
- Hepatic arteries >
- Hepatic portal veins
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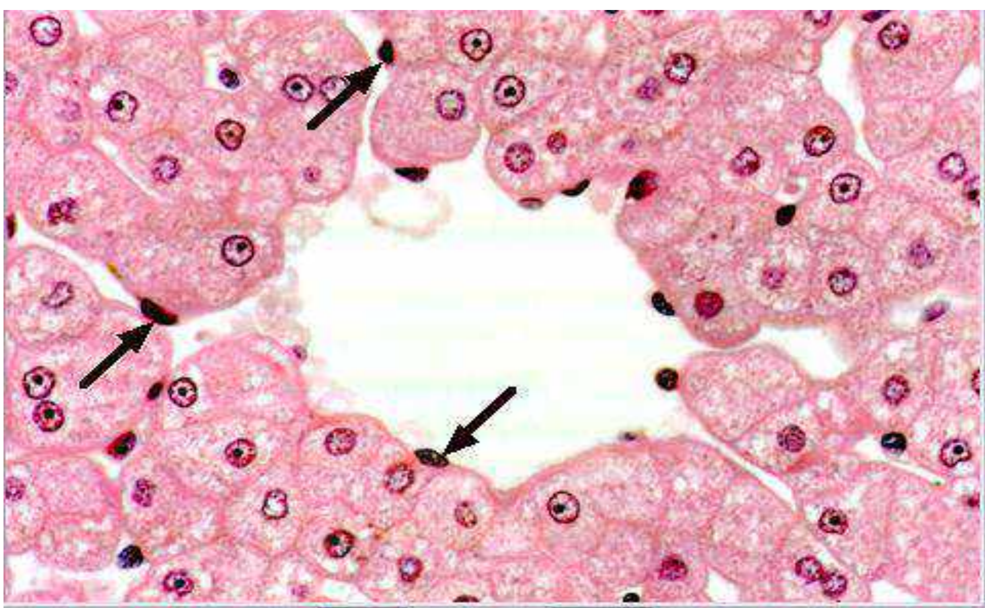
- Hepatocytes >
- › Liver sinusoids >

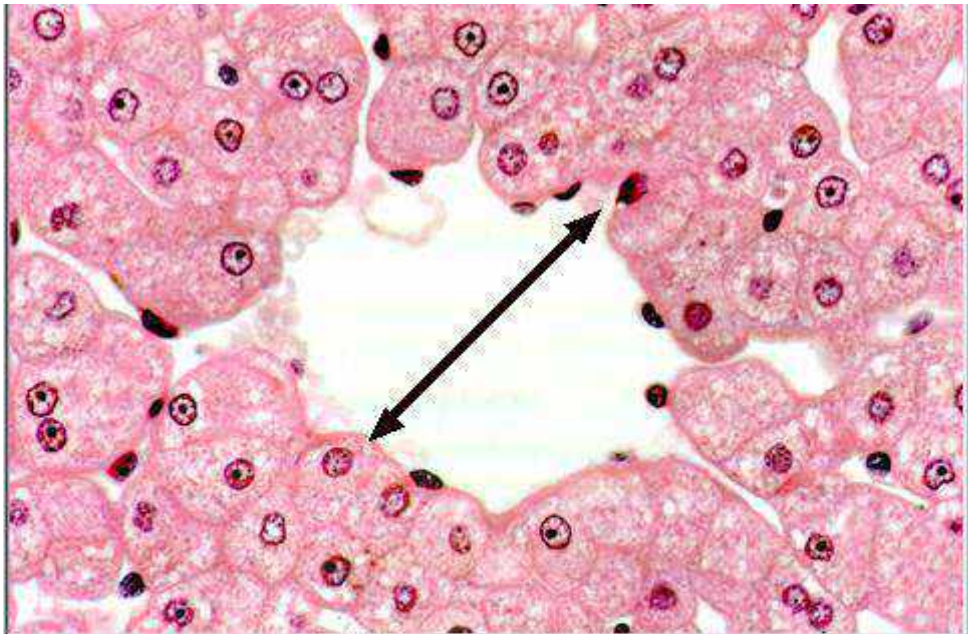


6 of 12

Liver -- A central vein is located at the center of a classic liver lobule. The central vein receives blood from the hepatic sinusoids separating plates of hepatocytes. These plates form anastomosing rows that radiate out from the central vein. Central veins anastomose to form three hepatic veins that drain into the inferior vena cava. 1000x

click to identify:

- Central vein
- Liver sinusoids
- Hepatocytes
- Blood cells
- › Endothelial cells



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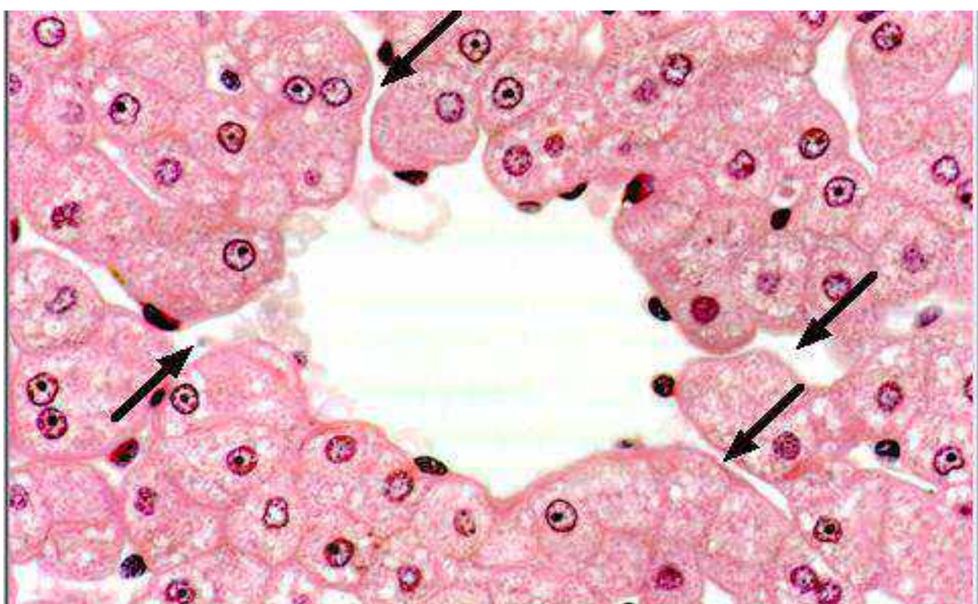

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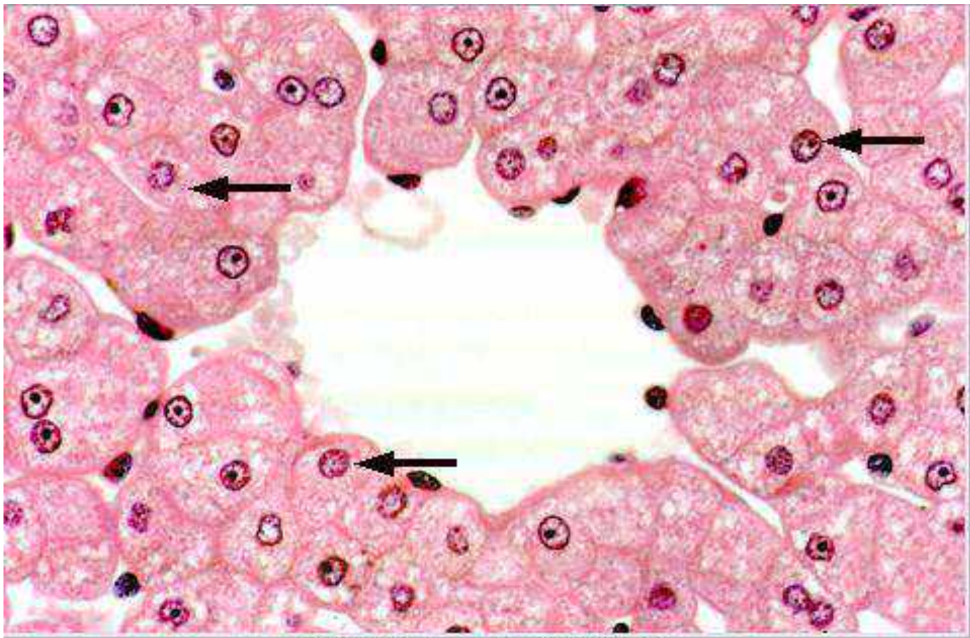

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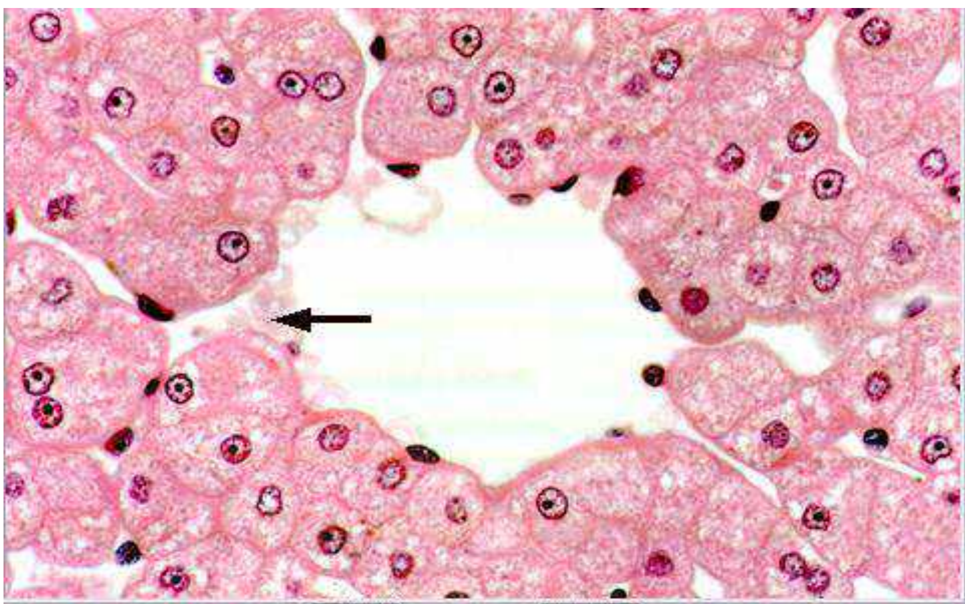

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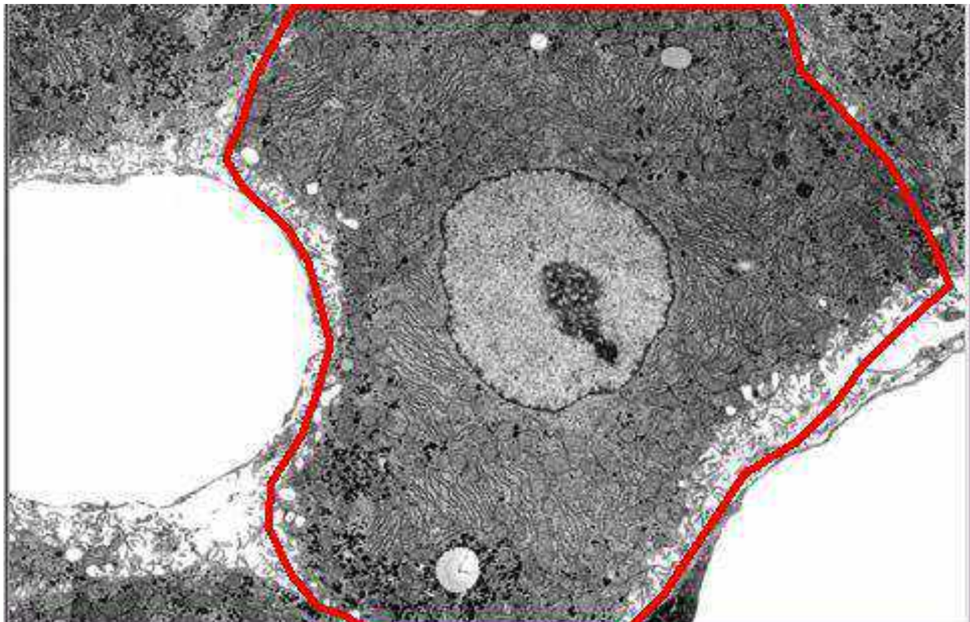
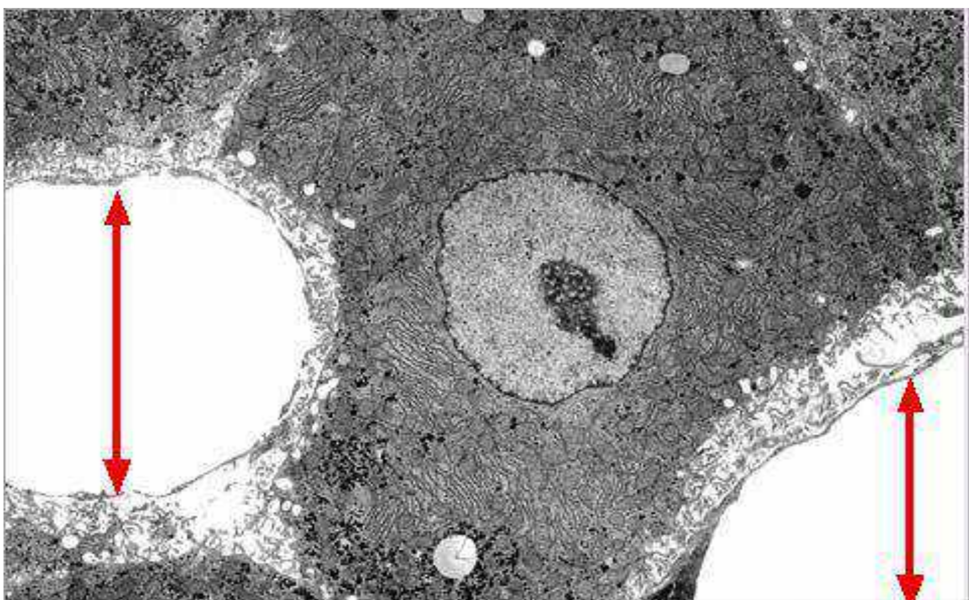


9 of 12

Liver -- This EM of the liver shows several hepatocytes abutting wide-bore, discontinuous capillaries, or sinusoids. Plates of hepatocytes, located between the sinusoids, are separated from them by the space of Disse. Plates of hepatocytes are arranged as a single row of cells, as seen here, or in plates two cells wide. 5000x

click to identify:

- > Hepatocyte
- Sinusoids
- Fenestrations and discontinuities
- Nucleus >
- RER
- Glycogen granules
- Microvilli >
- Space of Disse



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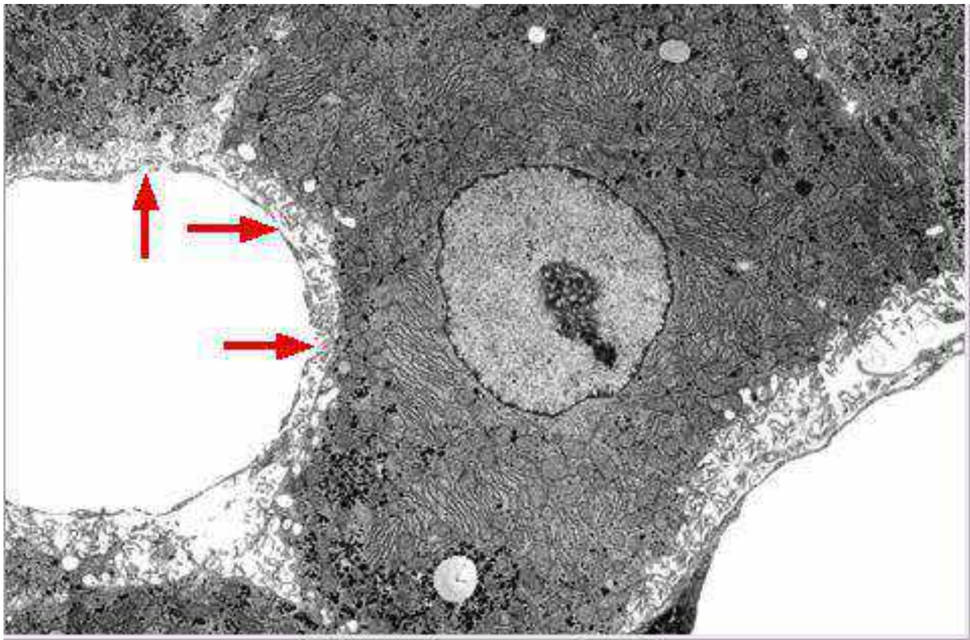

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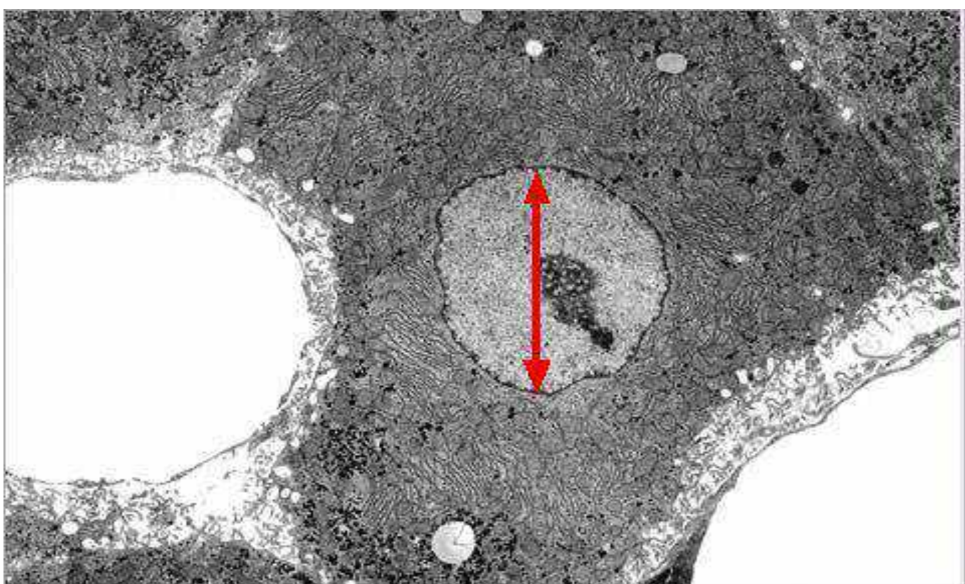

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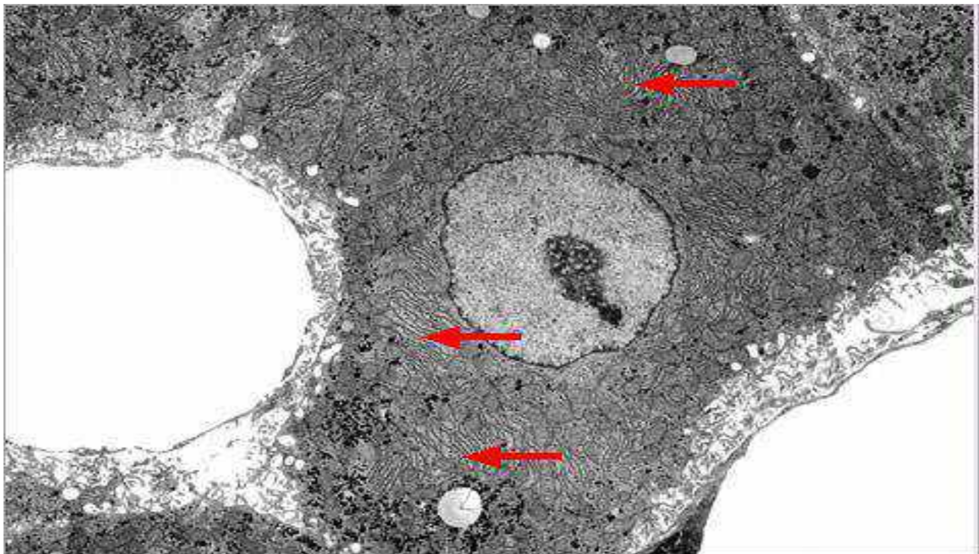
Because hepatocytes are such active cells, their nuclei are always very euchromatic, and the cells possess large numbers of mitochondria. Hepatocytes have abundant RER, the site of plasma protein production, that constitutes a major portion of the gland's endocrine secretion. Numerous glycogen granules, the storage form of glucose, are present.



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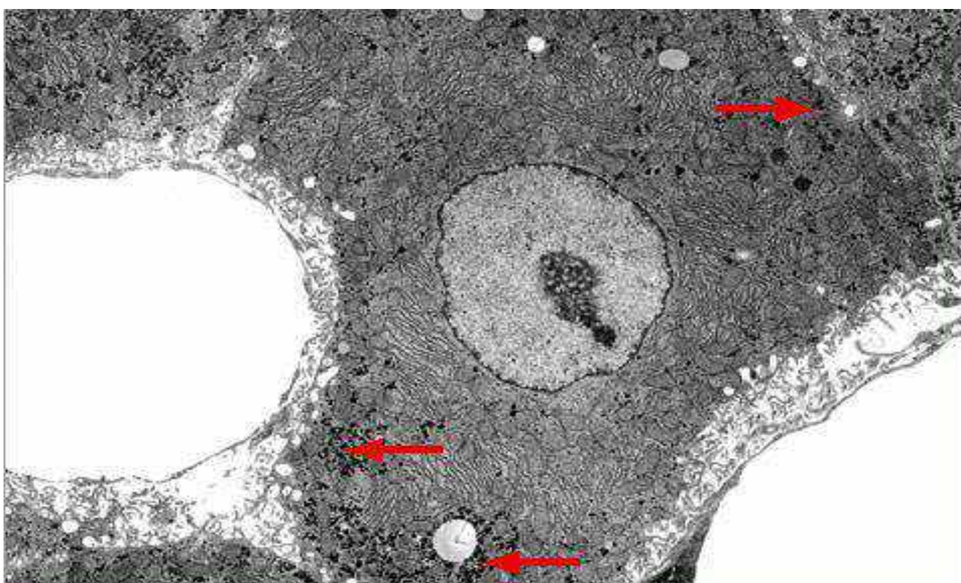

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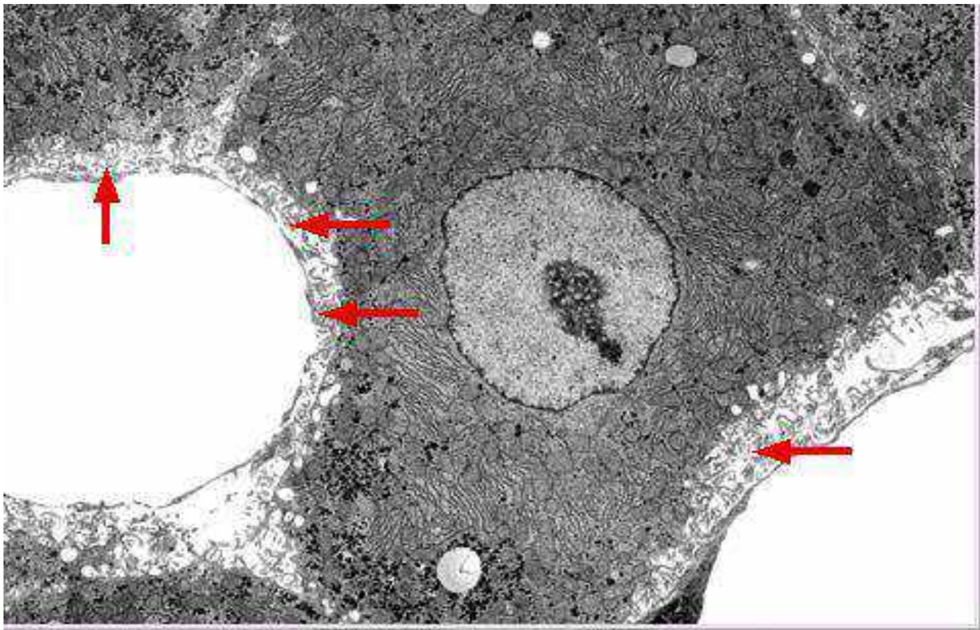

9 of 12

Microvilli increase the surface area of each hepatocyte. These microvilli project into the space of Disse, a perisinusoidal space between the hepatocytes and the sinusoids. Blood plasma escapes through endothelial fenestrations and gaps between endothelial cells to enter the space of Disse, thereby directly contacting the hepatocytes and their microvilli.

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- Hepatocyte
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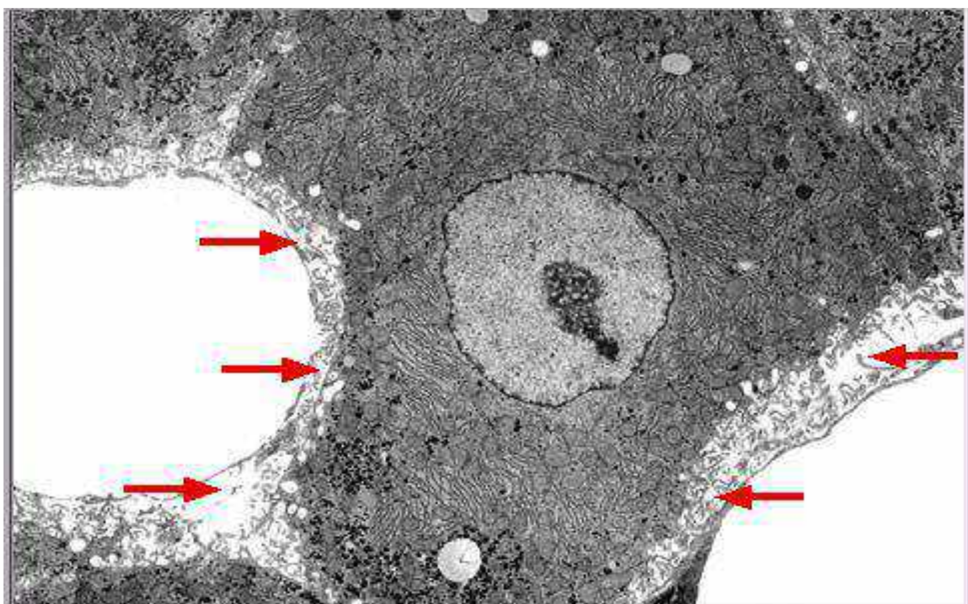
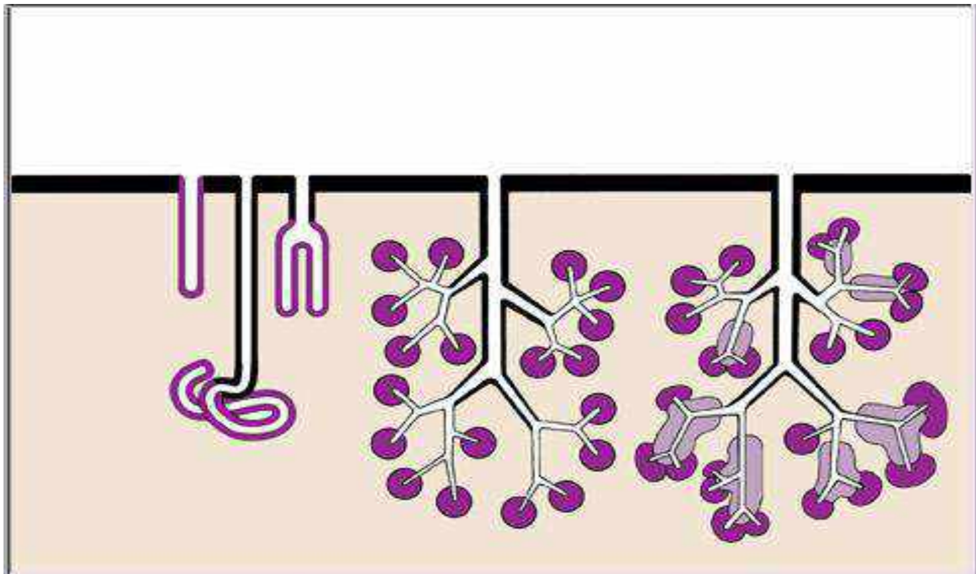


9 of 12

Microvilli increase the surface area of each hepatocyte. These microvilli project into the space of Disse, a perisinusoidal space between the hepatocytes and the sinusoids. Blood plasma escapes through endothelial fenestrations and gaps between endothelial cells to enter the space of Disse, thereby directly contacting the hepatocytes and their microvilli.

click to identify:

- Hepatocyte
- Sinusoids
- Fenestrations and discontinuities
- Nucleus >
- RER
- Glycogen granules
- Microvilli >
- › Space of Disse

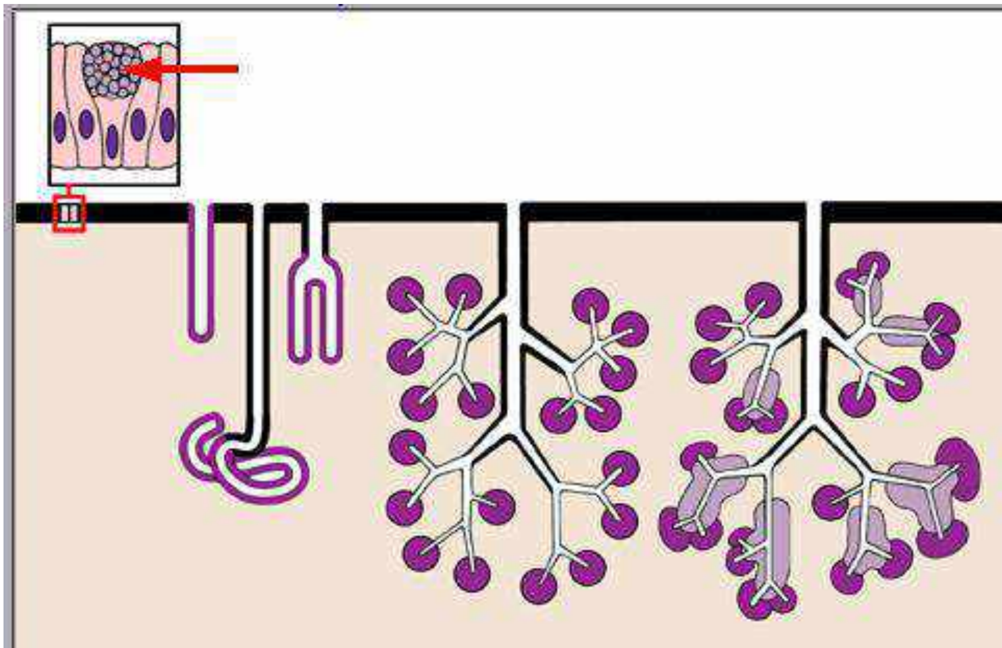


click to identify:

Unicellular gland >
Sheet gland >
Simple glands >
Tubular >
Coiled tubular >
Branched > tubular
Compound > glands
Acinar >
Tubuloacinar >

1 of 6

Exocrine glands -- Exocrine secretory cells remain either within or attached to the epithelial surface from which they originate. Secretory cells release their product(s) onto that surface epithelium directly or indirectly via ducts. Units of secretory cells are organized into tubules (test-tube shaped) or grapefruit-shaped acini (sing. acinus). Acini may also be called alveoli (sing. alveolus).

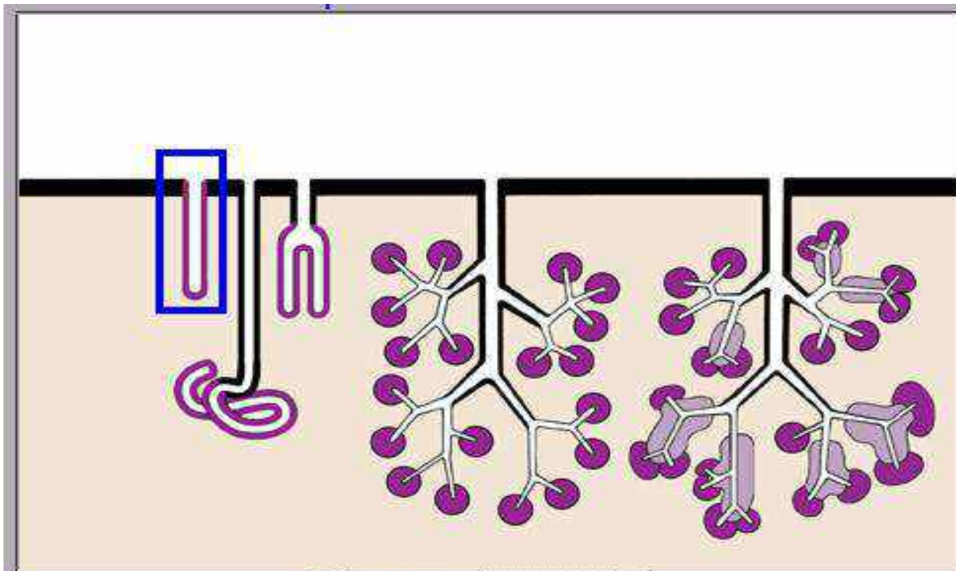


click to identify

> Unicellular gland
Sheet gland >
Simple glands >
Tubular >
Coiled tubular >
Branched > tubular
Compound > glands
Acinar >
Tubuloacinar >

1 of 6

A unicellular gland, the simplest exocrine gland, is a single secretory cell that remains in the epithelium where it forms. Although other examples exist, the most common unicellular exocrine gland is the goblet cell, demonstrated here. Goblet cells secrete mucus to lubricate the surface epithelium.

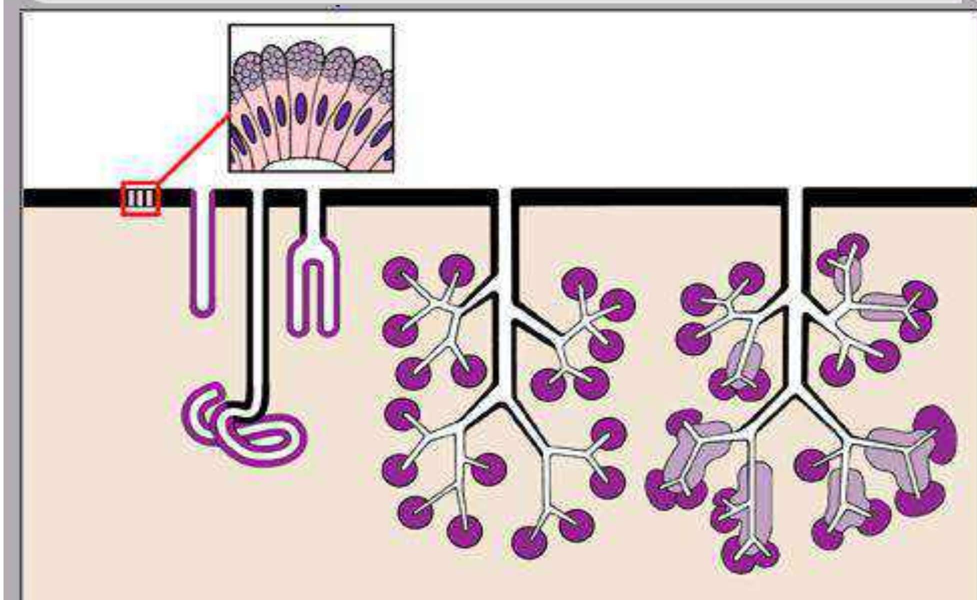


1 of 6

The least complex of the simple tubular glands consists of a secretory unit shaped like a test tube that connects directly to the surface epithelium without an intervening duct. Mucus is a common product of tubular secretory units, so cells of tubular glands frequently appear pale and frothy. Intestinal glands in small and large intestine are simple tubular glands.

click to identify:

- Unicellular gland >
- Sheet gland >
- Simple glands >
  - Tubular >
  - Coiled tubular >
  - Branched > tubular
- Compound > glands
  - Acinar >
  - Tubuloacinar >

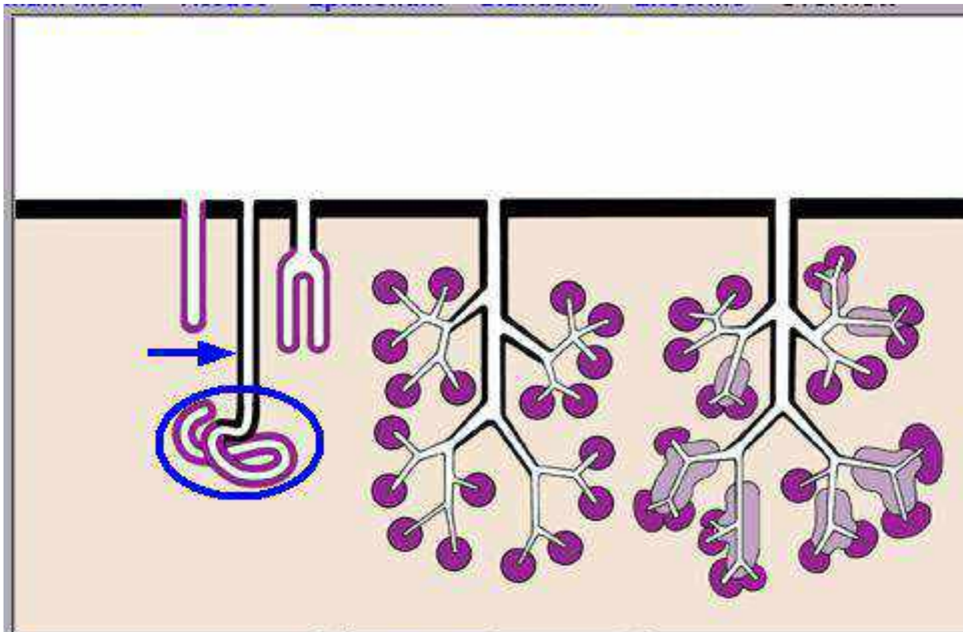


1 of 6

A sheet gland is a little more complex than a unicellular gland in that all cells of a surface epithelium differentiate into secretory cells, forming a secretory sheet. The only sheet gland in the human lines the lumen of the stomach, where the mucus it secretes protects the stomach from gastric acids.

click to identify:

- Unicellular gland >
- Sheet gland >
- Simple glands >
  - Tubular >
  - Coiled tubular >
  - Branched > tubular
- Compound > glands
  - Acinar >
  - Tubuloacinar >

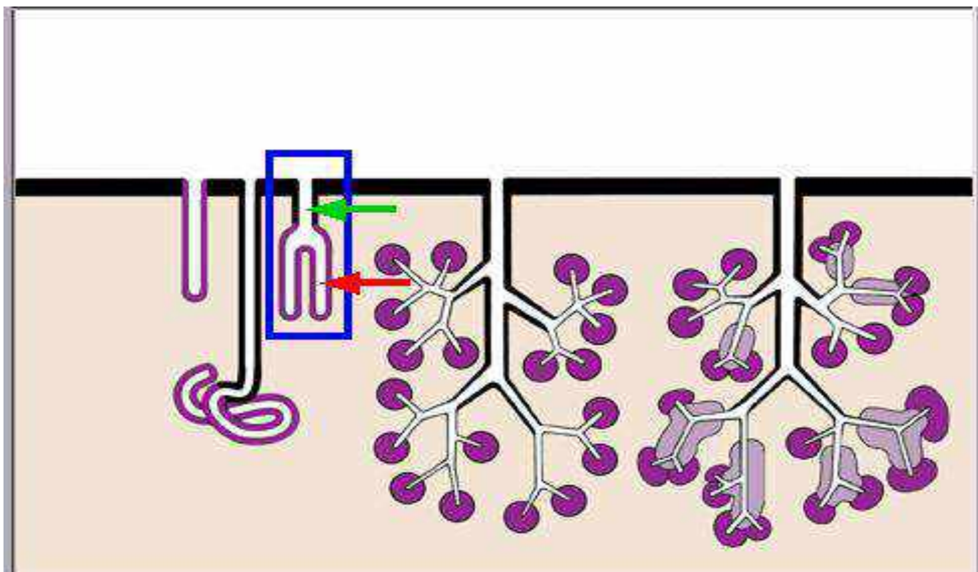


1 of 6

A simple coiled tubular gland has a tubular secretory unit (blue oval) that coils on itself like a ball of yarn; secretory product is conveyed to the surface epithelium by a single duct (blue arrow). The most common simple coiled tubular gland in the human does not secrete mucus, but is specialized to produce sweat.

click to identify:

- Unicellular gland >
- Sheet gland >
- Simple glands >
  - Tubular >
  - Coiled tubular >
  - Branched > tubular
- Compound > glands
  - Acinar >
  - Tubuloacinar >

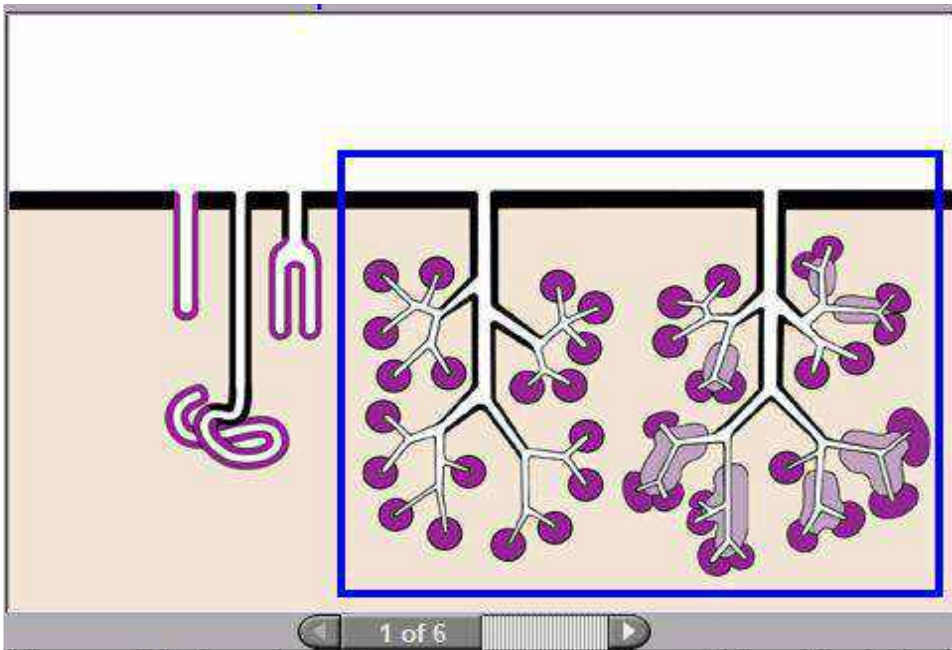


1 of 6

In simple branched tubular glands, secretory tubules (red arrow) branch; if a duct (green arrow) is present, it does not branch. (If the duct branched, this would be a compound gland.) Gastric glands are simple branched tubular glands.

click to identify:

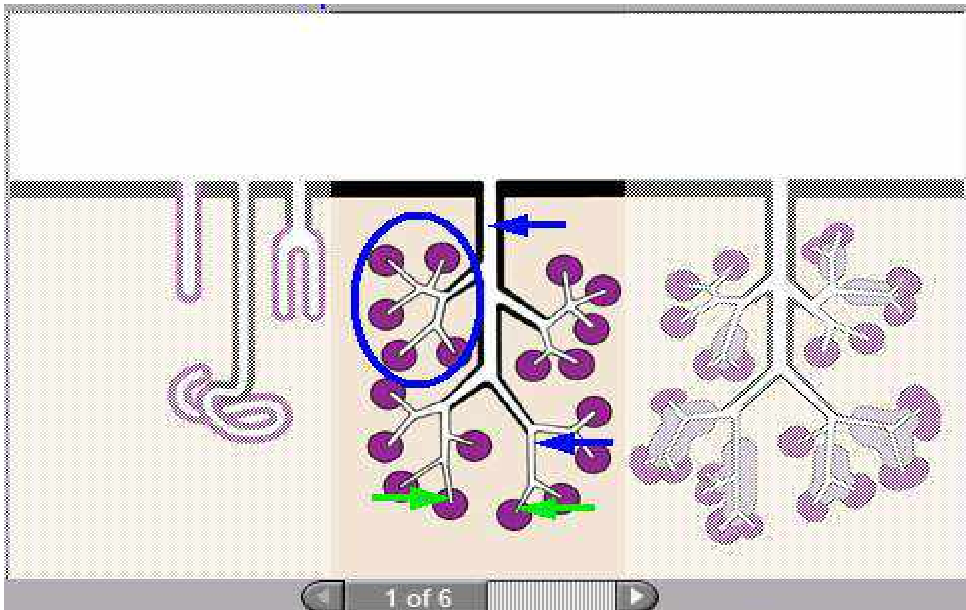
- Unicellular gland >
- Sheet gland >
- Simple glands >
  - Tubular >
  - Coiled tubular >
  - Branched > tubular
- Compound > glands
  - Acinar >
  - Tubuloacinar >



Compound glands are large, often macroscopic structures with branching ducts. Secretory units may be entirely acinar, entirely tubular or a combination of acinar and tubular. Compound glands can be subdivided into smaller subunits called lobules, each consisting of a duct and its attached secretory units.

click to identify:

- Unicellular gland >
- Sheet gland >
- Simple glands >
  - Tubular >
  - Coiled tubular >
  - Branched > tubular
- Compound > glands
  - Acinar >
  - Tubuloacinar >

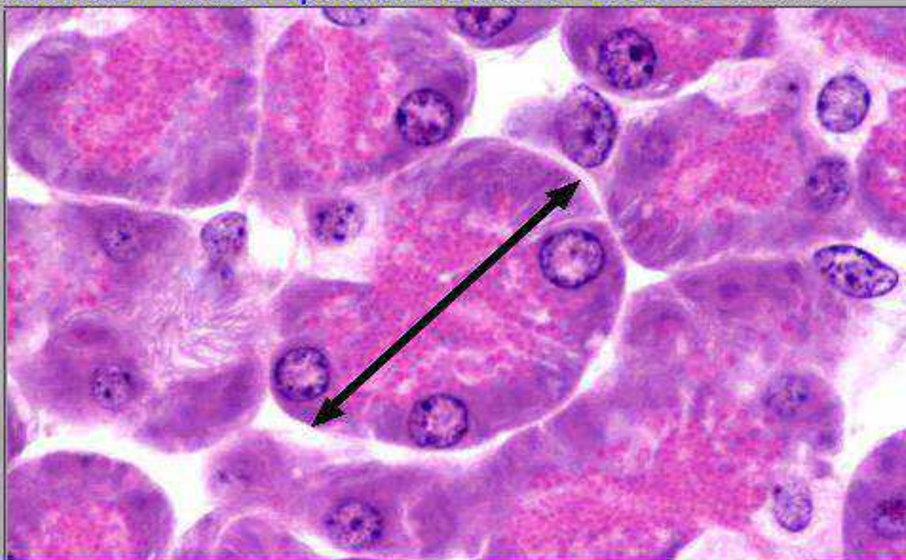


Compound acinar glands have branching ducts (blue arrows), lobules (oval) and acinar (alveolar) secretory units (magenta spheres). An acinus usually secretes a serous product and resembles a grapefruit; when sectioned, secretory cells resemble grapefruit wedges. Each acinus has a small central lumen (green arrows), sufficient to transport its watery product.

click to identify:

- Unicellular gland >
- Sheet gland >
- Simple glands >
  - Tubular >
  - Coiled tubular >
  - Branched > tubular
- Compound > glands
  - Acinar >
  - Tubuloacinar >

Main Menu > Tissues > Epithelium > Glandular > Exocrine > Overview



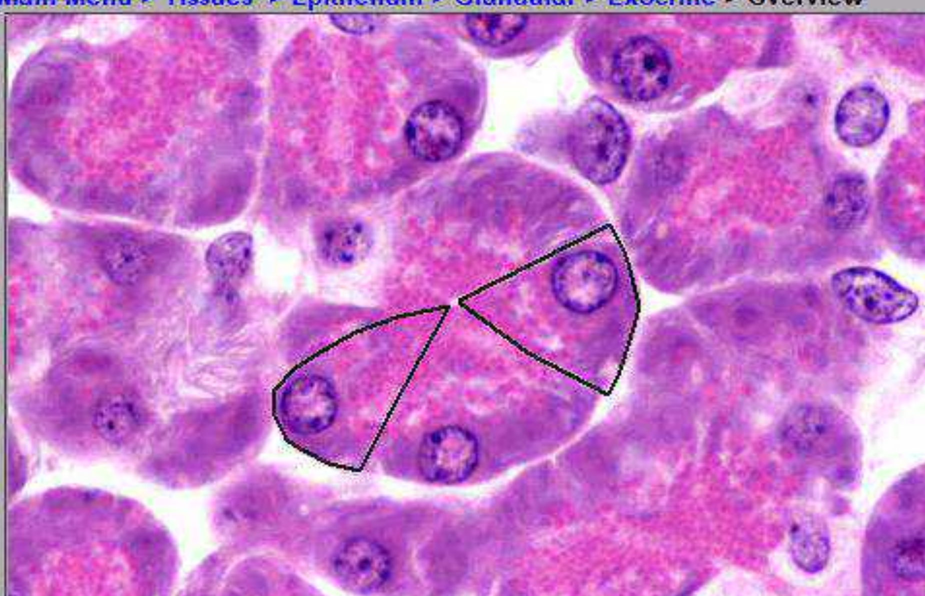
3 of 6

click to identify:

- Acinus
- Gland cells
- RER
- Secretory granules
- Lumen

Polarity -- Polarity is the cell feature exhibited when organelles are not homogenously distributed in the cytoplasm. Polarity is a characteristic of exocrine cells. These pyramidal, acinar cells syntheisize enzymes in the RER at the base of the cell. The product is stored in secretory granules in the cell apex adjacent to the lumen, into which it will be released. Pancreas 1000x

Main Menu > Tissues > Epithelium > Glandular > Exocrine > Overview



3 of 6

click to identify:

- Acinus
- Gland cells
- RER
- Secretory granules
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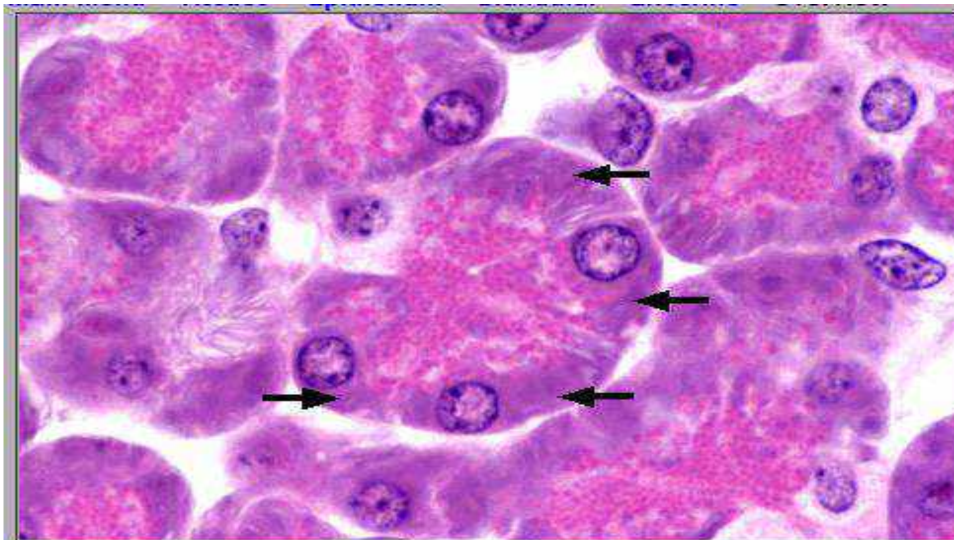

click to identify:

- Acinus
- Gland cells
- › RER
- Secretory granules
- Lumen

3 of 6

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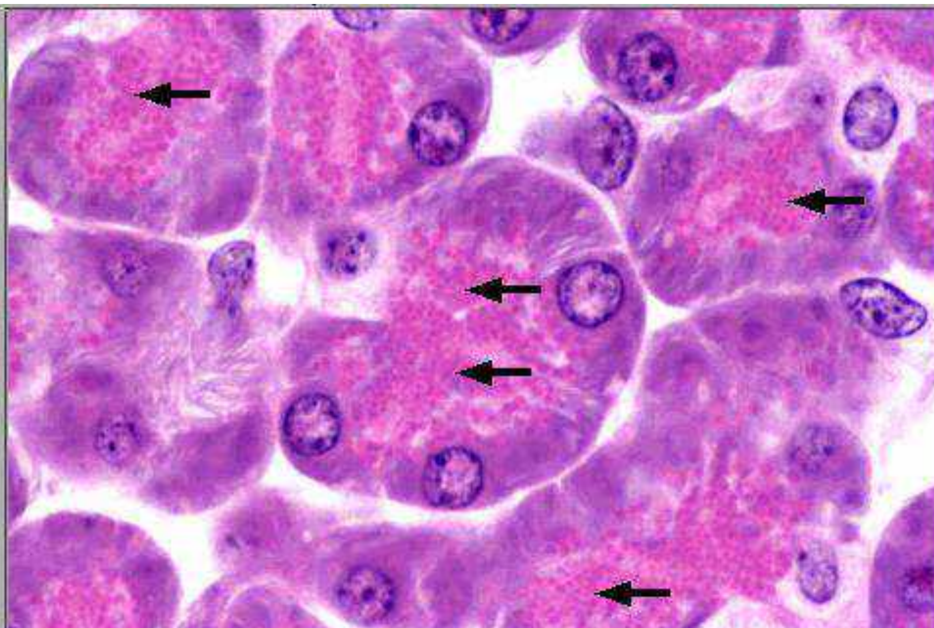

click to identify:

- Acinus
- Gland cells
- RER
- › Secretory granules
- Lumen

3 of 6

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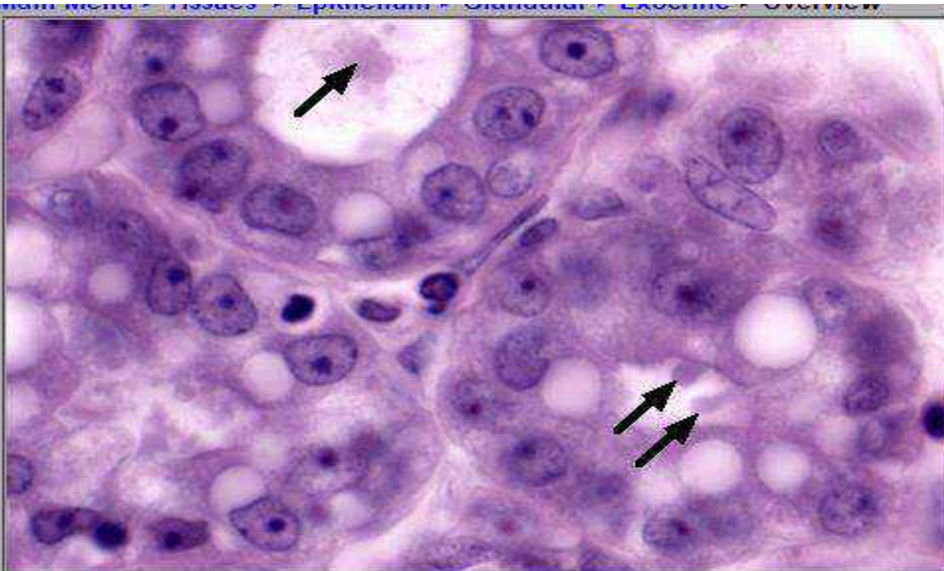
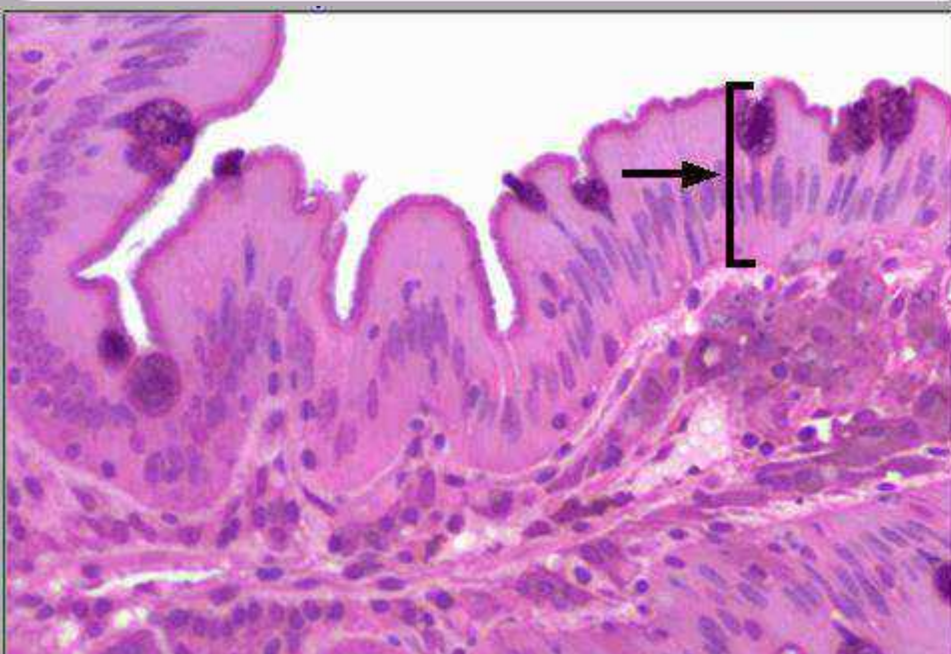


5 of 6

Modes of secretion: apocrine -- These secretory cells of the breast secrete by both merocrine (protein) and apocrine (lipid) modes of secretion. Very few glands secrete by the apocrine mode, which involves the loss of surface plasma membrane and a small amount of cytoplasm along with the secretory product. Note the secretory product being released in the lower right of the image. 1000x

click to identify:

- Secretory product
- Lipid droplet

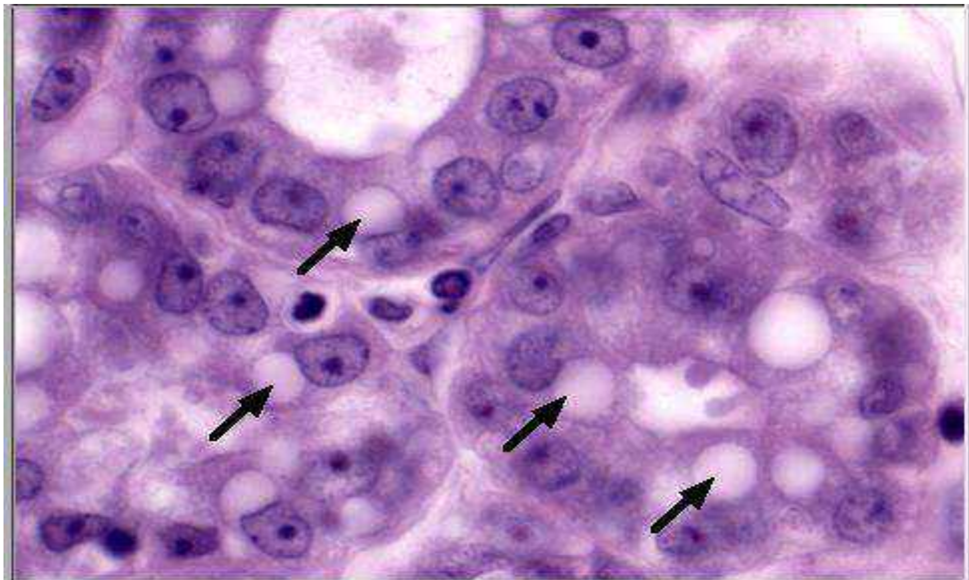


1 of 6

Unicellular gland -- The simplest gland is a unicellular gland, which can be either endocrine or exocrine. The goblet cells shown here represent unicellular exocrine glands that remain in the epithelium from which they originated. These cells secrete mucus and are prominent in the lining epithelium of the gastrointestinal and respiratory systems. Small intestine 400x

click to identify:

- Goblet cell
- Goblet cell nuclei
- Mucin
- Absorptive cells
- Brush border
- Loose CT



5 of 6

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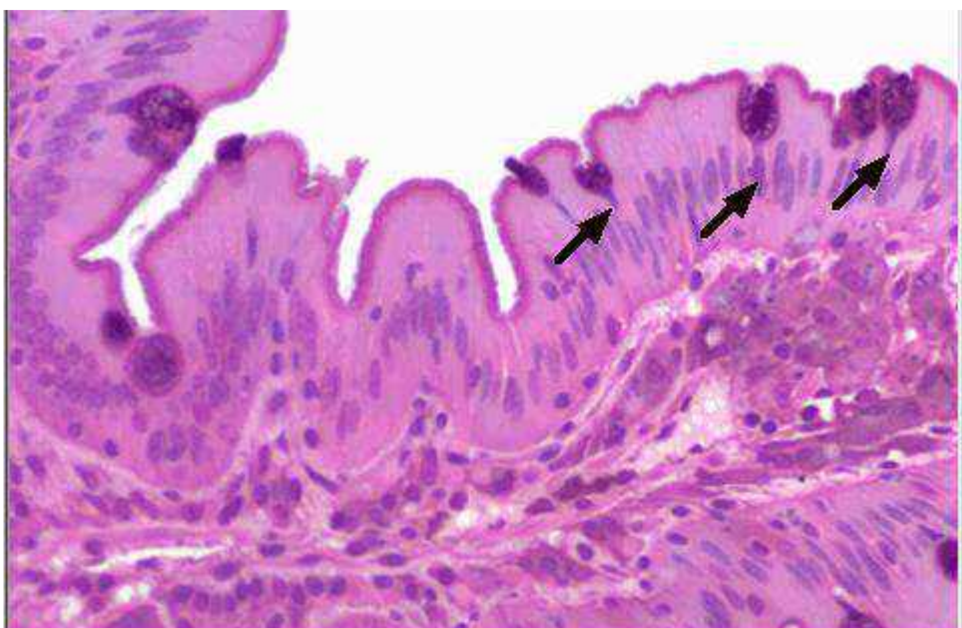
click to identify:

- Secretory product
- › Lipid droplet



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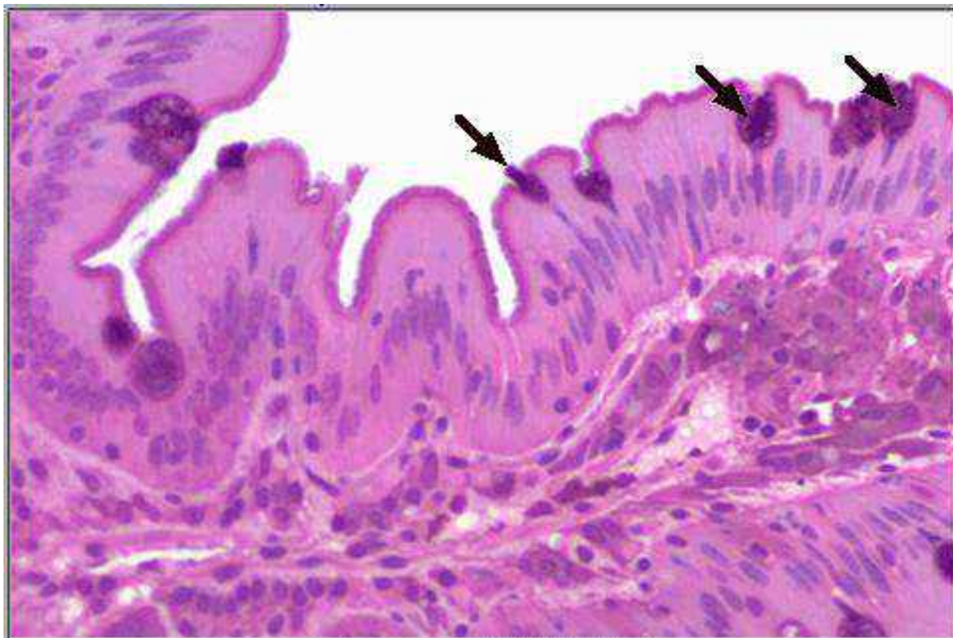
- Mucin
- Absorptive cells
- Brush border
- Loose CT



1 of 6

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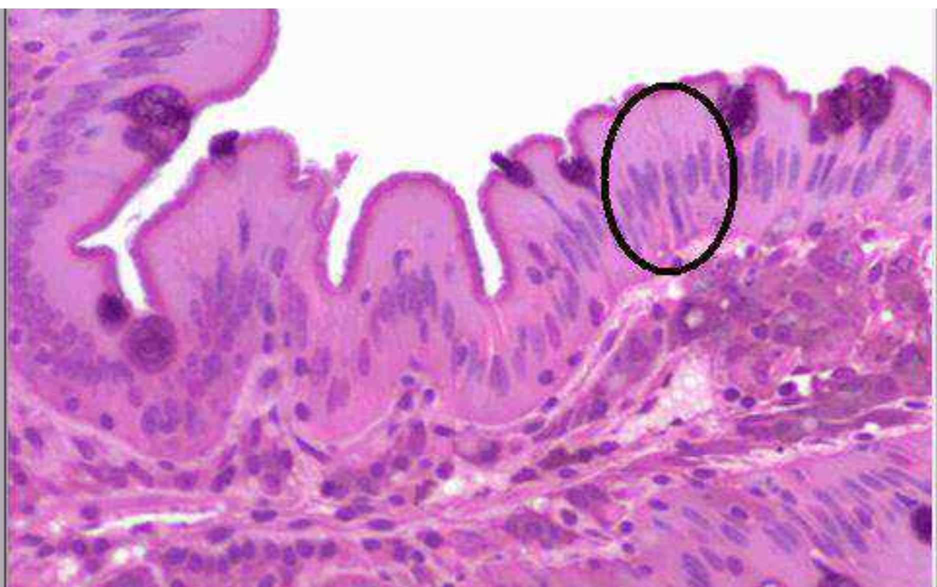
click to identify:

- Goblet cell
- Goblet cell nuclei
- › Mucin
- Absorptive cells
- Brush border
- Loose CT



1 of 6

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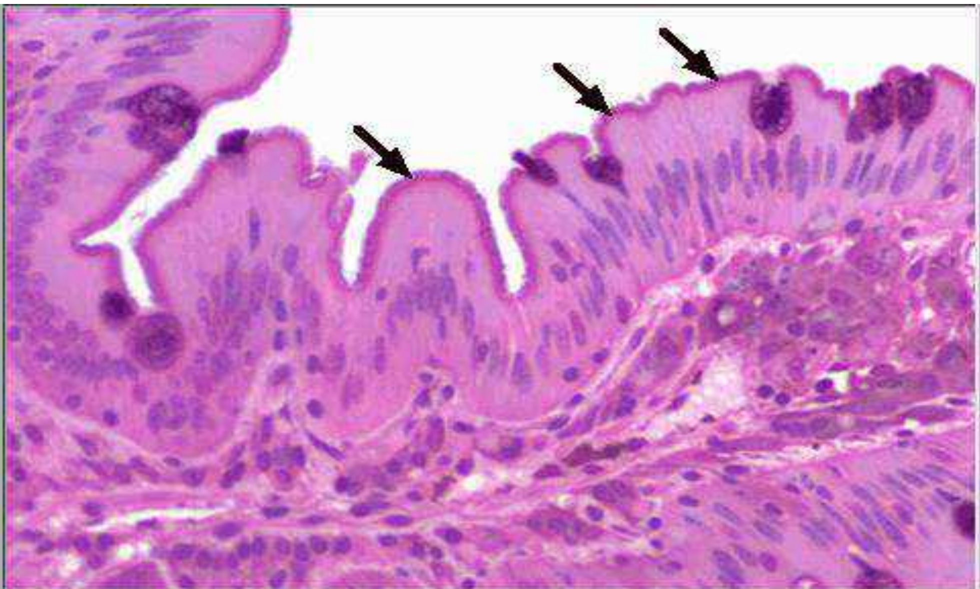
click to identify:

- Goblet cell
- Goblet cell nuclei
- Mucin
- › Absorptive cells
- Brush border
- Loose CT



1 of 6

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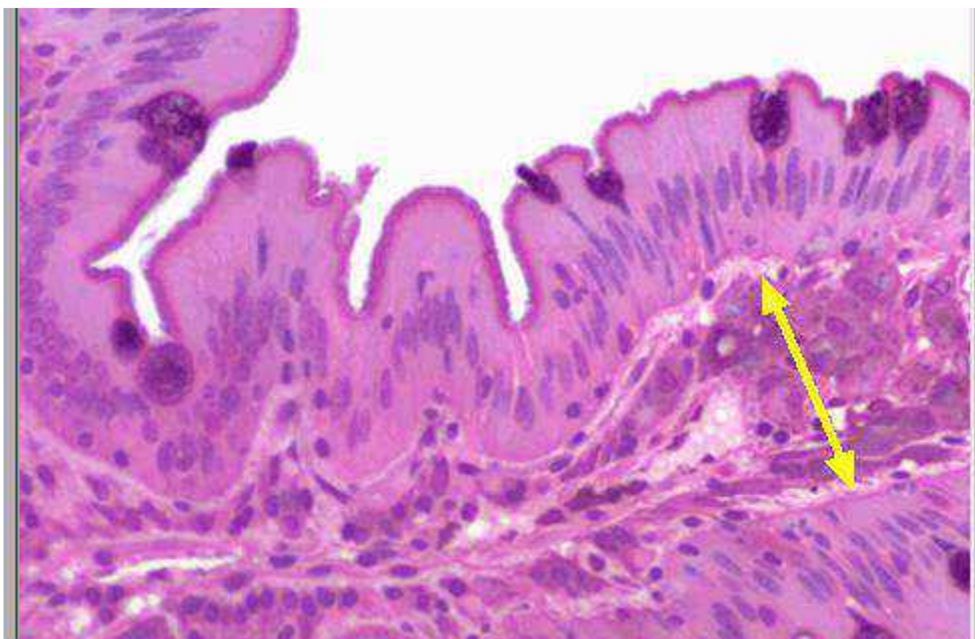
click to identify:

Goblet cell
Goblet cell nuclei
Mucin
Absorptive cells
> Brush border
Loose CT



1 of 6

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click to identify:

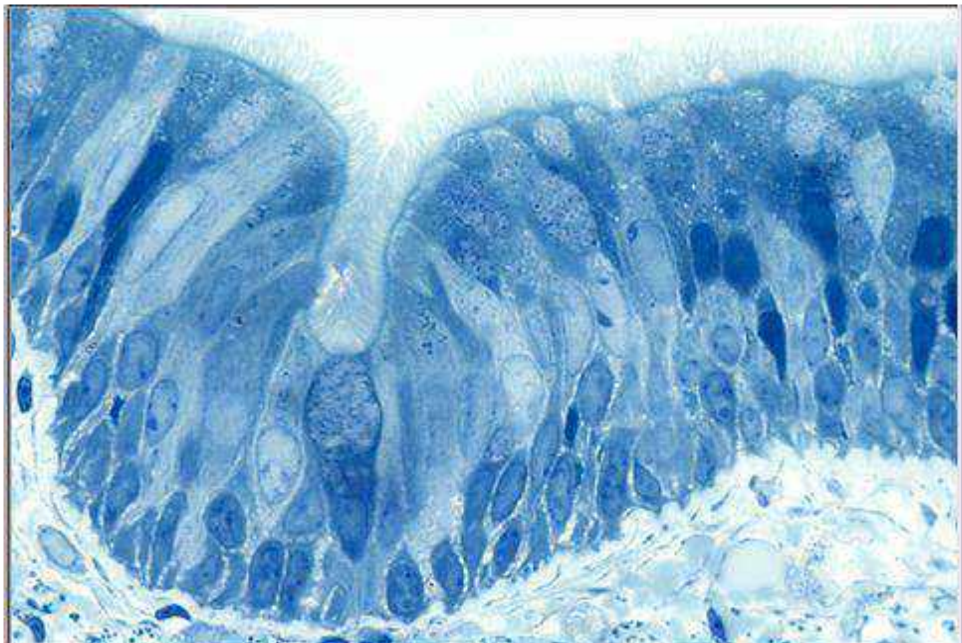
Goblet cell
Goblet cell nuclei
Mucin
Absorptive cells
Brush border
> Loose CT

2 of 6

Unicellular gland -- The mucin in these goblet cells is located in the apex of the cell, with the nucleus and remaining cytoplasm located beneath it, creating the goblet-like shape. Goblet cells release mucin proteins which become hydrated, thereby forming mucus. Goblet cells are commonly found in simple columnar epithelia, such as this lining of the small intestine. 1000x

click to identify:

Goblet cell nuclei
Mucin
Absorptive cells
Brush border

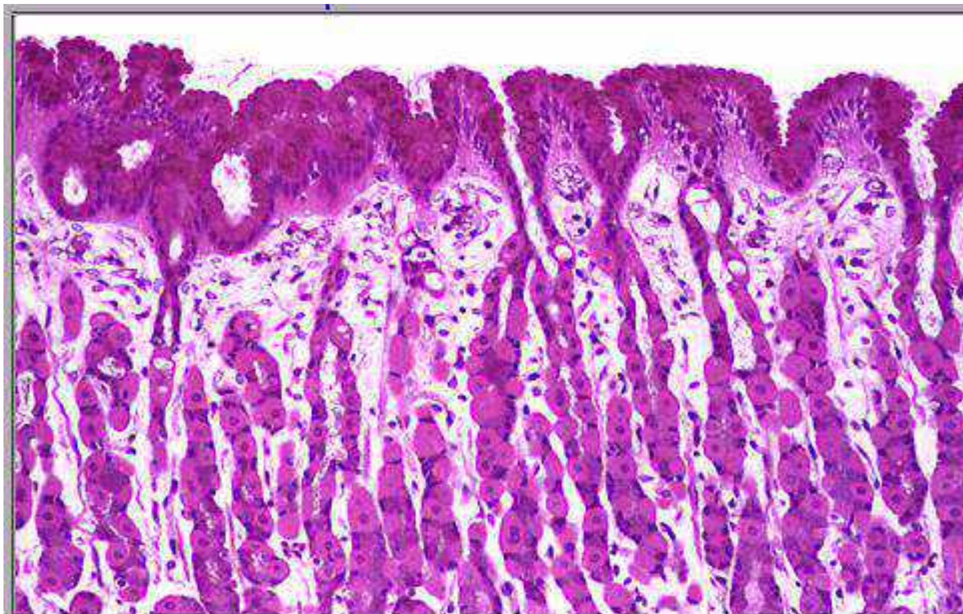


3 of 6

Unicellular gland -- This lining epithelium of the monkey trachea is a pseudostratified epithelium with cilia and goblet cells. Goblet cells release mucin proteins which become hydrated, thereby forming mucus. The mucus traps inhaled particles and the entire mucous sheet is moved upward by the beating action of associated cilia. 1000x

click to identify:

Pseudostratified epithelium
Cilia
Basal bodies
Goblet cell
Loose CT

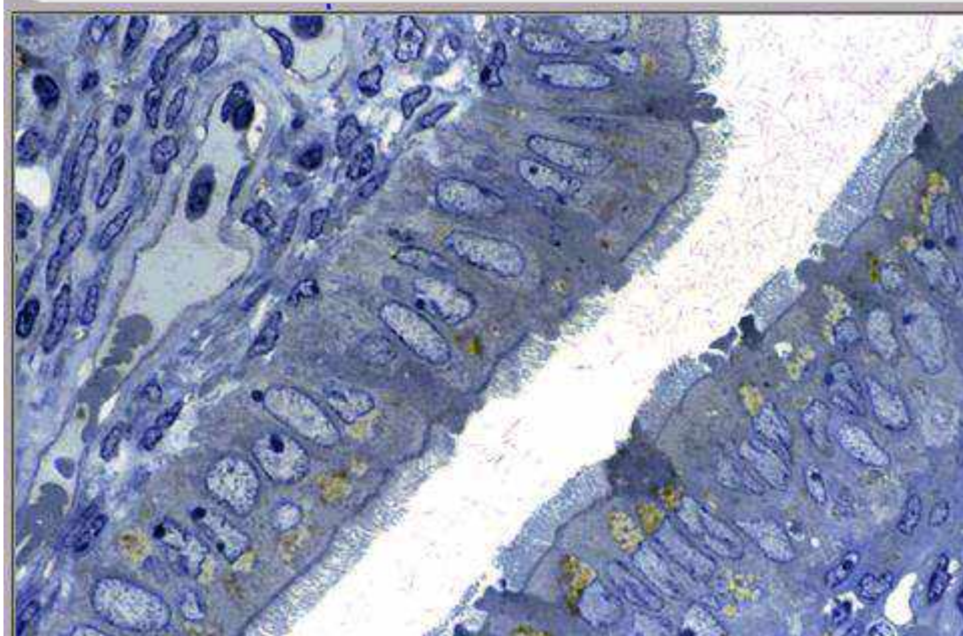


1 of 2

Sheet gland -- This fundic region of the stomach demonstrates a sheet gland, which forms the lining of the stomach. The multicellular sheet gland is an epithelial layer composed entirely of mucus-secreting cells. The mucus produced by this layer protects the stomach tissues from the acidic contents of the organ. 200x

click to identify:

- Sheet gland
- Tubular glands
- Stomach lumen

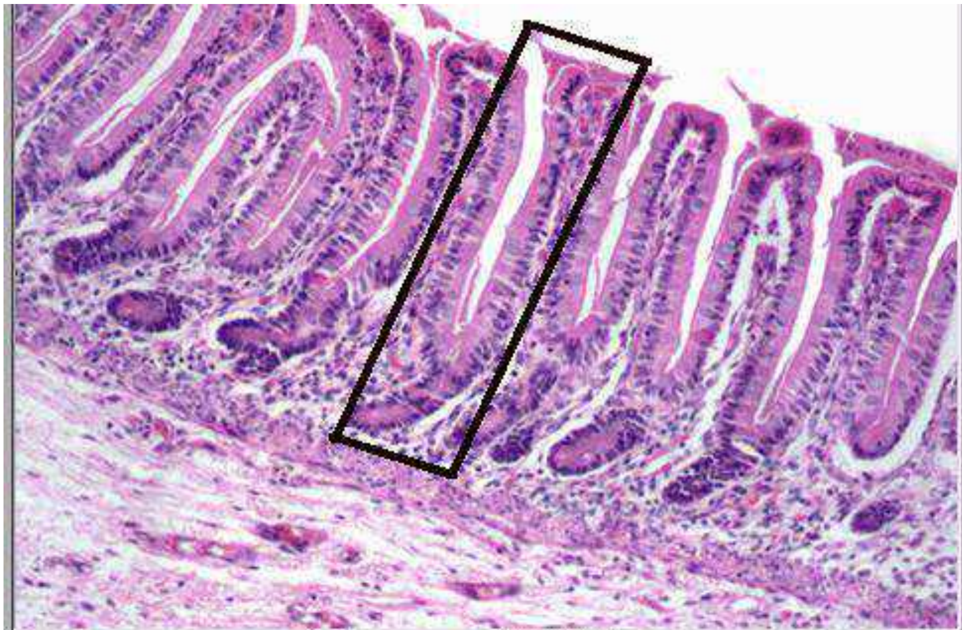


6 of 6

Unicellular gland -- Not all unicellular glands are goblet cells. This simple columnar epithelial lining of the oviduct demonstrates unicellular glands among the ciliated cells. The oviduct is the site of fertilization, and these unicellular glands provide nutrition to the oocyte, sperm and embryo. 1000x

click to identify:

- Simple columnar epithelium
- Secretory cells
- Cilia
- Basal bodies
- Loose CT



2 of 13

Simple tubular gland -- In this section of the large intestine, the simple tubular glands are slightly longer than the mucosal layer in which they are located. Note that the bases of the glands curve as they reach the muscularis muscosae. These glands are composed primarily of goblet and absorptive cells. 200x

click to identify:

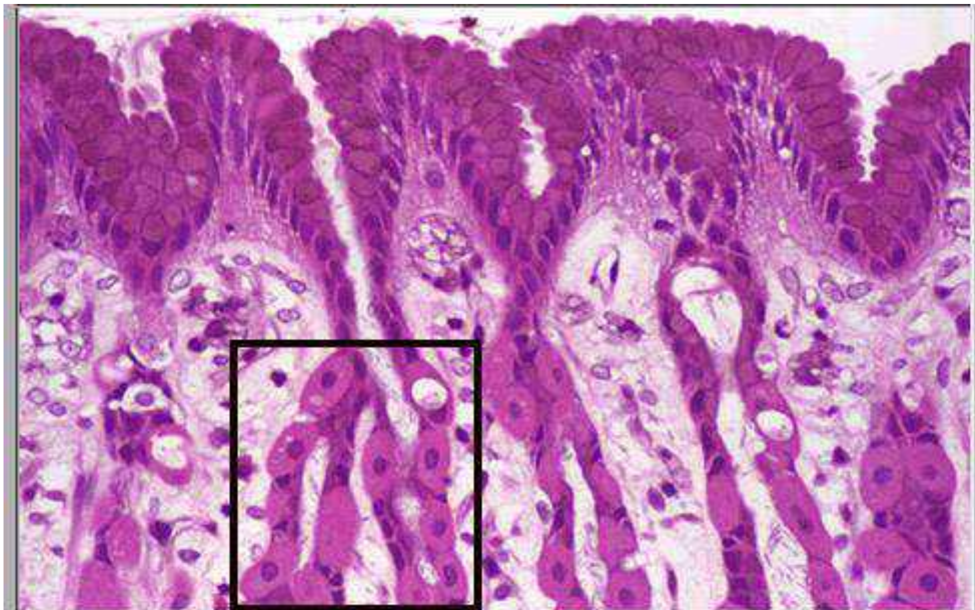
- Simple tubular gland
- Goblet cells
- Absorptive cells
- Gland lumens
- Intestinal lumen
- Muscularis mucosae

5 of 13

Simple, branched tubular gland -- This image of the stomach shows the structure of a simple, branched tubular gland. The secretory sheet lining the surface invaginates to form a gastric pit that acts as a duct for the gland. The secretory portions of the gland branch at their junction with the gastric pit. 400x

click to identify:

- Simple branched tubular gland
- Gastric pit
- Secretory tubules
- Sheet gland



5 of 13

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click to identify:

- Simple branched tubular gland
- Gastric pit
- Secretory tubules
- Sheet gland

5 of 13

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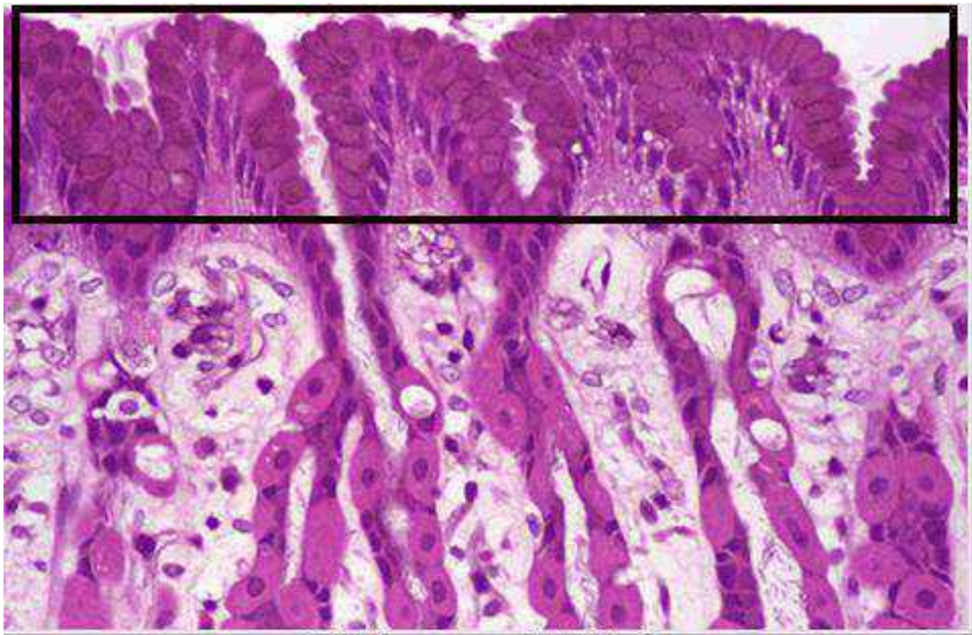
click to identify:

- Simple branched tubular gland
- Gastric pit
- Secretory tubules
- Sheet gland



5 of 13

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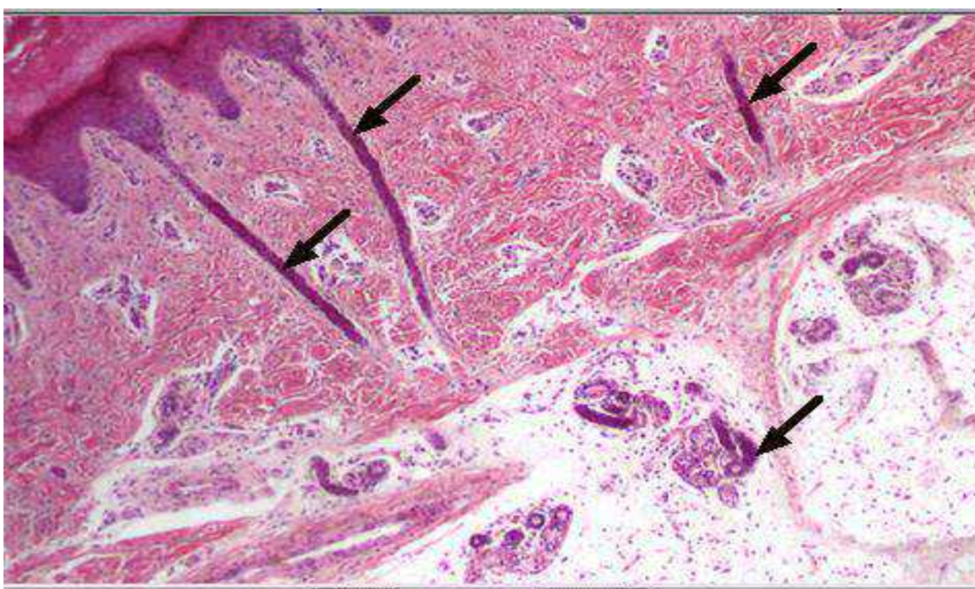
click to identify:

- Simple branched tubular gland
- Gastric pit
- Secretory tubules
- › Sheet gland

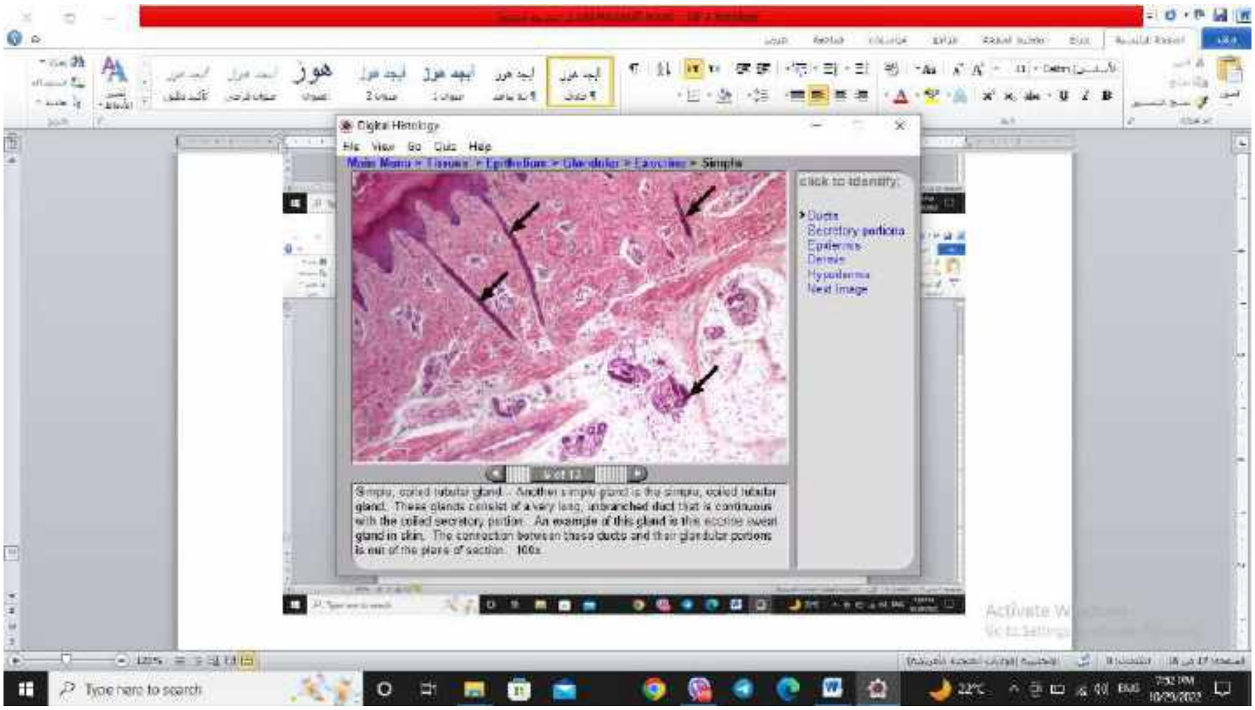


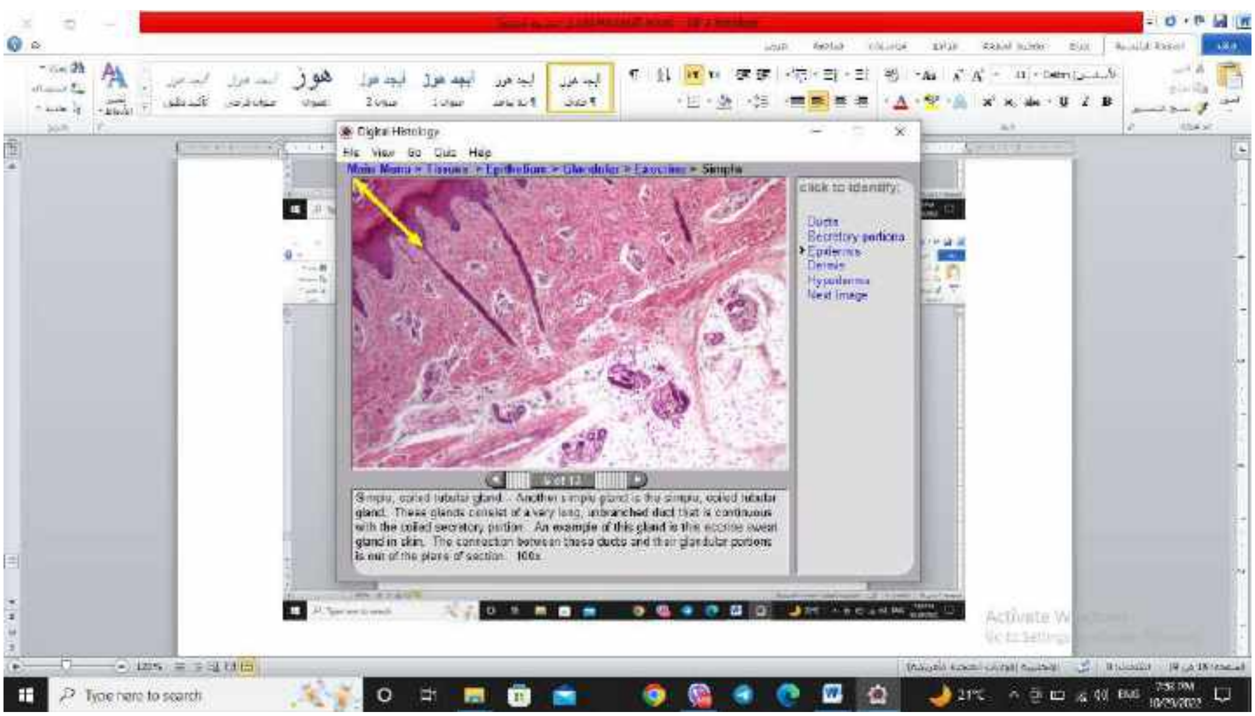
6 of 13

Simple, coiled tubular gland -- Another simple gland is the simple, coiled tubular gland. These glands consist of a very long, unbranched duct that is continuous with the coiled secretory portion. An example of this gland is this eccrine sweat gland in skin. The connection between these ducts and their glandular portions is out of the plane of section. 100x

click to identify:

- › Ducts
- Secretory portions
- Epidermis
- Dermis
- Hypodermis
- Next image


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Ducts
Secretory portions
Epidermis
Dermis
Hypodermis
Next Image
Simple, coiled tubular gland. - Another simple gland is the simple, coiled tubular gland. These glands consist of a very long, unbranched duct that is continuous with the coiled secretory portion. An example of this gland is the eccrine sweat gland in skin. The connection between these ducts and their glandular portions is out of the plane of section. 100x
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
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Ducts
Secretory portions
Epidermis
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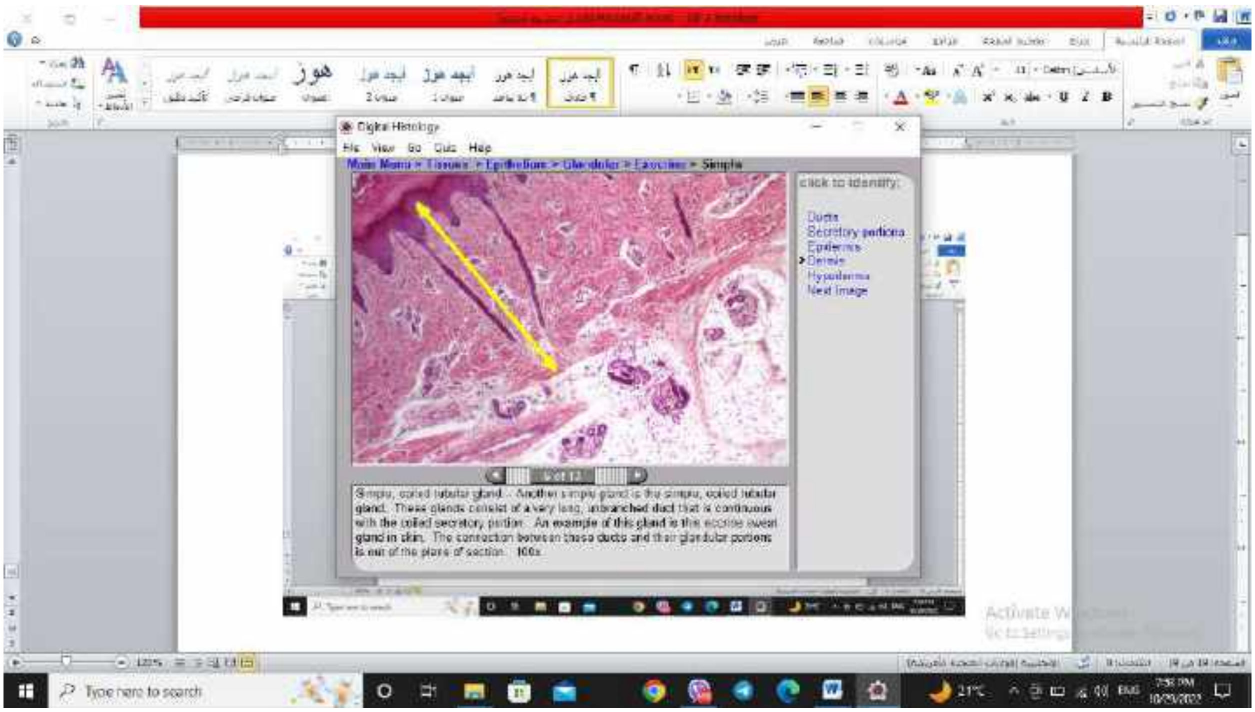
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File View Go Quiz Help
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Next Image
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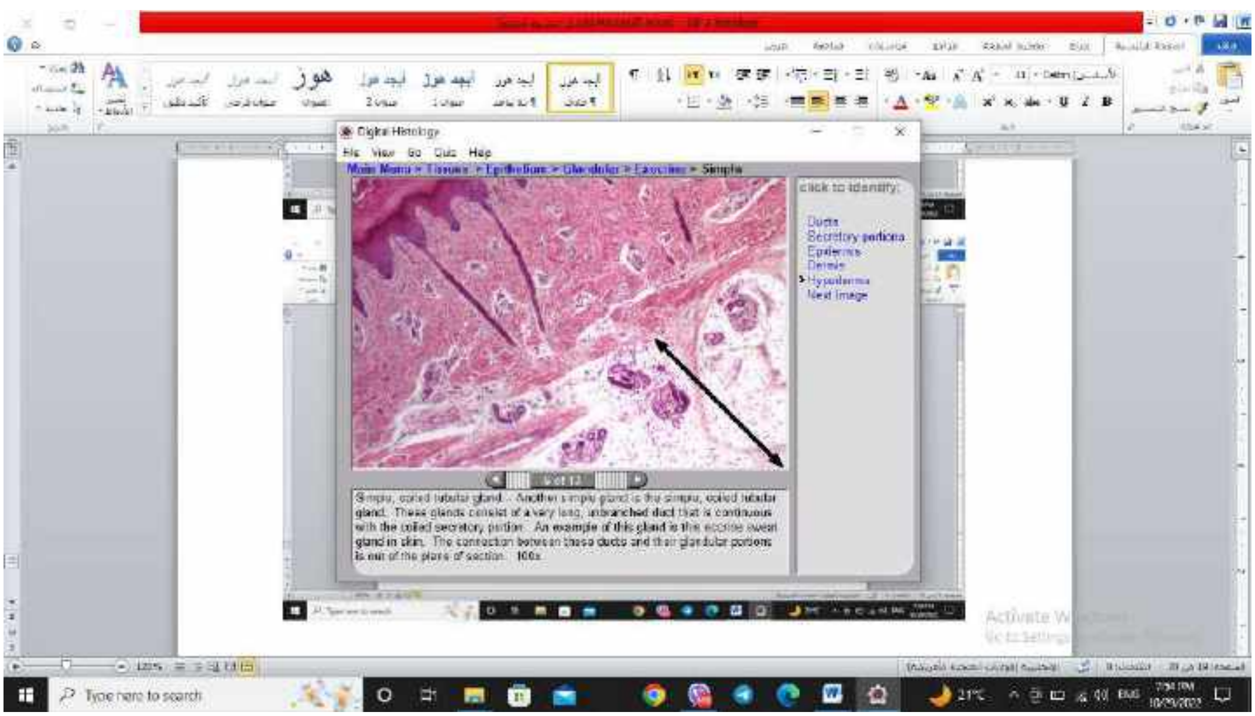
Type here to search


Digital Histology
File View Go Quiz Help
click to identify:
Ducts
Secretory portions
Epidermis
Dermis
Hypodermis
Next Image
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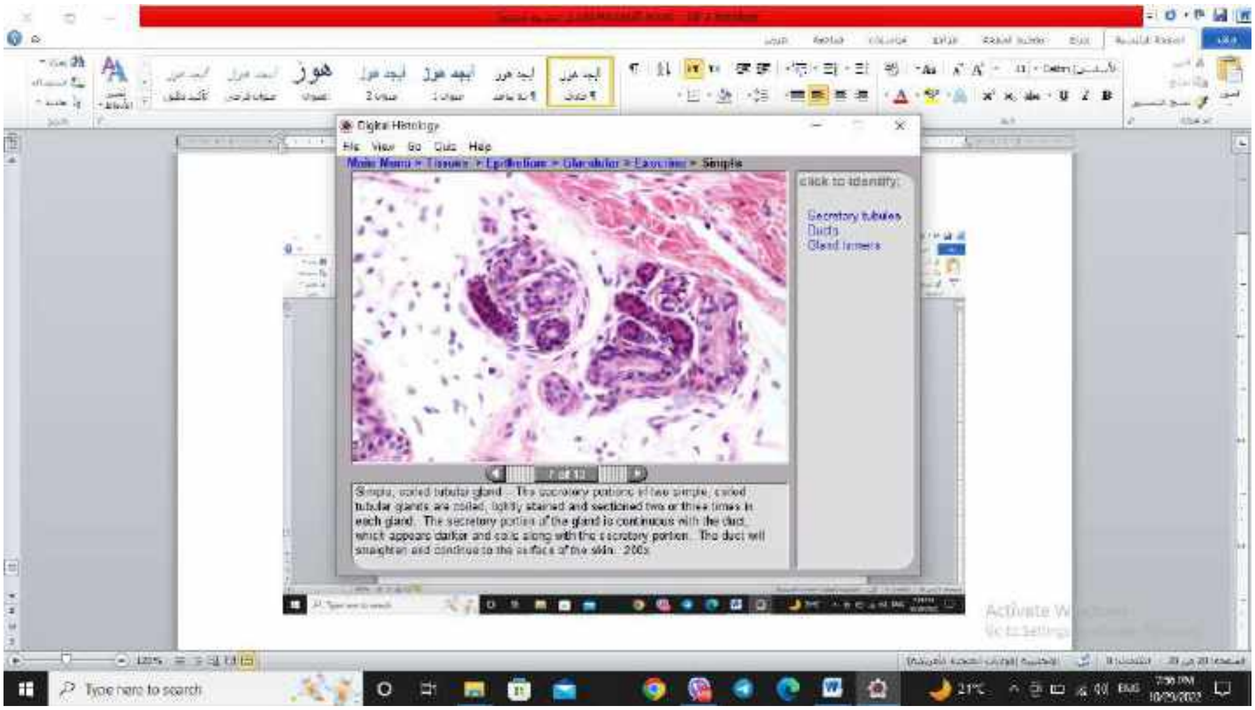
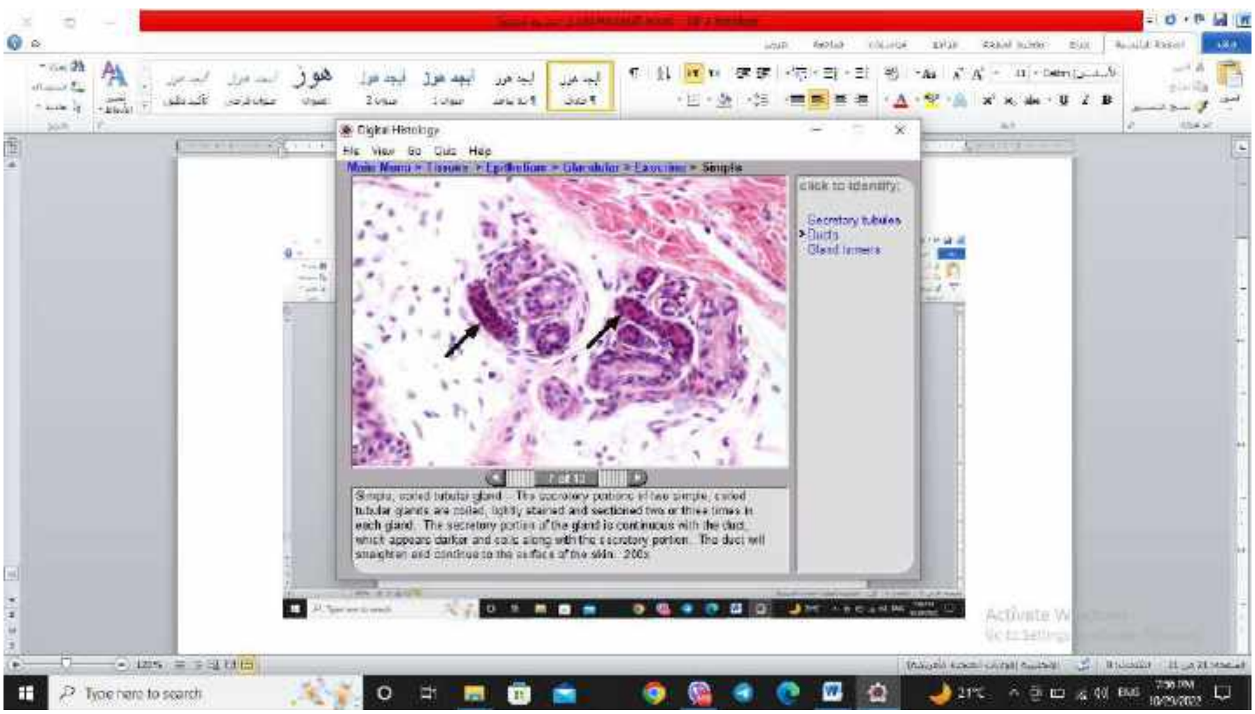
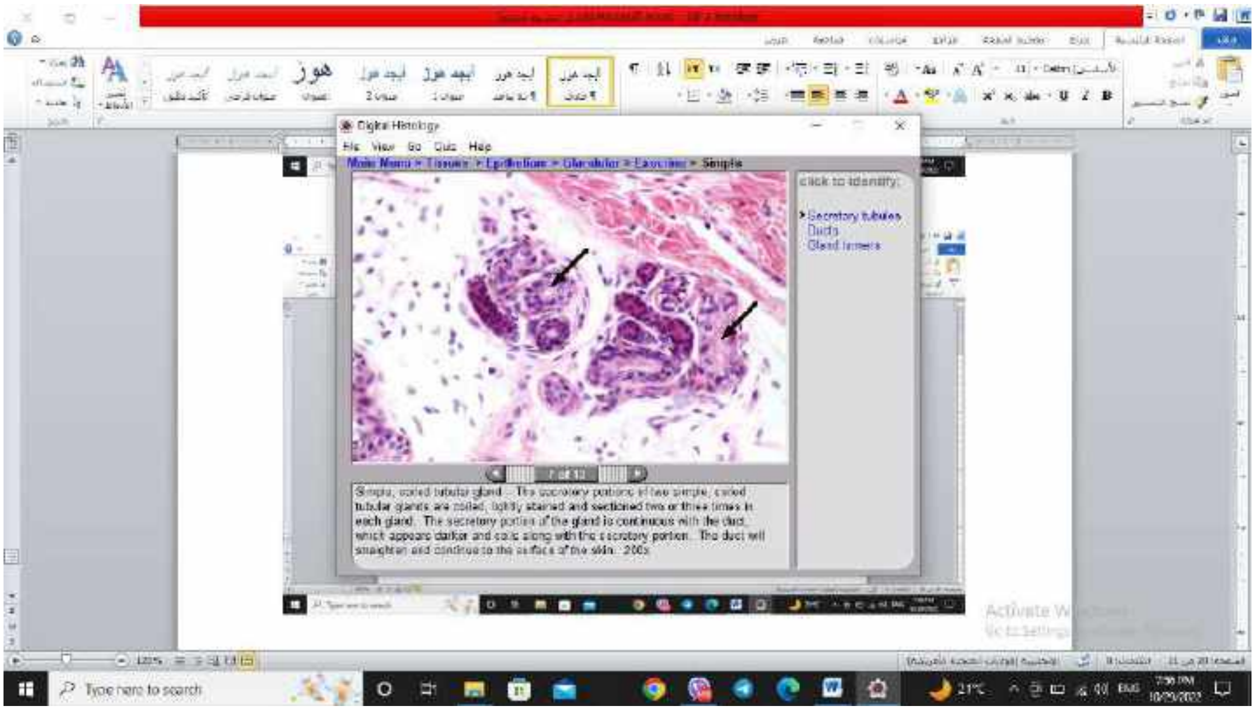
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Secretory tubules
Ducts
Gland lumens
Simple, coiled tubular gland – The secretory portions of two simple, coiled tubular glands are coiled, lightly stained and sectioned two or three times in each gland. The secretory portion of the gland is continuous with the duct, which appears darker and coils along with the secretory portion. The duct will straighten and continue to the surface of the skin. 200x


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Secretory tubules
Ducts
Gland lumens
Simple, coiled tubular gland – The secretory portions of two simple, coiled tubular glands are coiled, lightly stained and sectioned two or three times in each gland. The secretory portion of the gland is continuous with the duct, which appears darker and coils along with the secretory portion. The duct will straighten and continue to the surface of the skin. 200x


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Secretory tubules
Ducts
Gland lumens
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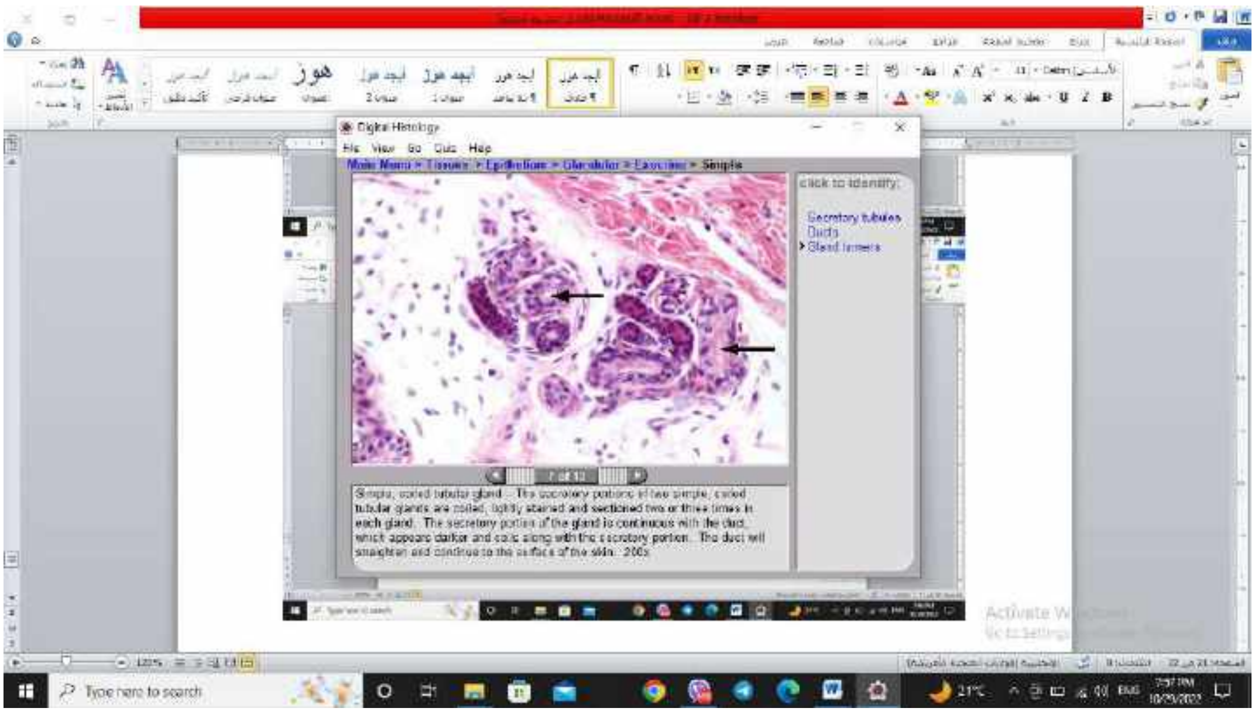
Type here to search
Activate Windows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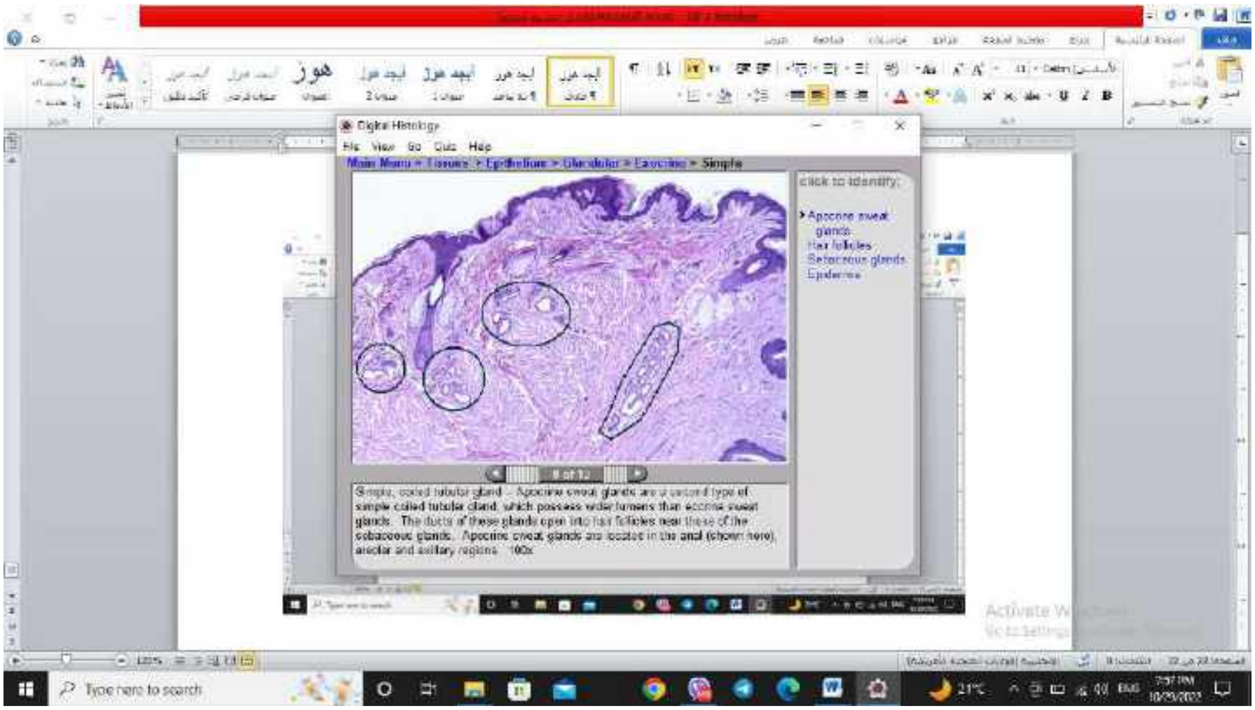
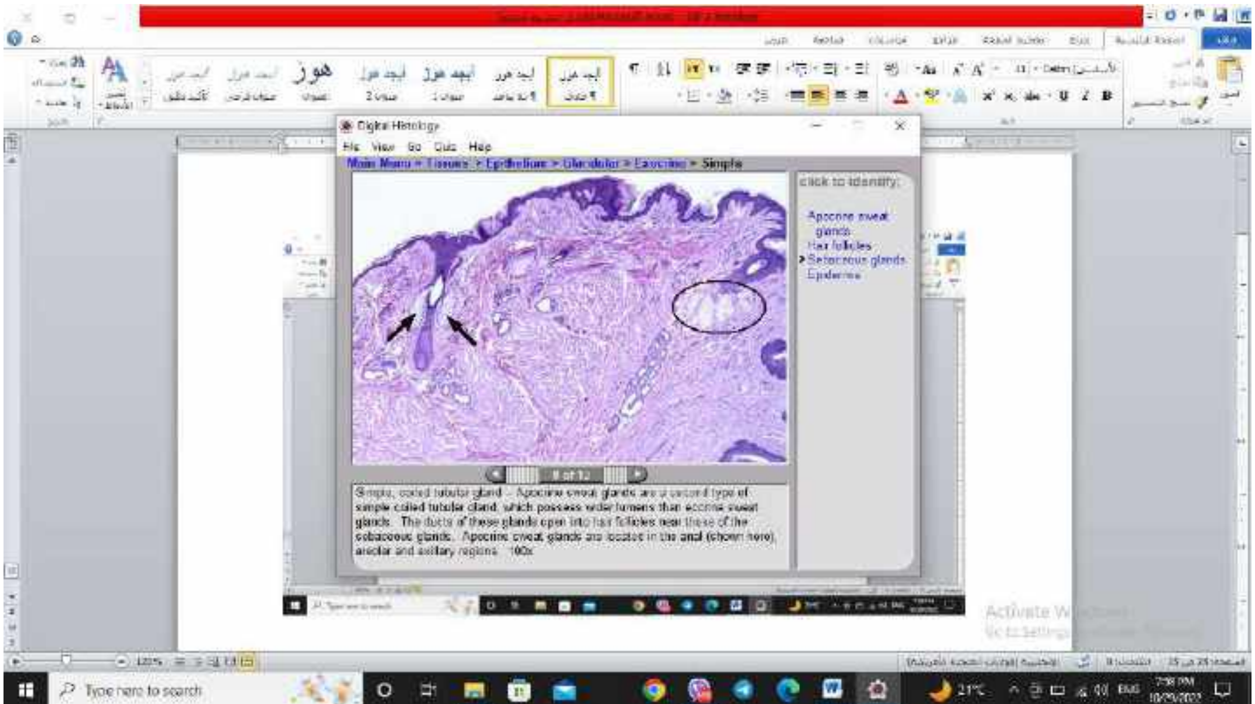

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Apocrine sweat glands
Hair follicles
Sebaceous glands
Epidermis
Simple, coiled tubular gland - Apocrine sweat glands are a second type of simple coiled tubular gland, which possess wider lumens than eccrine sweat glands. The ducts of these glands open into hair follicles near those of the sebaceous glands. Apocrine sweat glands are located in the anal (shown here), areolar and axillary regions. 100x
Activate Windows
Type here to search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Hair follicles
Sebaceous glands
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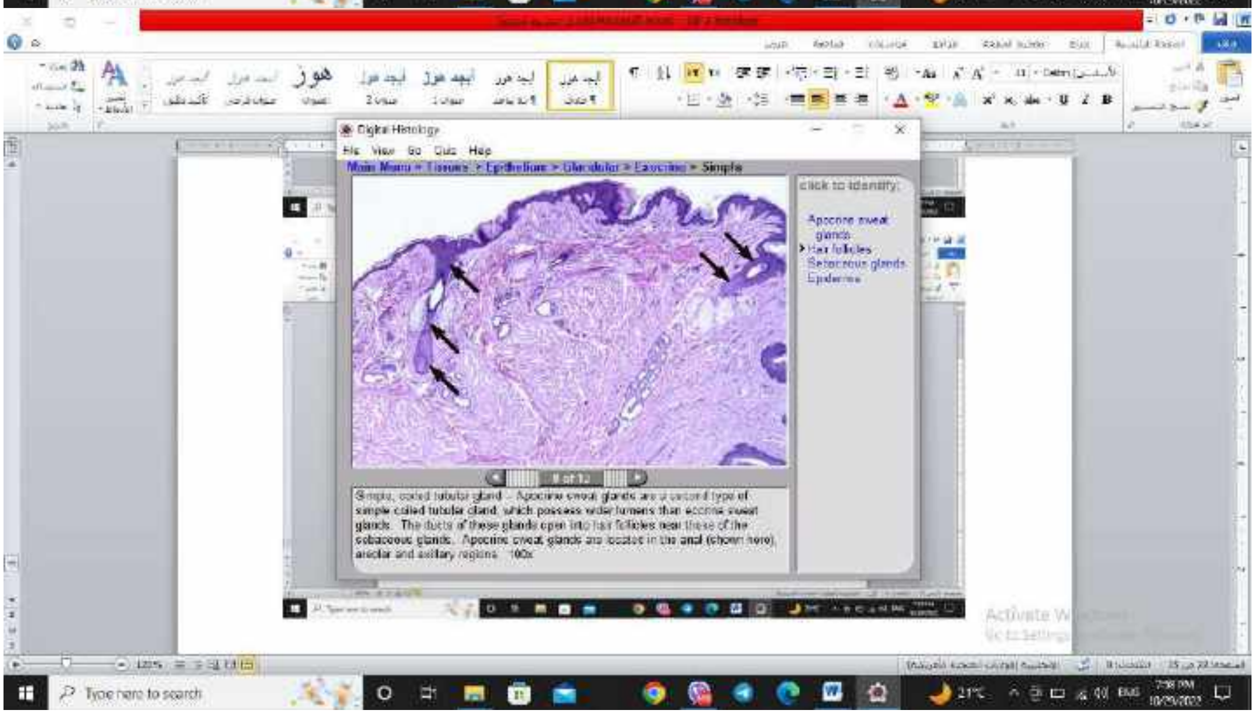
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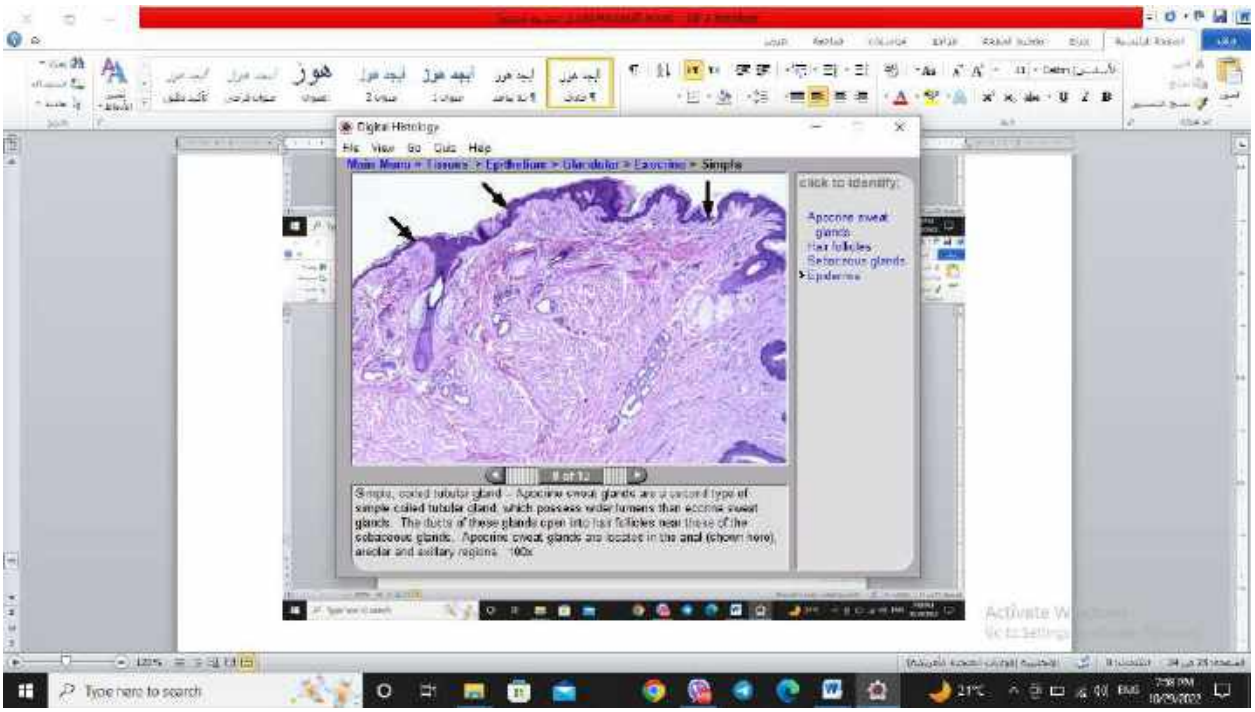
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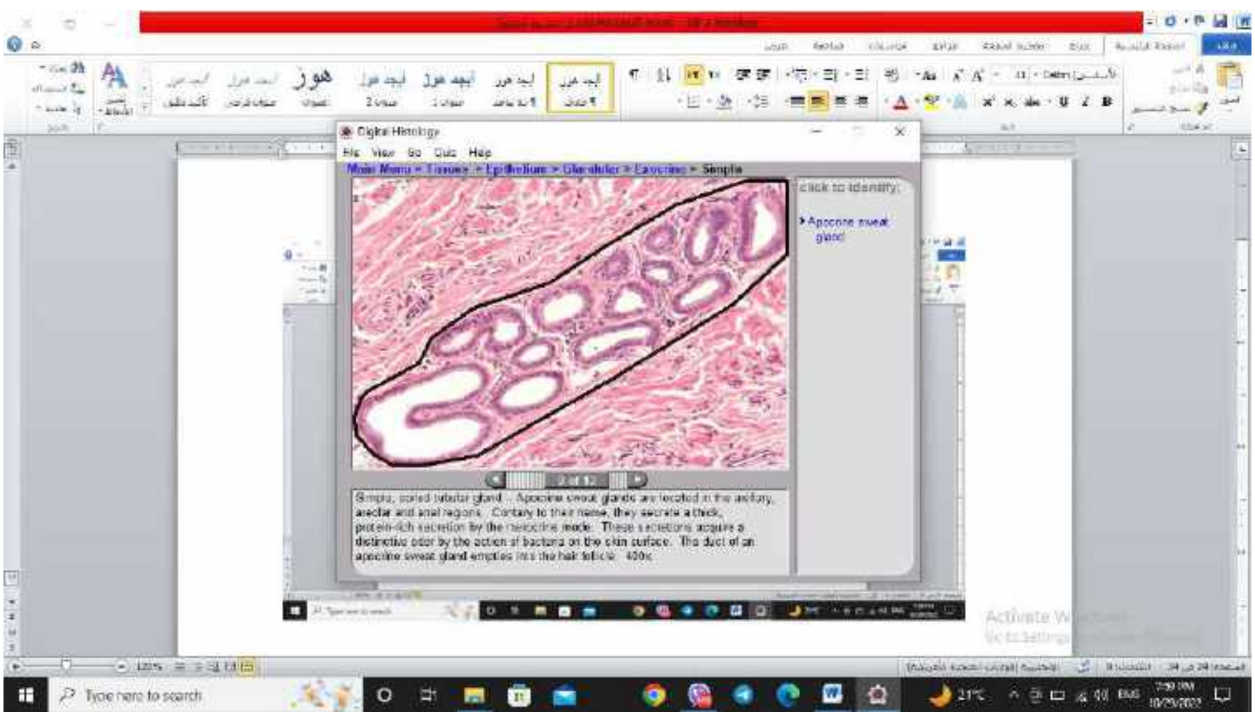
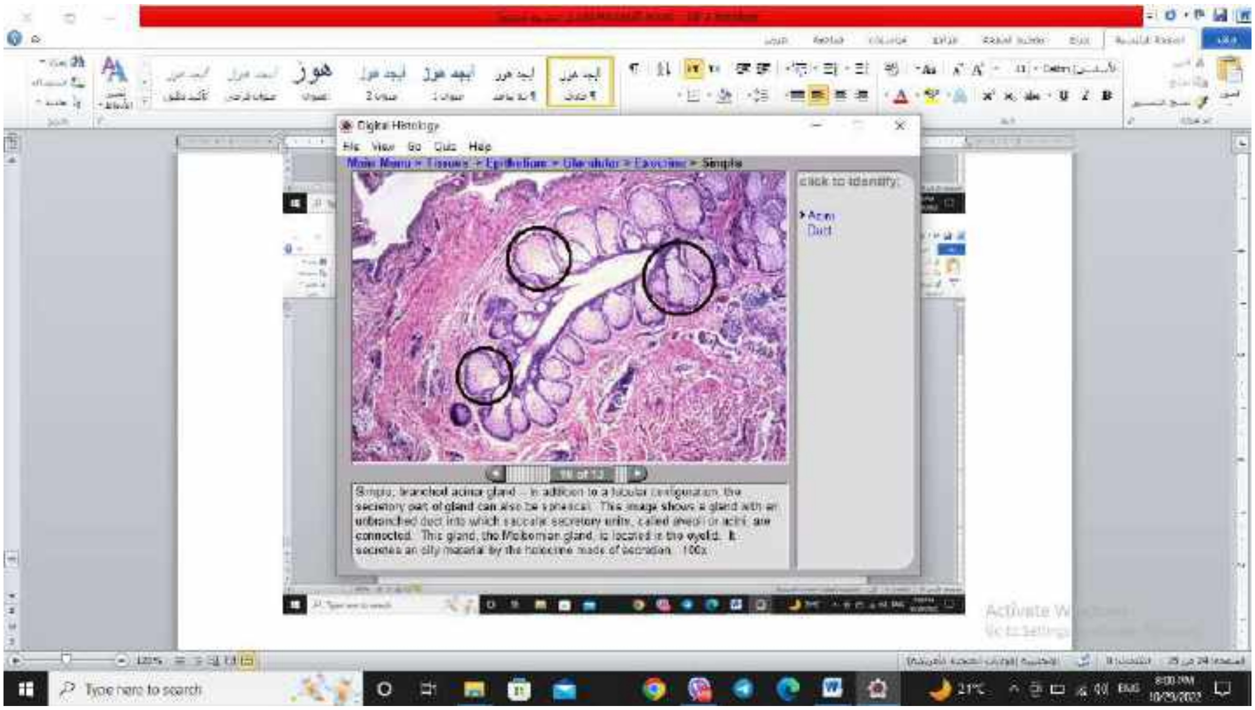

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Apocrine sweat gland
Simple, coiled tubular gland – Apocrine sweat glands are located in the axillary, areolar and anal regions. Contrary to their name, they secrete a thick, protein-rich secretion by the merocrine mode. These secretions acquire a distinctive odor by the action of bacteria on the skin surface. The duct of an apocrine sweat gland empties into the hair follicle. 400x
Type here to search
Activate Windows


Digital Histology
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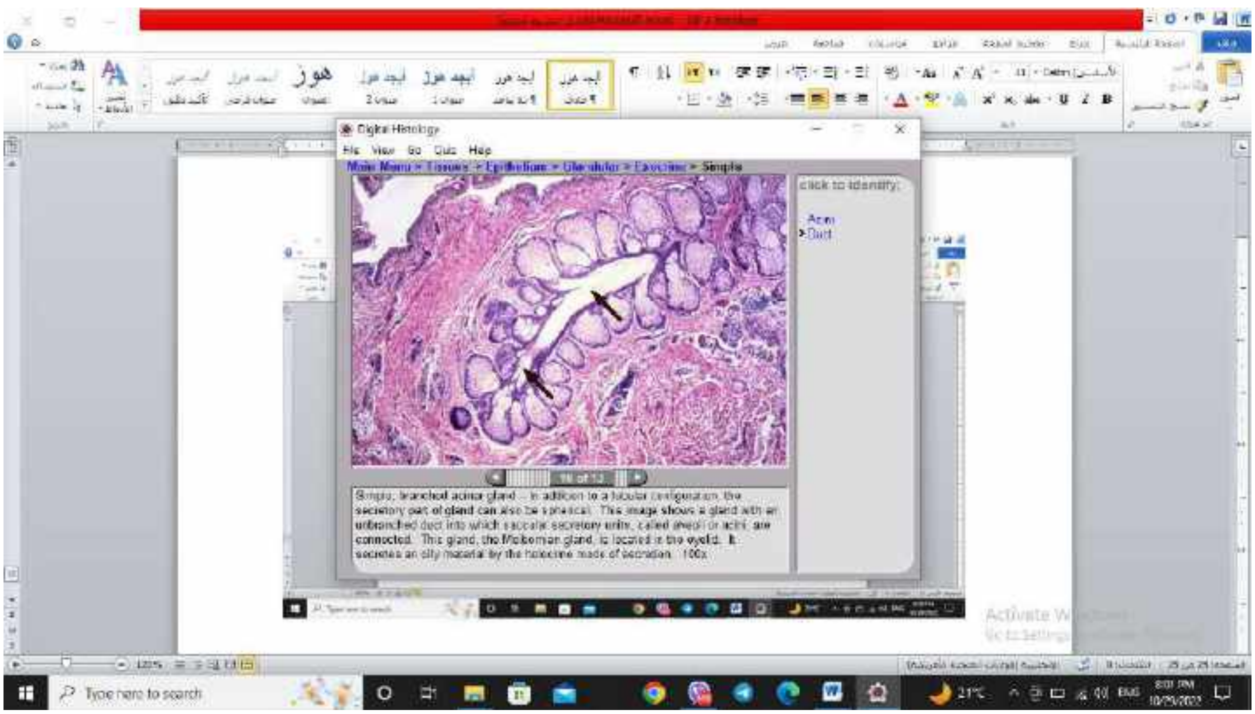
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Acini
Duct
Simple, branched acinar gland -- In addition to a tubular configuration, the secretory part of gland can also be spherical. This image shows a gland with an unbranched duct into which saccular secretory units, called alveoli or acini, are connected. This gland, the Meibomian gland, is located in the eyelid. It secretes an oily material by the holocrine mode of secretion. 100x
Type here to search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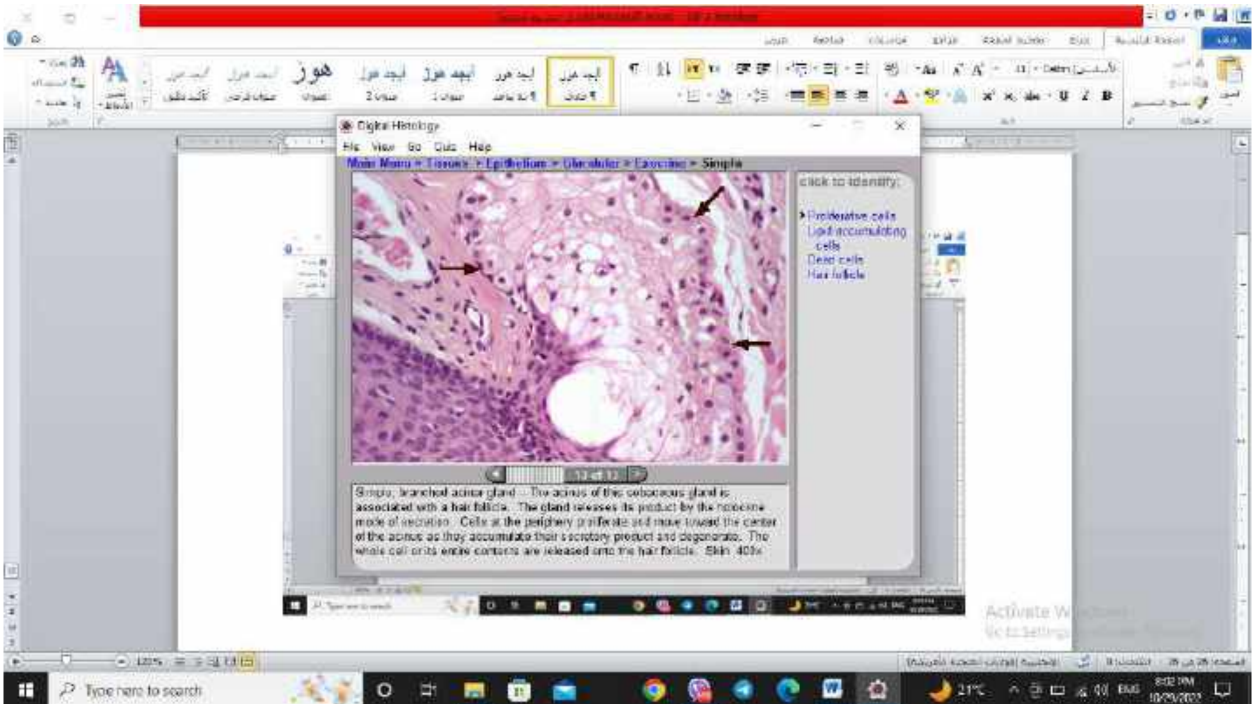
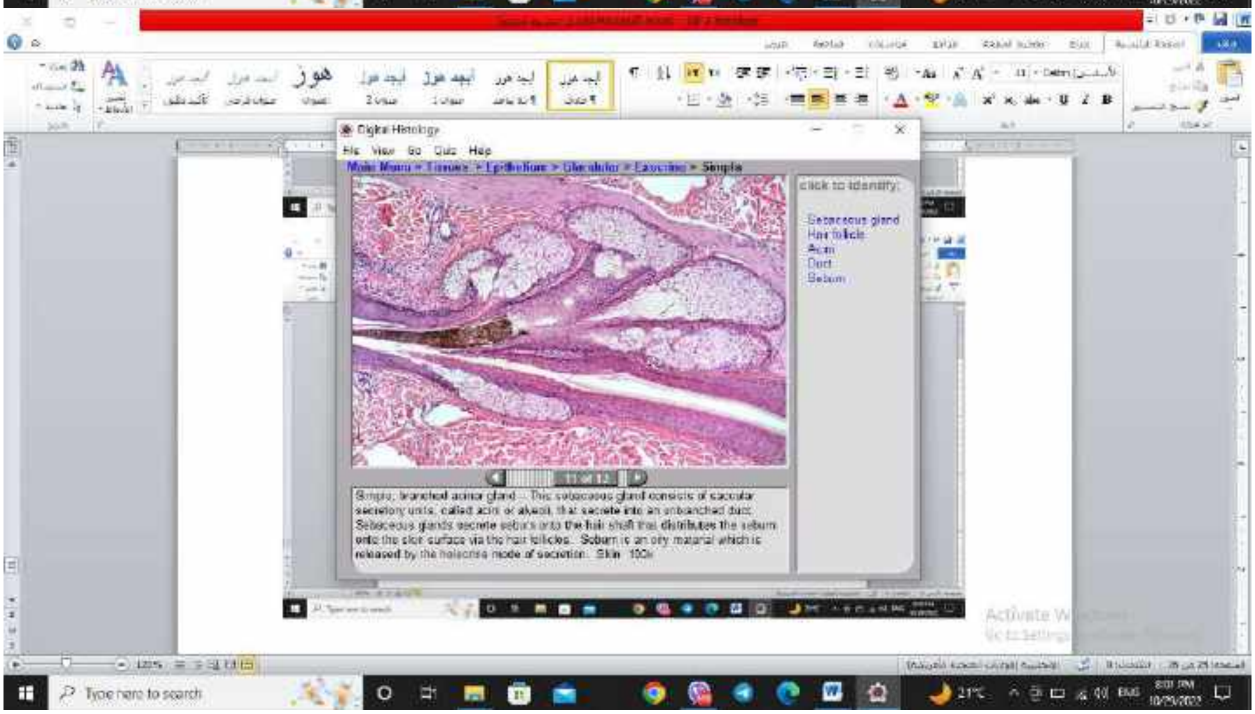
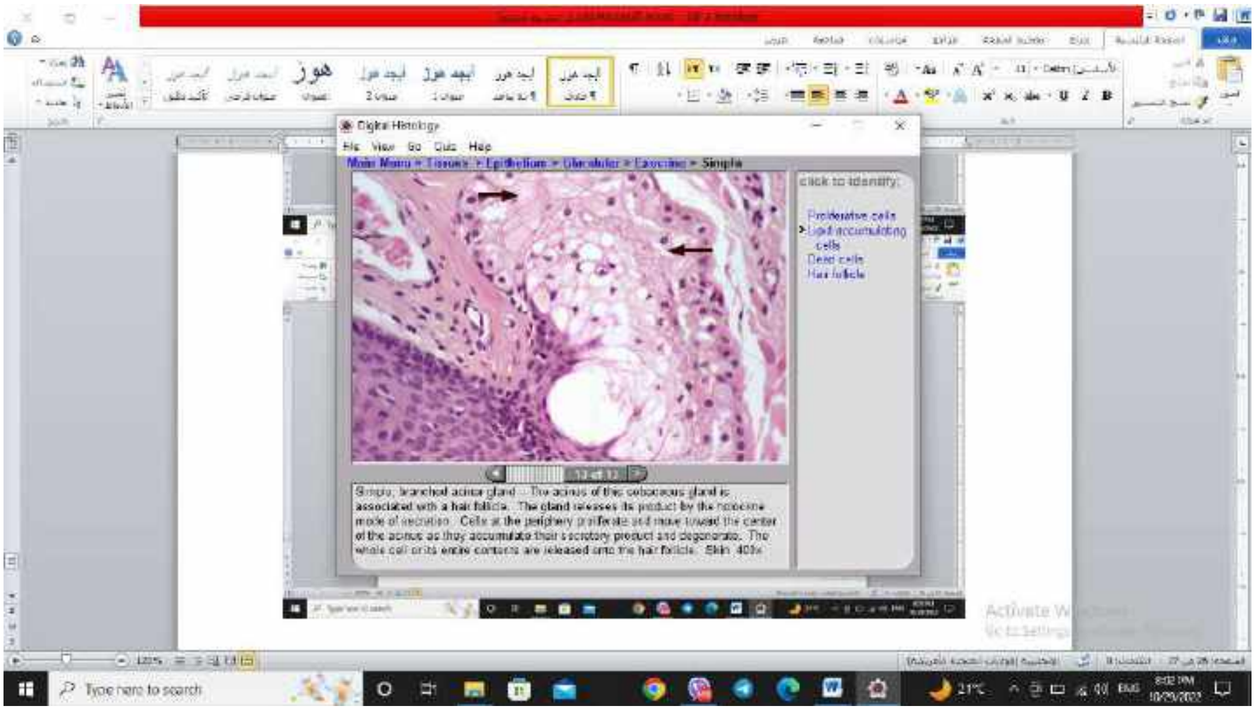

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Proliferative cells
Lipid accumulating cells
Dead cells
Hair follicle
Simple, branched acinar gland – The acinus of this sebaceous gland is associated with a hair follicle. The gland releases its product by the holocrine mode of secretion. Cells at the periphery proliferate and move toward the center of the acinus as they accumulate their secretory product and degenerate. The whole cell or its entire contents are released onto the hair follicle. Skin 400x
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
click to identify:
Sebaceous gland
Hair follicle
Acini
Duct
Sebum
Simple, branched acinar gland – This sebaceous gland consists of saccular secretory units, called acini or alveoli, that secrete into an unbranched duct. Sebaceous glands secrete sebum onto the hair shaft that distributes the sebum onto the skin surface via the hair follicles. Sebum is an oily material which is released by the holocrine mode of secretion. Skin 100x
Type here to search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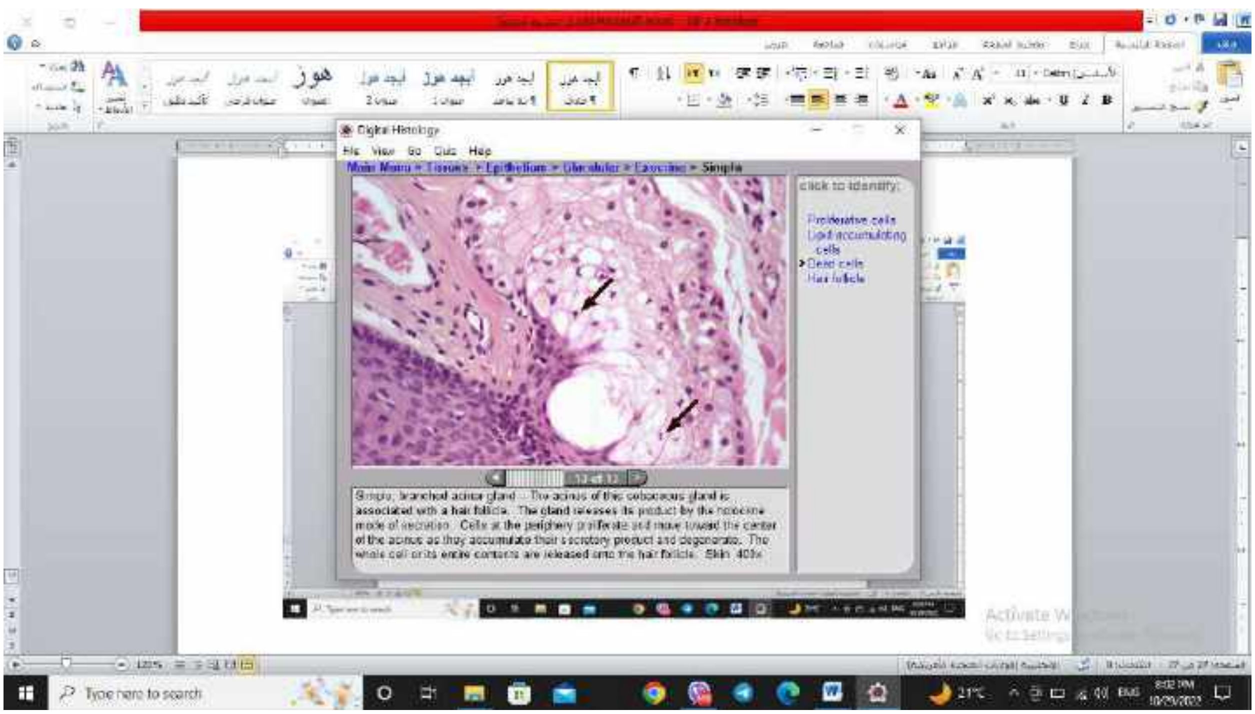
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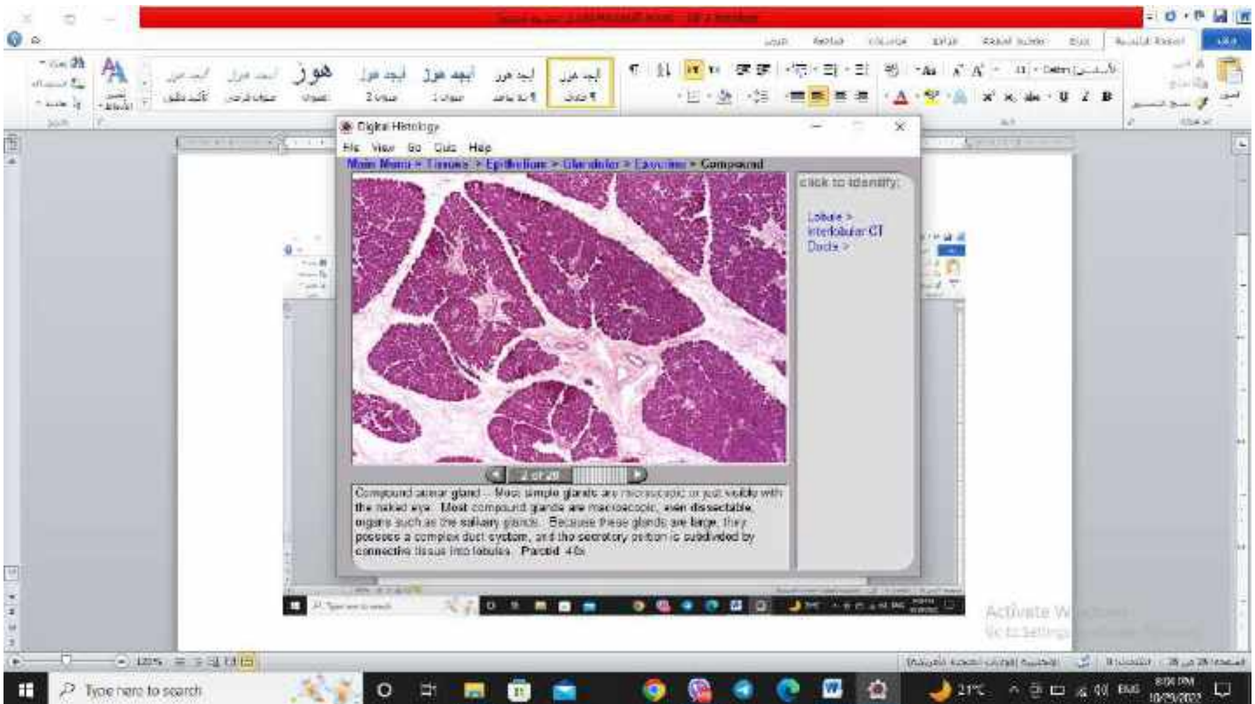
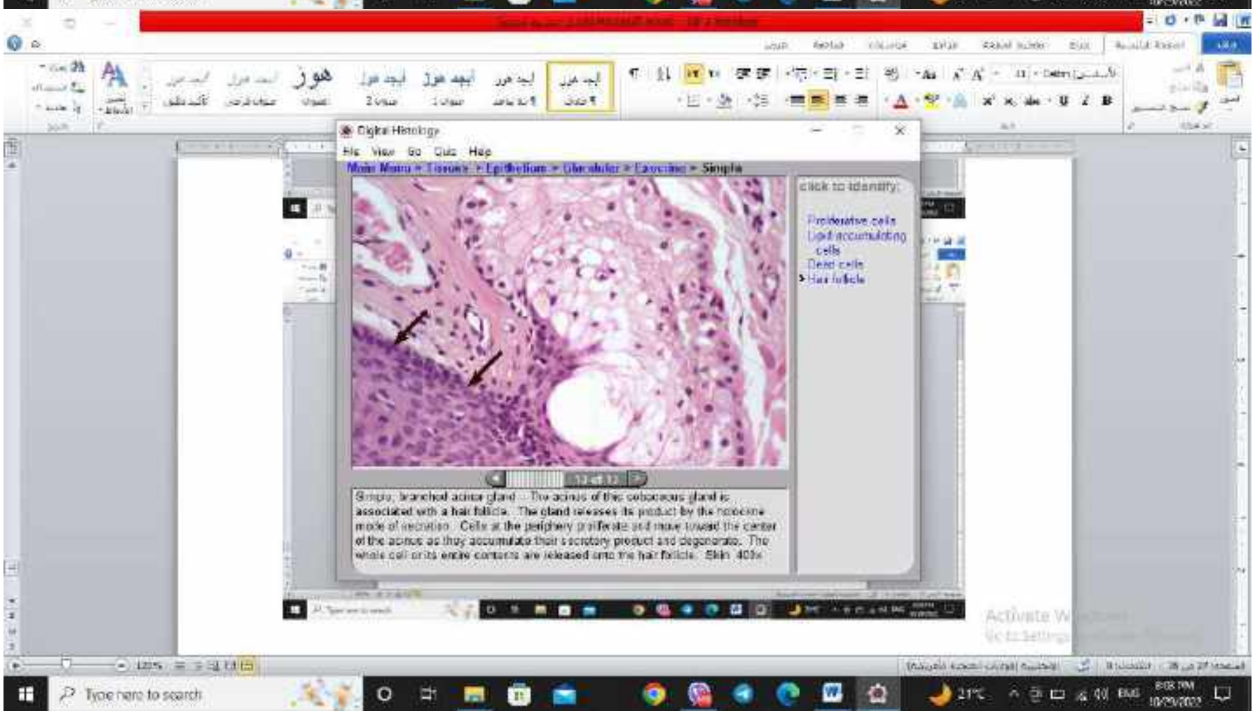


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Lobule >
Interlobular CT
Ducts >
Compound acinar gland -- Most simple glands are microscopic or just visible with the naked eye. Most compound glands are macroscopic, even dissectable, organs such as the salivary glands. Because these glands are large, they possess a complex duct system, and the secretory portion is subdivided by connective tissue into lobules. Parotid 40x
Type here to search



Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Simple
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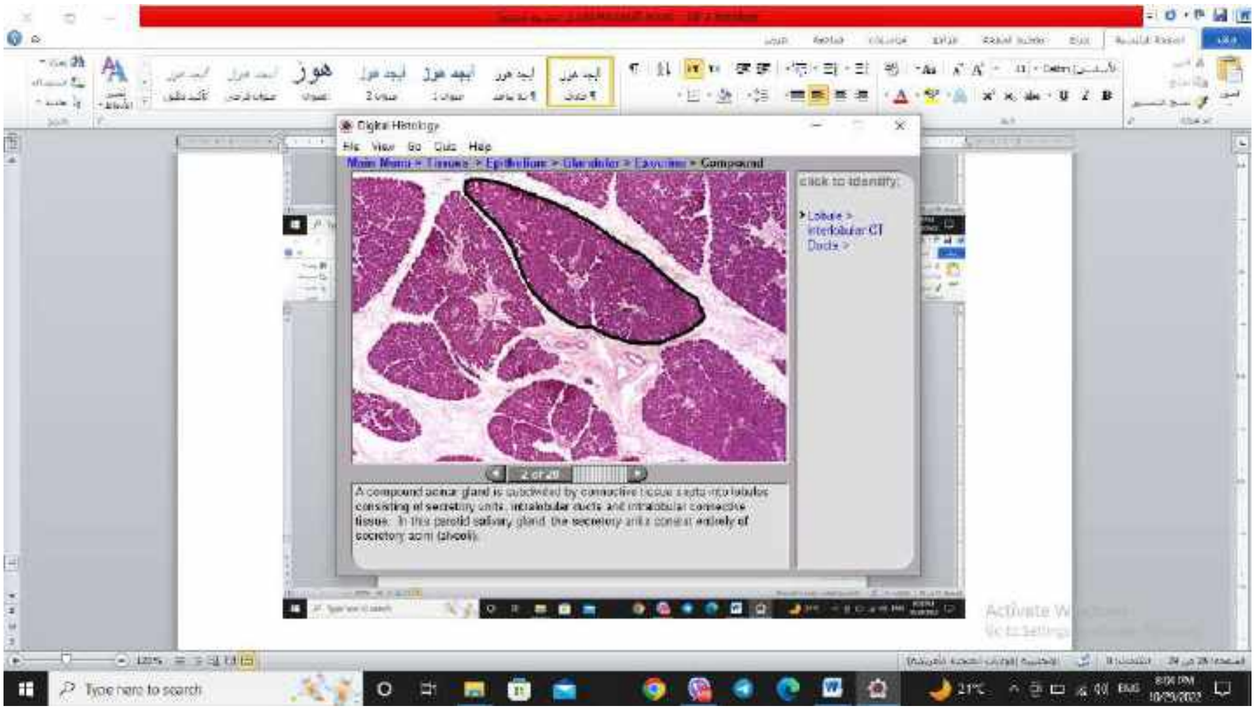
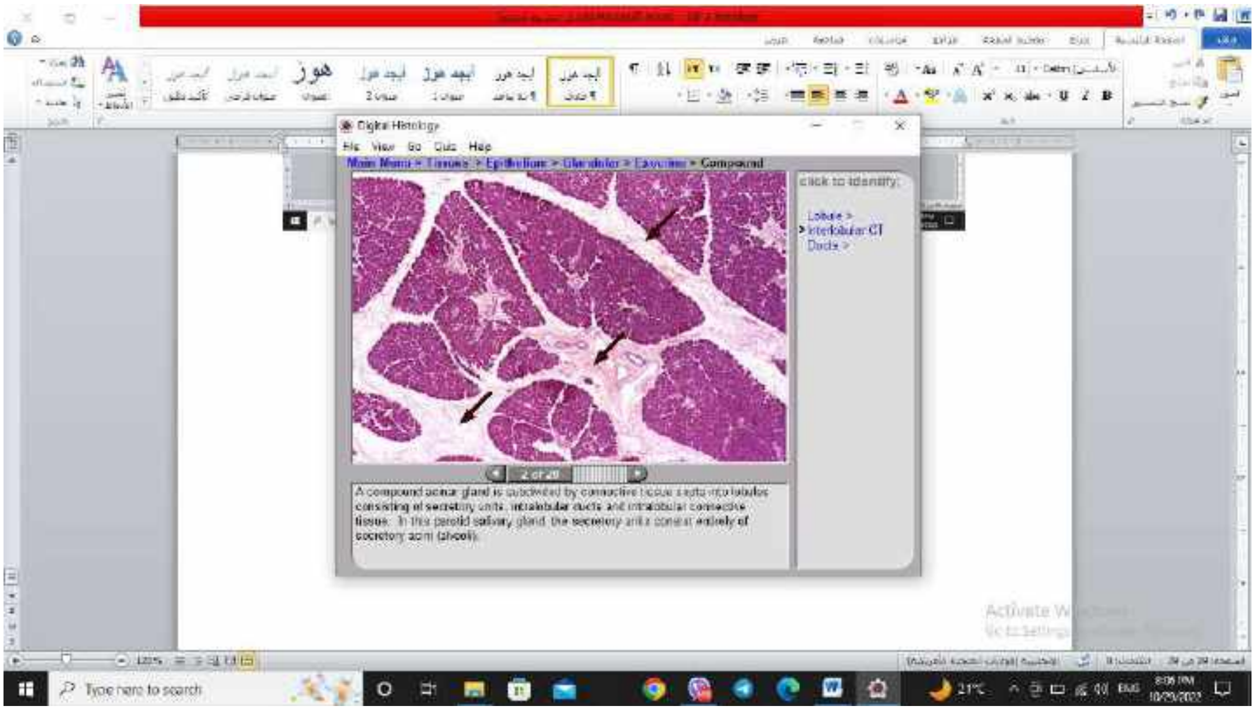

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Lobule >
Interlobular CT
Ducts >
2 of 20
A compound acinar gland is subdivided by connective tissue septa into lobules consisting of secretory units, intralobular ducts and intralobular connective tissue. In this parotid salivary gland the secretory units consist entirely of secretory acini (alveoli).
Type here to search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Lobule >
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Ducts >
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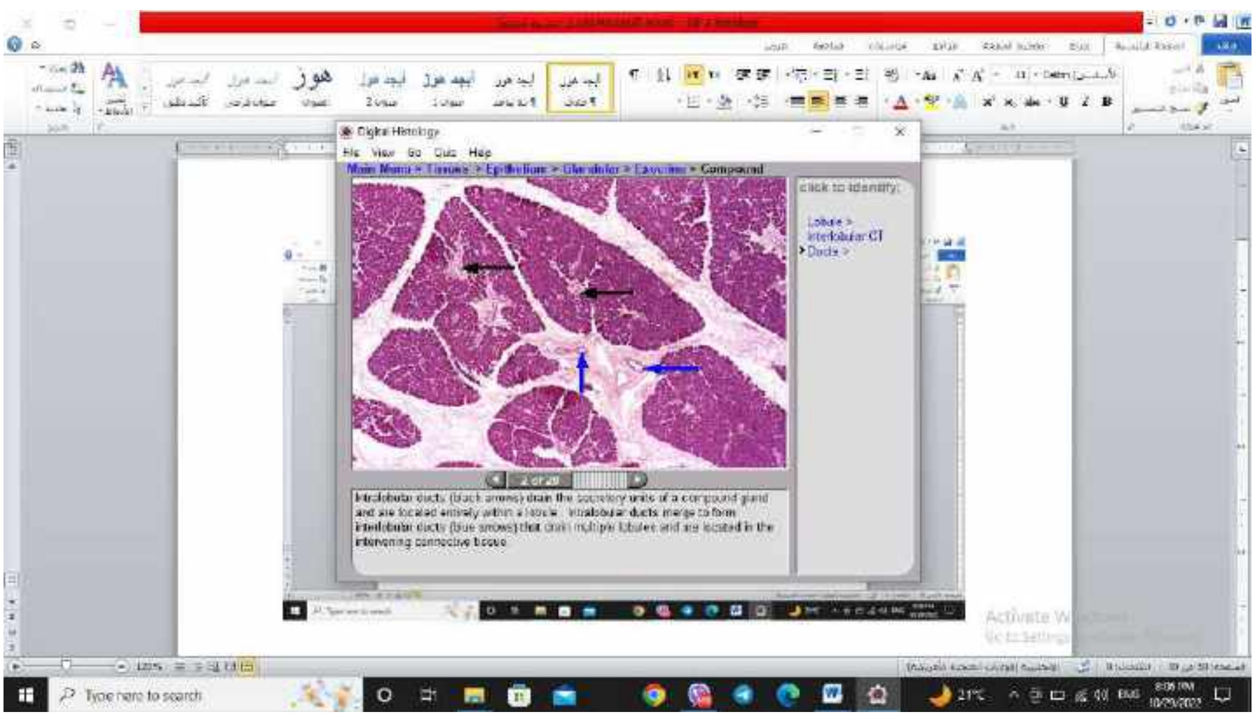
Activate Windows
Type here to search


Digital Histology
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Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Lobule >
Interlobular CT
Ducts >
2 of 20
Intralobular ducts (black arrows) drain the secretory units of a compound gland and are located entirely within a lobule. Intralobular ducts merge to form interlobular ducts (blue arrows) that drain multiple lobules and are located in the intervening connective tissue.
Activate Windows
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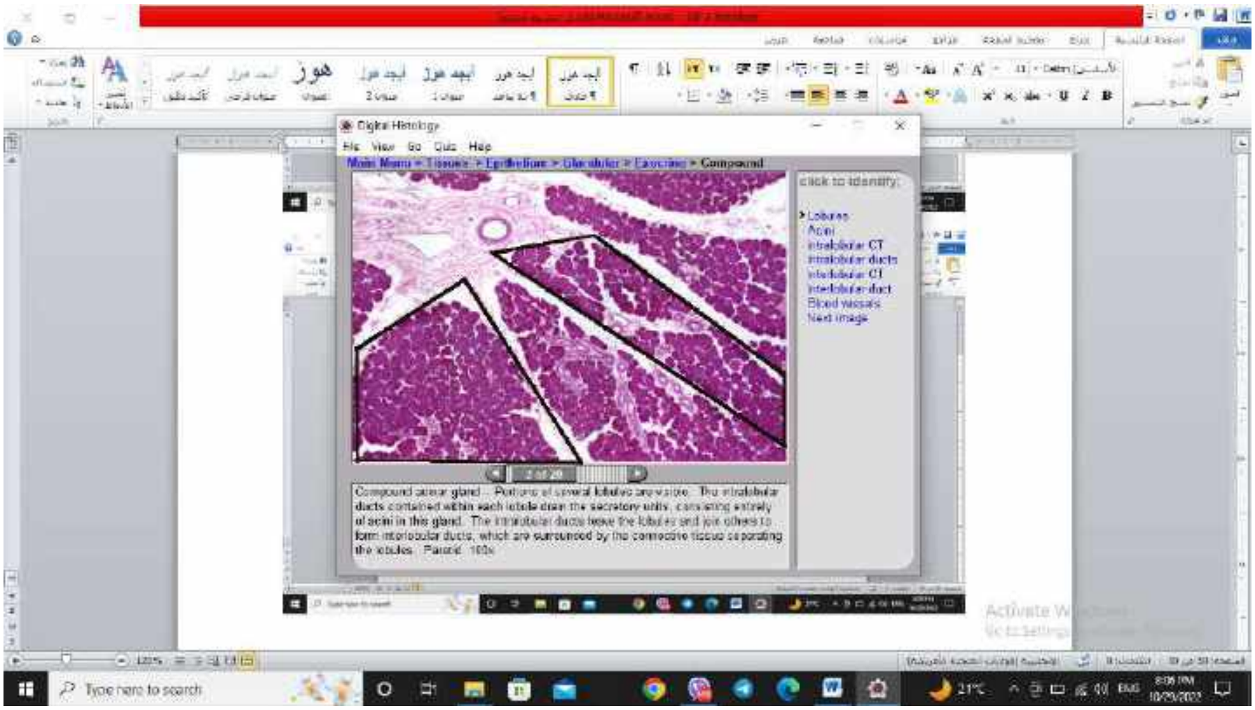
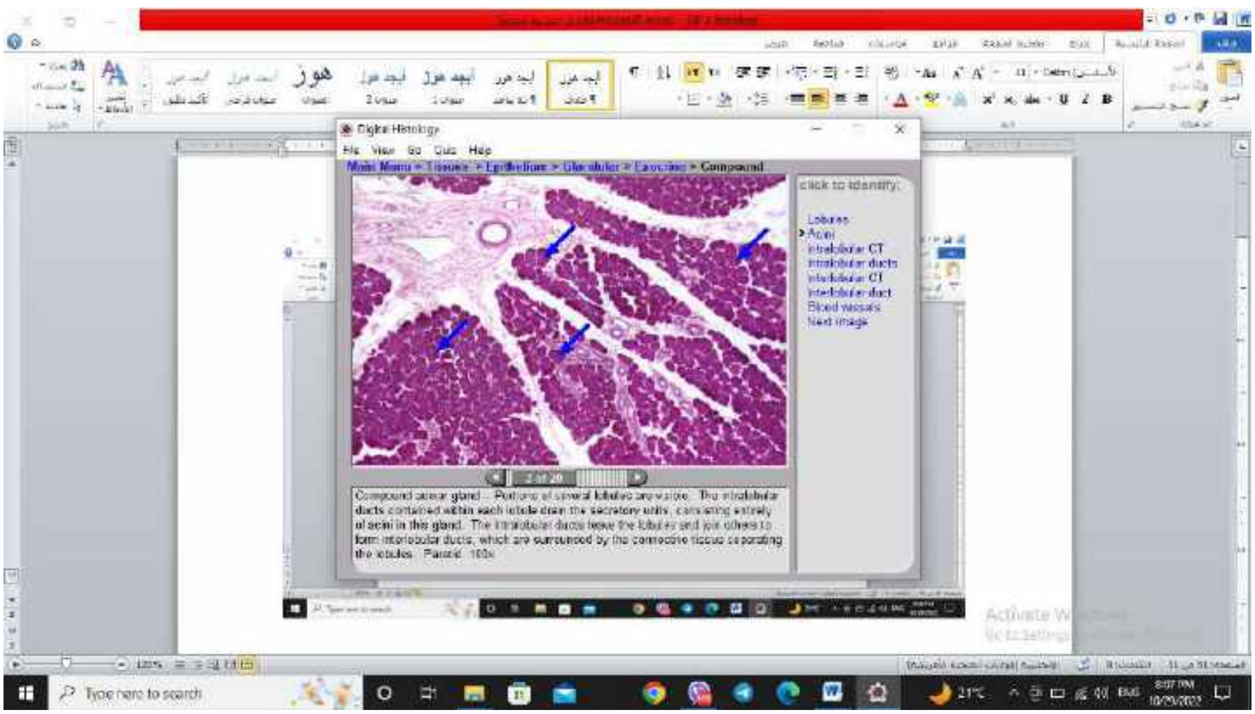

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Lobules
Acini
Intralobular CT
Intralobular ducts
Interlobular CT
Interlobular duct
Blood vessels
Next image
Compound acinar gland. Portions of several lobules are visible. The intralobular ducts contained within each lobule drain the secretory units, consisting entirely of acini in this gland. The intralobular ducts leave the lobules and join others to form interlobular ducts, which are surrounded by the connective tissue separating the lobules. Parotid. 100x
Type here to search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Acini
Intralobular CT
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Interlobular CT
Interlobular duct
Blood vessels
Next image
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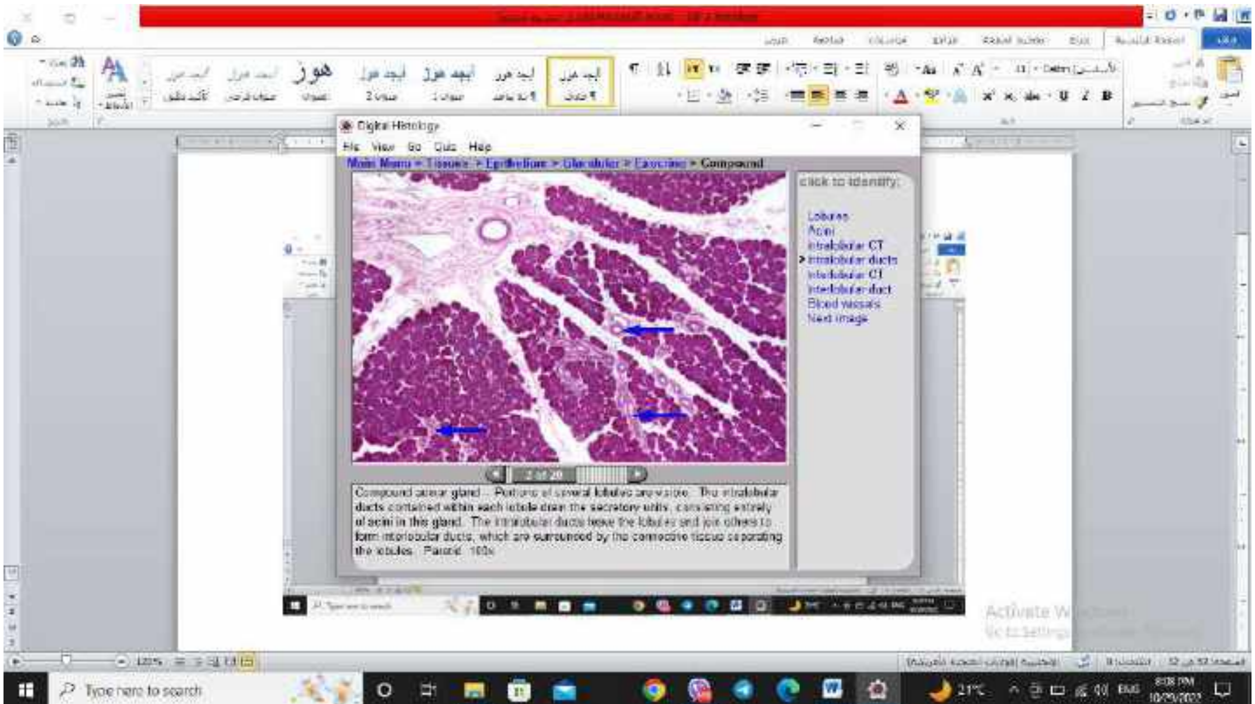
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Lobules
Acini
Intralobular CT
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Blood vessels
Next image
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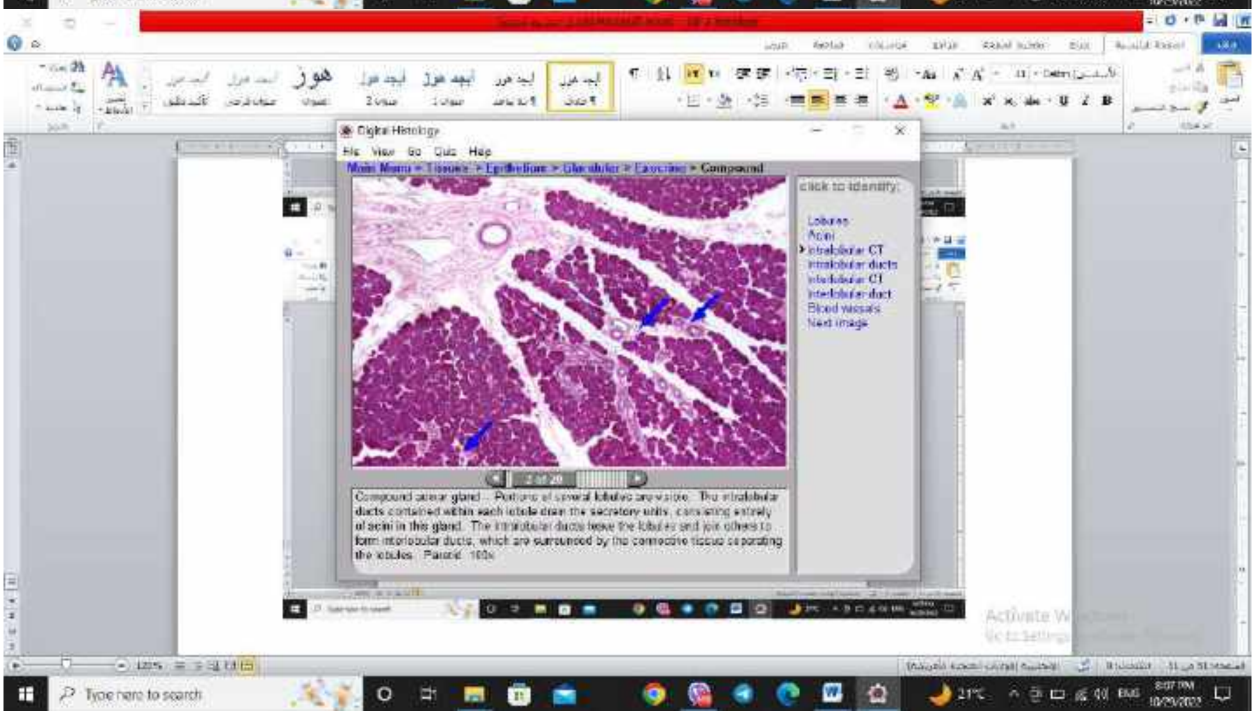
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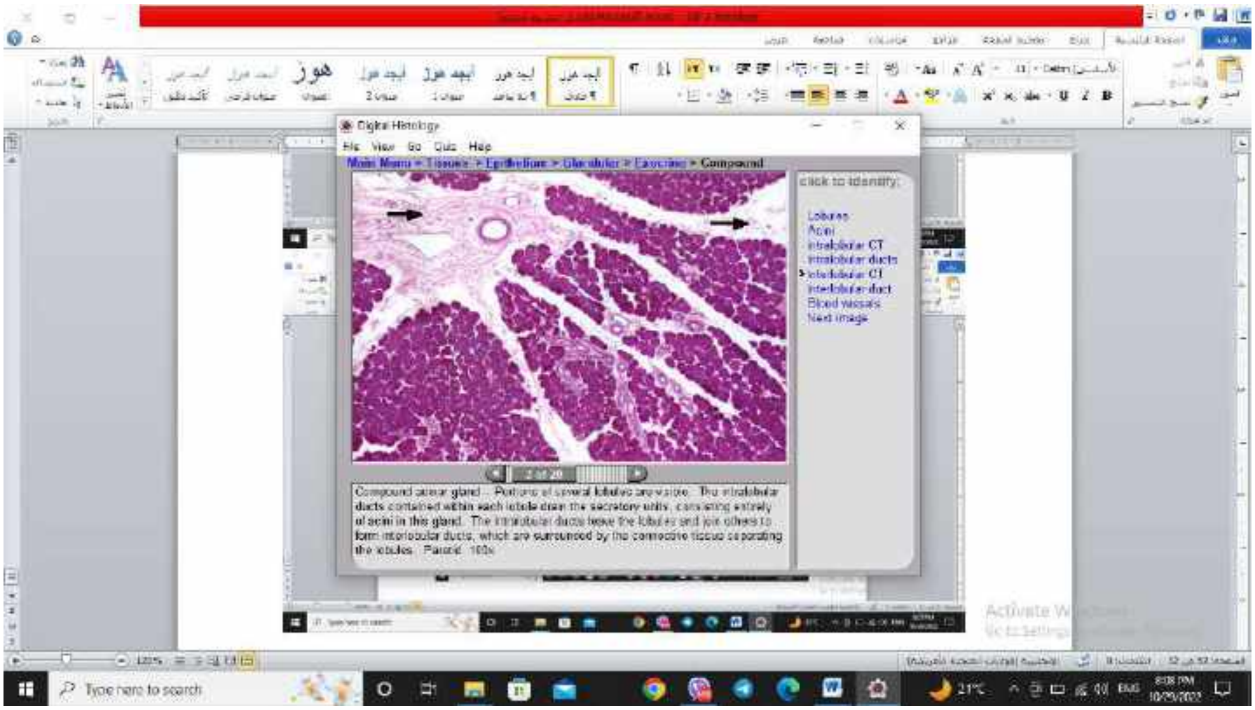
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Lobules
Acini
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Blood vessels
Next image
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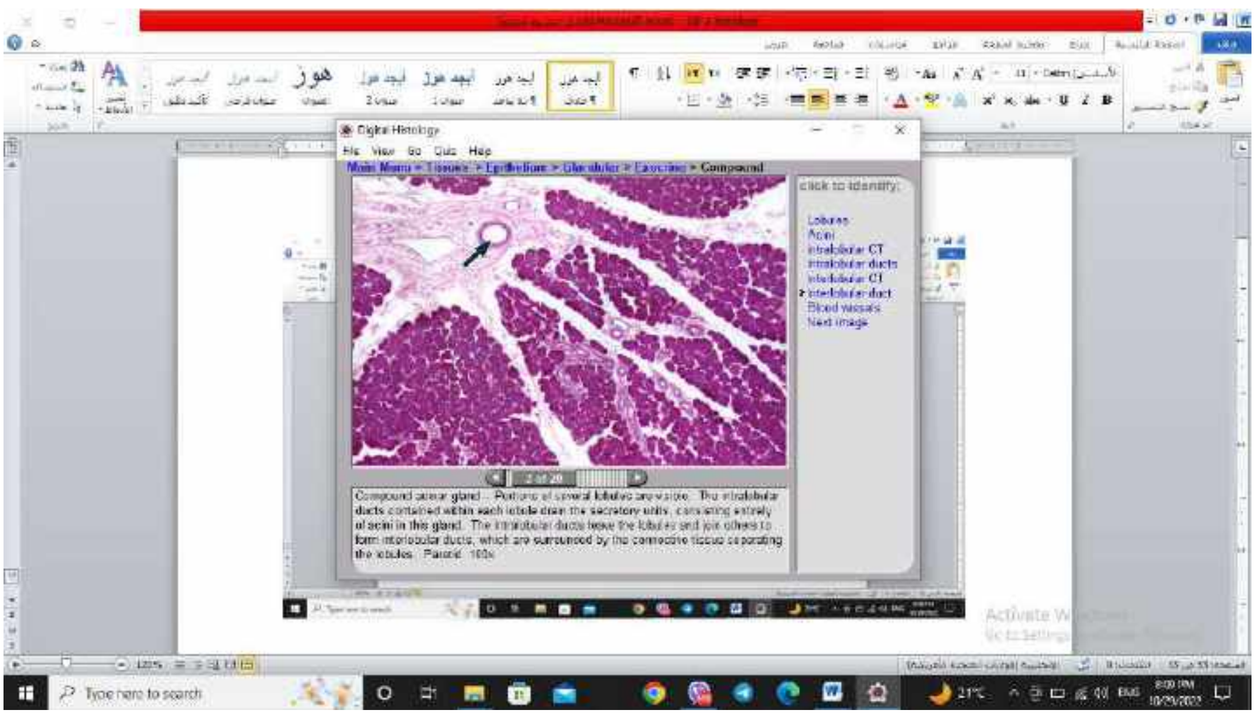
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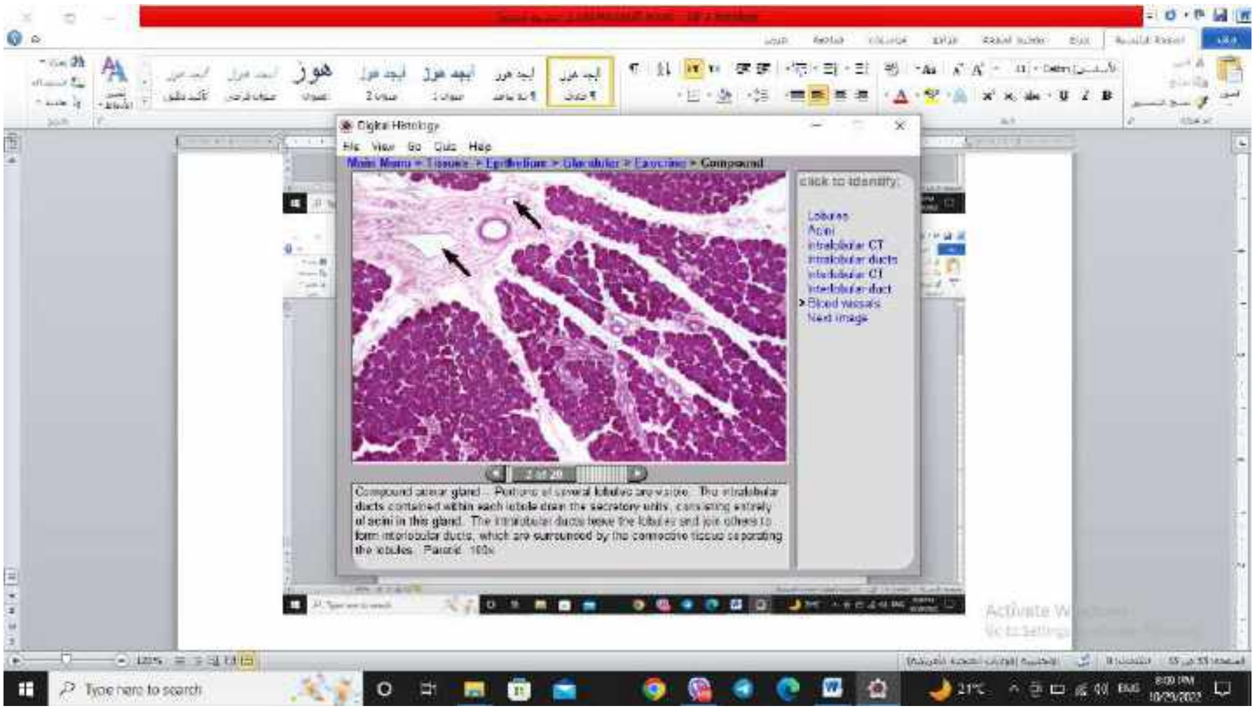
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click to identify:
Lobules
Acini
intralobular CT
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Blood vessels
Next image
2 of 20
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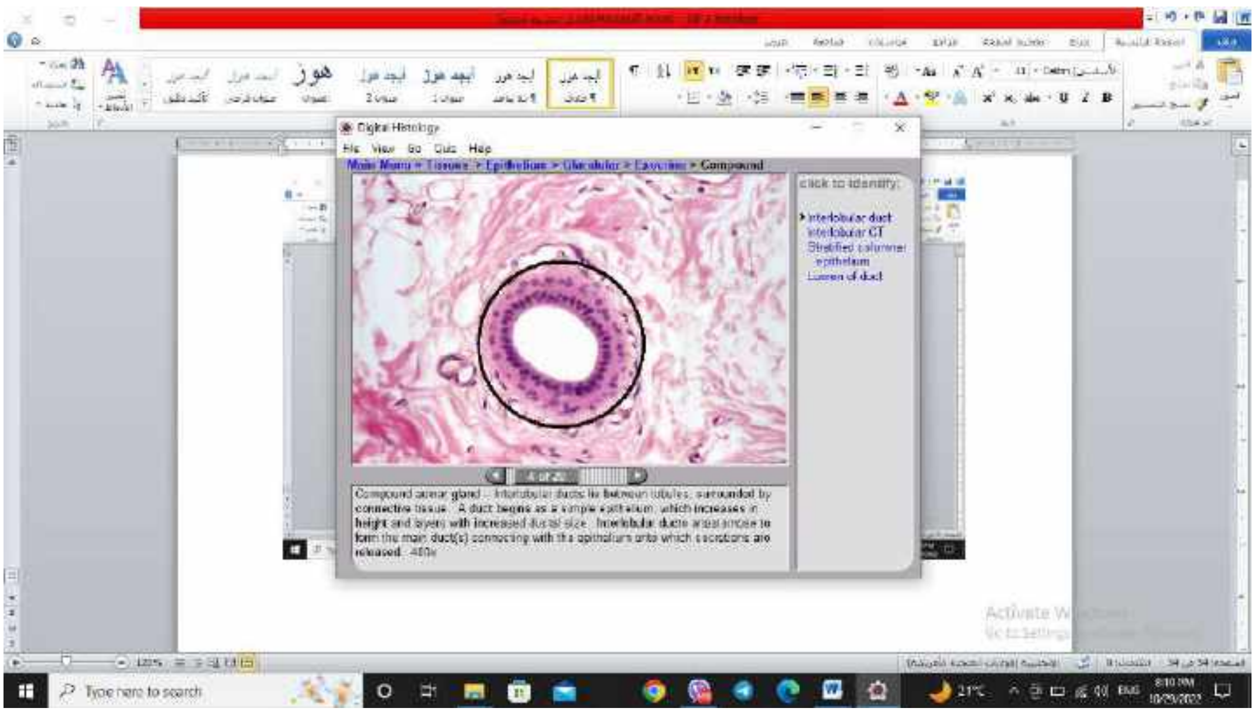
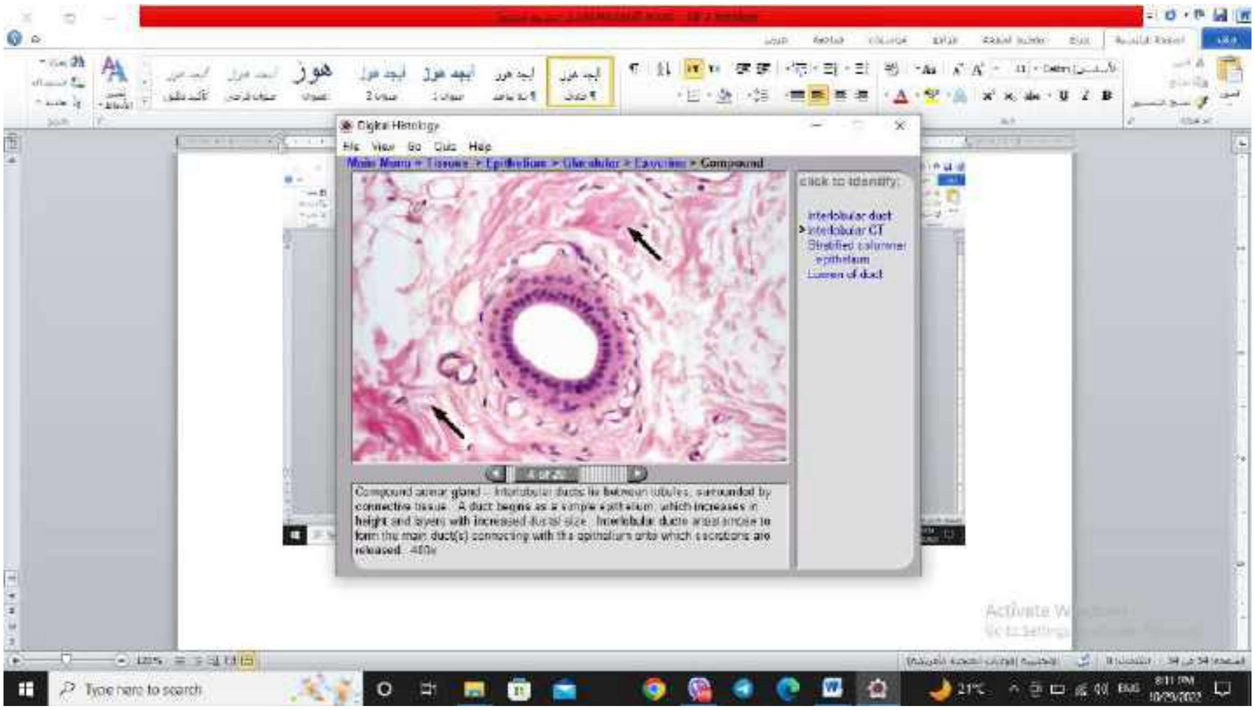

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
interlobular duct
interlobular CT
Stratified columnar epithelium
Lumen of duct
Compound acinar gland - Interlobular ducts lie between lobules, surrounded by connective tissue. A duct begins as a simple epithelium, which increases in height and layers with increased ductal size. Interlobular ducts anastomose to form the main duct(s) connecting with the epithelium onto which secretions are released. 400x
Type here to search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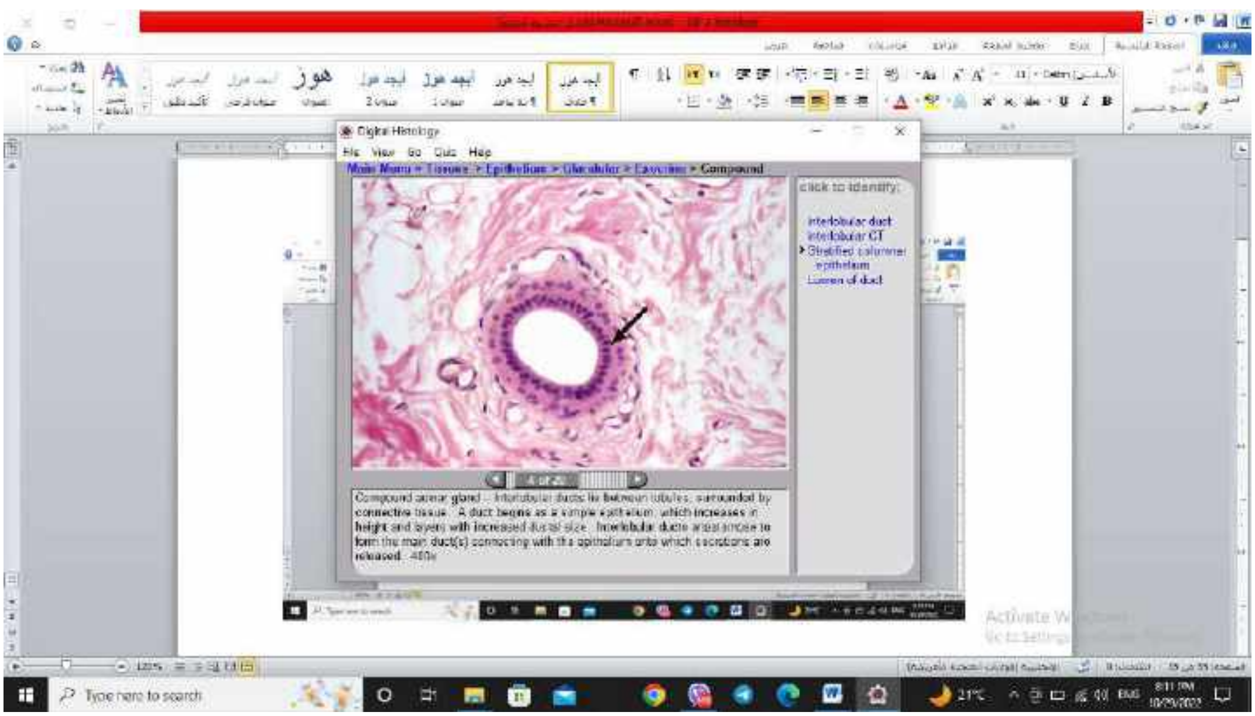
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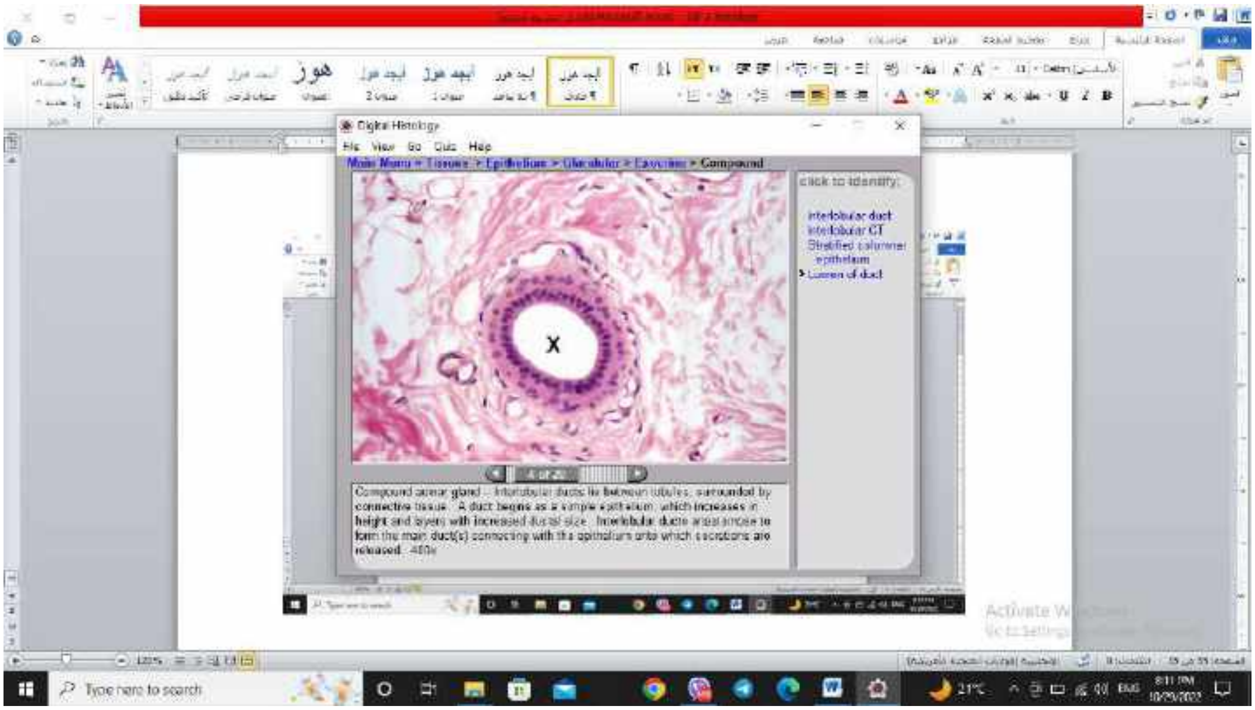
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X
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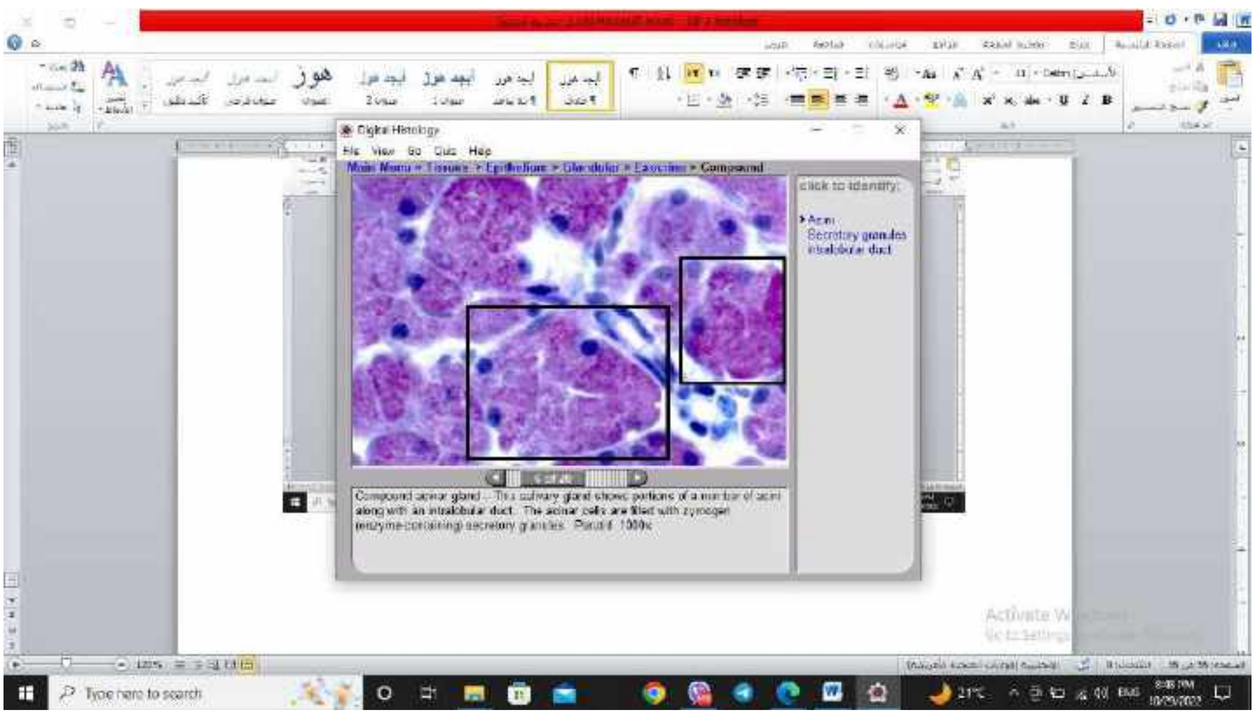
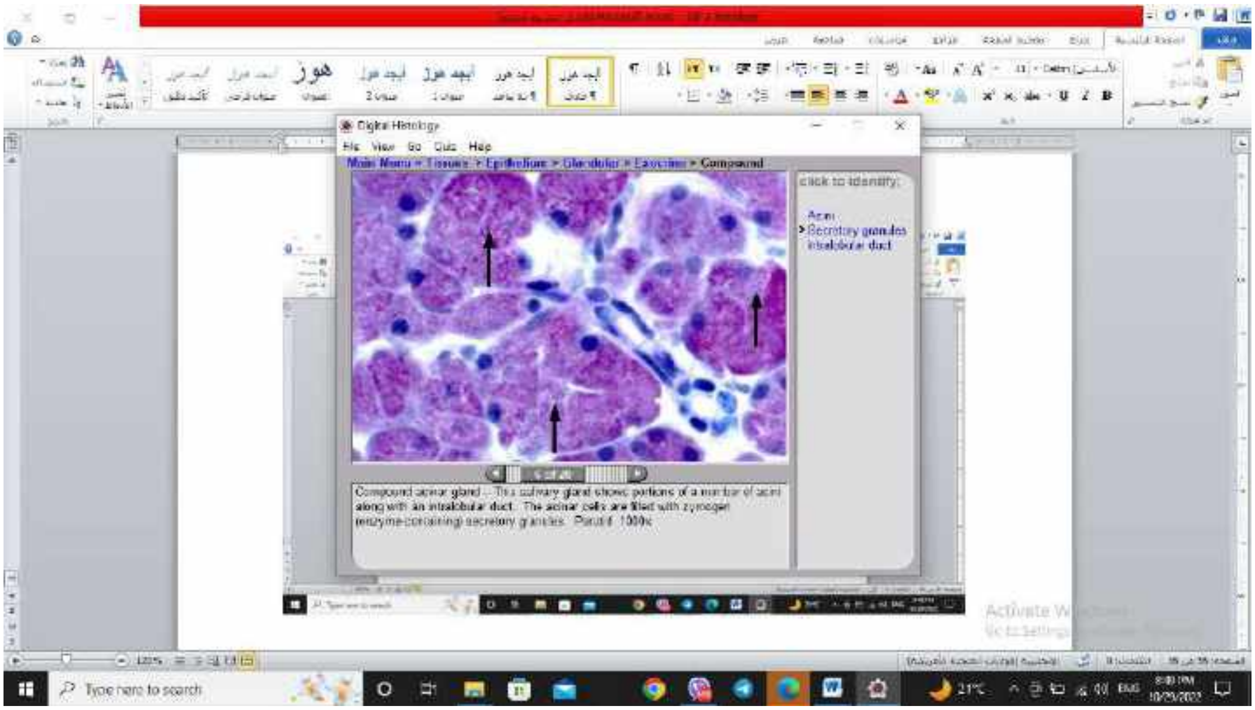

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Acini
Secretory granules
intralobular duct
Compound acinar gland – This salivary gland shows portions of a number of acini along with an intralobular duct. The acinar cells are filled with zymogen (enzyme-containing) secretory granules. Parotid. 1000x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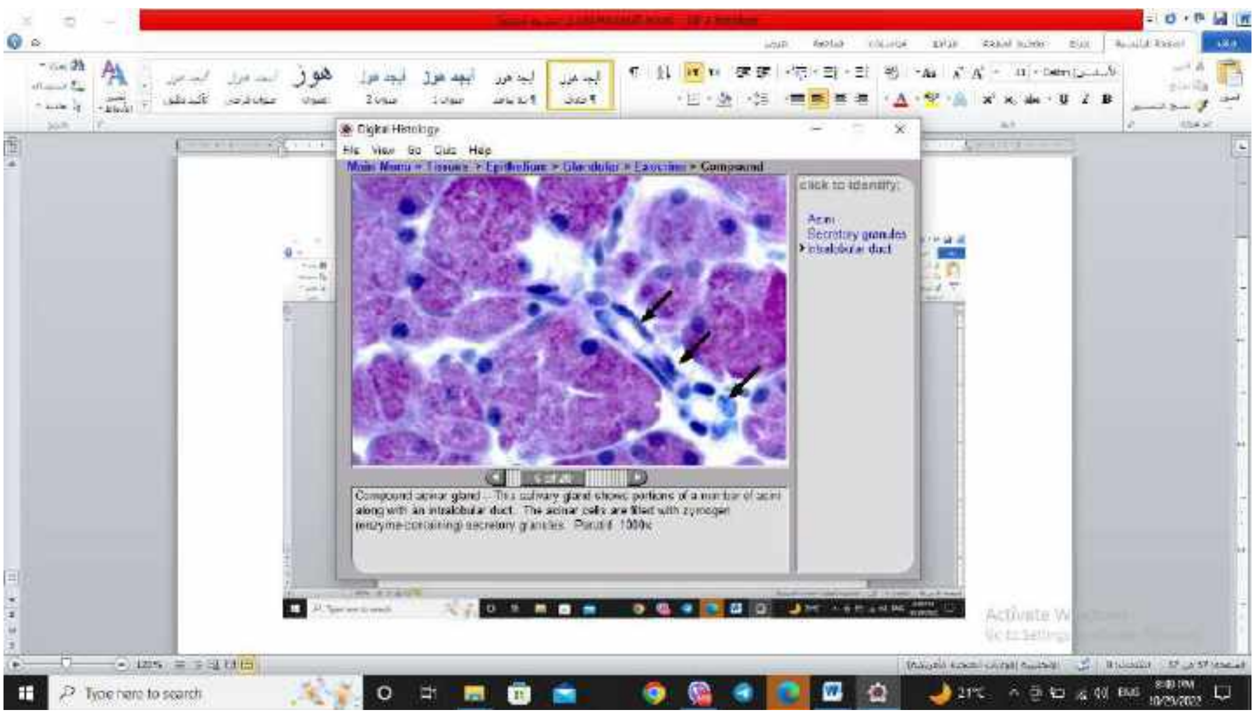
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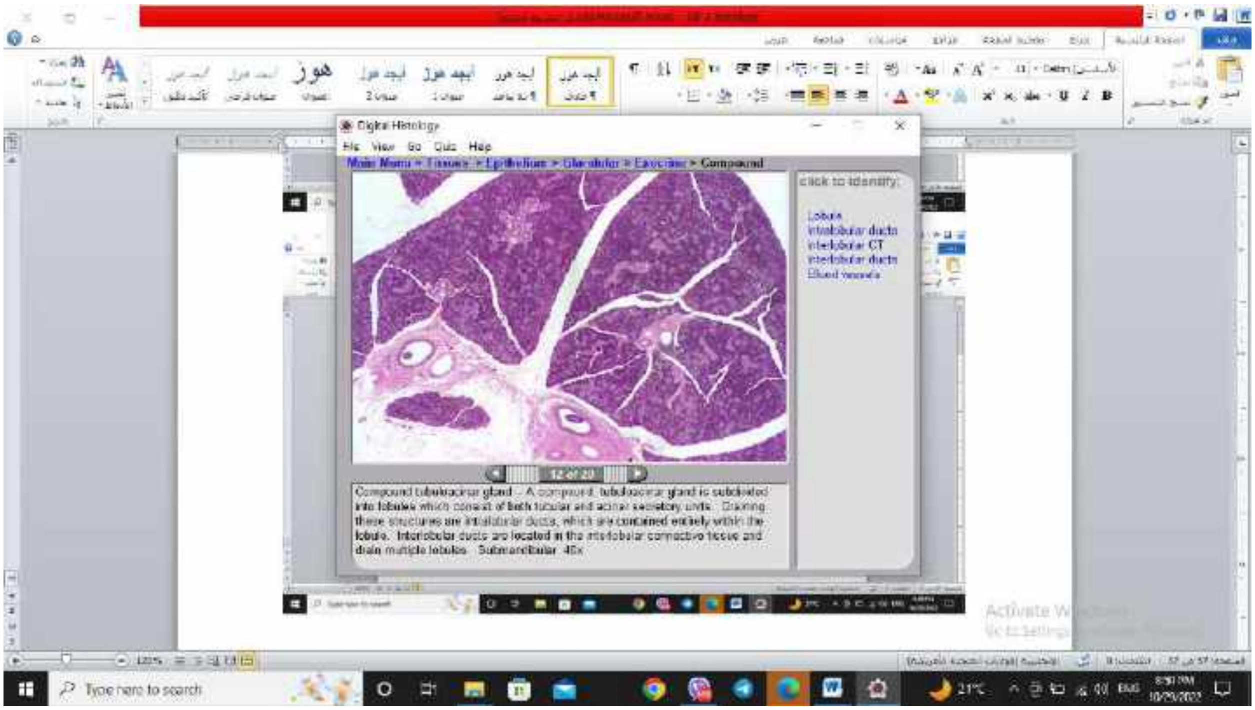
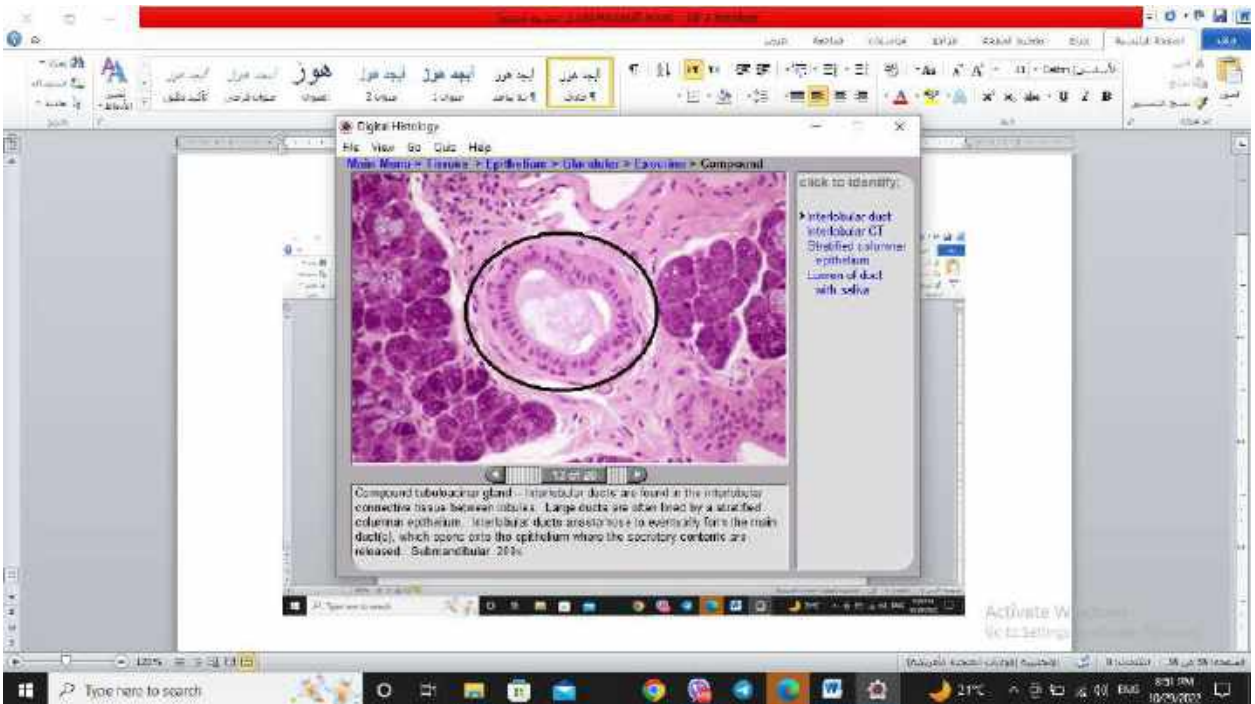
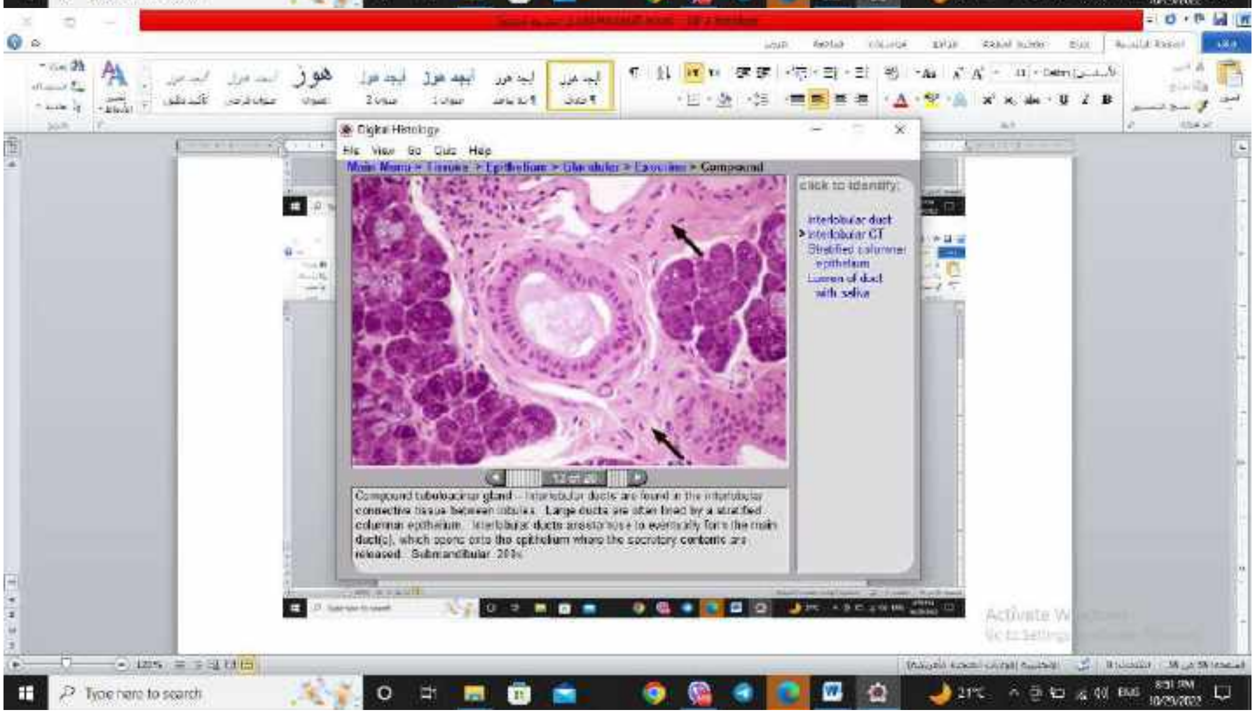
Compound acinar gland -- This salivary gland shows portions of a number of acini along with an intralobular duct. The acinar cells are filled with zymogen (enzyme-containing) secretory granules. Parotid 1000x
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Lobule
Intralobular ducts
Interlobular CT
Interlobular ducts
Blood vessels
12 of 20
Compound tubuloacinar gland – A compound tubuloacinar gland is subdivided into lobules which consist of both tubular and acinar secretory units. Draining these structures are intralobular ducts, which are contained entirely within the lobule. Interlobular ducts are located in the interlobular connective tissue and drain multiple lobules. Submandibular 40x
Type here to search
Activate Windows
Go to Settings to activate Windows.


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
interlobular duct
interlobular CT
Stratified columnar epithelium
Lumen of duct with saliva
Compound tubuloacinar gland – Interlobular ducts are found in the interlobular connective tissue between lobules. Large ducts are often lined by a stratified columnar epithelium. Interlobular ducts anastomose to eventually form the main duct(s), which open onto the epithelium where the secretory contents are released. Submandibular 20x
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
interlobular duct
interlobular CT
Stratified columnar epithelium
Lumen of duct with saliva
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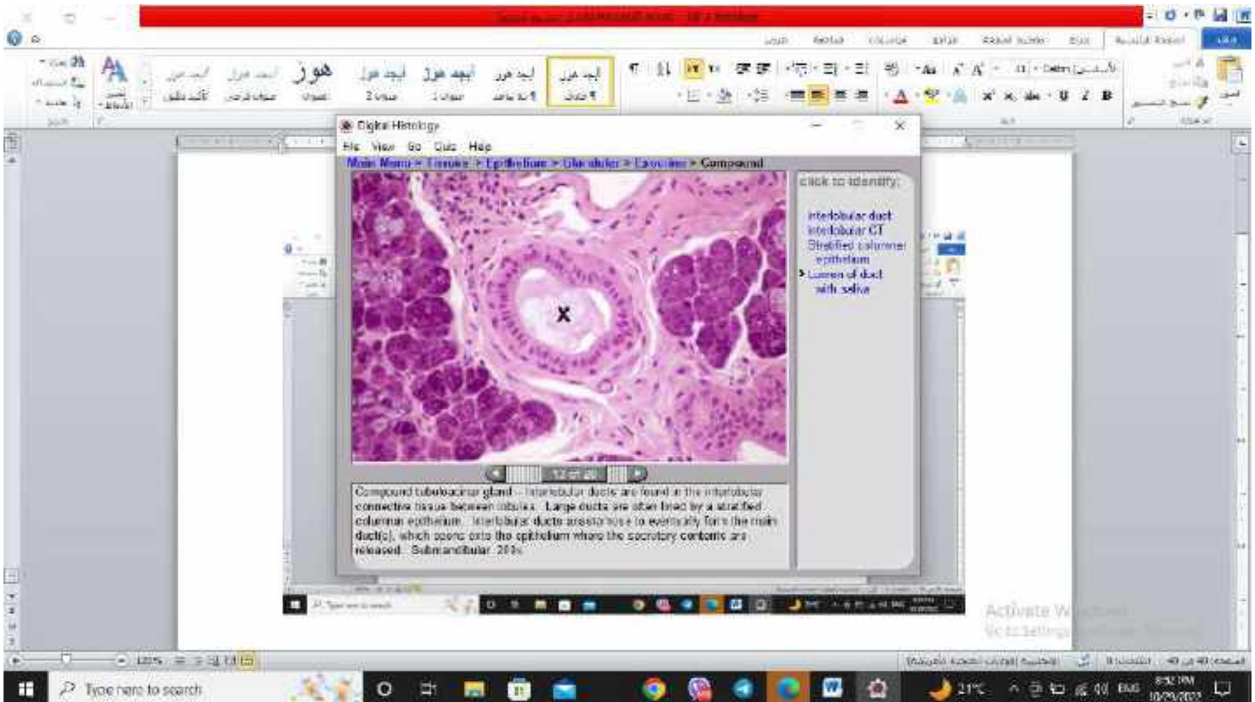
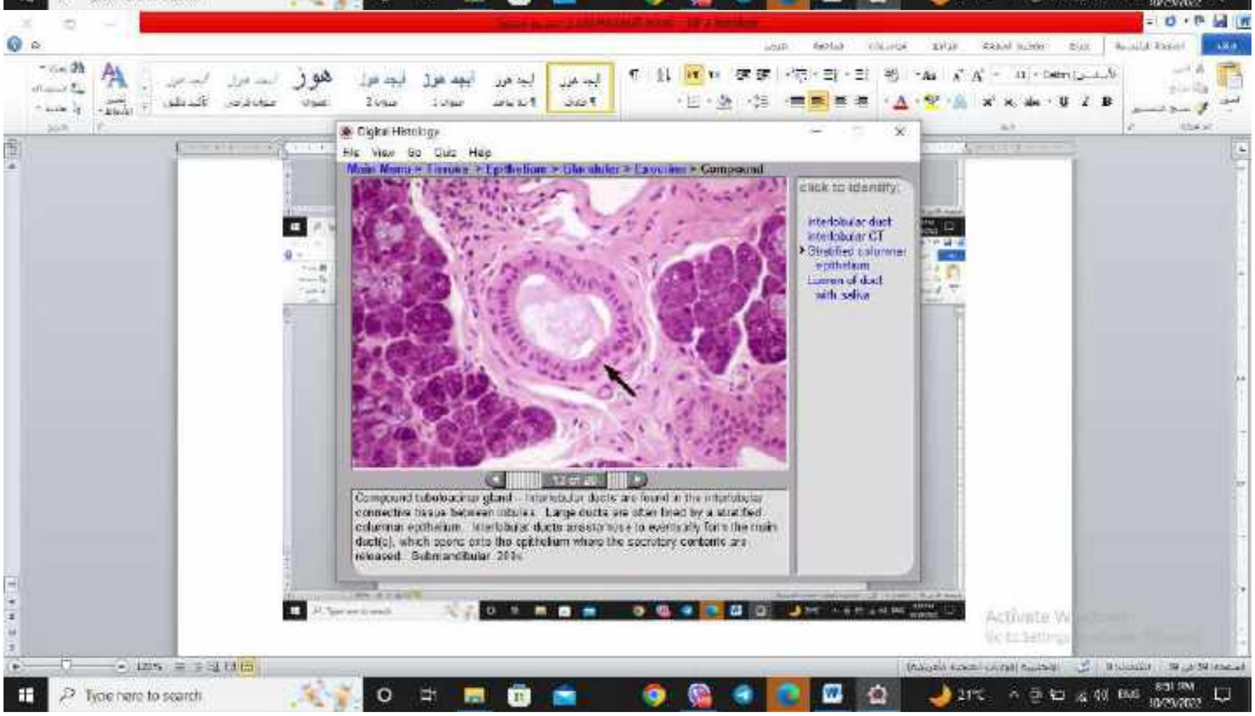
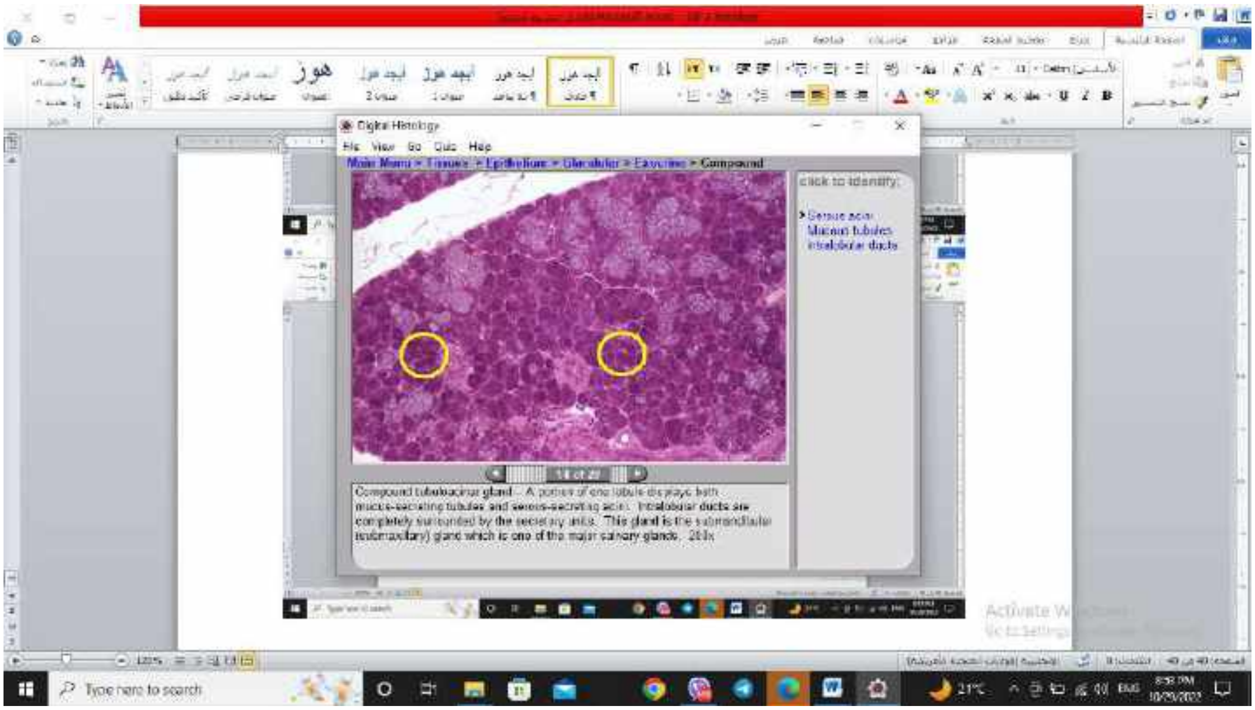
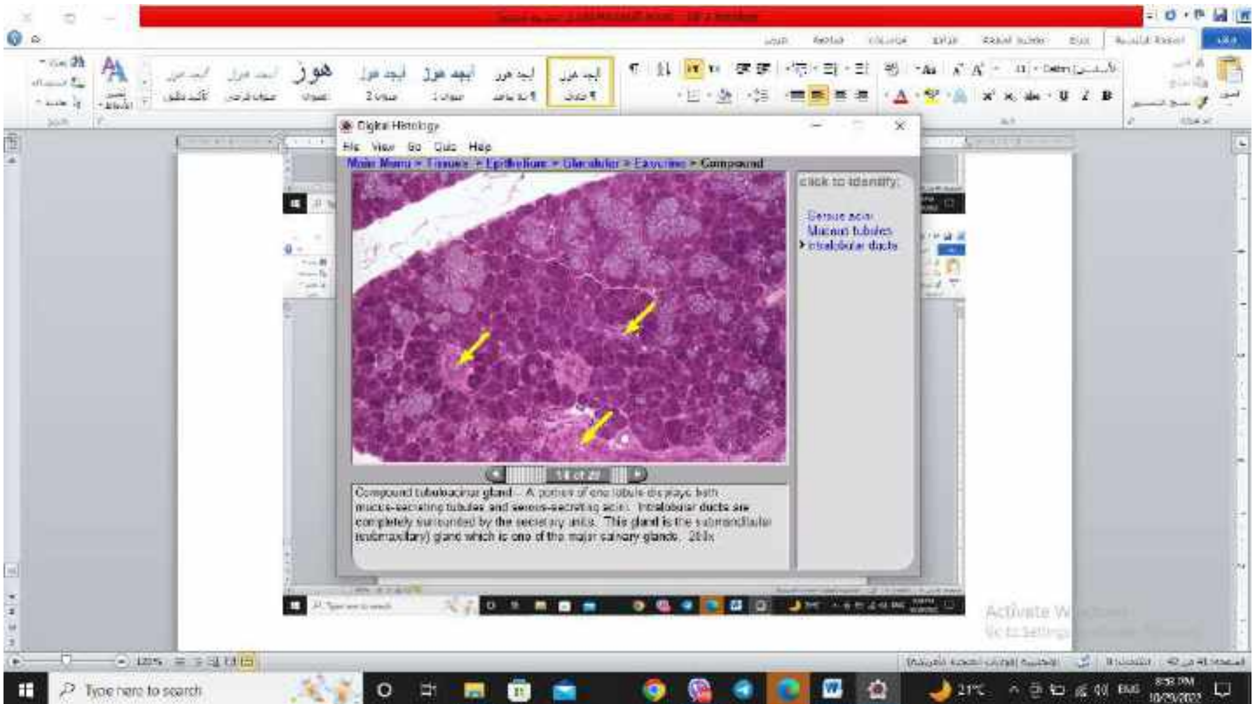
Activate Windows
Type here to search

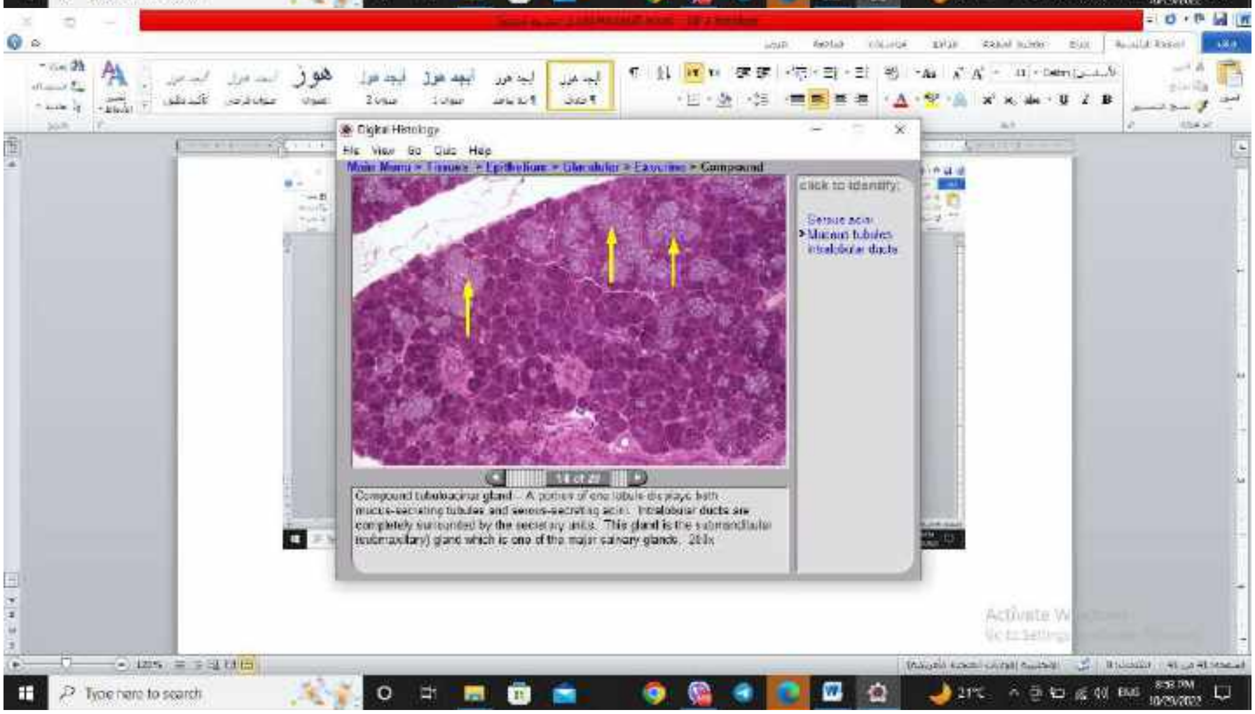

Digital Histology
File View Go Quiz Help
Compound
click to identify:
interlobular duct
interlobular CT
Stratified columnar epithelium
Lumen of duct with saliva
X
Type here to search

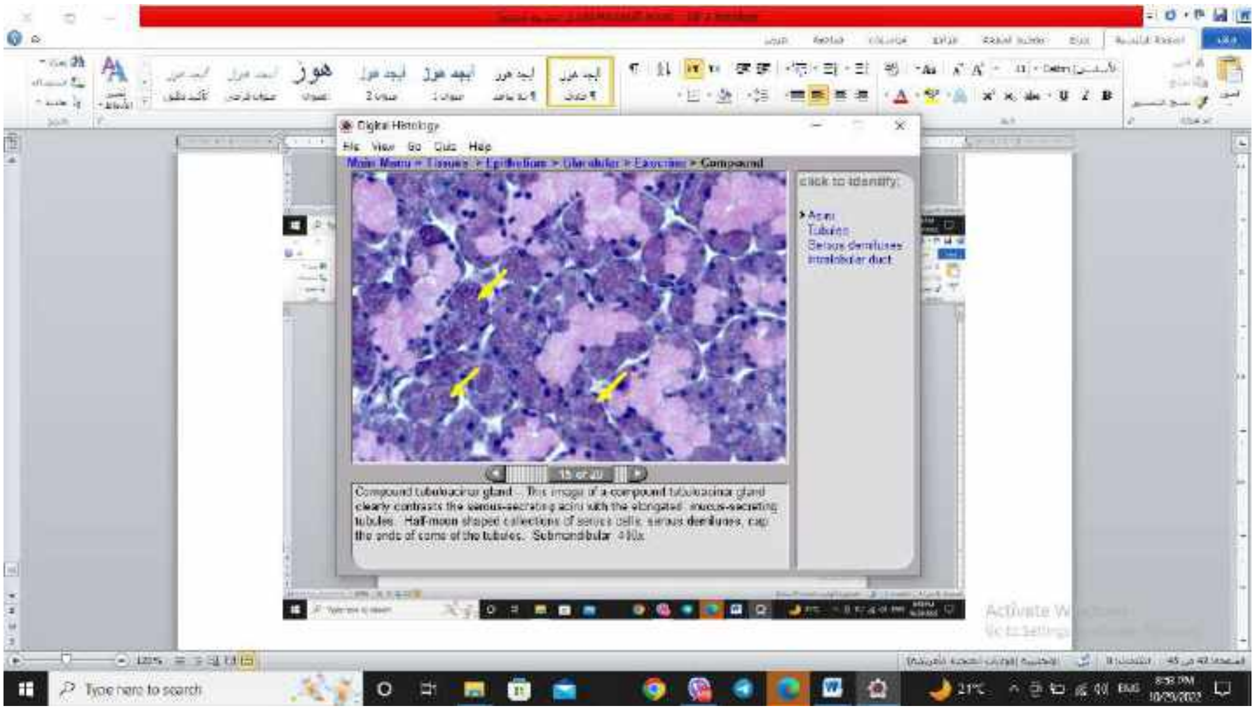

Digital Histology
File View Go Quiz Help
Compound
click to identify:
interlobular duct
interlobular CT
Stratified columnar epithelium
Lumen of duct with saliva
Type here to search



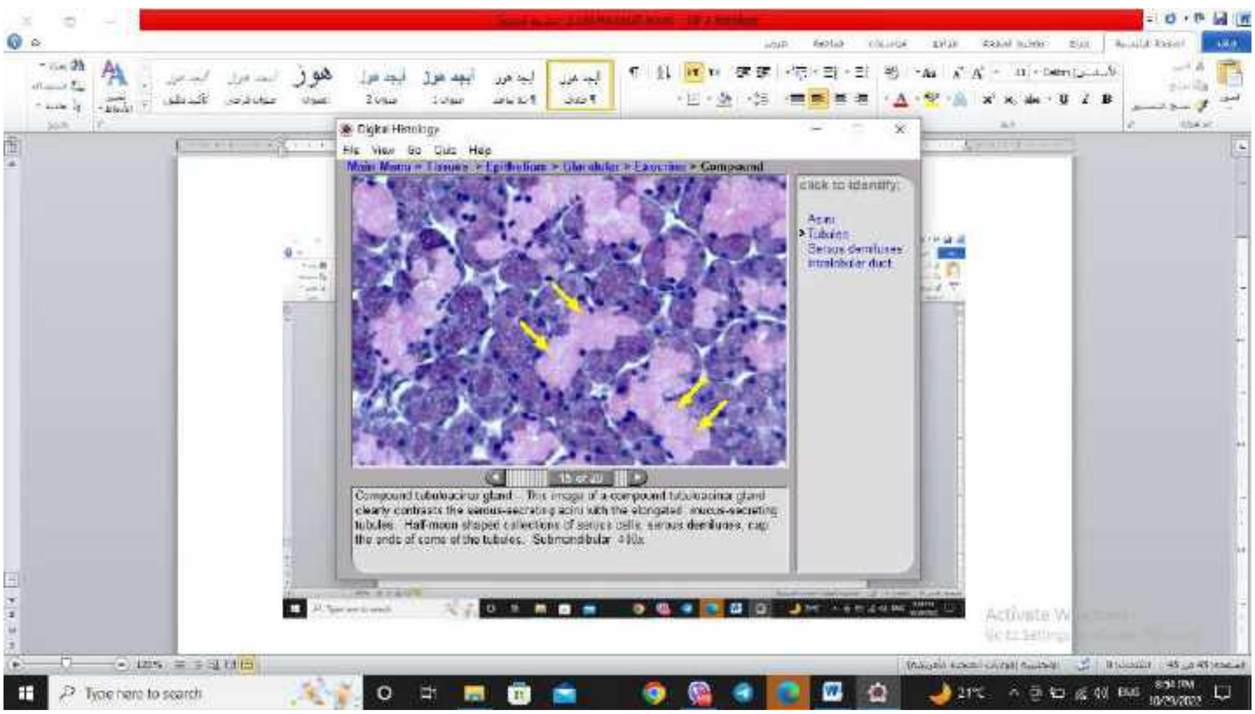
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Serous acini
Mucous tubules
Intralobular ducts
Compound tubuloacinar gland – A portion of one lobule displays both mucus-secreting tubules and serous-secreting acini. Intralobular ducts are completely surrounded by the secretory units. This gland is the submandibular (submaxillary) gland which is one of the major salivary glands. 200x


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Serous acini
Mucous tubules
Intralobular ducts
Compound tubuloacinar gland


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Serous acini
Mucous tubules
Intralobular ducts
Compound tubuloacinar gland



Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Acini
Tubules
Serous demilunes
Intralobular duct
15 of 20
Compound tubuloacinar gland - This image of a compound tubuloacinar gland clearly contrasts the serous-secreting acini with the elongated mucus-secreting tubules. Half-moon shaped collections of serous cells, serous demilunes, cap the ends of some of the tubules. Submandibular 400x
Type here to search



Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Acini
Tubules
Serous demilunes
Intralobular duct
15 of 20
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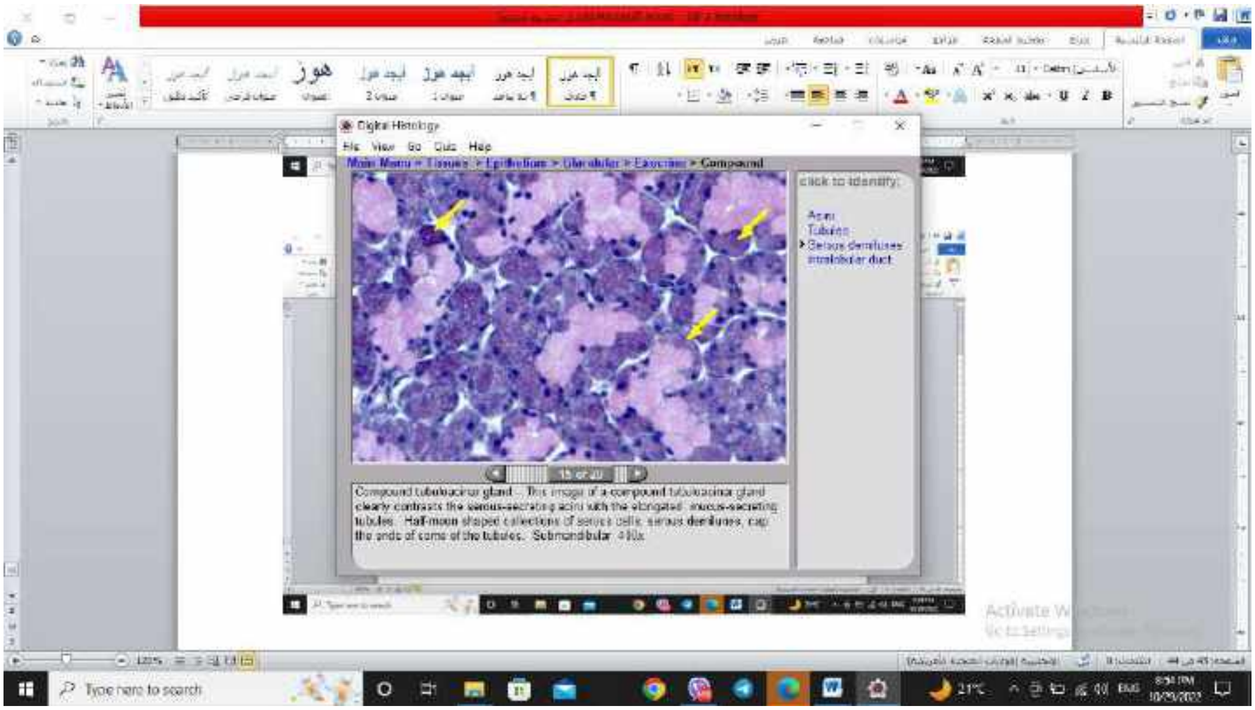
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Acini
Tubules
Serous demilunes
Intralobular duct
15 of 20
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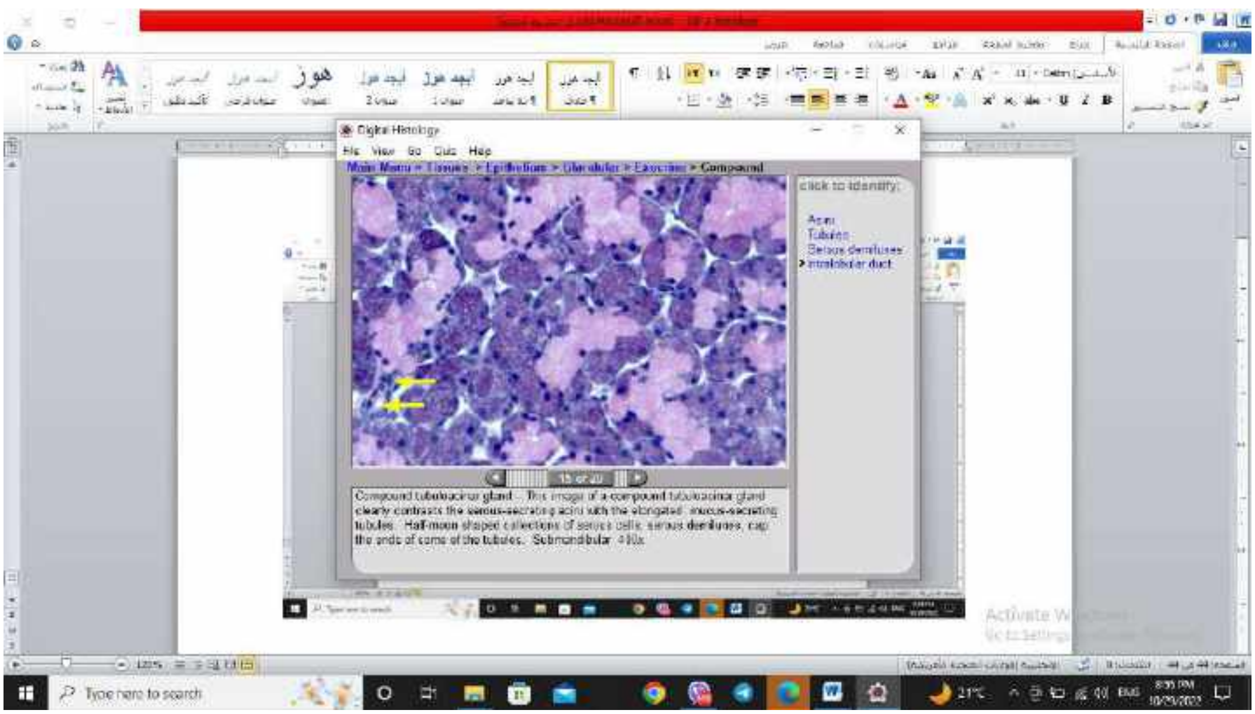
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File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Acini
Tubules
Serous demilunes
Intralobular duct
15 of 20
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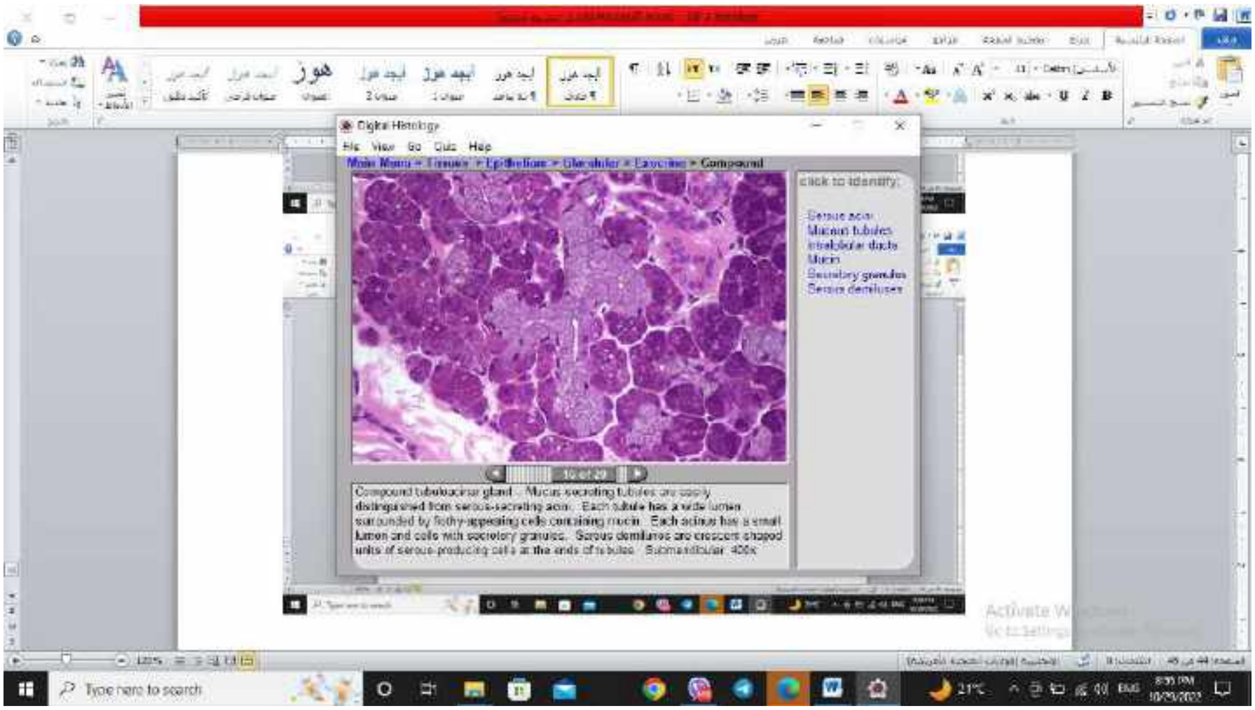
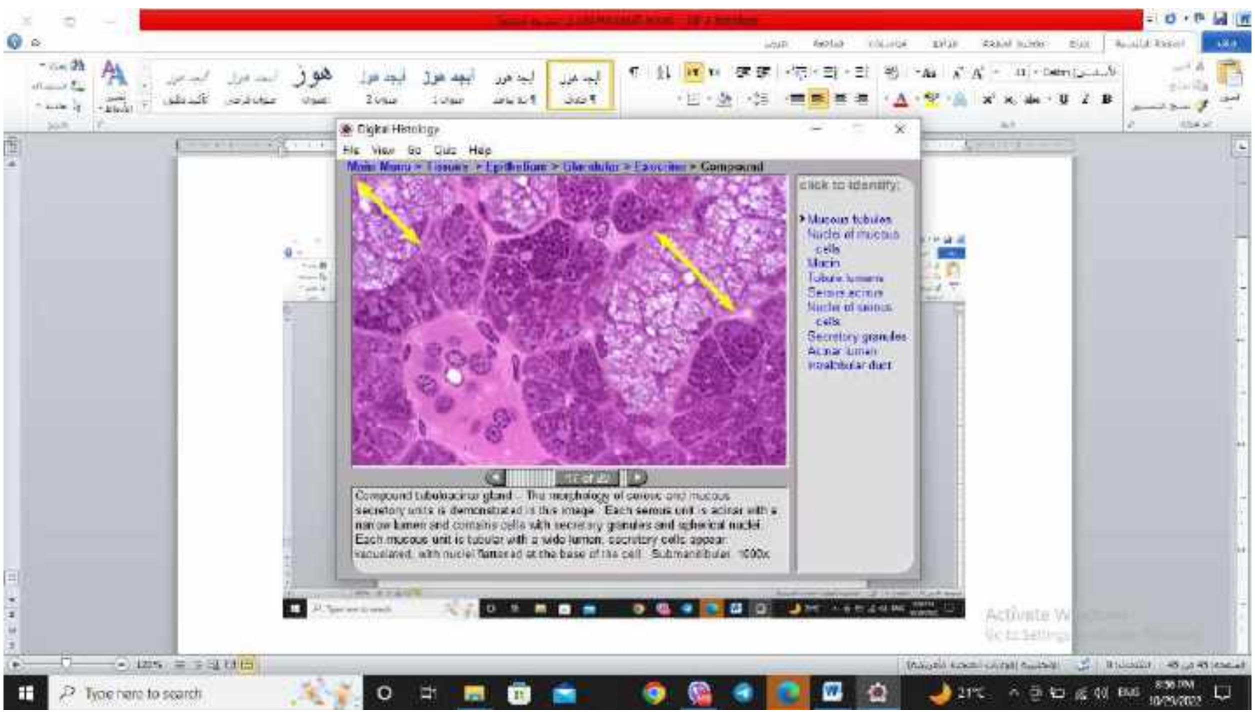
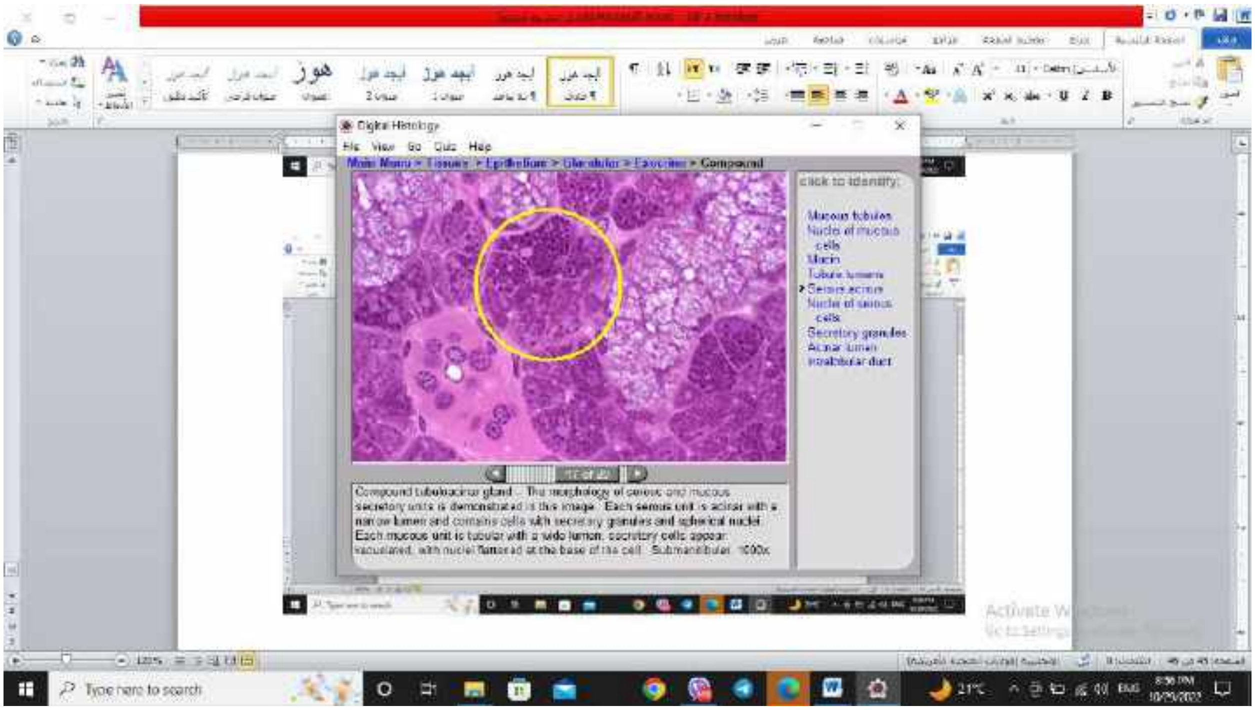

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Serous acini
Mucous tubules
Intralobular ducts
Mucin
Secretory granules
Serous demilunes
10 of 29
Compound tubuloacinar gland - Mucus secreting tubules are easily distinguished from serous-secreting acini. Each tubule has a wide lumen surrounded by frothy-appearing cells containing mucin. Each acinus has a small lumen and cells with secretory granules. Serous demilunes are crescent shaped units of serous-producing cells at the ends of tubules. Submandibular 400x
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Mucous tubules
Nuclei of mucous cells
Mucin
Tubule lumens
Serous acinus
Nuclei of serous cells
Secretory granules
Acinar lumen
Intralobular duct
Compound tubuloacinar gland - The morphology of serous and mucous secretory units is demonstrated in this image. Each serous unit is acinar with a narrow lumen and contains cells with secretory granules and spherical nuclei. Each mucous unit is tubular with a wide lumen, secretory cells appear vacuolated, with nuclei flattened at the base of the cell. Submandibular 1000x
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Mucous tubules
Nuclei of mucous cells
Mucin
Tubule lumens
Serous acinus
Nuclei of serous cells
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Acinar lumen
Intralobular duct
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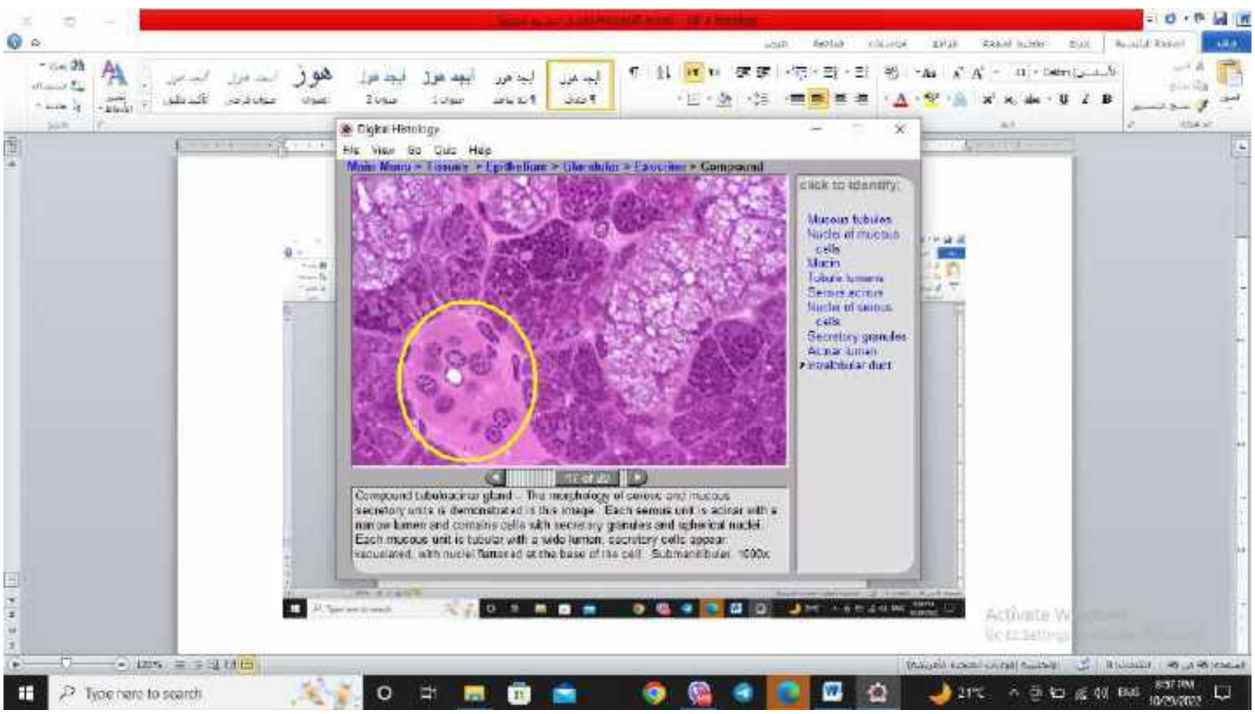
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Mucous tubules
Nuclei of mucous cells
Mucin
Tubule lumens
Serous acinus
Nuclei of serous cells
Secretory granules
Acinar lumen
Intralobular duct
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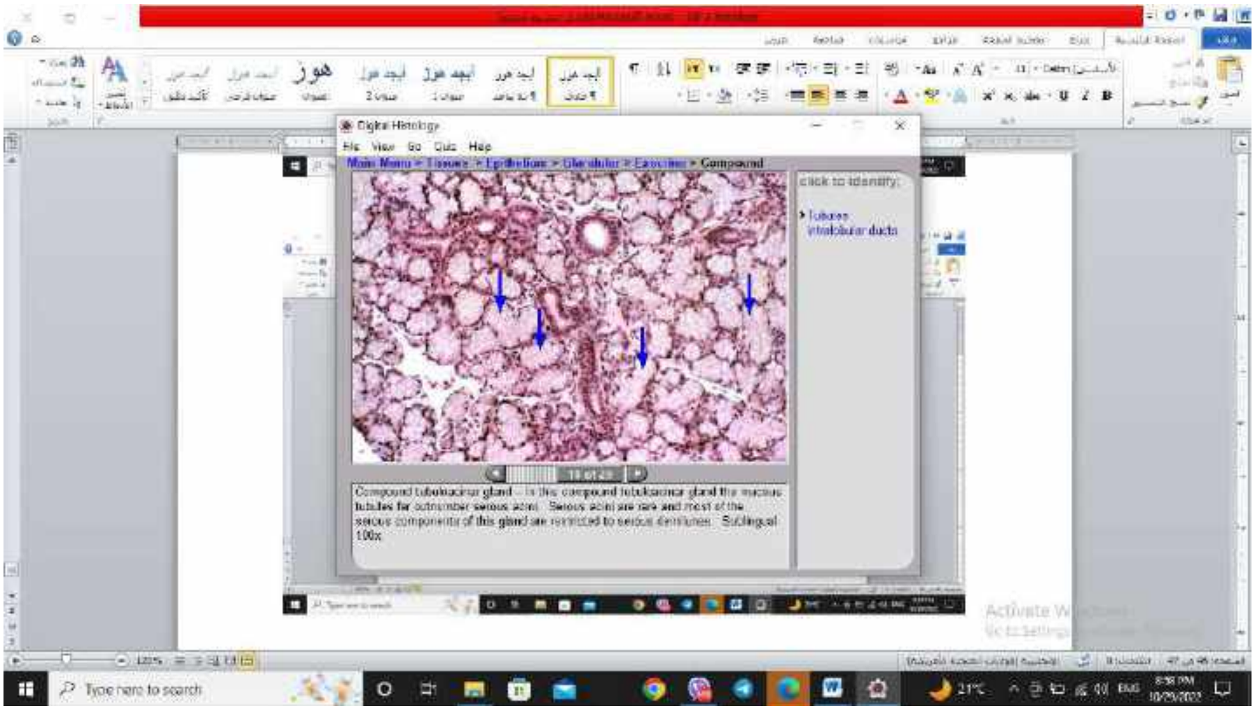
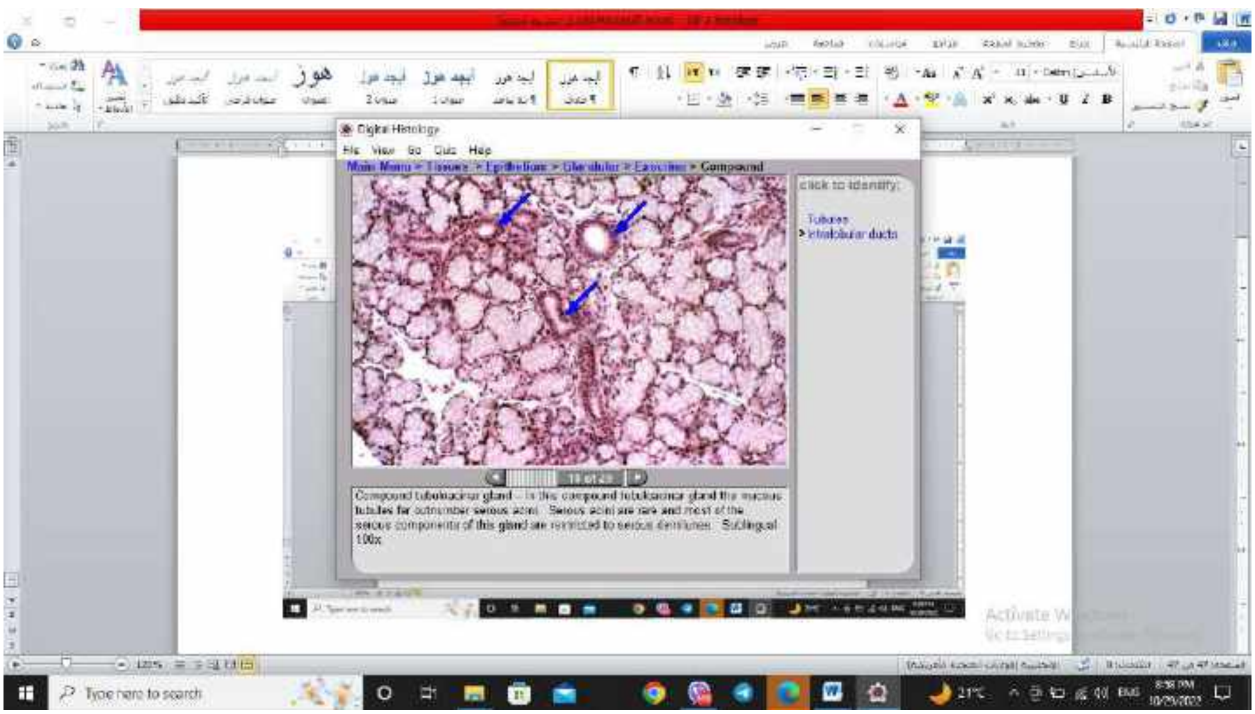
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Tubules
Intralobular ducts
Compound tubuloacinar gland -- In this compound tubuloacinar gland the mucous tubules far outnumber serous acini. Serous acini are rare and most of the serous components of this gland are restricted to serous demilunes. Sublingual 100x
Type here to search


Digital Histology
File View Go Quiz Help
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click to identify:
Tubules
Intralobular ducts
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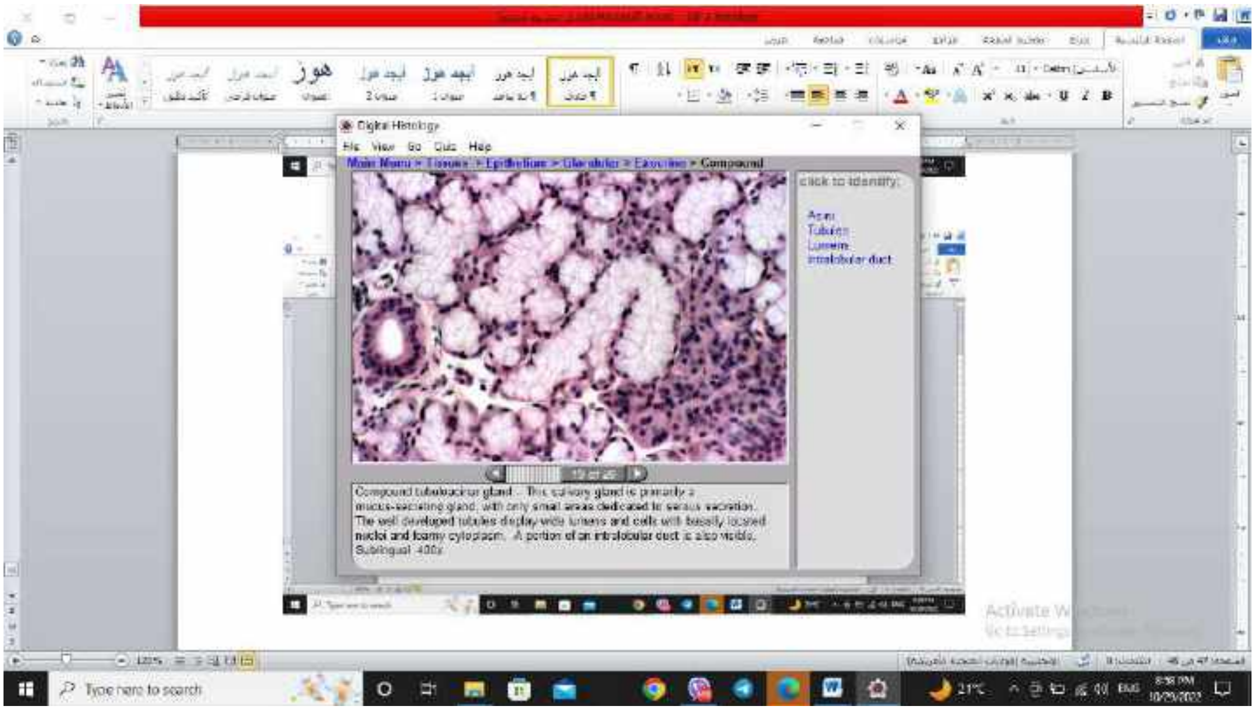
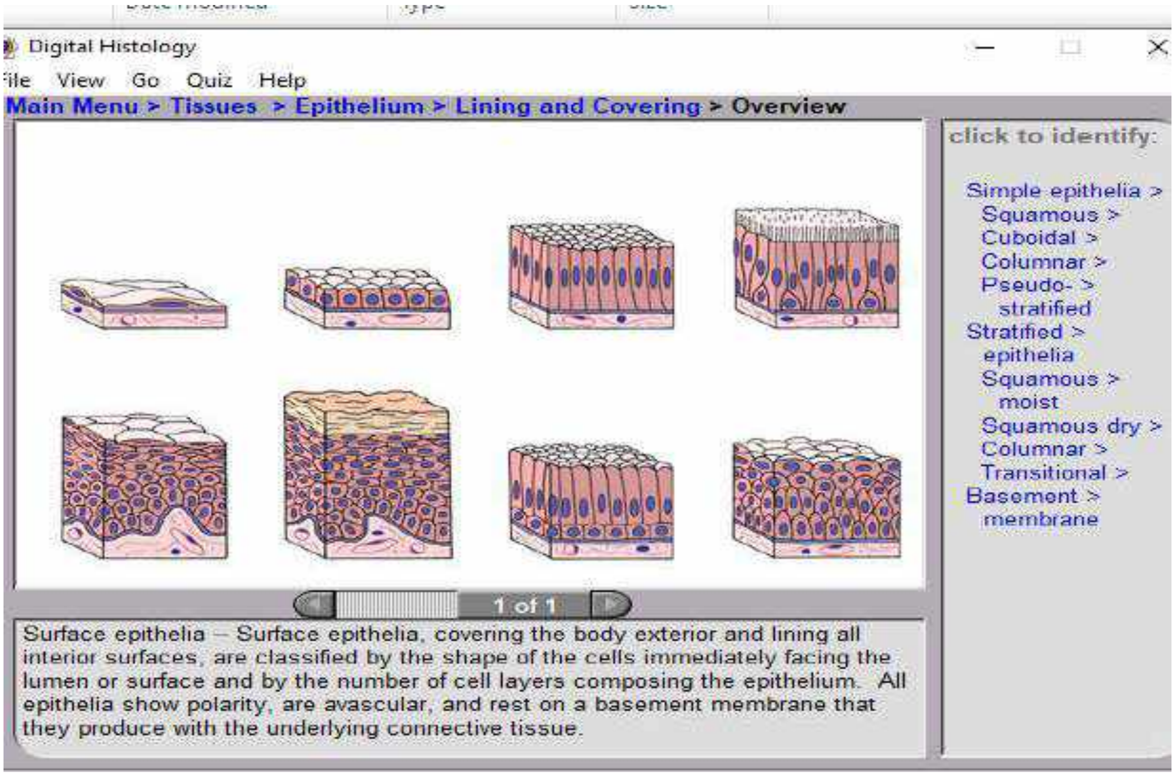
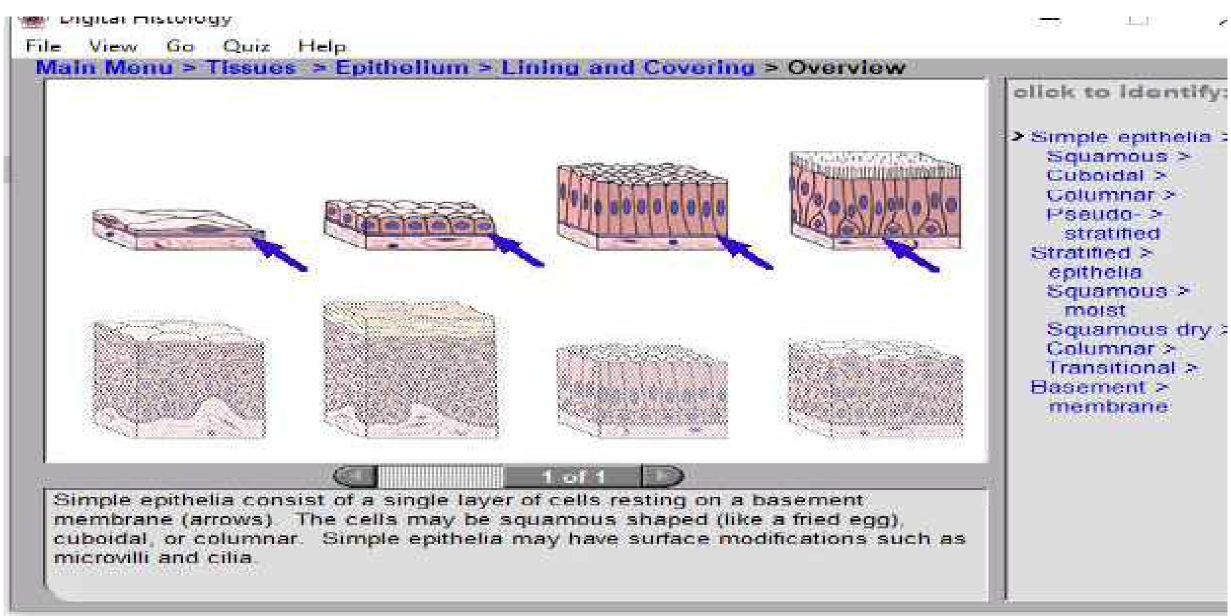
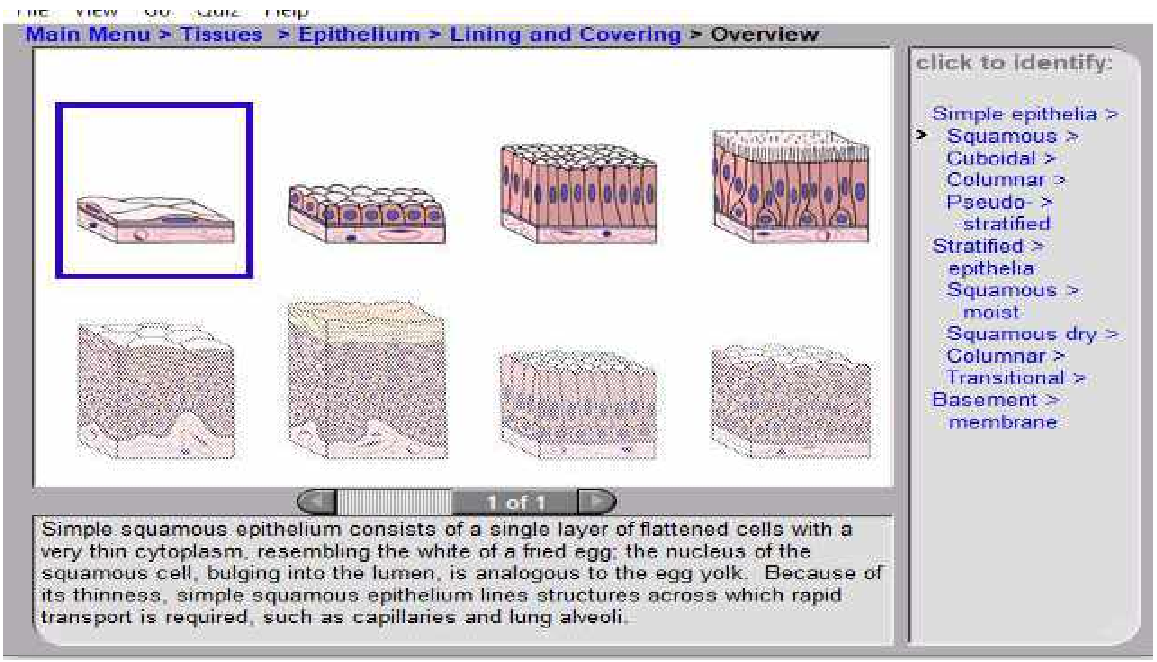
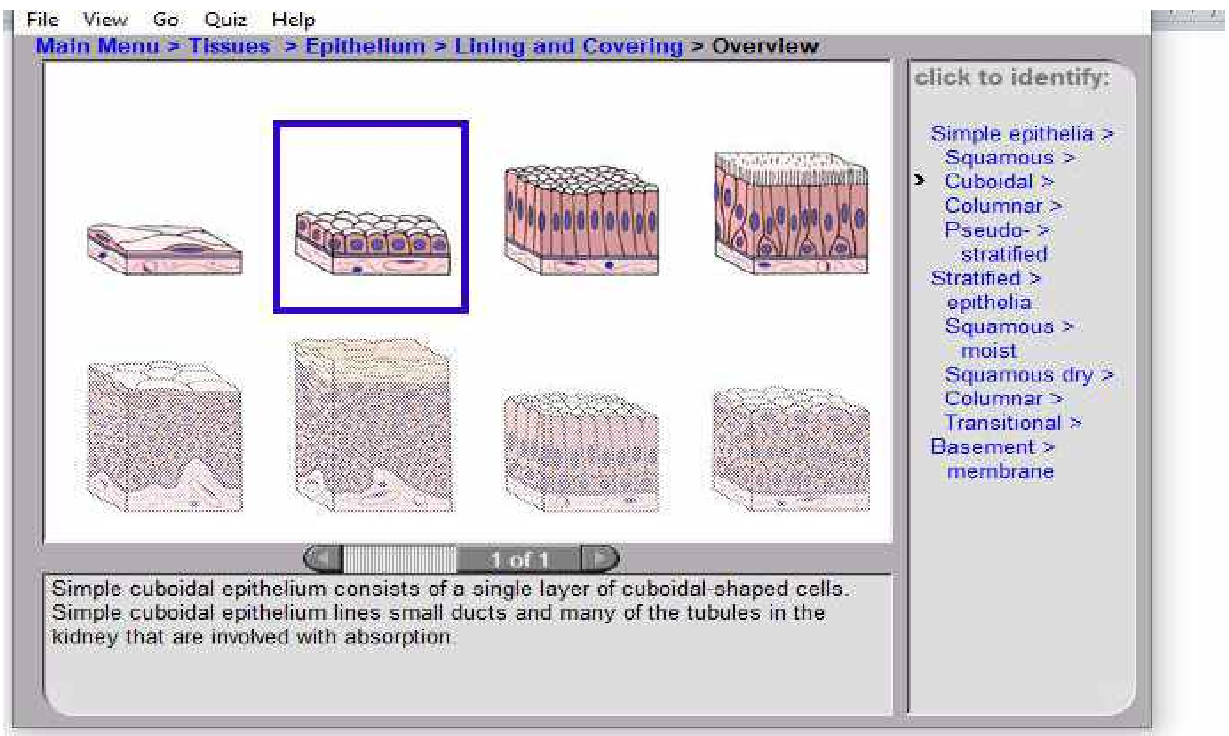
Type here to search

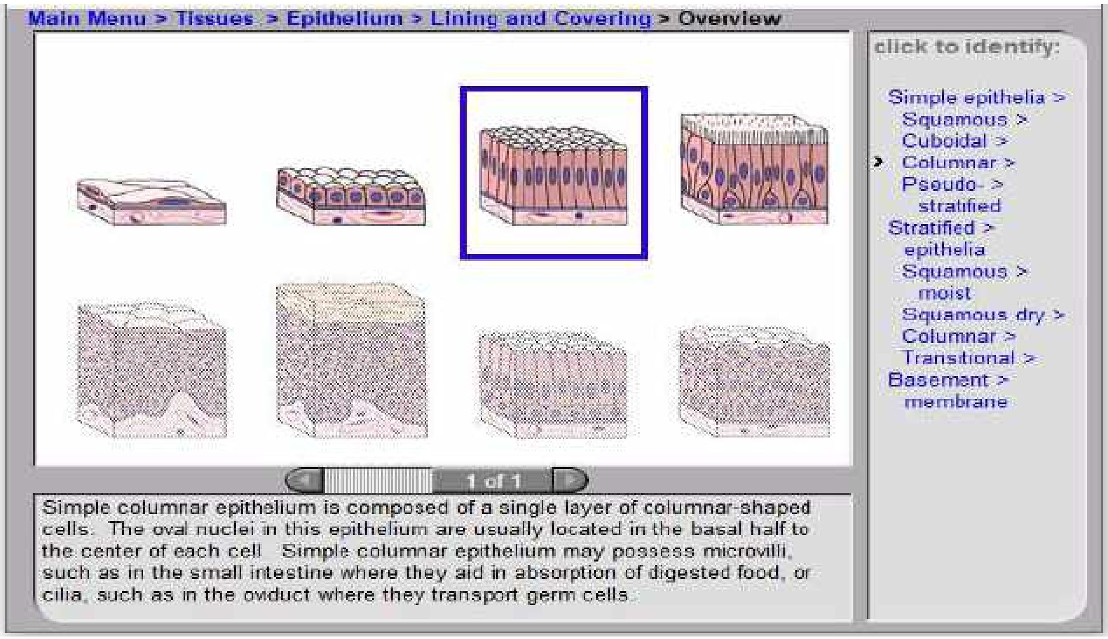

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Glandular > Exocrine > Compound
click to identify:
Acini
Tubules
Lumens
intralobular duct
Compound tubuloacinar gland - This salivary gland is primarily a mucus-secreting gland, with only small areas dedicated to serous secretion. The well developed tubules display wide lumens and cells with basally located nuclei and foamy cytoplasm. A portion of an intralobular duct is also visible. Sublingual 400x
Type here to search

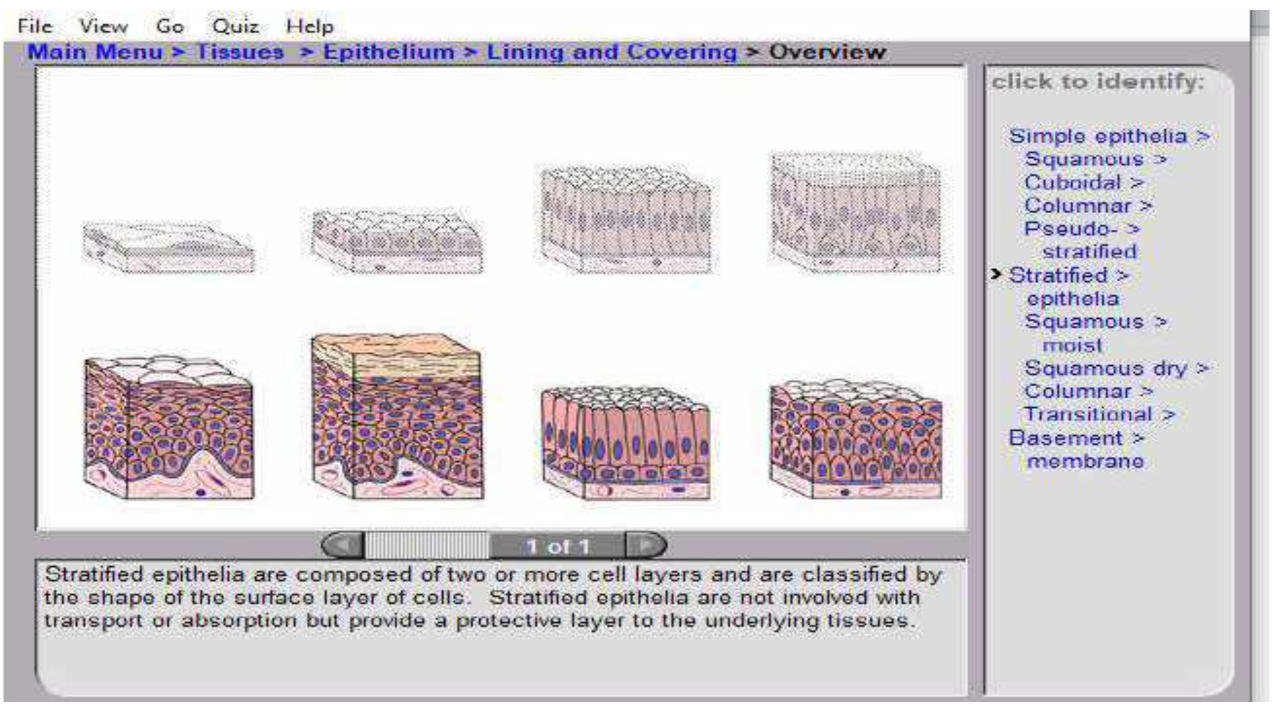

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- >
stratified
Stratified >
epithelia
Squamous >
moist
Squamous dry >
Columnar >
Transitional >
Basement >
membrane
1 of 1
Surface epithelia -- Surface epithelia, covering the body exterior and lining all interior surfaces, are classified by the shape of the cells immediately facing the lumen or surface and by the number of cell layers composing the epithelium. All epithelia show polarity, are avascular, and rest on a basement membrane that they produce with the underlying connective tissue.

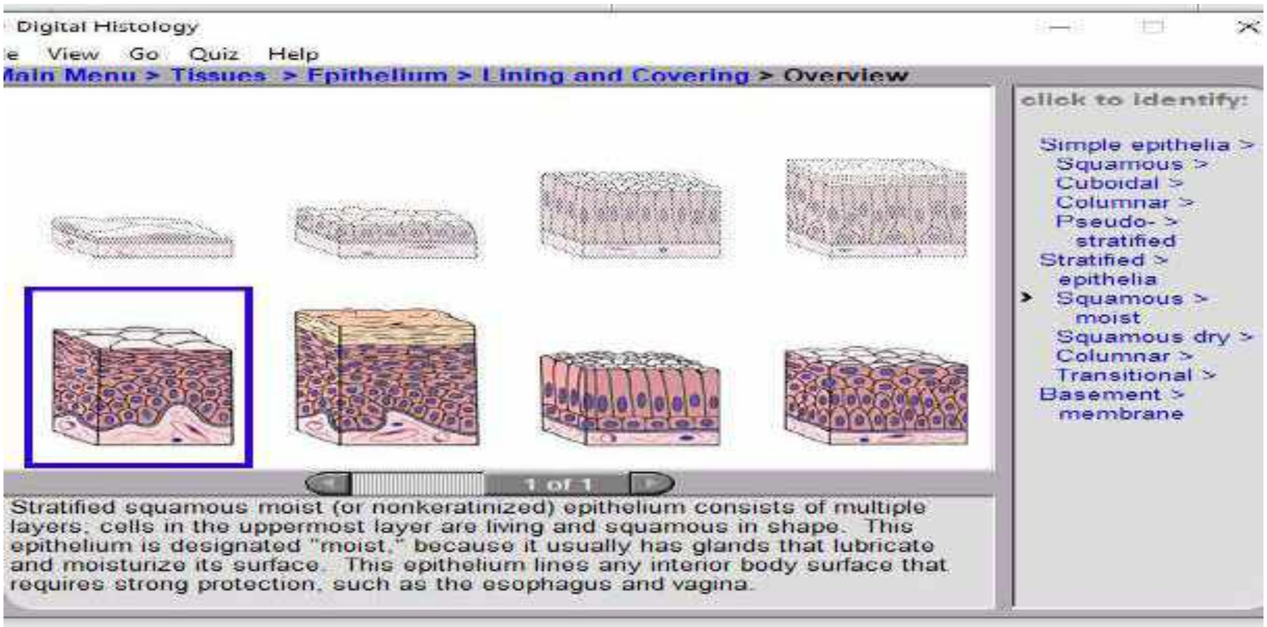

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
> Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- >
stratified
Stratified >
epithelia
Squamous >
moist
Squamous dry >
Columnar >
Transitional >
Basement >
membrane
1 of 1
Simple epithelia consist of a single layer of cells resting on a basement membrane (arrows). The cells may be squamous shaped (like a fried egg), cuboidal, or columnar. Simple epithelia may have surface modifications such as microvilli and cilia.

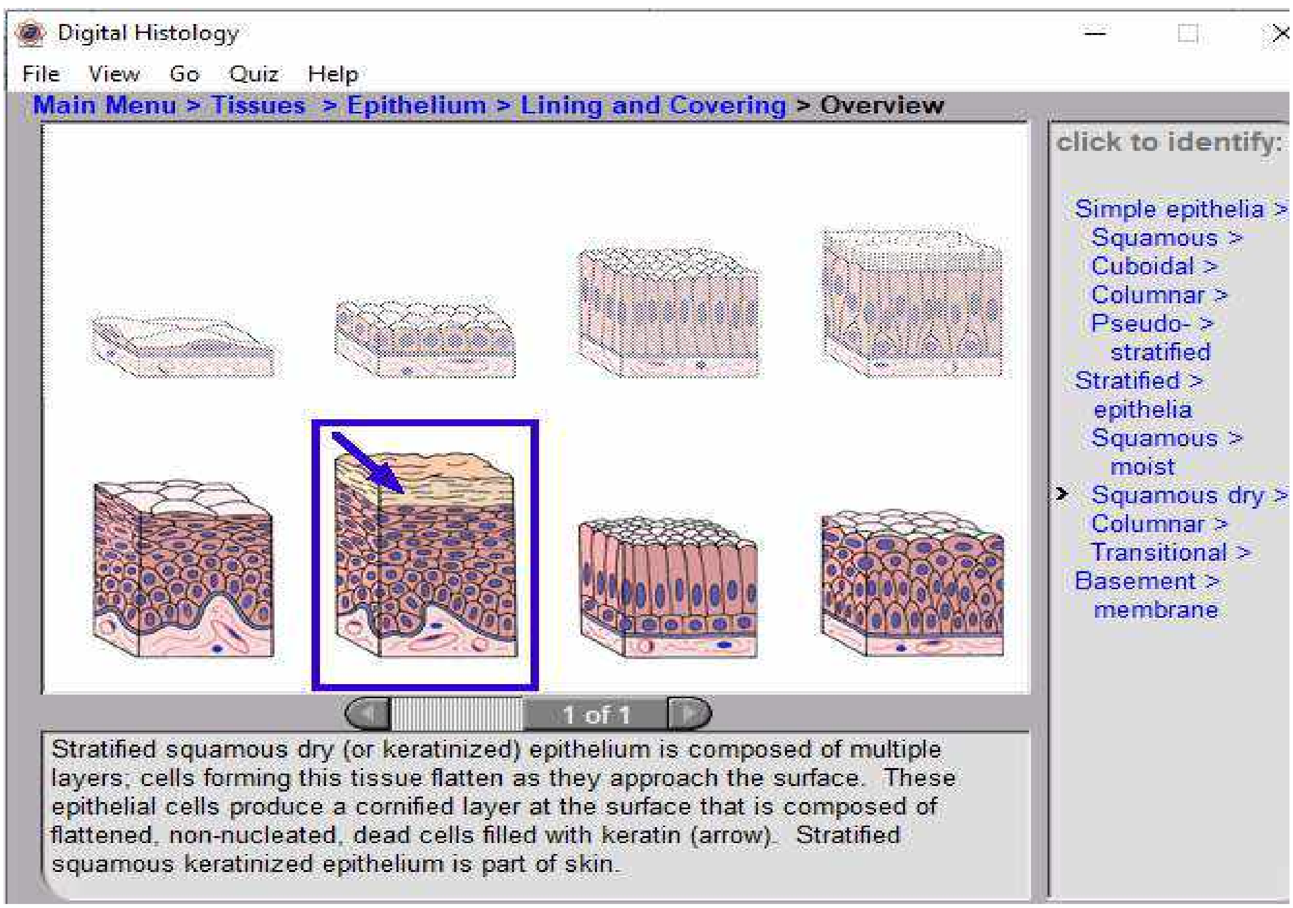

Main Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- > stratified
Stratified > epithelia
Squamous > moist
Squamous dry >
Columnar >
Transitional >
Basement > membrane
1 of 1
Simple squamous epithelium consists of a single layer of flattened cells with a very thin cytoplasm, resembling the white of a fried egg; the nucleus of the squamous cell, bulging into the lumen, is analogous to the egg yolk. Because of its thinness, simple squamous epithelium lines structures across which rapid transport is required, such as capillaries and lung alveoli.


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- > stratified
Stratified > epithelia
Squamous > moist
Squamous dry >
Columnar >
Transitional >
Basement > membrane
1 of 1
Simple cuboidal epithelium consists of a single layer of cuboidal-shaped cells. Simple cuboidal epithelium lines small ducts and many of the tubules in the kidney that are involved with absorption.

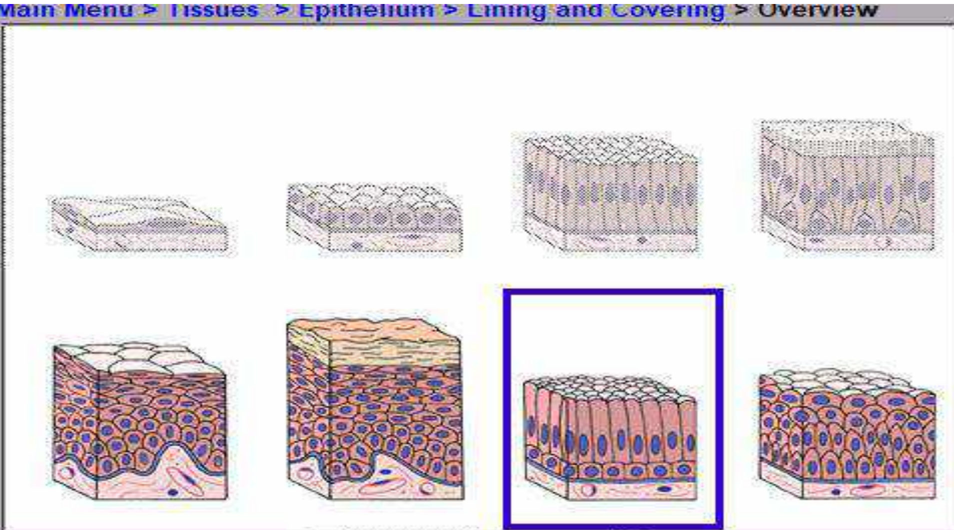

Main Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- >
stratified
Stratified >
epithelia
Squamous >
moist
Squamous dry >
Columnar >
Transitional >
Basement >
membrane
1 of 1
Simple columnar epithelium is composed of a single layer of columnar-shaped cells. The oval nuclei in this epithelium are usually located in the basal half to the center of each cell. Simple columnar epithelium may possess microvilli, such as in the small intestine where they aid in absorption of digested food, or cilia, such as in the oviduct where they transport germ cells.


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- >
stratified
Stratified >
epithelia
Squamous >
moist
Squamous dry >
Columnar >
Transitional >
Basement >
membrane
1 of 1
Stratified epithelia are composed of two or more cell layers and are classified by the shape of the surface layer of cells. Stratified epithelia are not involved with transport or absorption but provide a protective layer to the underlying tissues.


Digital Histology
e View Go Quiz Help
lain Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- > stratified
Stratified > epithelia
Squamous > moist
Squamous dry >
Columnar >
Transitional >
Basement > membrane
1 of 1
Stratified squamous moist (or nonkeratinized) epithelium consists of multiple layers; cells in the uppermost layer are living and squamous in shape. This epithelium is designated "moist," because it usually has glands that lubricate and moisturize its surface. This epithelium lines any interior body surface that requires strong protection, such as the esophagus and vagina.


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Overview
click to identify:
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- > stratified
Stratified > epithelia
Squamous > moist
Squamous dry >
Columnar >
Transitional >
Basement > membrane
1 of 1
Stratified squamous dry (or keratinized) epithelium is composed of multiple layers; cells forming this tissue flatten as they approach the surface. These epithelial cells produce a cornified layer at the surface that is composed of flattened, non-nucleated, dead cells filled with keratin (arrow). Stratified squamous keratinized epithelium is part of skin.

Main Menu > Tissues > Epithelium > Lining and Covering > Overview



1 of 1

click to identify:

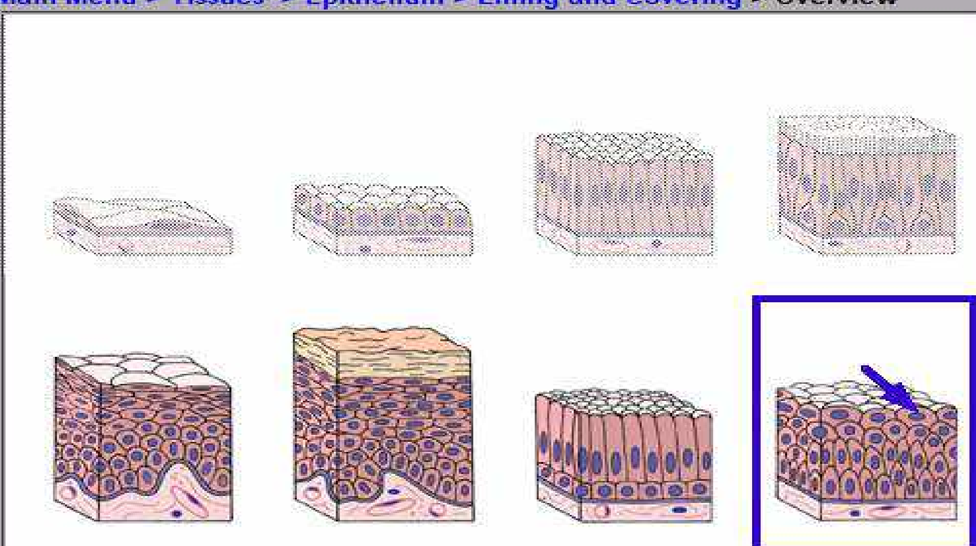
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- > stratified
Stratified > epithelia
Squamous > moist
Squamous dry >
Columnar >
Transitional >
Basement > membrane

Stratified columnar epithelium is composed of multiple layers, the uppermost of which is columnar-shaped. This epithelium is not found in a definitive location but is frequently seen in areas of epithelial transition, for example, in ducts as their linings are modified from a simple epithelium to a stratified squamous epithelium onto which the gland would secrete.

Digital Histology

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Overview



1 of 1

click to identify:

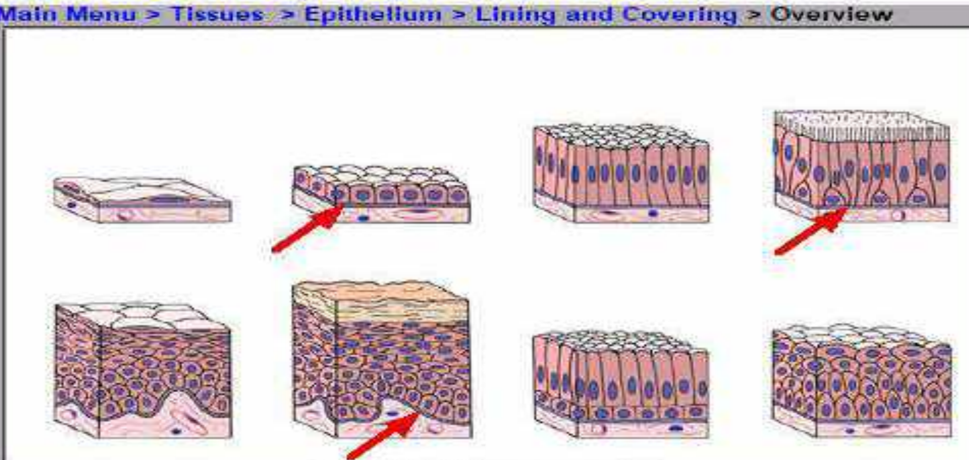
Simple epithelia >
Squamous >
Cuboidal >
Columnar >
Pseudo- > stratified
Stratified > epithelia
Squamous > moist
Squamous dry >
Columnar >
Transitional >
Basement > membrane

Transitional epithelium is also classified as stratified cuboidal, because its surface cells frequently assume a cuboidal shape. Transitional epithelium lines urinary passages that distend. Surface cells are called dome cells (arrow), because of their bulging shape; these cells, however, flatten to a squamous shape when the epithelium is distended, thus the name transitional.

Digital Histology

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Overview



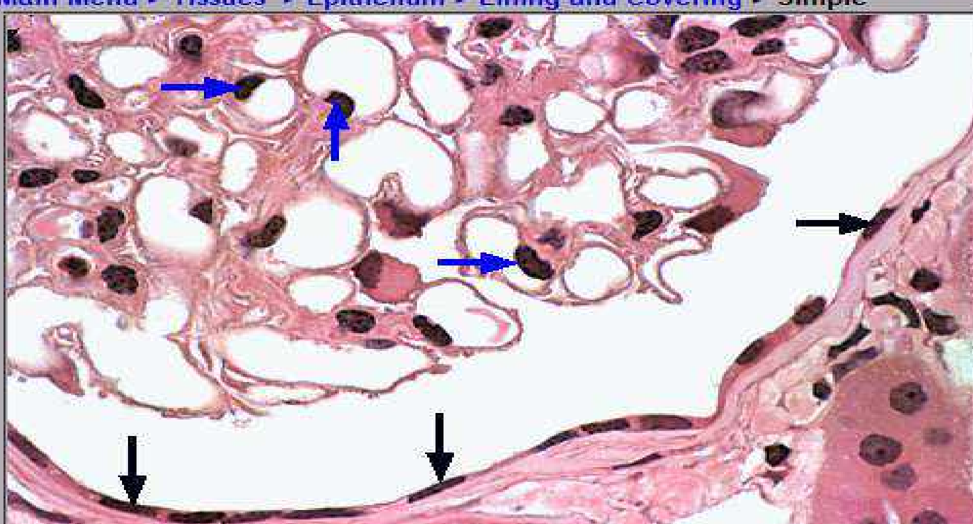
1 of 1

All epithelia rest on a basement membrane, which consists of a basal lamina, produced by the epithelial cells, and a reticular lamina, produced by fibroblasts in the underlying connective tissue. Because the basal lamina and reticular lamina cannot be resolved with the light microscope, the term basement membrane is used in light microscopy to refer to both of these structures, collectively.

click to identify:

- Simple epithelia >
  - Squamous >
  - Cuboidal >
  - Columnar >
  - Pseudo- > stratified
- Stratified > epithelia
  - Squamous > moist
  - Squamous dry >
  - Columnar >
  - Transitional >
- > Basement > membrane

Main Menu > Tissues > Epithelium > Lining and Covering > Simple

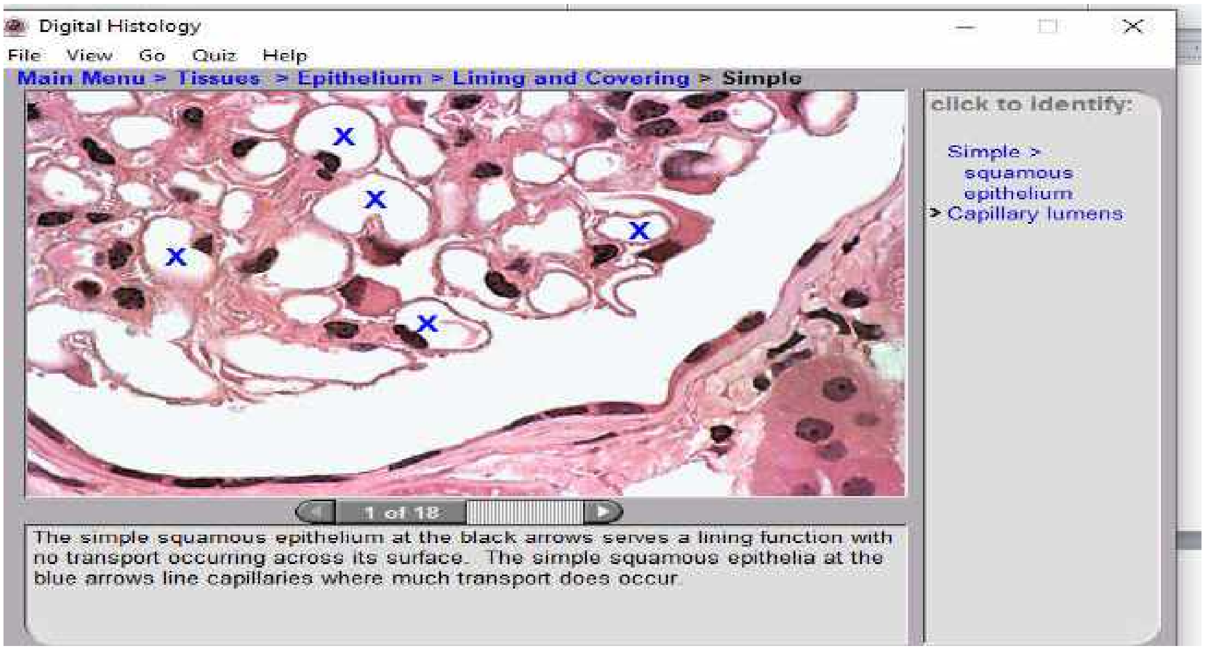


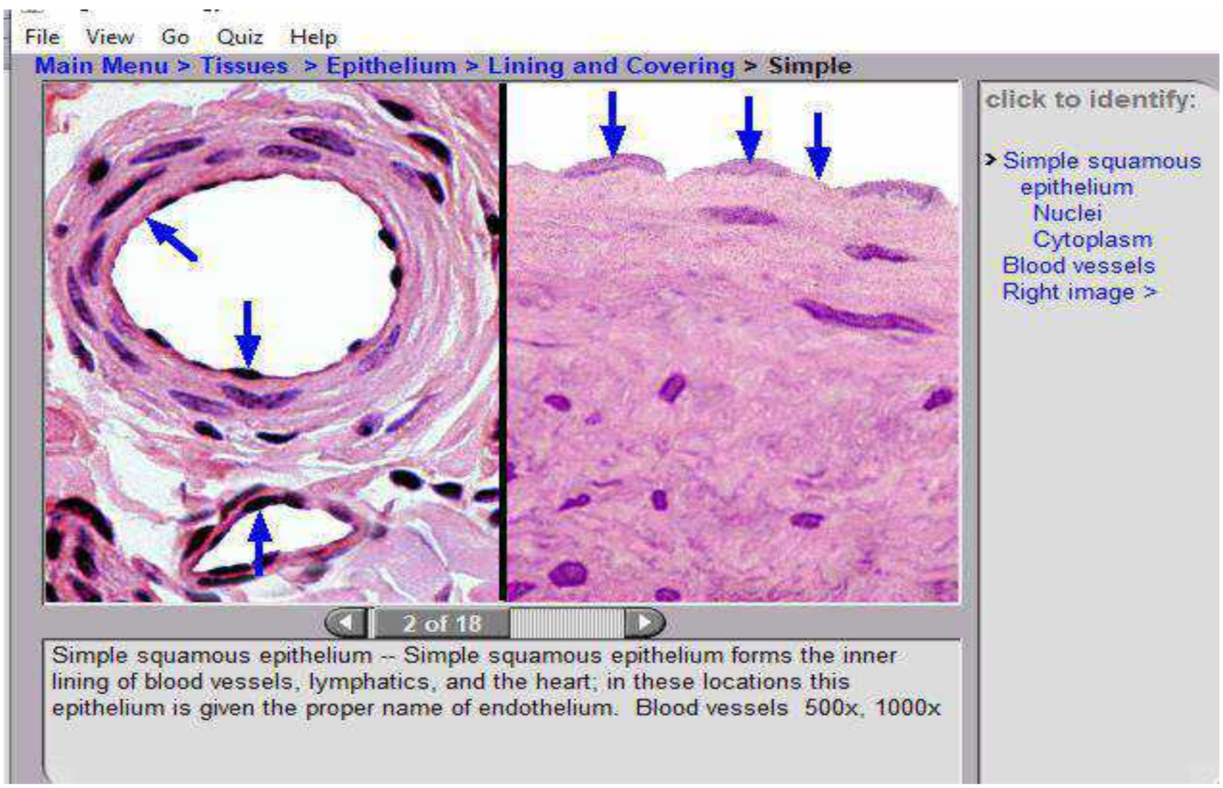
1 of 18

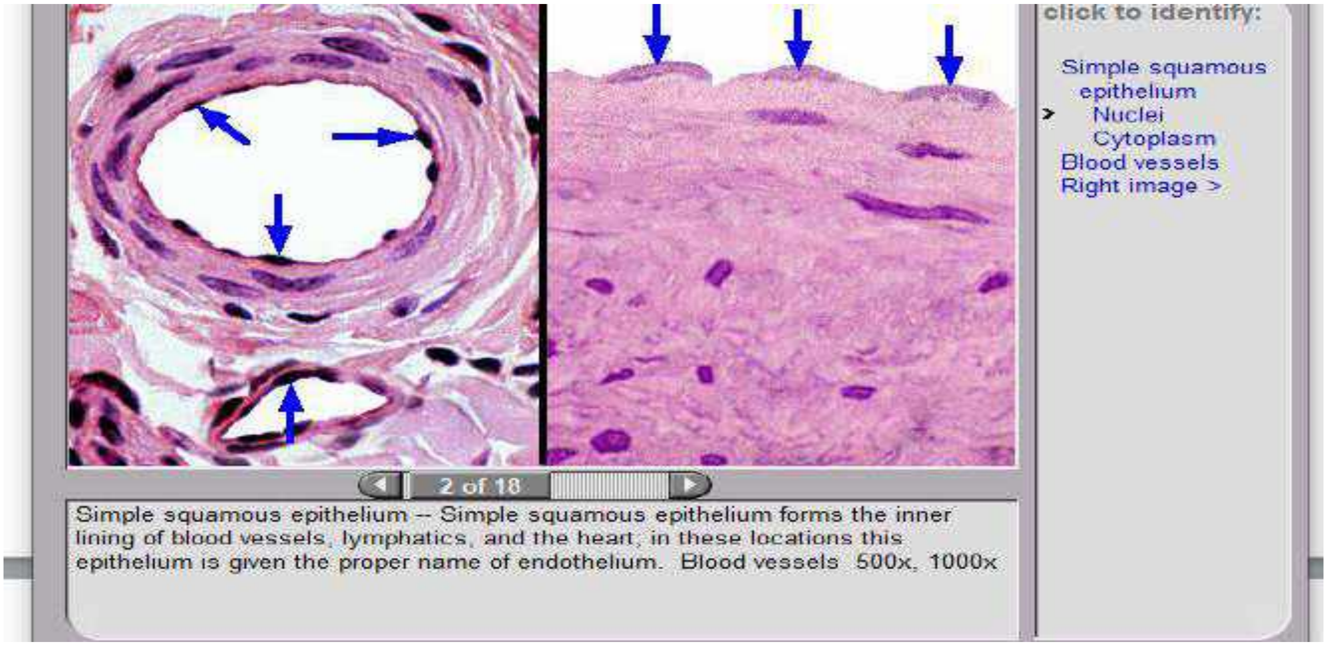
The simple squamous epithelium at the black arrows serves a lining function with no transport occurring across its surface. The simple squamous epithelia at the blue arrows line capillaries where much transport does occur.

click to identify:

- > Simple > squamous epithelium
- Capillary lumens


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
X
X
X
X
X
1 of 18
click to identify:
Simple > squamous epithelium
> Capillary lumens
The simple squamous epithelium at the black arrows serves a lining function with no transport occurring across its surface. The simple squamous epithelia at the blue arrows line capillaries where much transport does occur.


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
2 of 18
click to identify:
> Simple squamous epithelium
Nuclei
Cytoplasm
Blood vessels
Right image >
Simple squamous epithelium -- Simple squamous epithelium forms the inner lining of blood vessels, lymphatics, and the heart; in these locations this epithelium is given the proper name of endothelium. Blood vessels 500x, 1000x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Simple squamous epithelium
Nuclei
Cytoplasm
Blood vessels
Right image >
2 of 18
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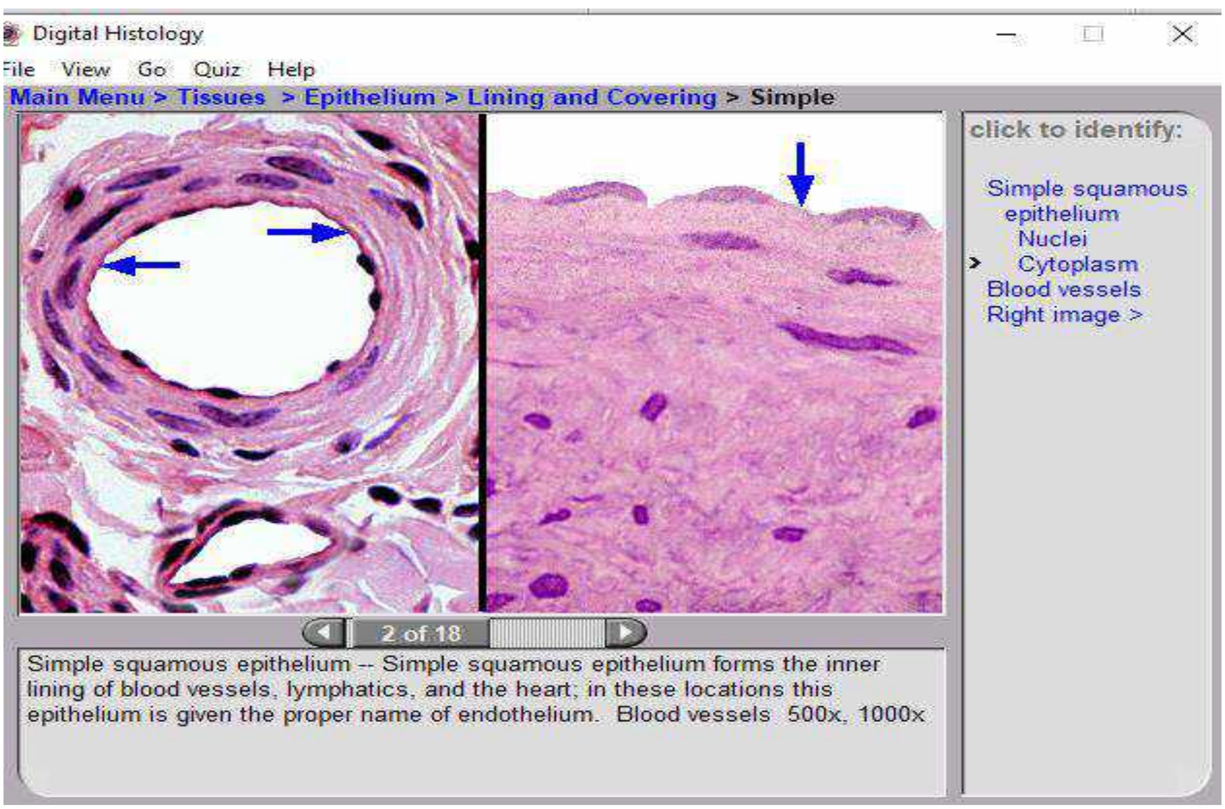
Digital Histology
File View Go Quiz Help
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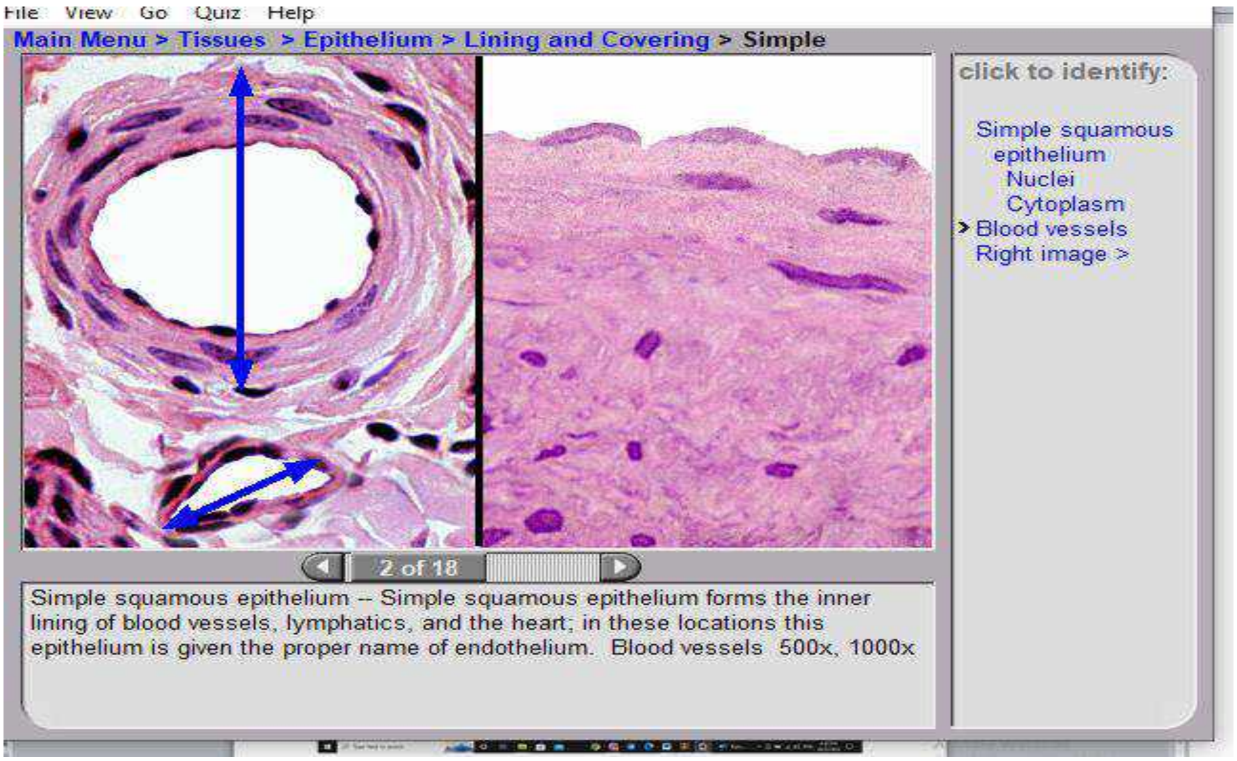
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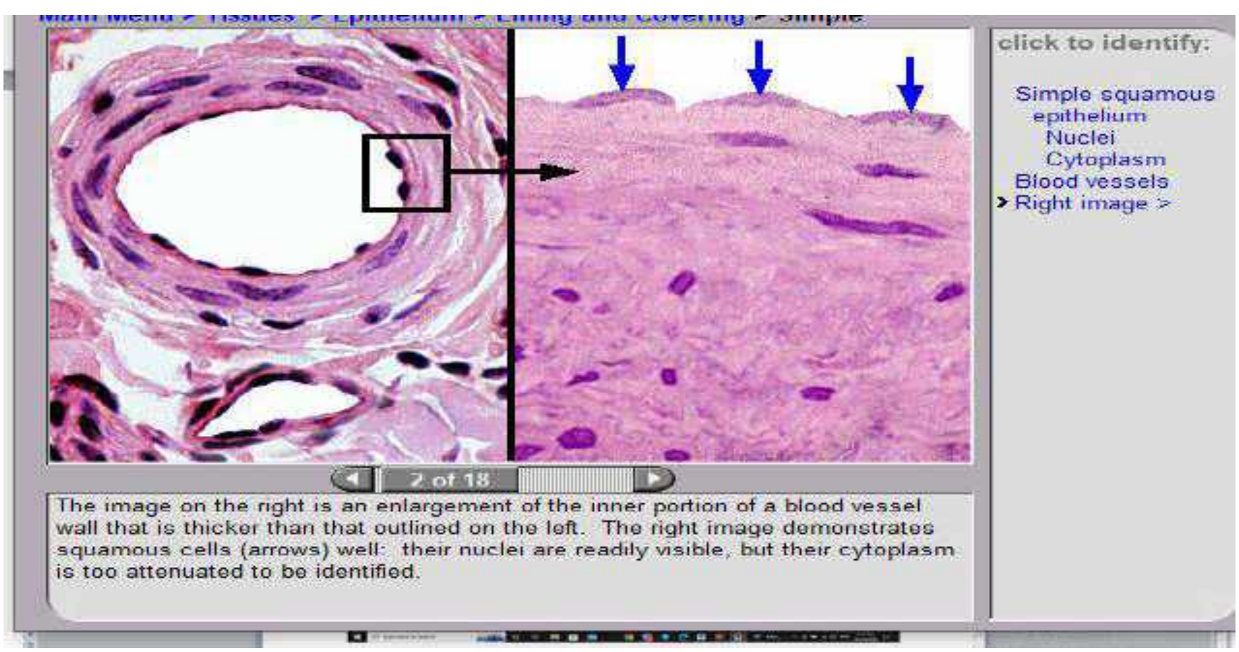
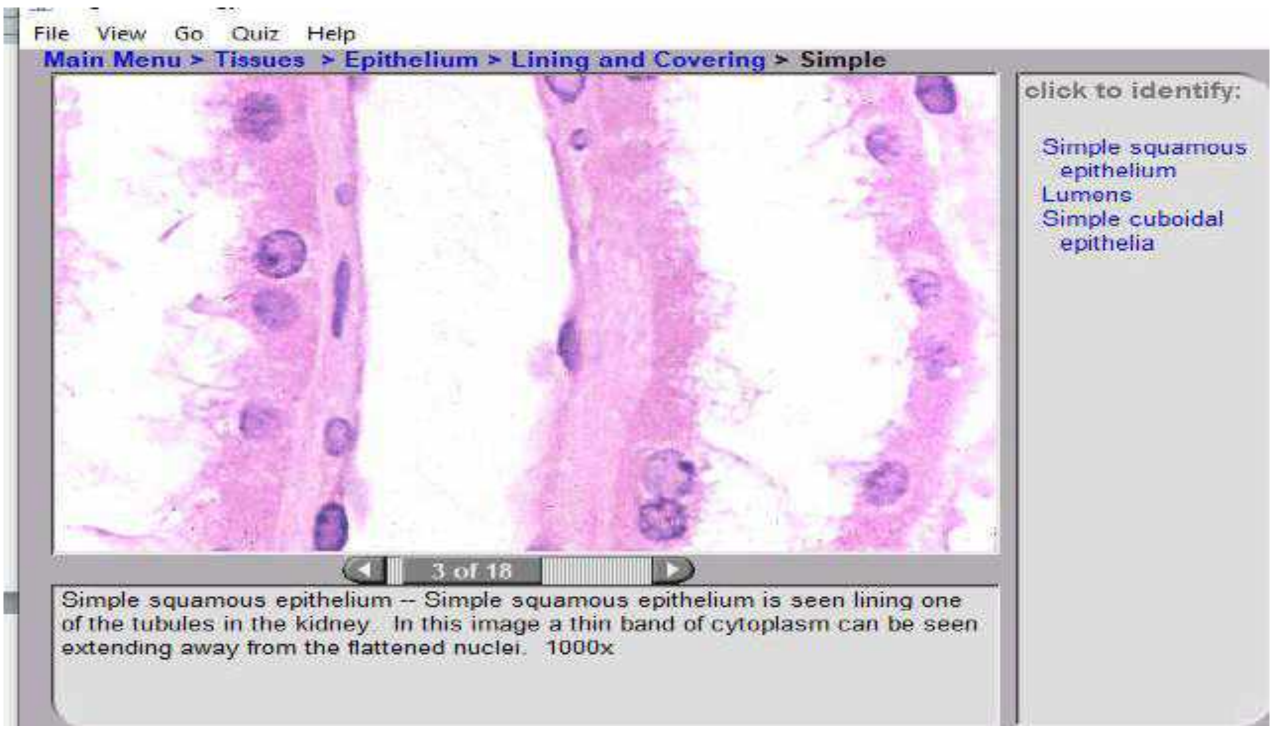
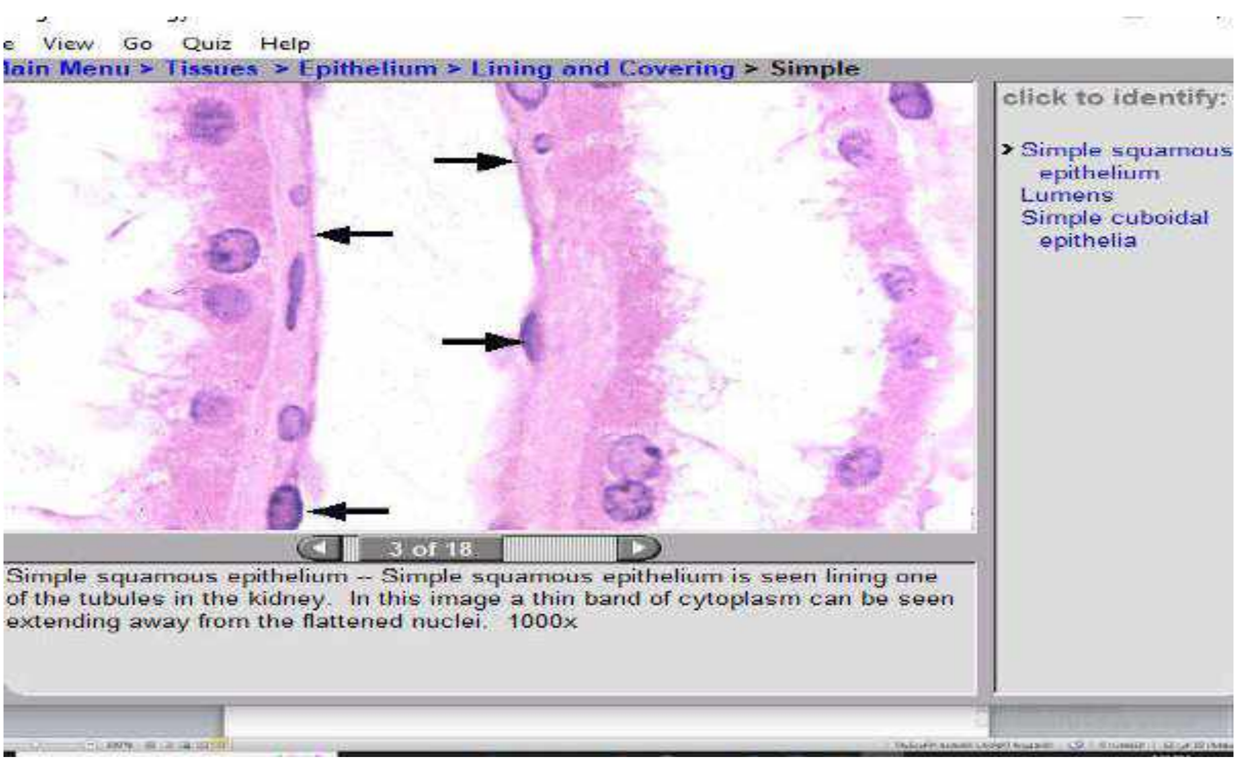

click to identify:
Simple squamous epithelium
Nuclei
Cytoplasm
Blood vessels
Right image >
2 of 18
The image on the right is an enlargement of the inner portion of a blood vessel wall that is thicker than that outlined on the left. The right image demonstrates squamous cells (arrows) well: their nuclei are readily visible, but their cytoplasm is too attenuated to be identified.


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
Simple squamous epithelium
Lumens
Simple cuboidal epithelia
3 of 18
Simple squamous epithelium -- Simple squamous epithelium is seen lining one of the tubules in the kidney. In this image a thin band of cytoplasm can be seen extending away from the flattened nuclei. 1000x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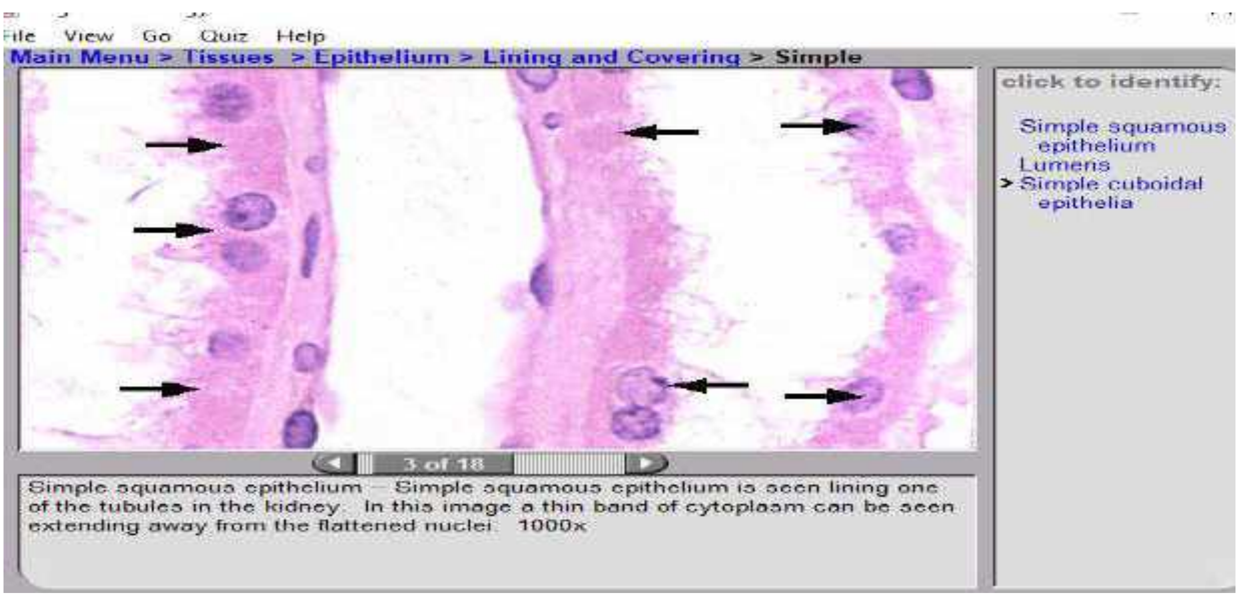
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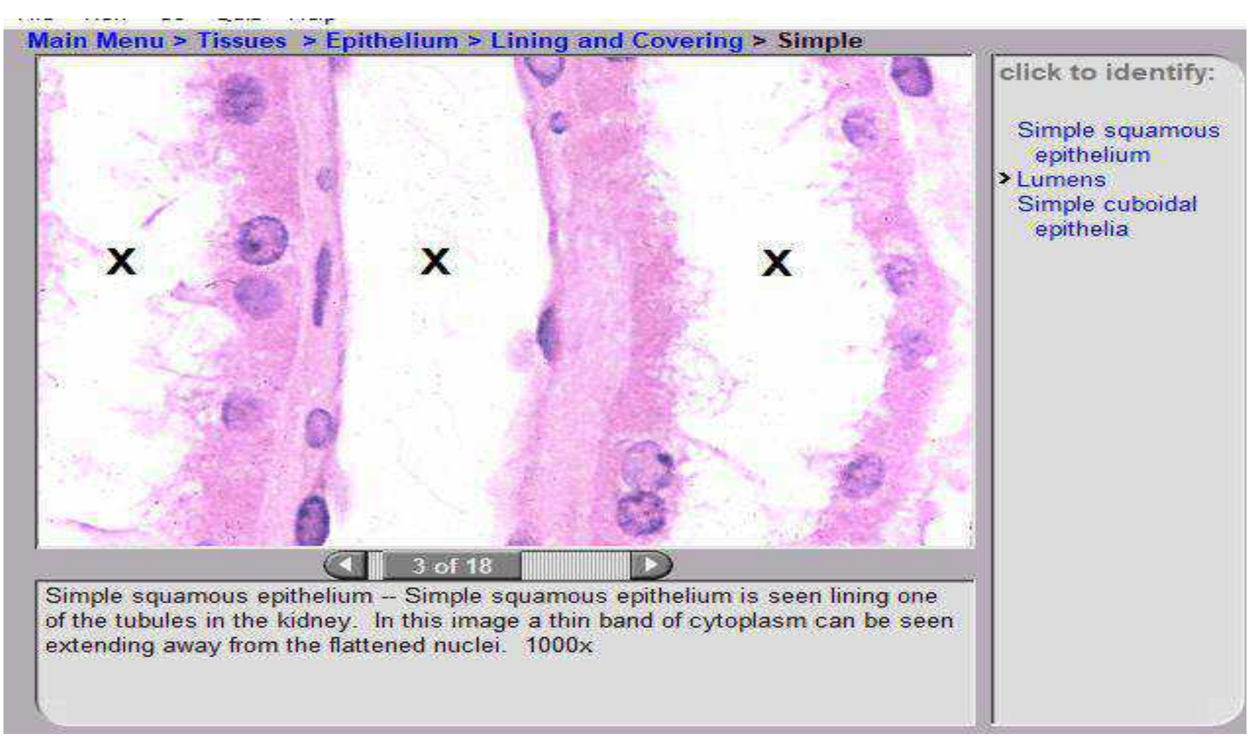
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
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> Lumens
Simple cuboidal epithelia
X
X
X
3 of 18
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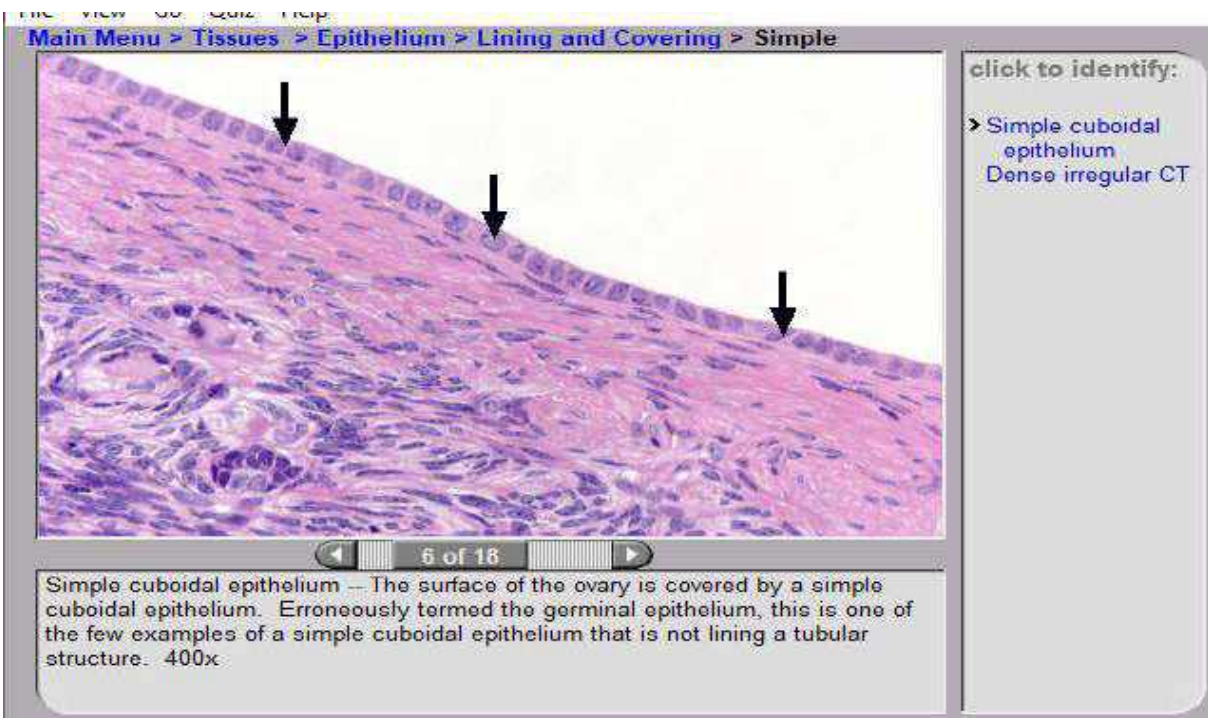
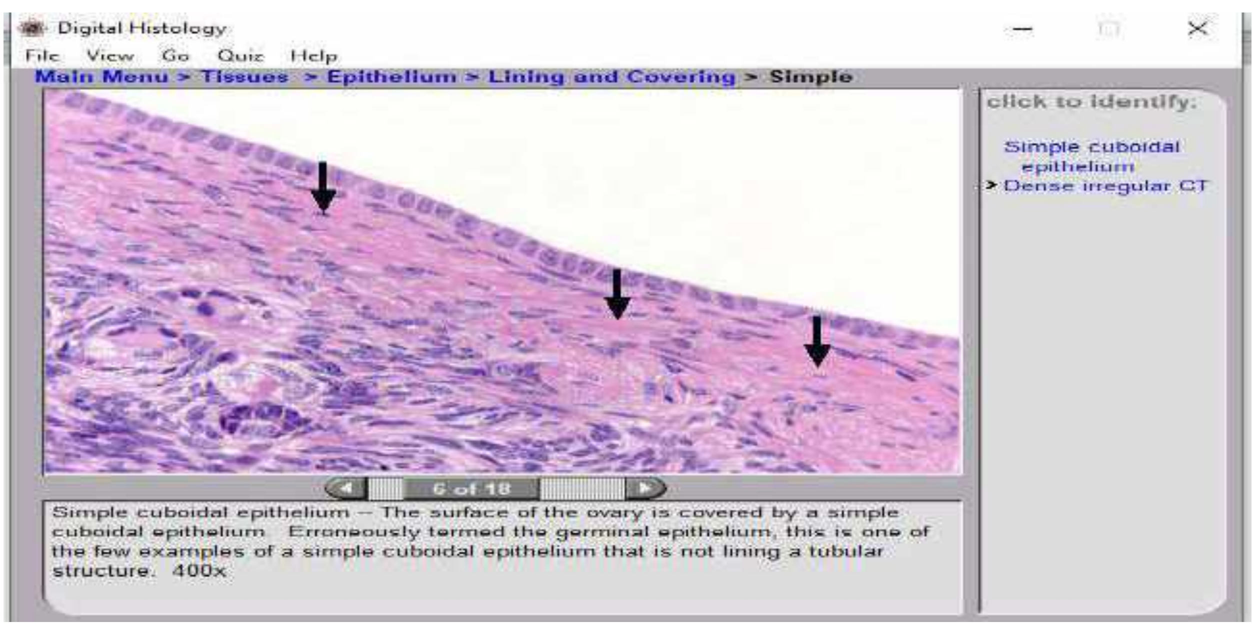

Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
Simple cuboidal epithelium
Dense irregular CT
6 of 18
Simple cuboidal epithelium -- The surface of the ovary is covered by a simple cuboidal epithelium. Erroneously termed the germinal epithelium, this is one of the few examples of a simple cuboidal epithelium that is not lining a tubular structure. 400x


Digital Histology
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Main Menu > Tissues > Epithelium > Lining and Covering > Simple
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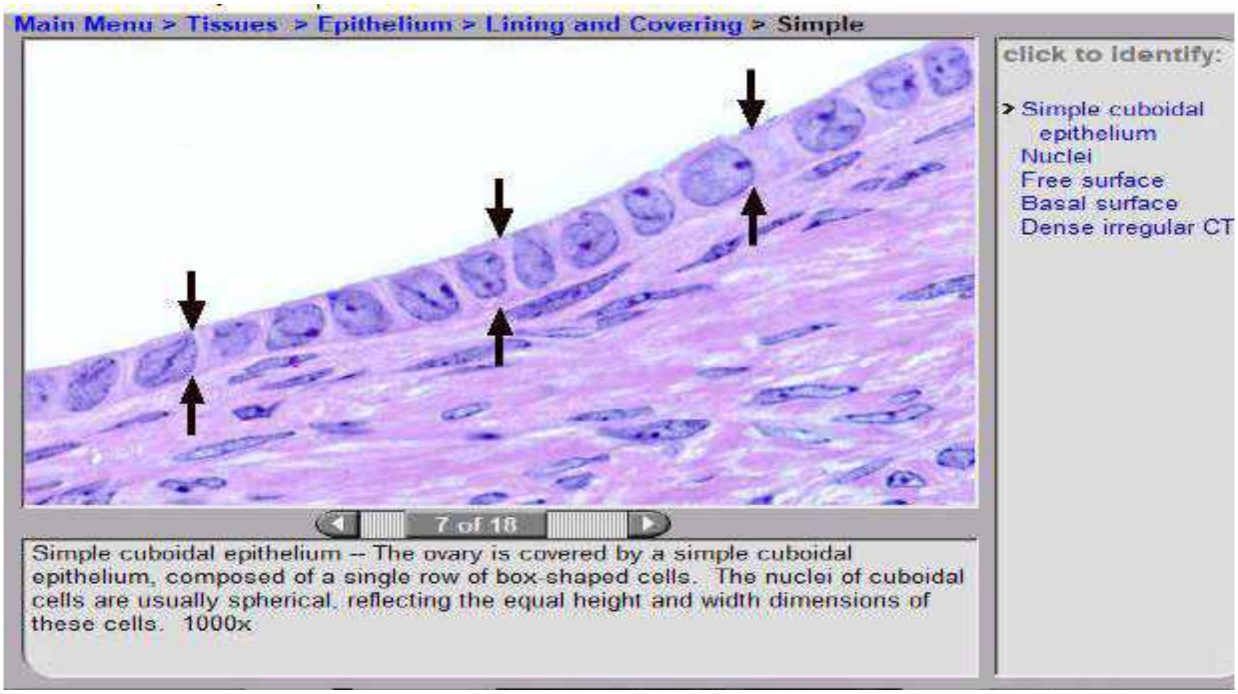
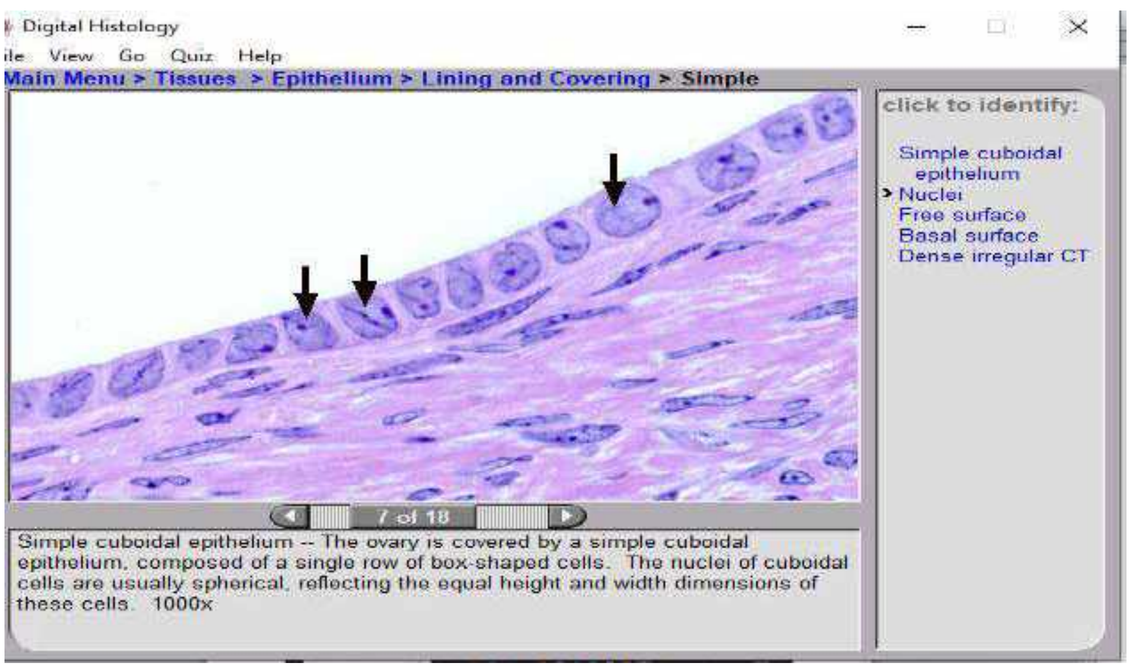

Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
Simple cuboidal epithelium
Nuclei
Free surface
Basal surface
Dense irregular CT
7 of 18
Simple cuboidal epithelium -- The ovary is covered by a simple cuboidal epithelium, composed of a single row of box-shaped cells. The nuclei of cuboidal cells are usually spherical, reflecting the equal height and width dimensions of these cells. 1000x


Digital Histology
ile View Go Quiz Help
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Simple cuboidal epithelium
Nuclei
Free surface
Basal surface
Dense irregular CT
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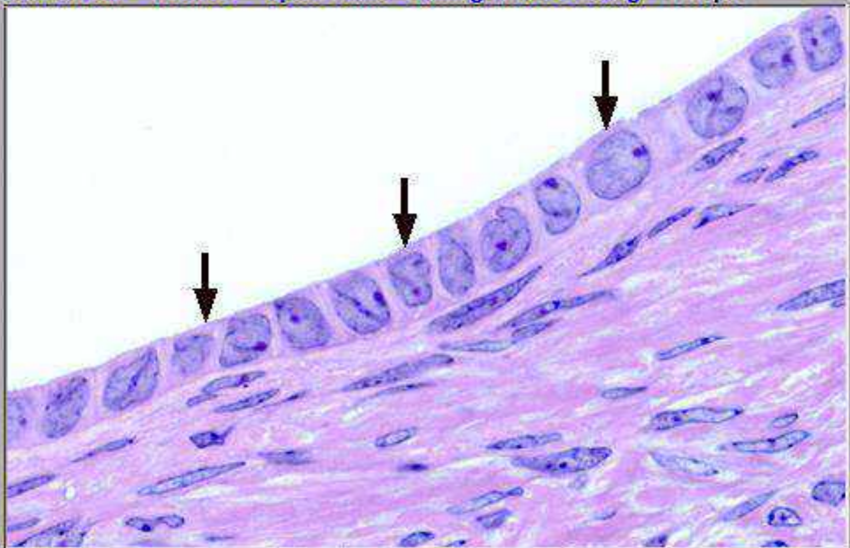
File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Simple



click to identify:

- Simple cuboidal epithelium
- Nuclei
- Free surface
- Basal surface
- Dense irregular CT

7 of 18

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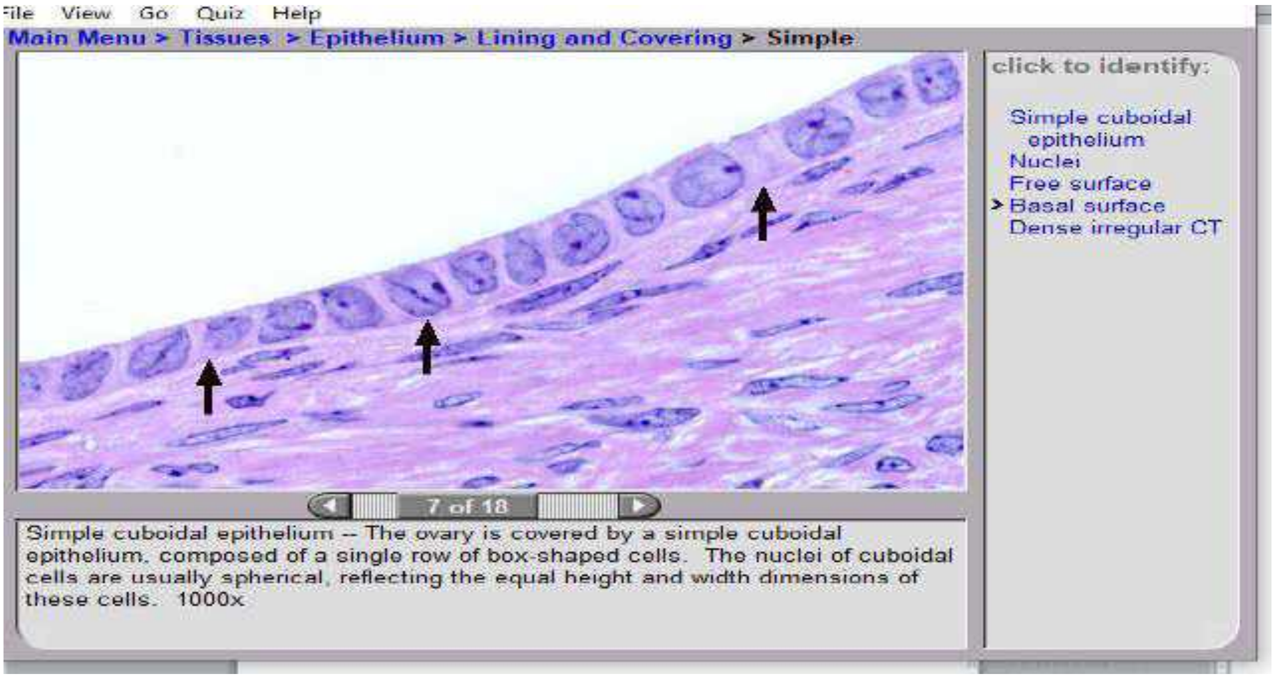
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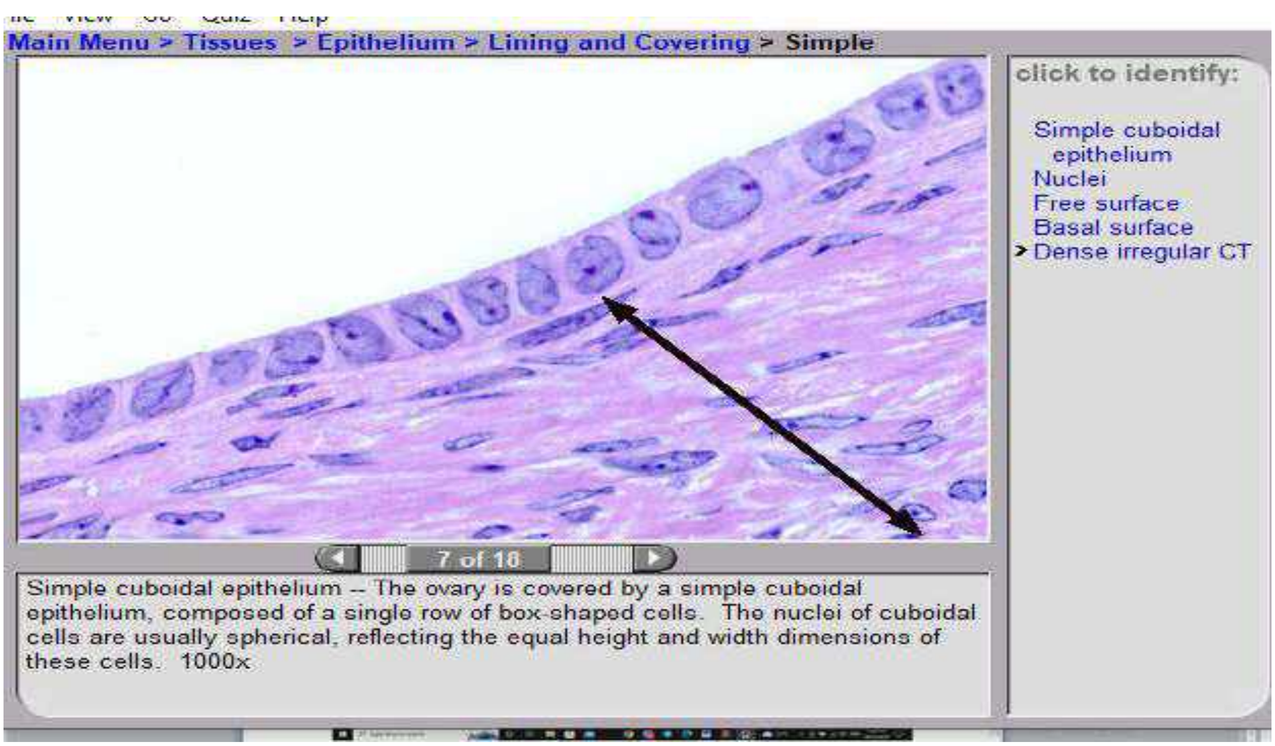
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Simple cuboidal epithelium
Nuclei
Free surface
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File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > **Simple**

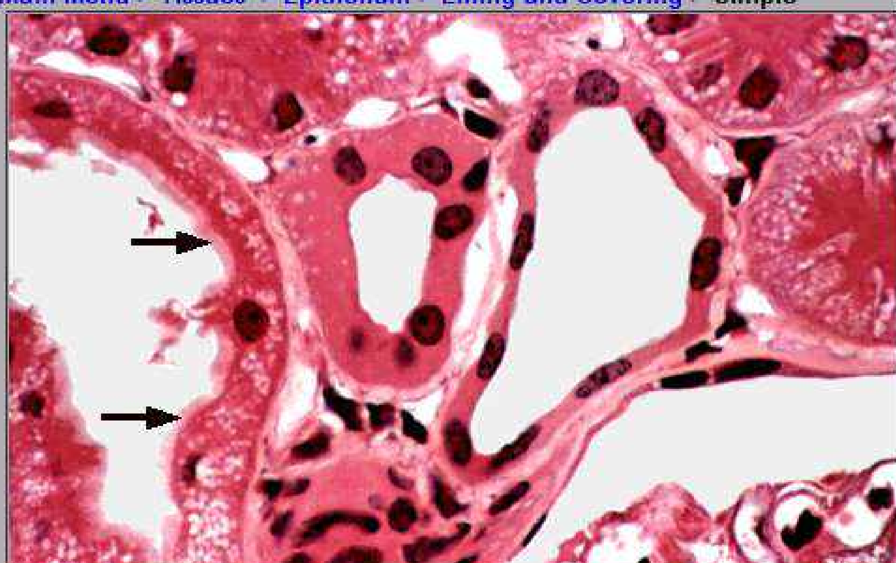
click to identify:

> Simple cuboidal epithelium
  Brush border
  Simple squamous epithelium

8 of 18

Simple cuboidal epithelia -- Many of the tubules in this image are lined by simple cuboidal epithelia. The cells in each single layer can vary from nearly cube-shaped to rectangular. Due to the plane of section, some cells appear to have no nuclei. Some cells also have a brush border (microvilli) on their free surfaces. Kidney 400x

Main Menu > Tissues > Epithelium > Lining and Covering > **Simple**



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> Brush border
  Simple squamous epithelium

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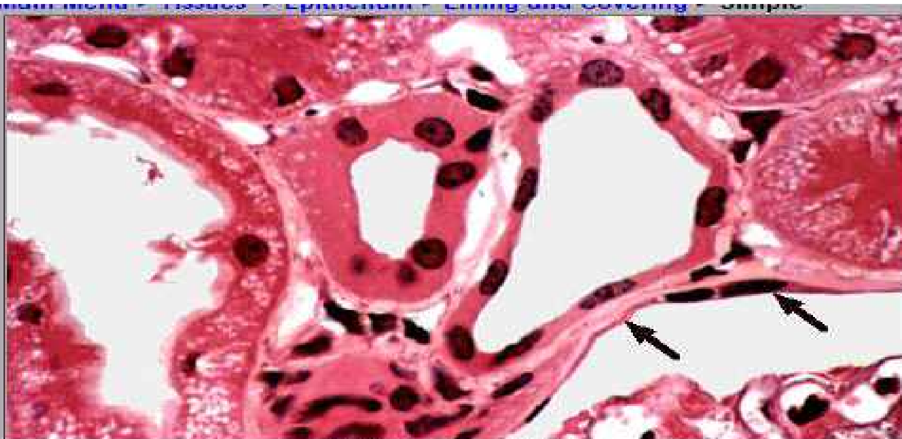

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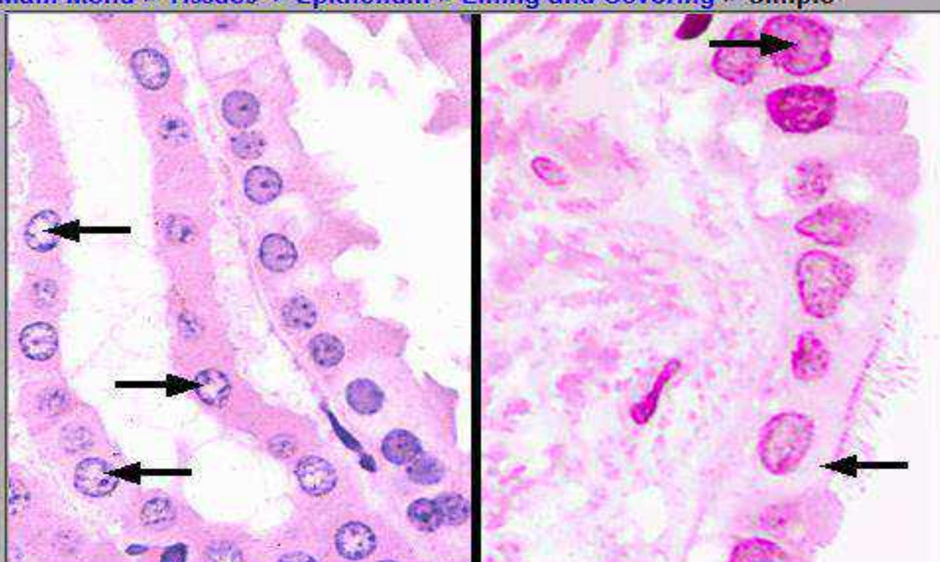
click to identify:

- Simple cuboidal epithelium
- Brush border
- > Simple squamous epithelium

عنوان 2 عنوان 1 ¶ بلا تباعد ¶ عادي

Digital Histology

File View Go Quiz Help



9 of 18

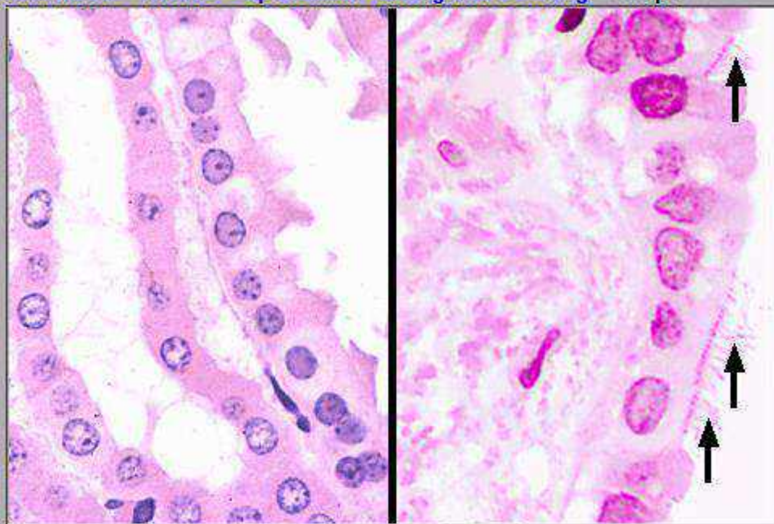
Simple cuboidal epithelium -- More examples of simple cuboidal epithelia demonstrate the shape of this single layer of cells. In the image on the right, some of the cuboidal cells are ciliated, displaying obvious basal bodies associated with these structures; secretory cells are also dispersed among these cells. Kidney 1000x; Bronchiole 1000x

click to identify:

- > Simple cuboidal epithelium
- Cilia
- Basal bodies
- Secretory cells
- Simple columnar epithelium

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > **Simple**



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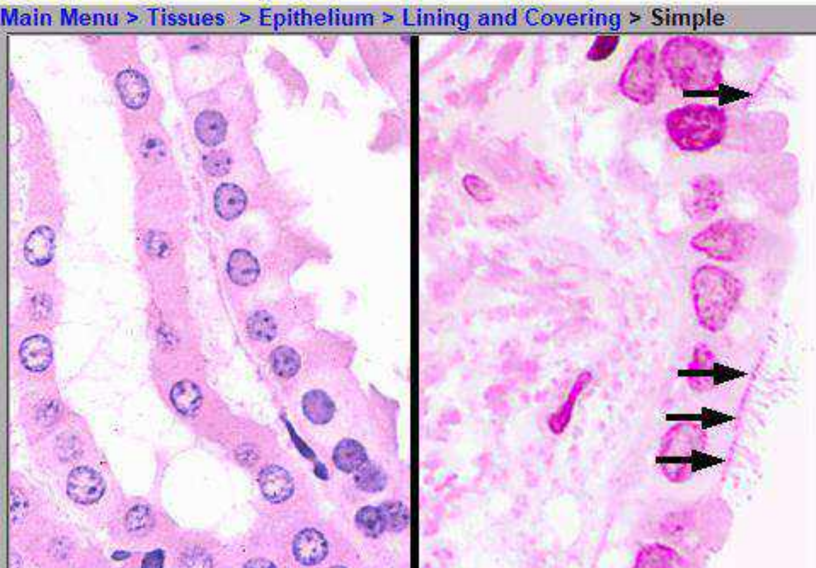
File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > **Simple**



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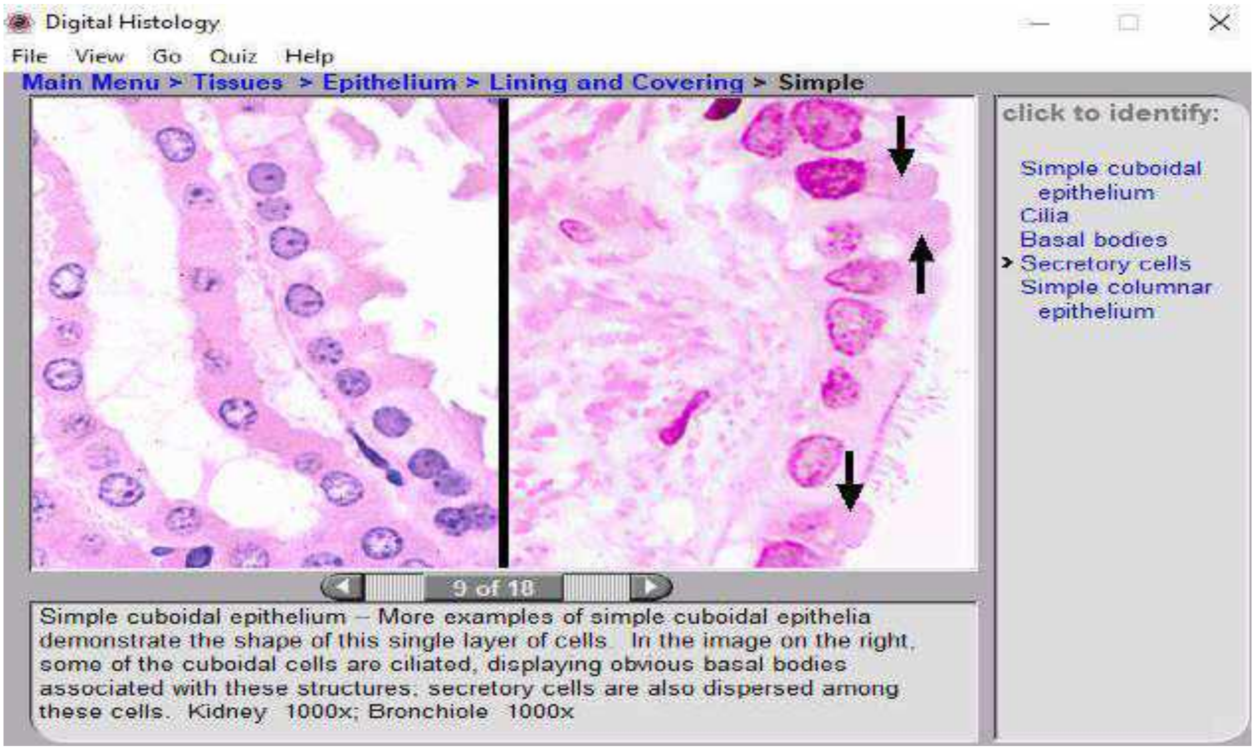
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Cilia
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> Secretory cells
Simple columnar epithelium
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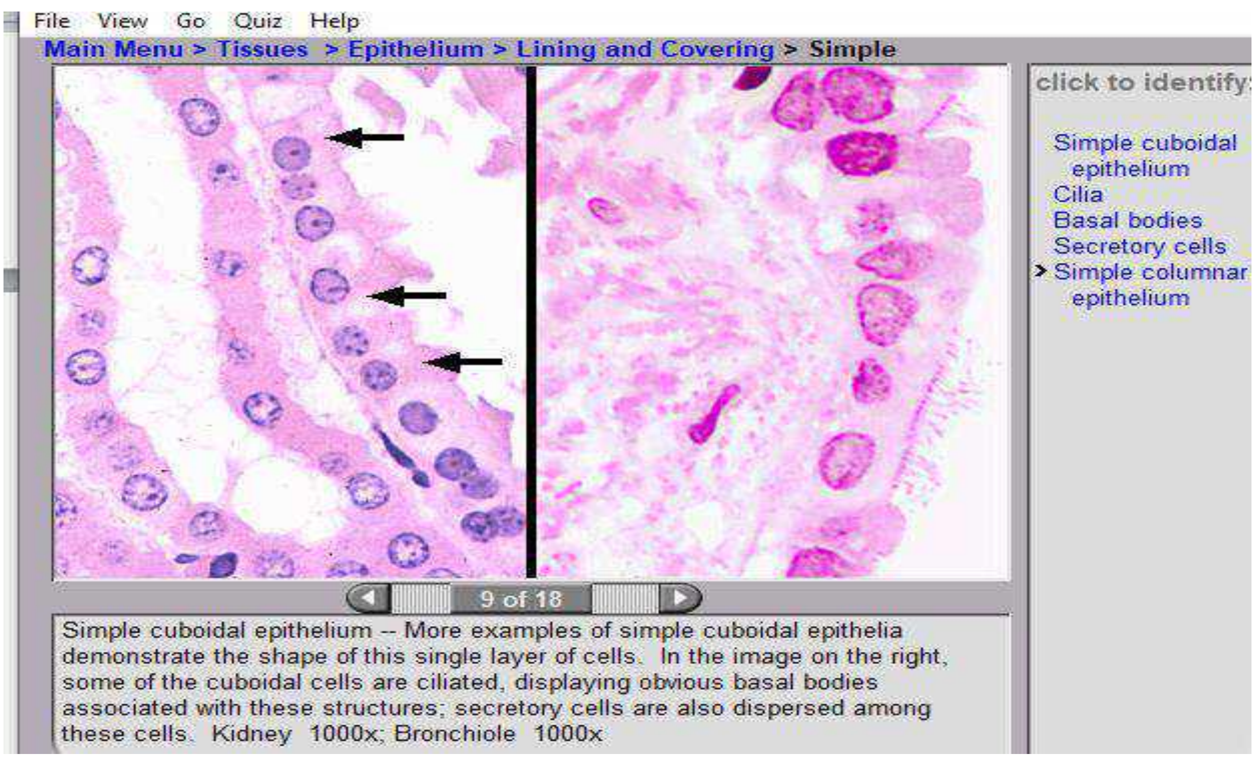
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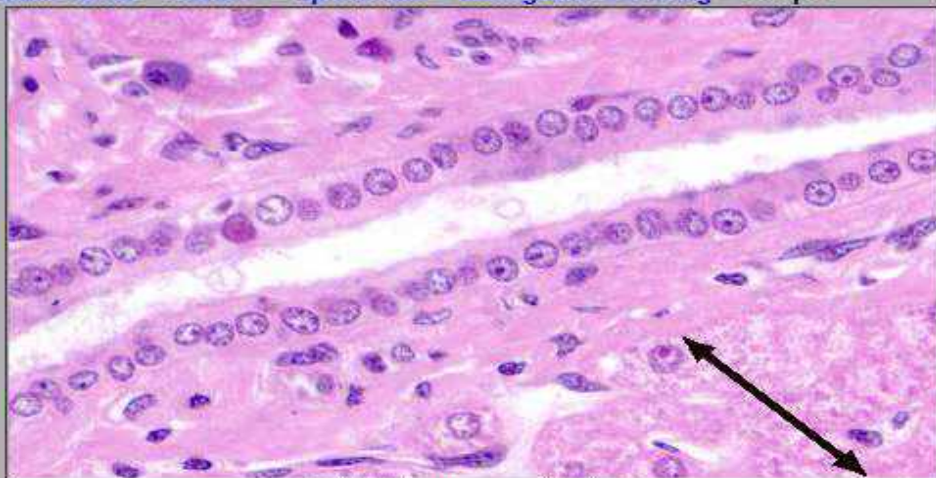


10 of 18

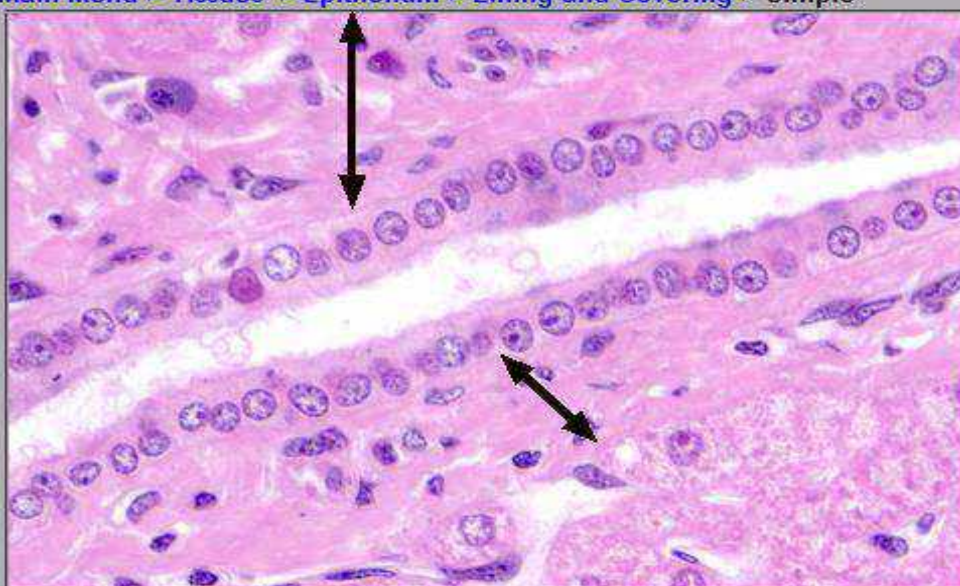
click to identify:

Simple cuboidal epithelium
Dense irregular CT
> Liver tissue
Lumen

Simple cuboidal epithelium -- Simple cuboidal epithelia often form the walls of ducts, as seen in this longitudinal section of the bile duct. While the cells in this image are tall cuboidal to low columnar, they are best classified as cuboidal. Liver 1000x

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Simple



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Liver tissue
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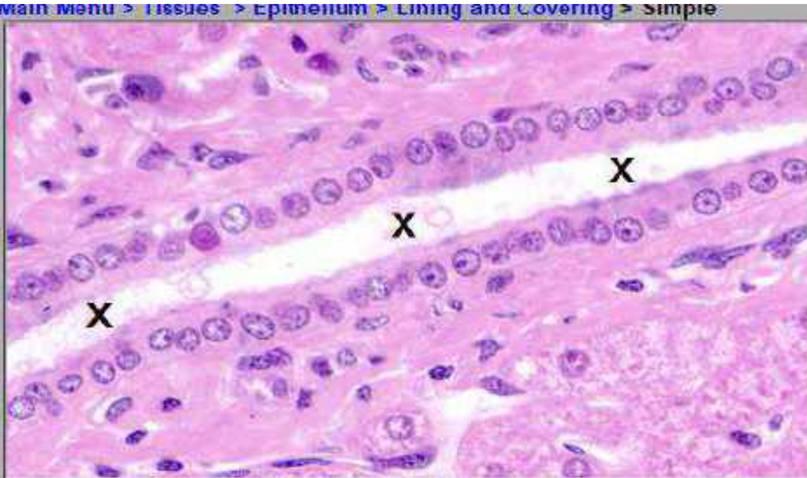
Main Menu > Tissues > Epithelium > Lining and Covering > Simple



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Simple cuboidal epithelium
Dense irregular
Liver tissue
> Lumen

10 of 18

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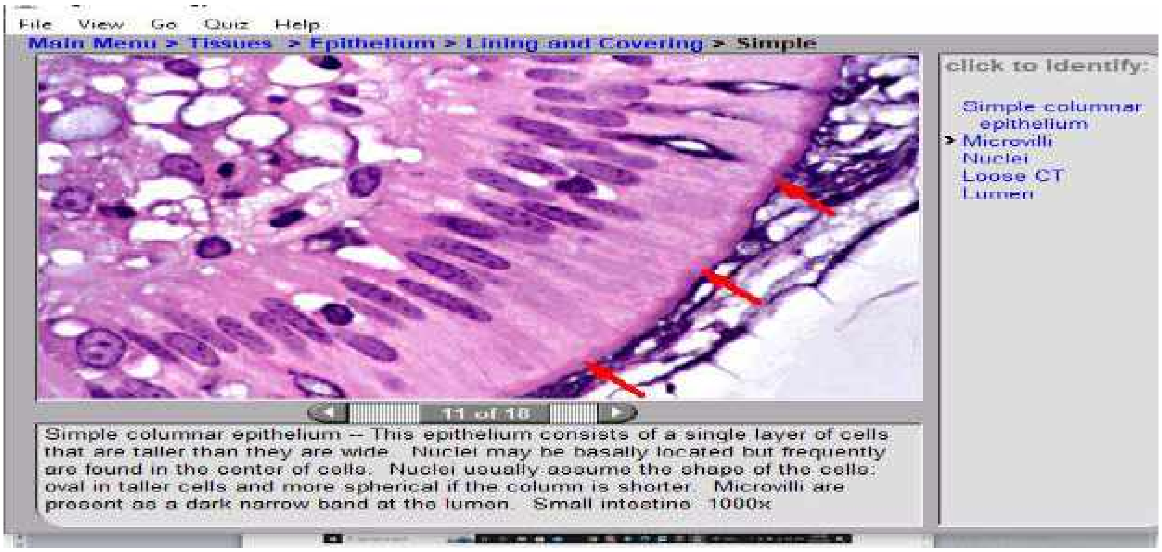
Main Menu > Tissues > Epithelium > Lining and Covering > Simple

click to identify:

> Simple columnar epithelium
Microvilli
Nuclei
Loose CT
Lumen

11 of 18

Simple columnar epithelium -- This epithelium consists of a single layer of cells that are taller than they are wide. Nuclei may be basally located but frequently are found in the center of cells. Nuclei usually assume the shape of the cells: oval in taller cells and more spherical if the column is shorter. Microvilli are present as a dark narrow band at the lumen. Small intestine 1000x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Main Menu > Tissues > Epithelium > Lining and Covering > Simple
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Simple columnar epithelium
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Nuclei
Loose CT
Lumen
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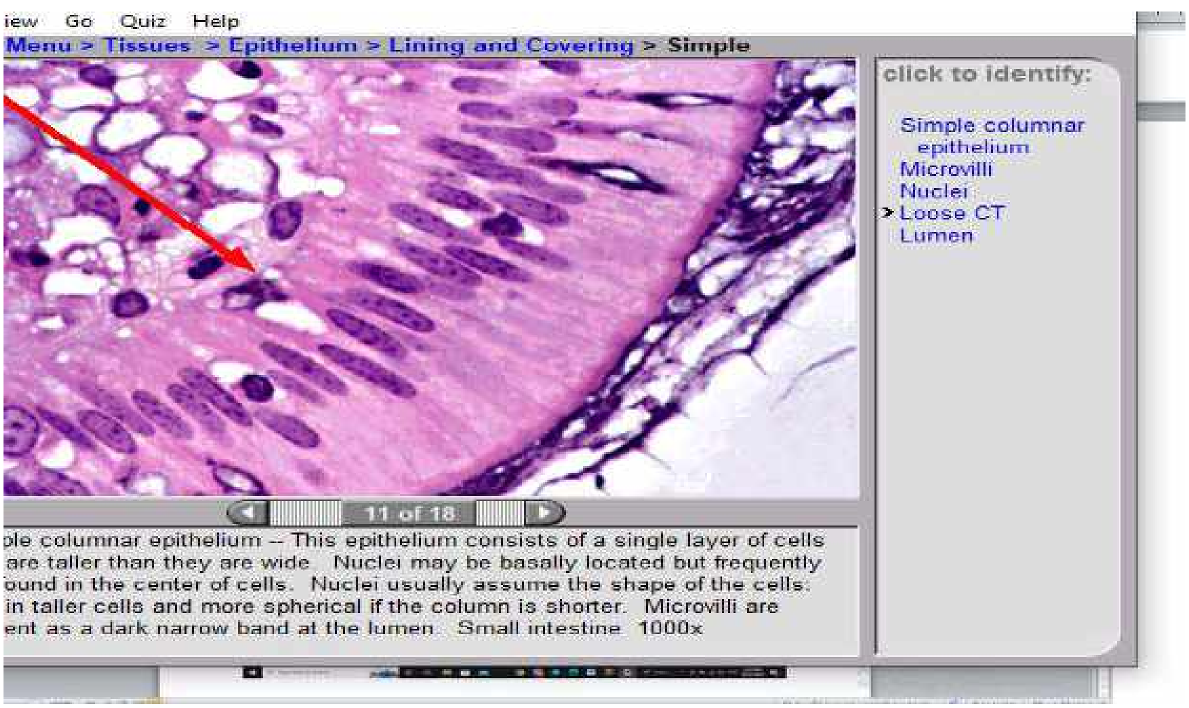
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Microvilli
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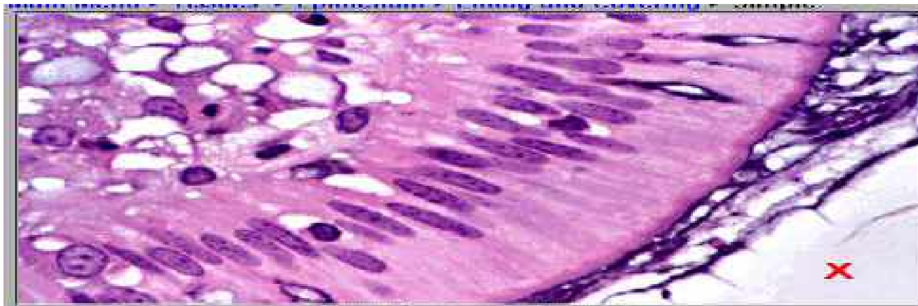

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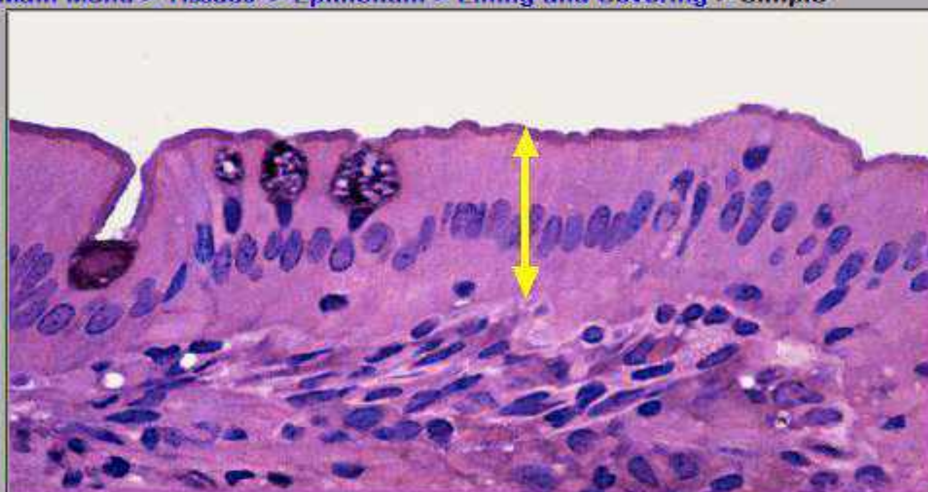
click to identi

- Simple column epithelium
- Microvilli
- Nuclei
- Loose CT
- Lumen

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Simple

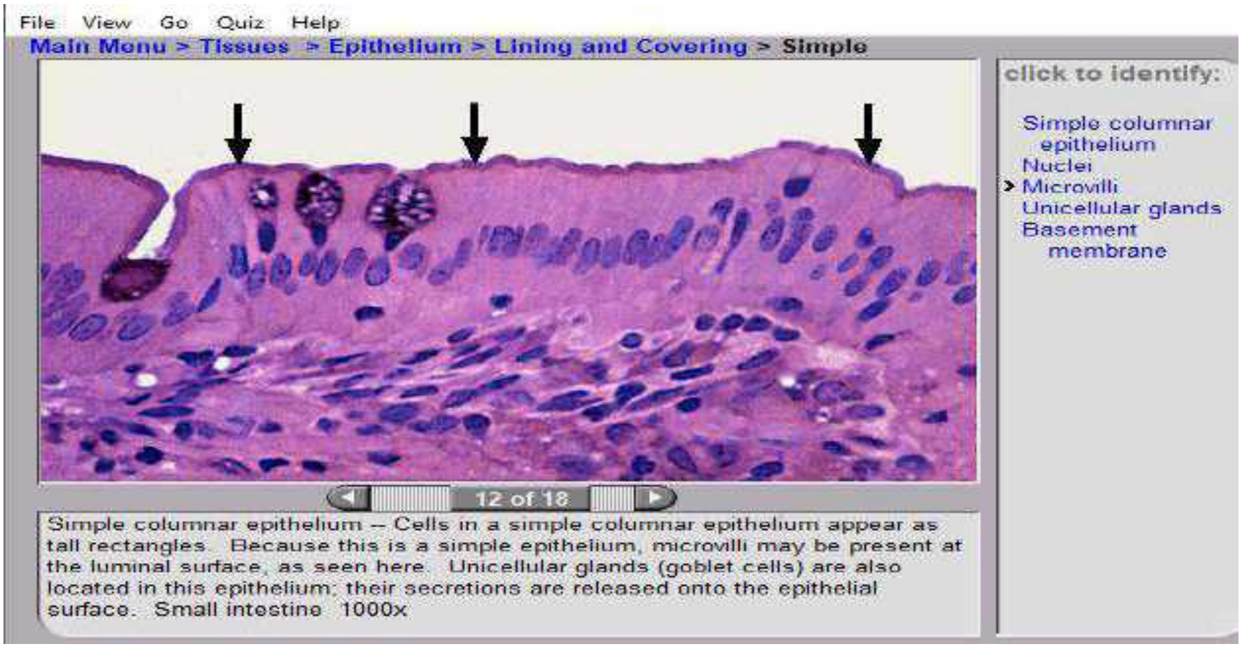


12 of 18

Simple columnar epithelium -- Cells in a simple columnar epithelium appear as tall rectangles. Because this is a simple epithelium, microvilli may be present at the luminal surface, as seen here. Unicellular glands (goblet cells) are also located in this epithelium; their secretions are released onto the epithelial surface. Small intestine 1000x

click to identify:

- Simple columnar epithelium
- Nuclei
- Microvilli
- Unicellular glands
- Basement membrane


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
Simple columnar epithelium
Nuclei
> Microvilli
Unicellular glands
Basement membrane
12 of 18
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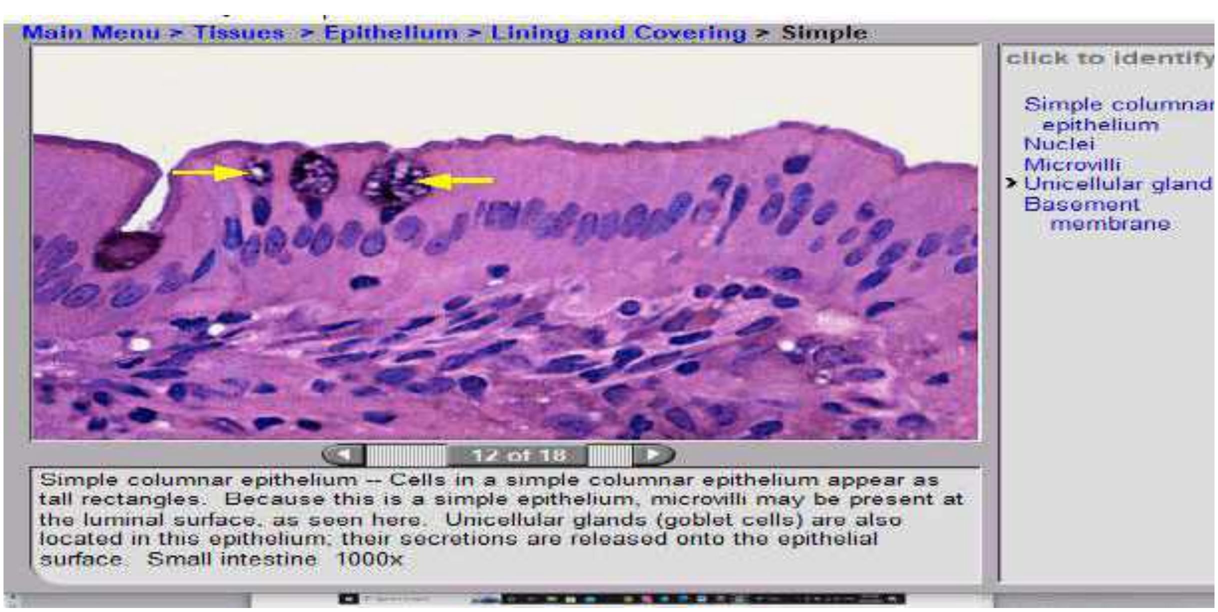
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click to identify
Simple columnar epithelium
Nuclei
Microvilli
> Unicellular gland
Basement membrane
12 of 18
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Main Menu > Tissues > Epithelium > Lining and Covering > Simple

12 of 18

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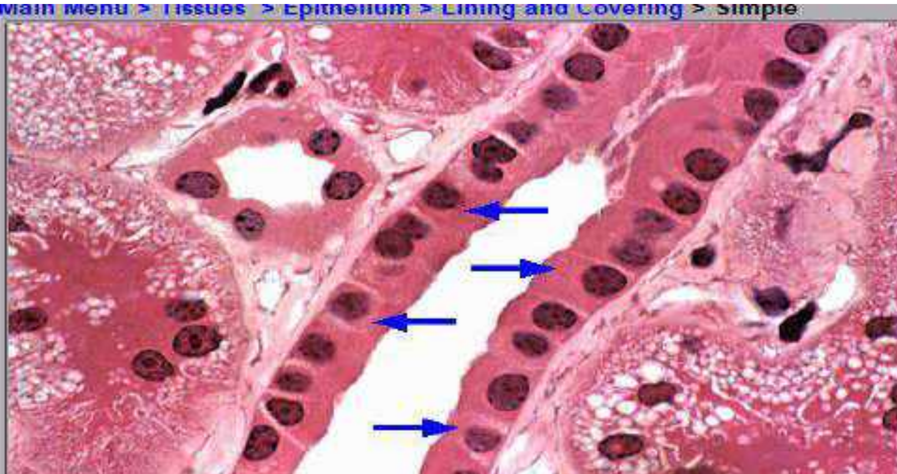
Main Menu > Tissues > Epithelium > Lining and Covering > Simple

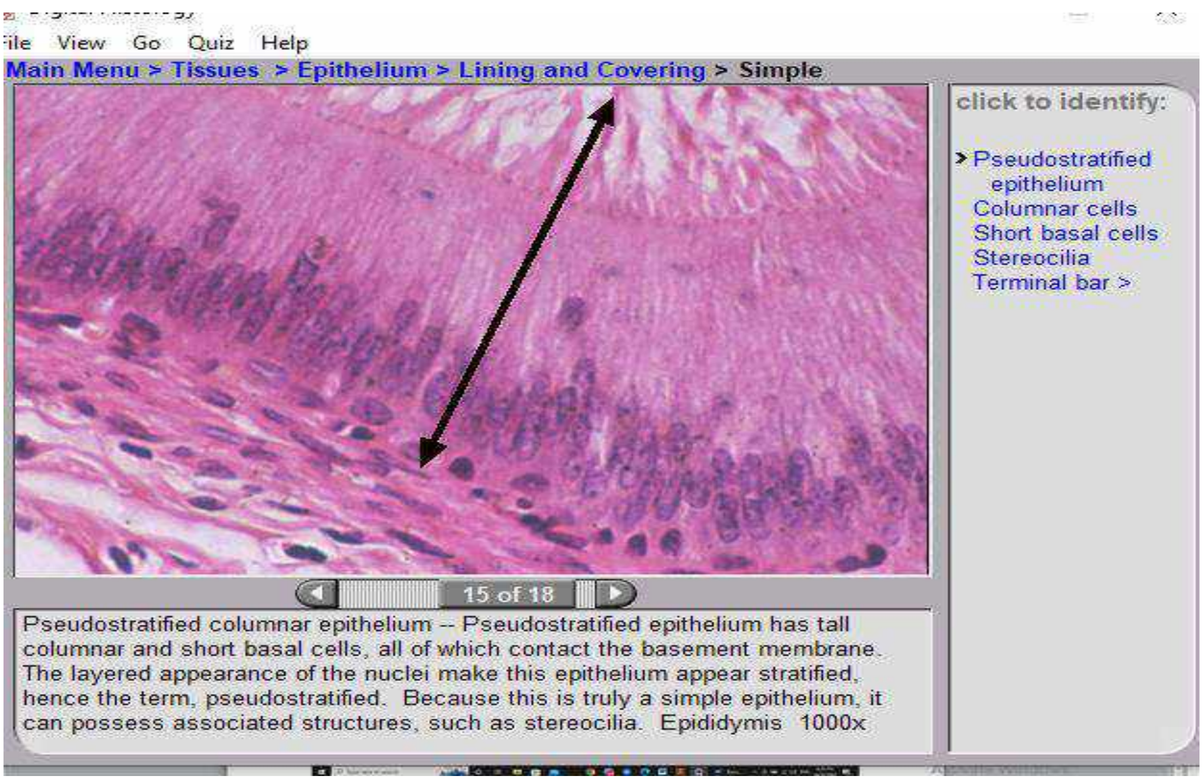


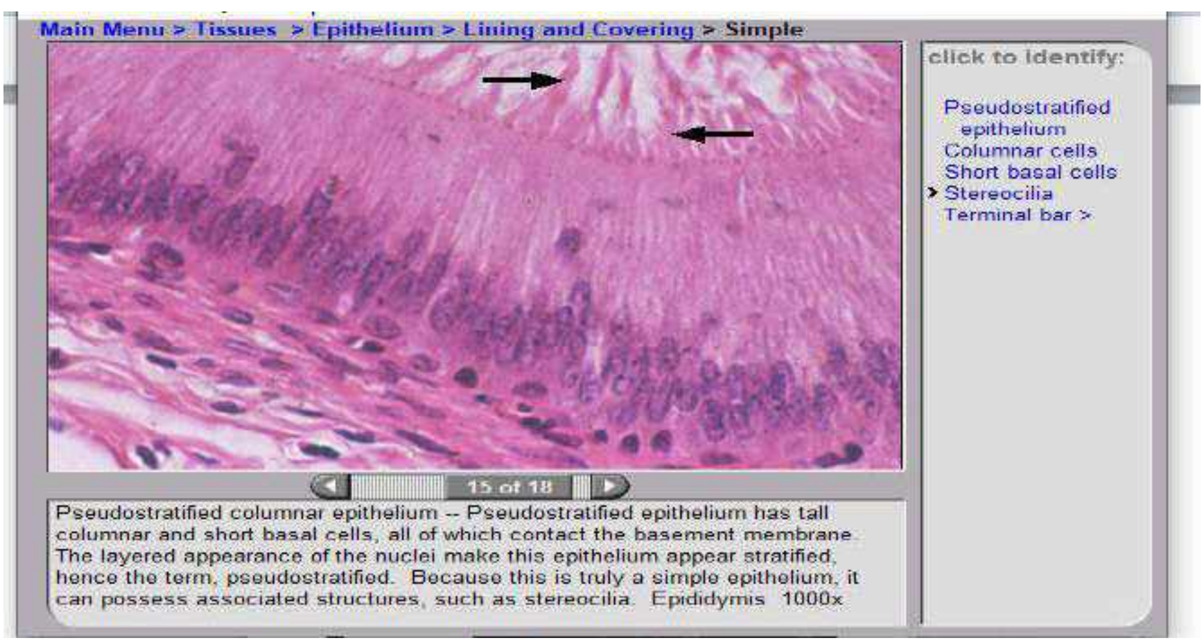
13 of 18

Simple columnar epithelium -- Although this simple columnar epithelium is shorter than those previously seen, its cells are still taller than they are wide. The nuclei of these shorter cells are more spherical and located at the basal surface of the cells. Kidney 1000x

click to identify:

- > Simple columnar epithelium
- Simple cuboidal epithelium


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
Pseudostratified epithelium
Columnar cells
Short basal cells
Stereocilia
Terminal bar >
15 of 18
Pseudostratified columnar epithelium -- Pseudostratified epithelium has tall columnar and short basal cells, all of which contact the basement membrane. The layered appearance of the nuclei make this epithelium appear stratified, hence the term, pseudostratified. Because this is truly a simple epithelium, it can possess associated structures, such as stereocilia. Epididymis 1000x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Terminal bar >
15 of 18
Pseudostratified columnar epithelium -- Pseudostratified epithelium has tall columnar and short basal cells, all of which contact the basement membrane. The layered appearance of the nuclei make this epithelium appear stratified, hence the term, pseudostratified. Because this is truly a simple epithelium, it can possess associated structures, such as stereocilia. Epididymis 1000x

Main Menu > Tissues > Epithelium > Lining and Covering > Simple

click to identify:

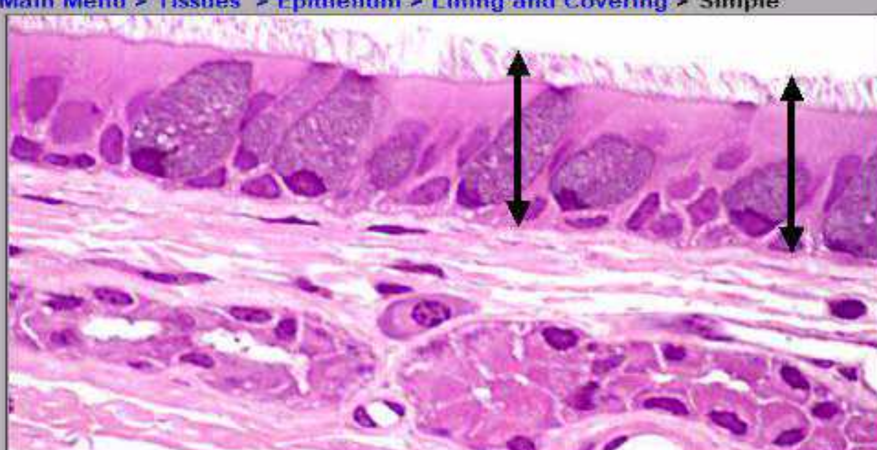
Pseudostratified epithelium
Columnar cells
Short basal cells
Stereocilia
> Terminal bar >

15 of 18

The terminal bar is the light microscopic term for the zonula occludens, zonula adherens and desmosome forming the junctional complex. The terminal bar appears as a small, red dot at the luminal surface of adjacent epithelial cells.

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Simple

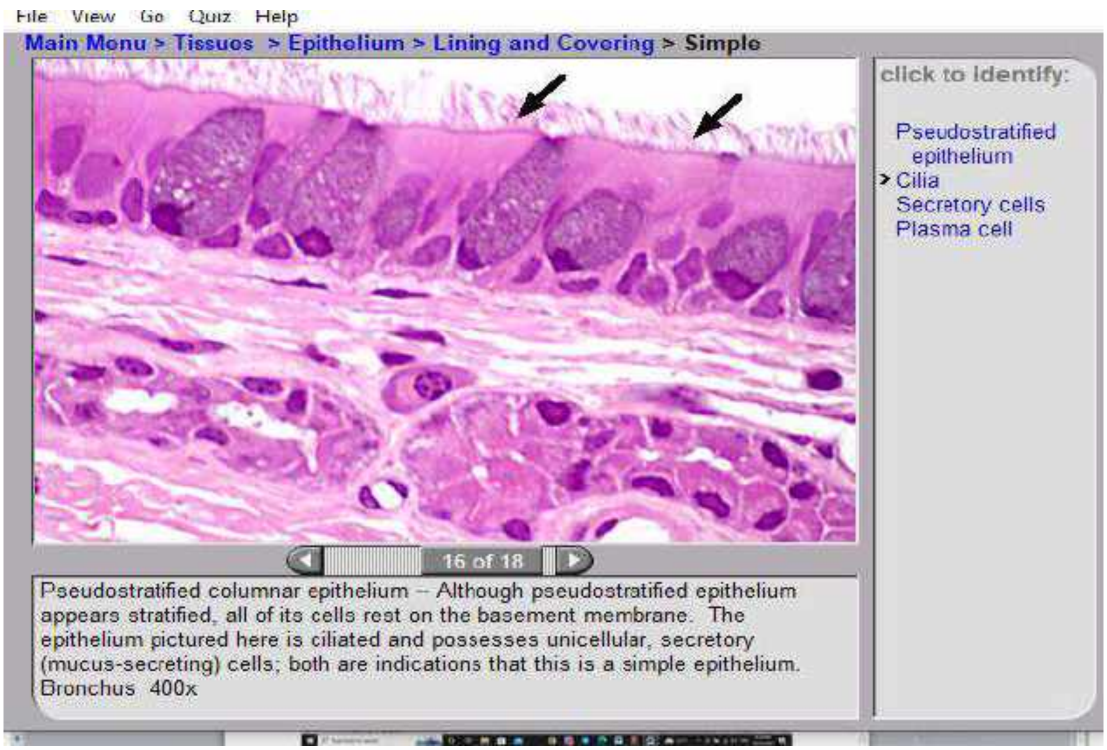


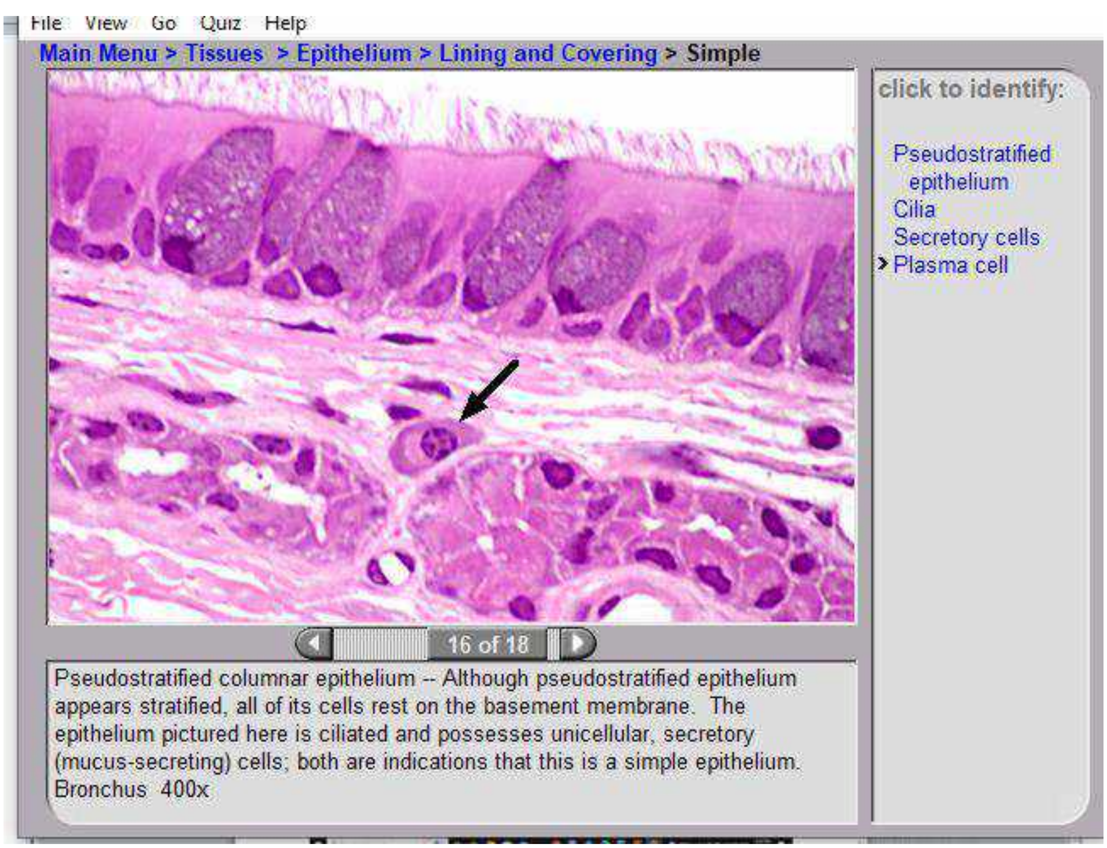
click to identify:

> Pseudostratified epithelium
Cilia
Secretory cells
Plasma cell

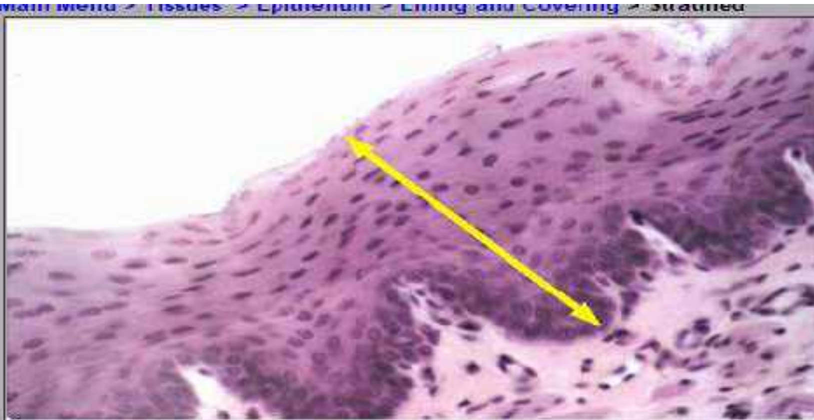
16 of 18

Pseudostratified columnar epithelium -- Although pseudostratified epithelium appears stratified, all of its cells rest on the basement membrane. The epithelium pictured here is ciliated and possesses unicellular, secretory (mucus-secreting) cells; both are indications that this is a simple epithelium. Bronchus 400x


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
Pseudostratified epithelium
Cilia
Secretory cells
Plasma cell
16 of 18
Pseudostratified columnar epithelium -- Although pseudostratified epithelium appears stratified, all of its cells rest on the basement membrane. The epithelium pictured here is ciliated and possesses unicellular, secretory (mucus-secreting) cells; both are indications that this is a simple epithelium.
Bronchus 400x


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Simple
click to identify:
Pseudostratified epithelium
Cilia
Secretory cells
Plasma cell
16 of 18
Pseudostratified columnar epithelium -- Although pseudostratified epithelium appears stratified, all of its cells rest on the basement membrane. The epithelium pictured here is ciliated and possesses unicellular, secretory (mucus-secreting) cells; both are indications that this is a simple epithelium.
Bronchus 400x

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified



click to identify:

> Stratified squamous nonkeratinized epithelium
Basal layer
Squamous cells
Basement membrane

1 of 12

Stratified squamous, nonkeratinized epithelium -- Stratified epithelia have multiple layers and are further classified by the shape of luminal cells. In stratified squamous epithelia, cells flatten as they are pushed from basal to surface layers. When living, nucleated cells are seen at the surface, a layer of keratin has not formed and the epithelium remains moist. Esophagus 400x

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified

click to identify

Stratified squamous nonkeratinized epithelium
> Basal layer
Squamous cells
Basement membrane

1 of 12

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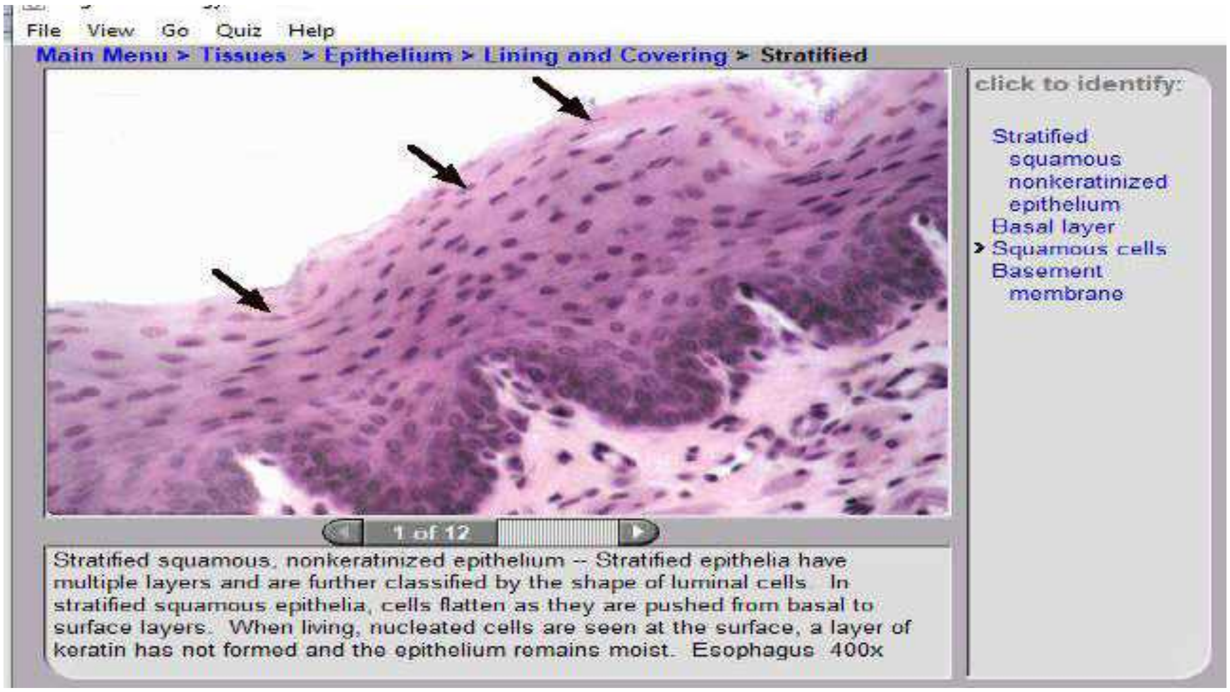
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified squamous nonkeratinized epithelium
Basal layer
Squamous cells
Basement membrane
1 of 12
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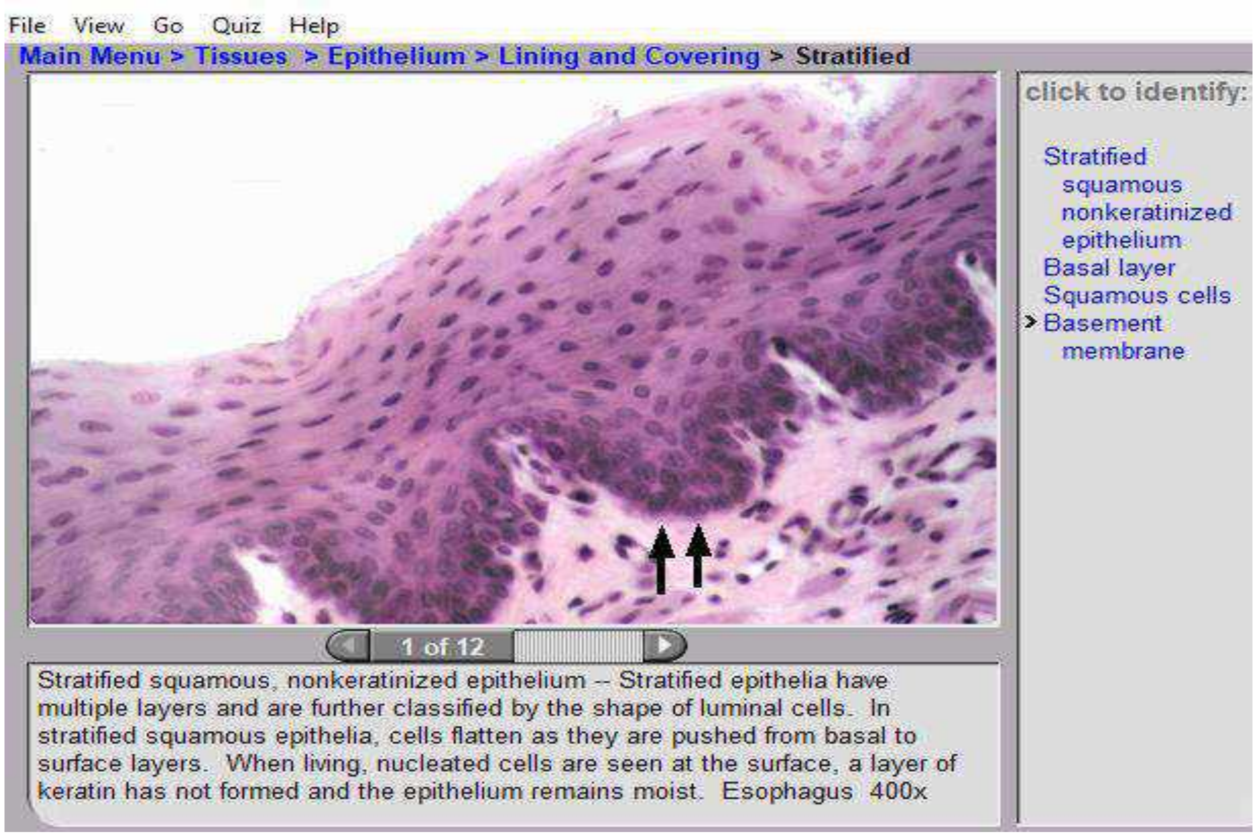
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified squamous nonkeratinized epithelium
Basal layer
Squamous cells
Basement membrane
1 of 12
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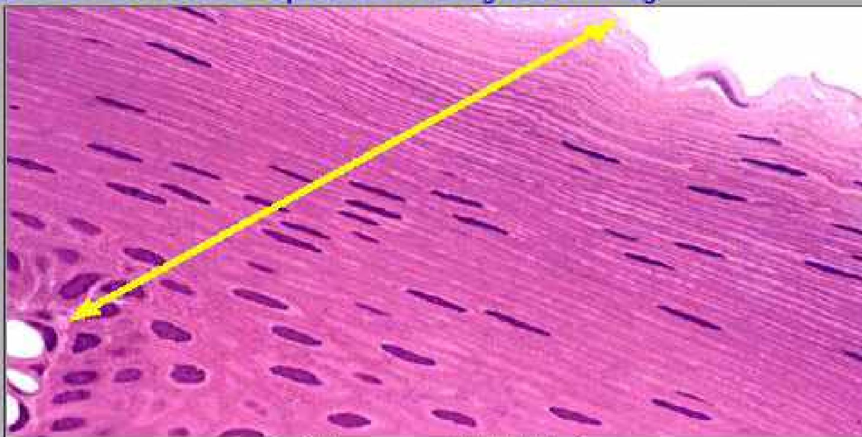
File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified



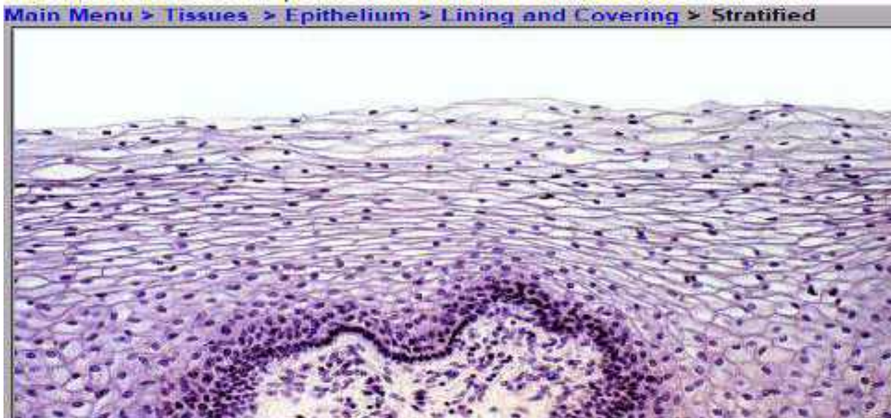
3 of 12

Stratified squamous, nonkeratinized epithelium -- This image demonstrates the transition of epithelial cells from cuboidal at the basement membrane to squamous cells at the surface. Stratified squamous moist epithelium with its multiple layers provides protection against friction and trauma to organs within the body. Esophagus 1000x

click to identify:

> Stratified squamous nonkeratinized epithelium
- Basal layer
- Squamous cells
- Basement membrane

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified

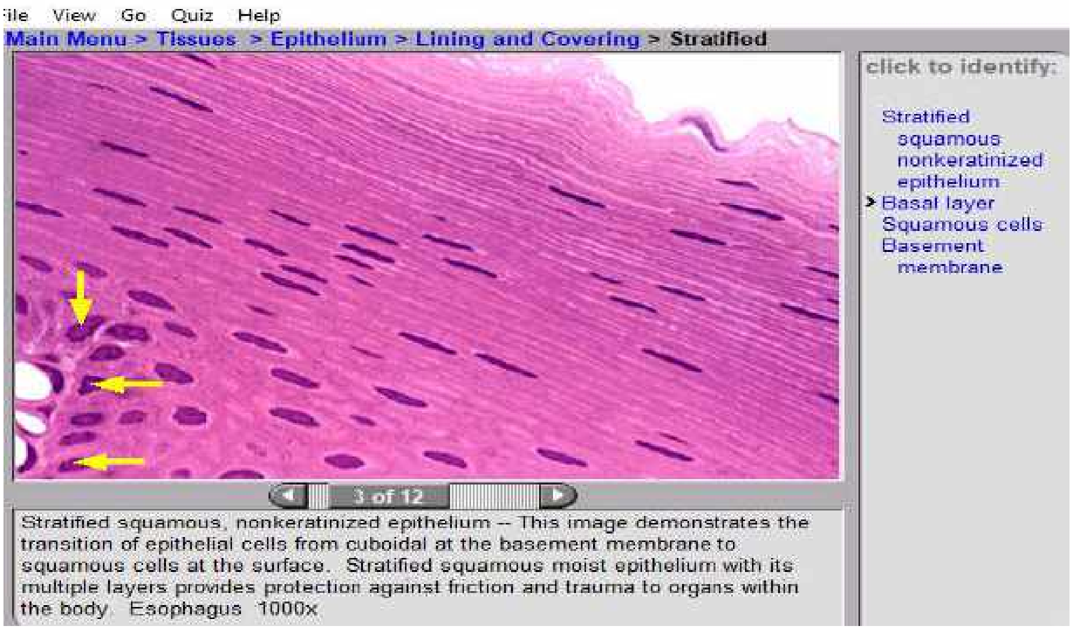


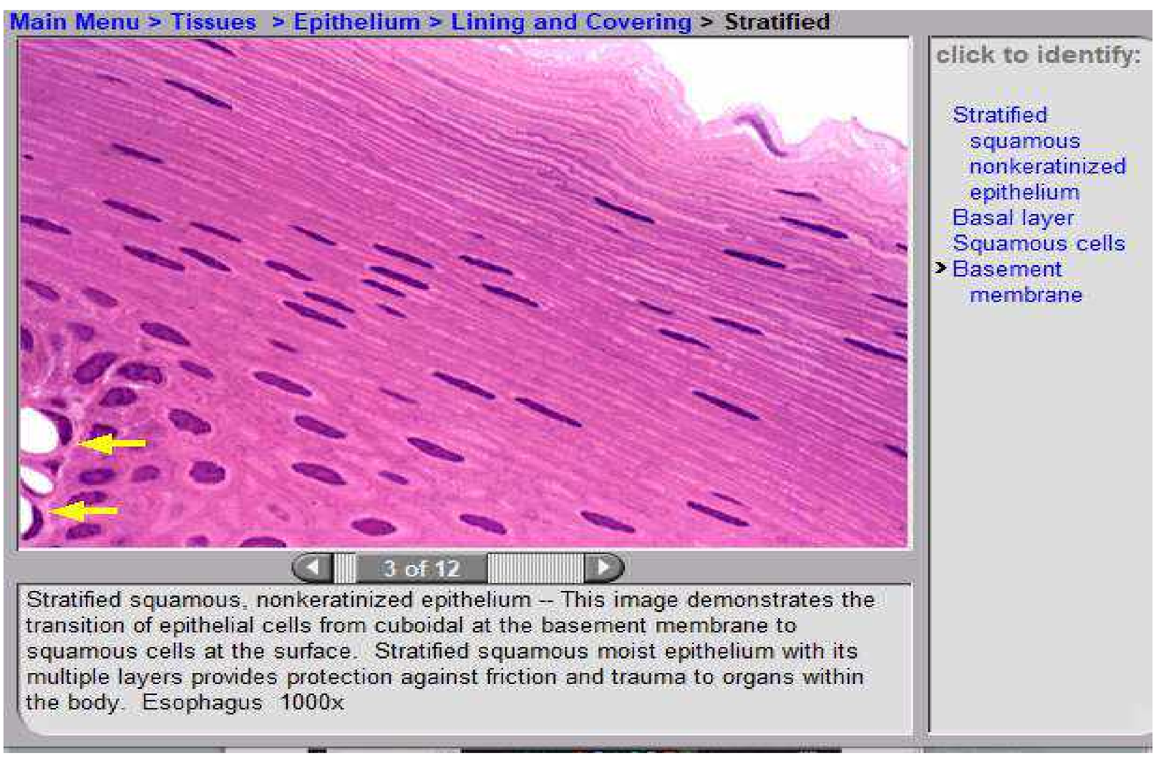
2 of 12

Stratified squamous, nonkeratinized epithelium -- This epithelium covers internal body surfaces which are exposed to some degree of physical trauma. This epithelium shows a basal layer of cuboidal cells, then several layers of polygonal cells that become progressively more flat until they become squamous at the luminal surface. Vagina 400x

click to identif

- Stratified squamous nonkeratinizec epithelium
- Basal layer
- Squamous cells
- Basement membrane


File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified squamous nonkeratinized epithelium
Basal layer
Squamous cells
Basement membrane
3 of 12
Stratified squamous, nonkeratinized epithelium -- This image demonstrates the transition of epithelial cells from cuboidal at the basement membrane to squamous cells at the surface. Stratified squamous moist epithelium with its multiple layers provides protection against friction and trauma to organs within the body. Esophagus 1000x


Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified squamous nonkeratinized epithelium
Basal layer
Squamous cells
Basement membrane
3 of 12
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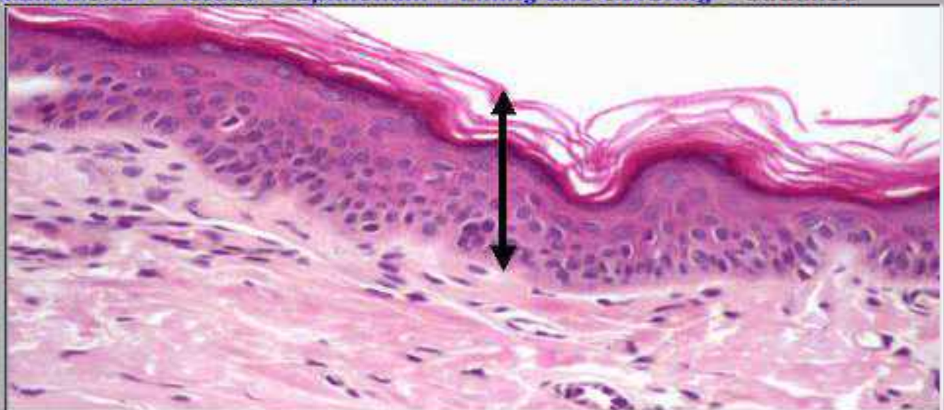
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified



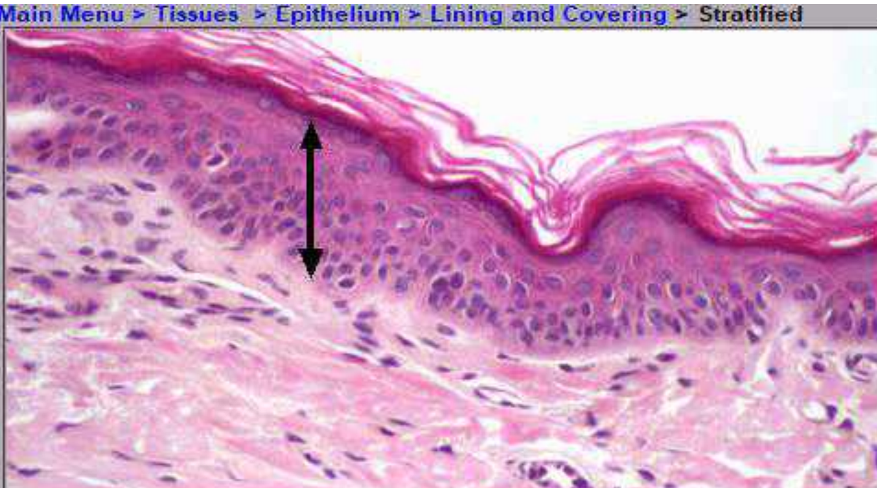
5 of 12

Stratified squamous, keratinized epithelium -- This epithelium, a subdivision of skin, covers the exterior, or "dry," surface of the body that is exposed to the external environment. The basal portion is composed of viable cells, while the outer layer is composed of dead cells made up almost entirely of the protein, keratin. Keratin provides protection against abrasion. 100x

click to identify

> Stratified squamous keratinized epithelium
Living cells
Dead cells

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified



5 of 12

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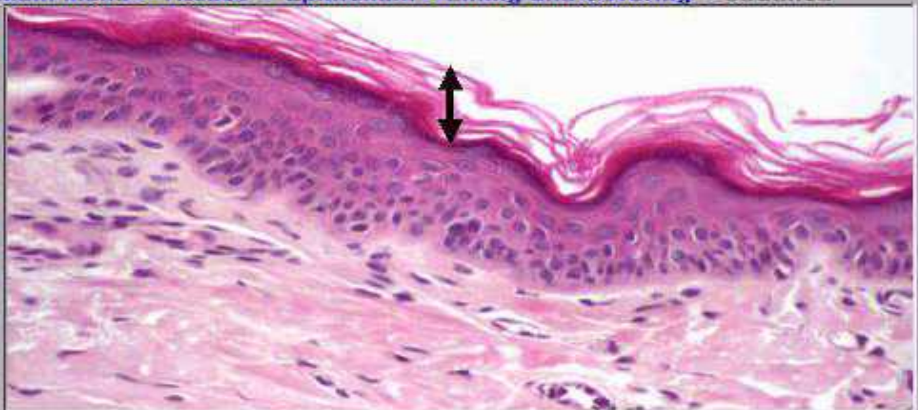
click to identify:

Stratified squamous keratinized epithelium
> Living cells
Dead cells

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified



click to identify:

Stratified squamous keratinized epithelium
Living cells
> Dead cells

5 of 12

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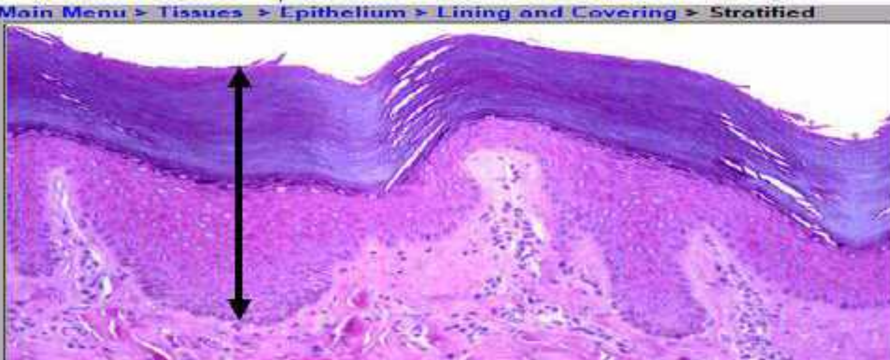
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified



click to identify:

> Stratified squamous keratinized epithelium
Living cells
Dead cells

6 of 12

Stratified squamous, keratinized epithelium -- Stratified squamous, keratinized epithelium forms the outer layer of the skin an area of the body that is subjected to a great deal of abrasion. Therefore, its outer protective layer, composed of dead cells forming keratin, is quite thick. 400x

File View Go Quiz Help

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified

click to identify:

Stratified squamous keratinized epithelium
> Living cells
Dead cells

6 of 12

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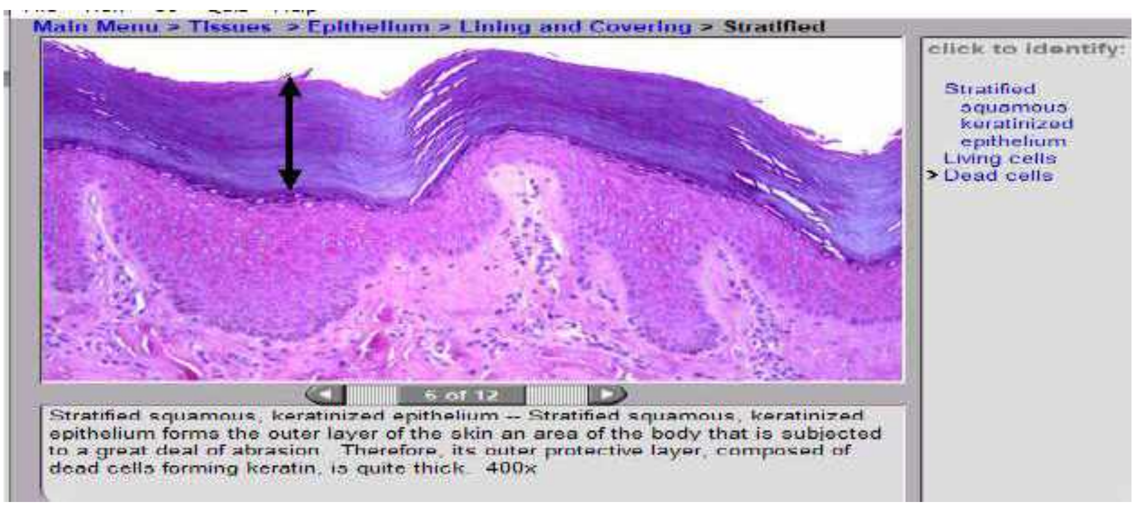

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified squamous keratinized epithelium
Living cells
> Dead cells
6 of 12
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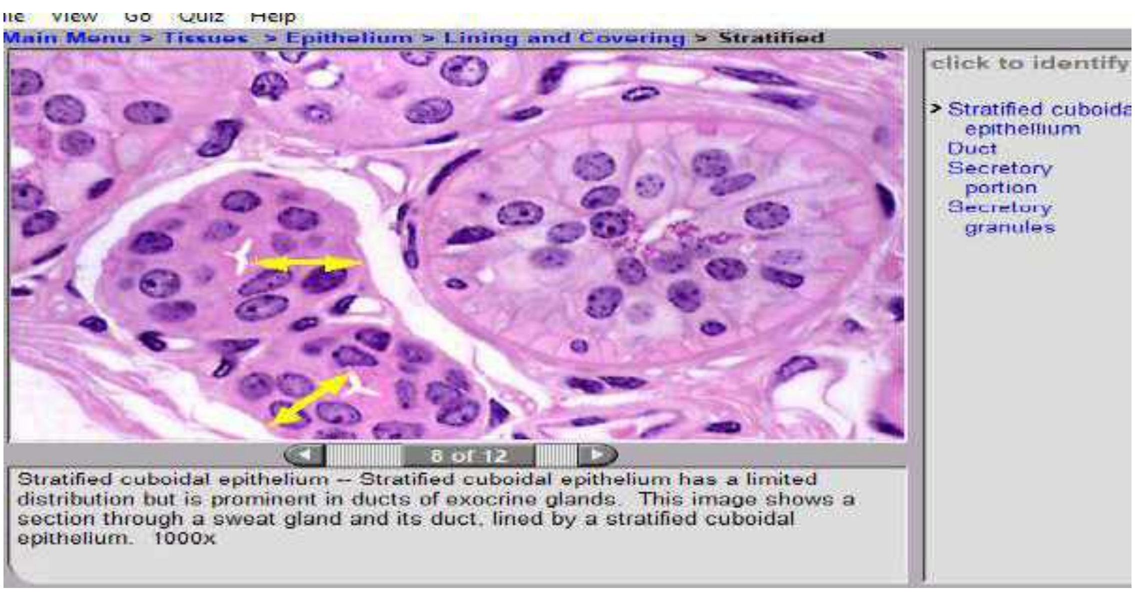
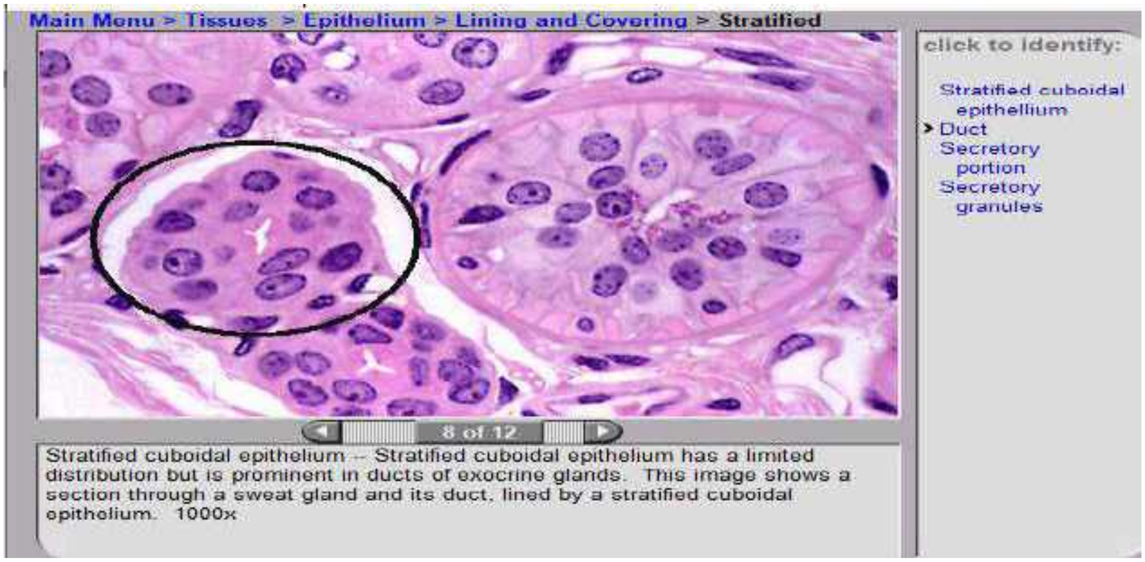


ile View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify
> Stratified cuboida epithelium
Duct
Secretory portion
Secretory granules
8 of 12
Stratified cuboidal epithelium -- Stratified cuboidal epithelium has a limited distribution but is prominent in ducts of exocrine glands. This image shows a section through a sweat gland and its duct, lined by a stratified cuboidal epithelium. 1000x


Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified cuboidal epithelium
> Duct
Secretory portion
Secretory granules
8 of 12
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Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified cuboidal epithelium
Duct
> Secretory portion
Secretory granules
8 of 12
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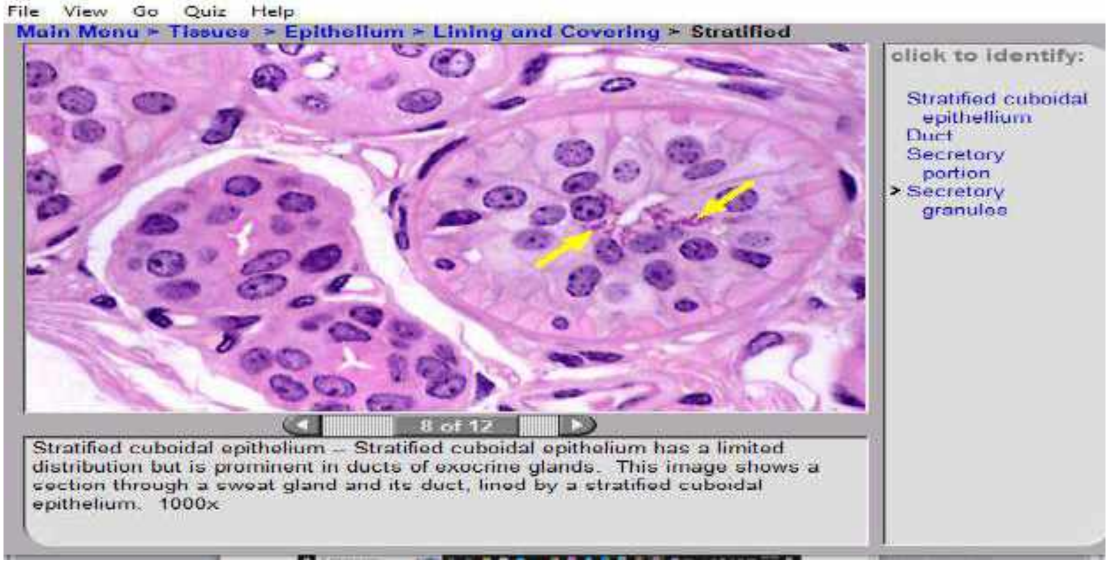
File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified cuboidal epithelium
Duct
Secretory portion
> Secretory granules
8 of 12
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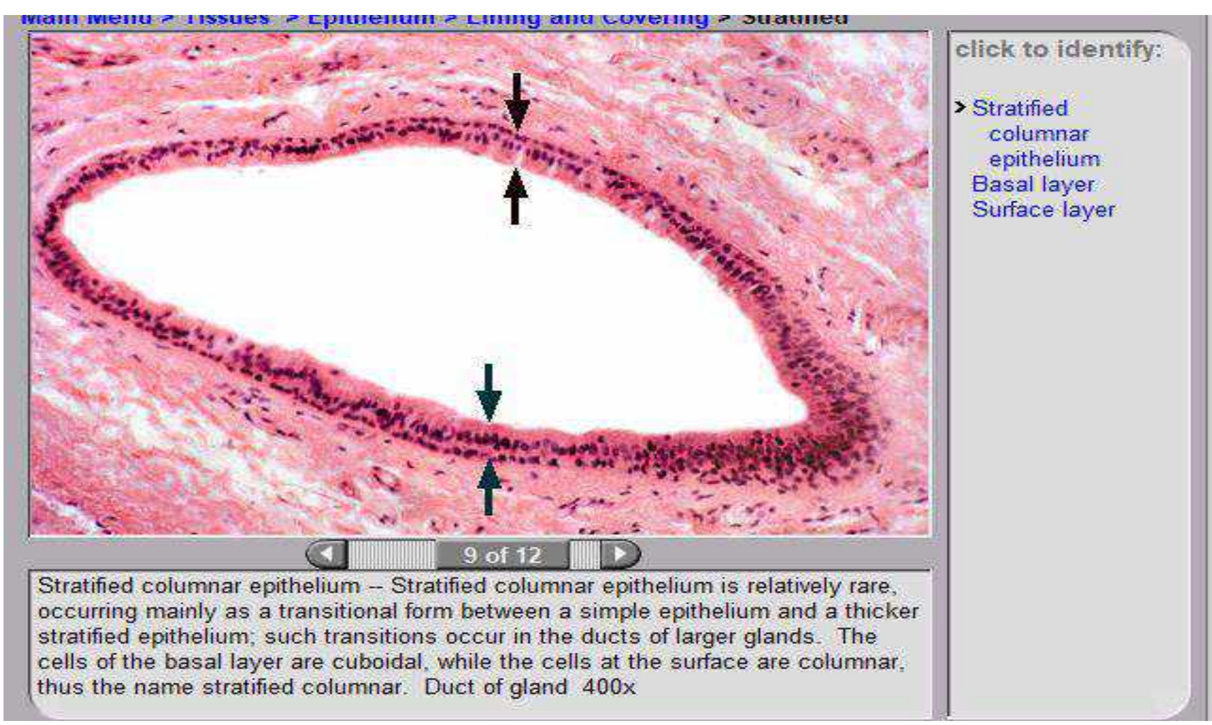
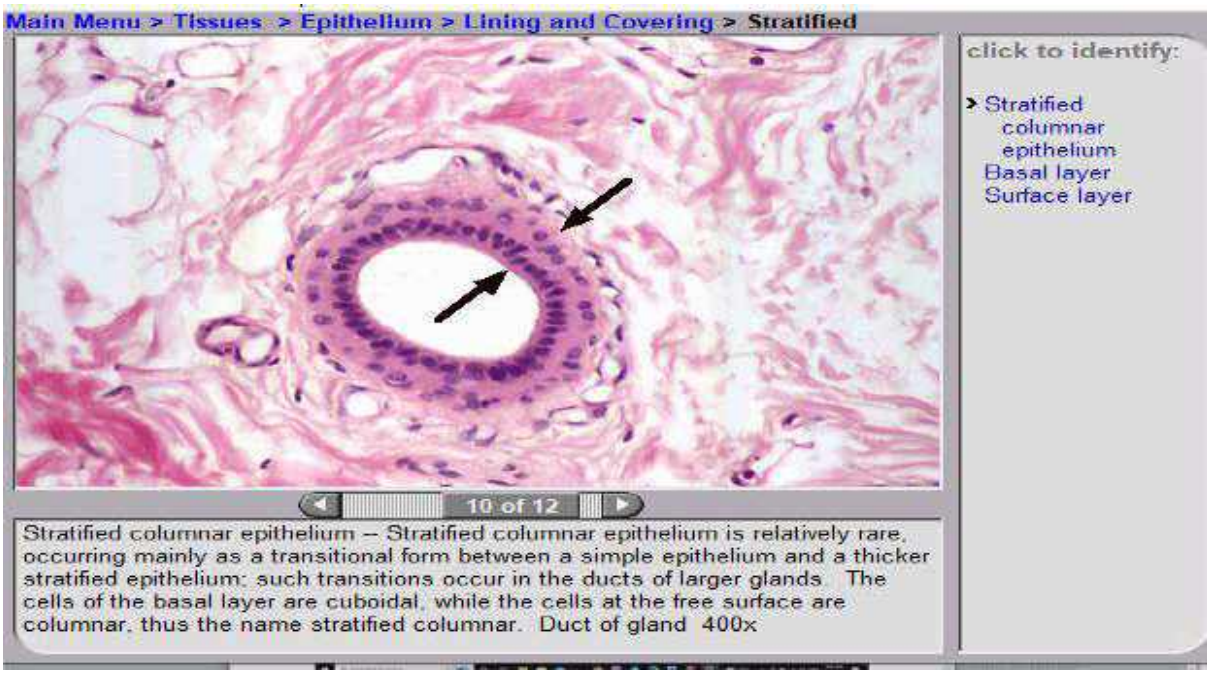

click to identify:
> Stratified columnar epithelium
Basal layer
Surface layer
9 of 12
Stratified columnar epithelium -- Stratified columnar epithelium is relatively rare, occurring mainly as a transitional form between a simple epithelium and a thicker stratified epithelium; such transitions occur in the ducts of larger glands. The cells of the basal layer are cuboidal, while the cells at the surface are columnar, thus the name stratified columnar. Duct of gland 400x


Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Stratified columnar epithelium
Basal layer
Surface layer
10 of 12
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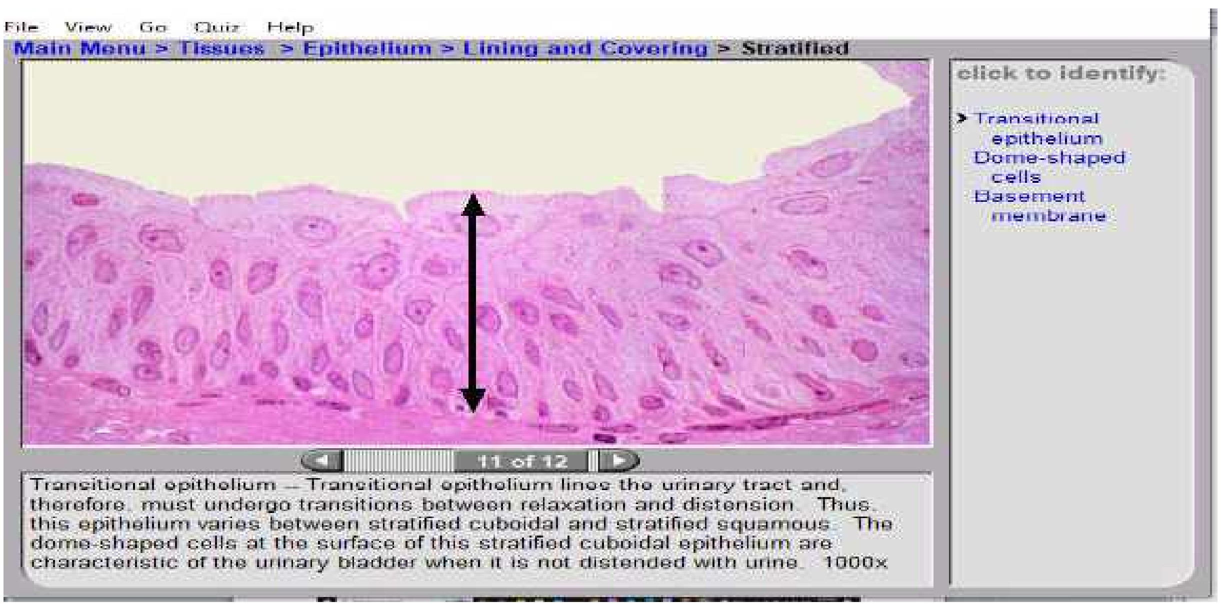
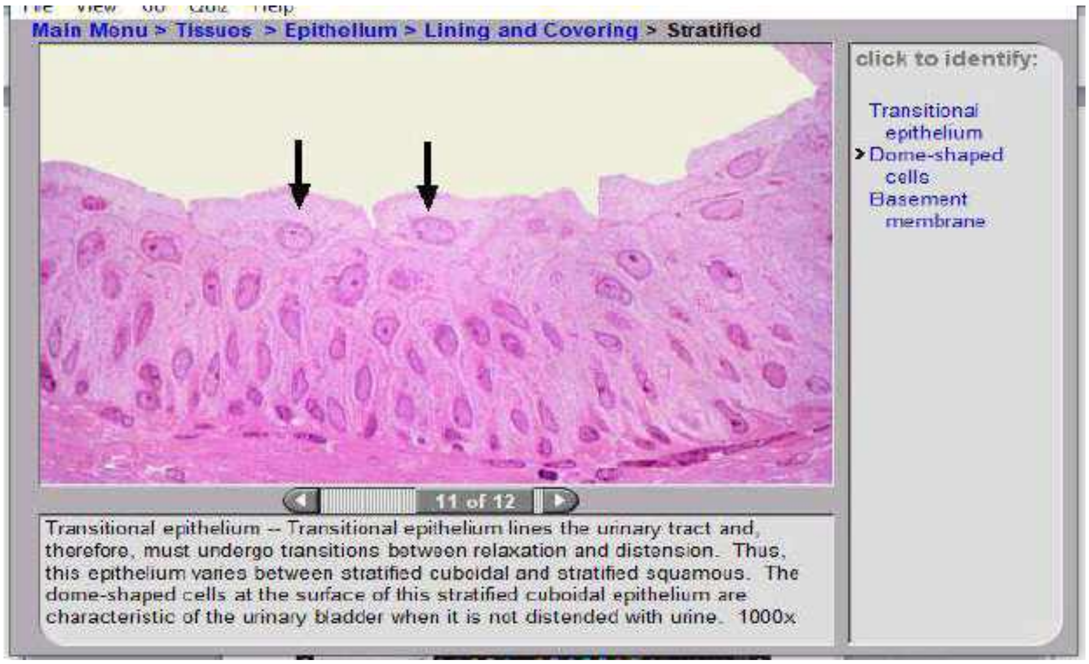

File View Go Quiz Help
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Transitional epithelium
Dome-shaped cells
Basement membrane
11 of 12
Transitional epithelium -- Transitional epithelium lines the urinary tract and, therefore, must undergo transitions between relaxation and distension. Thus, this epithelium varies between stratified cuboidal and stratified squamous. The dome-shaped cells at the surface of this stratified cuboidal epithelium are characteristic of the urinary bladder when it is not distended with urine. 1000x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click to identify:
Transitional epithelium
Dome-shaped cells
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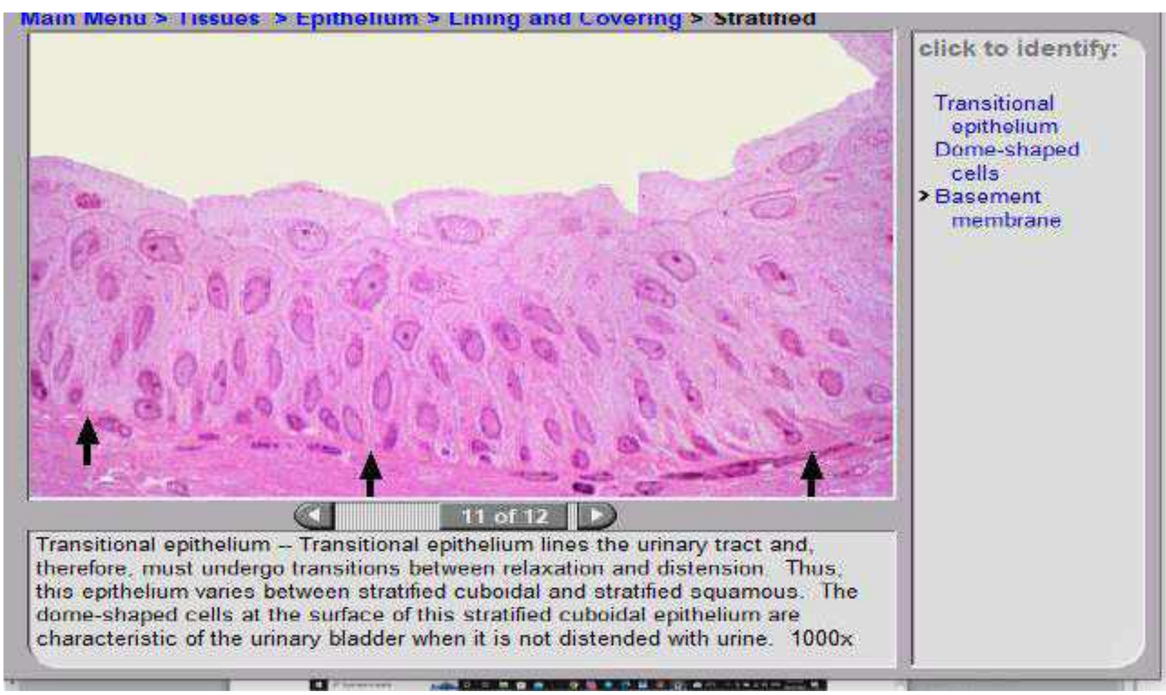
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Transitional epithelium
Dome-shaped cells
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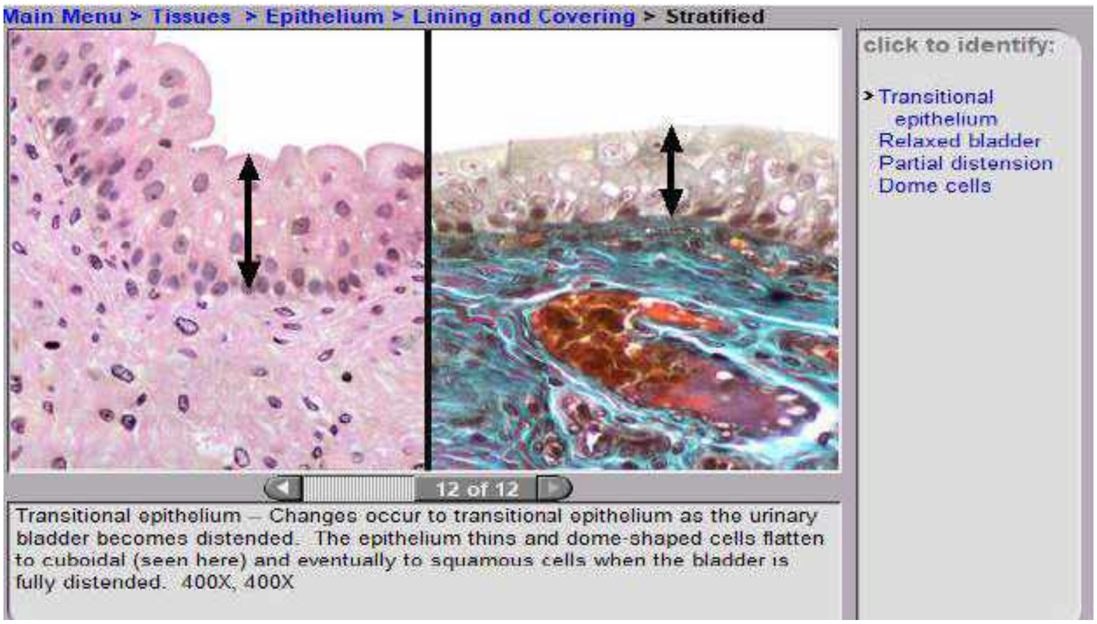
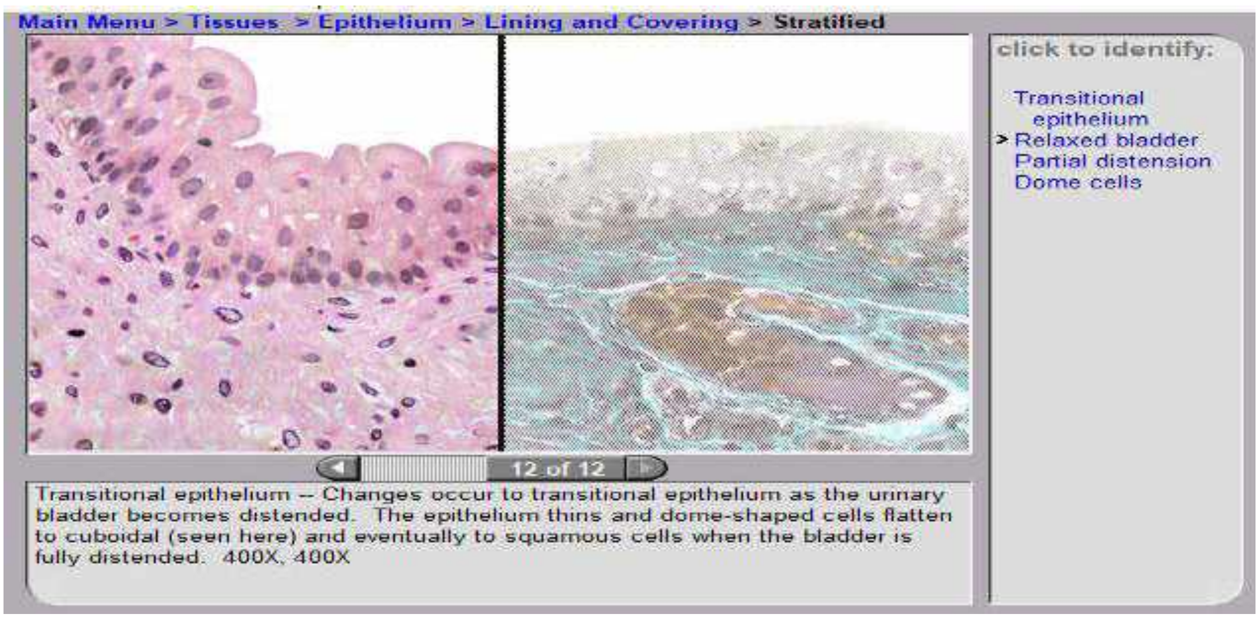

Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
> Transitional epithelium
Relaxed bladder
Partial distension
Dome cells
12 of 12
Transitional epithelium -- Changes occur to transitional epithelium as the urinary bladder becomes distended. The epithelium thins and dome-shaped cells flatten to cuboidal (seen here) and eventually to squamous cells when the bladder is fully distended. 400X, 400X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Transitional epithelium
> Relaxed bladder
Partial distension
Dome cells
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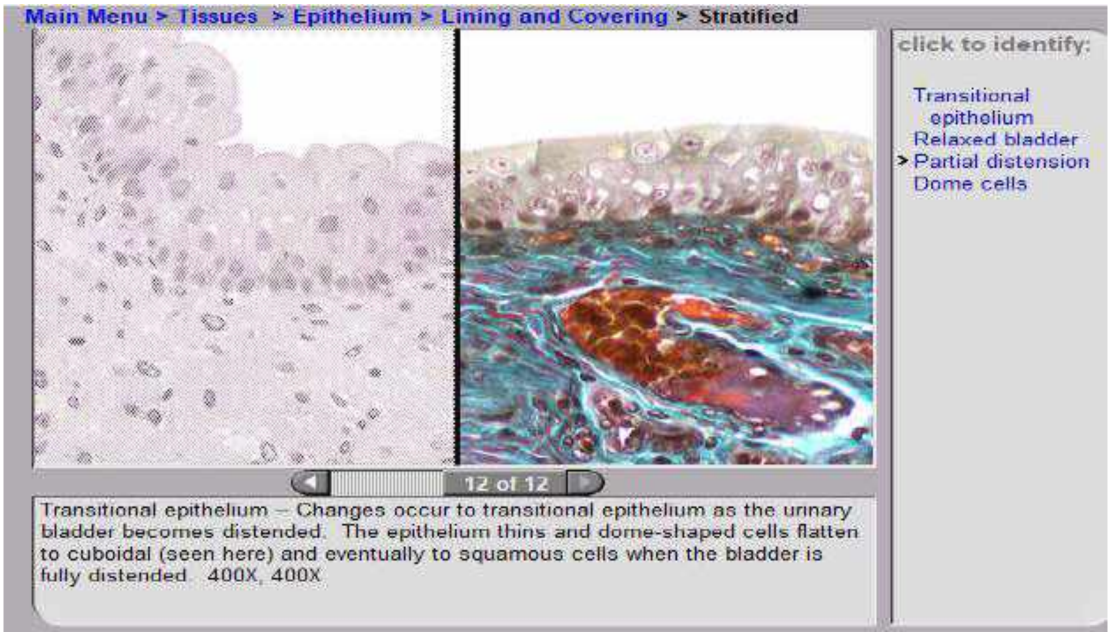
Main Menu > Tissues > Epithelium > Lining and Covering > Stratified
click to identify:
Transitional epithelium
Relaxed bladder
Partial distension
Dome cells
12 of 12
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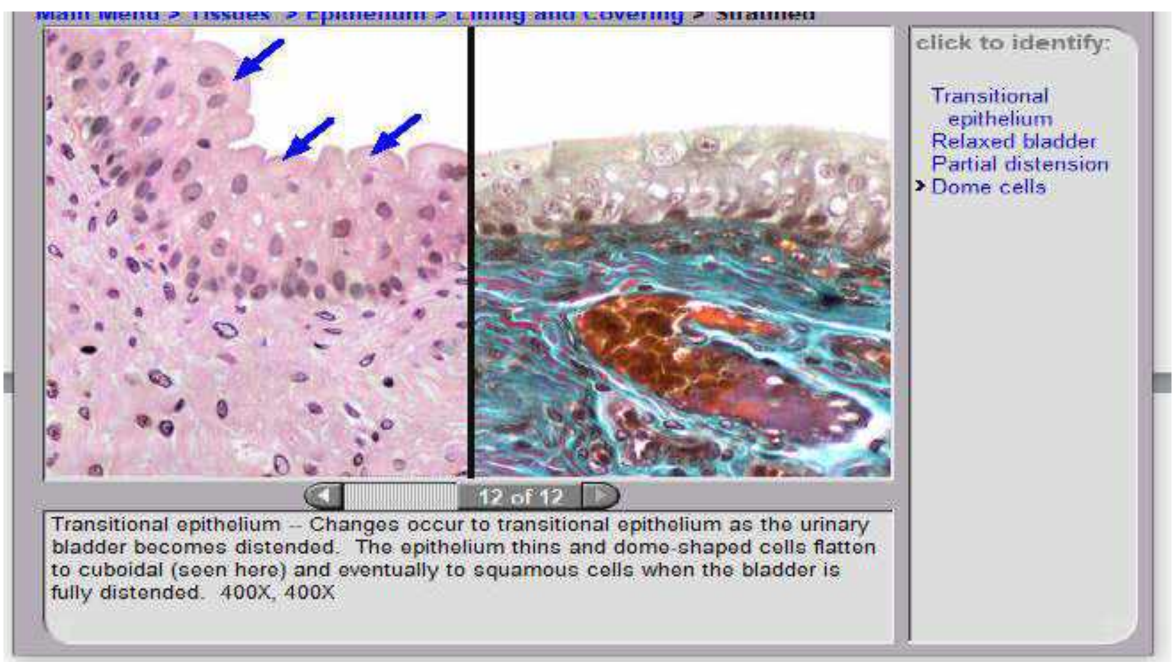
click to identify:
Transitional epithelium
Relaxed bladder
Partial distension
Dome cells
12 of 12
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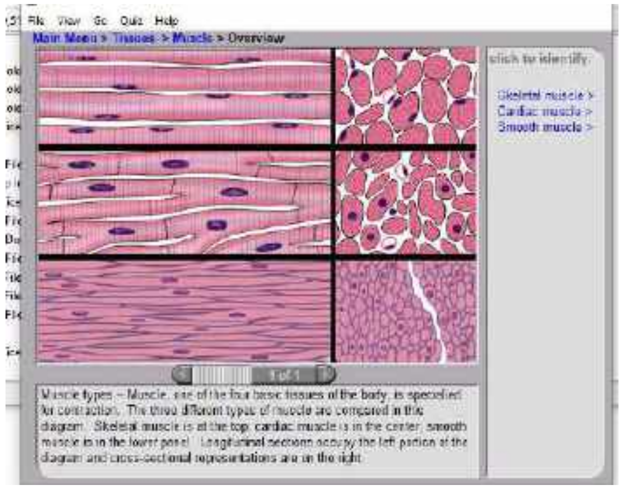
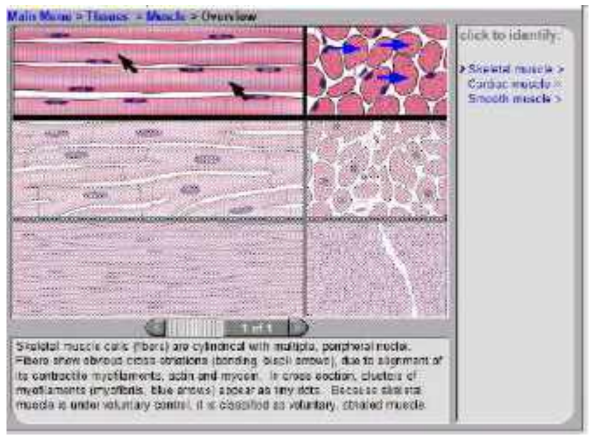
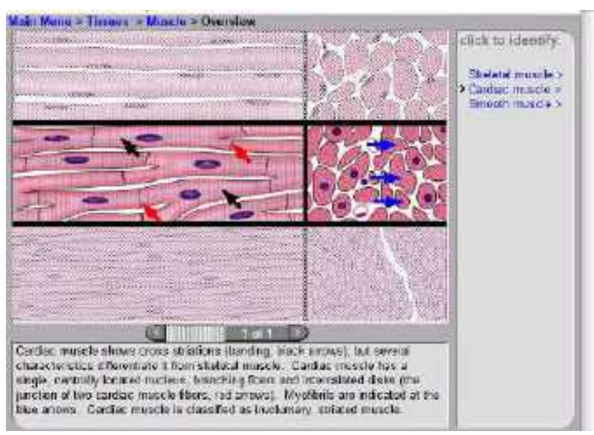
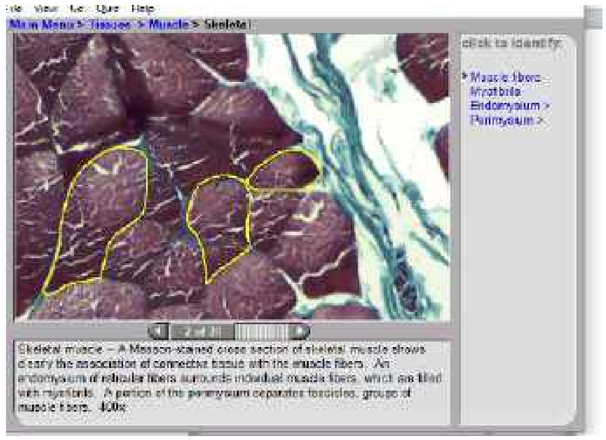
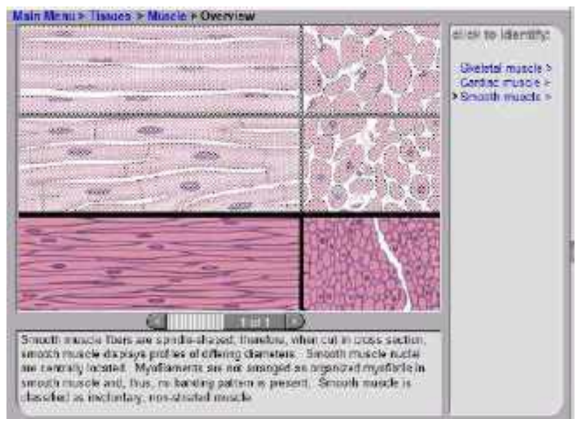
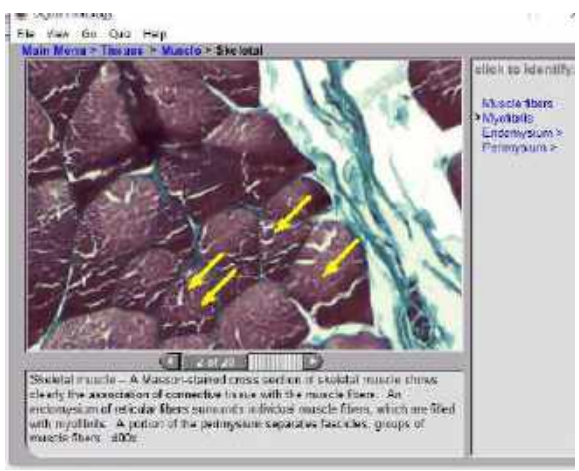

File View Go Quiz Help
Main Menu > Tissues > Muscle > Overview
click to identify:
Skeletal muscle >
Cardiac muscle >
Smooth muscle >
1 of 1
Muscle types -- Muscle, one of the four basic tissues of the body, is specialized for contraction. The three different types of muscle are compared in this diagram. Skeletal muscle is at the top; cardiac muscle is in the center; smooth muscle is in the lower panel. Longitudinal sections occupy the left portion of the diagram and cross-sectional representations are on the right.


Main Menu > Tissues > Muscle > Overview
click to identify:
> Skeletal muscle >
Cardiac muscle >
Smooth muscle >
1 of 1
Skeletal muscle cells (fibers) are cylindrical with multiple, peripheral nuclei. Fibers show obvious cross striations (banding, black arrows), due to alignment of its contractile myofilaments, actin and myosin. In cross section, clusters of myofilaments (myofibrils, blue arrows) appear as tiny dots. Because skeletal muscle is under voluntary control, it is classified as voluntary, striated muscle.


Main Menu > Tissues > Muscle > Overview
click to identify:
Skeletal muscle >
> Cardiac muscle >
Smooth muscle >
1 of 1
Cardiac muscle shows cross striations (banding, black arrows), but several characteristics differentiate it from skeletal muscle. Cardiac muscle has a single, centrally located nucleus, branching fibers and intercalated disks (the junction of two cardiac muscle fibers, red arrows). Myofibrils are indicated at the blue arrows. Cardiac muscle is classified as involuntary, striated muscle.


Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fibers
Myofibrils
Endomysium >
Perimysium >
Skeletal muscle – A Masson-stained cross section of skeletal muscle shows clearly the association of connective tissue with the muscle fibers. An endomysium of reticular fibers surrounds individual muscle fibers, which are filled with myofibrils. A portion of the perimysium separates fascicles, groups of muscle fibers. 400x


Main Menu > Tissues > Muscle > Overview
click to identify:
Skeletal muscle >
Cardiac muscle >
Smooth muscle >
Smooth muscle fibers are spindle-shaped; therefore, when cut in cross section, smooth muscle displays profiles of differing diameters. Smooth muscle nuclei are centrally located. Myofilaments are not arranged as organized myofibrils in smooth muscle and, thus, no banding pattern is present. Smooth muscle is classified as involuntary, non-striated muscle.


File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fibers
Myofibrils
Endomysium >
Perimysium >
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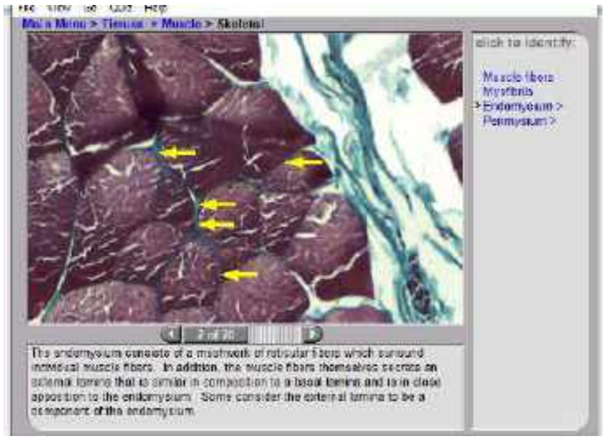
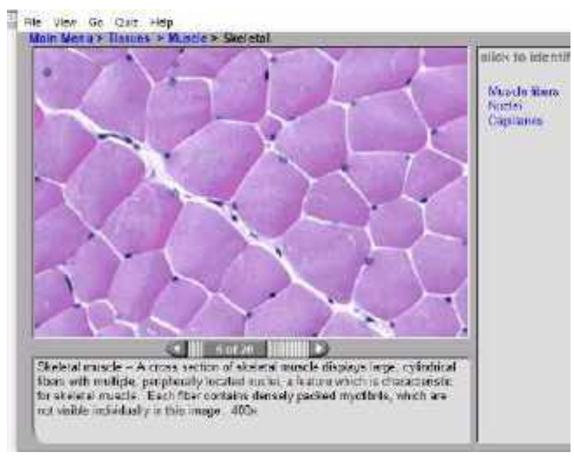
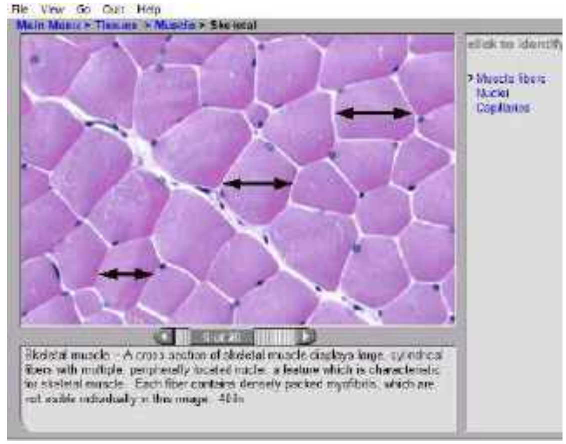

Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fibers
Myofibrils
> Endomysium >
Perimysium >
The endomysium consists of a meshwork of reticular fibers which surround individual muscle fibers. In addition, the muscle fibers themselves secrete an external lamina that is similar in composition to a basal lamina and is in close apposition to the endomysium. Some consider the external lamina to be a component of the endomysium.


File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fibers
Myofibrils
Endomysium >
> Perimysium >
2 of 20
The perimysium is composed of collagen fibers and segregates skeletal muscle fibers into functional groups called fascicles. Larger blood vessels and nerves travel in the perimysium.


File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
Muscle fibers
Nuclei
Capillaries
Skeletal muscle – A cross section of skeletal muscle displays large, cylindrical fibers with multiple, peripherally located nuclei, a feature which is characteristic for skeletal muscle. Each fiber contains densely packed myofibrils, which are not visible individually in this image. 400x


File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify
Muscle fibers
Nuclei
Capillaries
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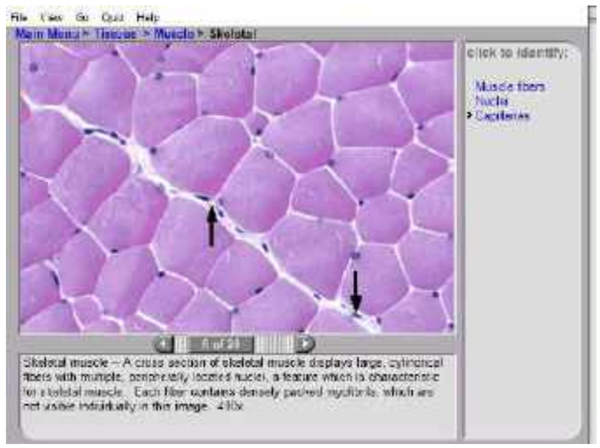
File View Go Quiz Help
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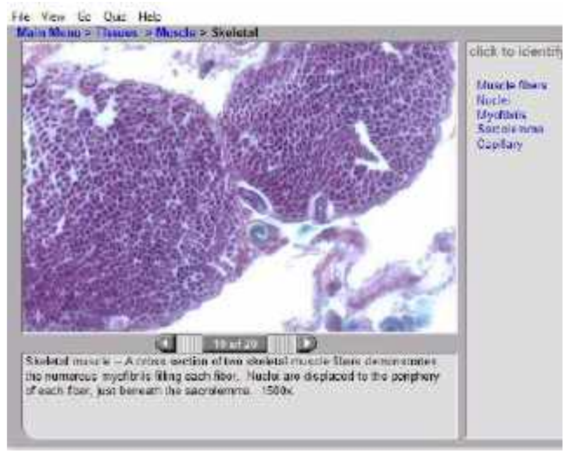
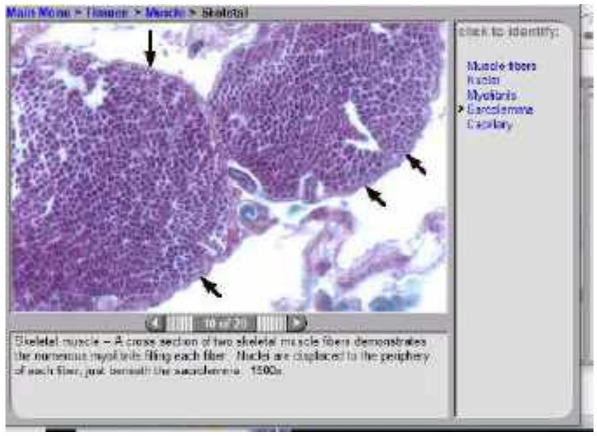
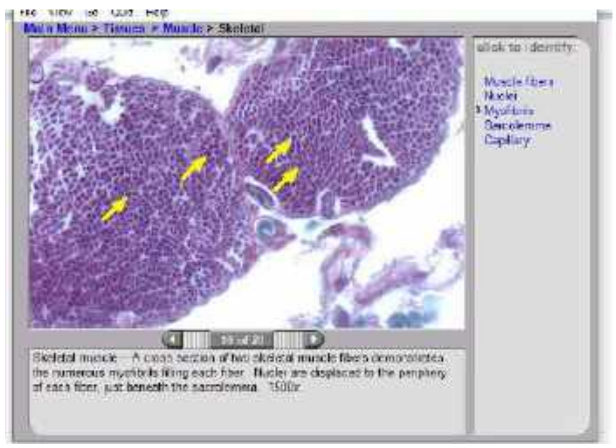
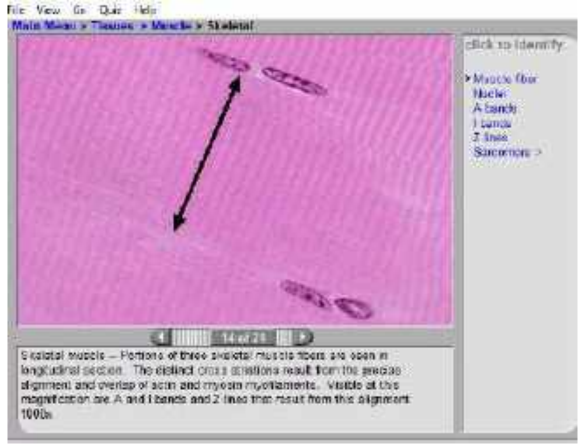
click to identify:
Muscle fibers
Nuclei
Capillaries
Skeletal muscle – A cross section of skeletal muscle displays large, cylindrical fibers with multiple, peripherally located nuclei, a feature which is characteristic for skeletal muscle. Each fiber contains densely packed myofibrils, which are not visible individually in this image. 400x

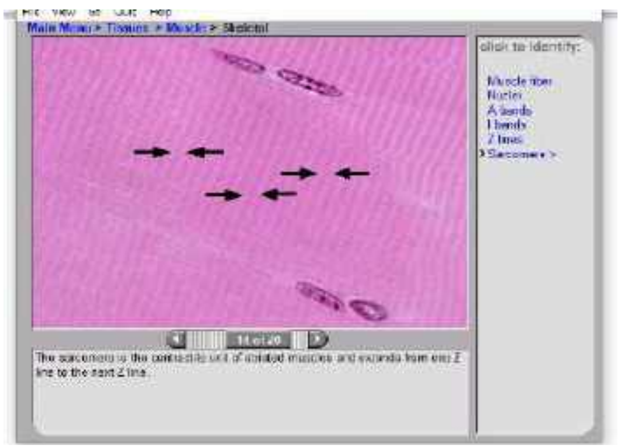

File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify
Muscle fibers
Nuclei
Myofibrils
Sarcolemma
Capillary
Skeletal muscle – A cross section of two skeletal muscle fibers demonstrates the numerous myofibrils filling each fiber. Nuclei are displaced to the periphery of each fiber, just beneath the sarcolemma. 1500x

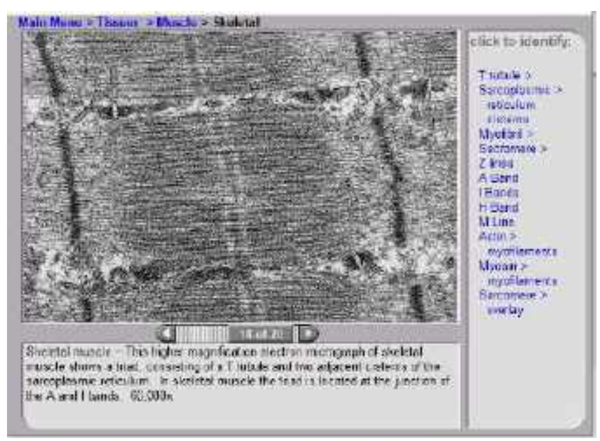

Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fibers
Nuclei
Myofibrils
Sarcolemma
Capillary
10 of 20
Skeletal muscle – A cross section of two skeletal muscle fibers demonstrates the numerous myofibrils filling each fiber. Nuclei are displaced to the periphery of each fiber, just beneath the sarcolemma. 1500x

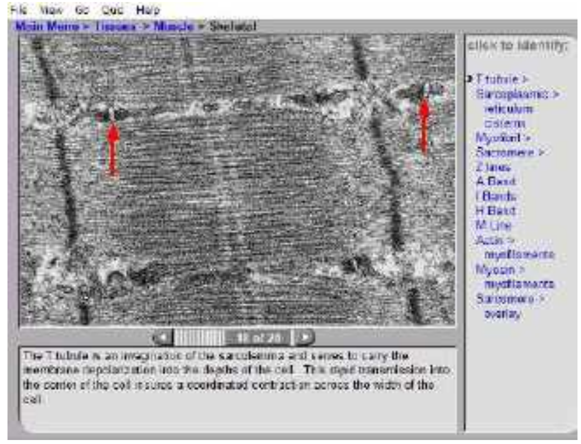

Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fibers
Nuclei
Myofibrils
Sarcolemma
Capillary
Skeletal muscle – A cross section of two skeletal muscle fibers demonstrates the numerous myofibrils filling each fiber. Nuclei are displaced to the periphery of each fiber, just beneath the sarcolemma. 1500x

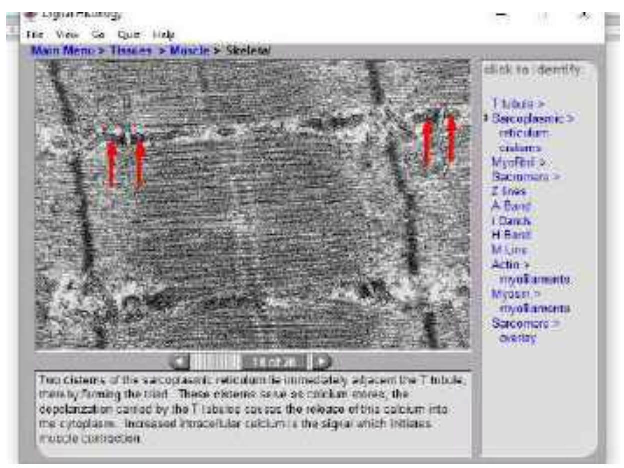

click to identify:
Muscle fiber
Nuclei
A bands
I bands
Z lines
Sarcomere
11 of 20
Skeletal muscle – Portions of three skeletal muscle fibers are seen in longitudinal section. The distinct cross striations result from the precise alignment and overlap of actin and myosin myofilaments. Visible at this magnification are A and I bands and Z lines that result from this alignment.

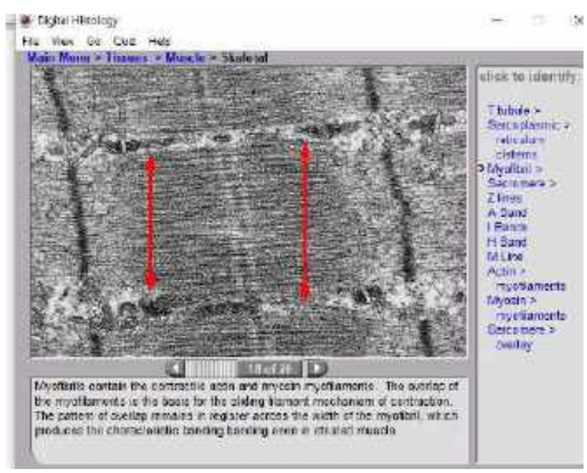

File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fiber
Nuclei
A bands
I bands
Z lines
Sarcomere >
Skeletal muscle -- Portions of three skeletal muscle fibers are seen in longitudinal section. The distinct cross striations result from the precise alignment and overlap of actin and myosin myofilaments. Visible at this magnification are A and I bands and Z lines that result from this alignment. 1000x

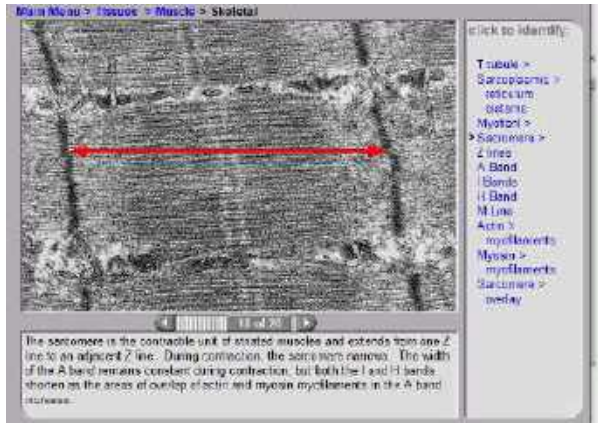

Main Menu > Tissues > Muscle > Skeletal
click to identify:
Muscle fiber
Nuclei
A bands
I bands
Z lines
Sarcomere >
The sarcomere is the contractile unit of striated muscles and extends from one Z line to the next Z line.

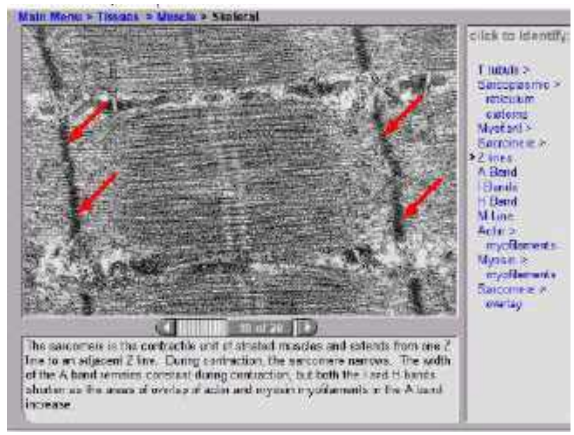

Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic >
reticulum
cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin >
myofilaments
Myosin >
myofilaments
Sarcomere >
overlay
Skeletal muscle -- This higher magnification electron micrograph of skeletal muscle shows a triad, consisting of a T tubule and two adjacent cisterns of the sarcoplasmic reticulum. In skeletal muscle the triad is located at the junction of the A and I bands. 60,000x


File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
The T tubule is an invagination of the sarcolemma and serves to carry the membrane depolarization into the depths of the cell. This rapid transmission into the center of the cell insures a coordinated contraction across the width of the cell.


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
Two cisterns of the sarcoplasmic reticulum lie immediately adjacent the T tubule, thereby forming the triad. These cisterns serve as calcium stores; the depolarization carried by the T tubules causes the release of this calcium into the cytoplasm. Increased intracellular calcium is the signal which initiates muscle contraction.


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
Myofibrils contain the contractile actin and myosin myofilaments. The overlap of the myofilaments is the basis for the sliding filament mechanism of contraction. The pattern of overlap remains in register across the width of the myofibril, which produces the characteristic banding banding seen in striated muscle.


Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
The sarcomere is the contractile unit of striated muscles and extends from one Z line to an adjacent Z line. During contraction, the sarcomere narrows. The width of the A band remains constant during contraction, but both the I and H bands shorten as the areas of overlap of actin and myosin myofilaments in the A band increase.


Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
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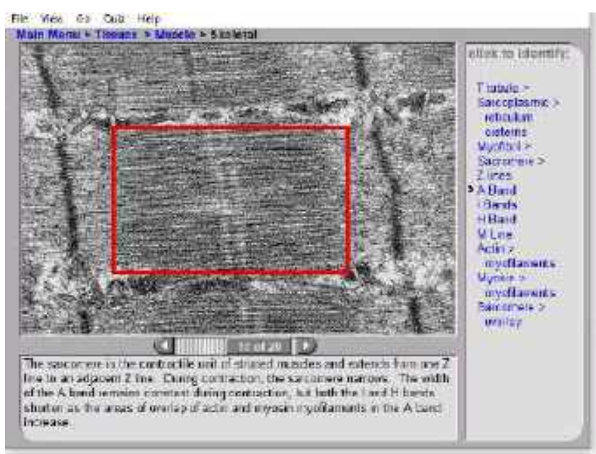
File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
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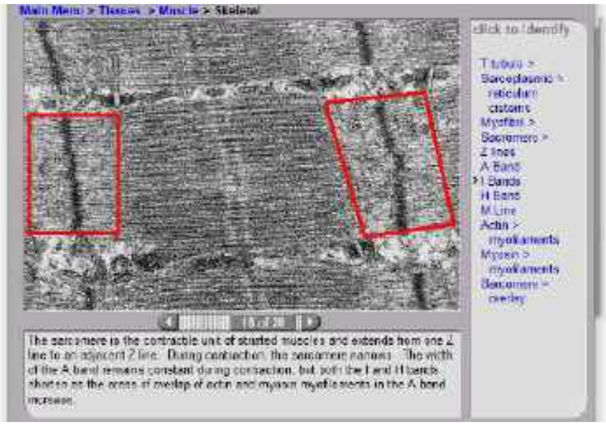
Main Menu > Tissues > Muscle > Skeletal
click to identify
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
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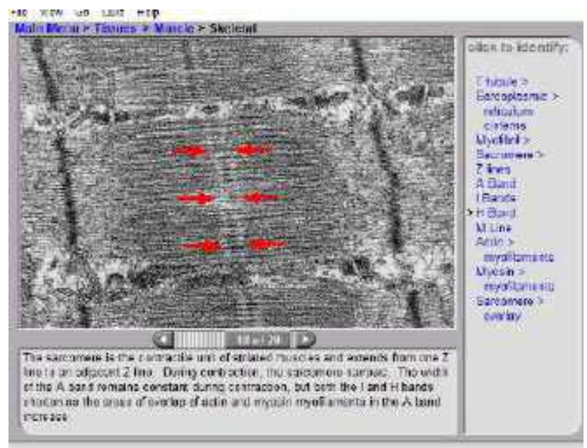
Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
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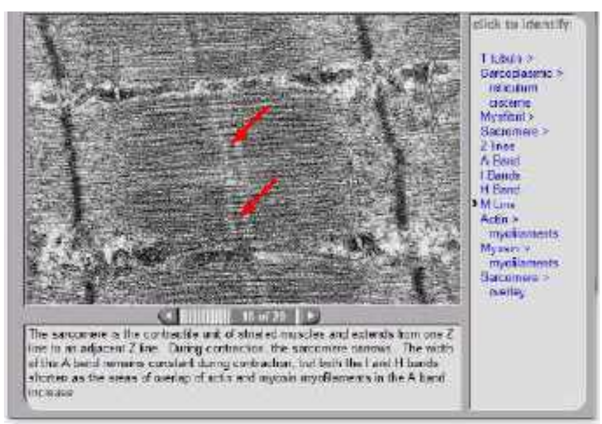
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
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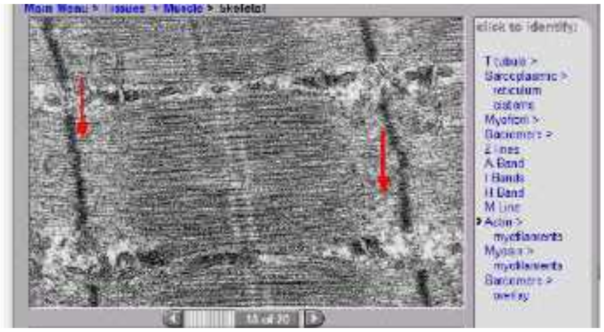
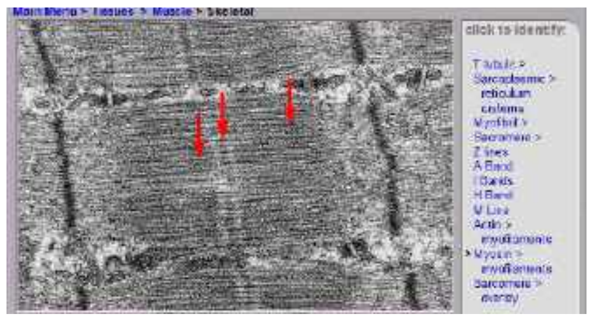

Main Menu > Tissues > Muscle > Skeletal
click to identify:
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay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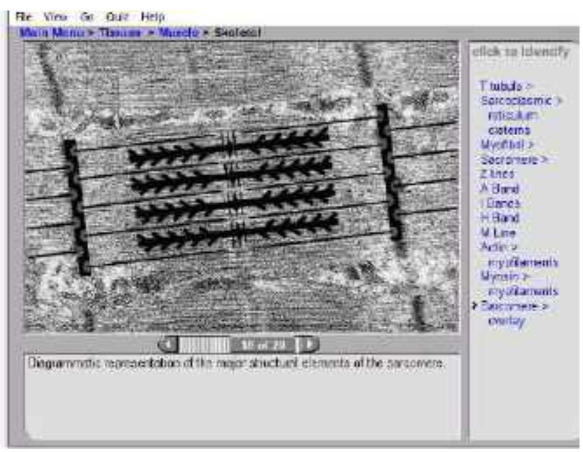
File View Go Quiz Help
Main Menu > Tissues > Muscle > Skeletal
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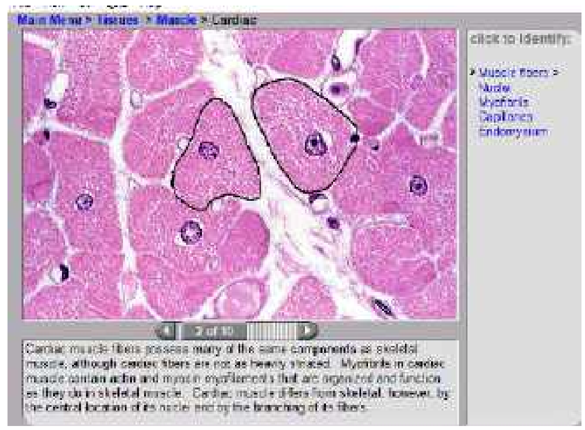
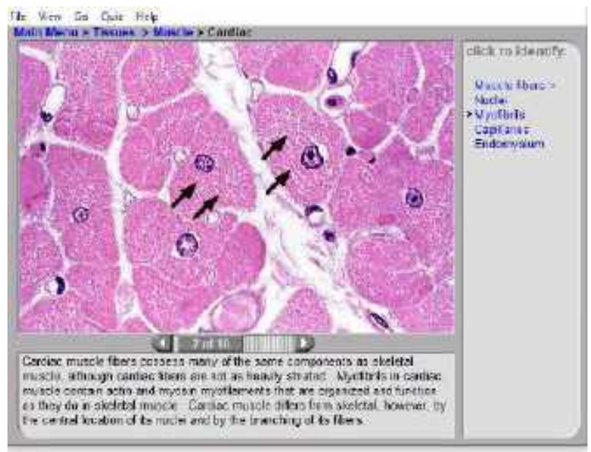
T tubule >
Sarcoplasmic > reticulum cisterns
Myofibril >
Sarcomere >
Z lines
A Band
I Bands
H Band
M Line
Actin > myofilaments
Myosin > myofilaments
Sarcomere > overlay
Diagrammatic representation of the major structural elements of the sarcomere.


Main Menu > Tissues > Muscle > Cardiac
click to identify:
> Muscle fibers >
Nuclei
Myofibrils
Capillaries
Endomysium
2 of 10
Cardiac muscle fibers possess many of the same components as skeletal muscle, although cardiac fibers are not as heavily striated. Myofibrils in cardiac muscle contain actin and myosin myofilaments that are organized and function as they do in skeletal muscle. Cardiac muscle differs from skeletal, however, by the central location of its nuclei and by the branching of its fibers.


File View Go Quiz Help
Main Menu > Tissues > Muscle > Cardiac
click to identify:
Muscle fibers >
Nuclei
> Myofibrils
Capillaries
Endomysium
2 of 10
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Myofibrils
> Capillaries
Endomysium
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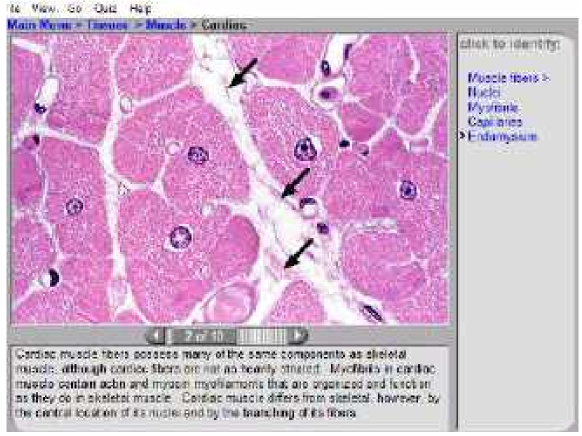
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Main Menu > Tissues > Muscle > Cardiac
click to identify:
Muscle fibers >
Nuclei
Myofibrils
Capillaries
> Endomysium
2 of 10
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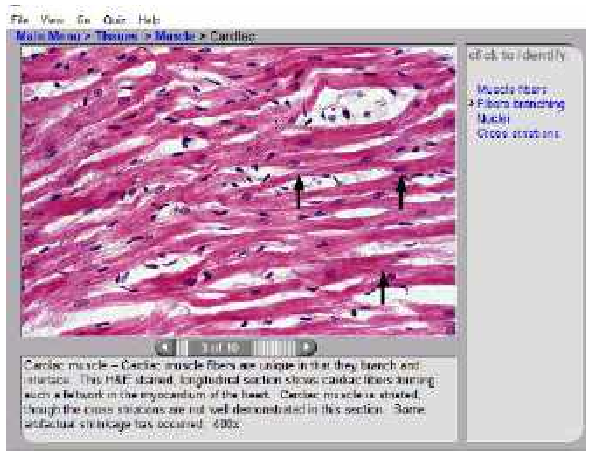
File View Go Quiz Help
Main Menu > Tissues > Muscle > Cardiac
click to identify:
> Muscle fibers
Fibers branching
Nuclei
Cross striations
3 of 10
Cardiac muscle – Cardiac muscle fibers are unique in that they branch and interlace. This H&E stained, longitudinal section shows cardiac fibers forming such a feltwork in the myocardium of the heart. Cardiac muscle is striated, though the cross striations are not well demonstrated in this section. Some artifactual shrinkage has occurred. 400x


File View Go Quiz Help
Main Menu > Tissues > Muscle > Cardiac
click to identify:
Muscle fibers
> Fibers branching
Nuclei
Cross striations
3 of 10
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File View Go Quiz Help
Main Menu > Tissues > Muscle > Cardiac
click to identify:
Muscle fibers
Nuclei
Myofibrils
Capillaries
Intercalated disks
4 of 10
Cardiac muscle -- A longitudinal section of cardiac muscle demonstrates its distinctive features, including striations (not easily seen in this image), centrally located nuclei and intercalated disks. Intercalated disks are complex, intercellular junctions between the ends of adjacent cardiac fibers. Components of intercalated disks cannot be resolved with the light microscope. 400x


File View Go Quiz Help
Main Menu > Tissues > Muscle > Cardiac
click to identify:
Muscle fibers
Nuclei
Myofibrils
Capillaries
Intercalated disks
4 of 10
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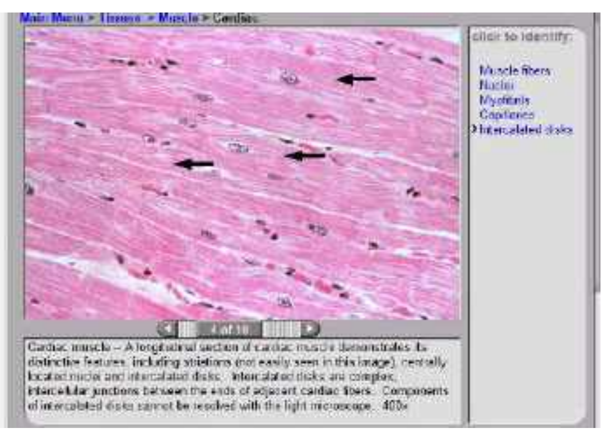
Main Menu > Tissues > Muscle > Cardiac
click to identify:
Muscle fibers
Nuclei
Myofibrils
Capillaries
Intercalated disks
4 of 10
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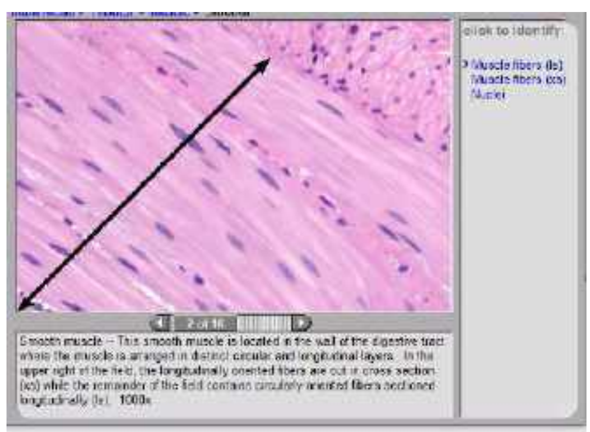
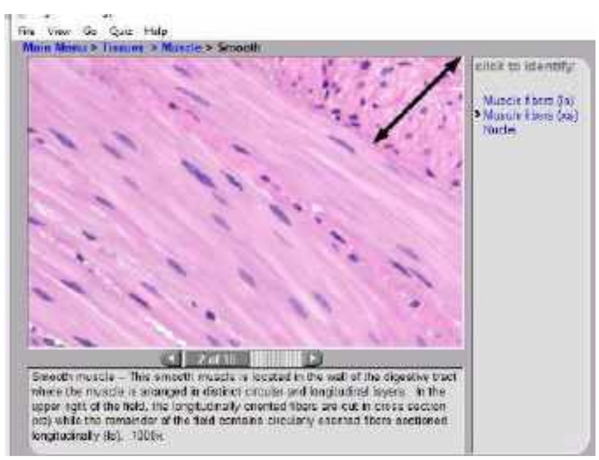
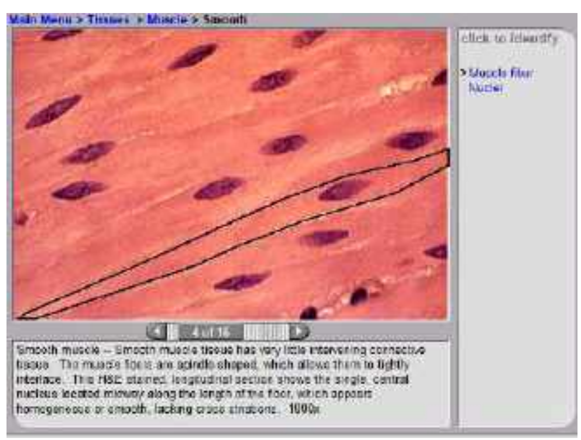
Main Menu > Tissues > Muscle > Cardiac
click to identify:
Muscle fibers
Nucleus
Myofibrils
Capillary
Intercalated disks
Cross striations
Cardiac muscle -- Intercalated disks and myofibrils are shown to advantage in this high magnification image of a longitudinal section of cardiac muscle. 1000x

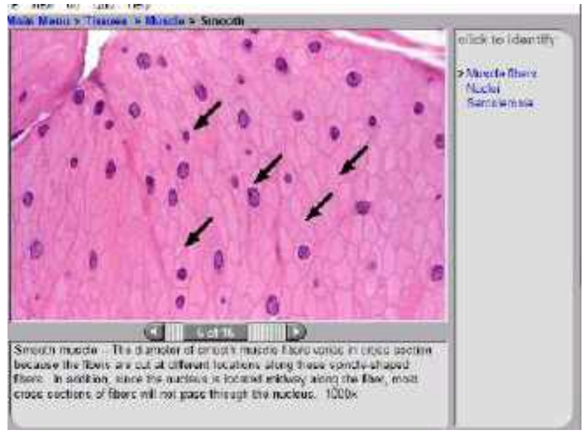

click to identify:
Muscle fibers (ls)
Muscle fibers (xs)
Nuclei
Smooth muscle -- This smooth muscle is located in the wall of the digestive tract where the muscle is arranged in distinct circular and longitudinal layers. In the upper right of the field, the longitudinally oriented fibers are cut in cross section (xs) while the remainder of the field contains circularly oriented fibers sectioned longitudinally (ls). 1000x

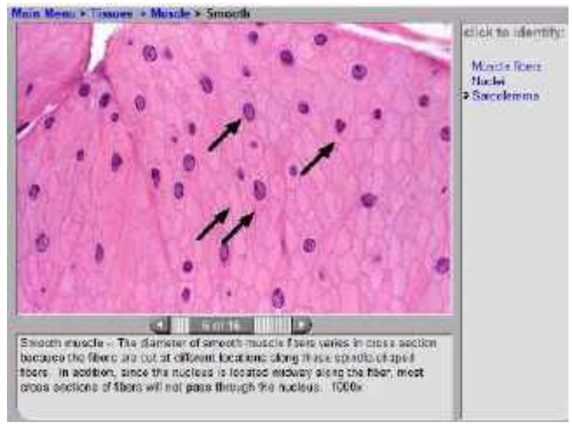

File View Go Quiz Help
Main Menu > Tissues > Muscle > Smooth
click to identify:
Muscle fibers (ls)
Muscle fibers (xs)
Nuclei
Smooth muscle -- This smooth muscle is located in the wall of the digestive tract where the muscle is arranged in distinct circular and longitudinal layers. In the upper right of the field, the longitudinally oriented fibers are cut in cross section (xs) while the remainder of the field contains circularly oriented fibers sectioned longitudinally (ls). 1000x

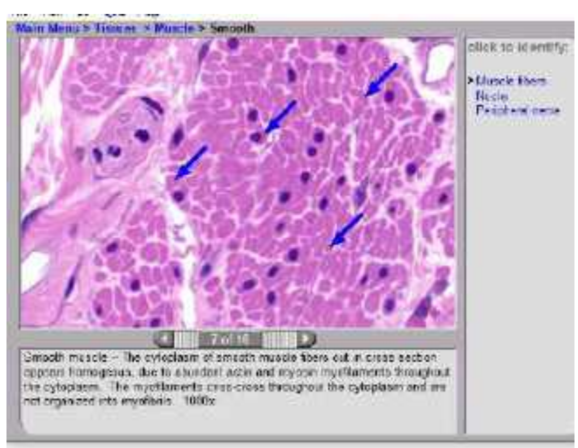

Main Menu > Tissues > Muscle > Smooth
click to identify
> Muscle fibers (ls)
Muscle fibers (xs)
Nuclei
Organelles >
Autonomic >
nerves
3 of 16
Smooth muscle -- Smooth muscle located in the wall of the digestive tract is arranged in distinct circular and longitudinal layers. Because smooth muscle fibers are spindle-shaped with a single, centrally located nucleus, cross sections of this tissue will display profiles of varying diameters, which may or may not contain the nucleus. 1000x

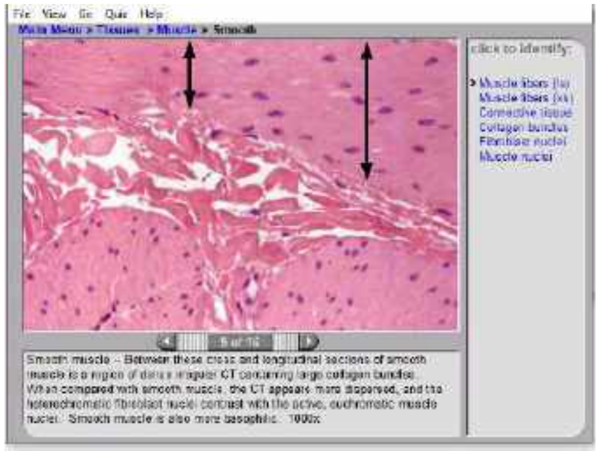

View Go Quit Help
Main Menu > Tissues > Muscle > Smooth
click to identify
Muscle fibers (ls)
> Muscle fibers (xs)
Nuclei
Organelles >
Autonomic >
nerves
3 of 16
Smooth muscle -- Smooth muscle located in the wall of the digestive tract is arranged in distinct circular and longitudinal layers. Because smooth muscle fibers are spindle-shaped with a single, centrally located nucleus, cross sections of this tissue will display profiles of varying diameters, which may or may not contain the nucleus. 1000x


Main Menu > Tissues > Muscle > Smooth
click to identify
> Muscle fiber
Nuclei
4 of 16
Smooth muscle -- Smooth muscle tissue has very little intervening connective tissue. The muscle fibers are spindle shaped, which allows them to tightly interlace. This H&E stained, longitudinal section shows the single, central nucleus located midway along the length of the fiber, which appears homogeneous or smooth, lacking cross striations. 1000x

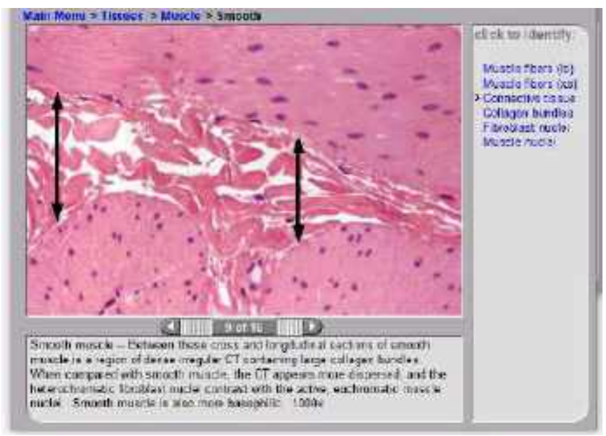

Main Menu > Tissues > Muscle > Smooth
click to identify
> Muscle fibers
Nuclei
Sarcolemma
Smooth muscle – The diameter of smooth muscle fibers varies in cross section because the fibers are cut at different locations along these spindle-shaped fibers. In addition, since the nucleus is located midway along the fiber, most cross sections of fibers will not pass through the nucleus. 1000x


Main Menu > Tissues > Muscle > Smooth
click to identify:
Muscle fibers
Nuclei
> Sarcolemma
Smooth muscle – The diameter of smooth muscle fibers varies in cross section because the fibers are cut at different locations along these spindle-shaped fibers. In addition, since the nucleus is located midway along the fiber, most cross sections of fibers will not pass through the nucleus. 1000x

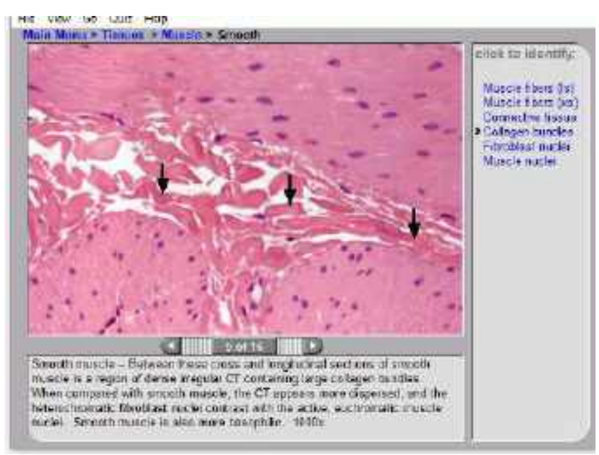

Main Menu > Tissues > Muscle > Smooth
click to identify:
> Muscle fibers
Nuclei
Peripheral nerve
Smooth muscle – The cytoplasm of smooth muscle fibers cut in cross section appears homogeneous, due to abundant actin and myosin myofilaments throughout the cytoplasm. The myofilaments criss-cross throughout the cytoplasm and are not organized into myofibrils. 1000x



File View Go Quiz Help
Main Menu > Tissues > Muscle > Smooth
click to identify:
Muscle fibers (ls)
Muscle fibers (xs)
Connective tissue
Collagen bundles
Fibroblast nuclei
Muscle nuclei
Smooth muscle – Between these cross and longitudinal sections of smooth muscle is a region of dense irregular CT containing large collagen bundles. When compared with smooth muscle, the CT appears more dispersed, and the heterochromatic fibroblast nuclei contrast with the active, euchromatic muscle nuclei. Smooth muscle is also more basophilic. 1000x



Main Menu > Tissues > Muscle > Smooth
click to identify:
Muscle fibers (ls)
Muscle fibers (xs)
Connective tissue
Collagen bundles
Fibroblast nuclei
Muscle nuclei
9 of 16
Smooth muscle – Between these cross and longitudinal sections of smooth muscle is a region of dense irregular CT containing large collagen bundles. When compared with smooth muscle, the CT appears more dispersed, and the heterochromatic fibroblast nuclei contrast with the active, euchromatic muscle nuclei. Smooth muscle is also more basophilic. 1000x



Main Menu > Tissues > Muscle > Smooth
click to identify:
Muscle fibers (ls)
Muscle fibers (xs)
Connective tissue
Collagen bundles
Fibroblast nuclei
Muscle nuclei
9 of 16
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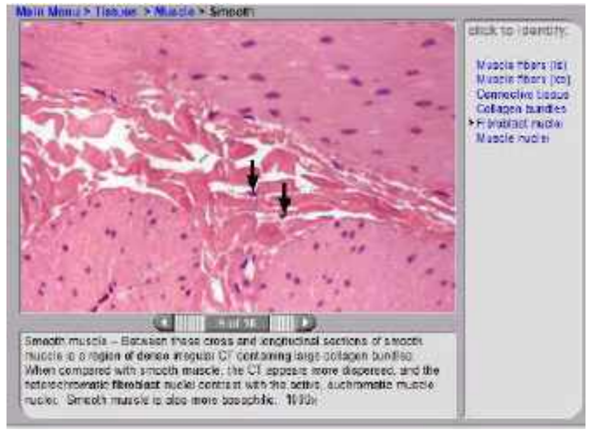
Main Menu > Tissues > Muscle > Smooth
click to identify:
Muscle fibers (ls)
Muscle fibers (cs)
Connective tissue
Collagen bundles
Fibroblast nuclei
Muscle nuclei
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click to identify:
Muscle fibers (ls)
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Collagen bundles
Fibroblast nuclei
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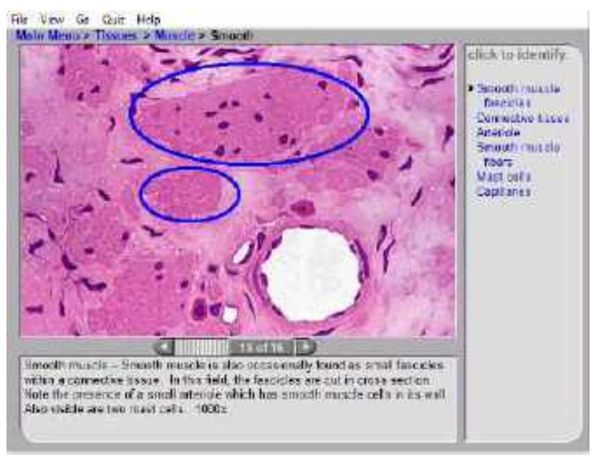
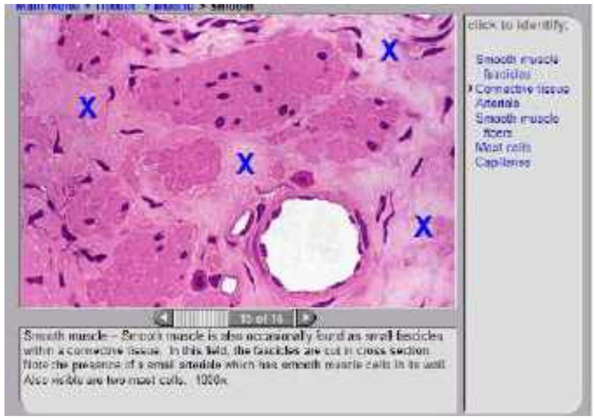

File View Go Quiz Help
Main Menu > Tissues > Muscle > Smooth
click to identify:
Smooth muscle fascicles
Connective tissue
Arteriole
Smooth muscle fibers
Mast cells
Capillaries
Smooth muscle – Smooth muscle is also occasionally found as small fascicles within a connective tissue. In this field, the fascicles are cut in cross section. Note the presence of a small arteriole which has smooth muscle cells in its wall. Also visible are two mast cells. 1000x



Main Menu > Tissues > Muscle > Smooth
X
X
X
X
click to identify:
Smooth muscle fascicles
Connective tissue
Arteriole
Smooth muscle fibers
Mast cells
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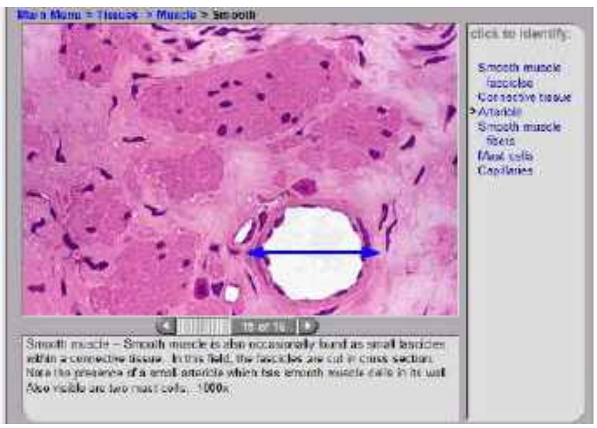

Main Menu > Tissues > Muscle > Smooth
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Connective tissue
Arteriole
Smooth muscle fibers
Mast cells
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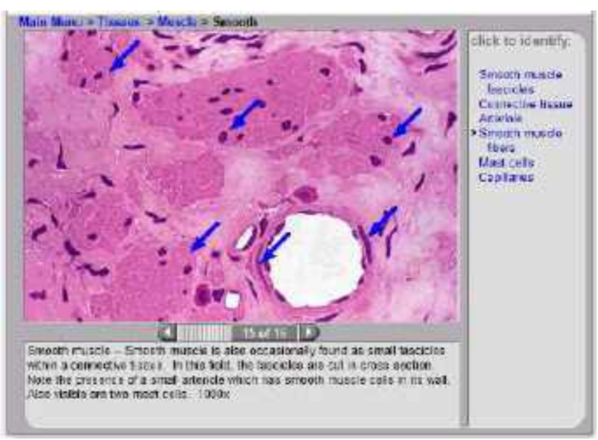

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click to identify:
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Connective tissue
Arteriole
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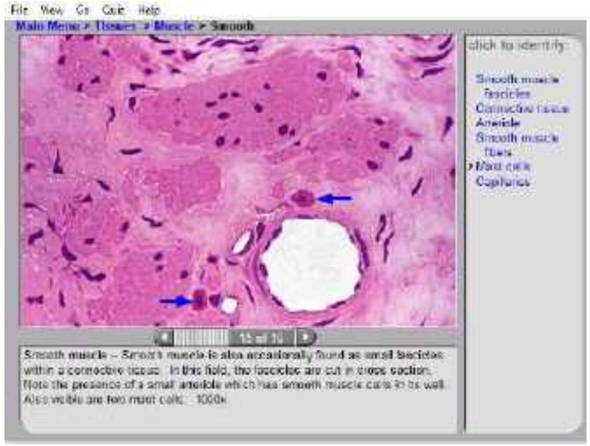
File View Go Quiz Help
Main Menu > Tissues > Muscle > Smooth
click to identify:
Smooth muscle fascicles
Connective tissue
Arteriole
Smooth muscle fibers
Mast cells
Capillaries
15 of 16
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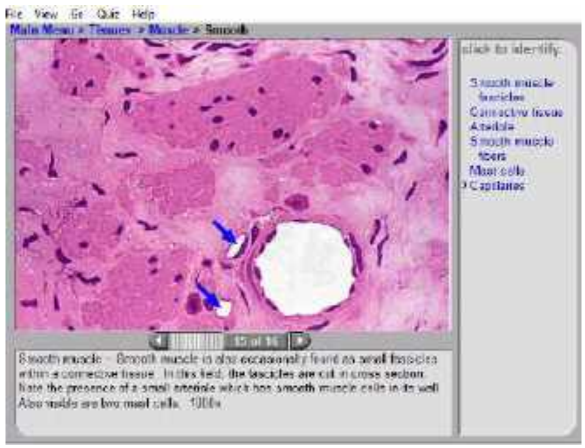
File View Go Quiz Help
Main Menu > Tissues > Muscle > Smooth
click to identify:
Smooth muscle fascicles
Connective tissue
Arteriole
Smooth muscle fibers
Mast cells
Capillaries
15 of 16
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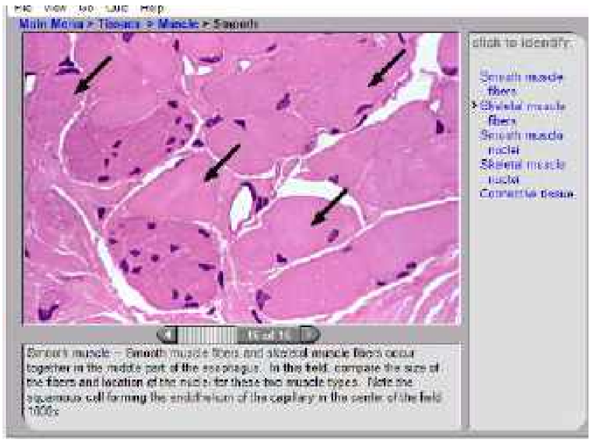
click to identify:
Smooth muscle fibers
Skeletal muscle fibers
Smooth muscle nuclei
Skeletal muscle nuclei
Connective tissue
16 of 16
Smooth muscle – Smooth muscle fibers and skeletal muscle fibers occur together in the middle part of the esophagus. In this field, compare the size of the fibers and location of the nuclei for these two muscle types. Note the squamous cell forming the endothelium of the capillary in the center of the field. 1000x


File View Go Quiz Help
Main Menu > Tissues > Muscle > Smooth
click to identify:
Smooth muscle fibers
Skeletal muscle fibers
Smooth muscle nuclei
Skeletal muscle nuclei
Connective tissue
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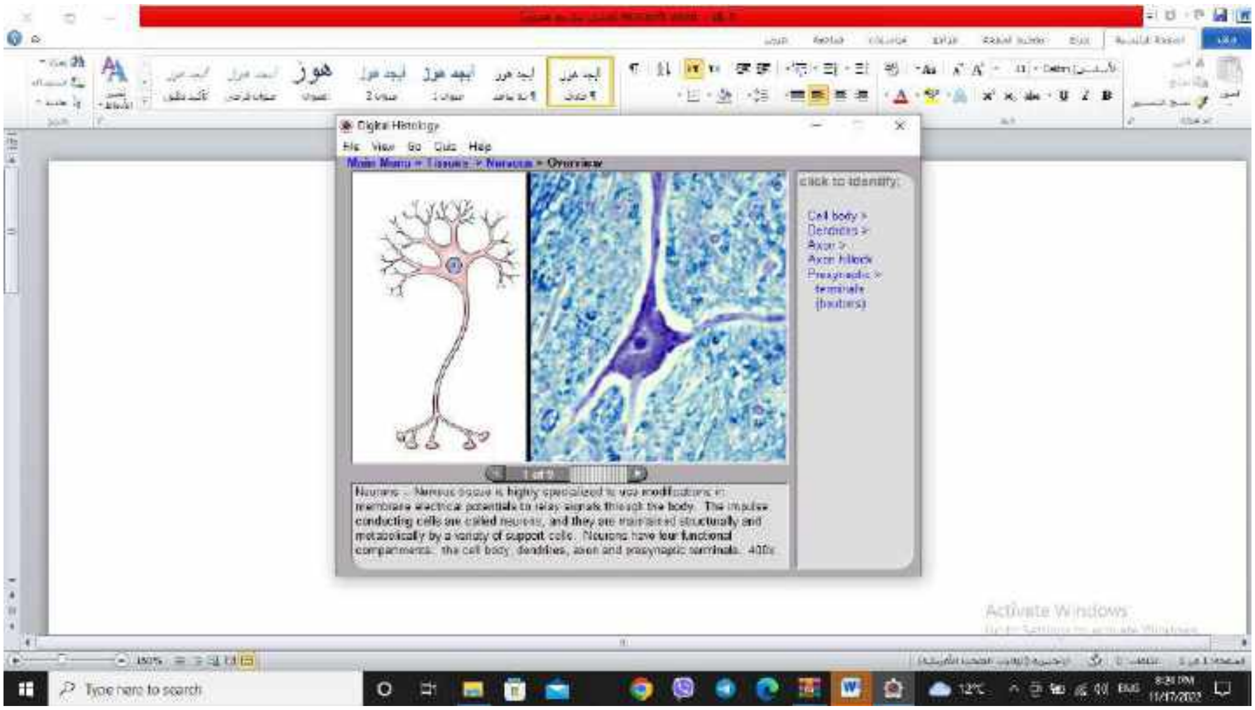
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Cell body >
Dendrites >
Axon >
Axon hillock
Presynaptic >
terminals
(boutons)
Neurons -- Nervous tissue is highly specialized to use modifications in membrane electrical potentials to relay signals through the body. The impulse conducting cells are called neurons, and they are maintained structurally and metabolically by a variety of support cells. Neurons have four functional compartments: the cell body, dendrites, axon and presynaptic terminals. 400x
Activate Windows
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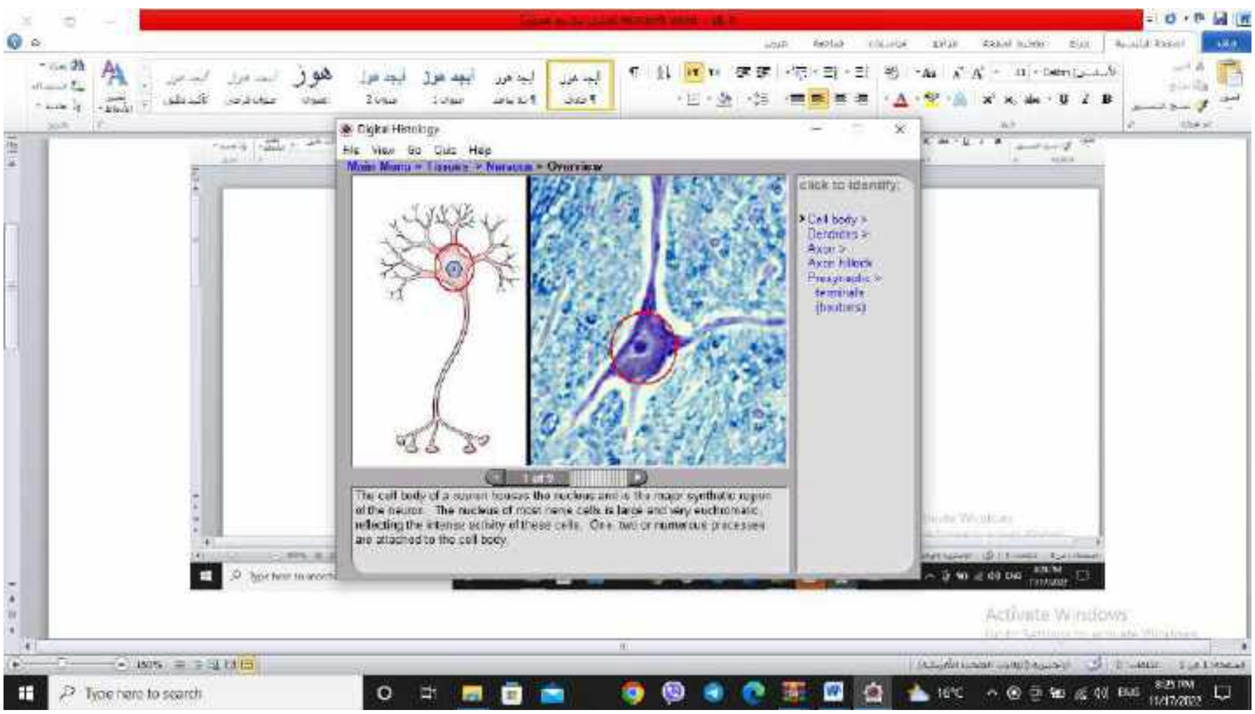
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Cell body >
Dendrites >
Axon >
Axon hillock
Presynaptic >
terminals
(boutons)
The cell body of a neuron houses the nucleus and is the major synthetic region of the neuron. The nucleus of most nerve cells is large and very euchromatic, reflecting the intense activity of these cells. One, two or numerous processes are attached to the cell body.
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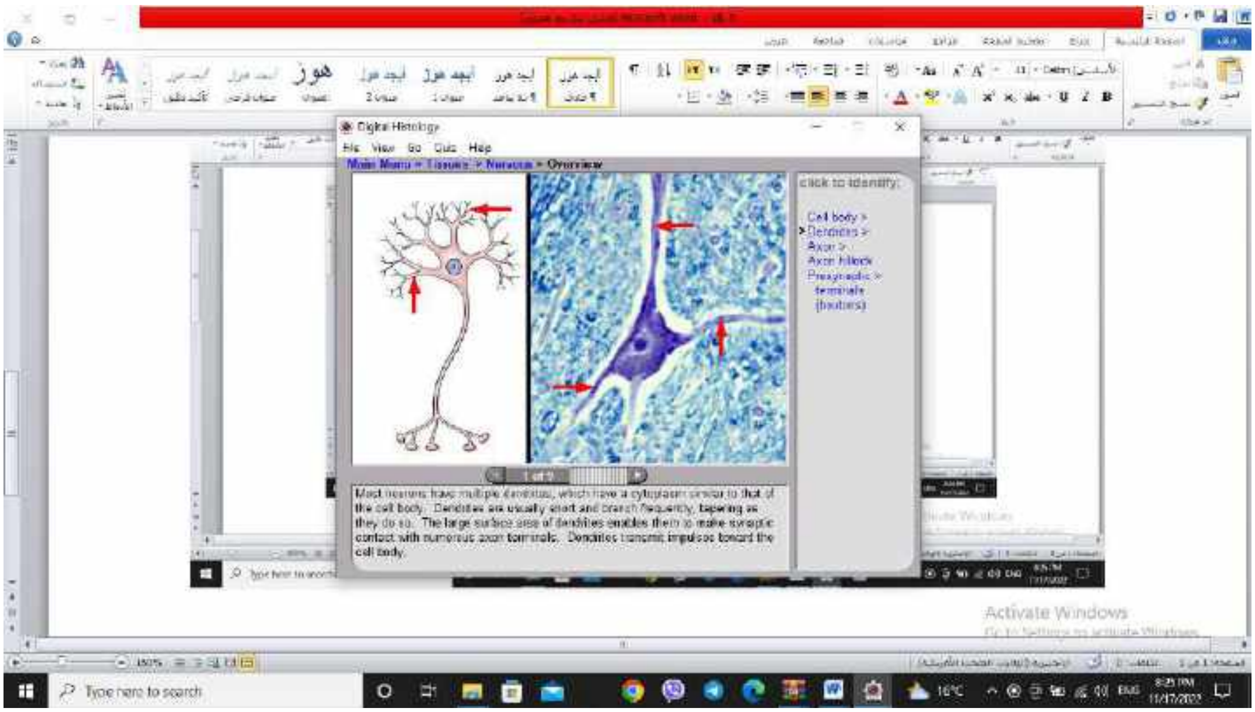
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Cell body >
Dendrites >
Axon >
Axon hillock
Presynaptic > terminals (boutons)
Most neurons have multiple dendrites, which have a cytoplasm similar to that of the cell body. Dendrites are usually short and branch frequently, tapering as they do so. The large surface area of dendrites enables them to make synaptic contact with numerous axon terminals. Dendrites transmit impulses toward the cell body.
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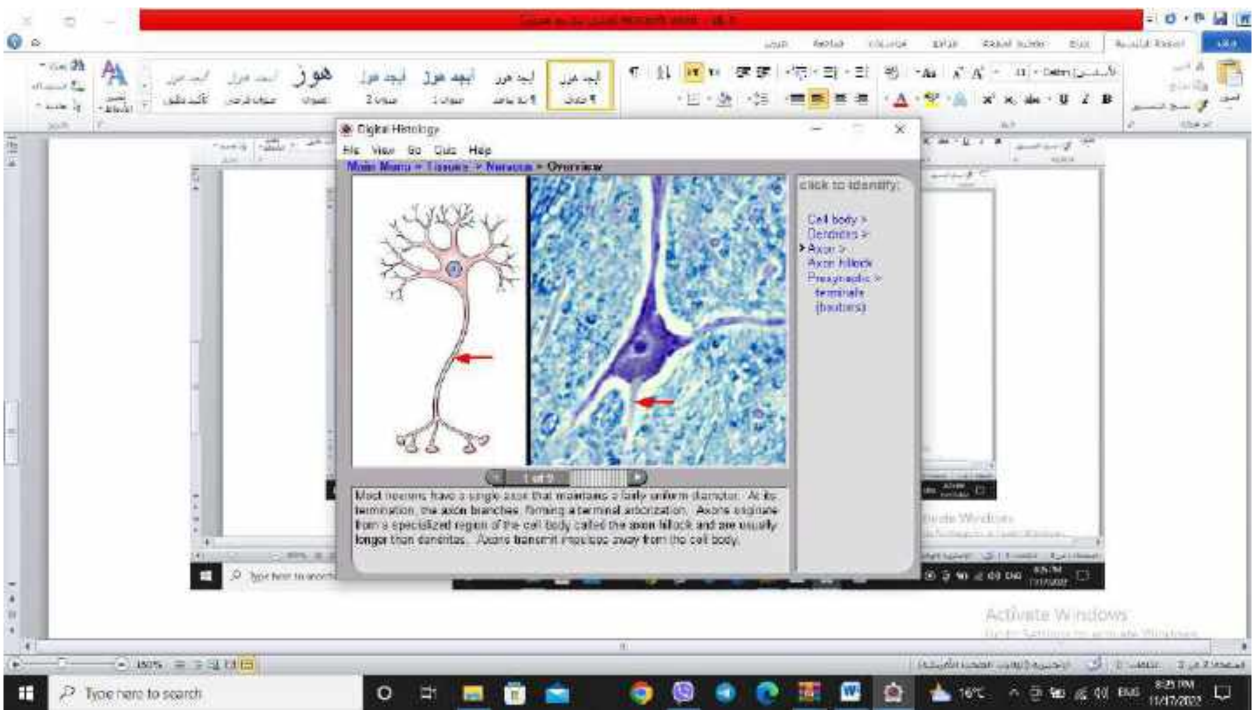
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Cell body >
Dendrites >
Axon >
Axon hillock
Presynaptic > terminals (boutons)
Most neurons have a single axon that maintains a fairly uniform diameter. At its termination, the axon branches, forming a terminal arborization. Axons originate from a specialized region of the cell body called the axon hillock and are usually longer than dendrites. Axons transmit impulses away from the cell body.
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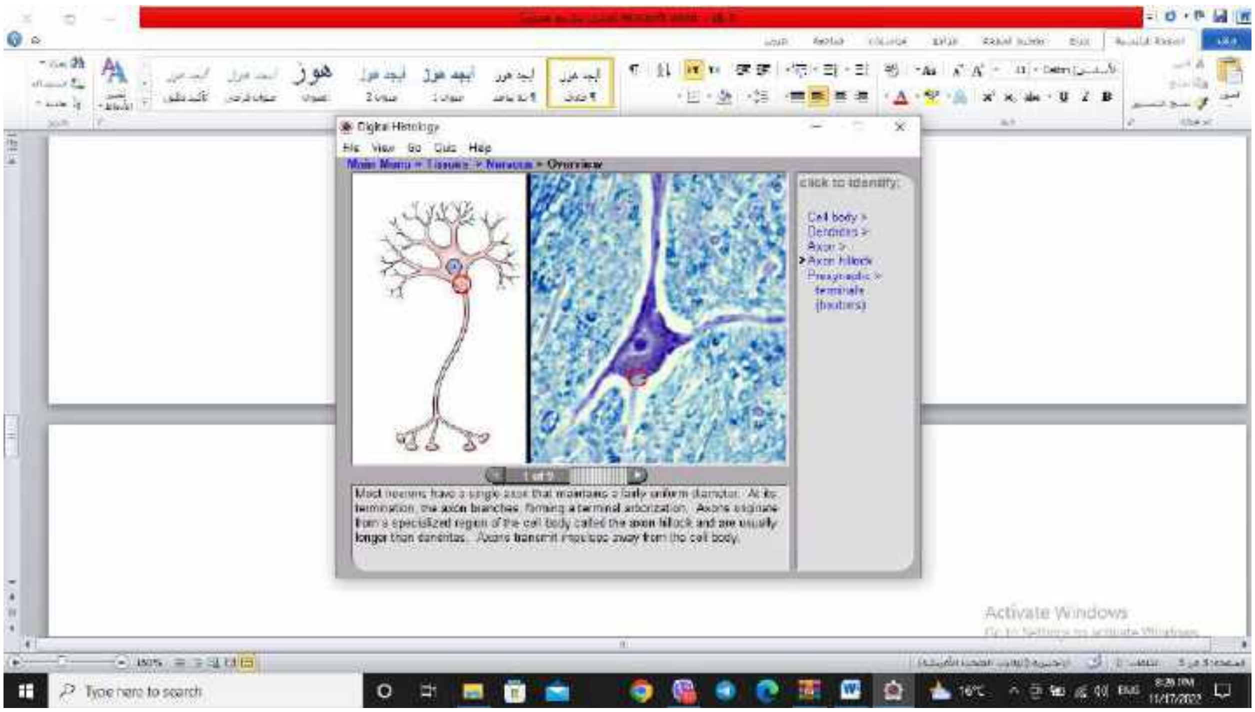
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Cell body >
Dendrites >
Axon >
> Axon hillock
Presynaptic > terminals (boutons)
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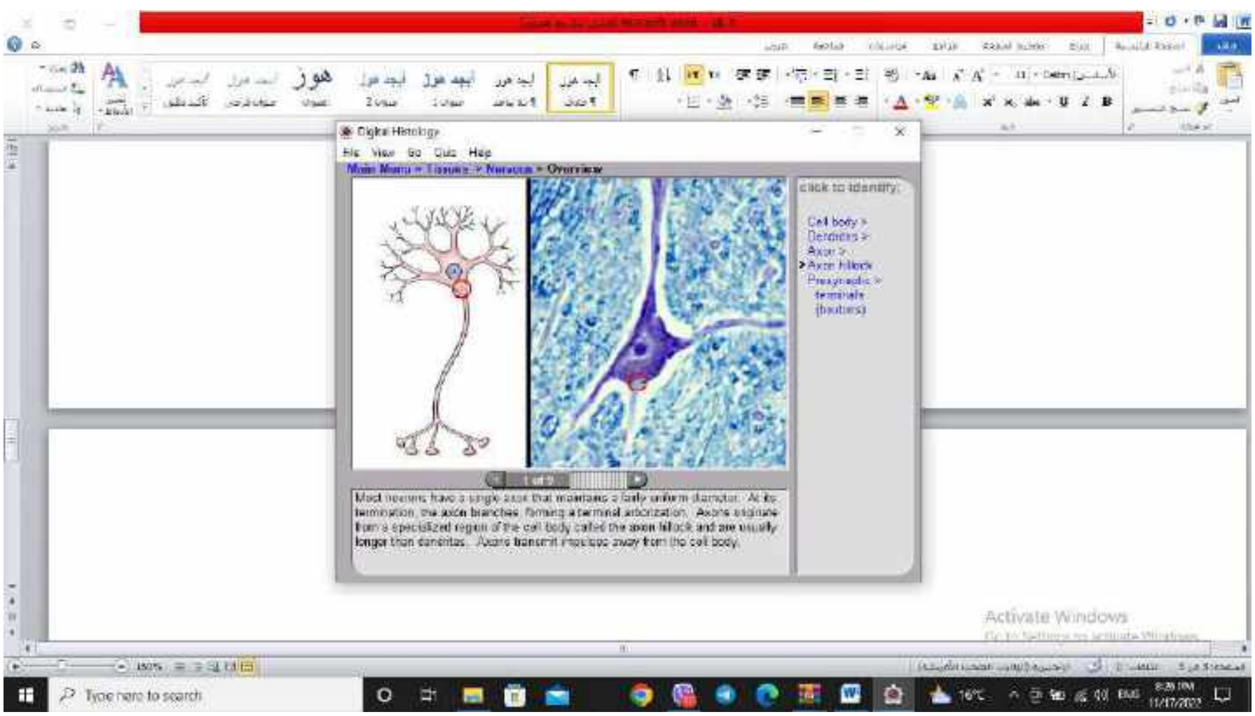
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Cell body >
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Presynaptic > terminals (boutons)
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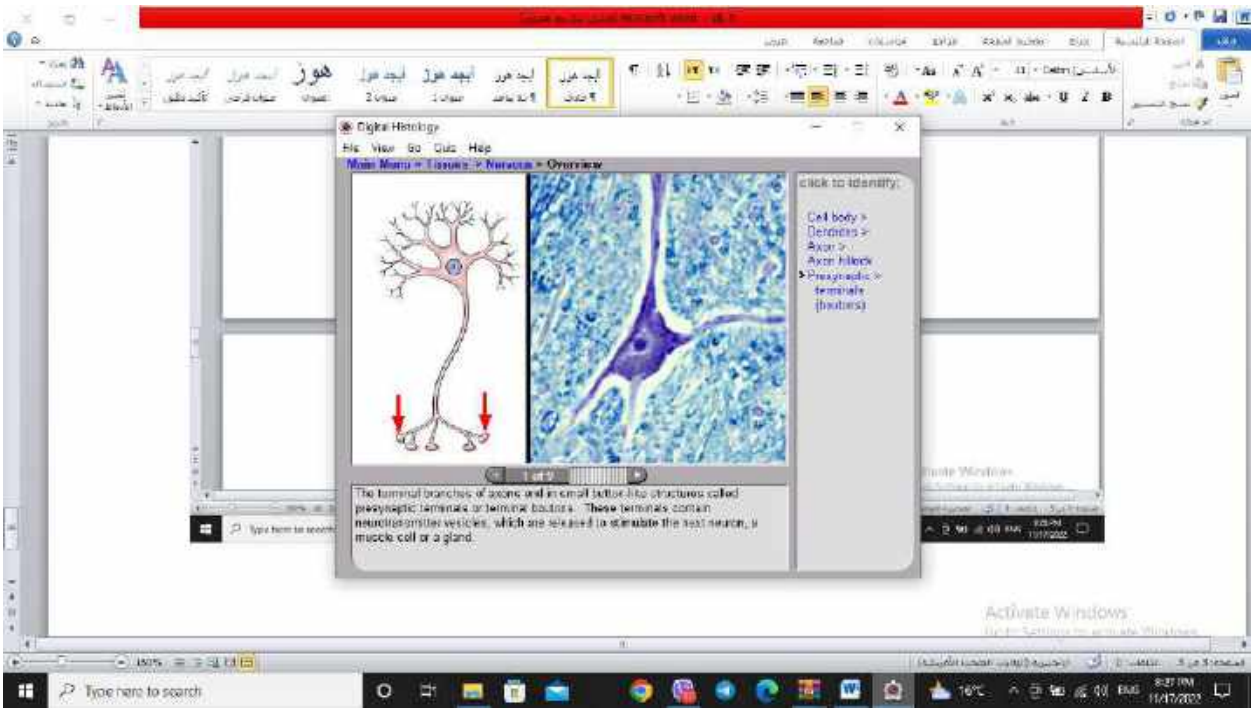
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Cell body >
Dendrites >
Axon >
Axon hillock
Presynaptic > terminals (boutons)
The terminal branches of axons end in small button-like structures called presynaptic terminals or terminal boutons. These terminals contain neurotransmitter vesicles, which are released to stimulate the next neuron, a muscle cell or a gland.
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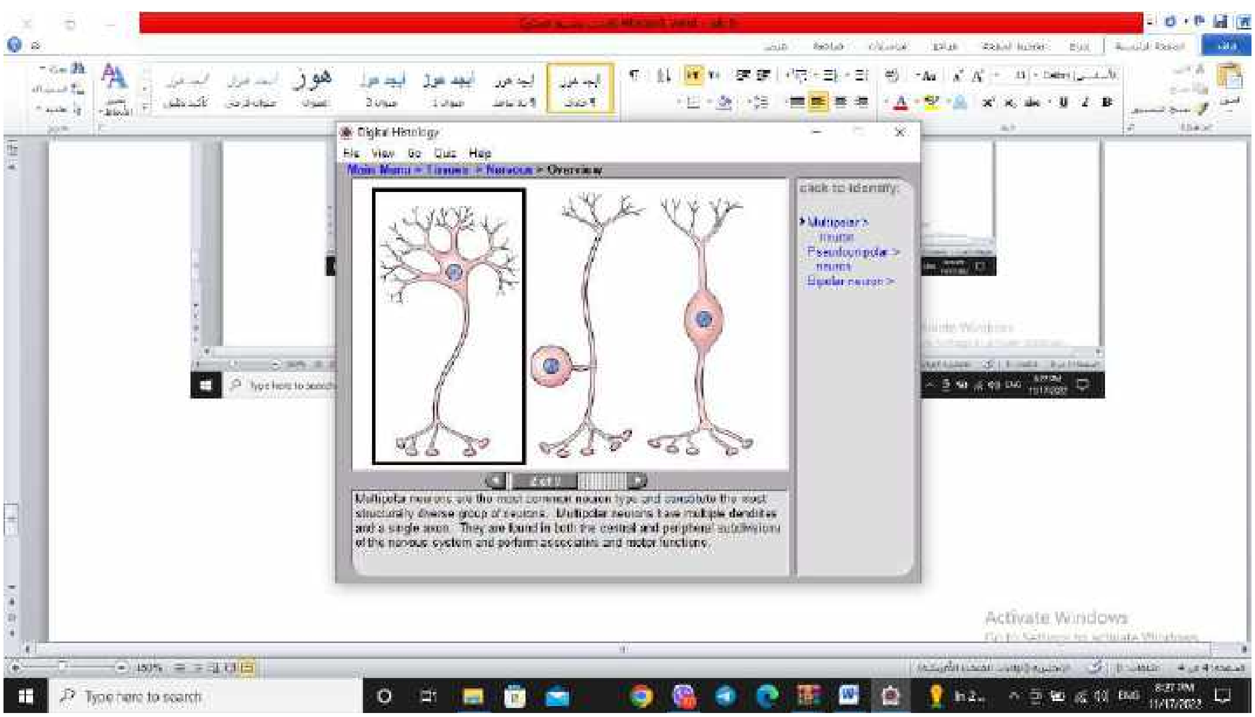
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Multipolar > neuron
Pseudounipolar > neuron
Bipolar neuron >
Multipolar neurons are the most common neuron type and constitute the most structurally diverse group of neurons. Multipolar neurons have multiple dendrites and a single axon. They are found in both the central and peripheral subdivisions of the nervous system and perform associative and motor functions.
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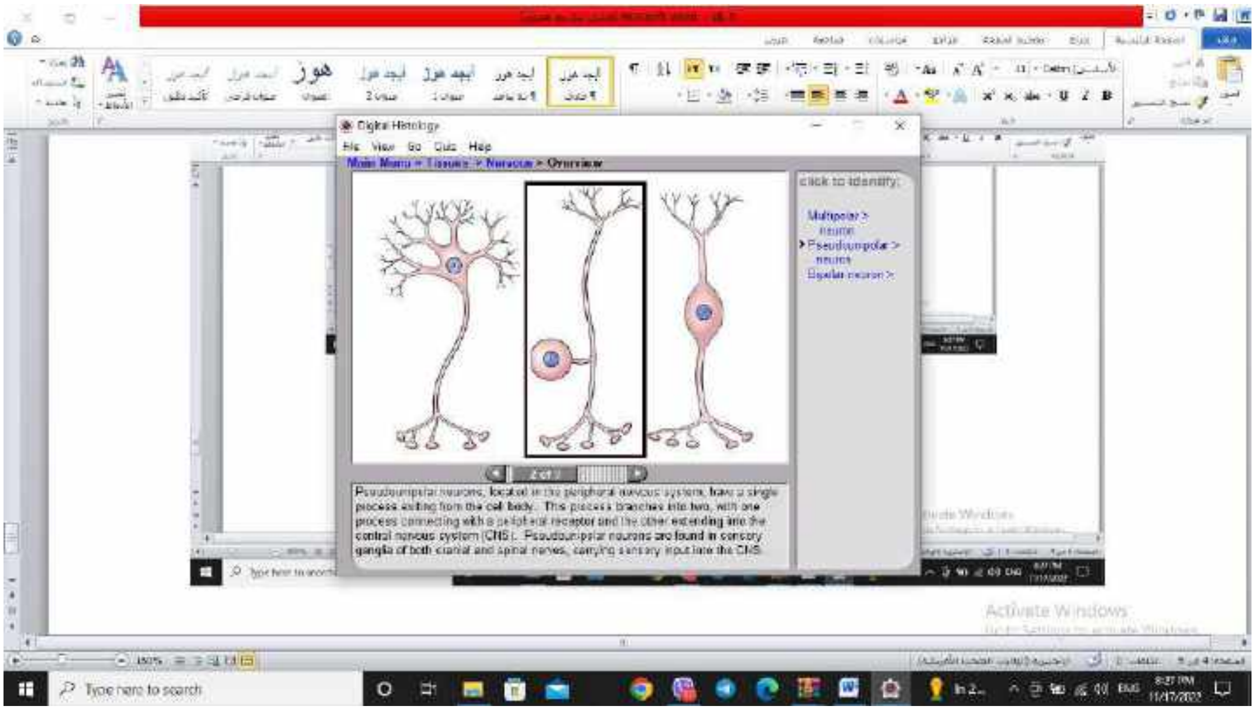
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Multipolar > neuron
Pseudounipolar > neuron
Bipolar neuron >
Pseudounipolar neurons, located in the peripheral nervous system, have a single process exiting from the cell body. This process branches into two, with one process connecting with a peripheral receptor and the other extending into the central nervous system (CNS). Pseudounipolar neurons are found in sensory ganglia of both cranial and spinal nerves, carrying sensory input into the CNS.
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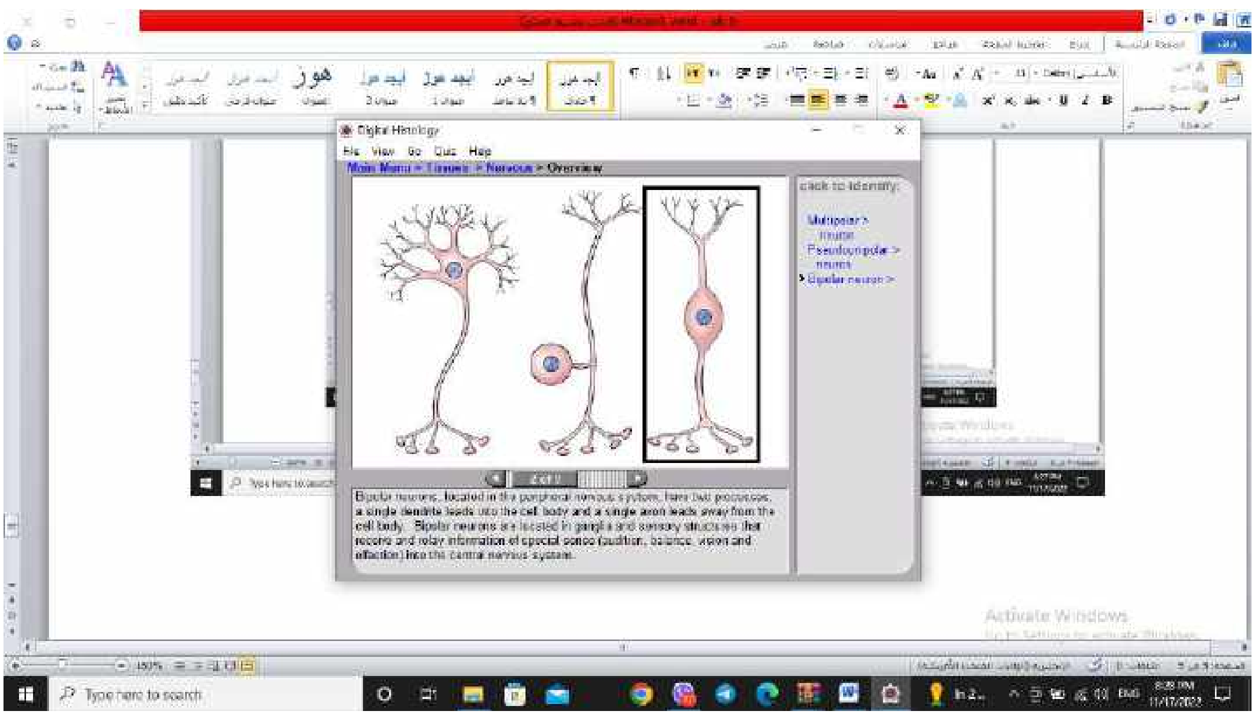
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Multipolar > neuron
Pseudounipolar > neuron
Bipolar neuron >
Bipolar neurons, located in the peripheral nervous system, have two processes, a single dendrite leads into the cell body and a single axon leads away from the cell body. Bipolar neurons are located in ganglia and sensory structures that receive and relay information of special sense (audition, balance, vision and olfaction) into the central nervous system.
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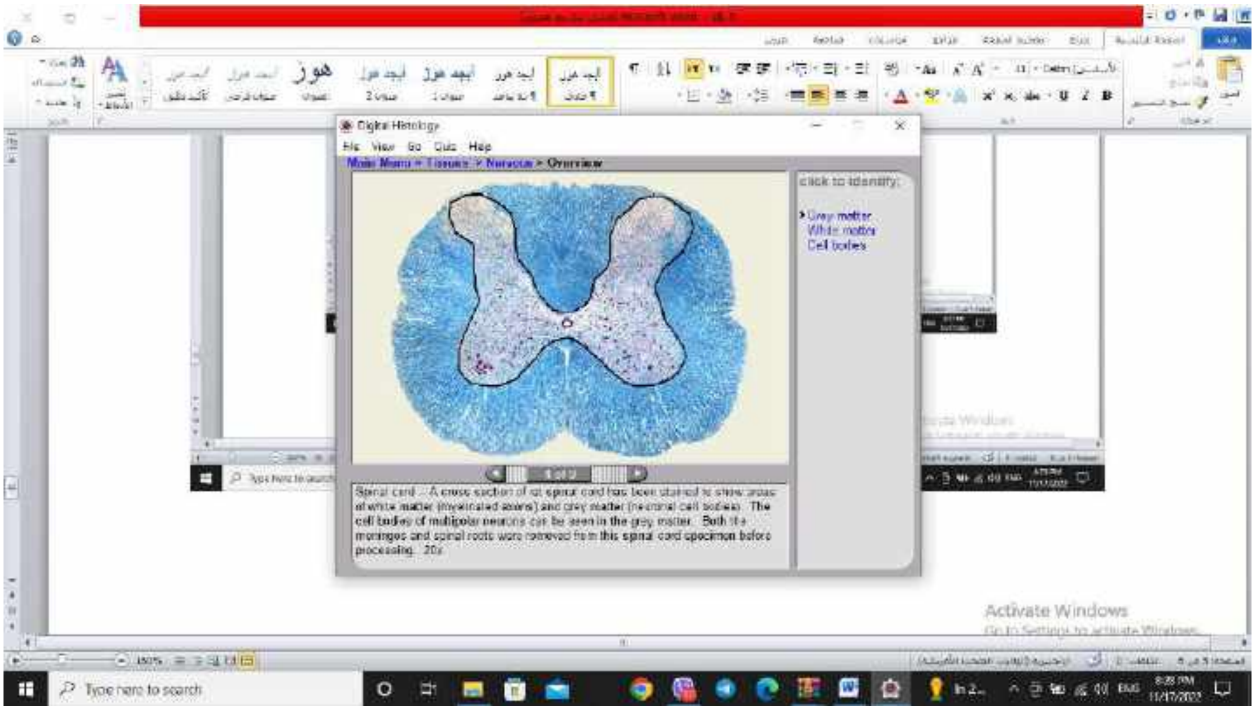
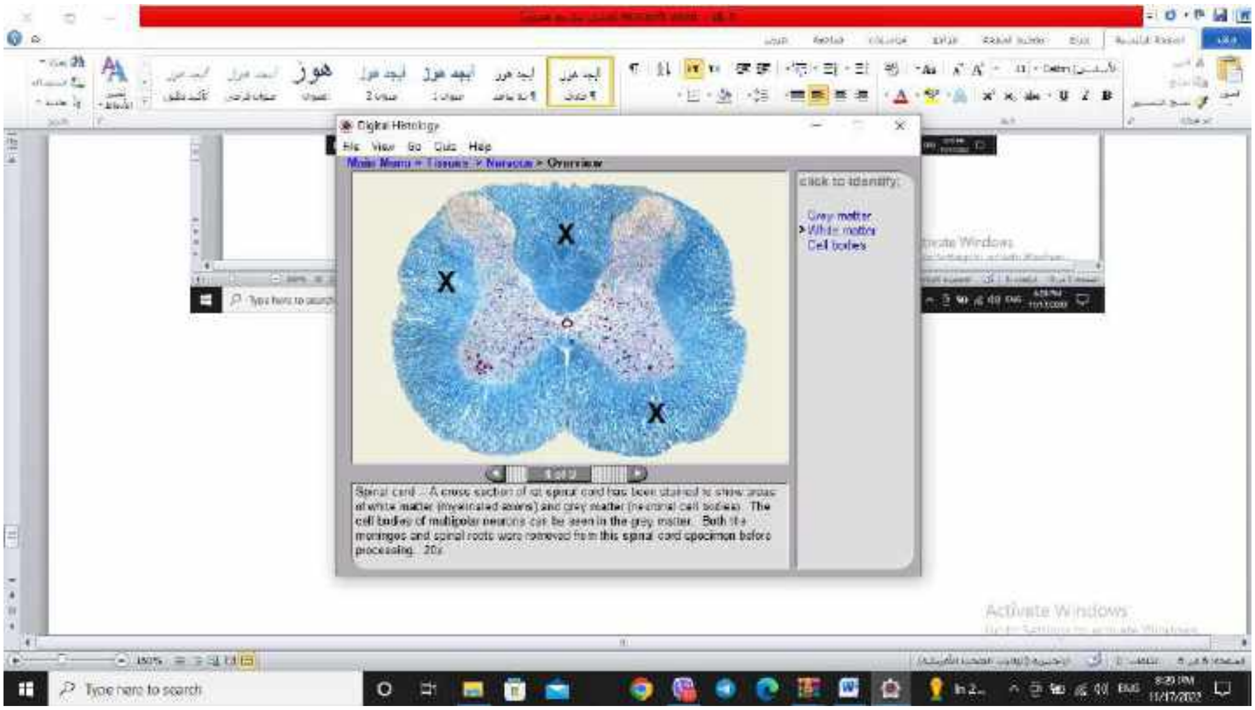


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Grey matter
White matter
Cell bodies
Spinal cord – A cross section of rat spinal cord has been stained to show areas of white matter (myelinated axons) and grey matter (neuronal cell bodies). The cell bodies of multipolar neurons can be seen in the grey matter. Both the meninges and spinal roots were removed from this spinal cord specimen before processing. 20x
Activate Windows
Go to Settings to activate Windows.
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Grey matter
White matter
Cell bodies
X
X
X
X
Spinal cord -- A cross section of rat spinal cord has been stained to show areas of white matter (myelinated axons) and grey matter (neuronal cell bodies). The cell bodies of multipolar neurons can be seen in the grey matter. Both the meninges and spinal roots were removed from this spinal cord specimen before processing. 20x
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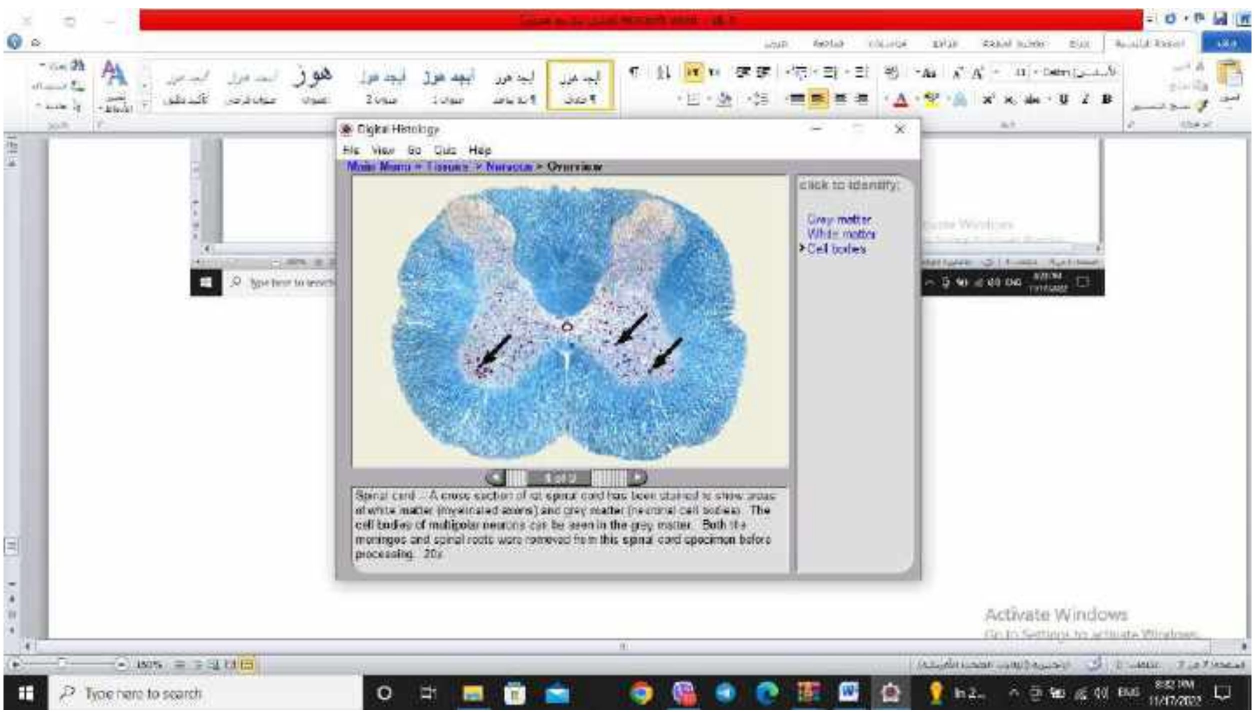
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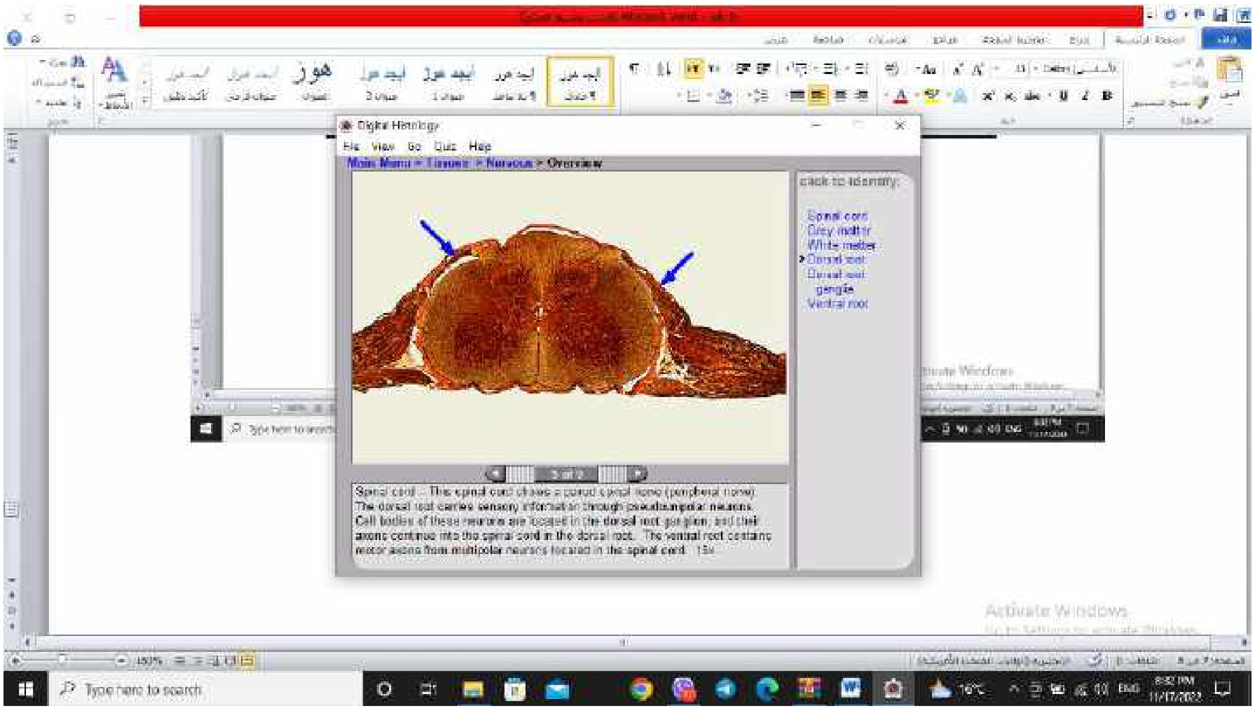
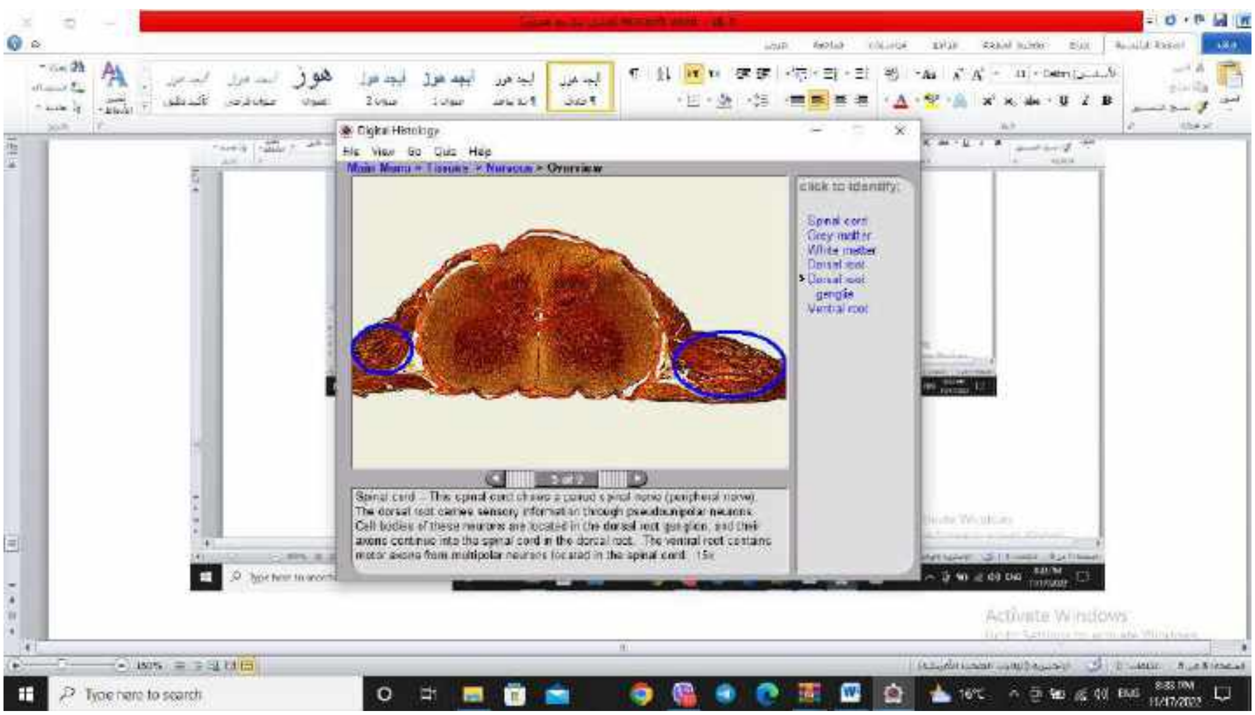

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Spinal cord
Grey matter
White matter
Dorsal root
Dorsal root ganglia
Ventral root
Spinal cord – This spinal cord shows a paired spinal nerve (peripheral nerve). The dorsal root carries sensory information through pseudounipolar neurons. Cell bodies of these neurons are located in the dorsal root ganglion, and their axons continue into the spinal cord in the dorsal root. The ventral root contains motor axons from multipolar neurons located in the spinal cord. 15x
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
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Grey matter
White matter
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Dorsal root ganglia
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Activate Windows
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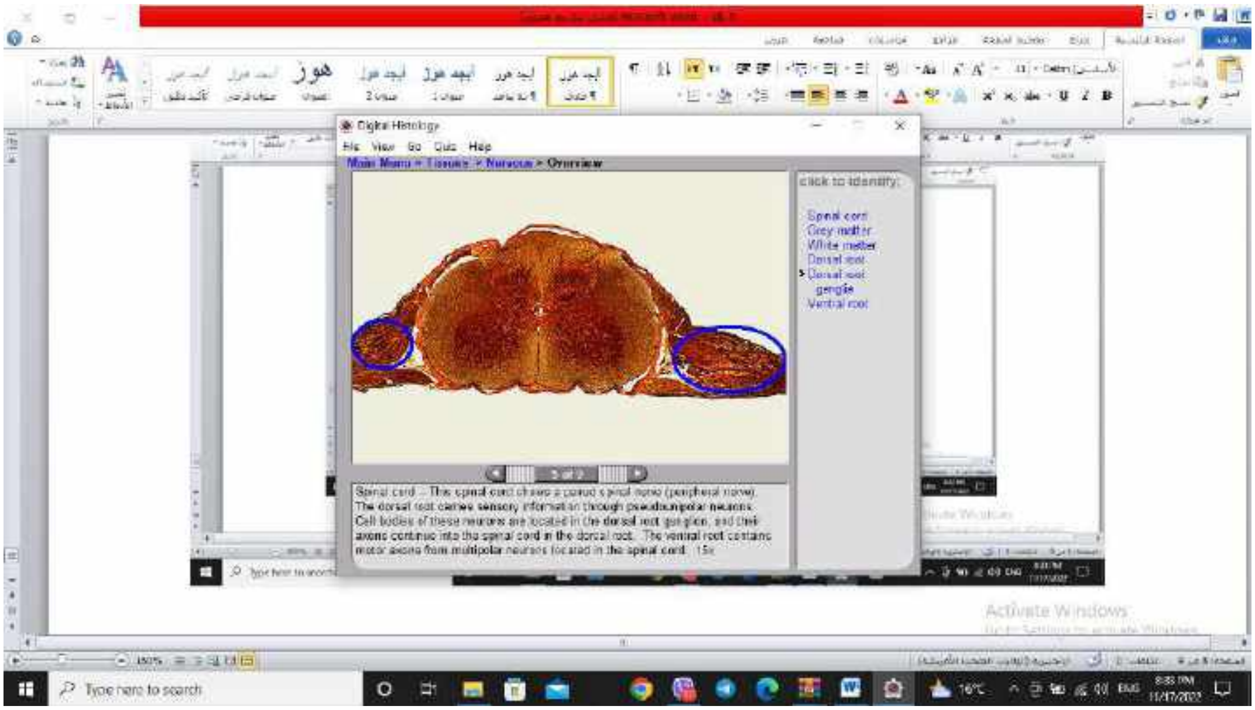
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
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Grey matter
White matter
Dorsal root
Dorsal root ganglia
Ventral root
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motor axons from multipolar neurons located in the spinal cord. 15x
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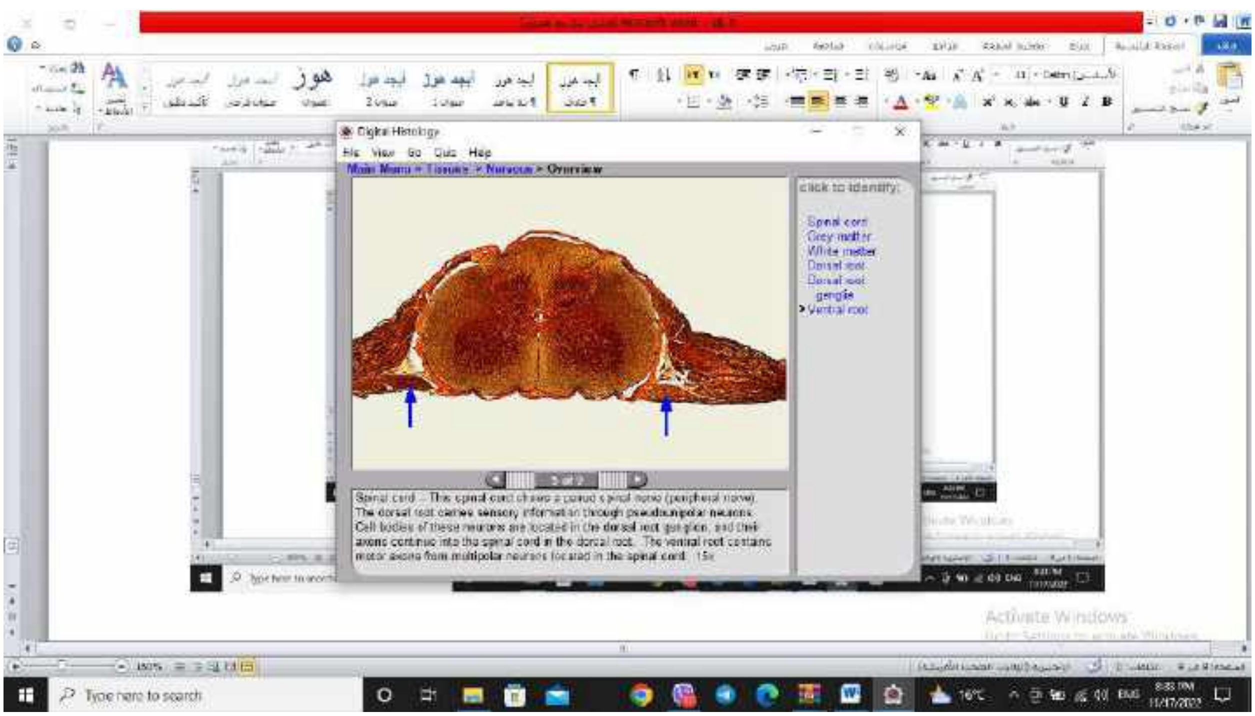
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Grey matter
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Dorsal root
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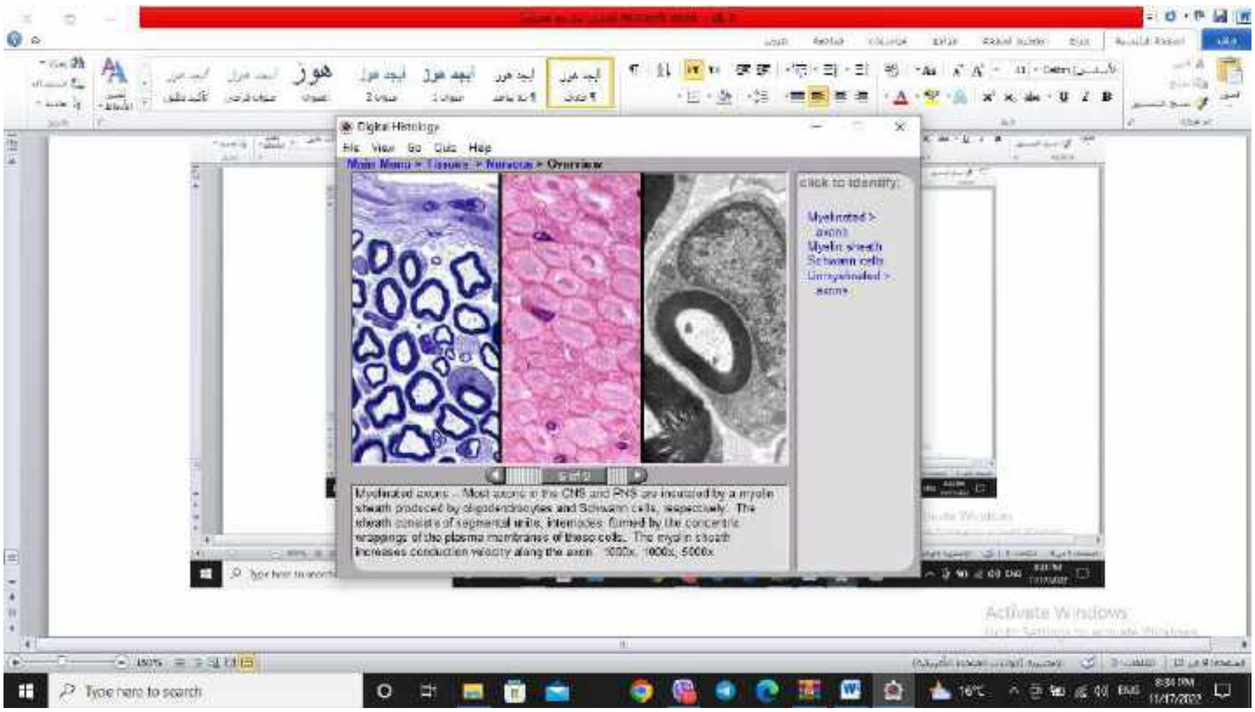
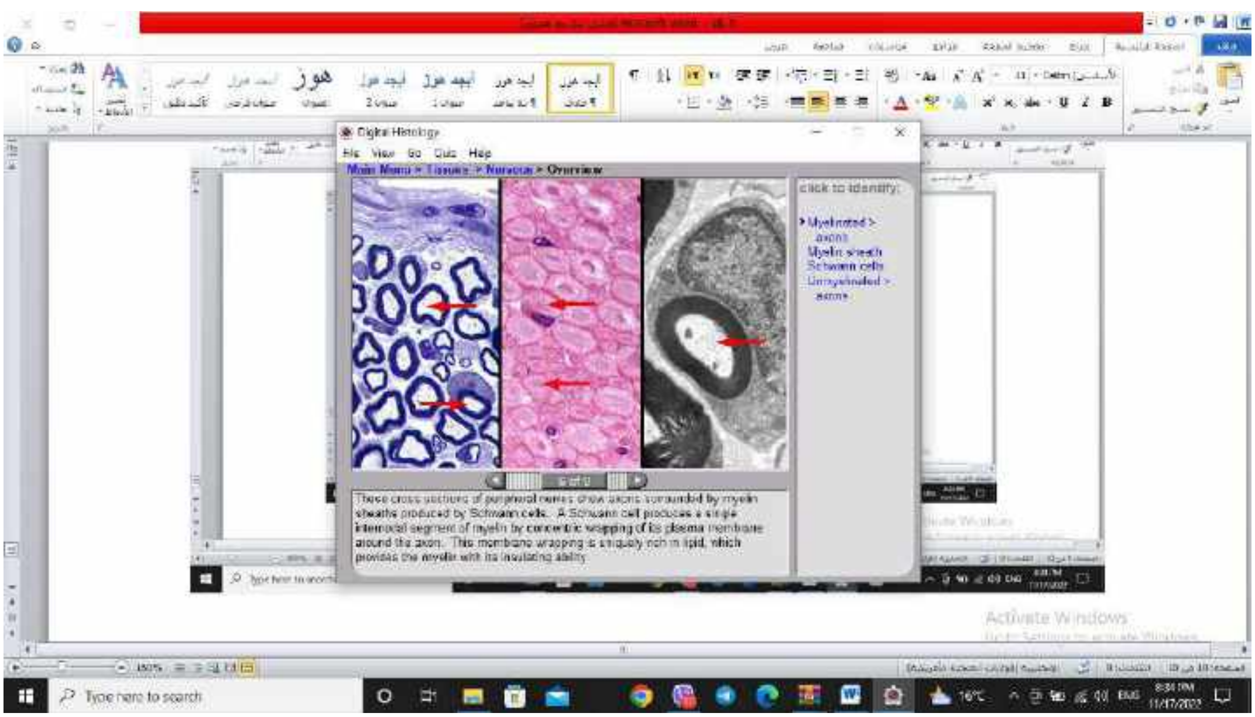
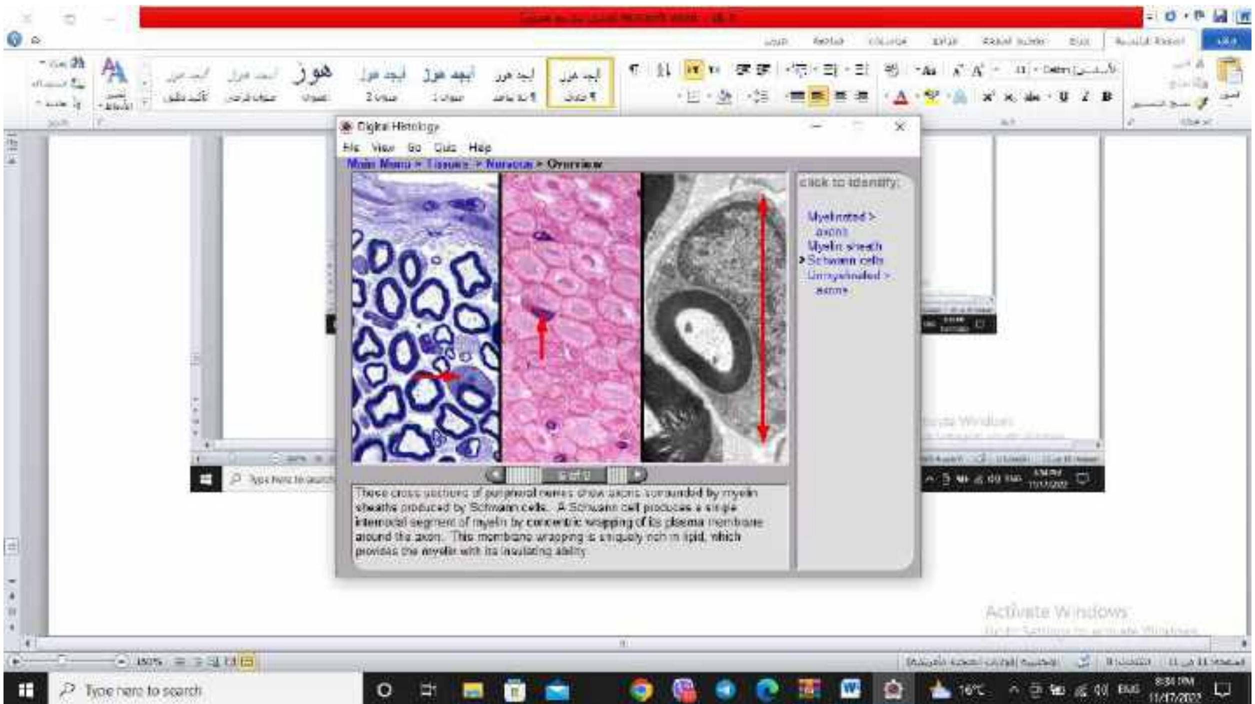

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Myelinated > axons
Myelin sheath
Schwann cells
Unmyelinated > axons
Myelinated axons – Most axons in the CNS and PNS are insulated by a myelin sheath produced by oligodendrocytes and Schwann cells, respectively. The sheath consists of segmental units, internodes formed by the concentric wrappings of the plasma membranes of these cells. The myelin sheath increases conduction velocity along the axon. 1000x, 1000x, 5000x
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Myelinated > axons
Myelin sheath
Schwann cells
Unmyelinated > axons
These cross sections of peripheral nerves show axons surrounded by myelin sheaths produced by Schwann cells. A Schwann cell produces a single internodal segment of myelin by concentric wrapping of its plasma membrane around the axon. This membrane wrapping is uniquely rich in lipid, which provides the myelin with its insulating ability.
Activate Windows
Type here to search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Myelin sheath
Schwann cells
Unmyelinated > axons
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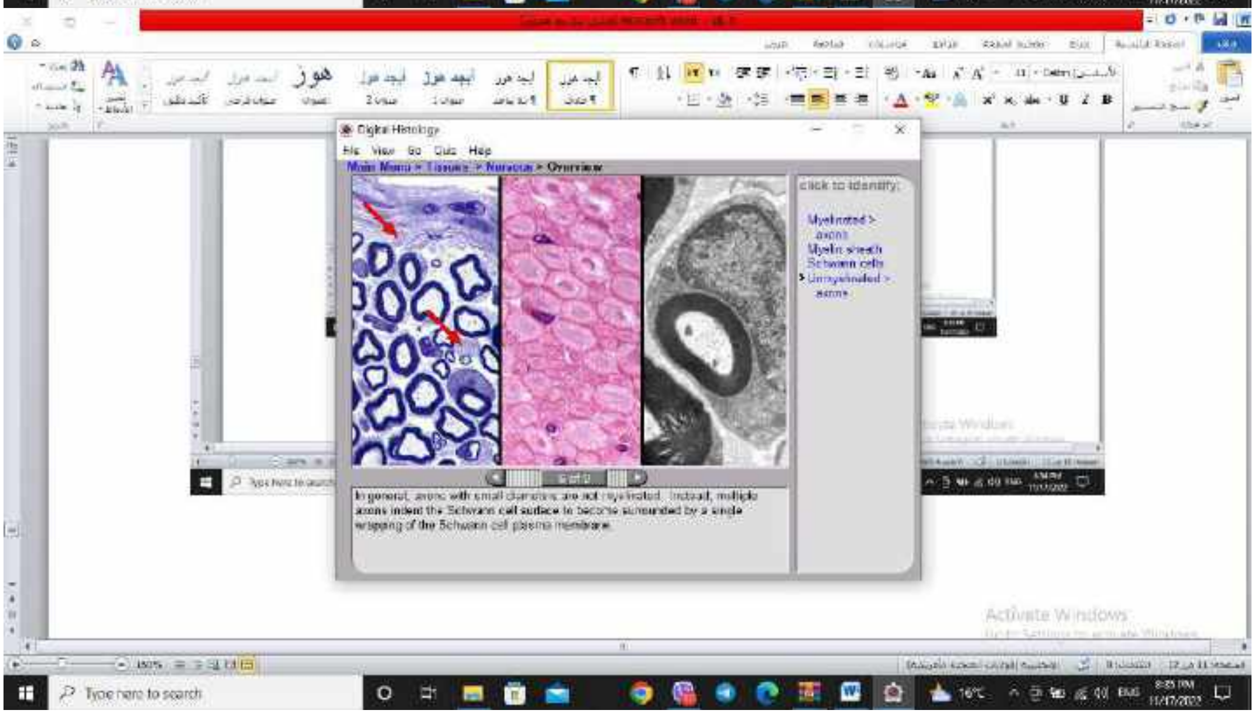
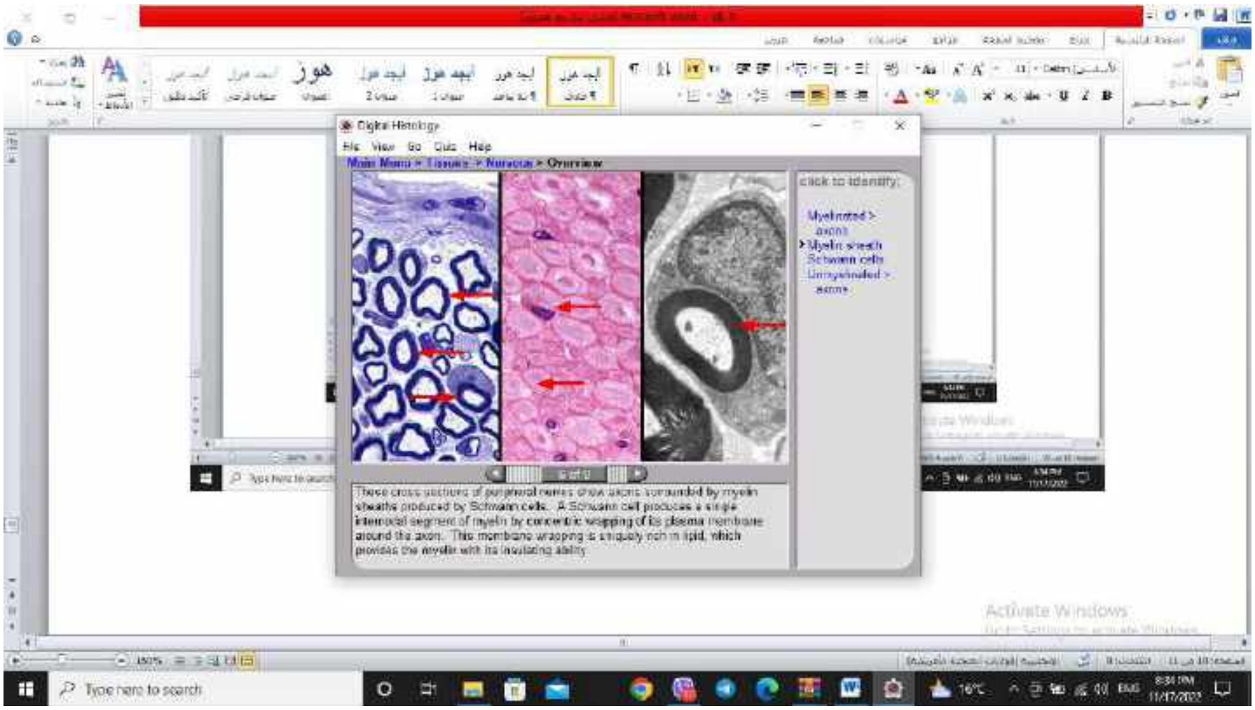

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Myelinated > axons
Myelin sheath
Schwann cells
Unmyelinated > axons
In general, axons with small diameters are not myelinated. Instead, multiple axons indent the Schwann cell surface to become surrounded by a single wrapping of the Schwann cell plasma membrane.
Activate Windows
Type here to search



Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Myelinated > axons
Myelin sheath
Schwann cells
Unmyelinated > axons
These cross sections of peripheral nerves show axons surrounded by myelin sheaths produced by Schwann cells. A Schwann cell produces a single internodal segment of myelin by concentric wrapping of its plasma membrane around the axon. This membrane wrapping is uniquely rich in lipid, which provides the myelin with its insulating ability.
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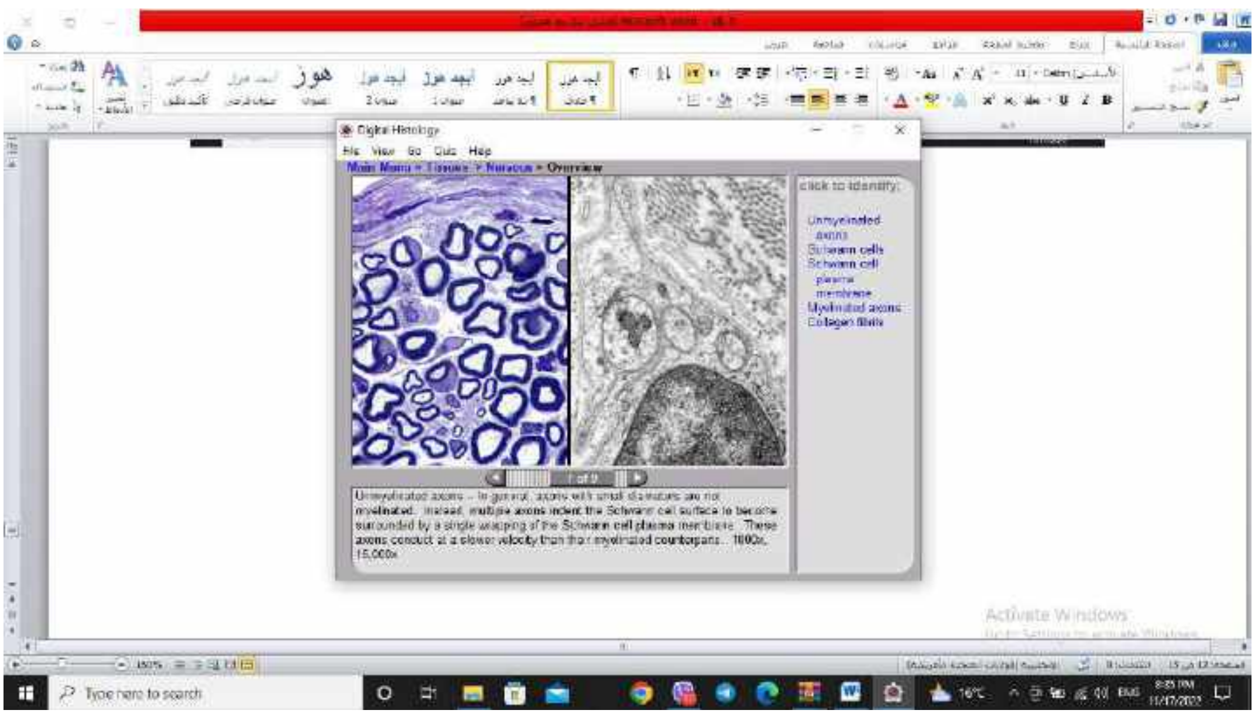

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Unmyelinated axons
Schwann cells
Schwann cell plasma membrane
Myelinated axons
Collagen fibrils
Unmyelinated axons -- In general, axons with small diameters are not myelinated. Instead, multiple axons indent the Schwann cell surface to become surrounded by a single wrapping of the Schwann cell plasma membrane. These axons conduct at a slower velocity than their myelinated counterparts. 1000x, 15,000x
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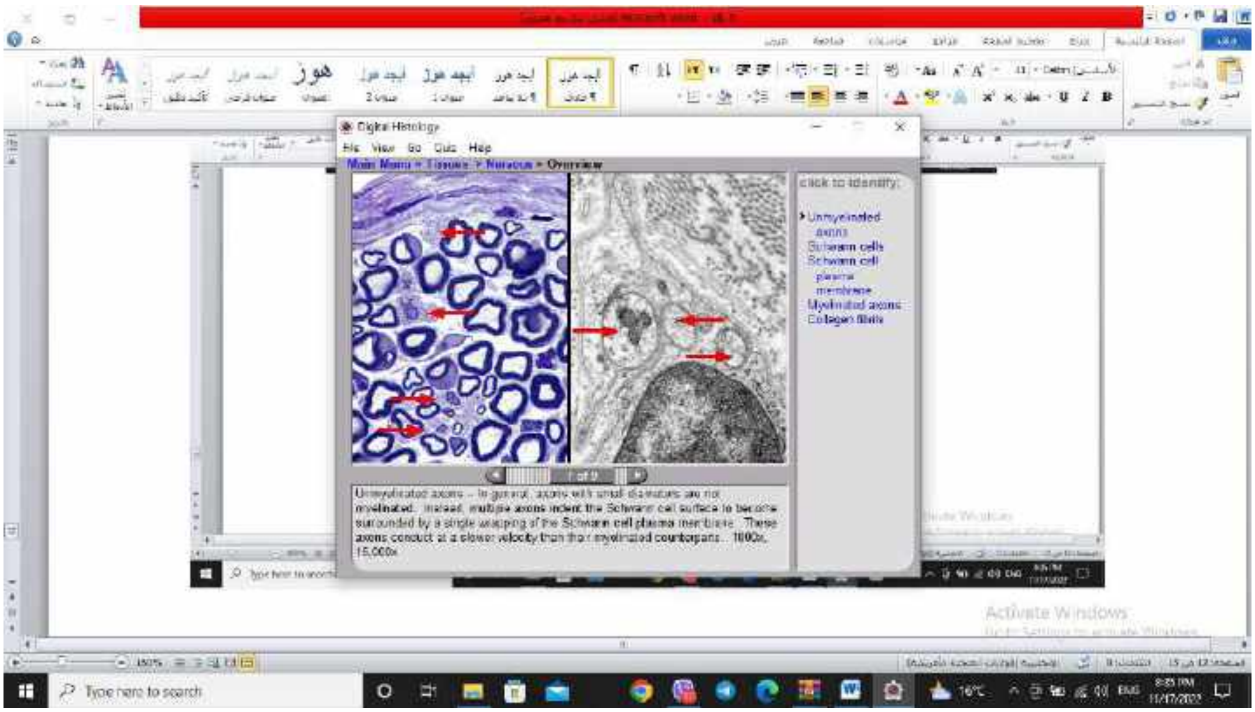
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Unmyelinated axons
Schwann cells
Schwann cell plasma membrane
Myelinated axons
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1 of 9
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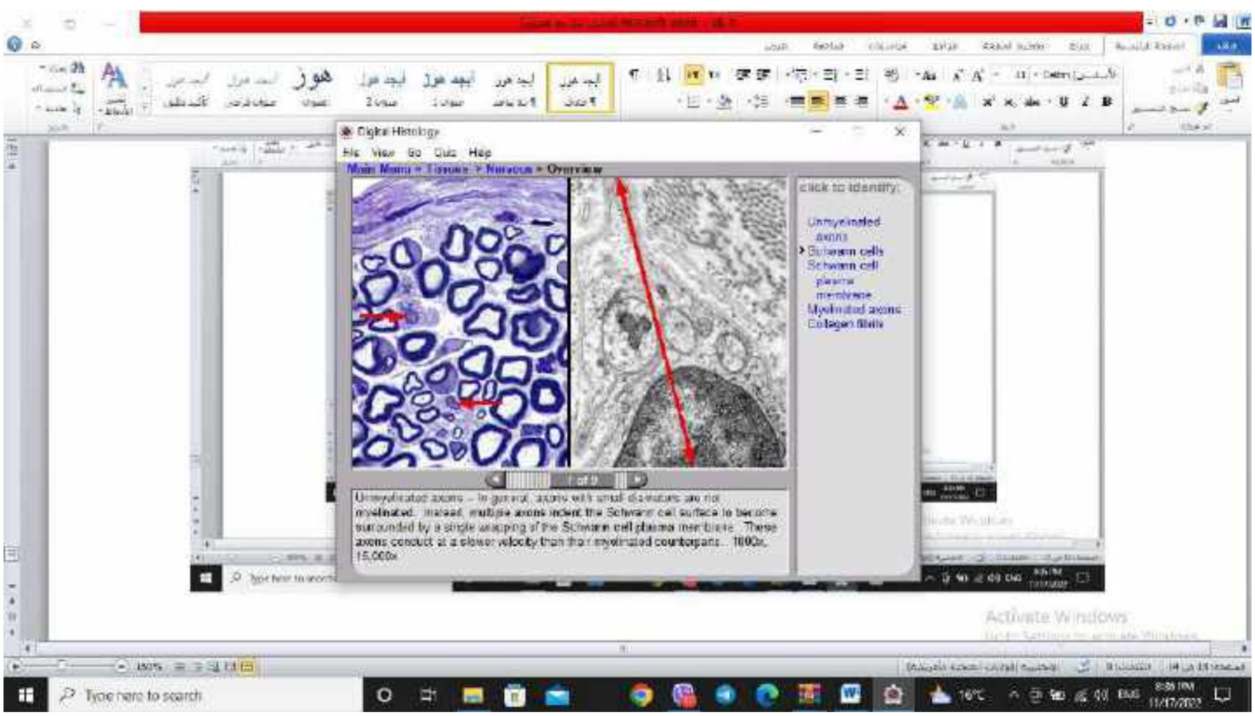
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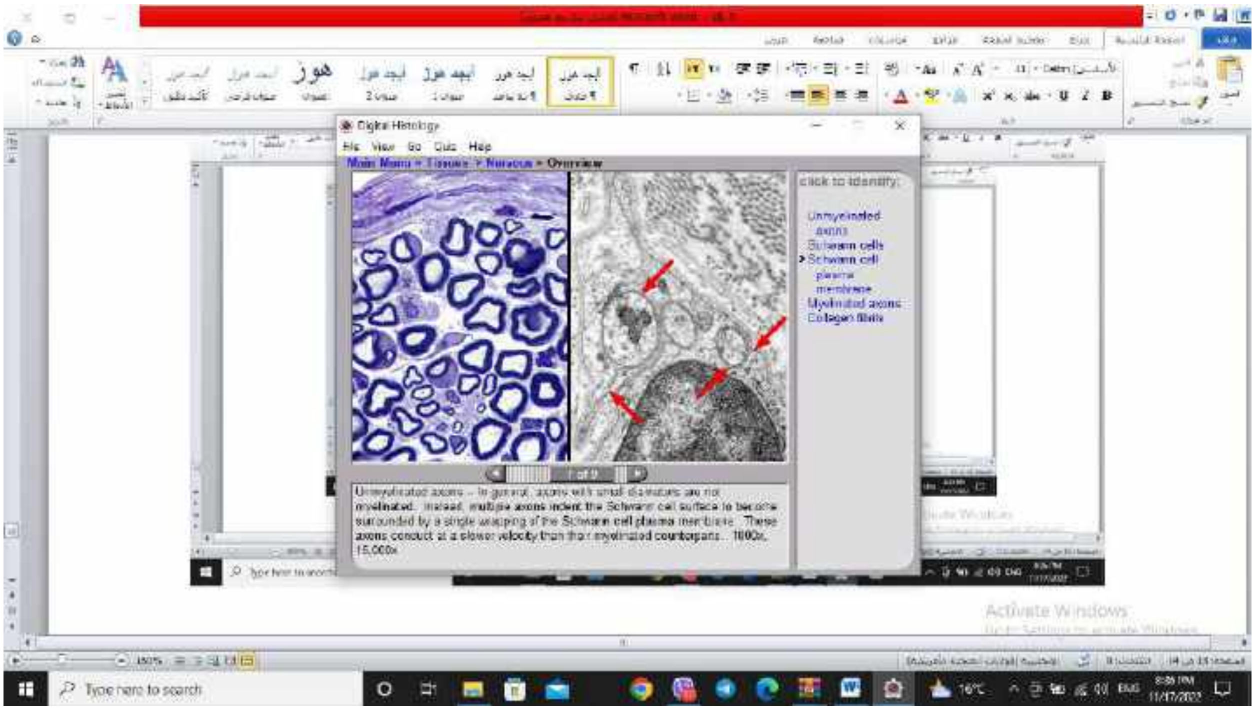
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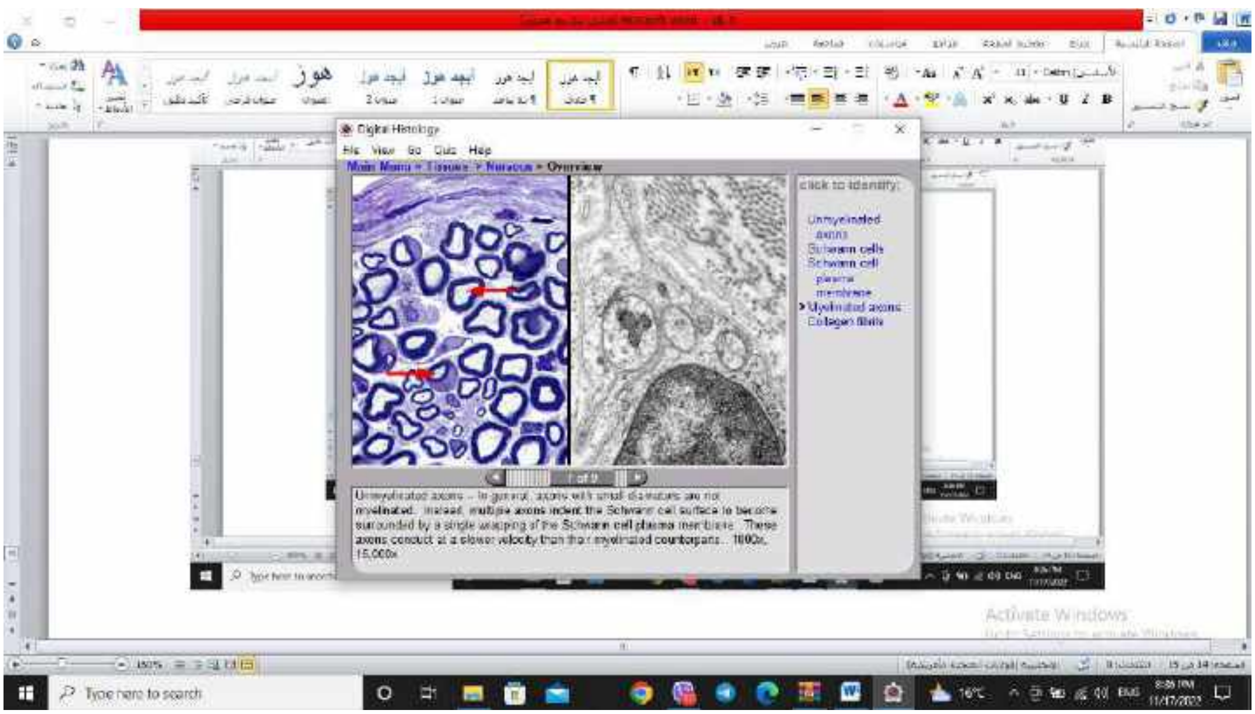
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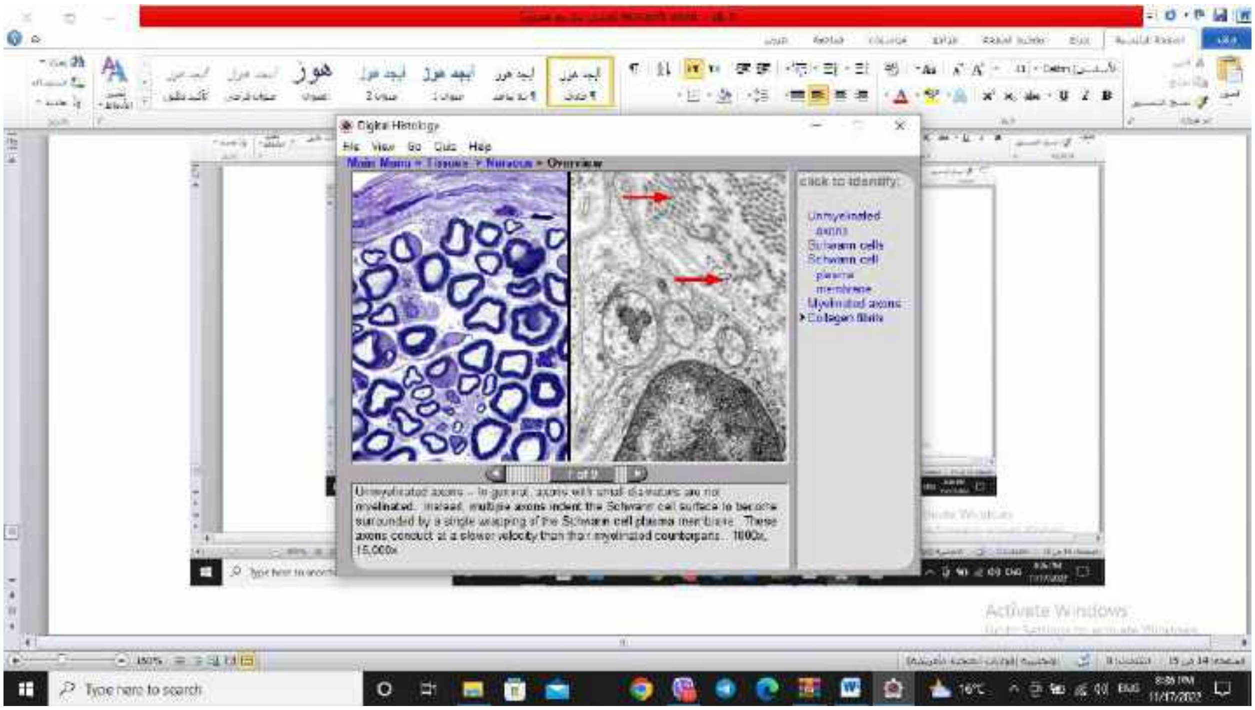
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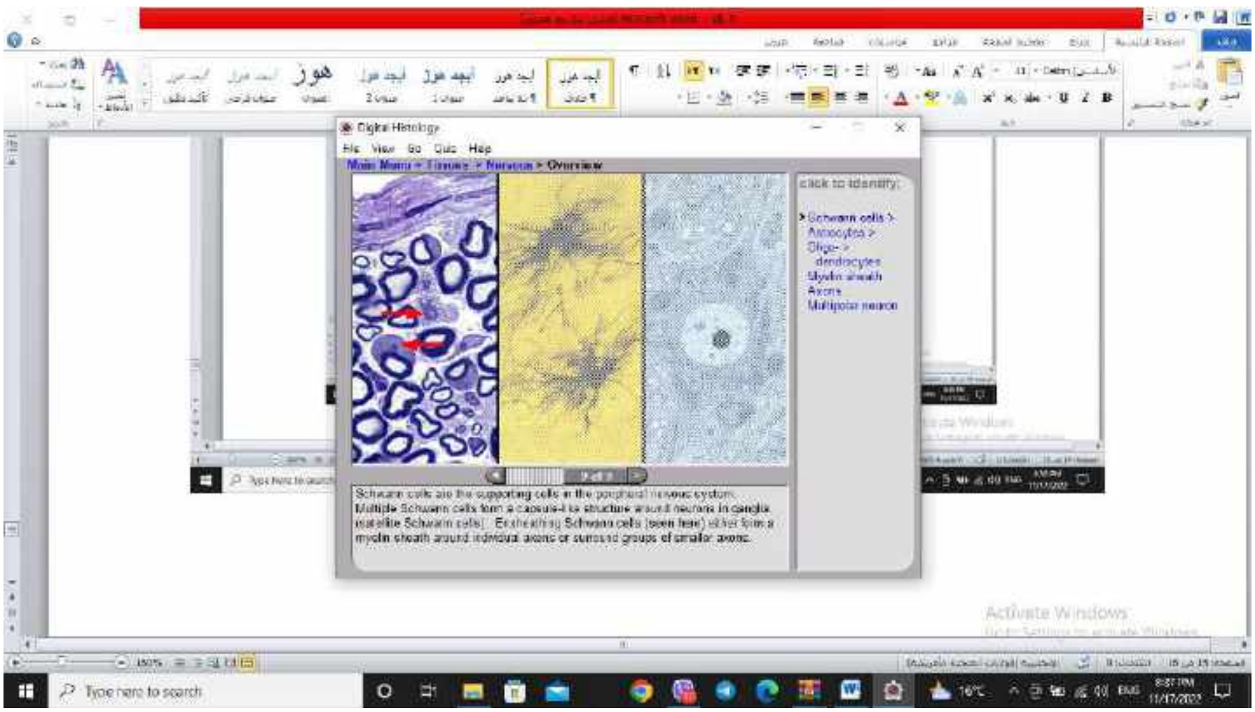
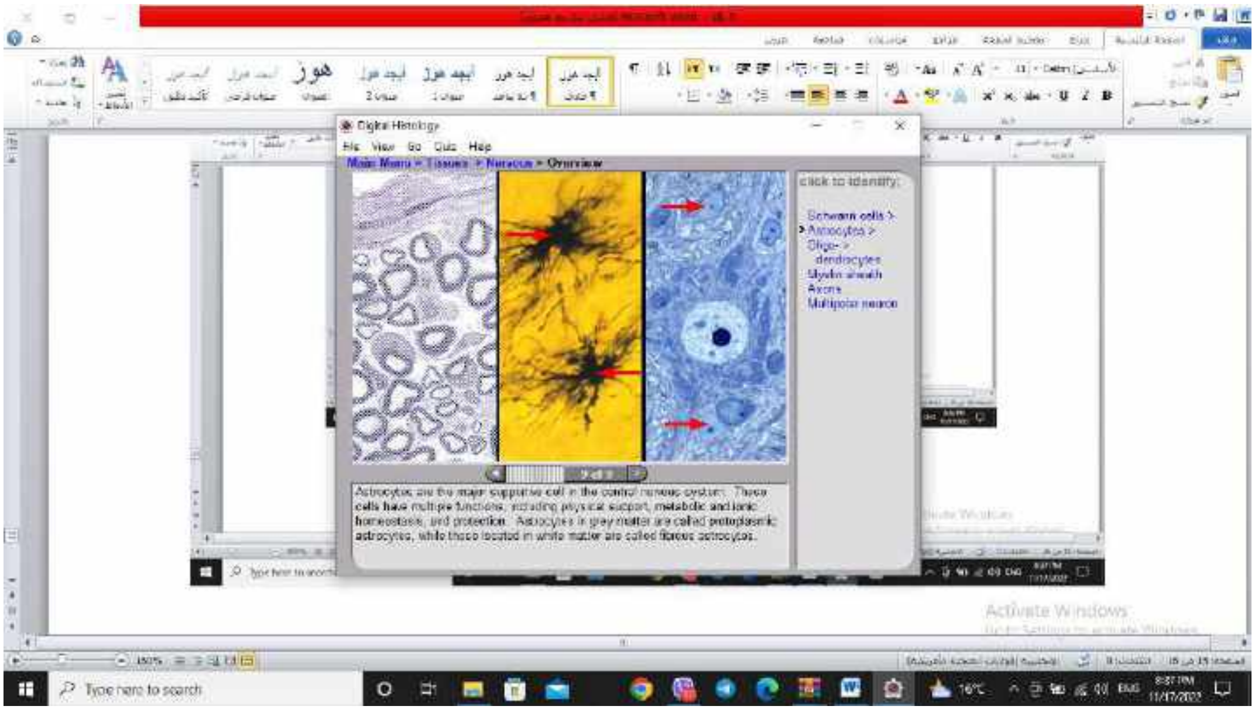

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Overview
click to identify:
Schwann cells >
Astrocytes >
Oligo-dendrocytes
Myelin sheath
Axons
Multipolar neuron
Schwann cells are the supporting cells in the peripheral nervous system. Multiple Schwann cells form a capsule-like structure around neurons in ganglia (satellite Schwann cells). Ensheathing Schwann cells (seen here) either form a myelin sheath around individual axons or surround groups of smaller axons.
Activate Windows
Type here to search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Main Menu > Tissues > Nervous > Overview
click to identify:
Schwann cells >
Astrocytes >
Oligo- >
dendrocytes
Myelin sheath
Axons
Multipolar neuron
Astrocytes are the major supportive cell in the central nervous system. These cells have multiple functions, including physical support, metabolic and ionic homeostasis, and protection. Astrocytes in grey matter are called protoplasmic astrocytes, while those located in white matter are called fibrous astrocytes.
Activate Windows
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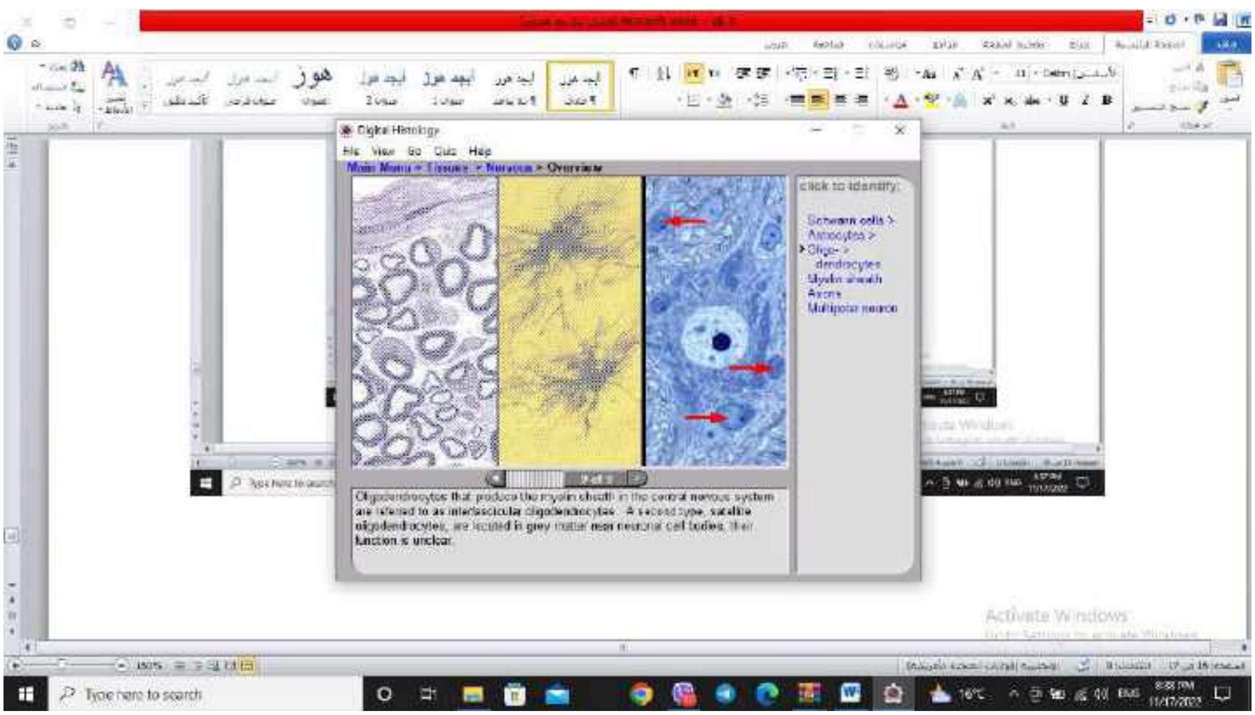
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File View Go Quiz Help
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click to identify:
Schwann cells >
Astrocytes >
Oligo- >
dendrocytes
Myelin sheath
Axons
Multipolar neuron
Oligodendrocytes that produce the myelin sheath in the central nervous system are referred to as interfascicular oligodendrocytes. A second type, satellite oligodendrocytes, are located in grey matter near neuronal cell bodies; their function is unclear.
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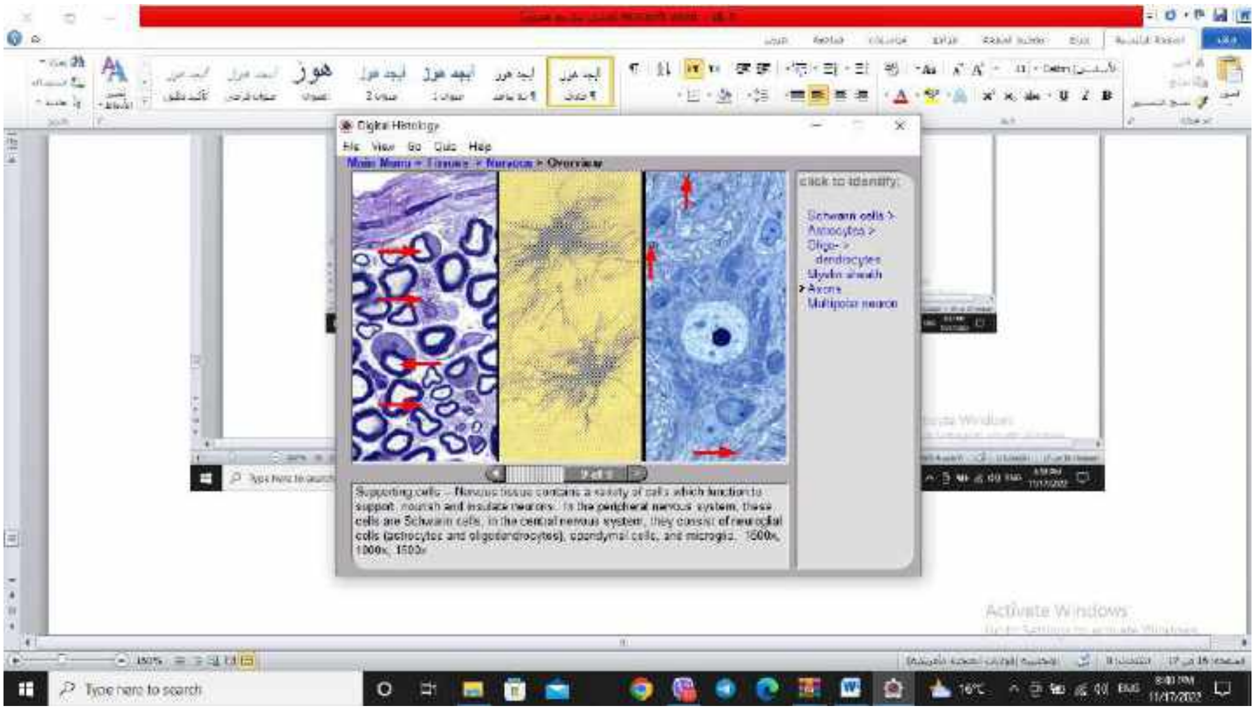
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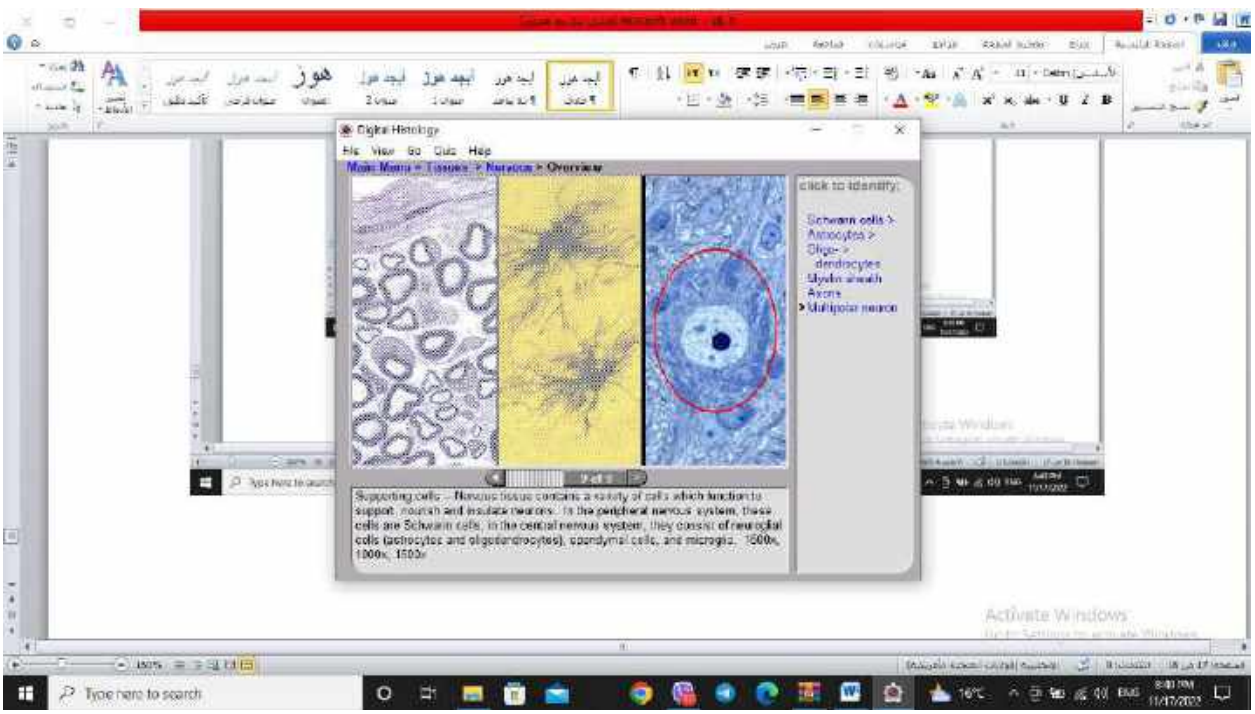
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click to identify:
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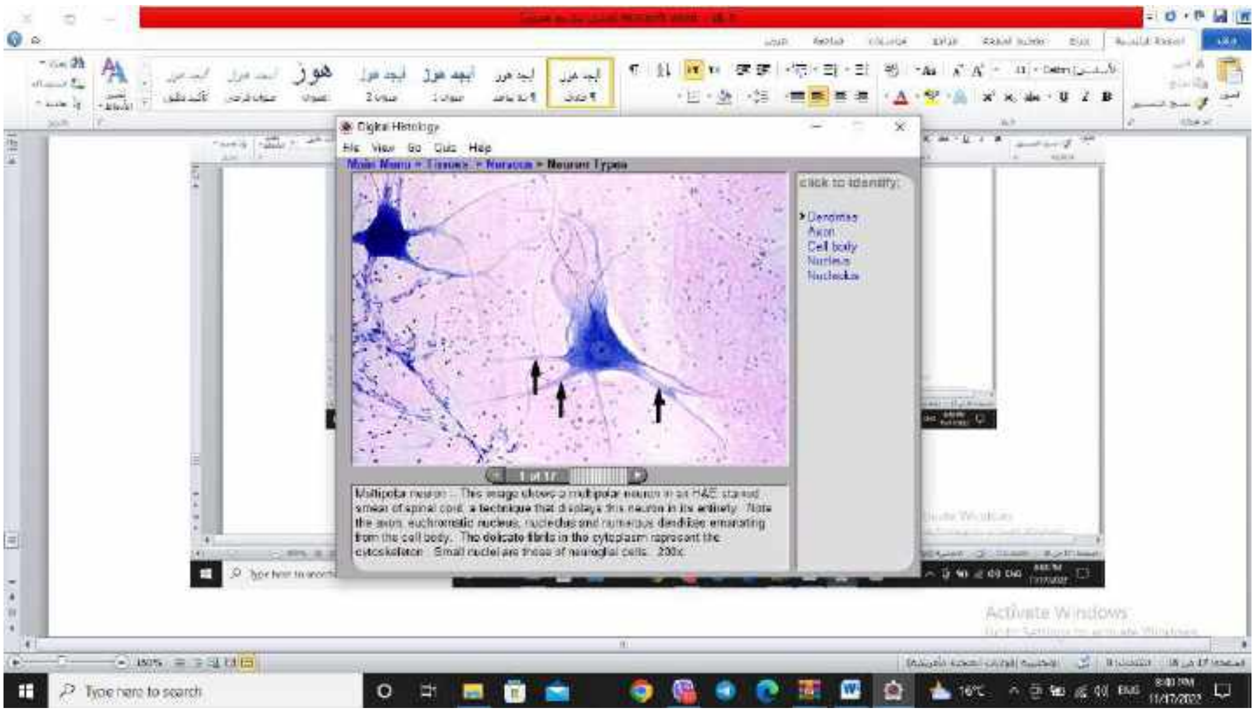
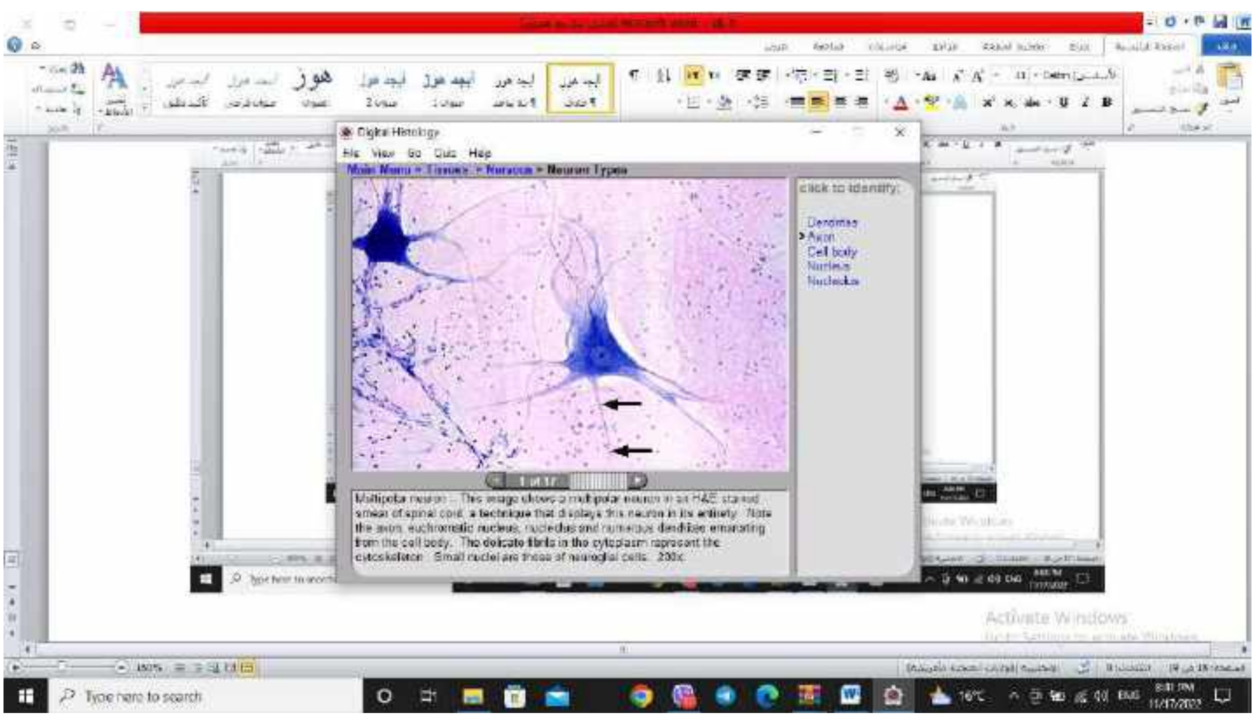

Digital Histology
File View Go Quiz Help
Neuron Types
click to identify:
Axon
Cell body
Nucleus
Nucleolus
1 of 17
Activate Windows
Type here to search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Cell body
Nucleus
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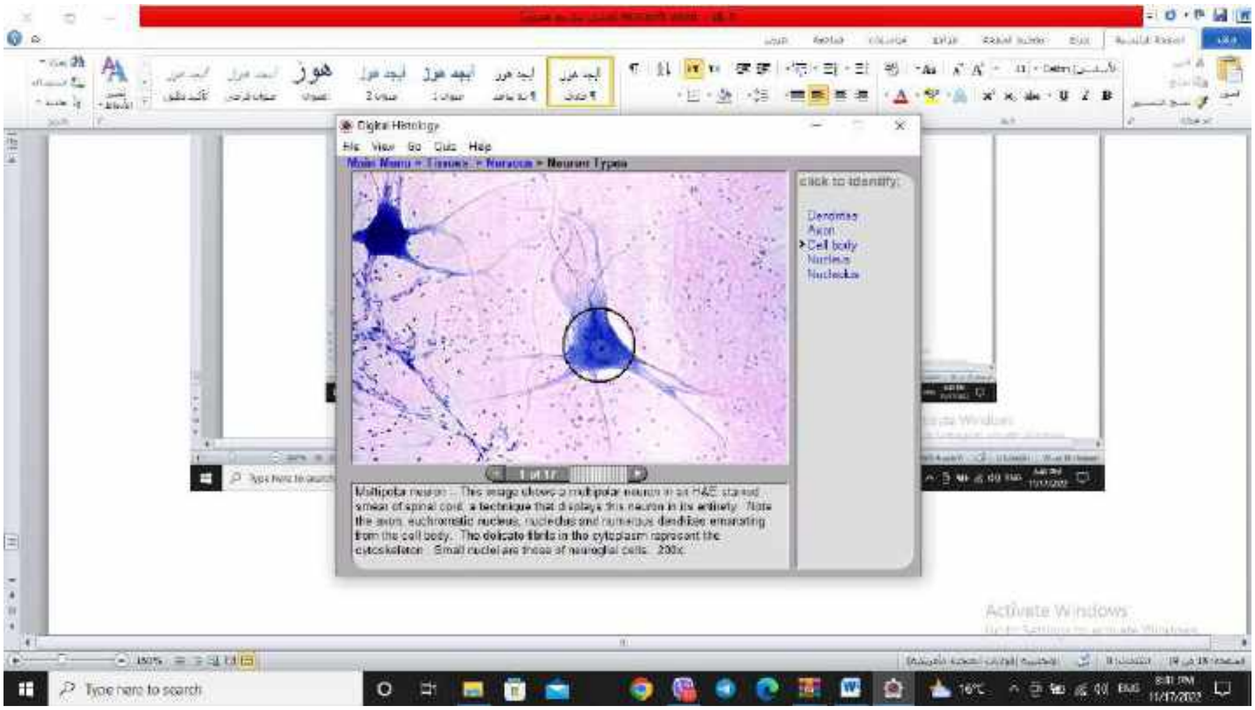
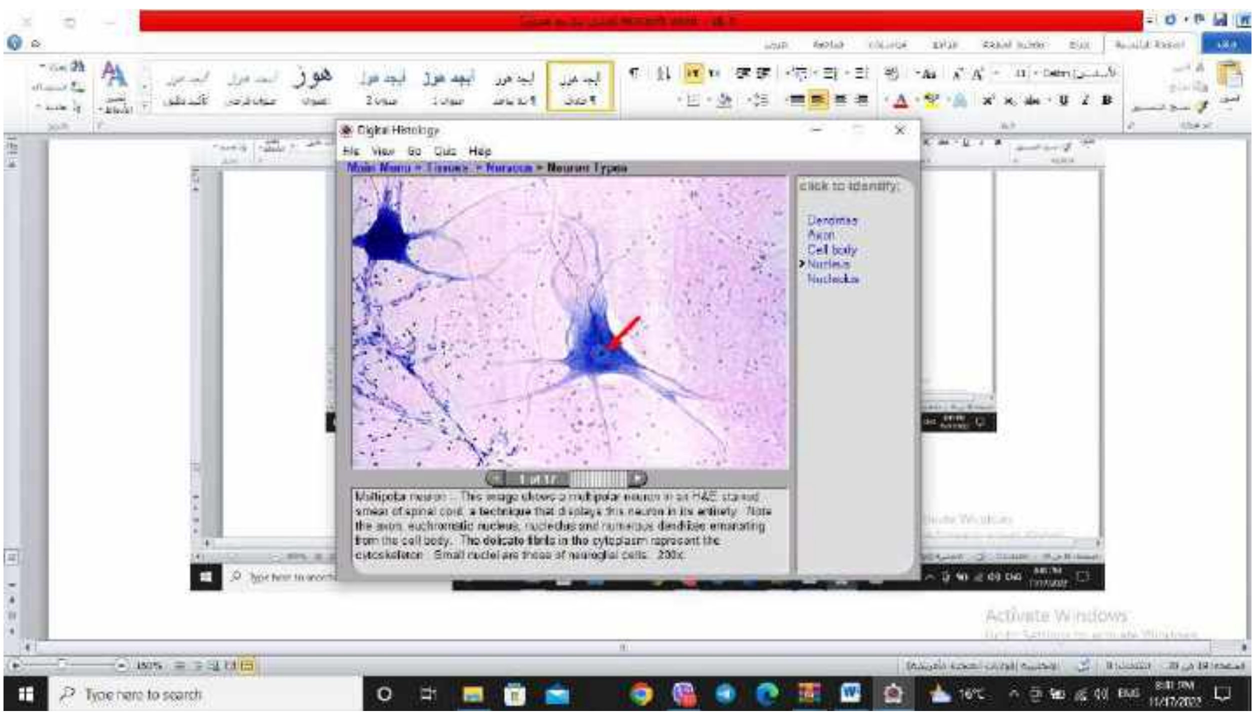

Digital Histology
File View Go Quiz Help
Neuron Types
click to identify:
Cell body
Activate Windows
Type here to search


Digital Histology
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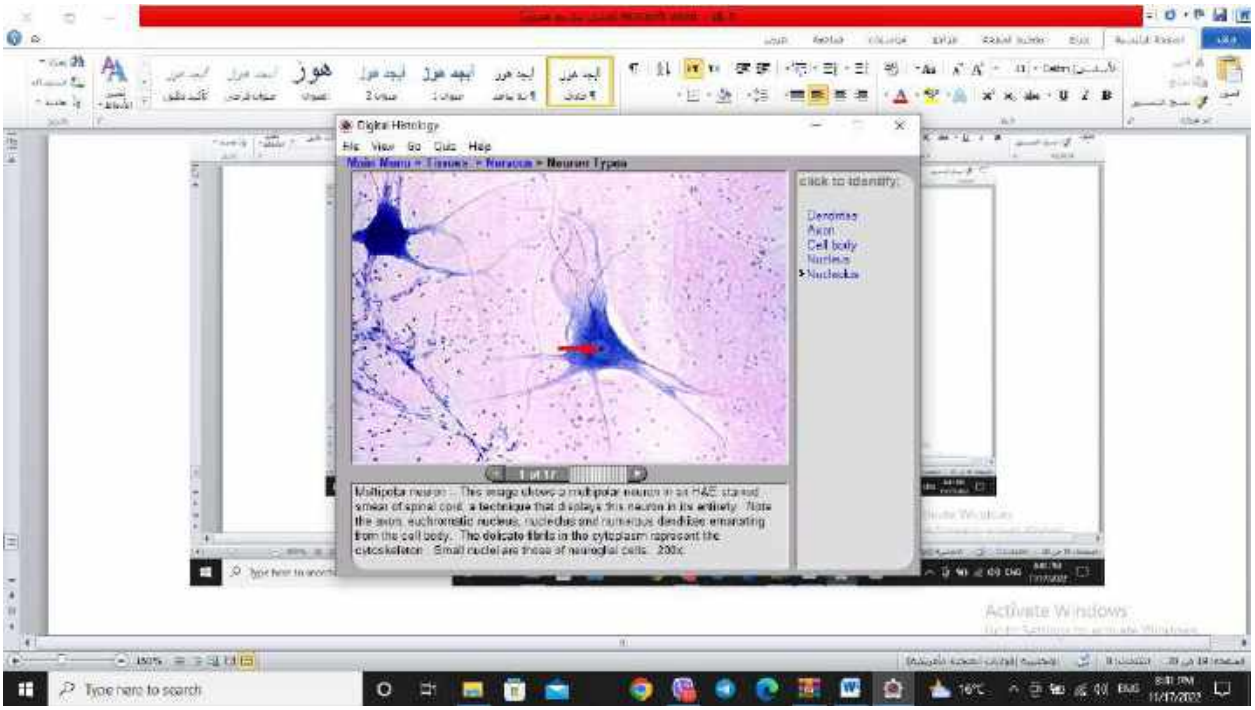
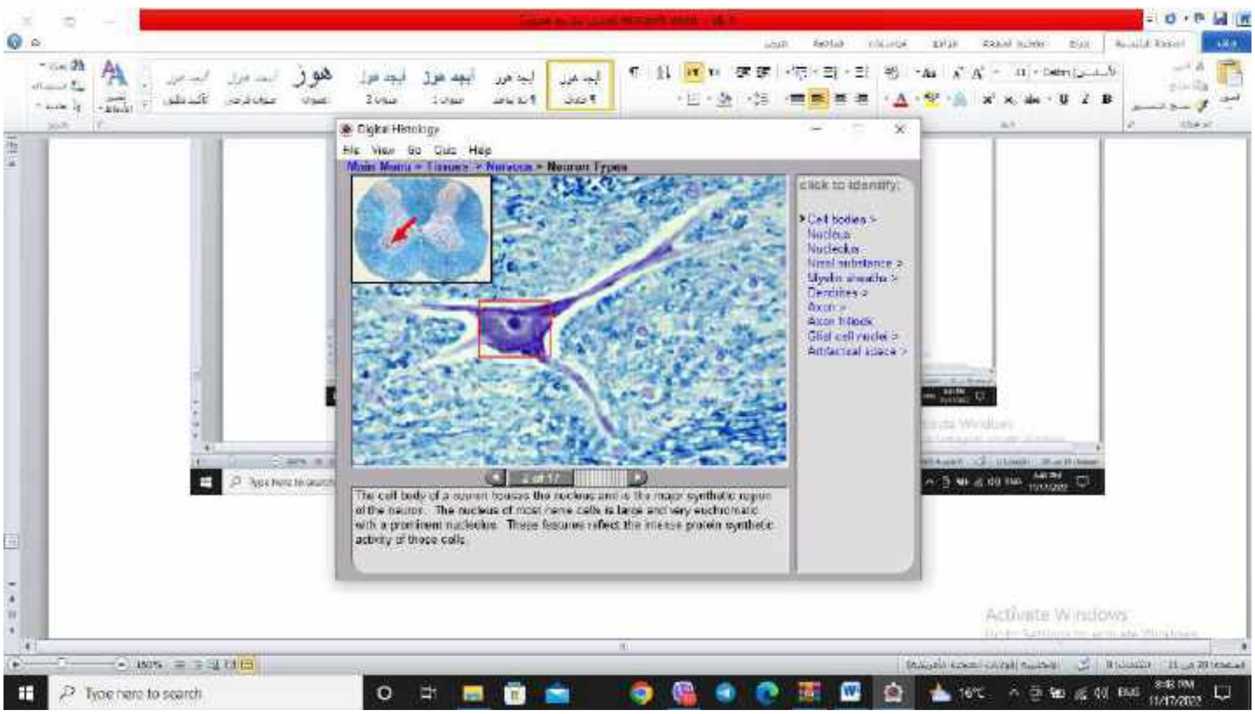
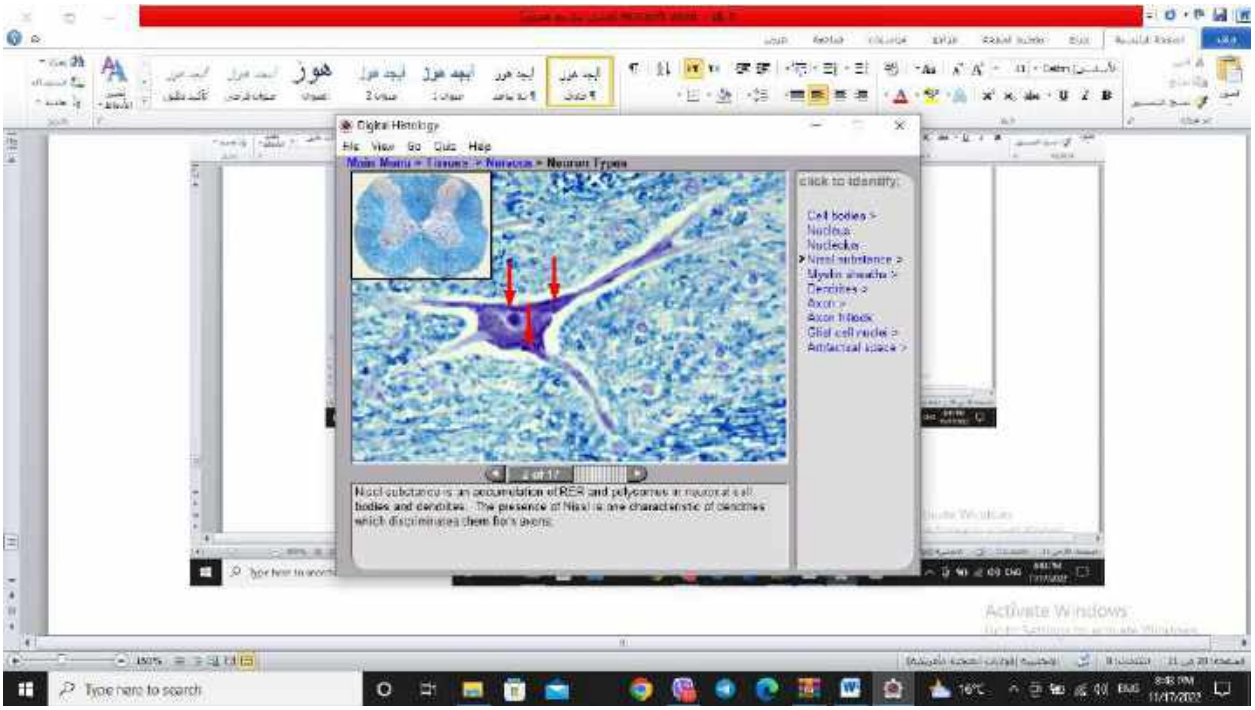
Neuron Types
click to identify:
Cell body
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Neuron Types
click to identify:
Axon
Cell body
1 of 17
The delicate fibrils in the cytoplasm represent the
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Neuron Types
click to identify:
Cell bodies >
Dendrites >
Axon >
2 of 17
The nucleus of most nerve cells is large and very euchromatic
activity of these cells.
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Cell bodies >
Nucleus
Nucleolus
Nissl substance >
Myelin sheaths >
Dendrites >
Axon >
Axon hillock
Glial cell nuclei >
Artifactual space >
Nissl substance is an accumulation of RER and polysomes in neuronal cell bodies and dendrites. The presence of Nissl is one characteristic of dendrites which discriminates them from axons.
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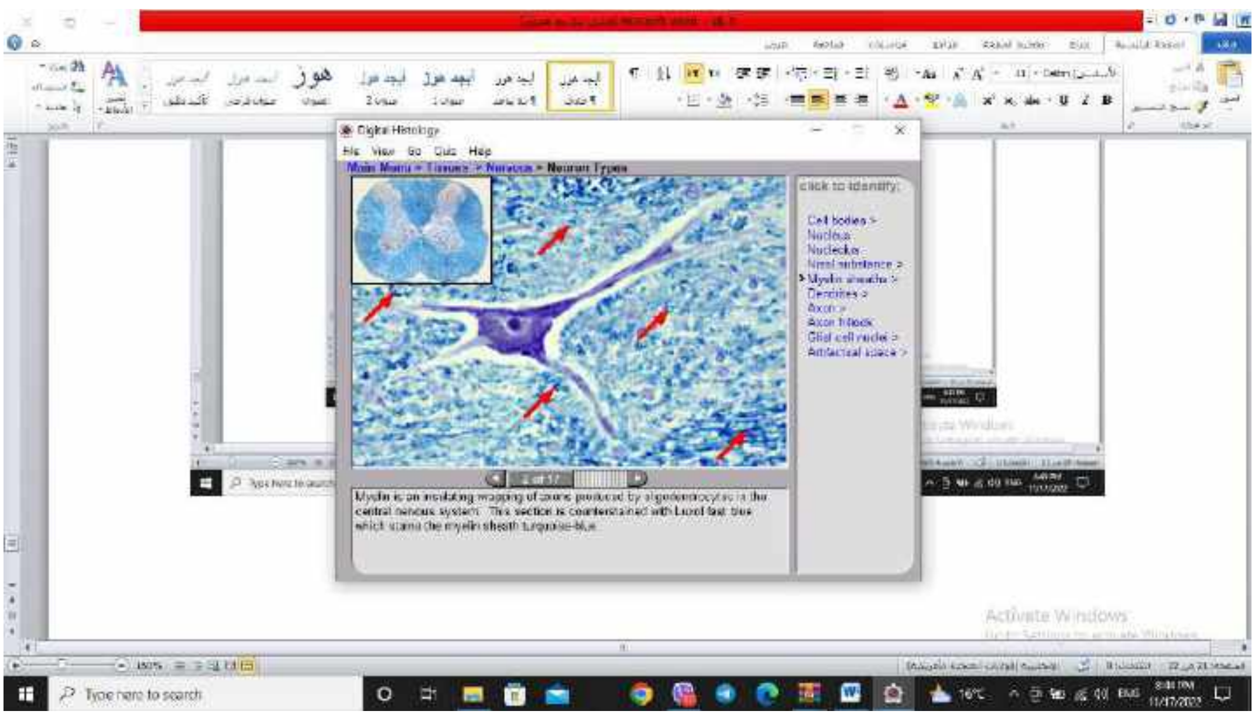
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Cell bodies >
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Nucleolus
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Dendrites >
Axon >
Axon hillock
Glial cell nuclei >
Artifactual space >
Myelin is an insulating wrapping of axons produced by oligodendrocytes in the central nervous system. This section is counterstained with Luxol fast blue which stains the myelin sheath turquoise-blue.
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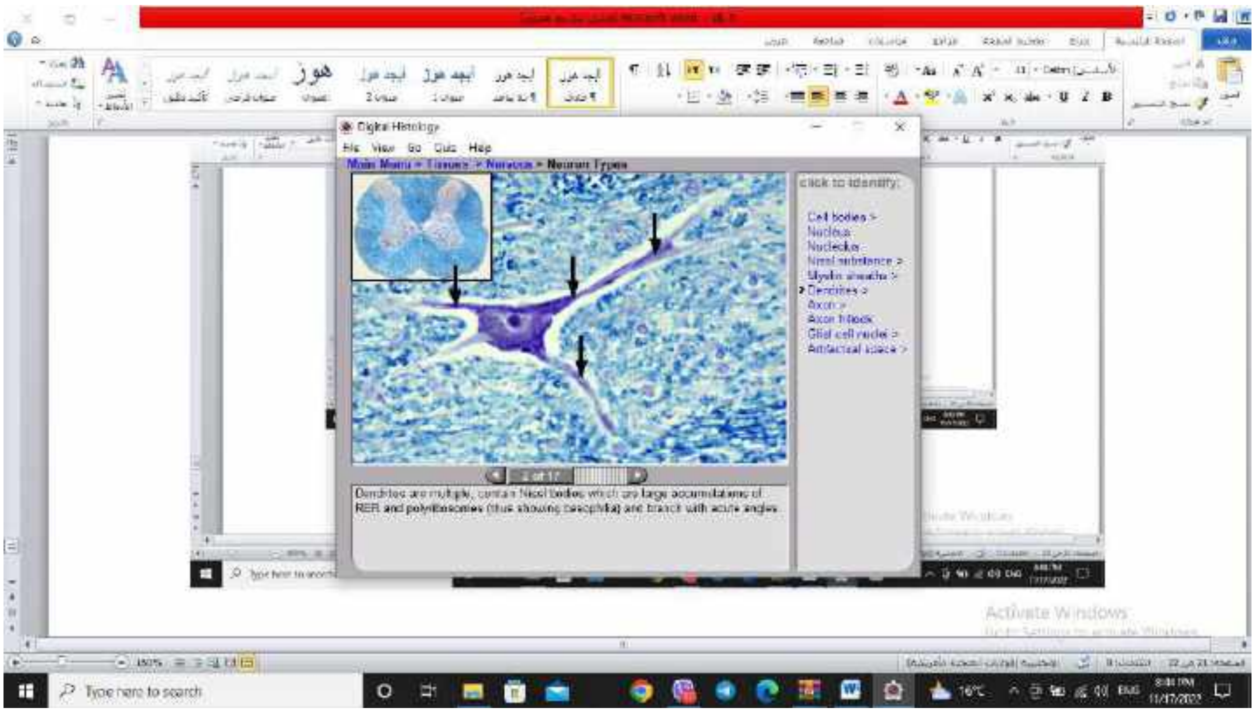
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click to identify:
Cell bodies >
Nucleus
Nucleolus
Nissl substance >
Myelin sheaths >
Dendrites >
Axon >
Axon hillock
Glial cell nuclei >
Artifactual space >
Dendrites are multiple, contain Nissl bodies which are large accumulations of RER and polyribosomes (thus showing basophilia) and branch with acute angles.
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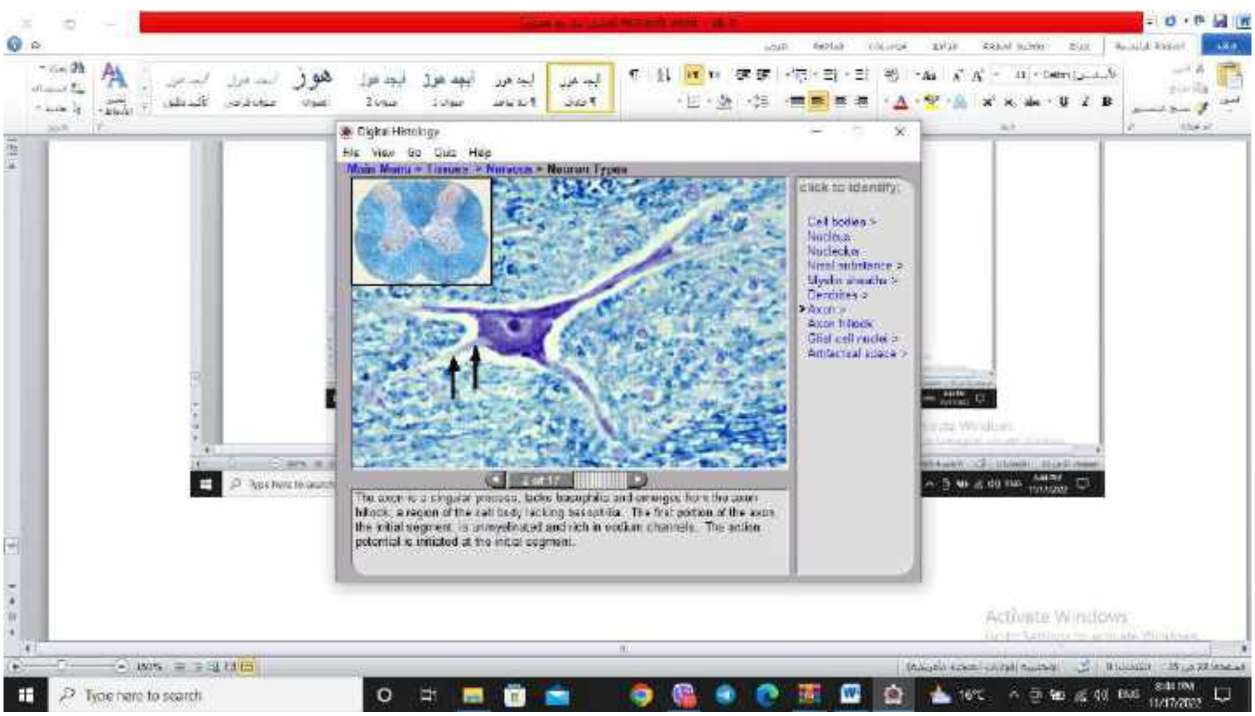
Digital Histology
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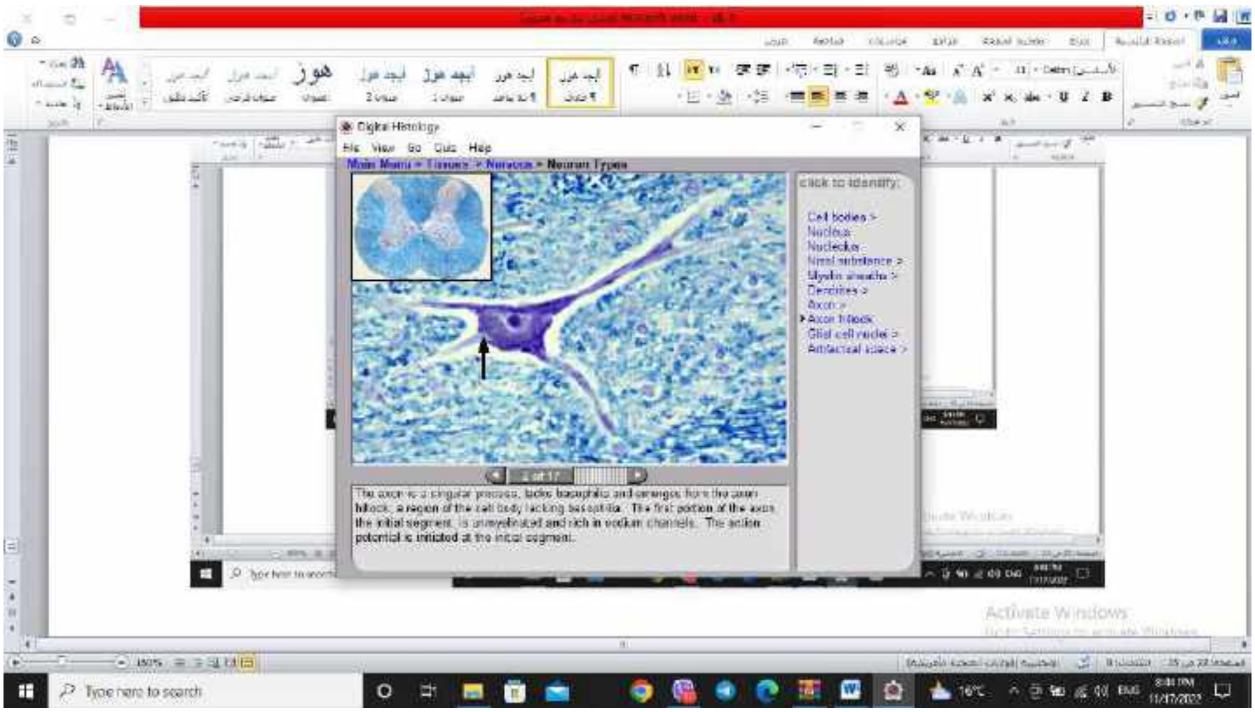
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Cell bodies >
Nucleus
Nucleolus
Nissl substance >
Myelin sheaths >
Dendrites >
Axon >
Axon hillock
Glial cell nuclei >
Artifactual space >
The axon is a singular process, lacks basophilia and emerges from the axon hillock, a region of the cell body lacking basophilia. The first portion of the axon, the initial segment, is unmyelinated and rich in sodium channels. The action potential is initiated at the initial segment.
Activate Windows
Type here to search


Digital Histology
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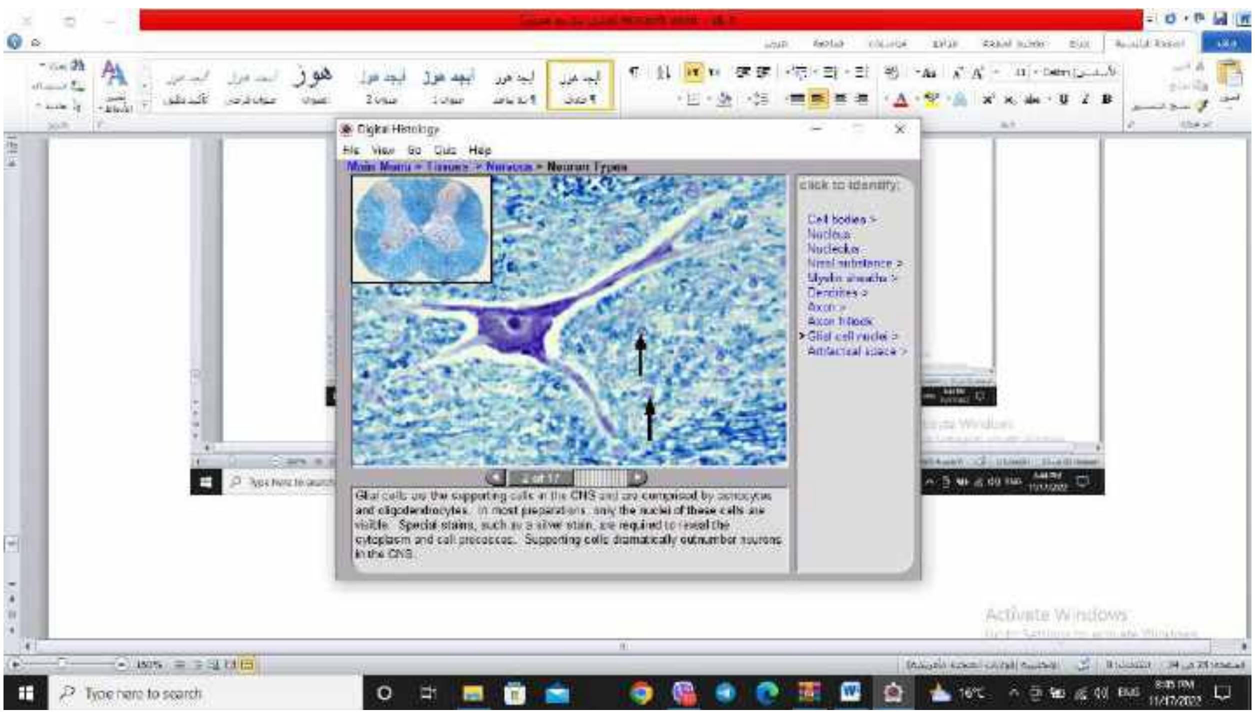
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Nucleolus
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Myelin sheaths >
Dendrites >
Axon >
Axon hillock
Glial cell nuclei >
Artifactual space >
Glial cells are the supporting cells in the CNS and are comprised by astrocytes and oligodendrocytes. In most preparations, only the nuclei of these cells are visible. Special stains, such as a silver stain, are required to reveal the cytoplasm and cell processes. Supporting cells dramatically outnumber neurons in the CNS.
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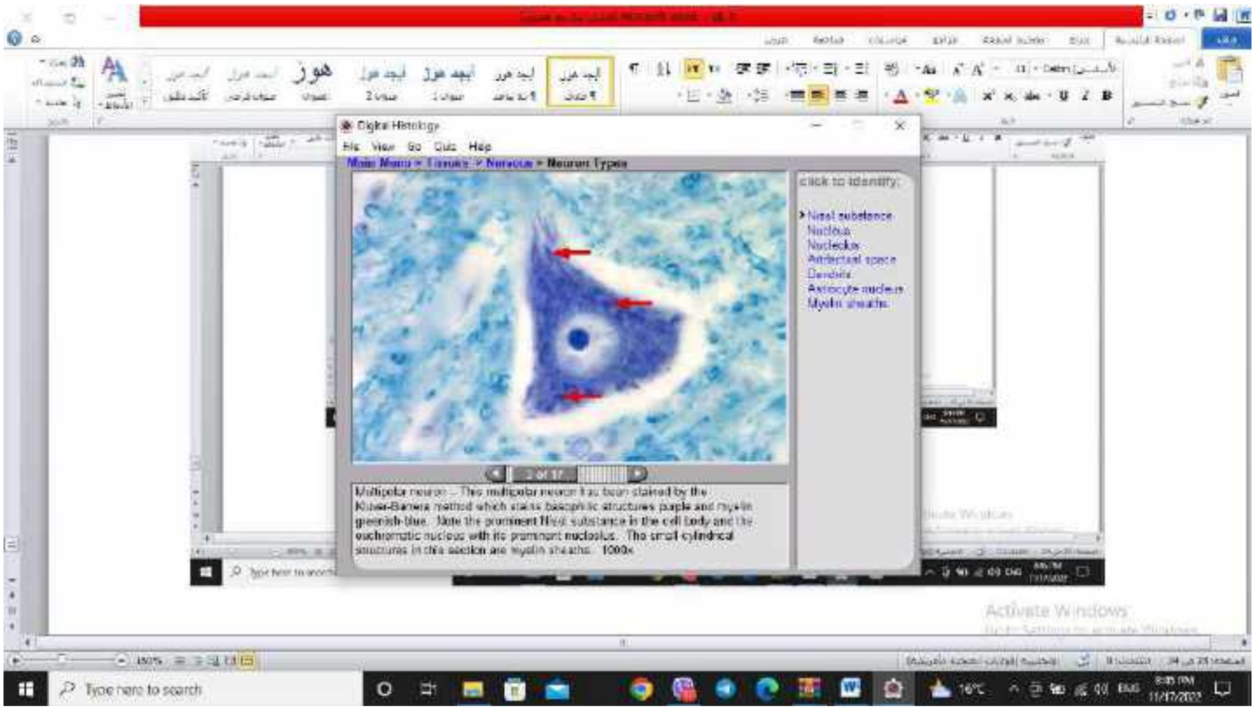
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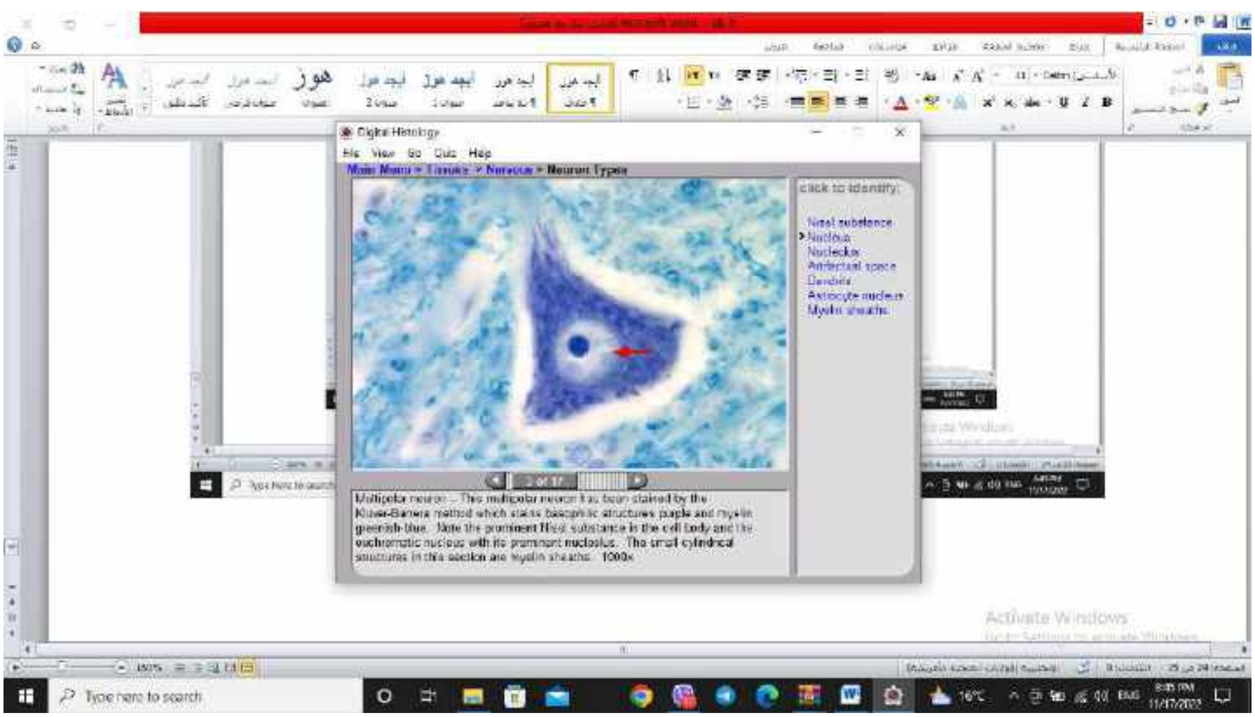
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Nissl substance
Nucleus
Nucleolus
Artifactual space
Dendrite
Astrocyte nucleus
Myelin sheaths
Multipolar neuron - This multipolar neuron has been stained by the Kluver-Barrera method which stains basophilic structures purple and myelin greenish-blue. Note the prominent Nissl substance in the cell body and the euchromatic nucleus with its prominent nucleolus. The small cylindrical structures in this section are myelin sheaths. 1000x
Activate Windows
Type here to search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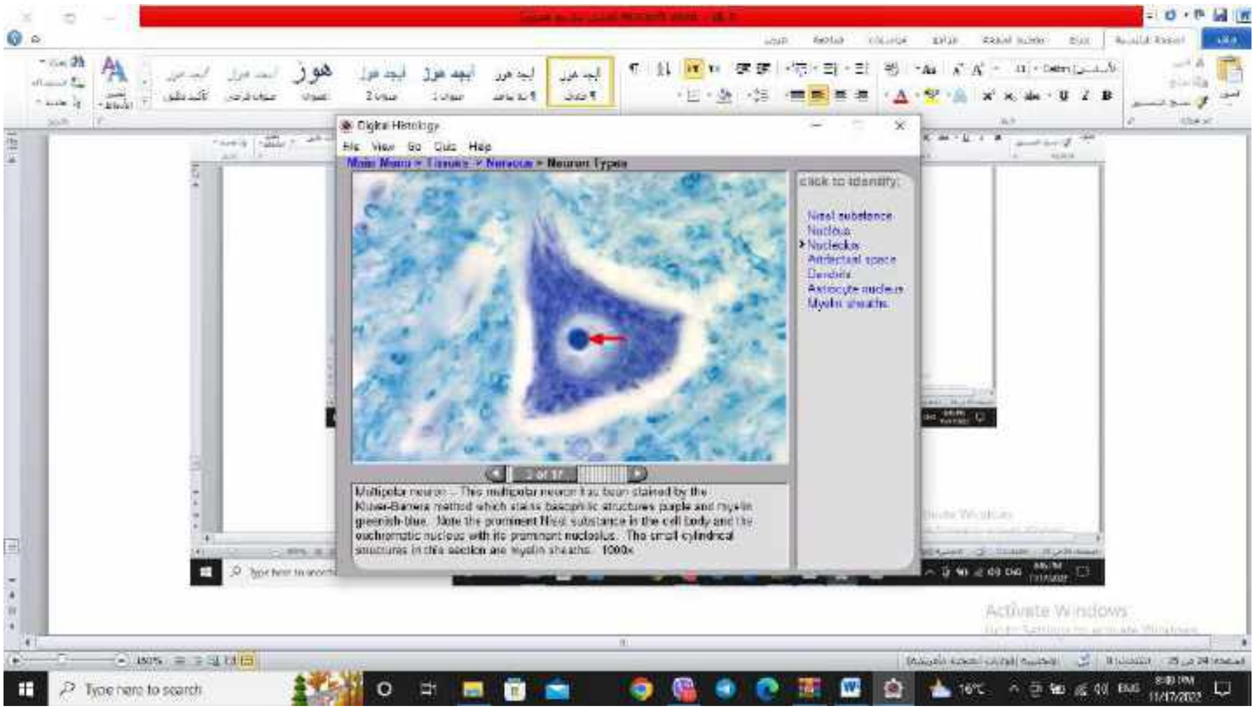
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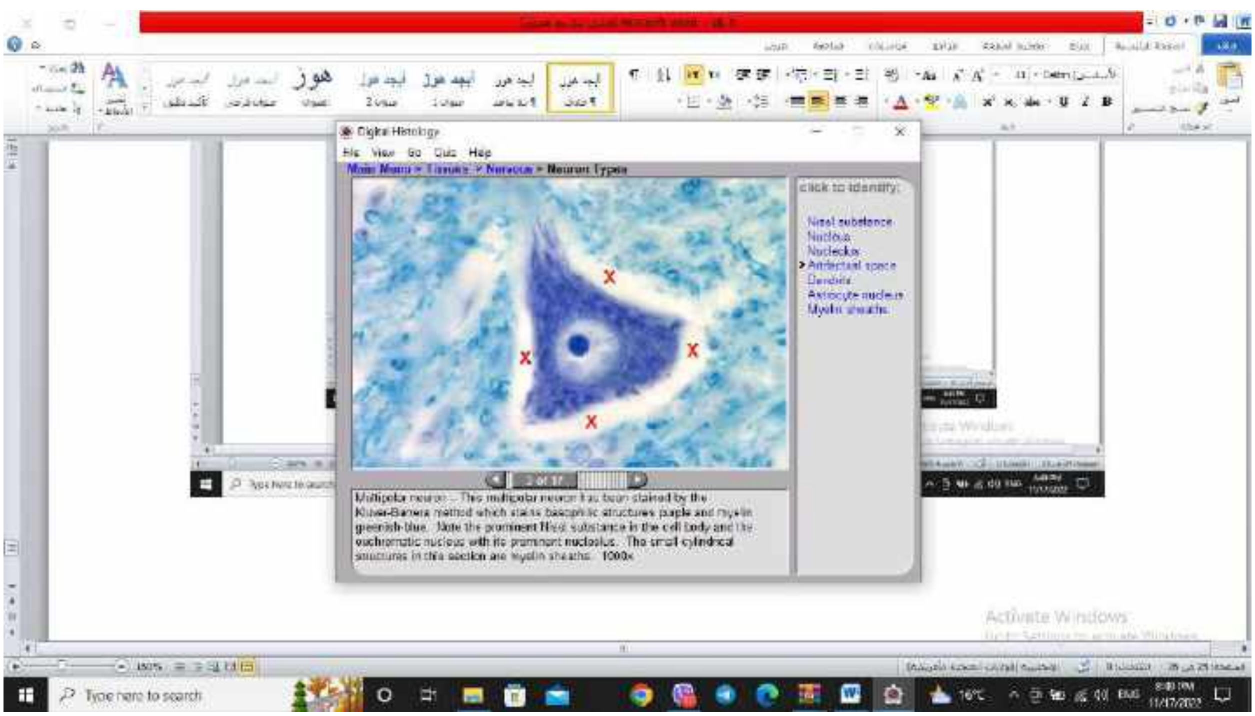
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X
X
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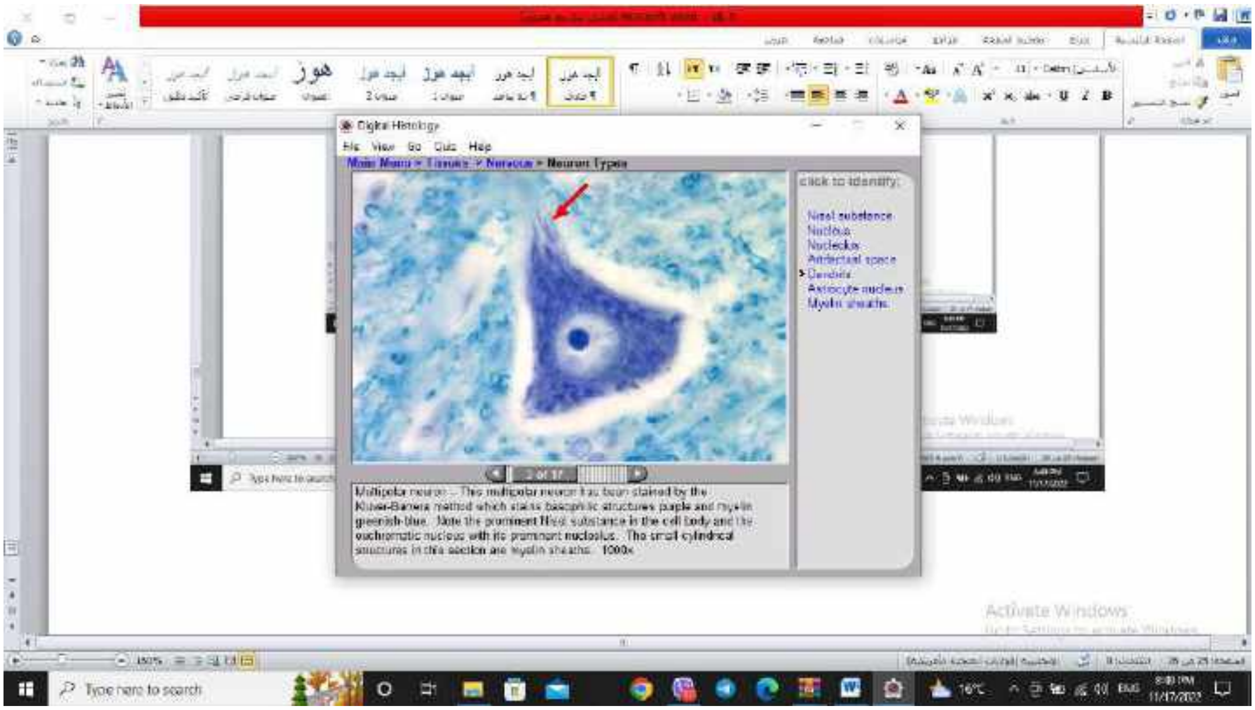
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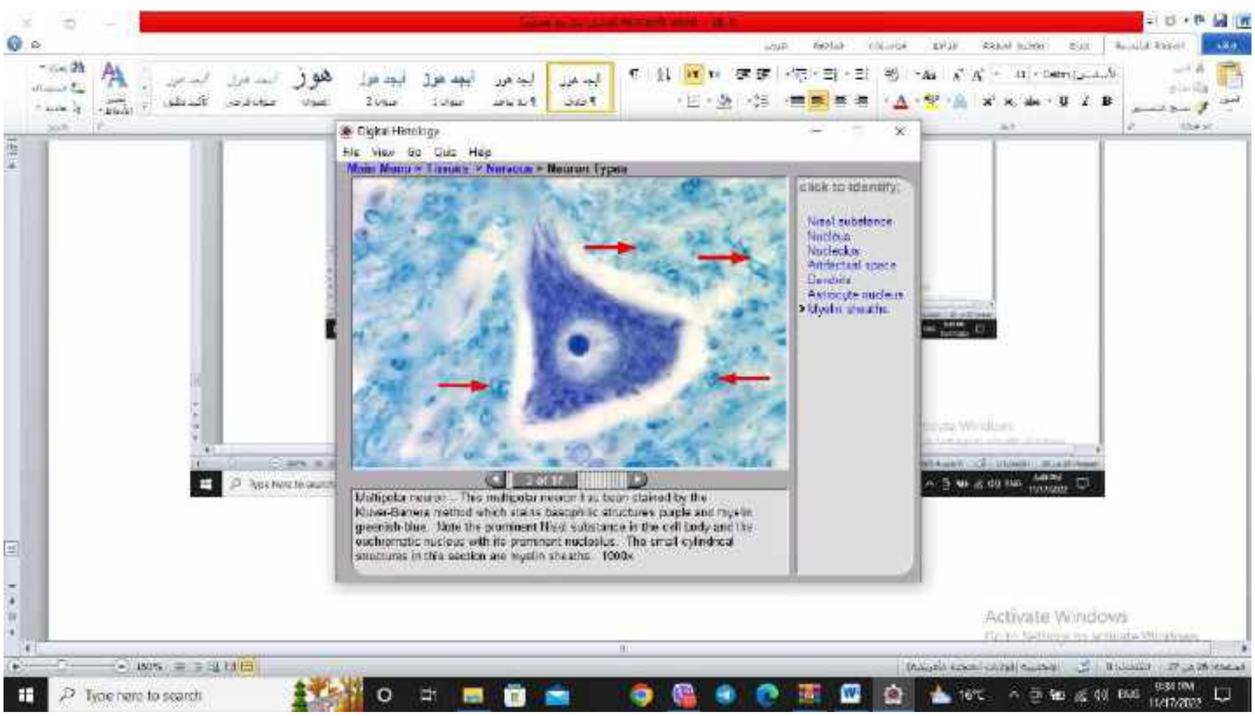
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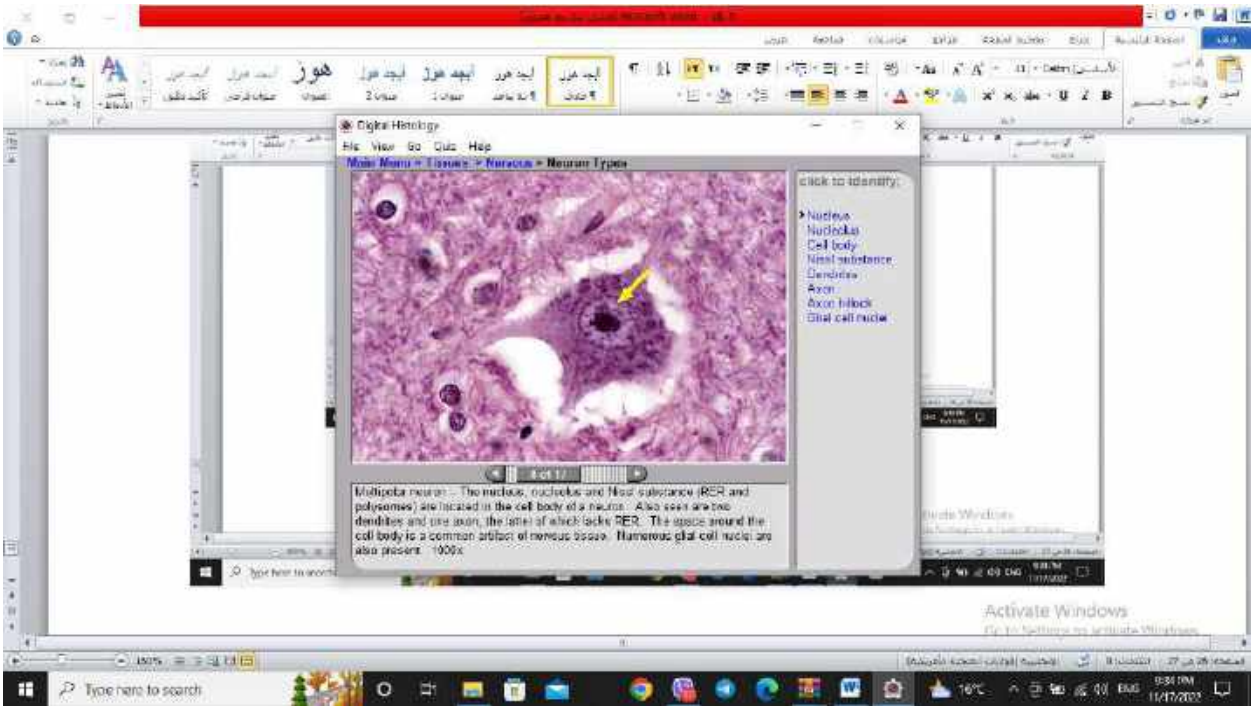

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Axon
Axon hillock
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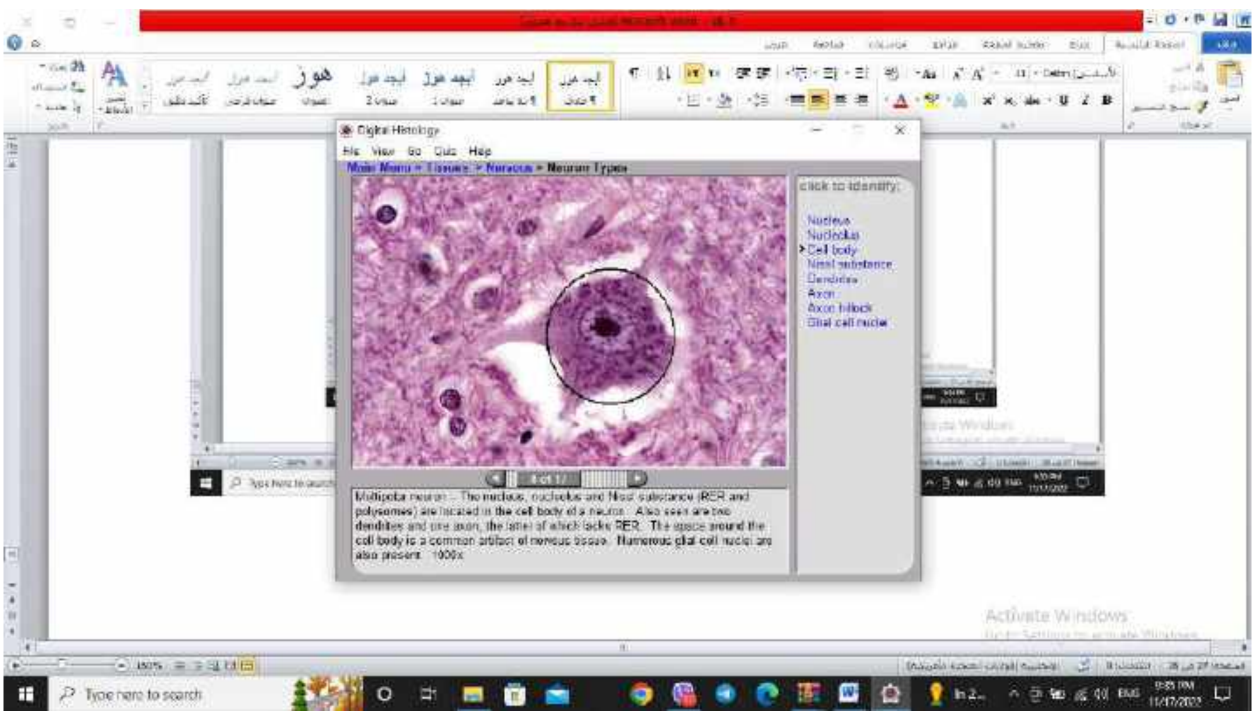

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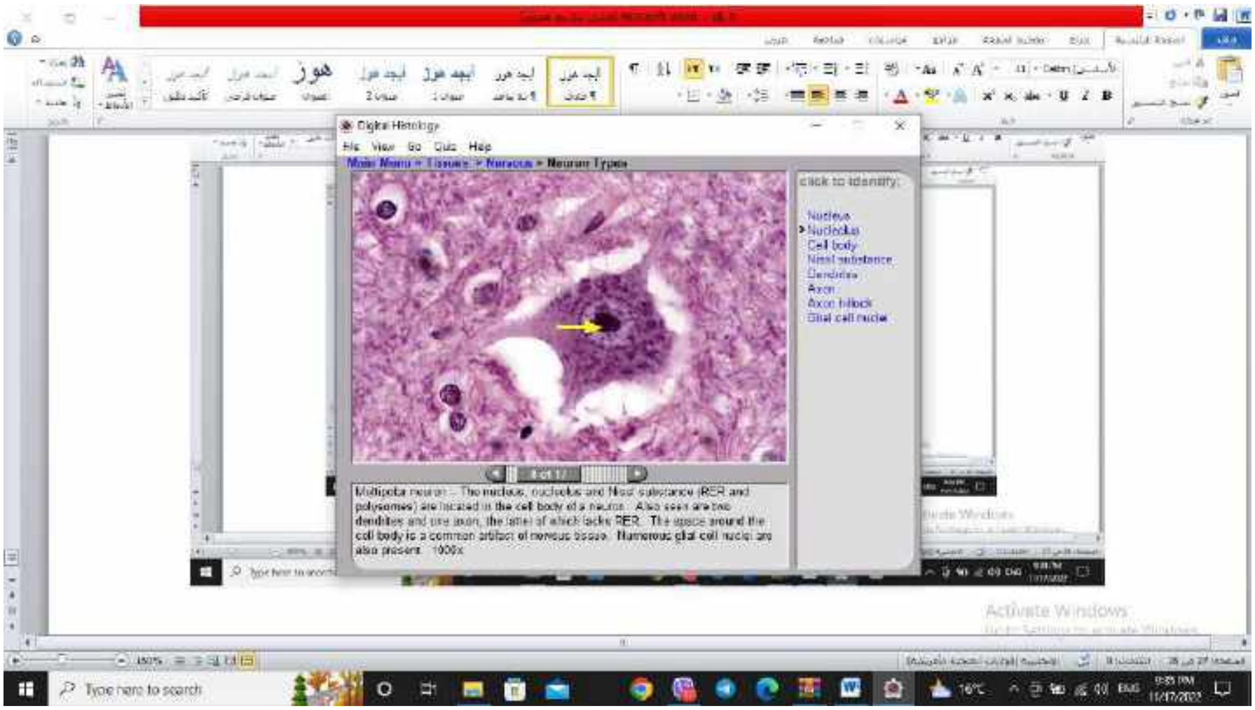
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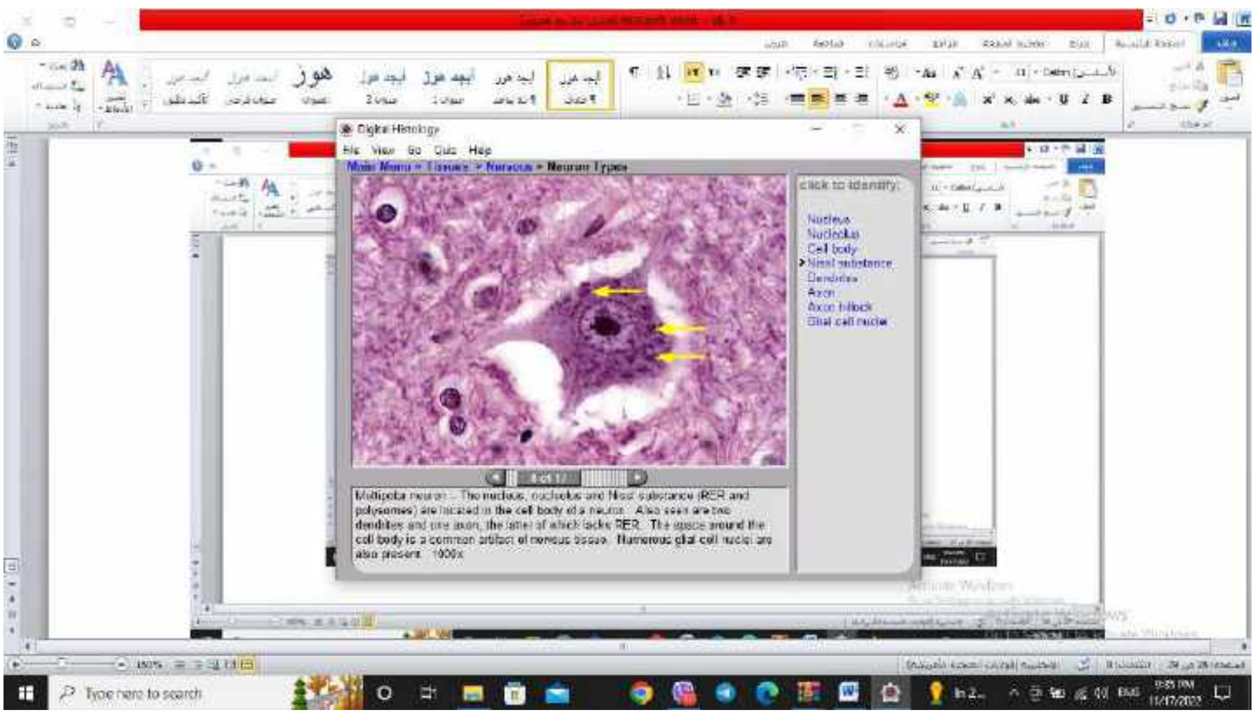
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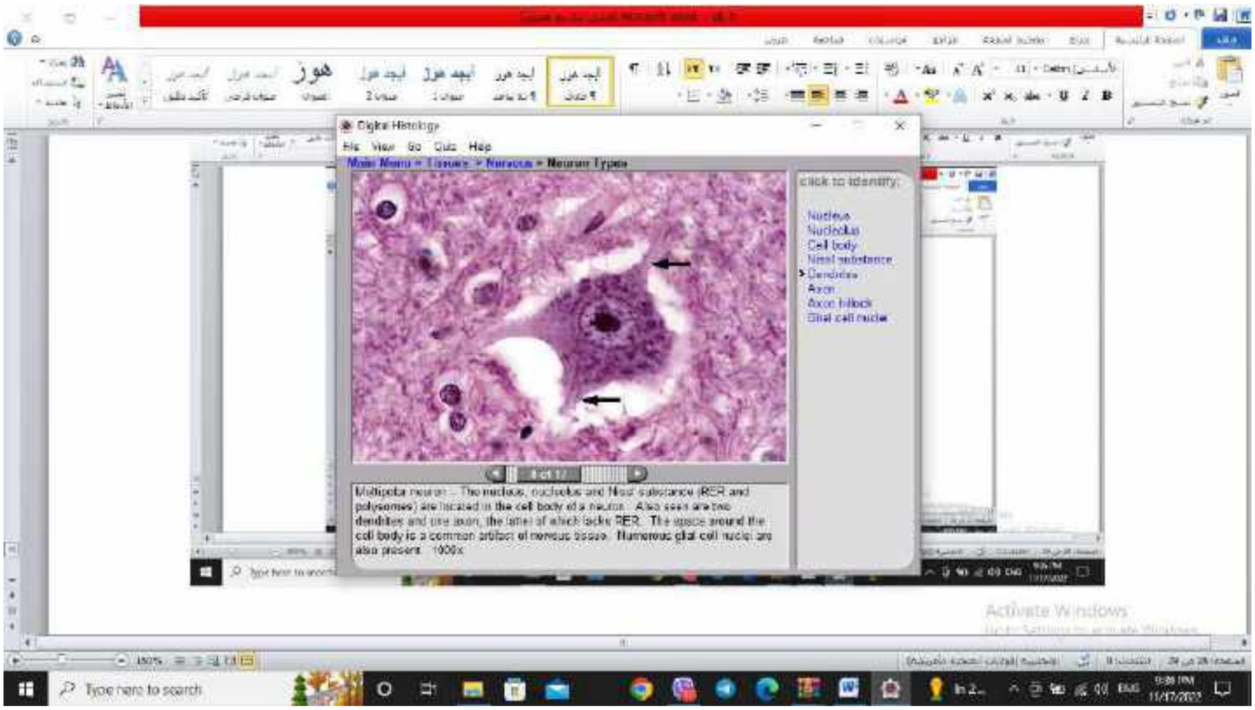
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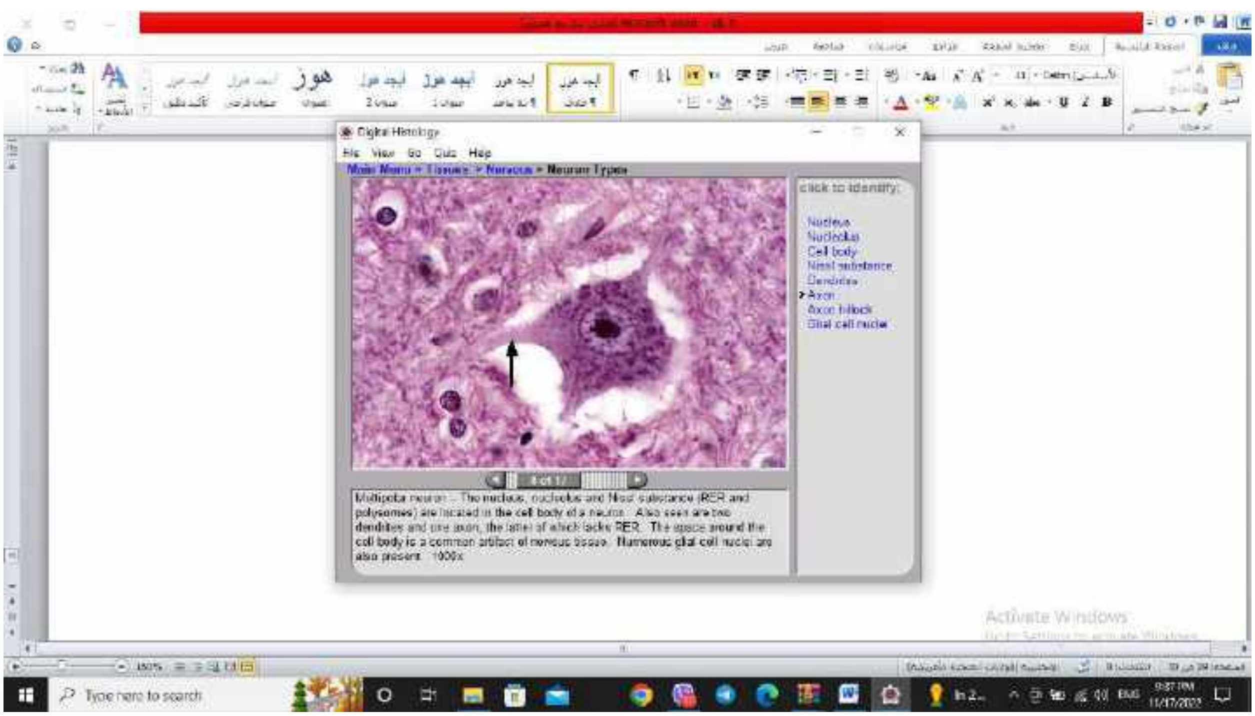
Axon hillock
Glial cell nuclei
Multipolar neuron - The nucleus, nucleolus and Nissl substance (RER and polysomes) are located in the cell body of a neuron. Also seen are two dendrites and one axon, the latter of which lacks RER. The space around the cell body is a common artifact of nervous tissue. Numerous glial cell nuclei are also present. 1000x
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Nucleus
Nucleolus
Cell body
Nissl substance
Dendrites
Axon
Axon hillock
Glial cell nuclei
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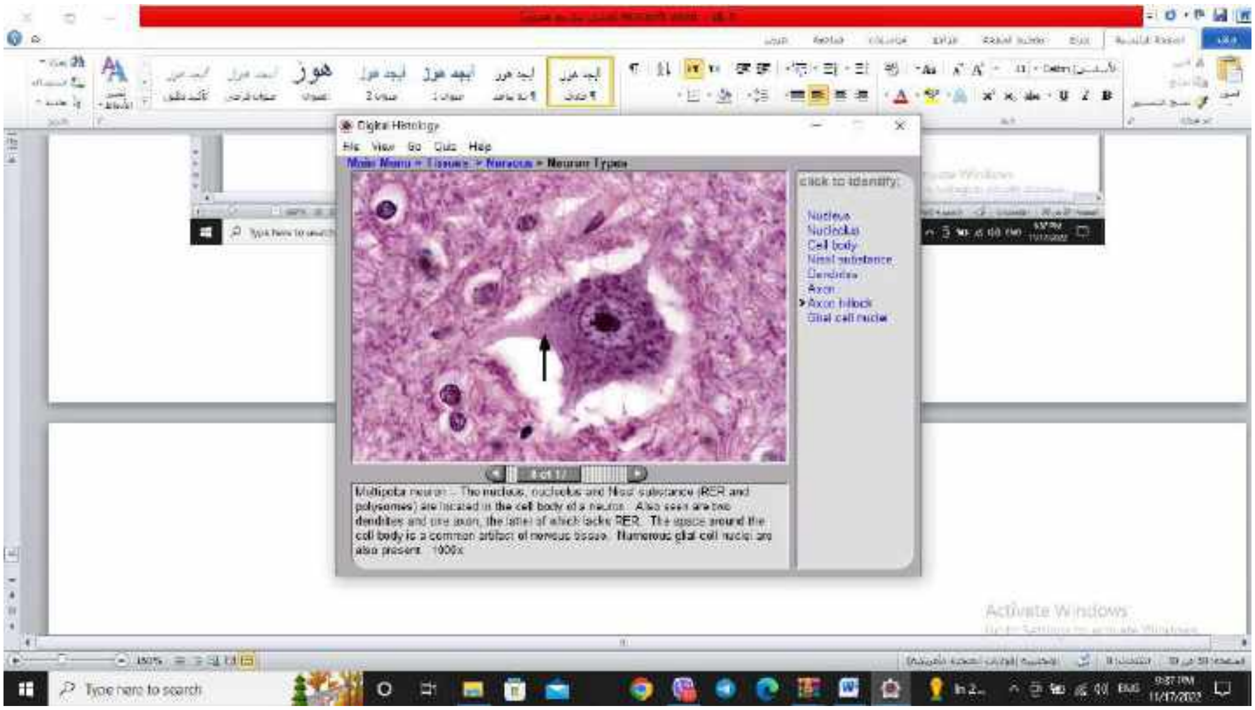
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Nucleolus
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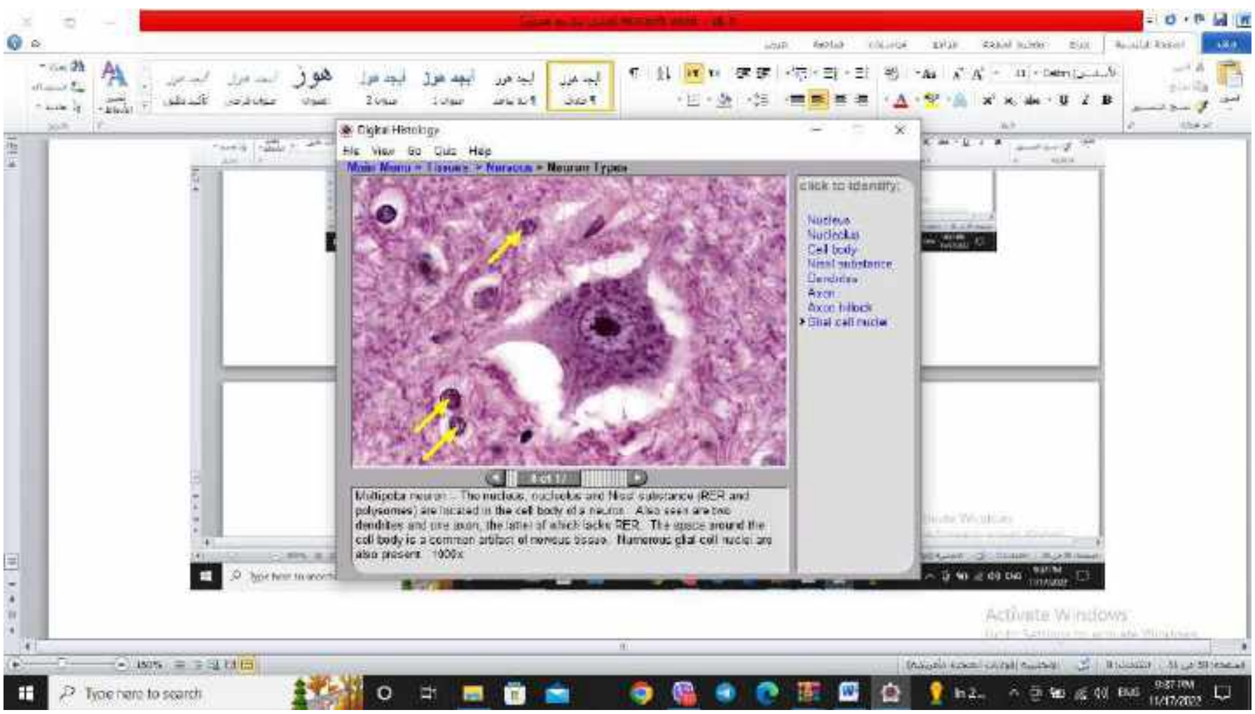
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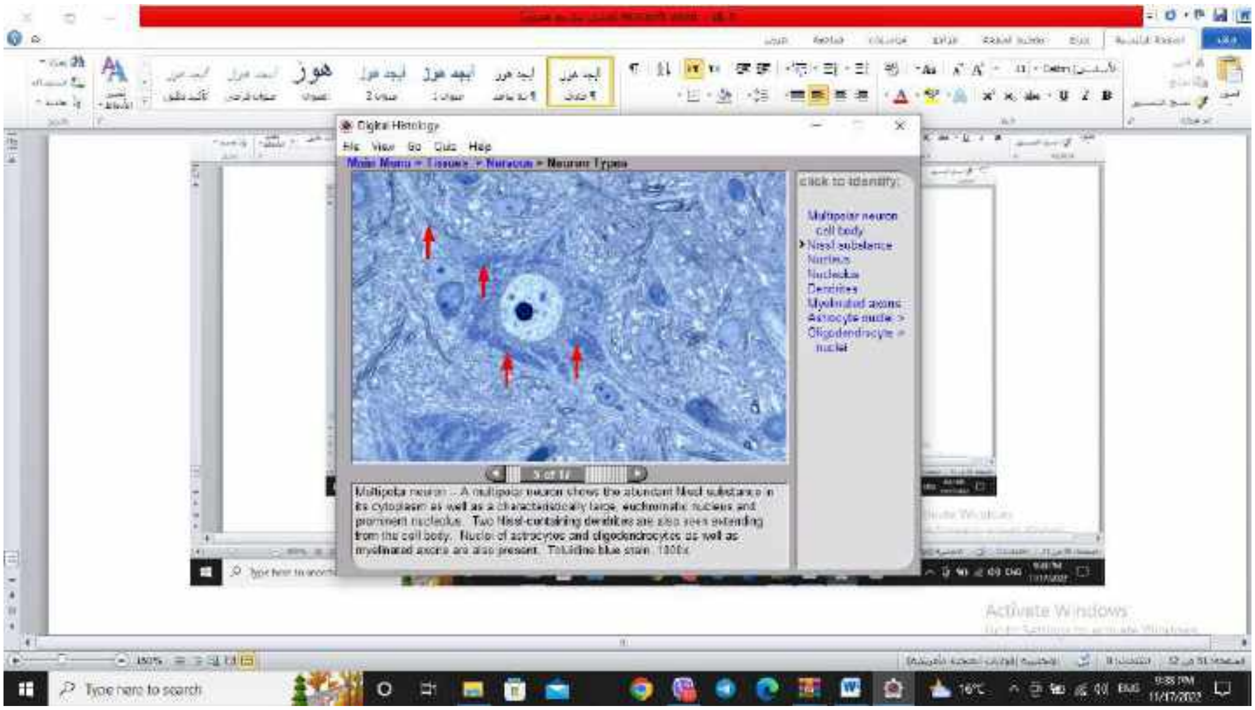
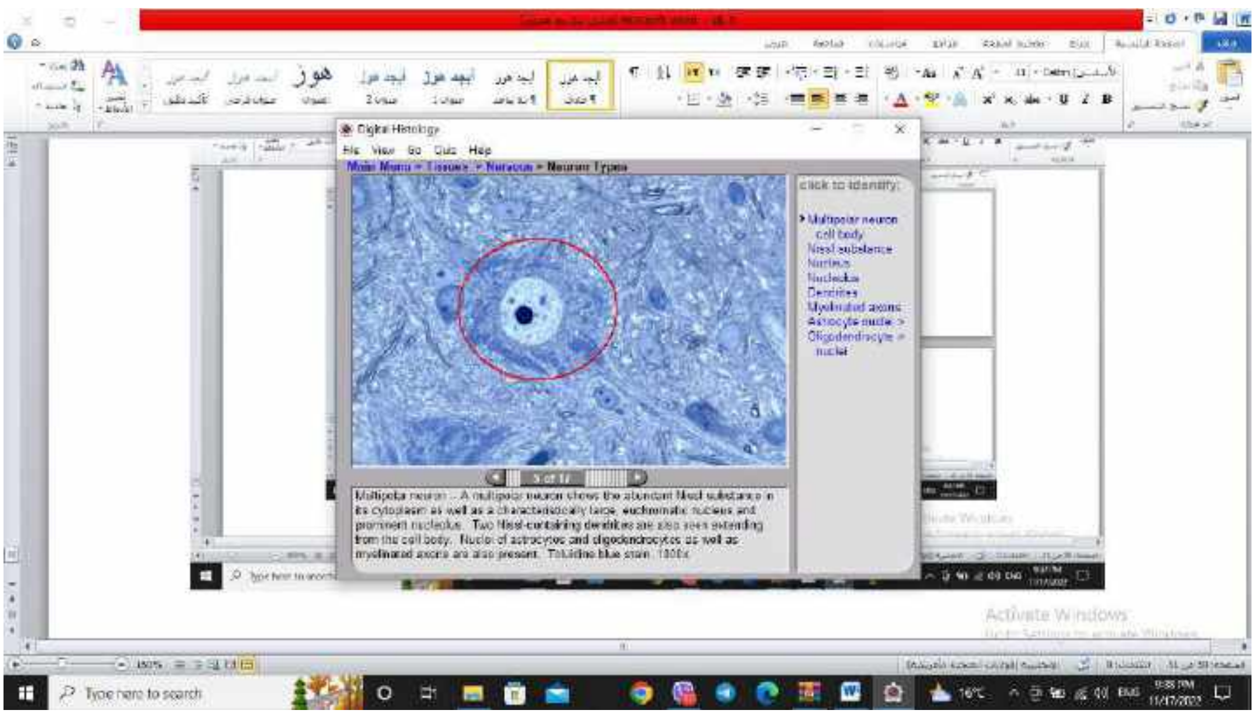

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Multipolar neuron cell body
Nissl substance
Nucleus
Nucleolus
Dendrites
Myelinated axons
Astrocyte nuclei >
Oligodendrocyte > nuclei
5 of 17
Multipolar neuron – A multipolar neuron shows the abundant Nissl substance in its cytoplasm as well as a characteristically large, euchromatic nucleus and prominent nucleolus. Two Nissl-containing dendrites are also seen extending from the cell body. Nuclei of astrocytes and oligodendrocytes as well as myelinated axons are also present. Toluidine blue stain. 1000x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Main Menu > Tissues > Nervous > Neuron Types
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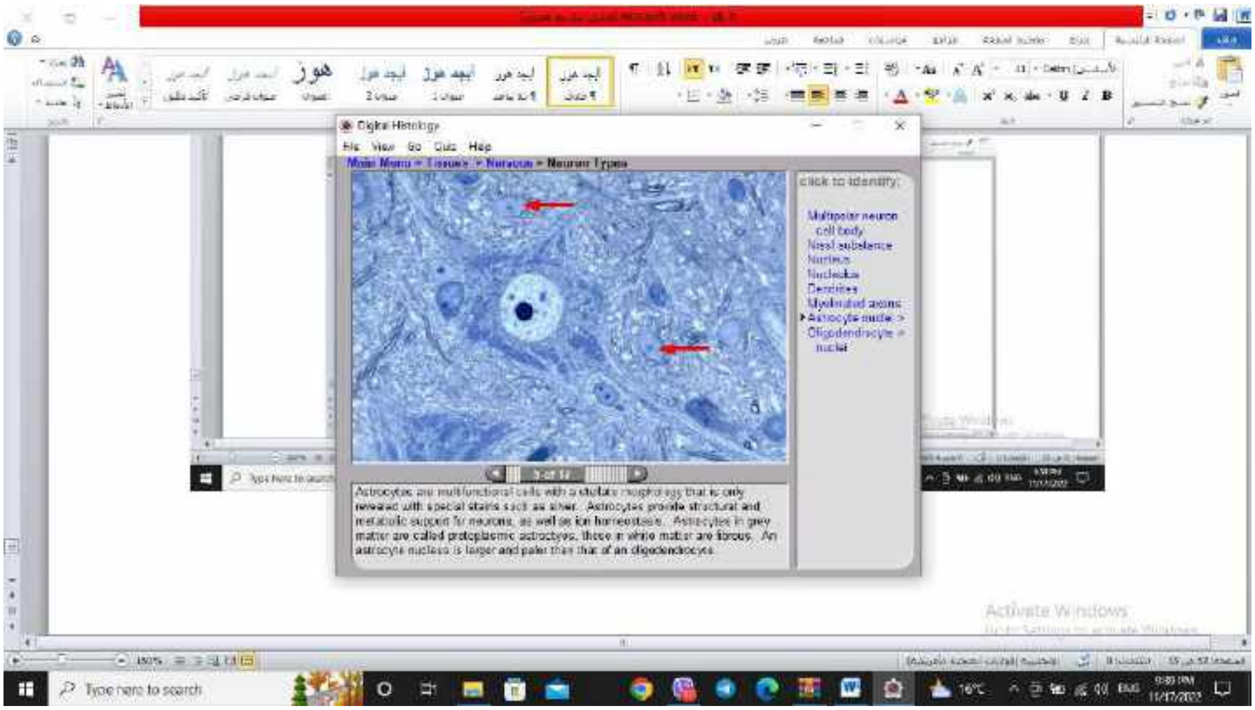
Digital Histology
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Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Multipolar neuron cell body
Nissl substance
Nucleus
Nucleolus
Dendrites
Myelinated axons
Astrocyte nuclei >
Oligodendrocyte nuclei
Astrocytes are multifunctional cells with a stellate morphology that is only revealed with special stains such as silver. Astrocytes provide structural and metabolic support for neurons, as well as ion homeostasis. Astrocytes in grey matter are called protoplasmic astrocytes, those in white matter are fibrous. An astrocyte nucleus is larger and paler than that of an oligodendrocyte.
Activate Windows
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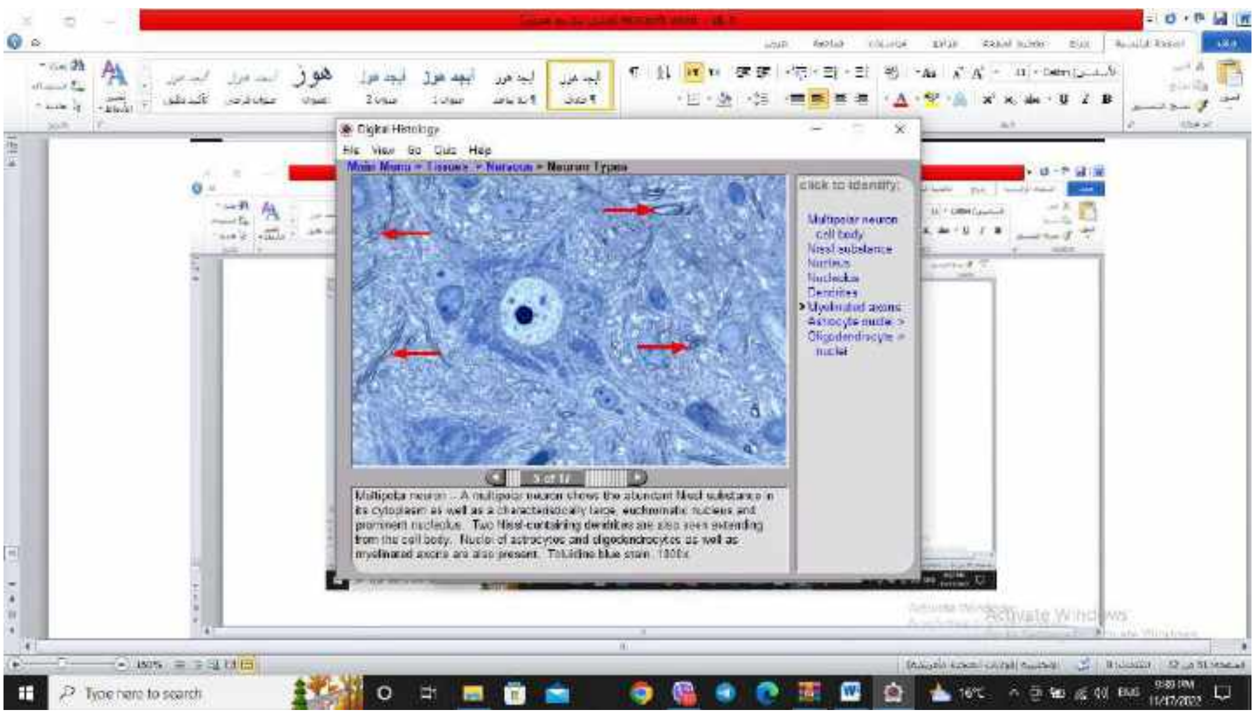
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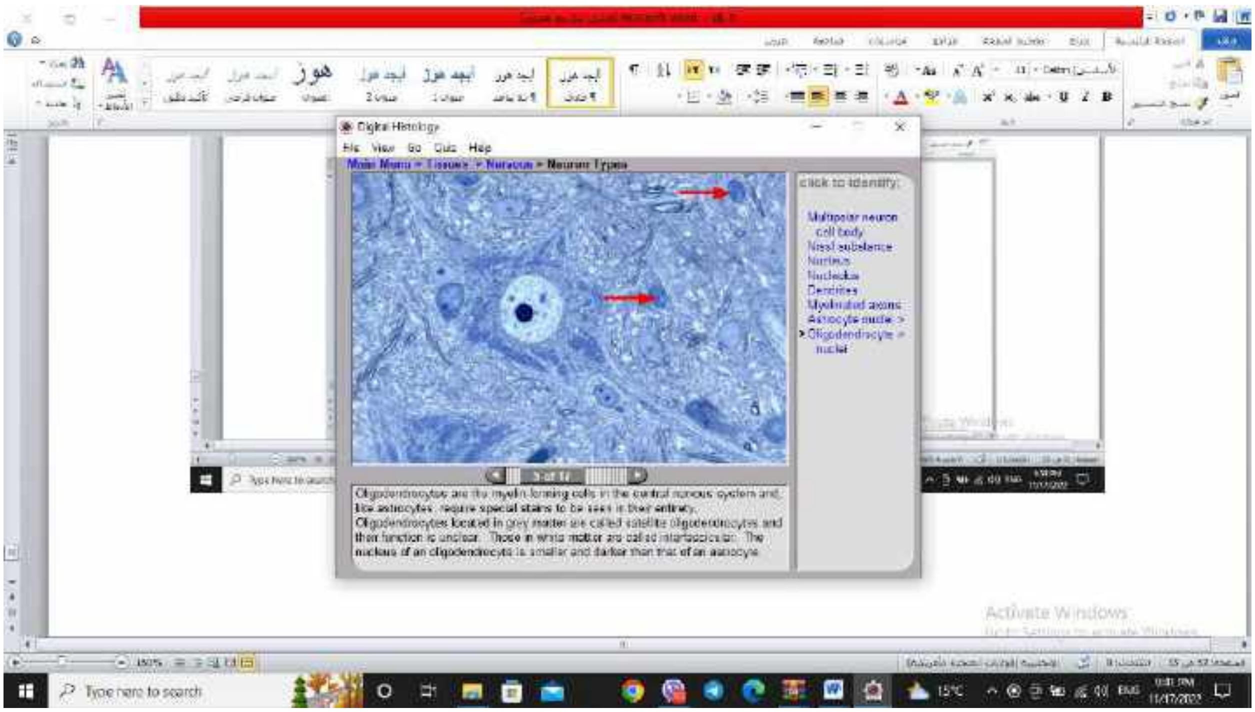

Digital Histology
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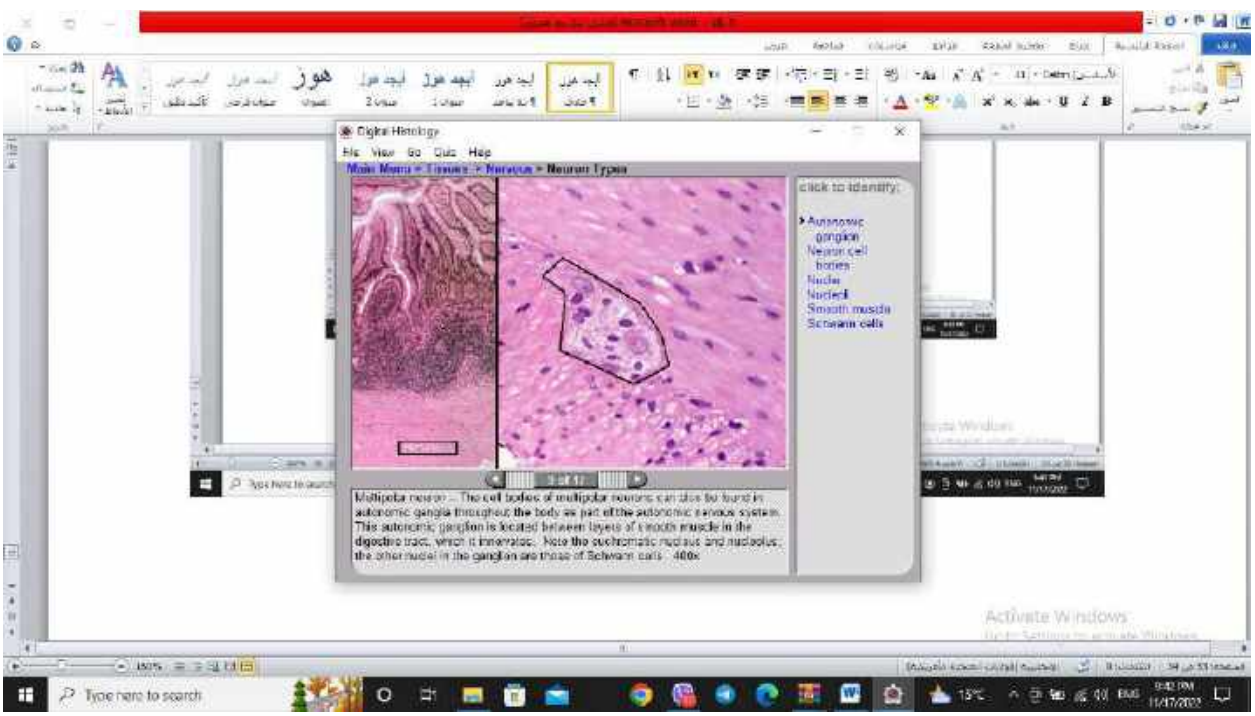
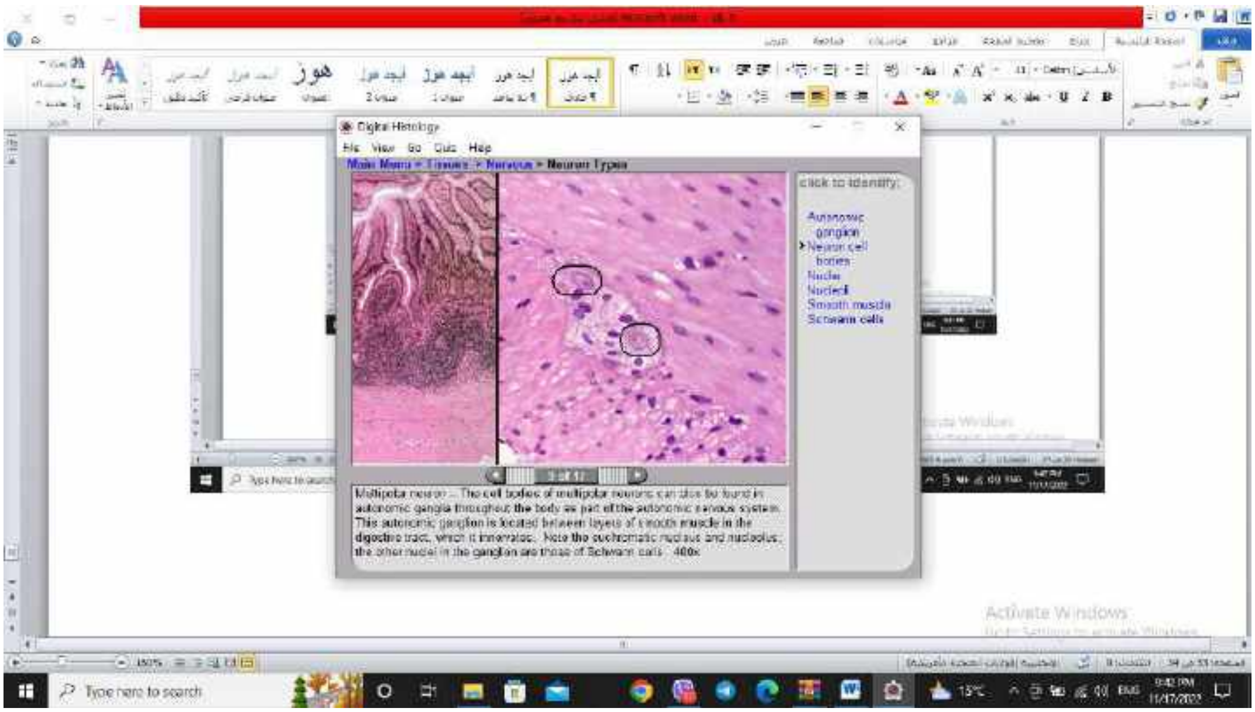
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Multipolar neuron cell body
Nissl substance
Nucleus
Nucleolus
Dendrites
Myelinated axons
Astrocyte nuclei
Oligodendrocyte nuclei
Oligodendrocytes are the myelin-forming cells in the central nervous system and, like astrocytes, require special stains to be seen in their entirety.
Oligodendrocytes located in grey matter are called satellite oligodendrocytes and their function is unclear. Those in white matter are called interfascicular. The nucleus of an oligodendrocyte is smaller and darker than that of an astrocyte.
Activate Windows
Type here to search



Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Autonomic ganglion
Neuron cell bodies
Nuclei
Nucleoli
Smooth muscle
Schwann cells
Multipolar neuron ... The cell bodies of multipolar neurons can also be found in autonomic ganglia throughout the body as part of the autonomic nervous system. This autonomic ganglion is located between layers of smooth muscle in the digestive tract, which it innervates. Note the euchromatic nucleus and nucleolus; the other nuclei in the ganglion are those of Schwann cells. 400x
Activate Windows
Type here to search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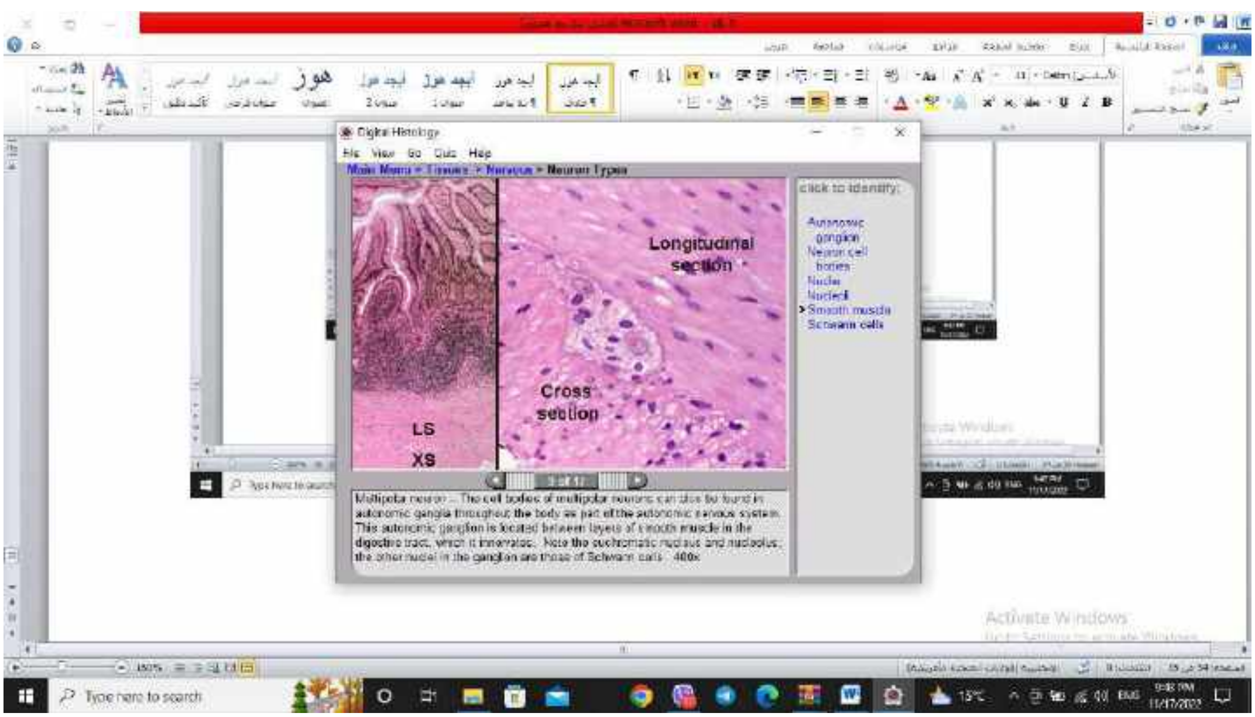
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
Longitudinal section
Cross section
LS
XS
click to identify:
Autonomic ganglion
Neuron cell bodies
Nuclei
Nucleoli
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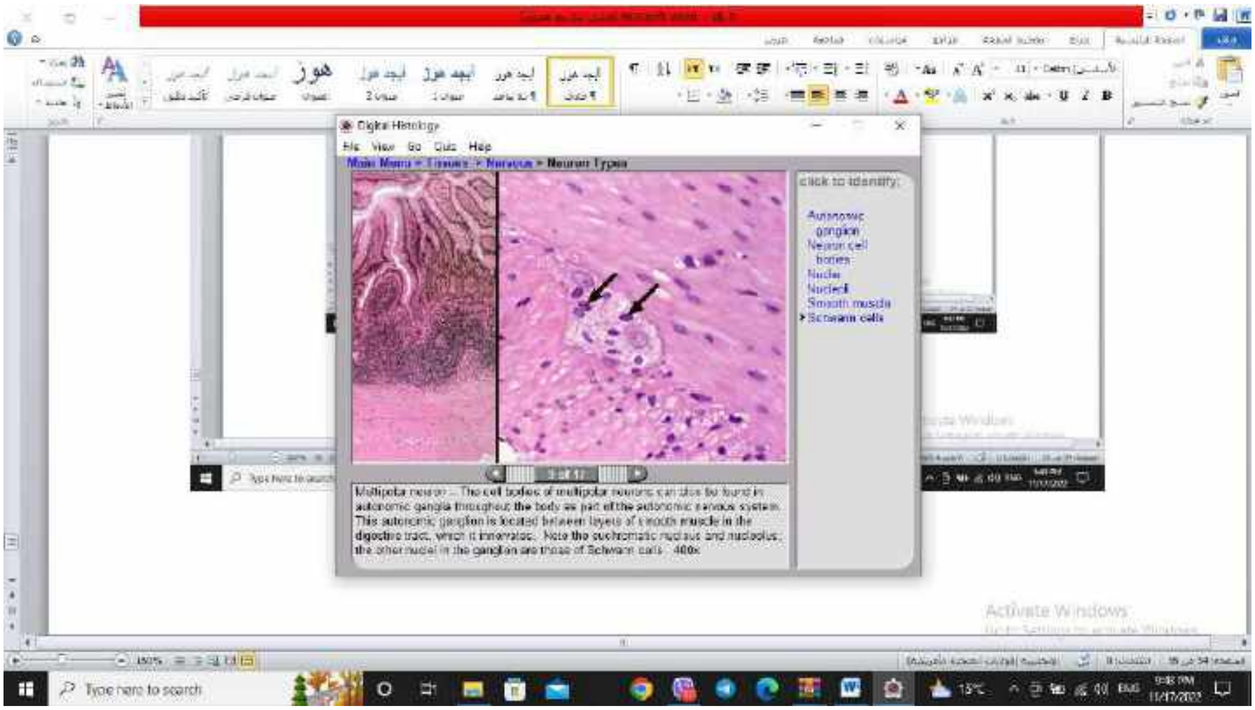
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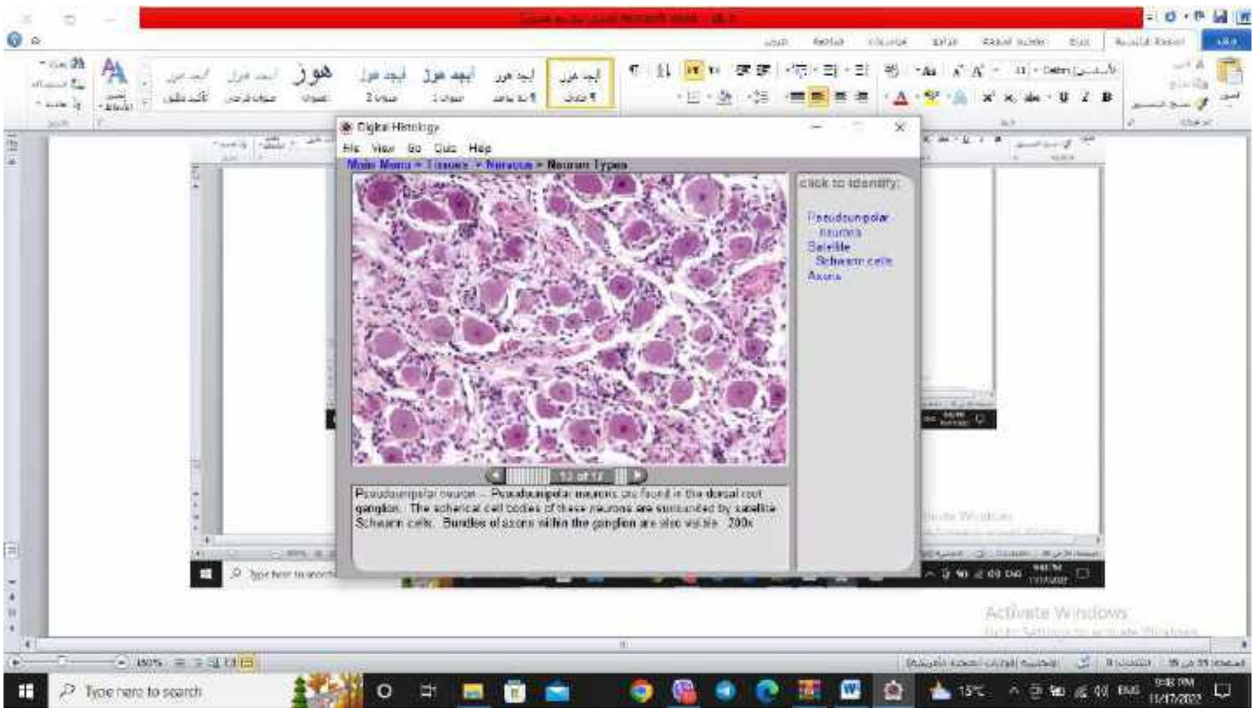
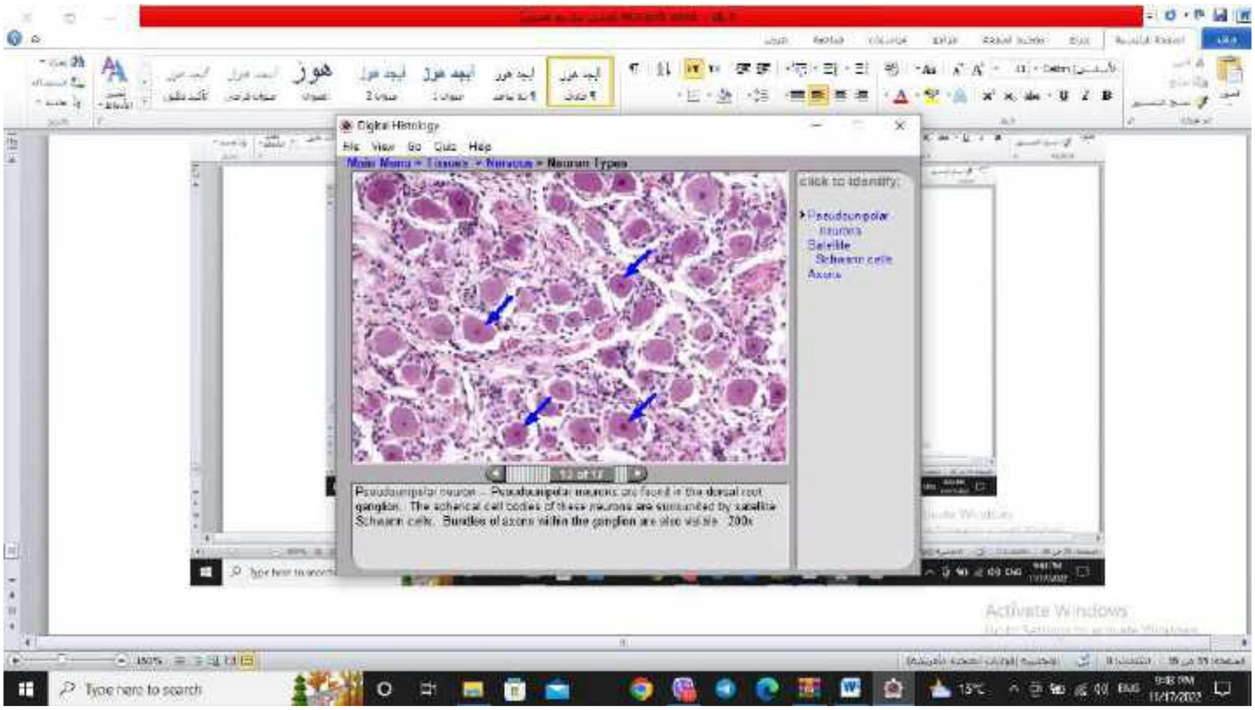

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Pseudounipolar neurons
Satellite Schwann cells
Axons
Pseudounipolar neuron – Pseudounipolar neurons are found in the dorsal root ganglion. The spherical cell bodies of these neurons are surrounded by satellite Schwann cells. Bundles of axons within the ganglion are also visible. 200x
Activate Windows
Type here to search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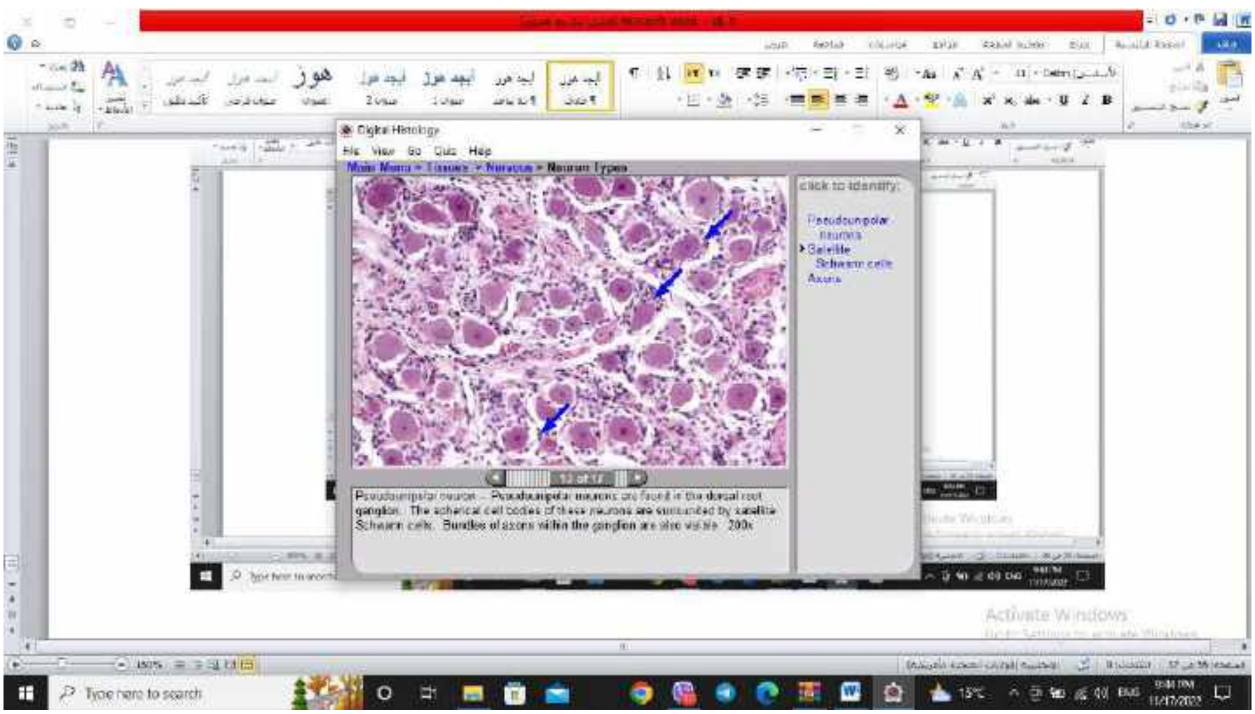
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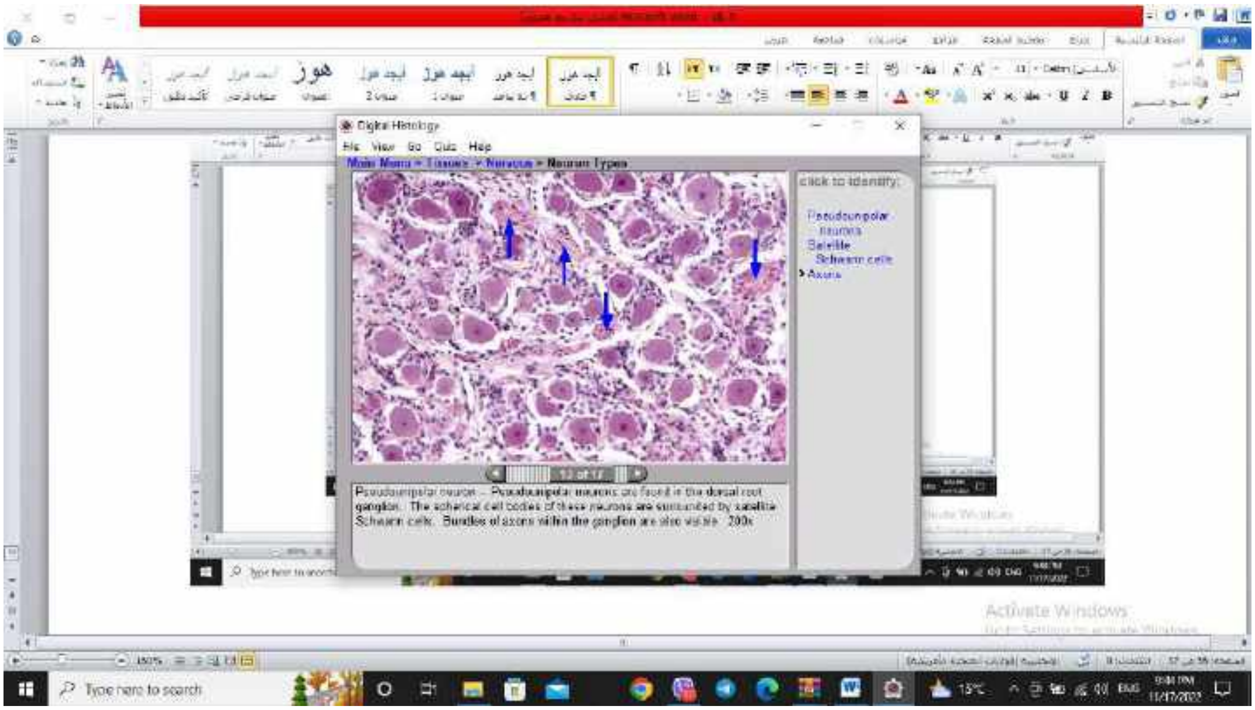
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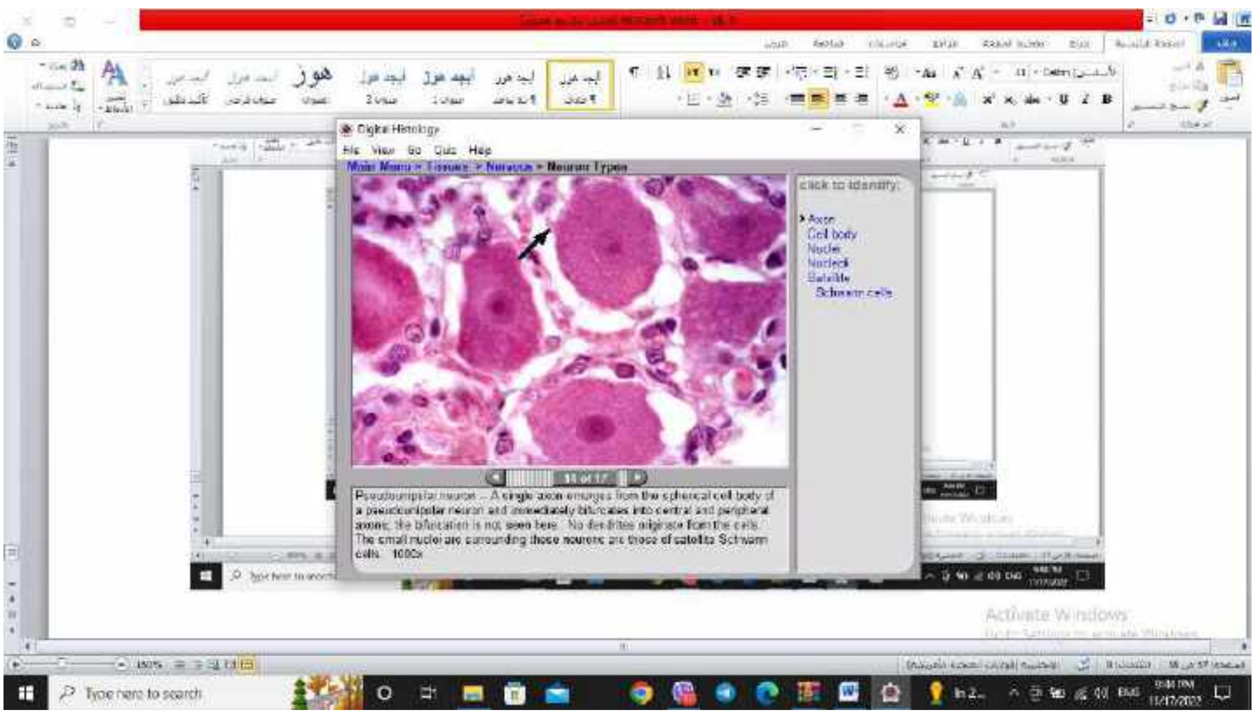
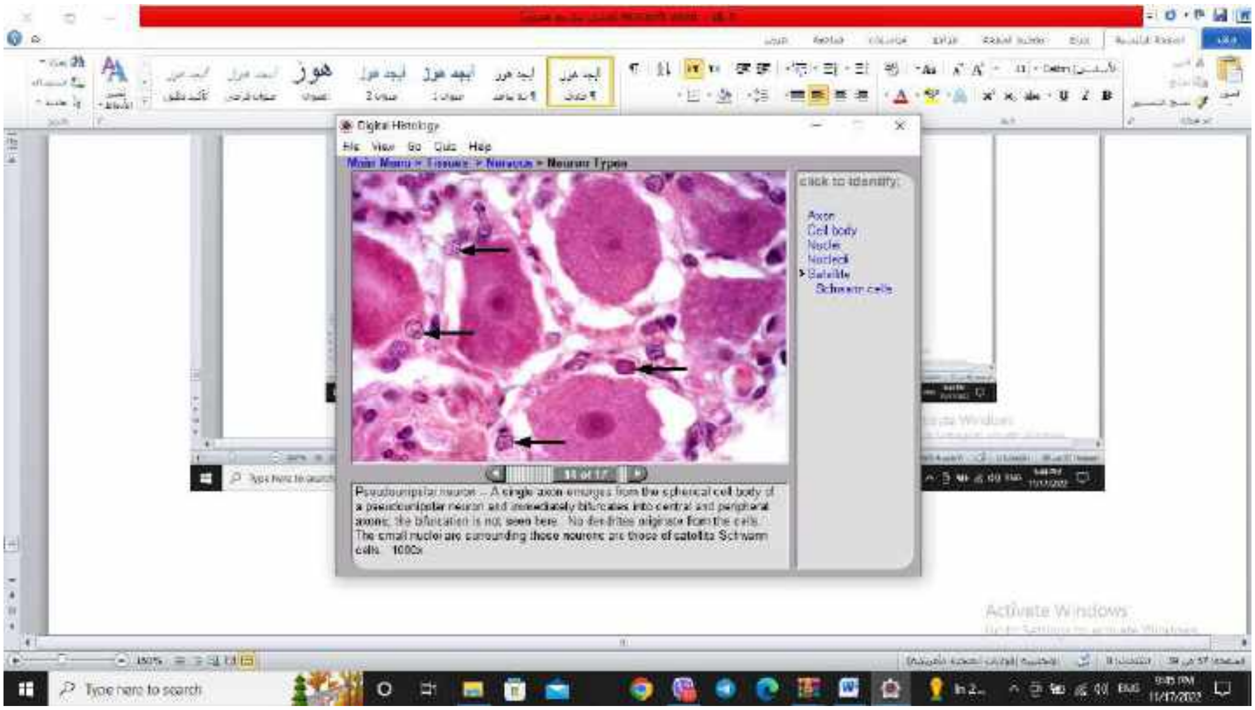

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Axon
Cell body
Nuclei
Nucleoli
Satellite Schwann cells
Pseudounipolar neuron -- A single axon emerges from the spherical cell body of a pseudounipolar neuron and immediately bifurcates into central and peripheral axons; the bifurcation is not seen here. No dendrites originate from the cells. The small nuclei are surrounding these neurons are those of satellite Schwann cells. 1000x
Activate Windows
Type here to search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Cell body
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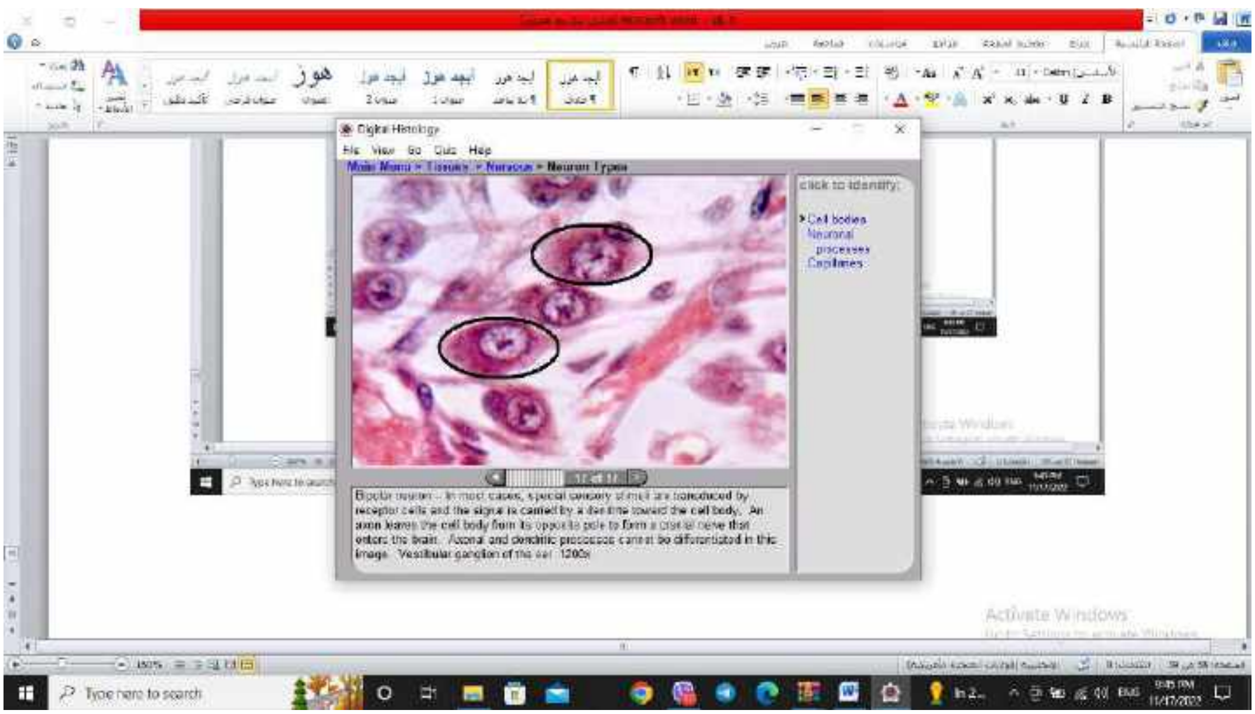
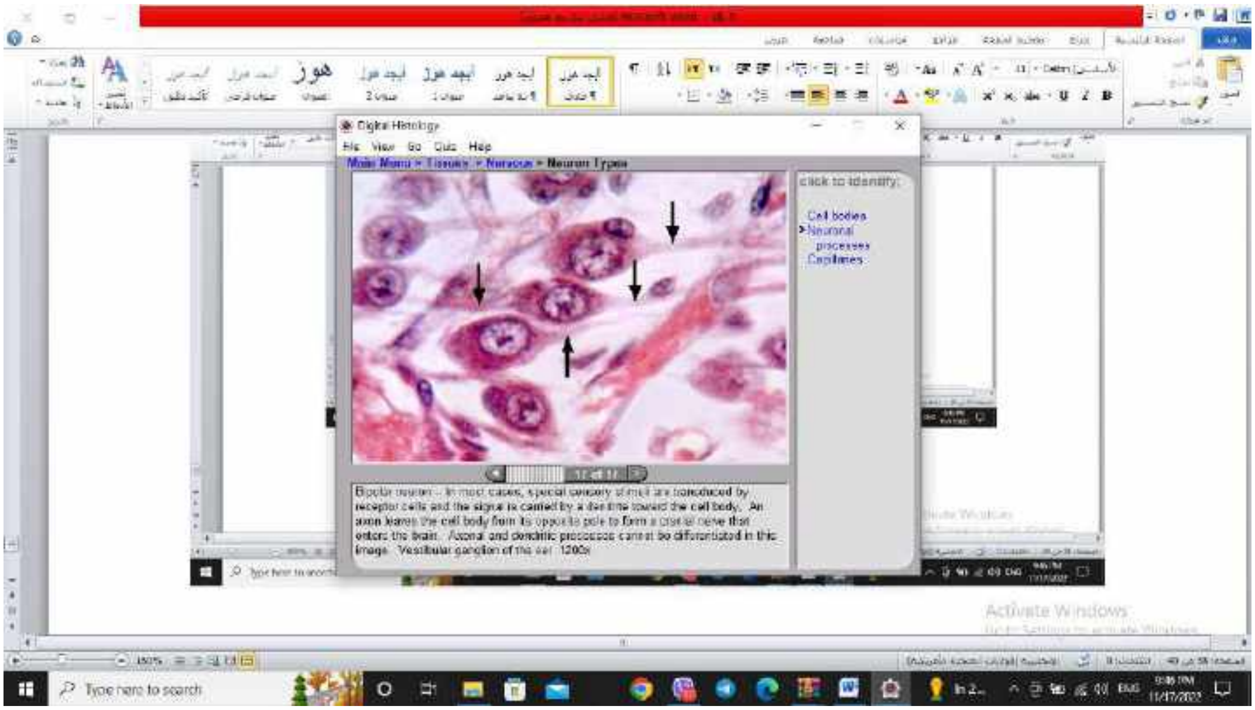
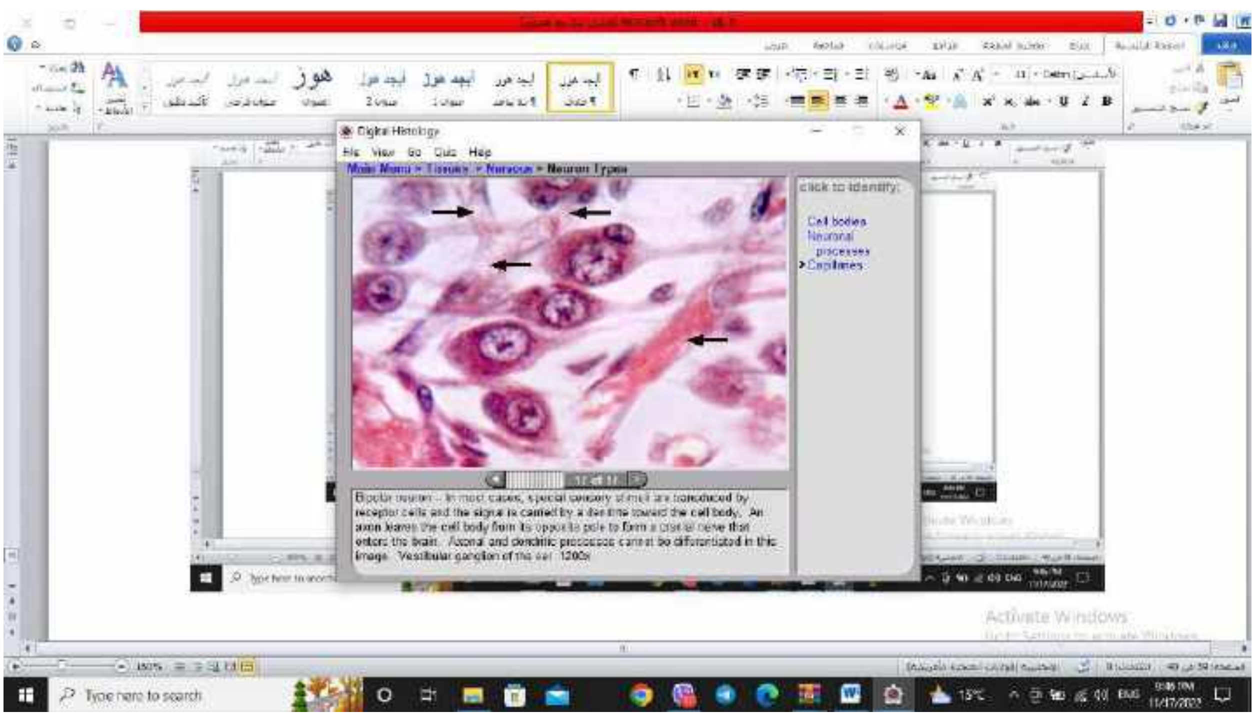

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Cell bodies
Neuronal processes
Capillaries
Bipolar neuron – In most cases, special sensory stimuli are transduced by receptor cells and the signal is carried by a dendrite toward the cell body. An axon leaves the cell body from its opposite pole to form a cranial nerve that enters the brain. Axonal and dendritic processes cannot be differentiated in this image. Vestibular ganglion of the ear. 1200x
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Neuron Types
click to identify:
Cell bodies
Neuronal processes
Capillaries
Activate Windows
Type here to search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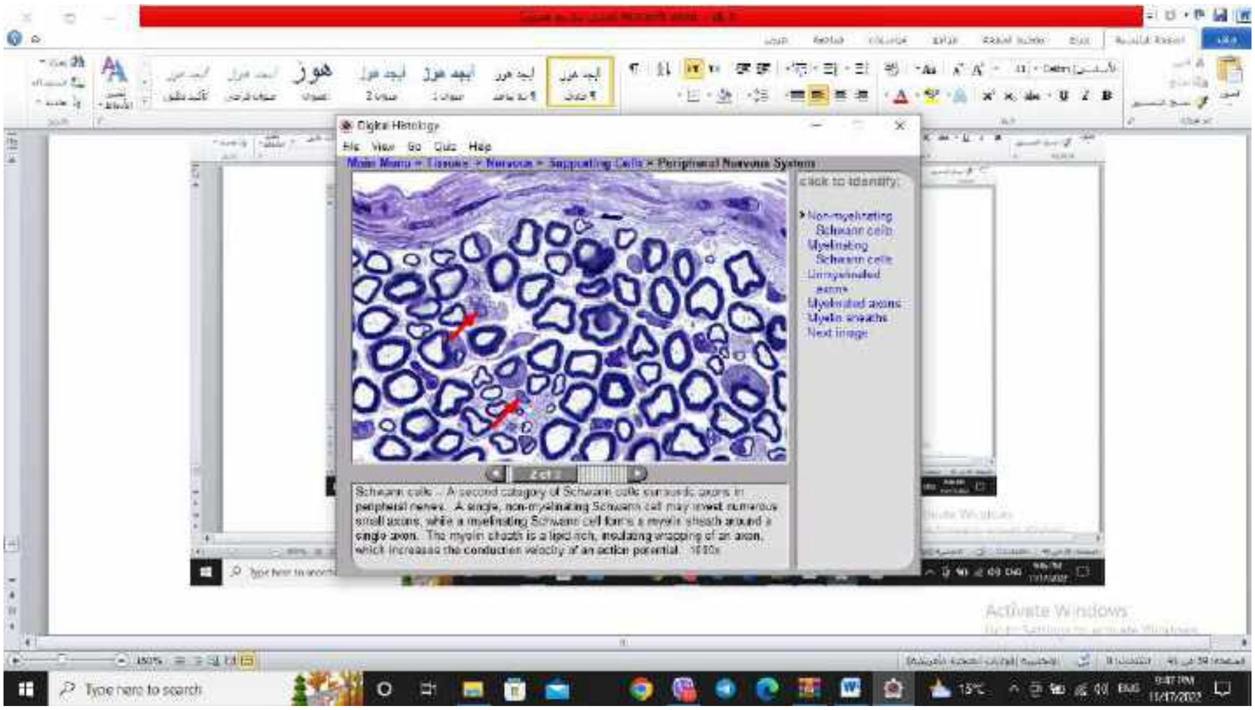
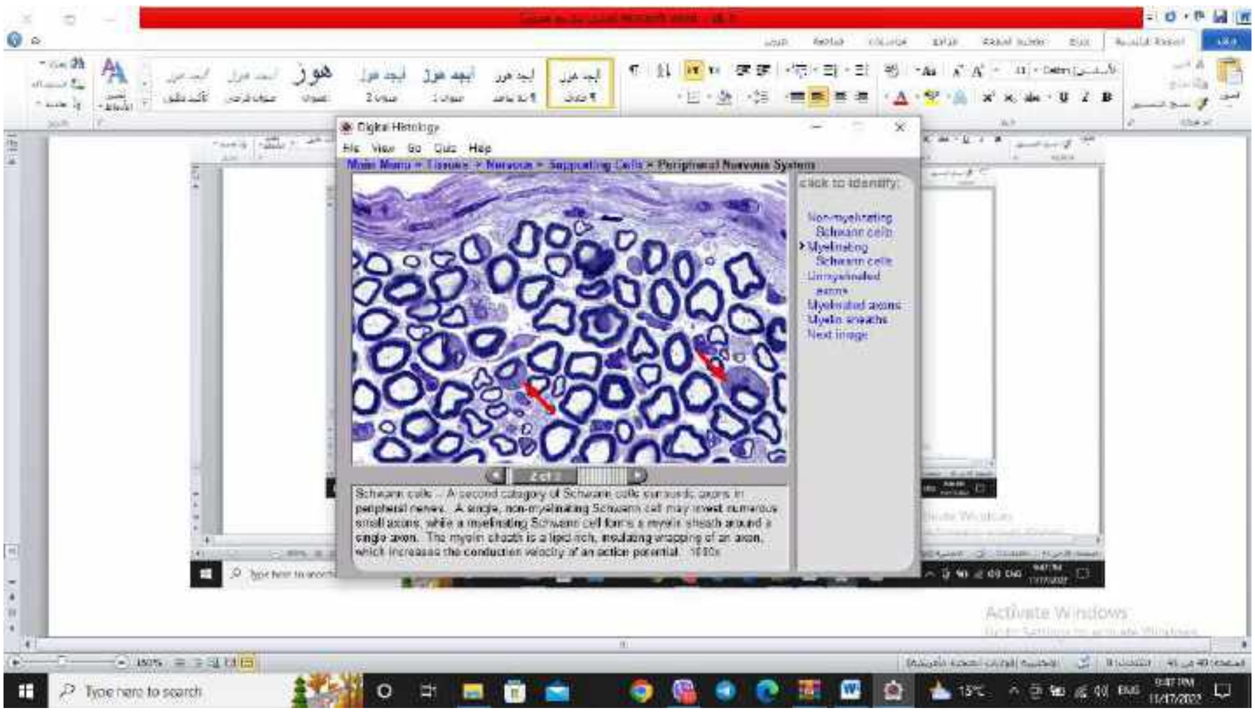

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Peripheral Nervous System
click to identify:
Non-myelinating Schwann cells
Myelinating Schwann cells
Unmyelinated axons
Myelinated axons
Myelin sheaths
Next image
Schwann cells - A second category of Schwann cells surrounds axons in peripheral nerves. A single, non-myelinating Schwann cell may invest numerous small axons, while a myelinating Schwann cell forms a myelin sheath around a single axon. The myelin sheath is a lipid-rich, insulating wrapping of an axon, which increases the conduction velocity of an action potential.
Activate Windows
Type here to search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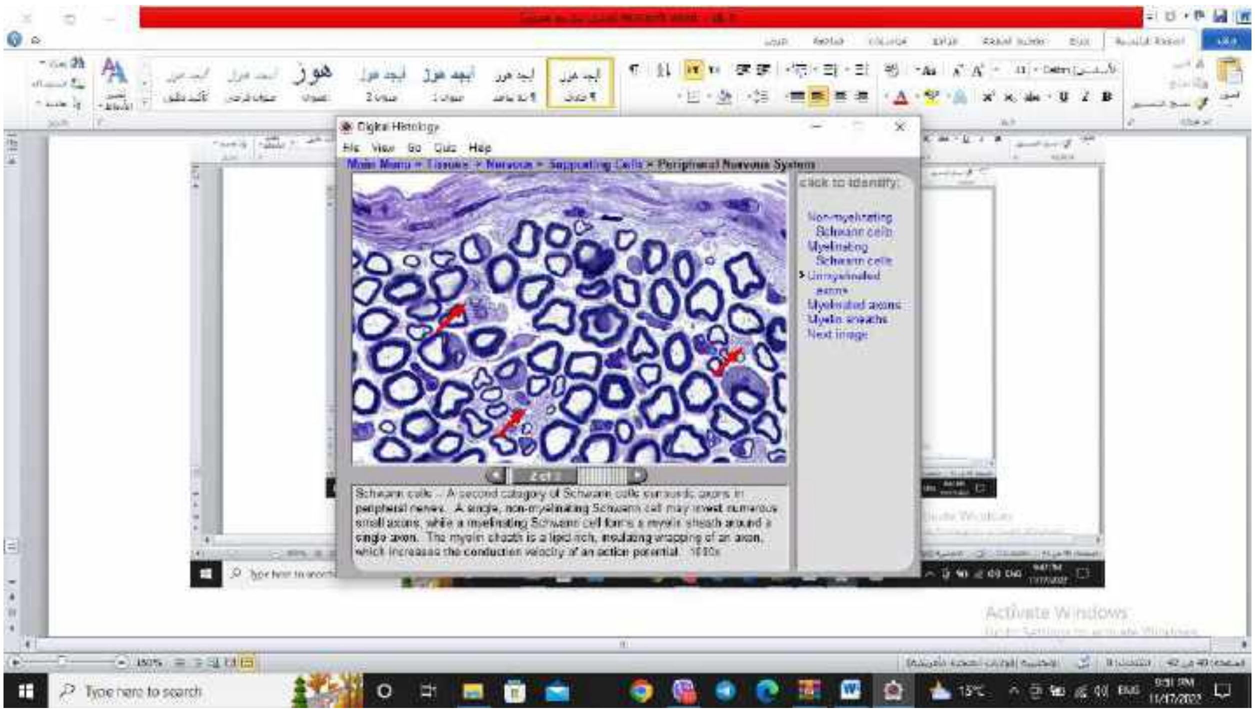
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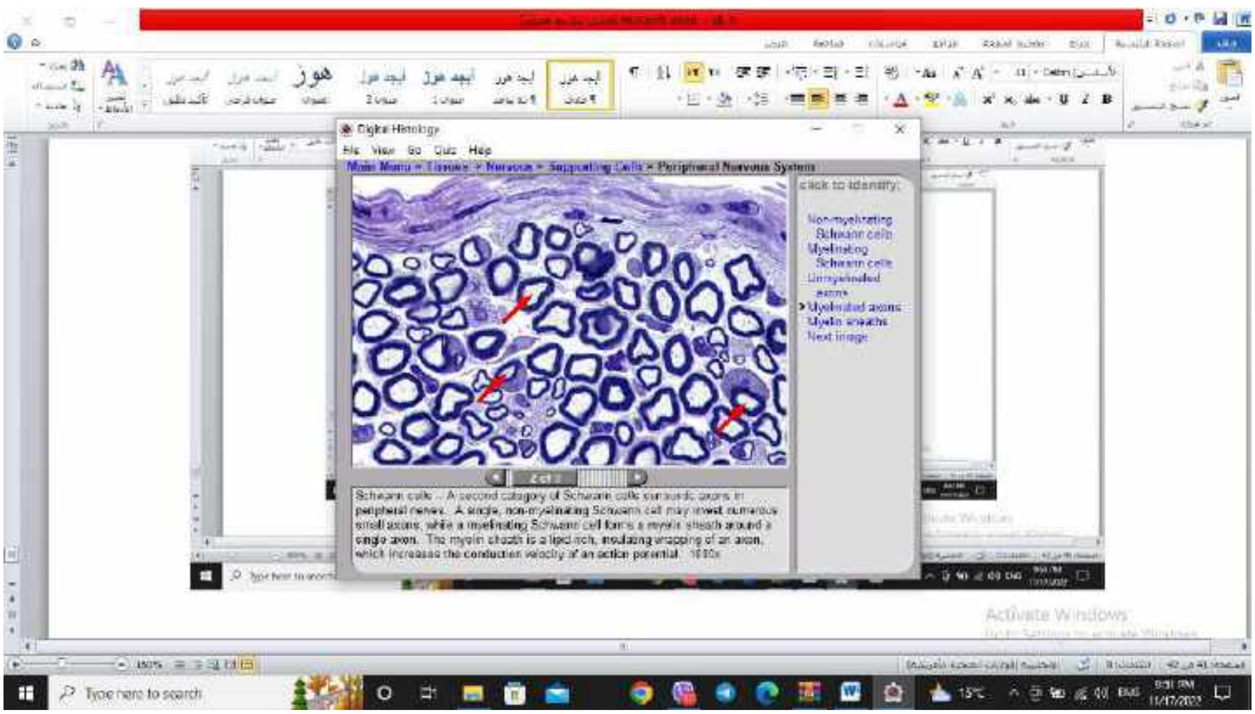
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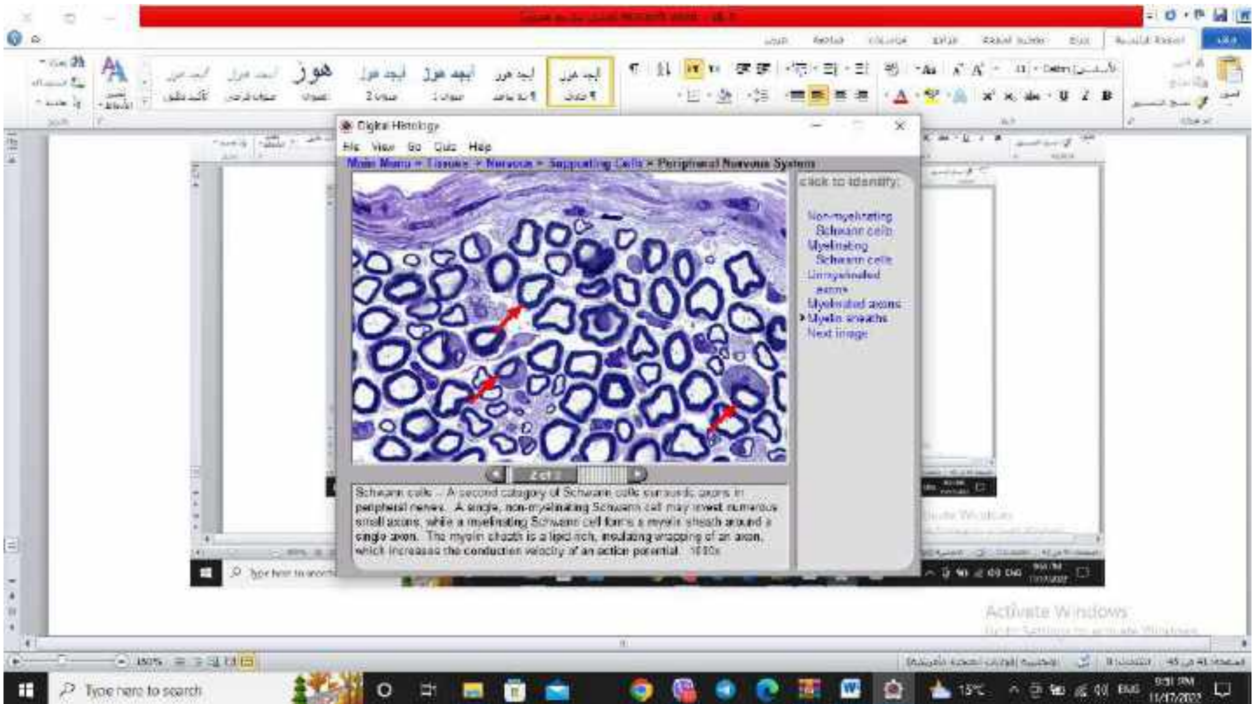
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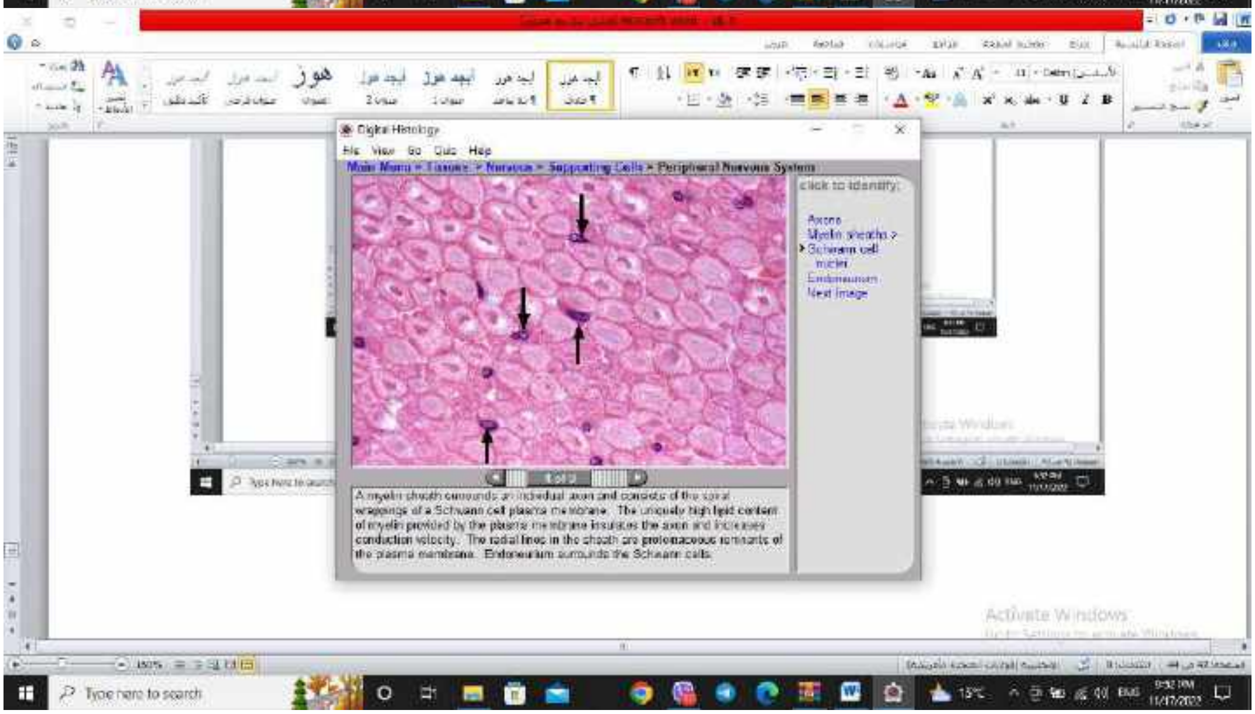
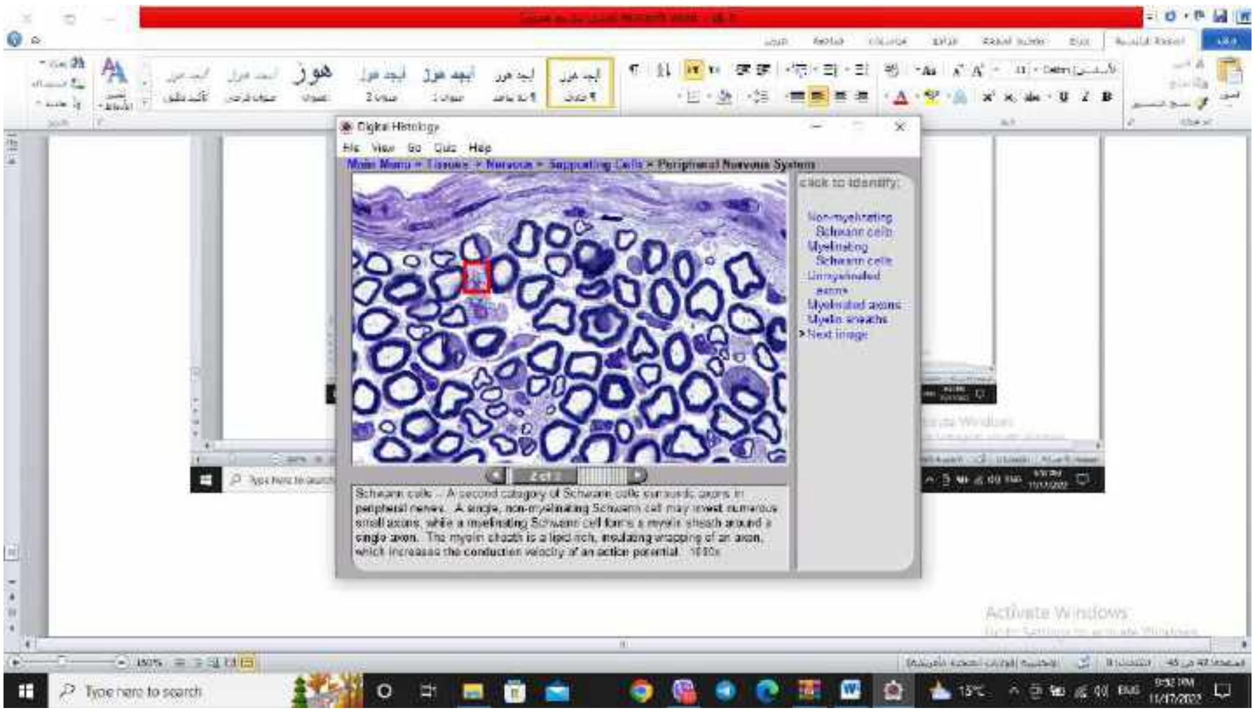

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Peripheral Nervous System
click to identify:
Axons
Myelin sheaths
Schwann cell nuclei
Endoneurium
Next Image
A myelin sheath surrounds an individual axon and consists of the spiral wrappings of a Schwann cell plasma membrane. The uniquely high lipid content of myelin provided by the plasma membrane insulates the axon and increases conduction velocity. The radial lines in the sheath are proteinaceous remnants of the plasma membrane. Endoneurium surrounds the Schwann cells.
Activate Windows
Type here to search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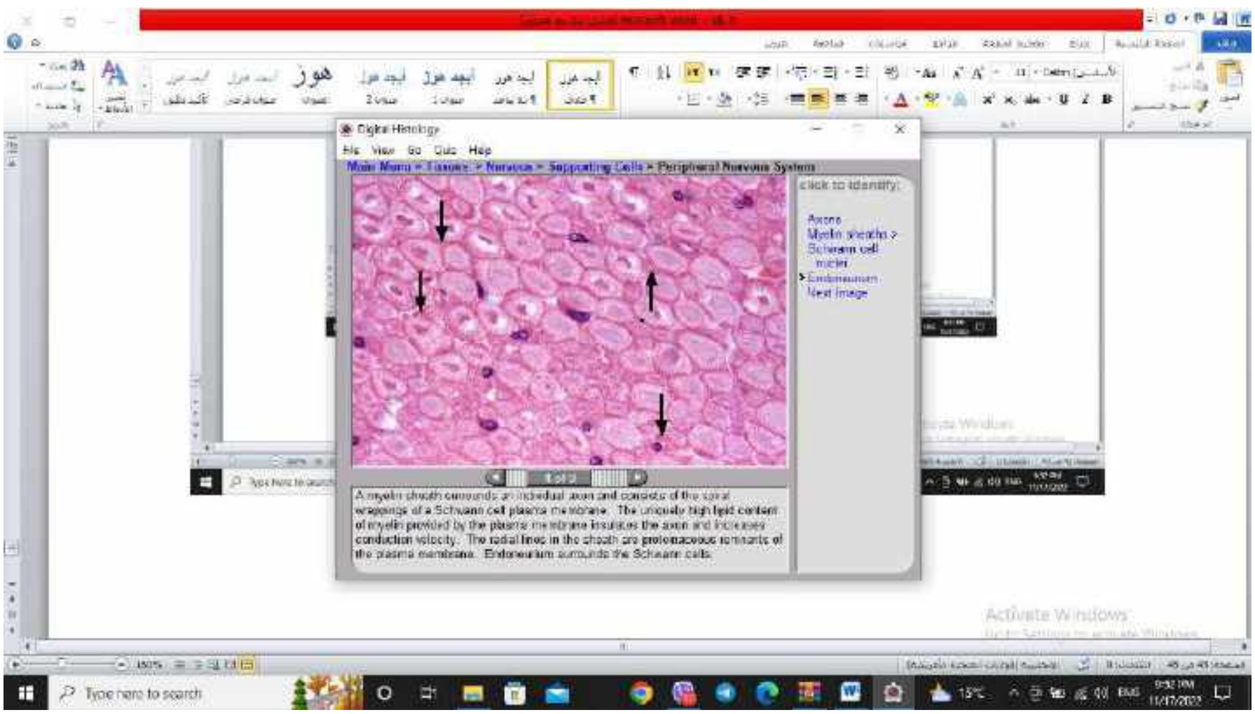
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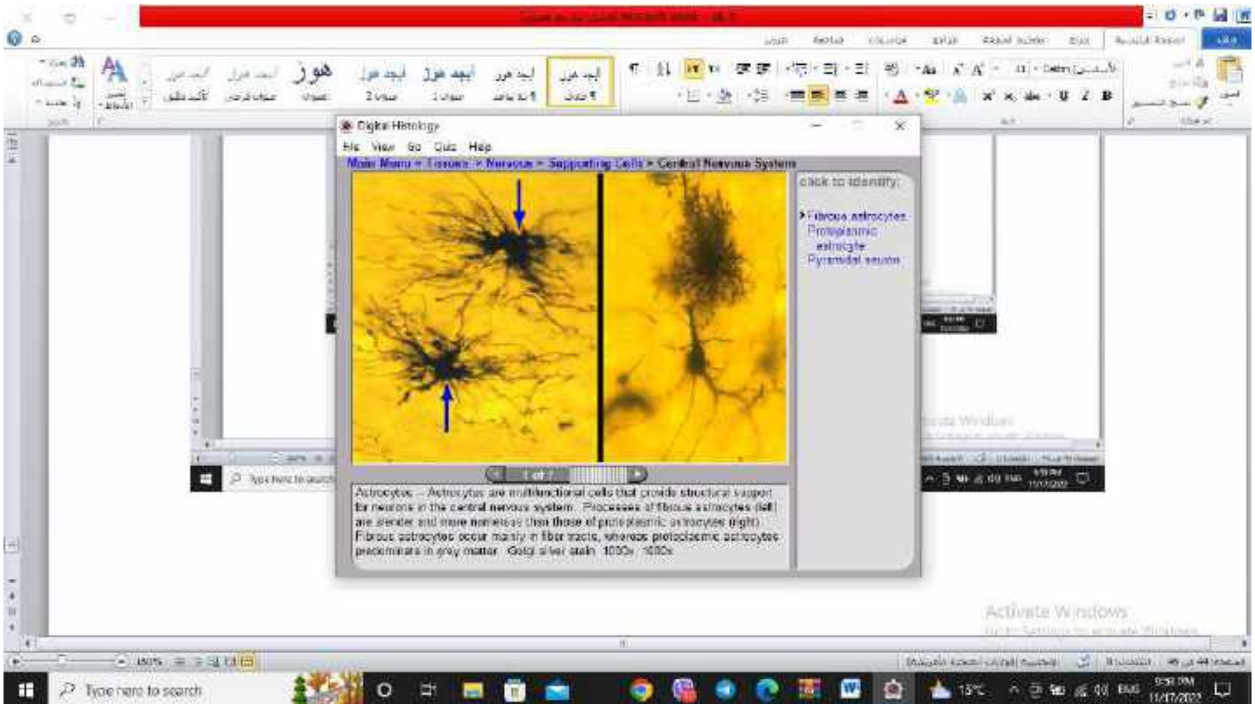
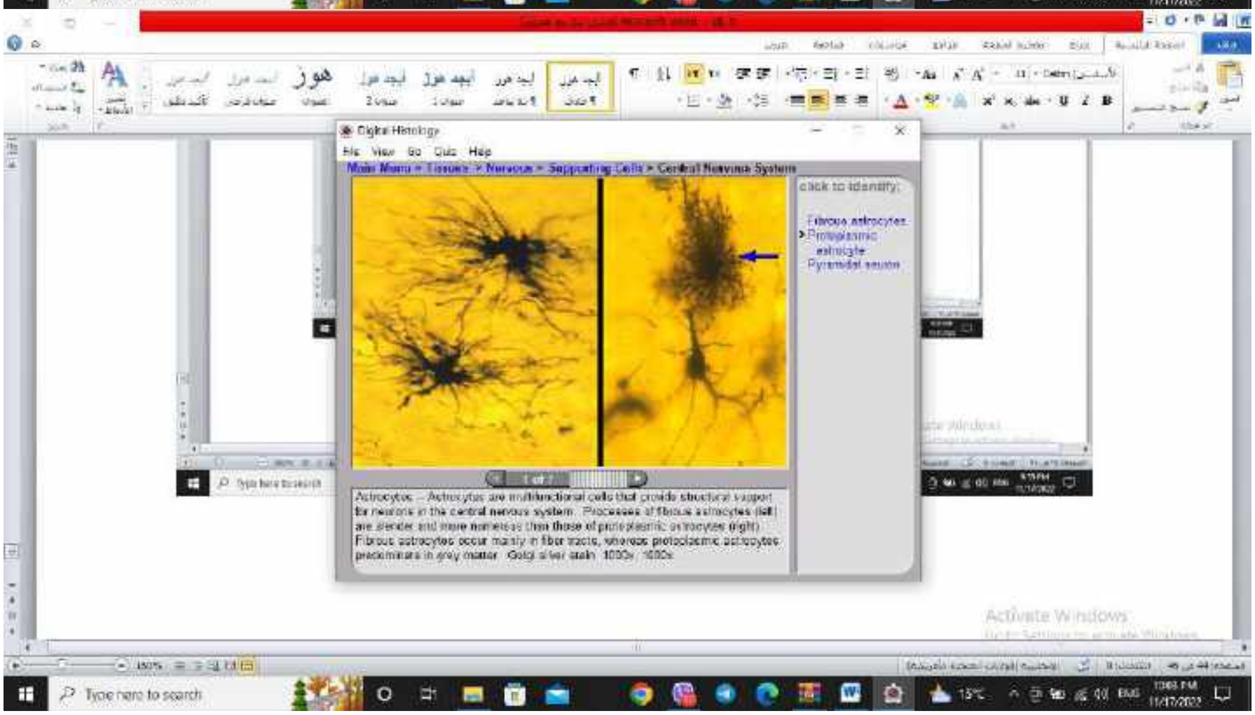

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Fibrous astrocytes
Protoplasmic astrocyte
Pyramidal neuron
1 of 7
Astrocytes -- Astrocytes are multifunctional cells that provide structural support for neurons in the central nervous system. Processes of fibrous astrocytes (left) are slender and more numerous than those of protoplasmic astrocytes (right). Fibrous astrocytes occur mainly in fiber tracts, whereas protoplasmic astrocytes predominate in grey matter. Golgi silver stain. 1000x, 1000x.
Activate Windows
Type here to search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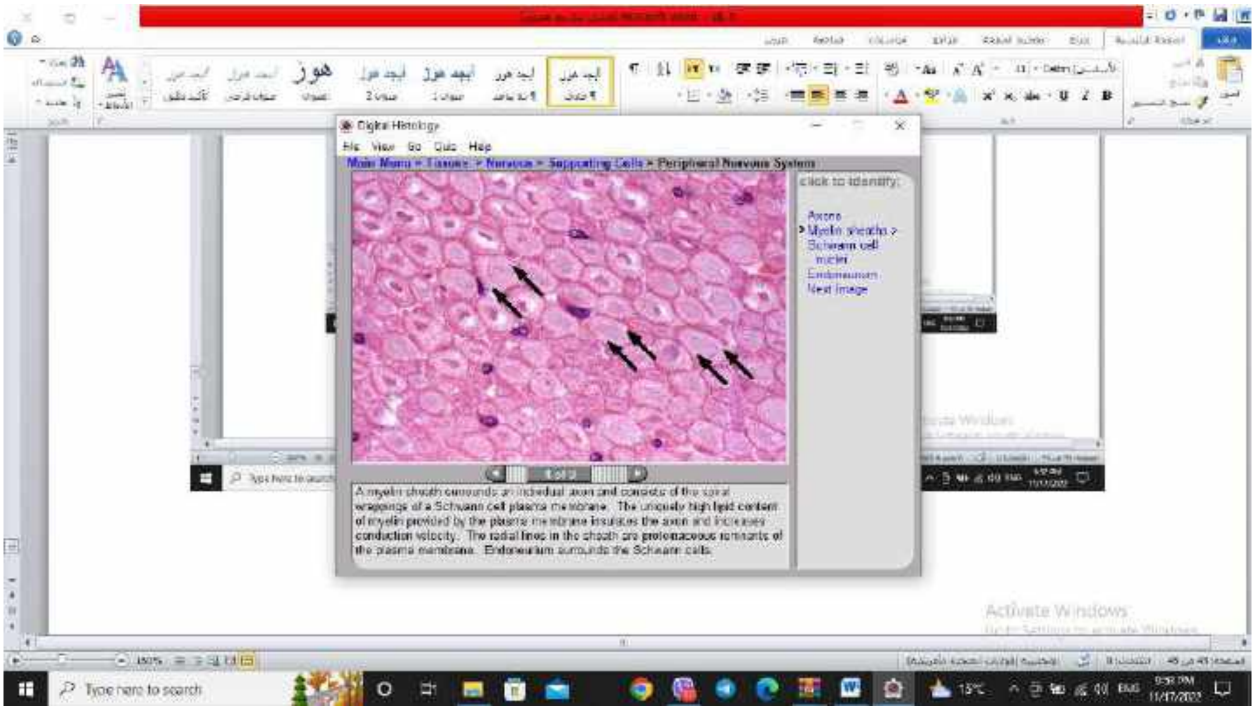
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File View Go Quiz Help
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Axons
Myelin sheaths > Schwann cell nuclei
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A myelin sheath surrounds an individual axon and consists of the spiral wrappings of a Schwann cell plasma membrane. The uniquely high lipid content of myelin provided by the plasma membrane insulates the axon and increases conduction velocity. The radial lines in the sheath are proteinaceous remnants of the plasma membrane. Endoneurium surrounds the Schwann cells.
Activate Windows
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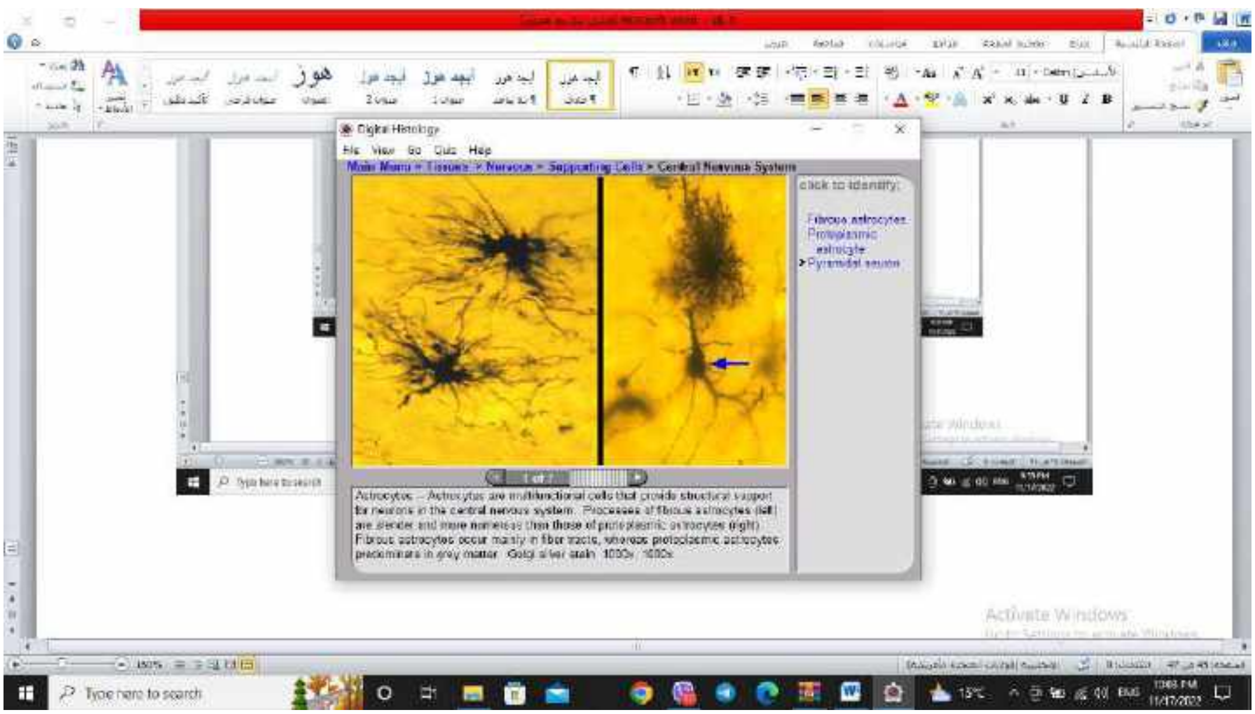
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Fibrous astrocytes
Protoplasmic astrocyte
Pyramidal neuron
Astrocytes – Astrocytes are multifunctional cells that provide structural support for neurons in the central nervous system. Processes of fibrous astrocytes (left) are slender and more numerous than those of protoplasmic astrocytes (right). Fibrous astrocytes occur mainly in fiber tracts, whereas protoplasmic astrocytes predominate in grey matter. Golgi silver stain. 1000x, 1000x.
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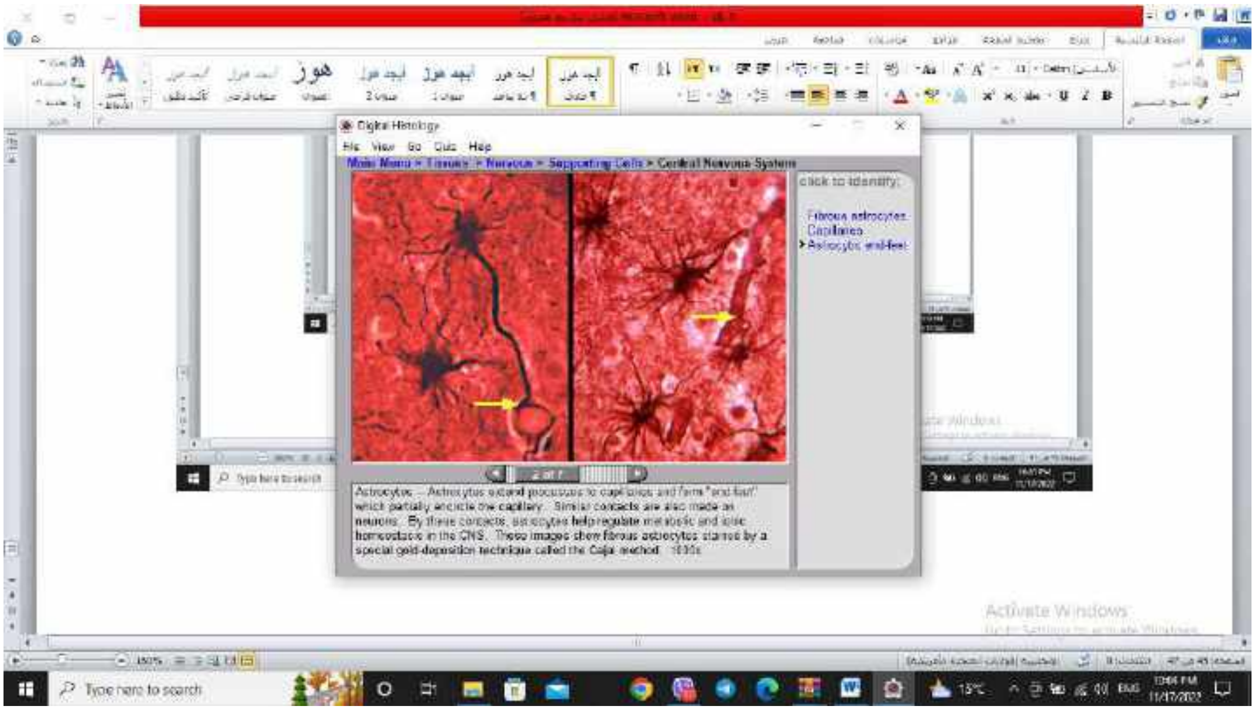

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Fibrous astrocytes
Capillaries
Astrocytic end-feet
Astrocytes -- Astrocytes extend processes to capillaries and form "end feet" which partially encircle the capillary. Similar contacts are also made on neurons. By these contacts, astrocytes help regulate metabolic and ionic homeostasis in the CNS. These images show fibrous astrocytes stained by a special gold-deposition technique called the Cajal method.
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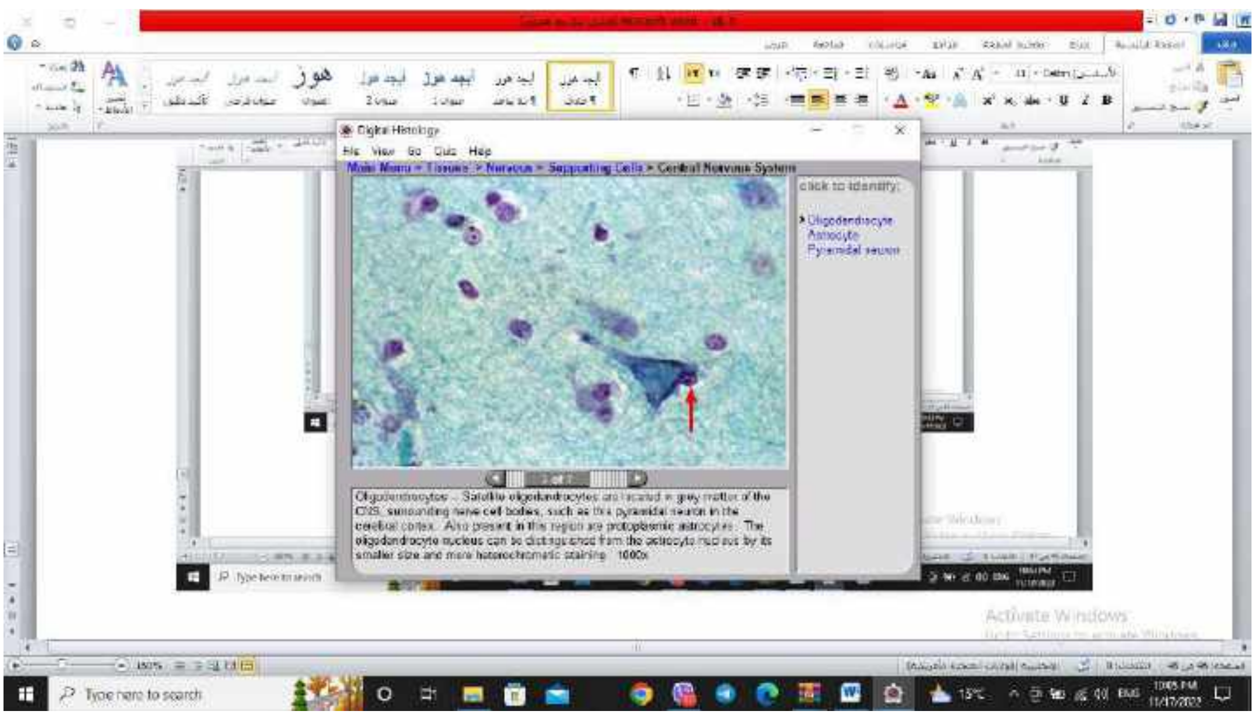

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Oligodendrocyte
Astrocyte
Pyramidal neuron
Oligodendrocytes -- Satellite oligodendrocytes are located in grey matter of the CNS, surrounding nerve cell bodies, such as this pyramidal neuron in the cerebral cortex. Also present in this region are protoplasmic astrocytes. The oligodendrocyte nucleus can be distinguished from the astrocyte nucleus by its smaller size and more heterochromatic staining. 1000x
Activate Windows
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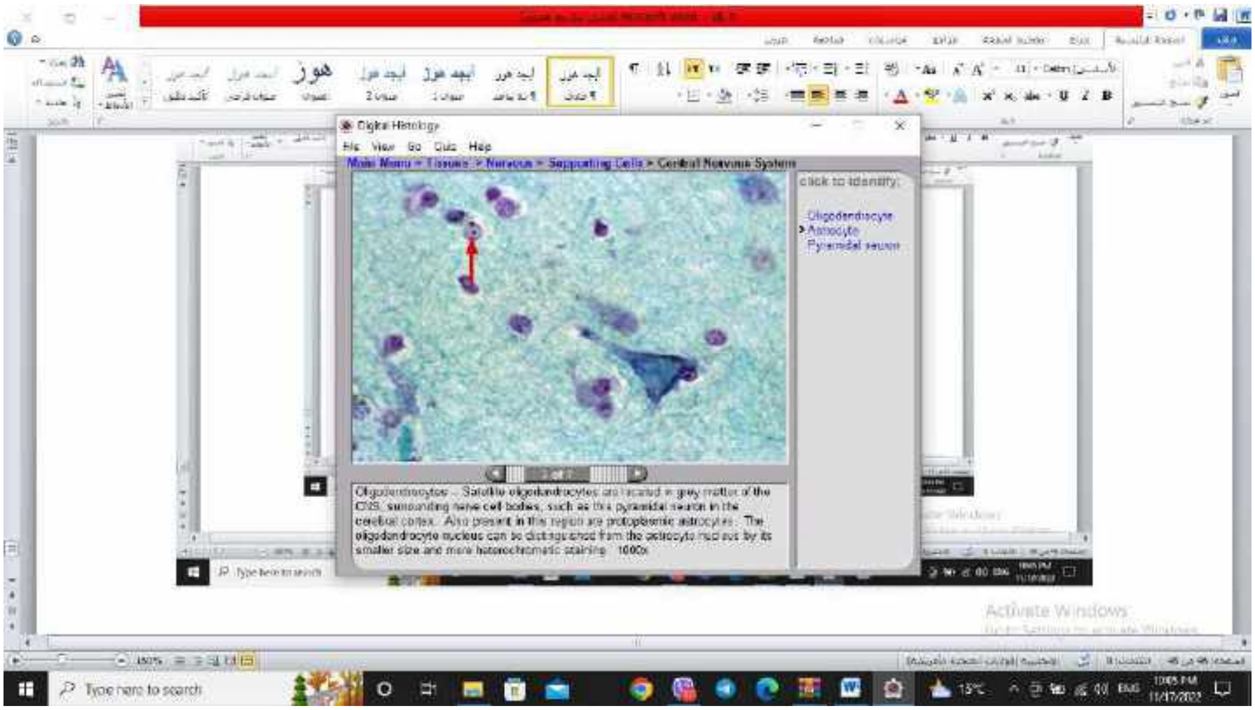
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Oligodendrocyte
Astrocyte
Pyramidal neuron
Oligodendrocytes - Satellite oligodendrocytes are located in grey matter of the CNS, surrounding nerve cell bodies, such as this pyramidal neuron in the cerebral cortex. Also present in this region are protoplasmic astrocytes. The oligodendrocyte nucleus can be distinguished from the astrocyte nucleus by its smaller size and more heterochromatic staining. 1000x
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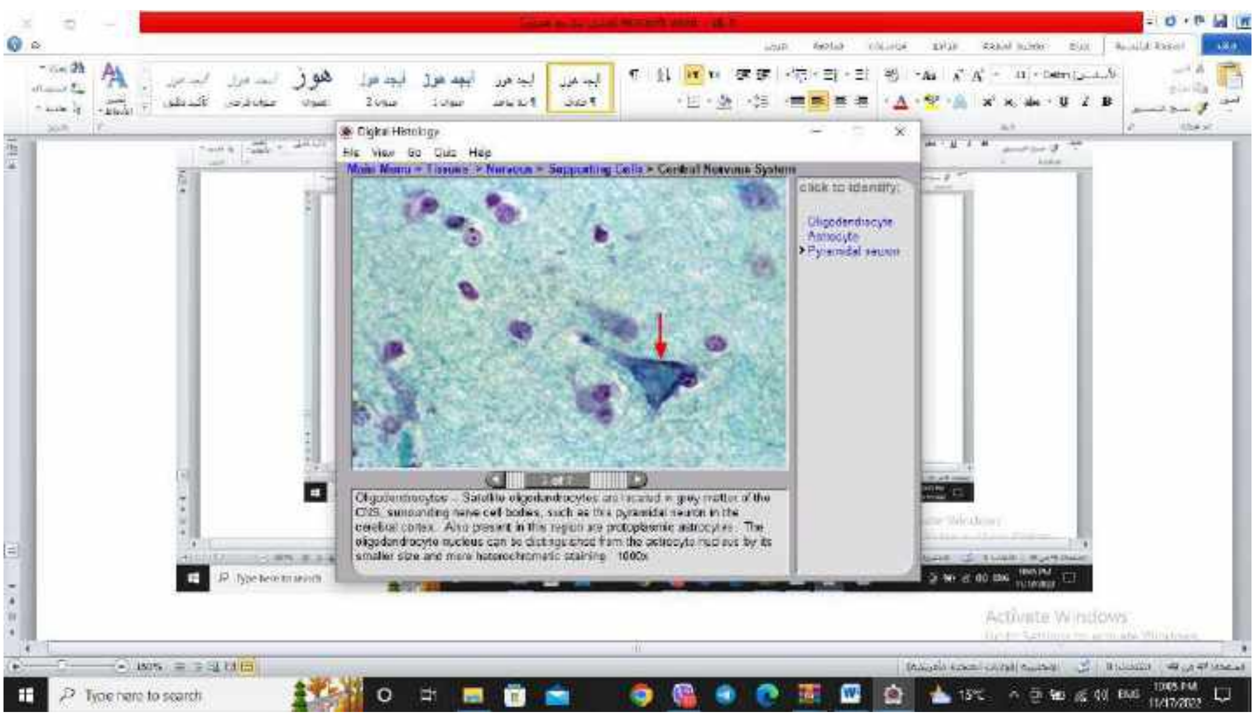
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Oligodendrocyte
Astrocyte
Pyramidal neuron
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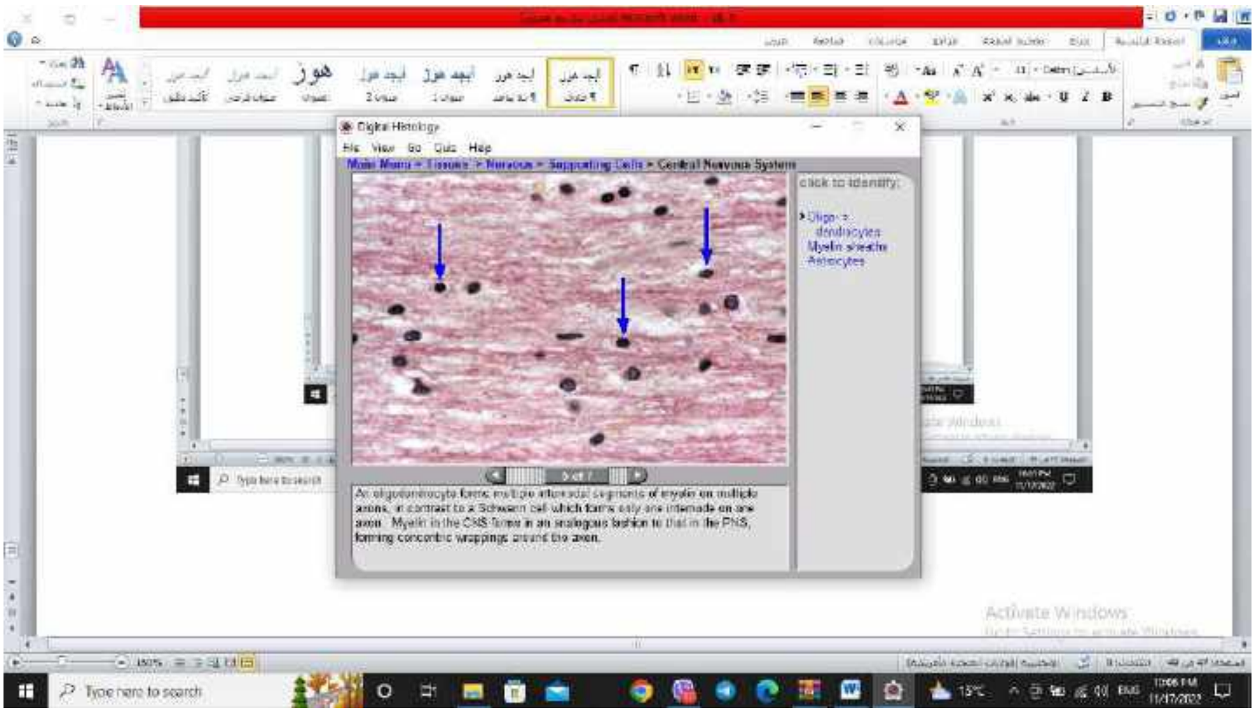
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Oligo-dendrocytes
Myelin sheaths
Astrocytes
An oligodendrocyte forms multiple internodal segments of myelin on multiple axons, in contrast to a Schwann cell which forms only one internode on one axon. Myelin in the CNS forms in an analogous fashion to that in the PNS, forming concentric wrappings around the axon.
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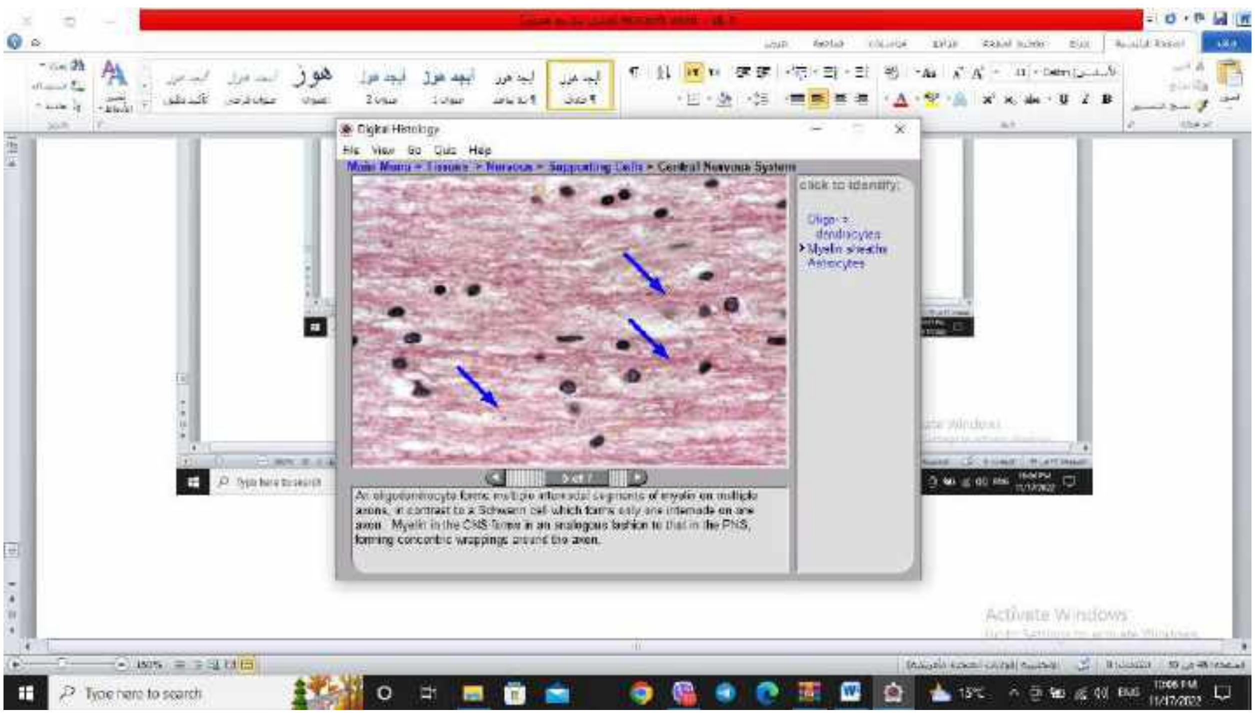
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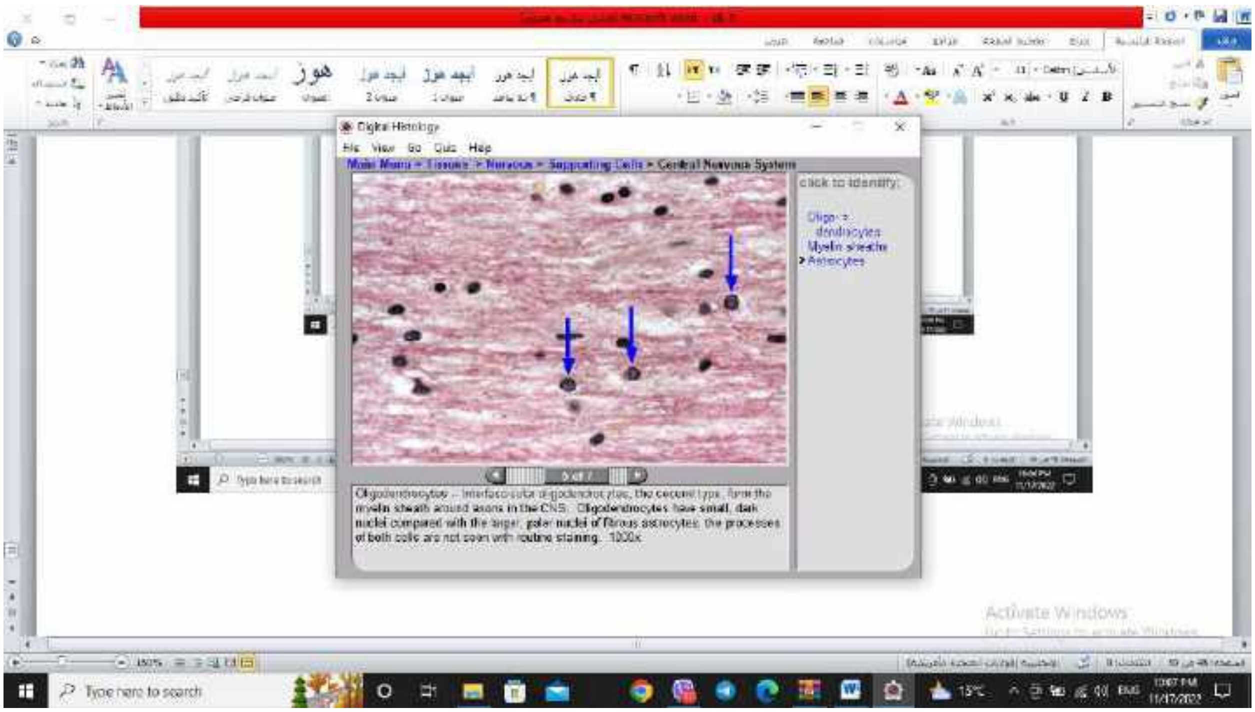
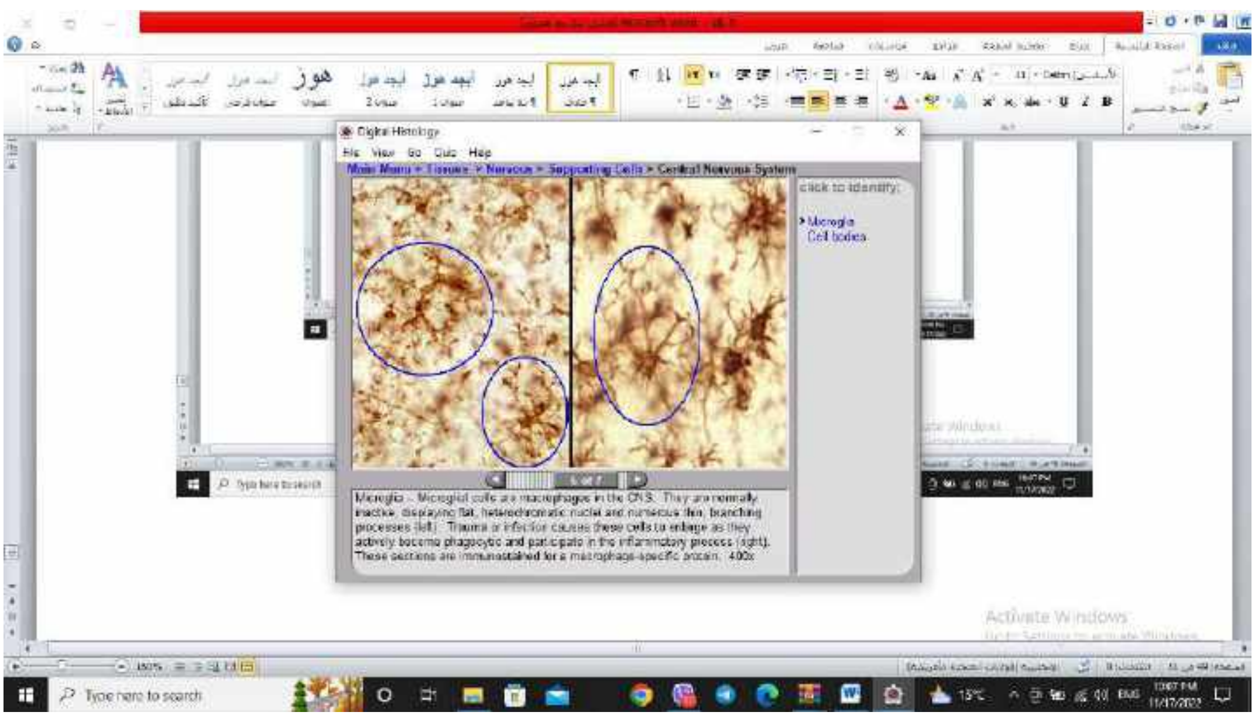
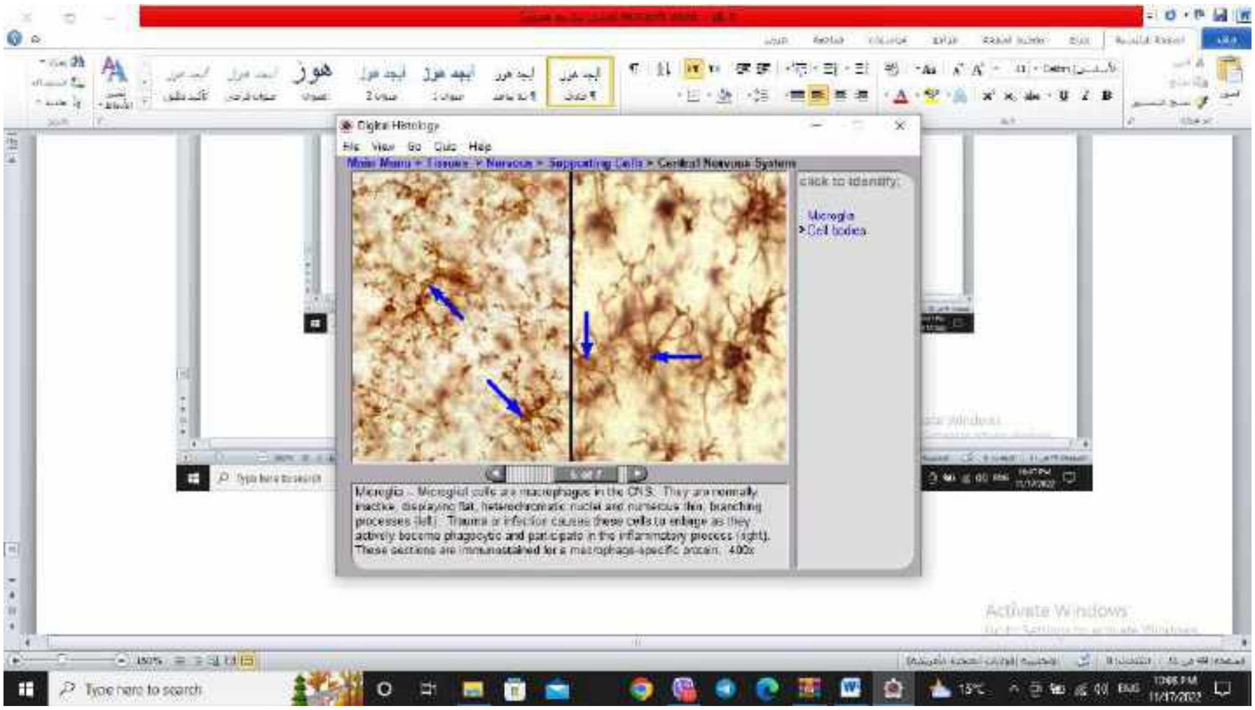

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Oligo-dendrocytes
Myelin sheaths
Astrocytes
Oligodendrocytes – Interfascicular oligodendrocytes, the second type, form the myelin sheath around axons in the CNS. Oligodendrocytes have small, dark nuclei compared with the larger, paler nuclei of fibrous astrocytes; the processes of both cells are not seen with routine staining. 1000x


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Supporting Cells > Central Nervous System
click to identify:
Microglia
Cell bodies
Microglia – Microglial cells are macrophages in the CNS. They are normally inactive, displaying flat, heterochromatic nuclei and numerous thin, branching processes (left). Trauma or infection causes these cells to enlarge as they actively become phagocytic and participate in the inflammatory process (right). These sections are immunostained for a macrophage-specific protein. 400x



Digital Histology
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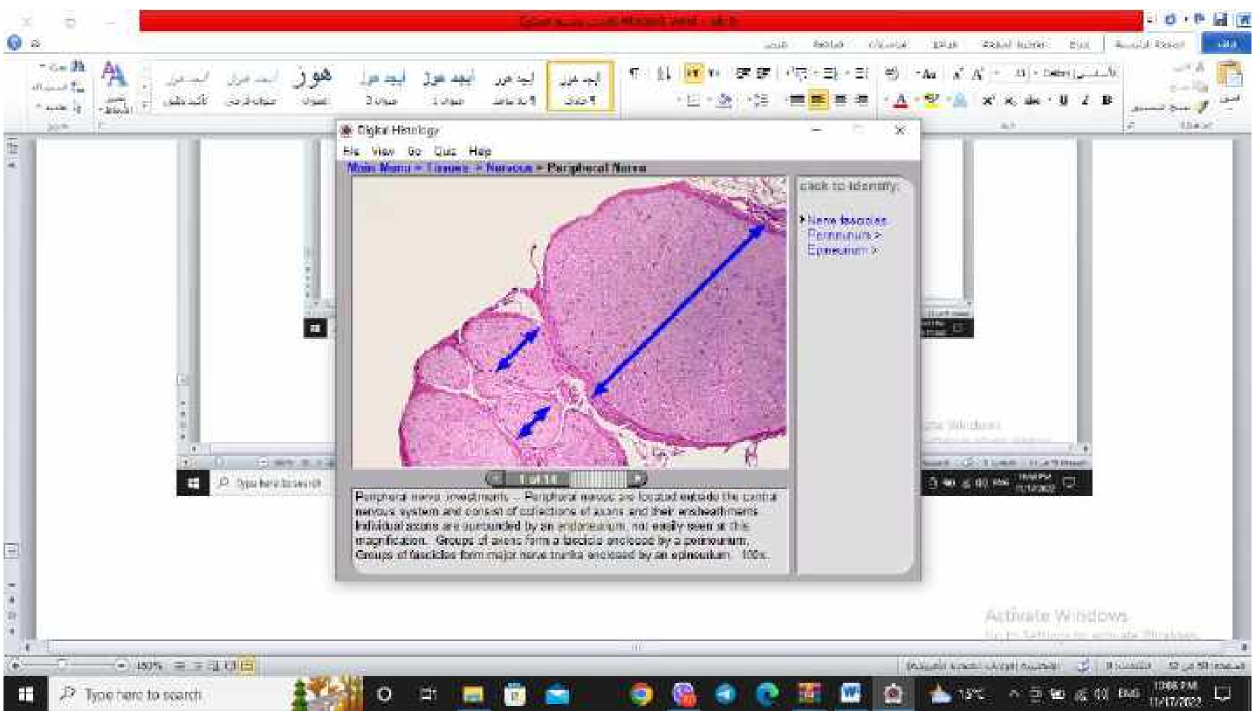

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Nerve fascicles
Perineurium >
Epineurium >
1 of 14
Peripheral nerve investments – Peripheral nerves are located outside the central nervous system and consist of collections of axons and their ensheathments. Individual axons are surrounded by an endoneurium, not easily seen at this magnification. Groups of axons form a fascicle enclosed by a perineurium. Groups of fascicles form major nerve trunks enclosed by an epineurium. 100x
Activate Windows
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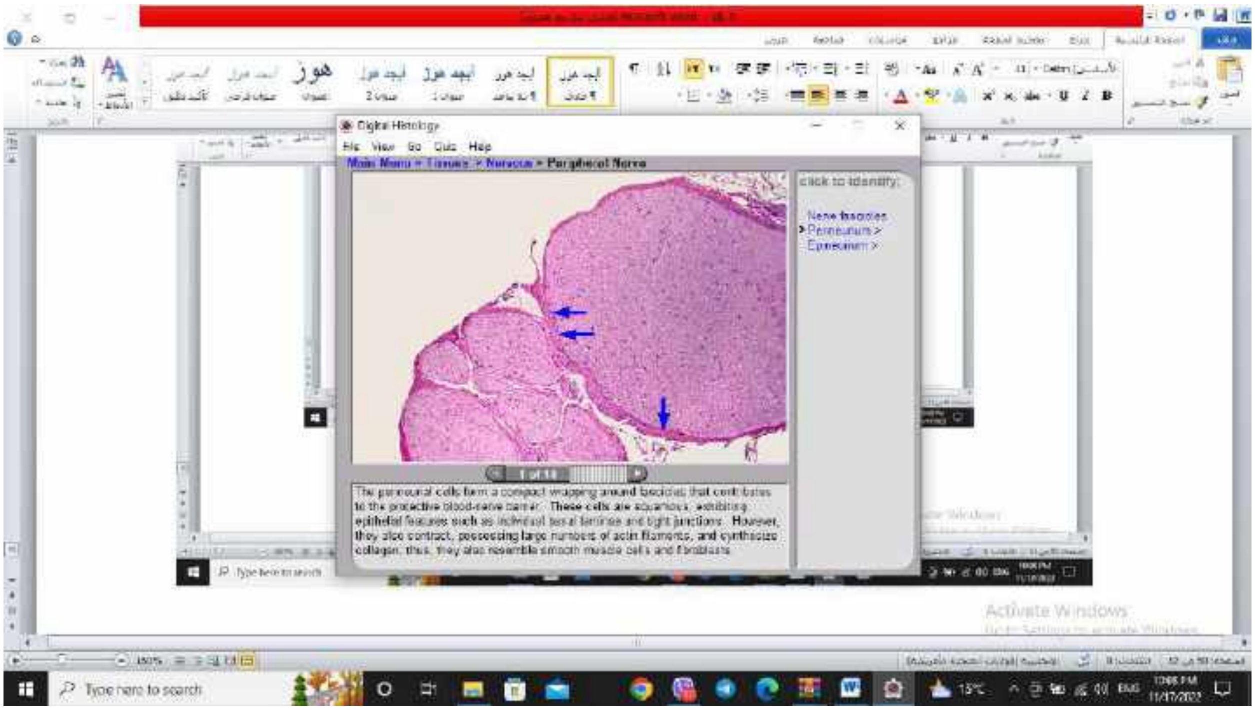
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Nerve fascicles
Perineurium >
Epineurium >
The perineurial cells form a compact wrapping around fascicles that contributes to the protective blood-nerve barrier. These cells are squamous, exhibiting epithelial features such as individual basal laminae and tight junctions. However, they also contract, possessing large numbers of actin filaments, and synthesize collagen; thus, they also resemble smooth muscle cells and fibroblasts.
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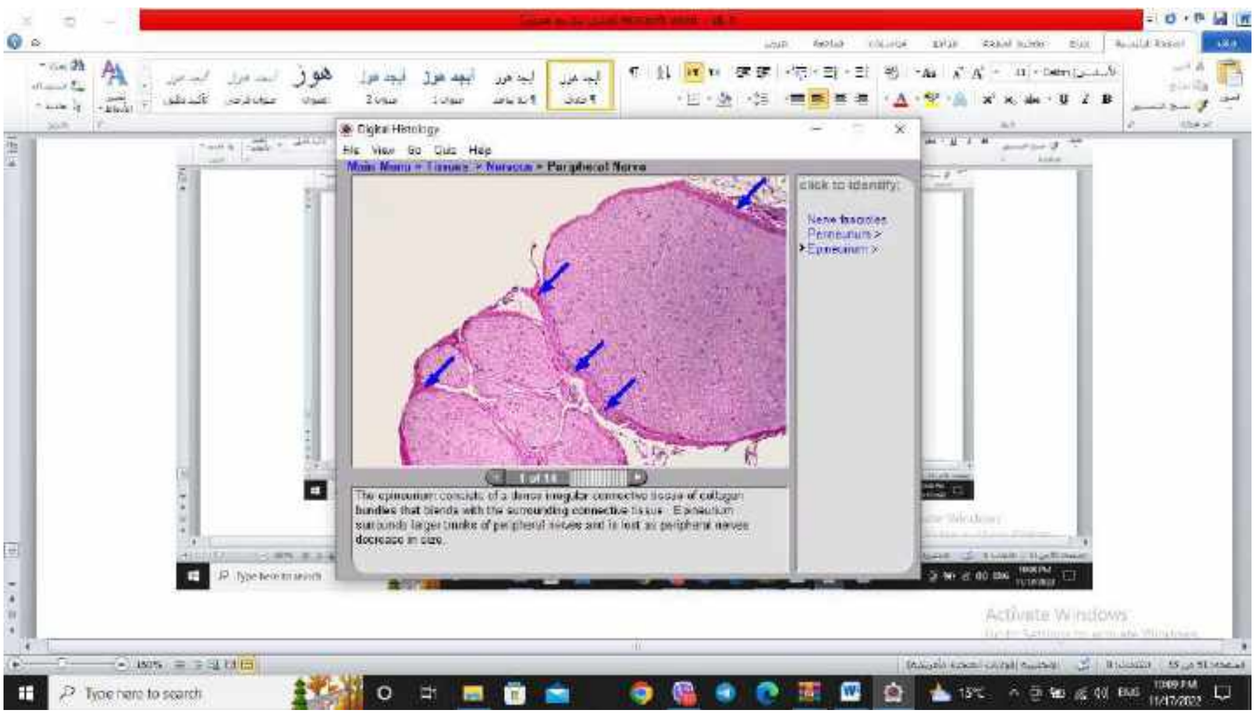
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Nerve fascicles
Perineurium >
Epineurium >
The epineurium consists of a dense irregular connective tissue of collagen bundles that blends with the surrounding connective tissue. Epineurium surrounds larger trunks of peripheral nerves and is lost as peripheral nerves decrease in size.
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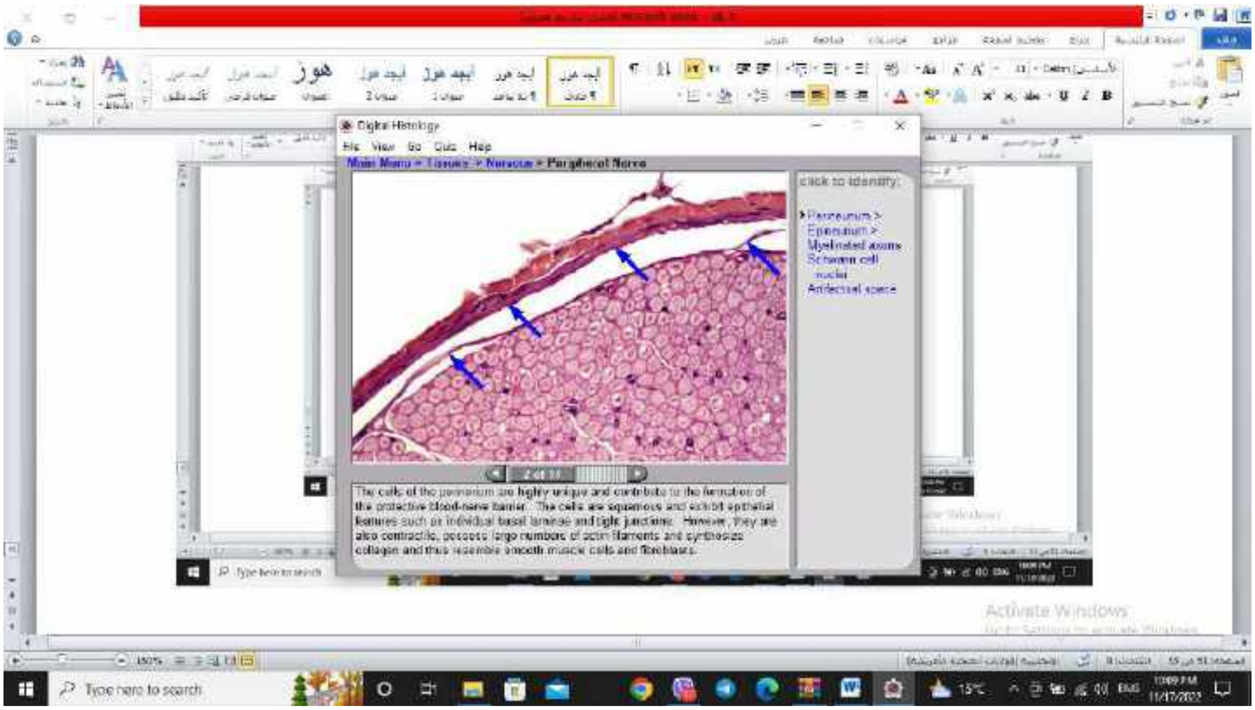
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Perineurium >
Epineurium >
Myelinated axons
Schwann cell nuclei
Antifectual space
The cells of the perineurium are highly unique and contribute to the formation of the protective blood-nerve barrier. The cells are squamous and exhibit epithelial features such as individual basal laminae and tight junctions. However, they are also contractile, possess large numbers of actin filaments and synthesize collagen and thus resemble smooth muscle cells and fibroblasts.
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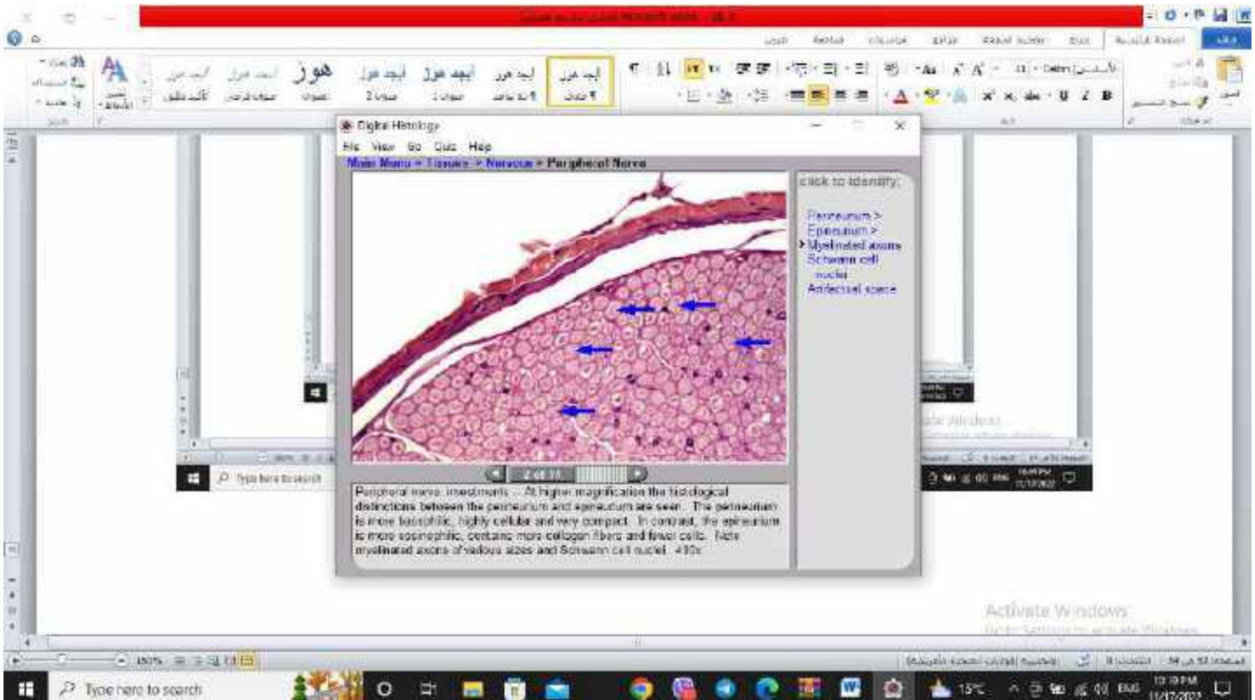
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Perineurium >
Epineurium >
Myelinated axons
Schwann cell nuclei
Artifactual space
Peripheral nerve: investments -- At higher magnification the histological distinctions between the perineurium and epineurium are seen. The perineurium is more basophilic, highly cellular and very compact. In contrast, the epineurium is more eosinophilic, contains more collagen fibers and fewer cells. Note myelinated axons of various sizes and Schwann cell nuclei. 410x
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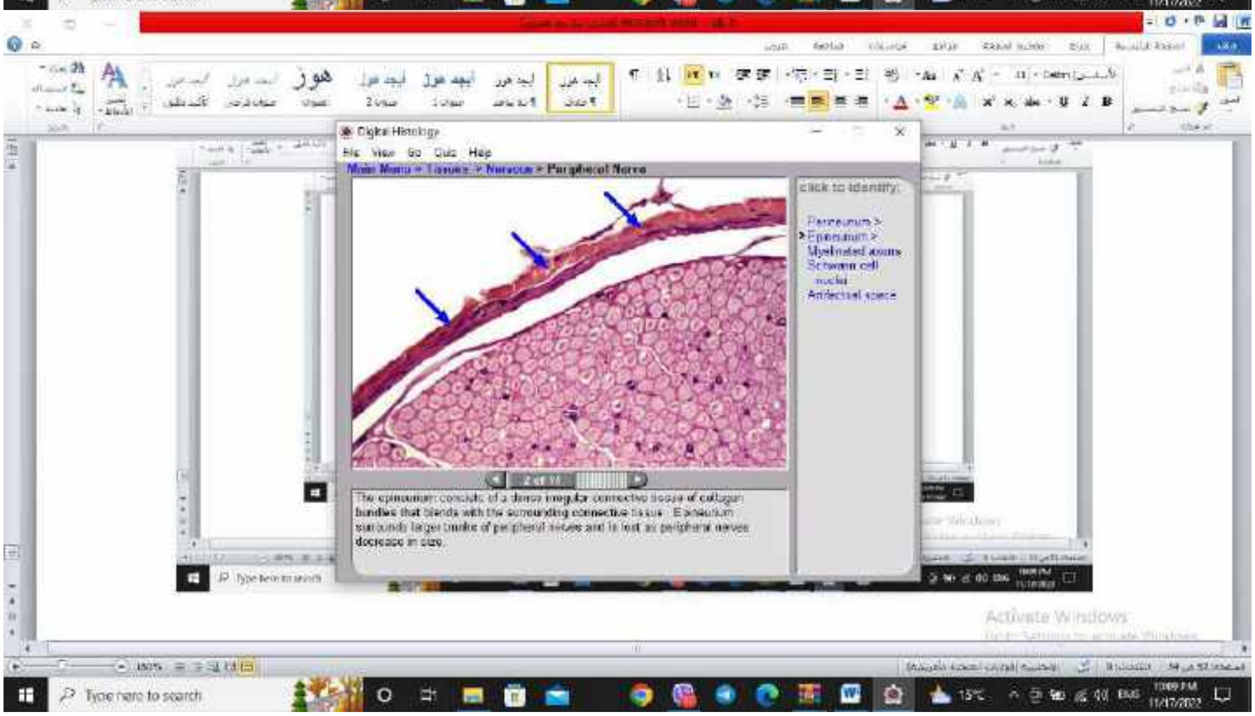
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Perineurium >
Epineurium >
Myelinated axons
Schwann cell nuclei
Artifactual space
The epineurium consists of a dense irregular connective tissue of collagen bundles that blends with the surrounding connective tissue. Epineurium surrounds larger trunks of peripheral nerves and is lost as peripheral nerves decrease in size.
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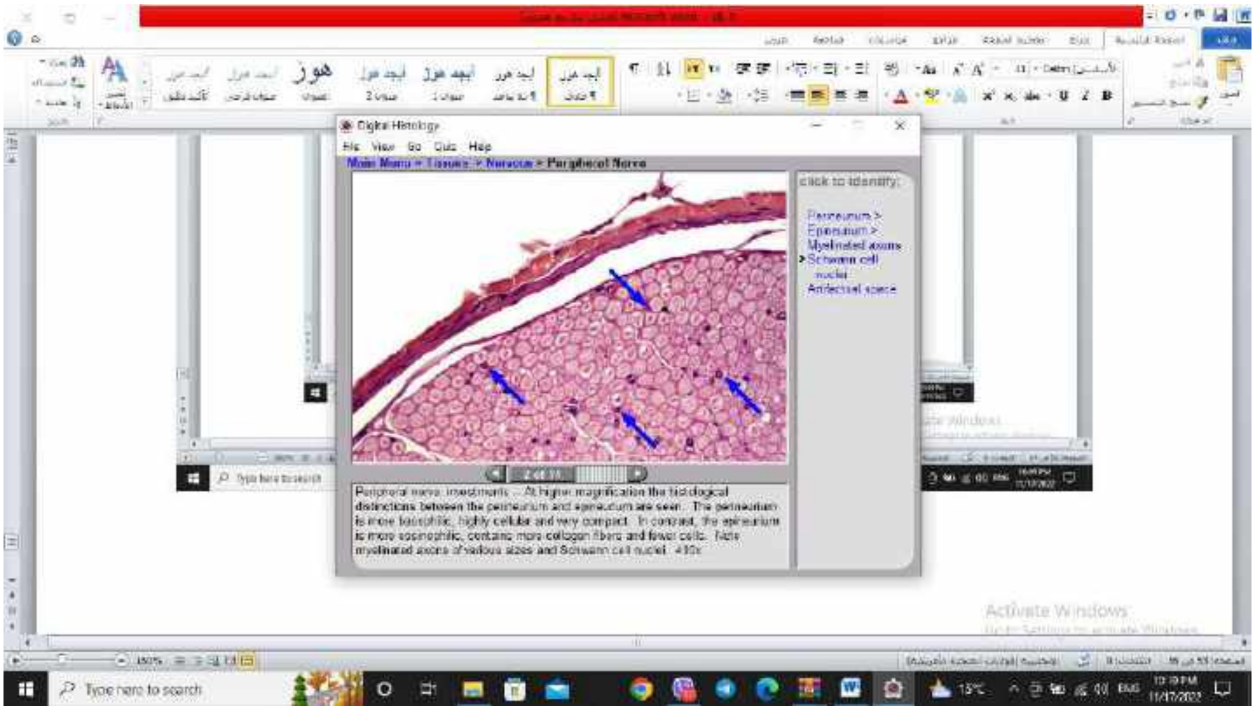
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Perineurium >
Epineurium >
Myelinated axons
Schwann cell nuclei
Artifactual space
Activate Windows
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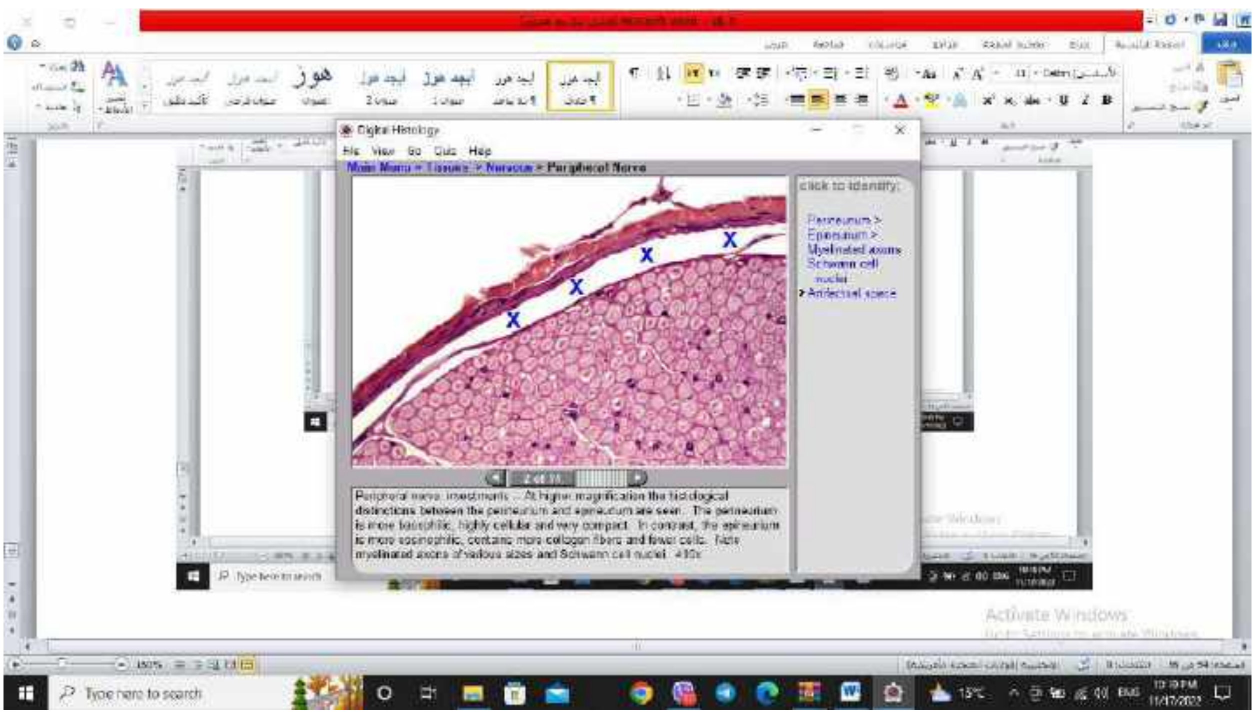
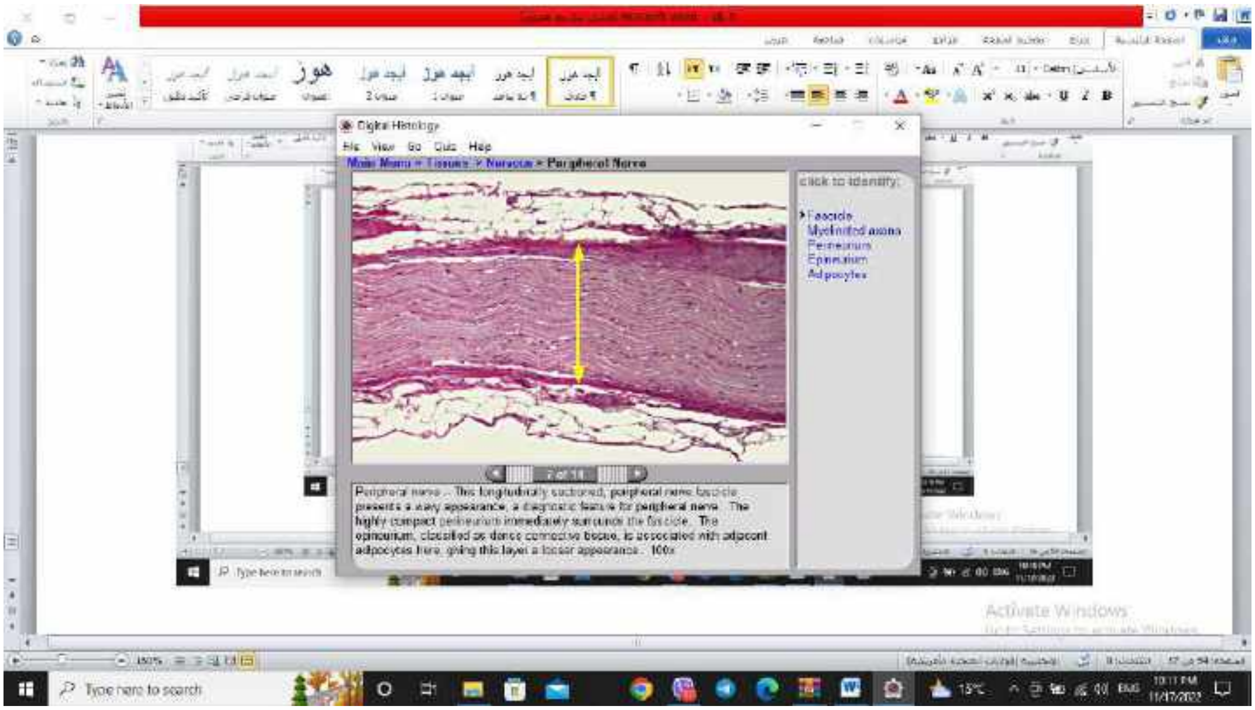

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
X
X
X
X
click to identify:
Perineurium >
Epineurium >
Myelinated axons
Schwann cell nuclei
Artifactual space
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Fascicle
Myelinated axons
Perineurium
Epineurium
Adipocytes
Peripheral nerve .. This longitudinally sectioned, peripheral nerve fascicle presents a wavy appearance, a diagnostic feature for peripheral nerve. The highly compact perineurium immediately surrounds the fascicle. The epineurium, classified as dense connective tissue, is associated with adjacent adipocytes here, giving this layer a looser appearance. 100x
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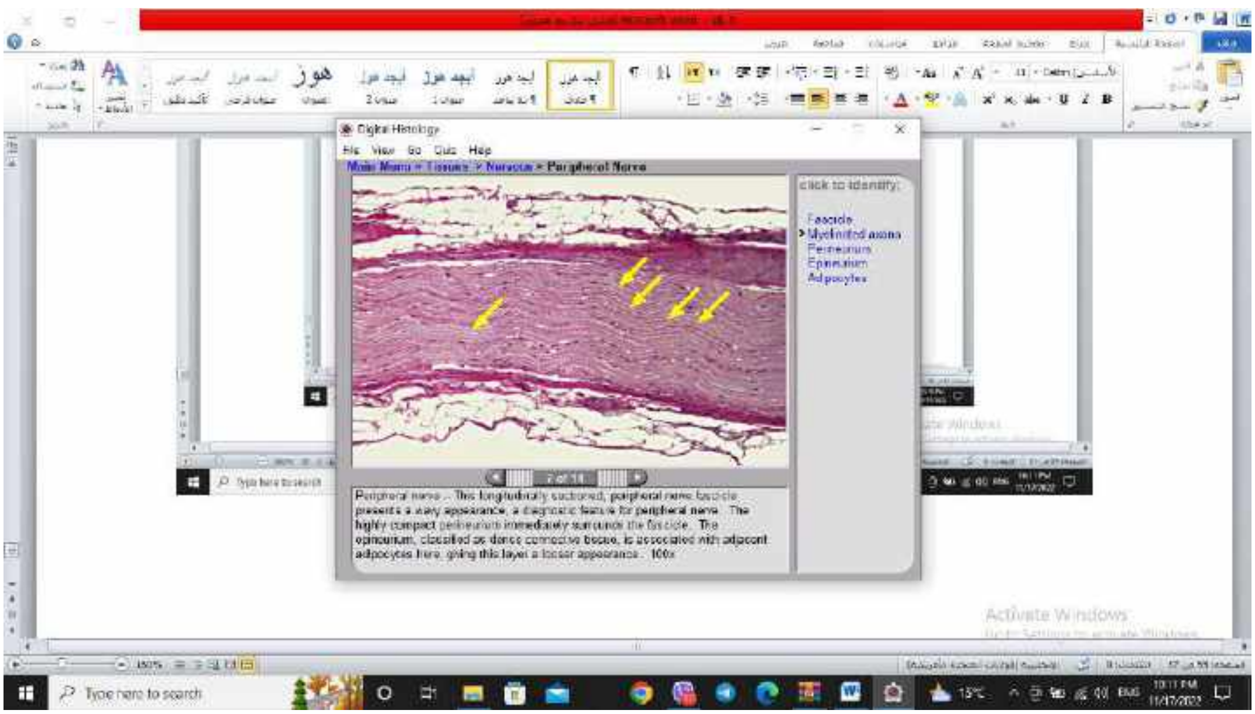
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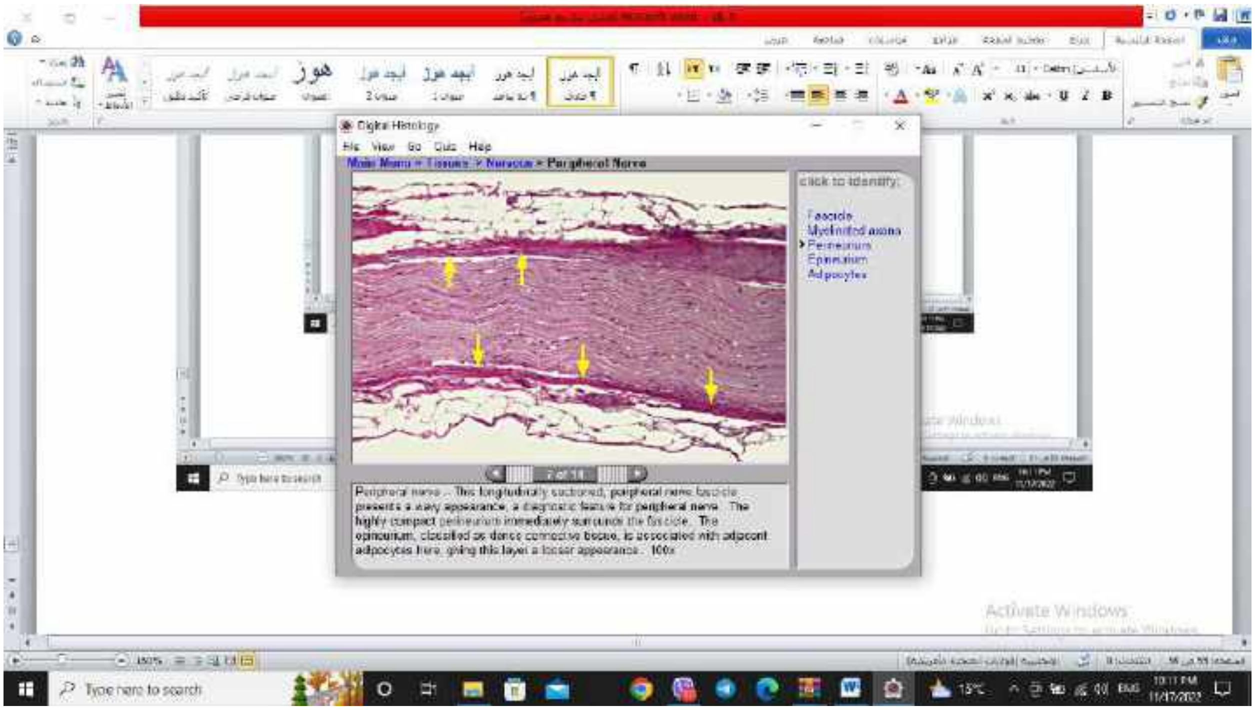
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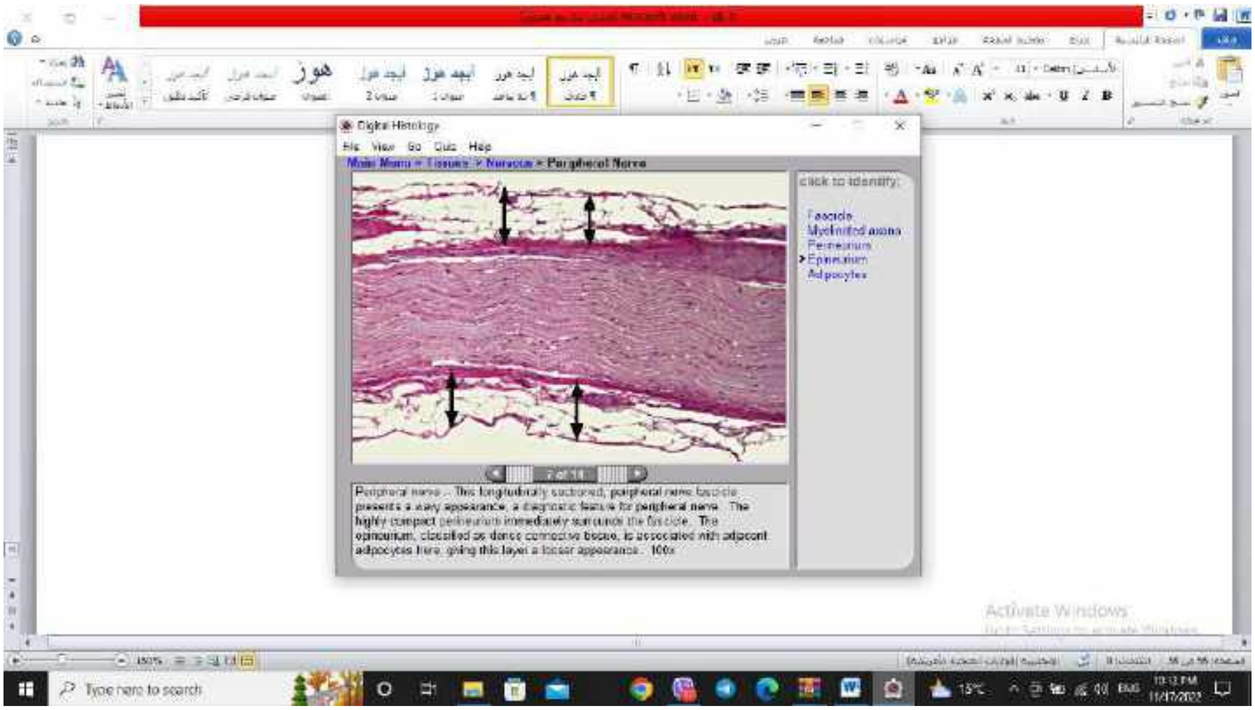
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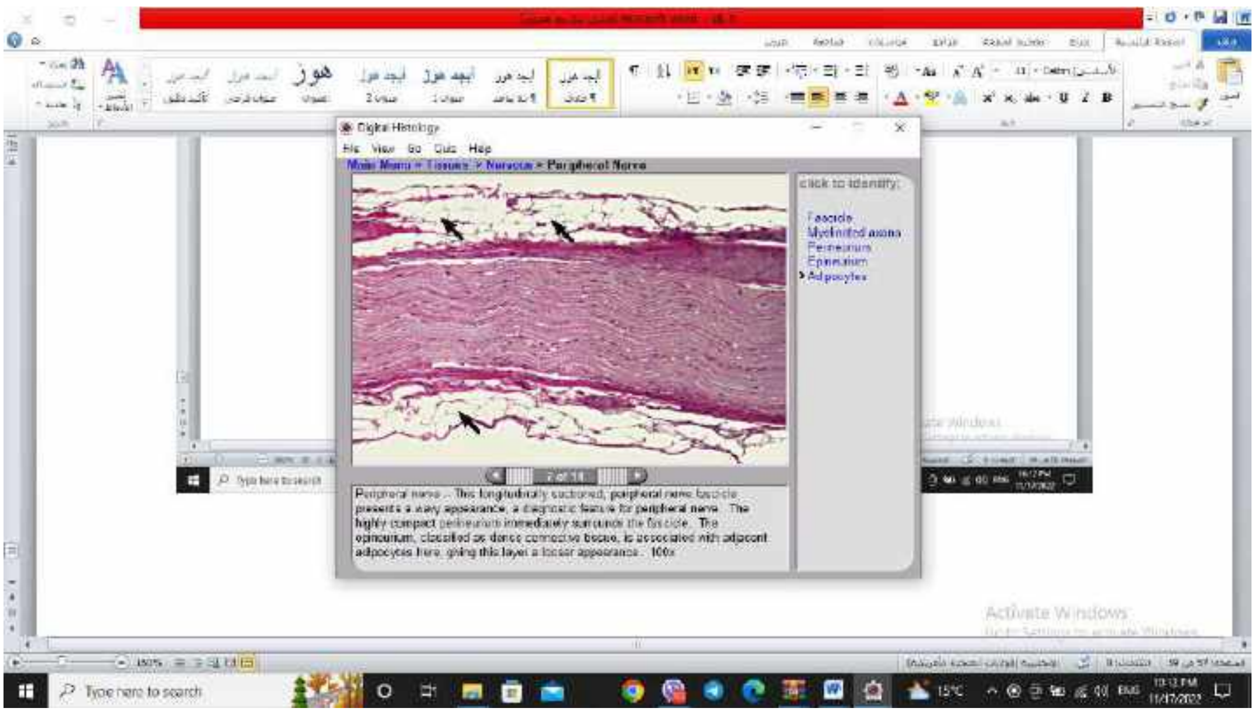
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Myelinated axons
Perineurium
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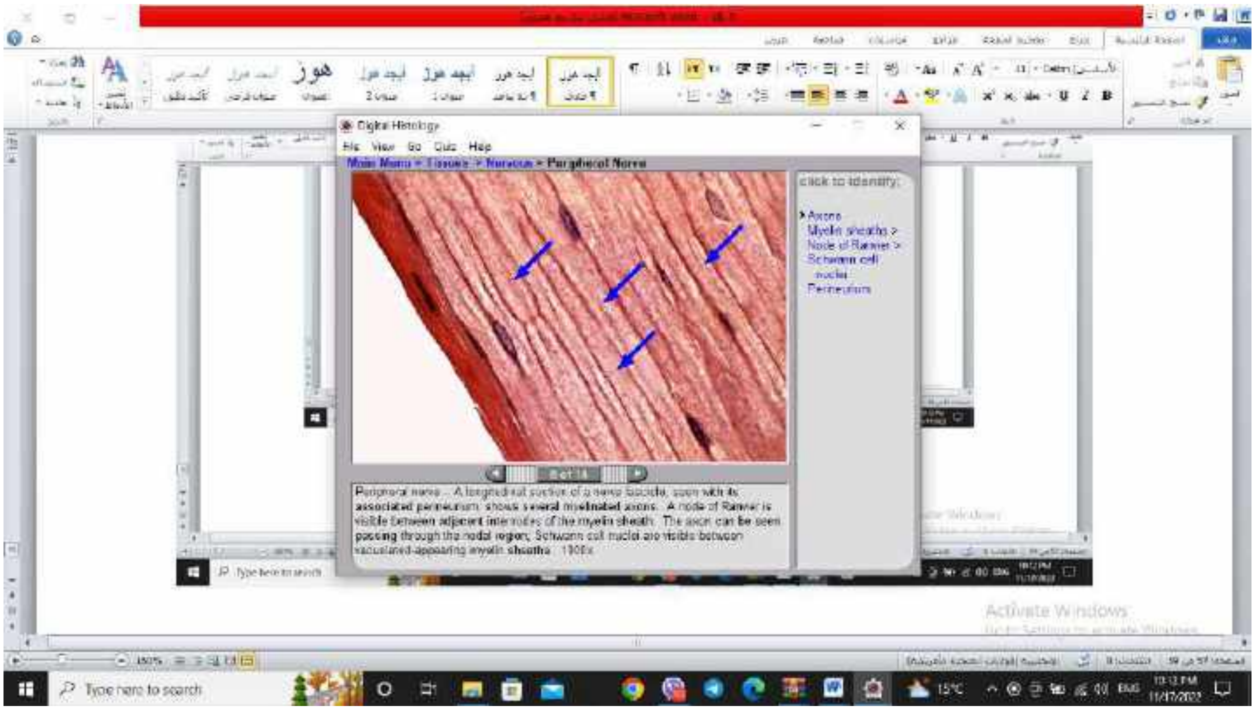
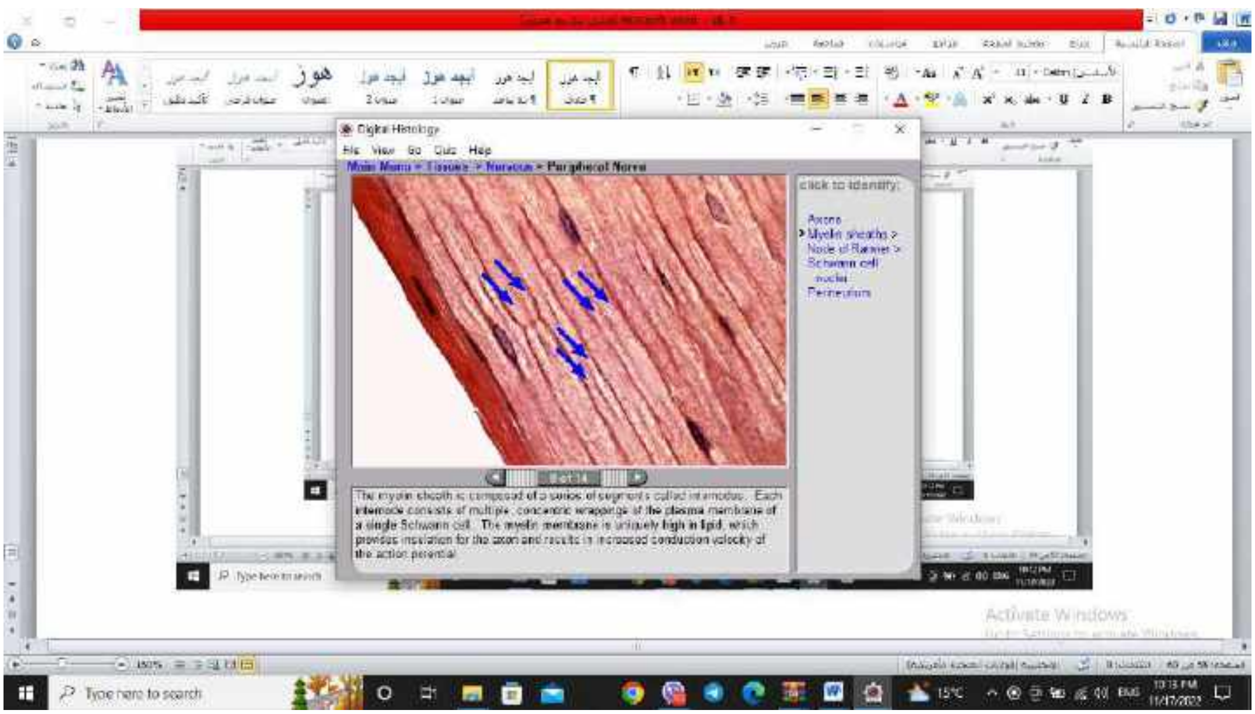

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Axons
Myelin sheaths >
Node of Ranvier >
Schwann cell nuclei
Perineurium
Activate Windows
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Axons
Myelin sheaths >
Node of Ranvier >
Schwann cell nuclei
Perineurium
The myelin sheath is composed of a series of segments called internodes. Each internode consists of multiple, concentric wrappings of the plasma membrane of a single Schwann cell. The myelin membrane is uniquely high in lipid, which provides insulation for the axon and results in increased conduction velocity of the action potential
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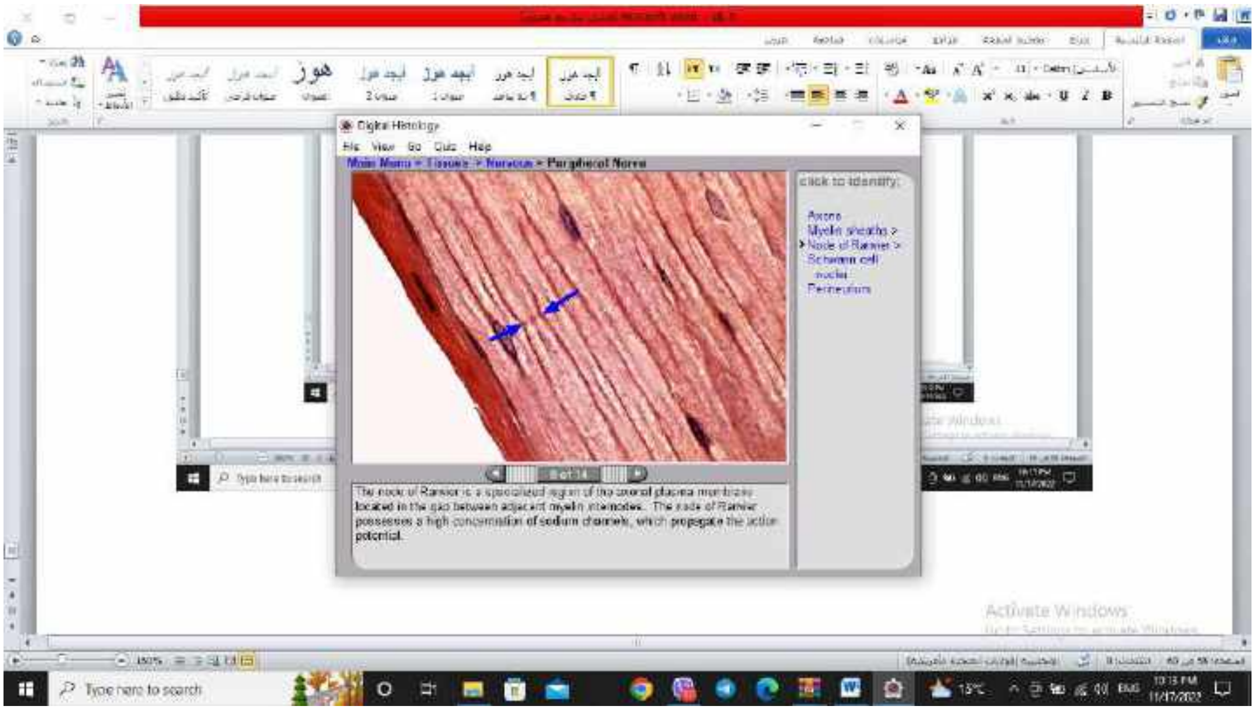
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File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Axons
Myelin sheaths >
Node of Ranvier >
Schwann cell nuclei
Perineurium
The node of Ranvier is a specialized region of the axonal plasma membrane located in the gap between adjacent myelin internodes. The node of Ranvier possesses a high concentration of sodium channels, which propagate the action potential.
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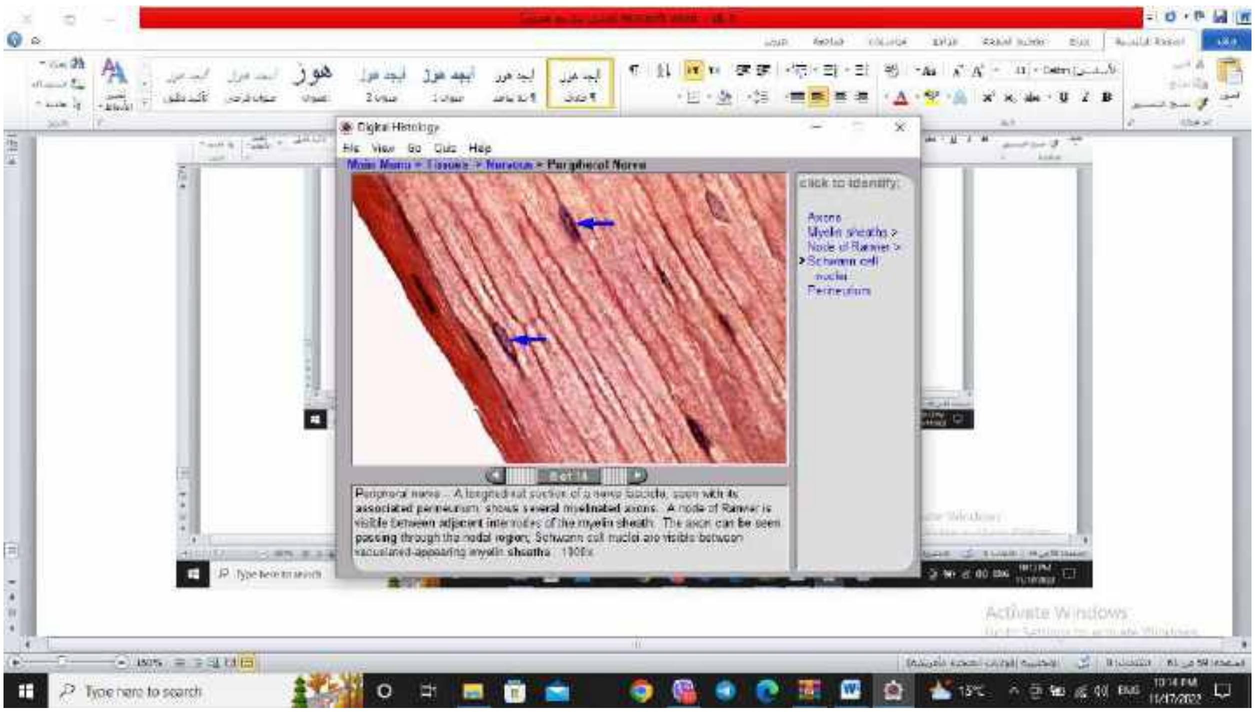
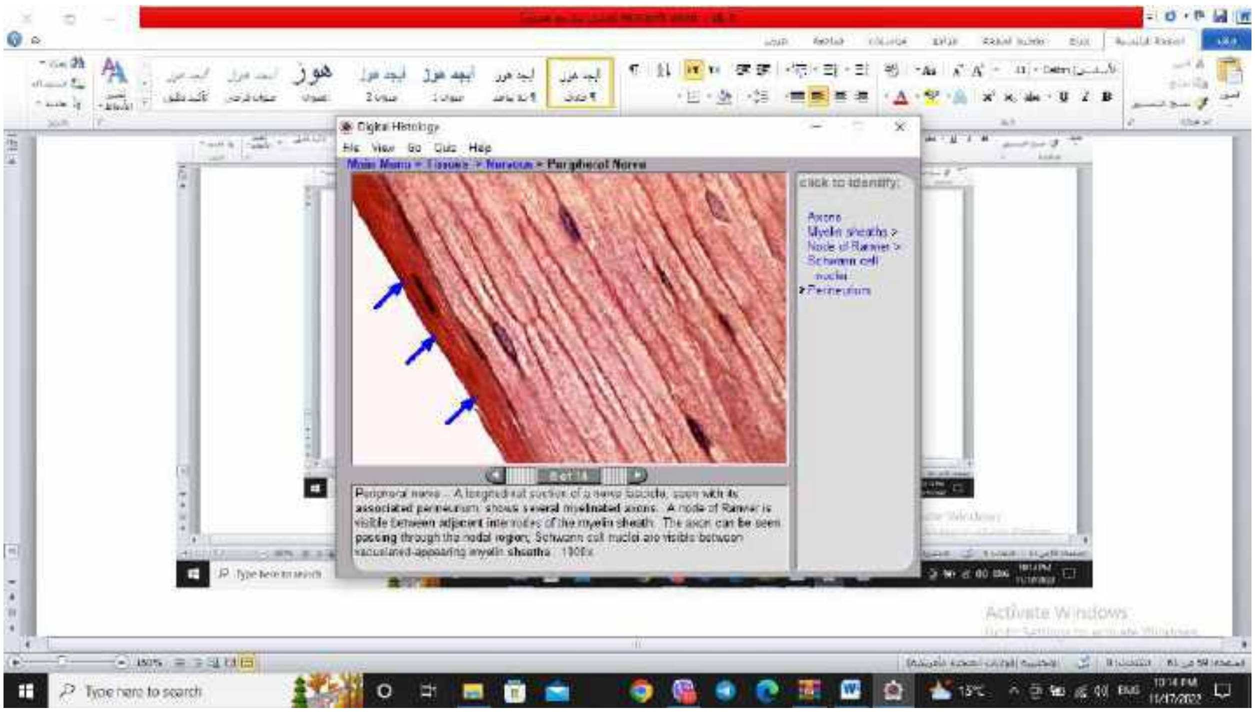

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Axons
Myelin sheaths >
Node of Ranvier >
Schwann cell nuclei
Perineurium
Peripheral nerve - A longitudinal section of a nerve fascicle, seen with its associated perineurium, shows several myelinated axons. A node of Ranvier is visible between adjacent internodes of the myelin sheath. The axon can be seen passing through the nodal region; Schwann cell nuclei are visible between vacuolated-appearing myelin sheaths. 1300x
Activate Windows
Type here to search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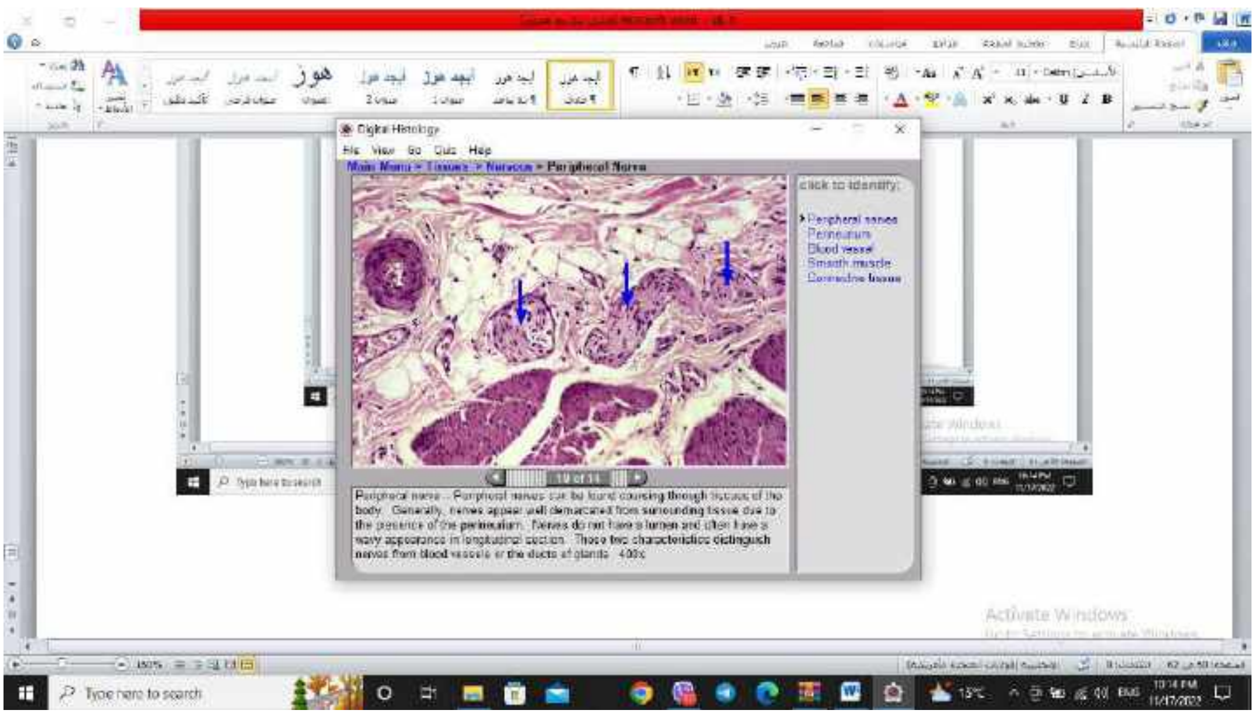
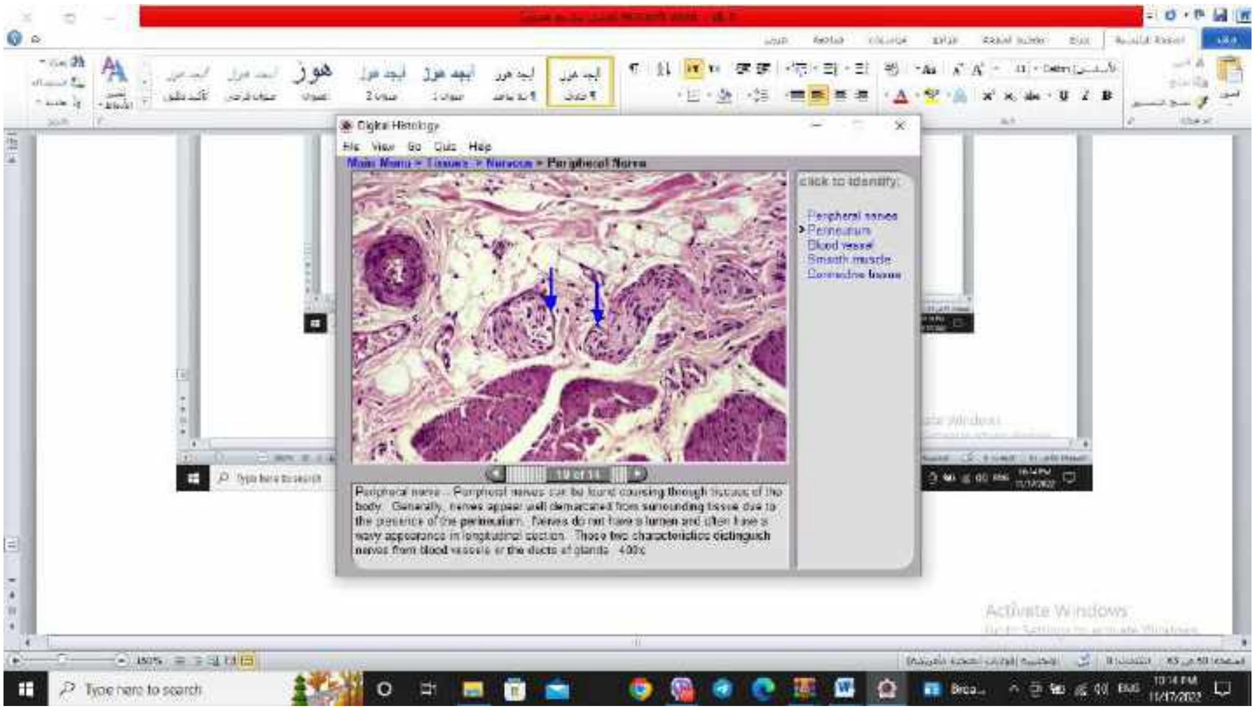

Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Peripheral nerves
Perineurium
Blood vessel
Smooth muscle
Connective tissue
Peripheral nerve... Peripheral nerves can be found coursing through tissues of the body. Generally, nerves appear well demarcated from surrounding tissue due to the presence of the perineurium. Nerves do not have a lumen and often have a wavy appearance in longitudinal section. These two characteristics distinguish nerves from blood vessels or the ducts of glands. 400x
Activate Windows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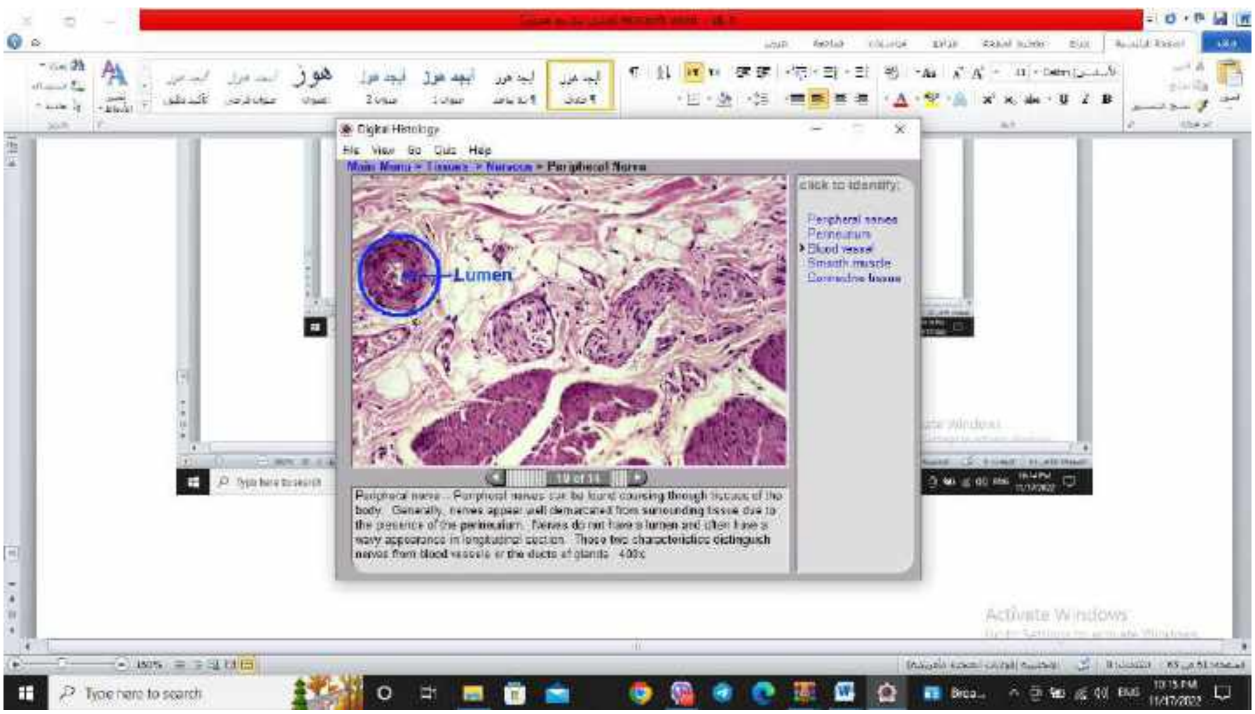
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Peripheral nerves
Perineurium
Blood vessel
Smooth muscle
Connective tissue
Lumen
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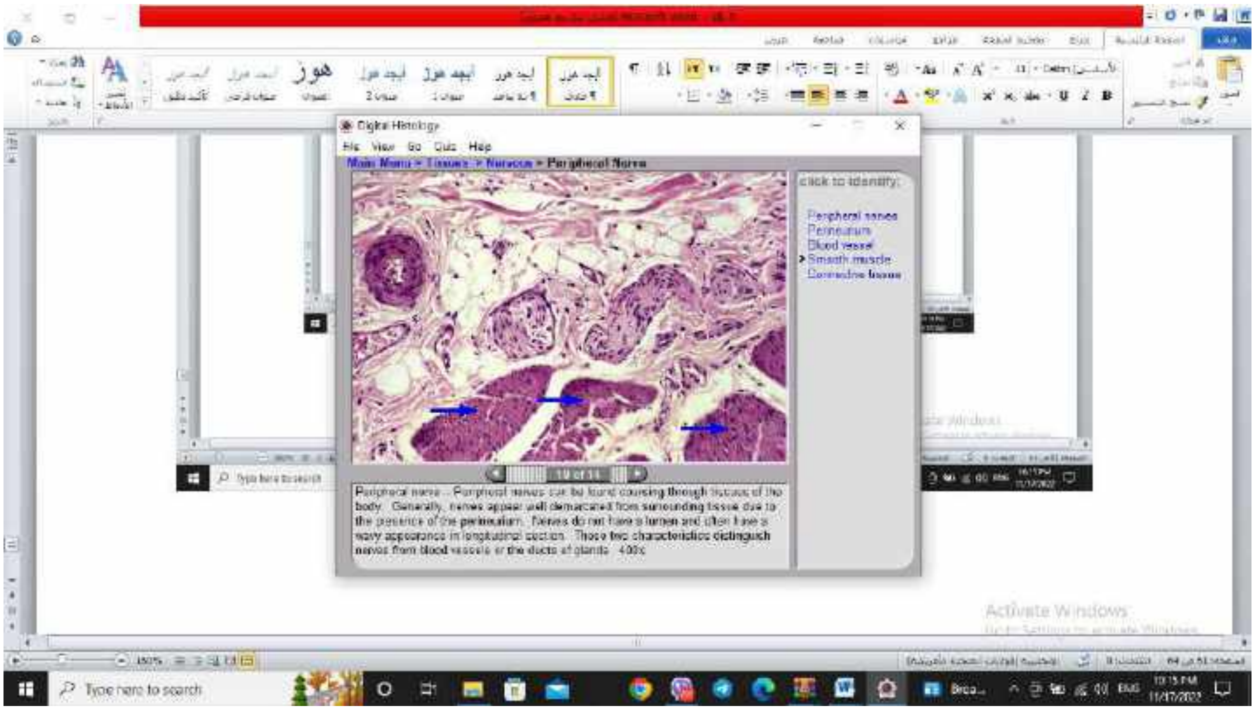
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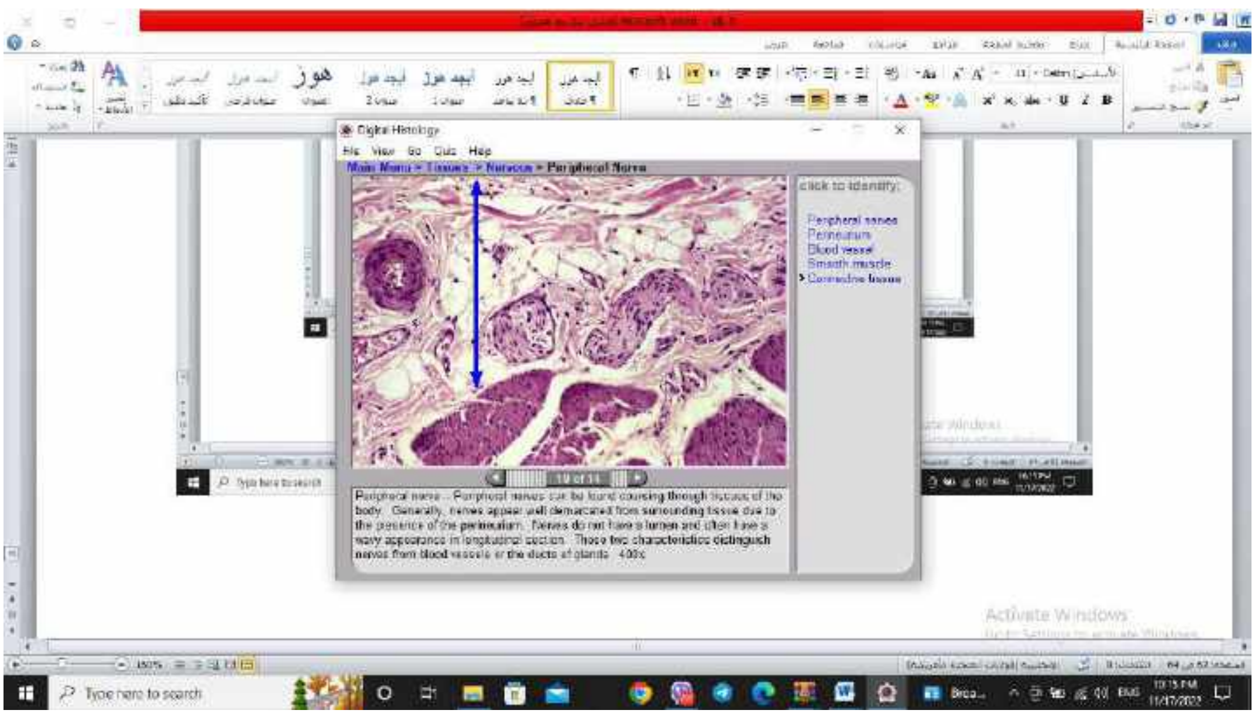
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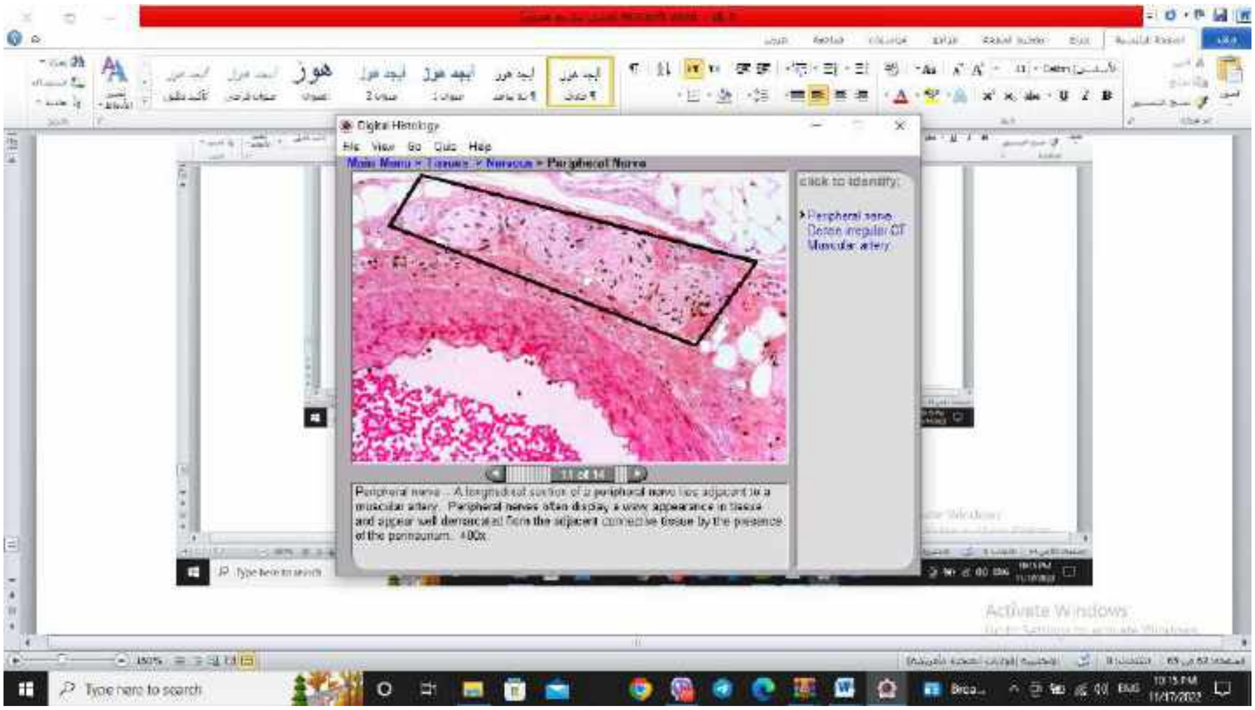
Digital Histology
File View Go Quiz Help
Main Menu > Tissues > Nervous > Peripheral Nerve
click to identify:
Peripheral nerve
Dense irregular CT
Muscular artery
11 of 14
Peripheral nerve... A longitudinal section of a peripheral nerve lies adjacent to a muscular artery. Peripheral nerves often display a wavy appearance in tissue and appear well demarcated from the adjacent connective tissue by the presence of the perineurium. 400x
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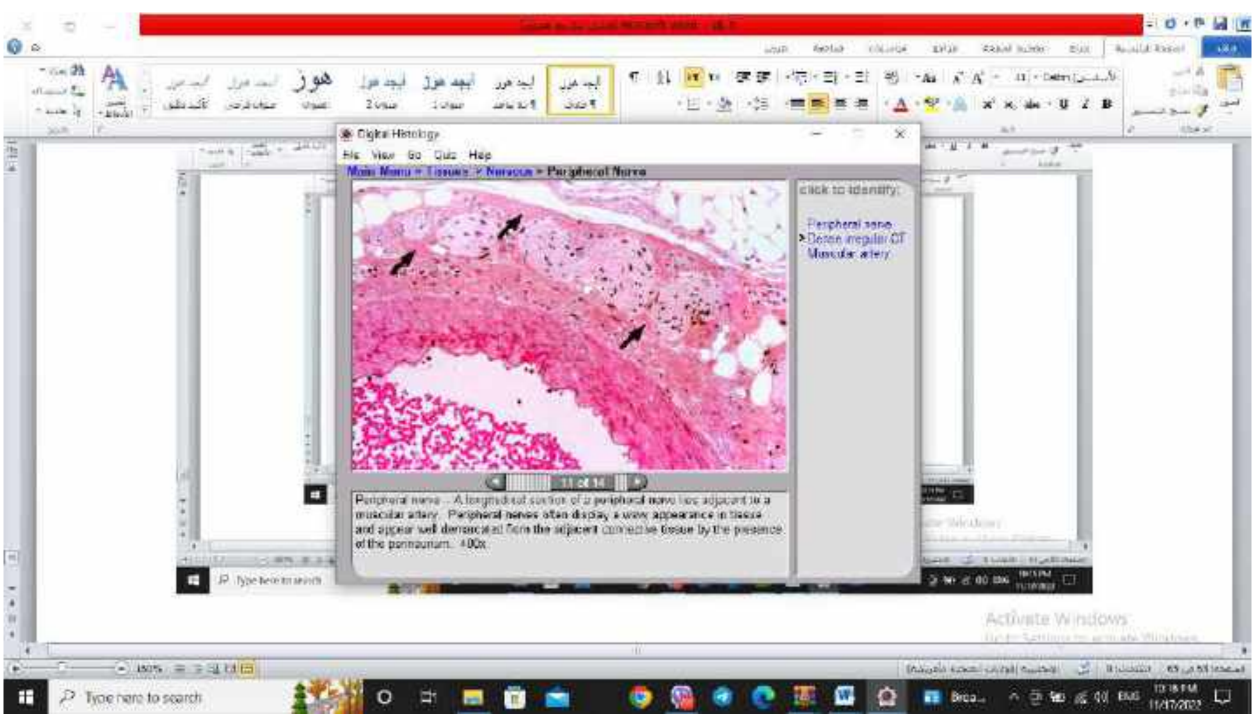
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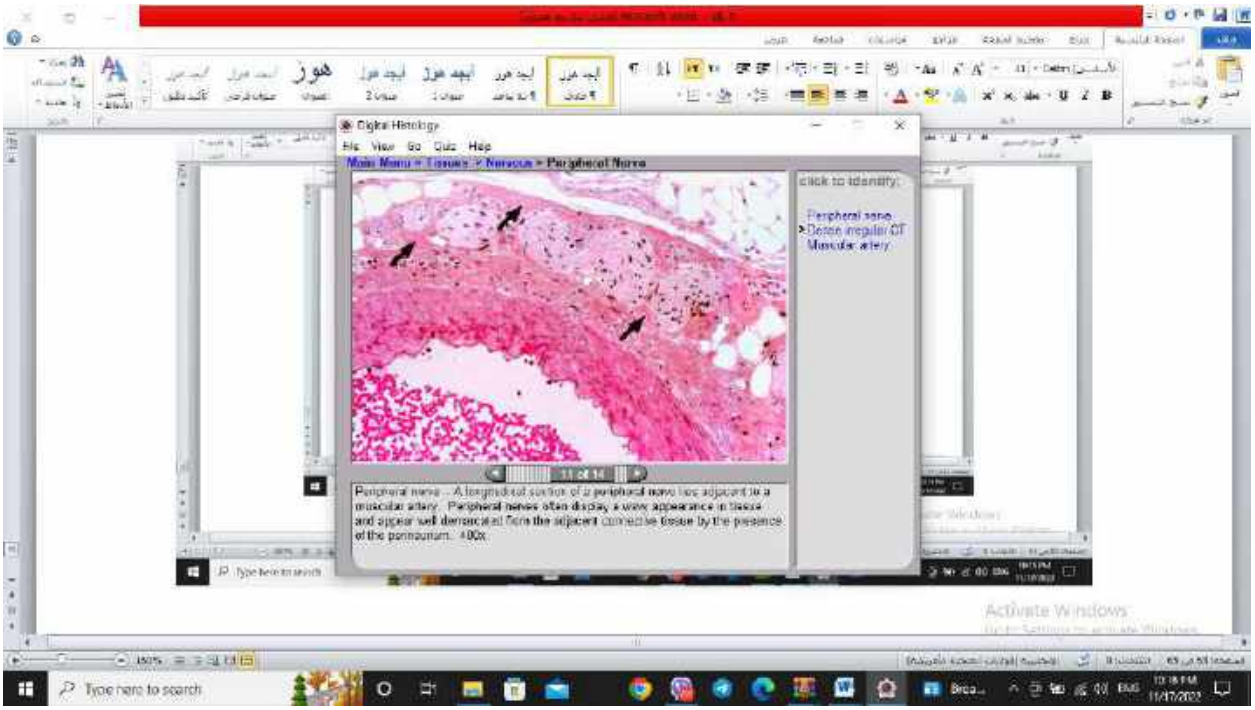
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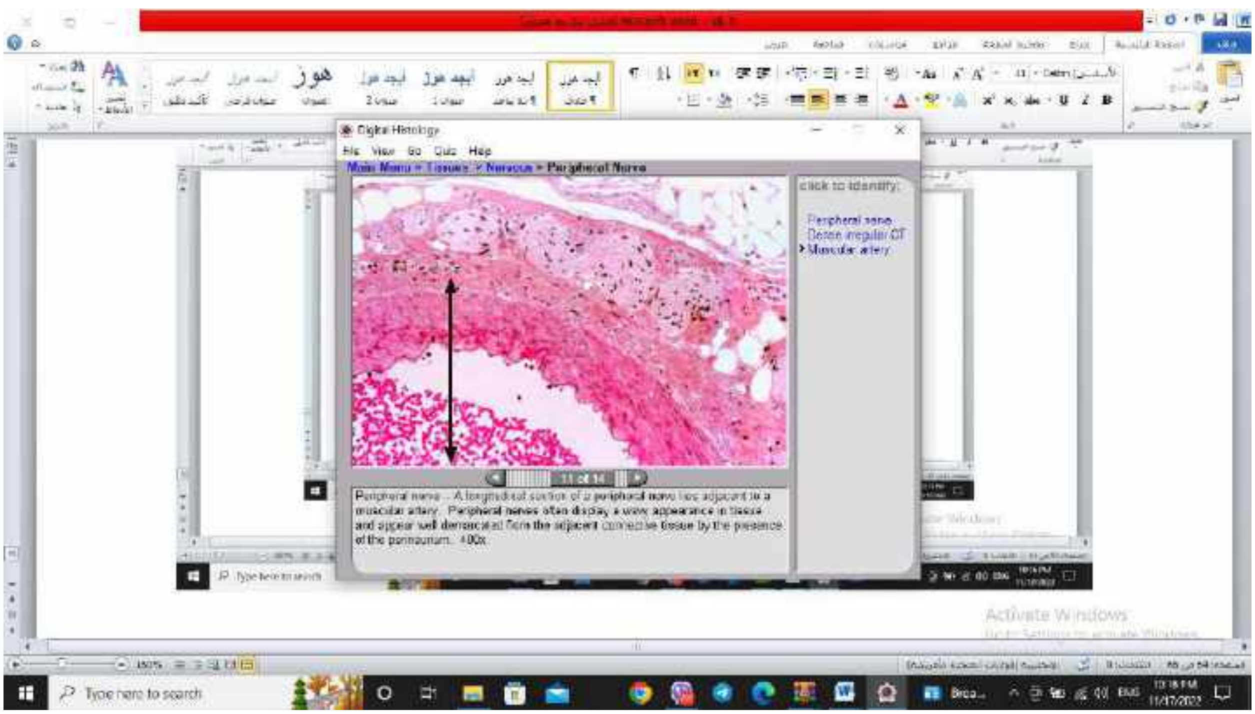
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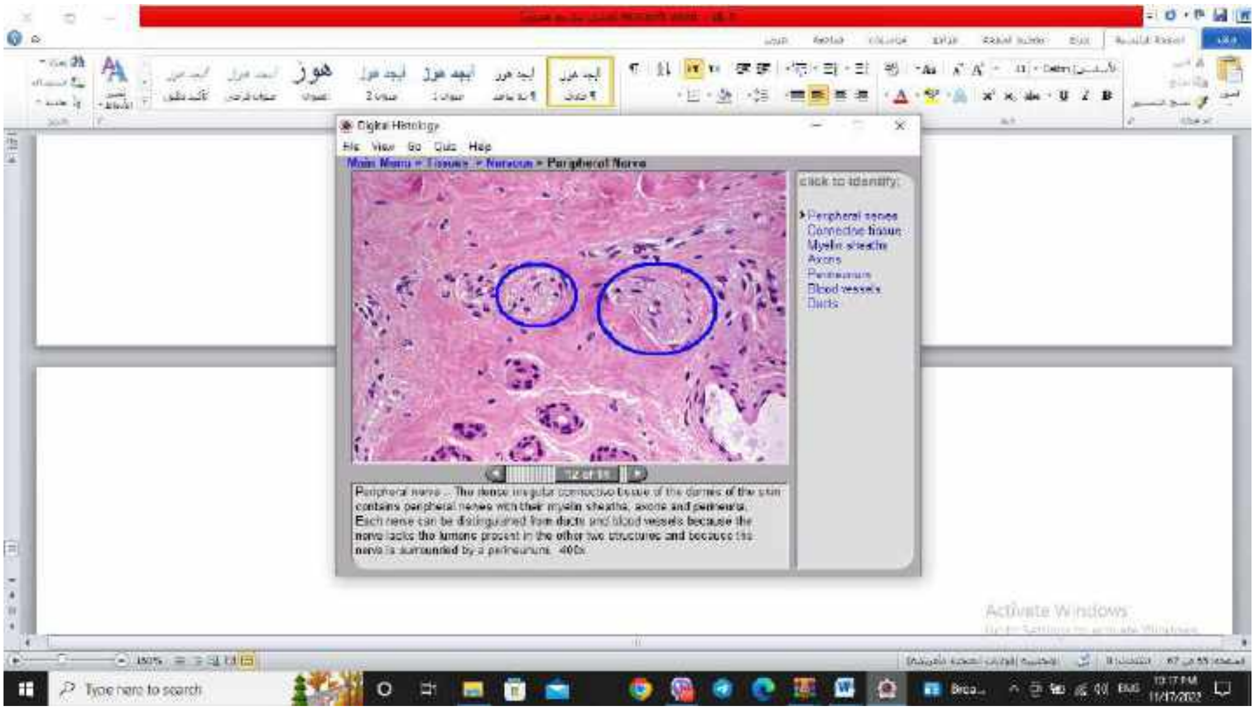
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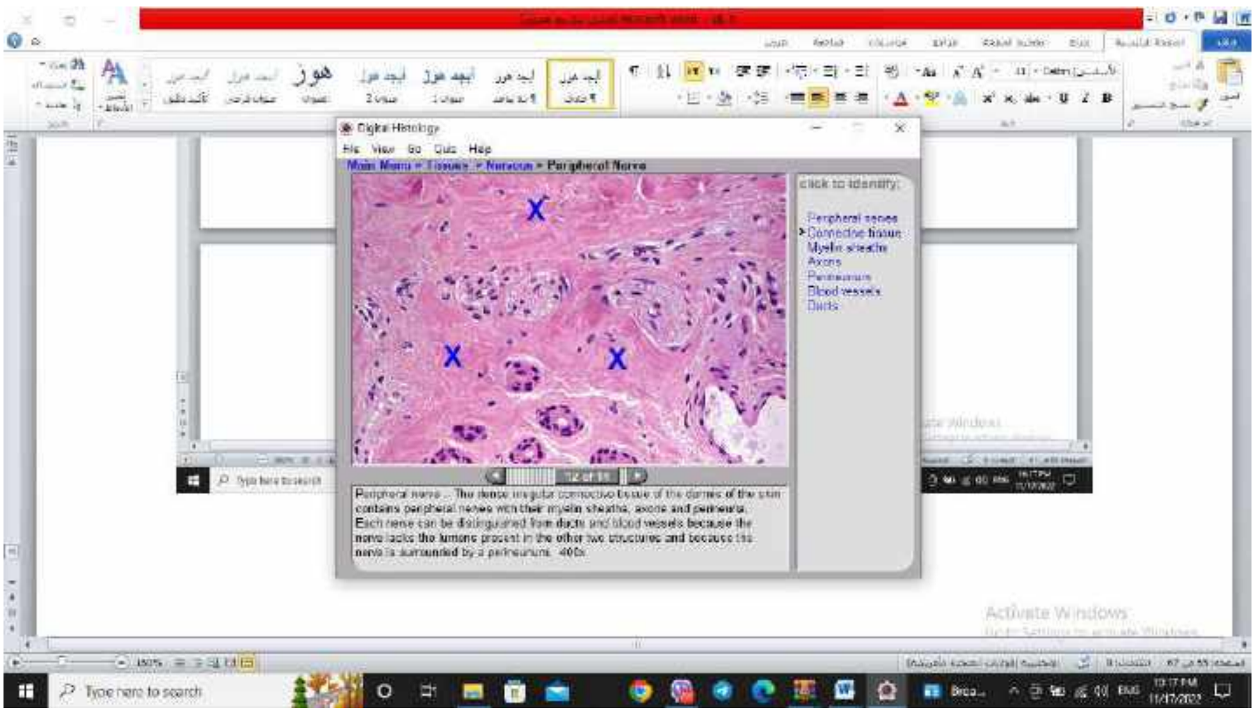
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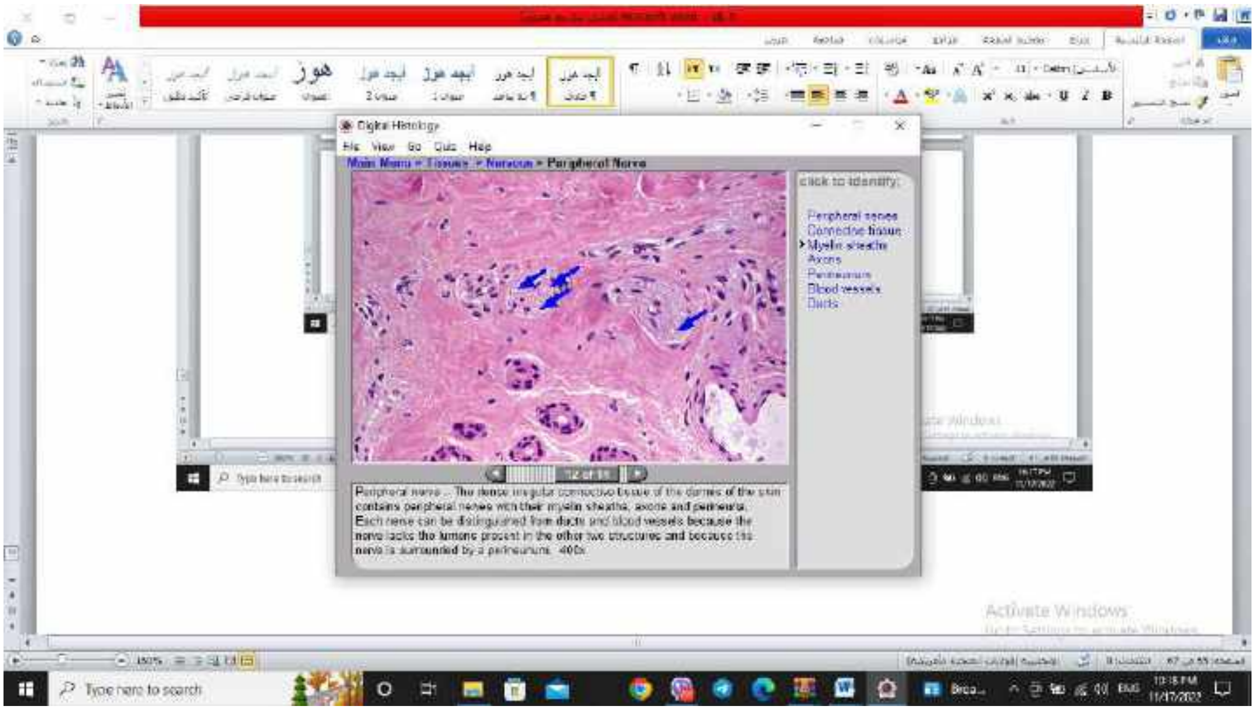

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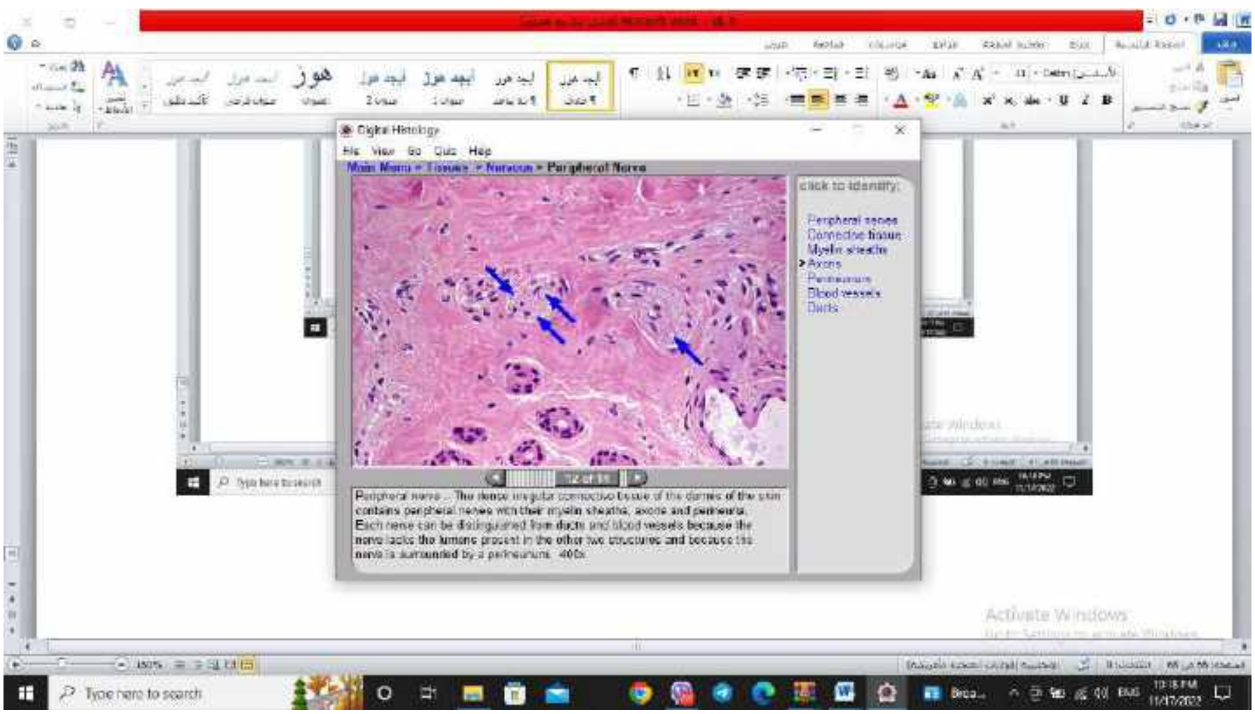

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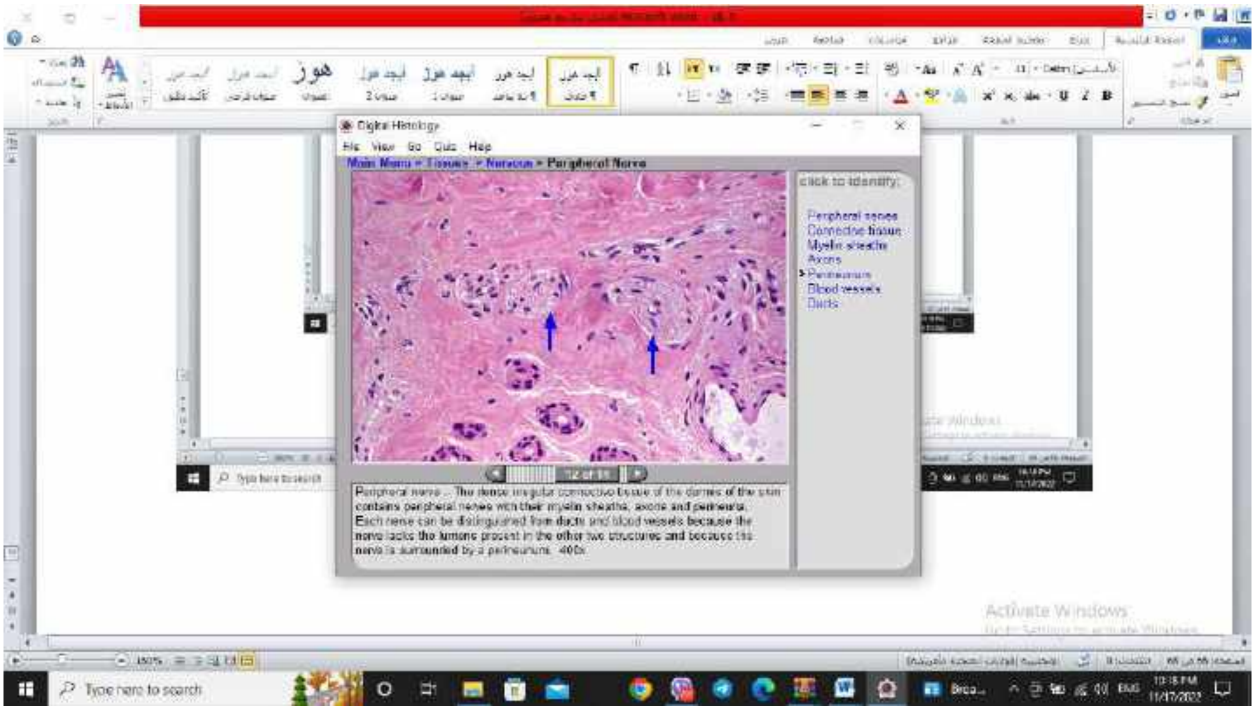
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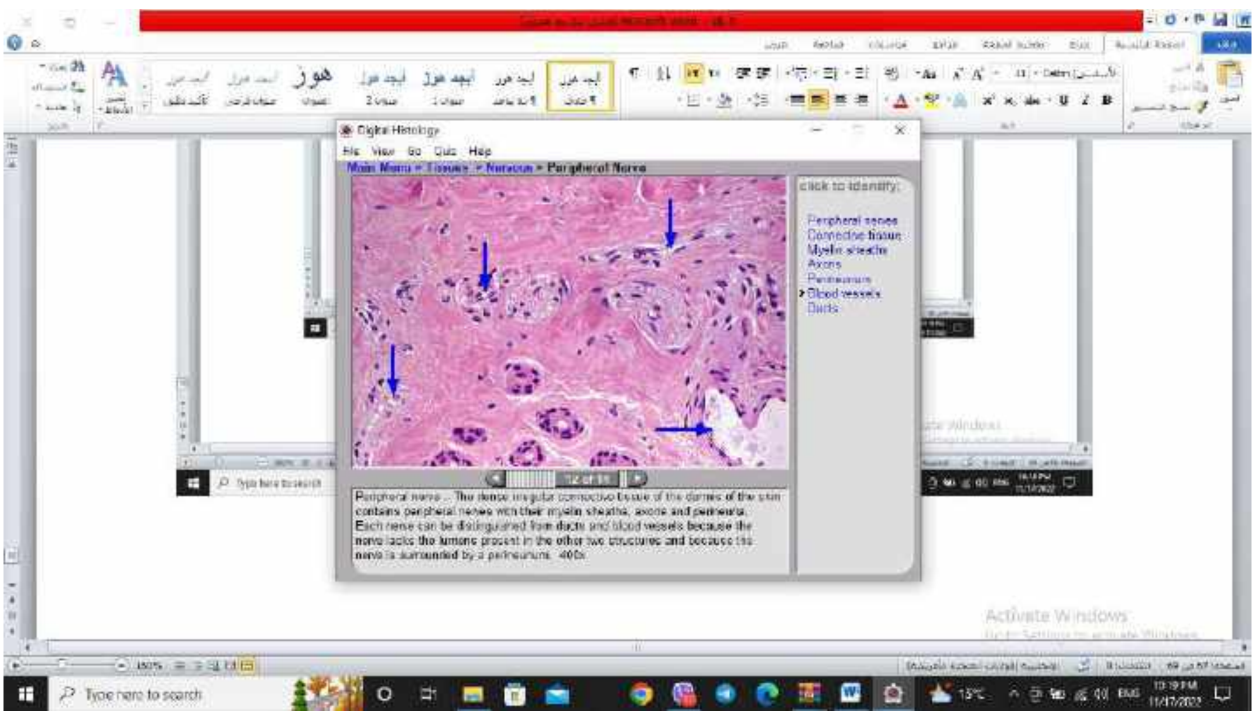
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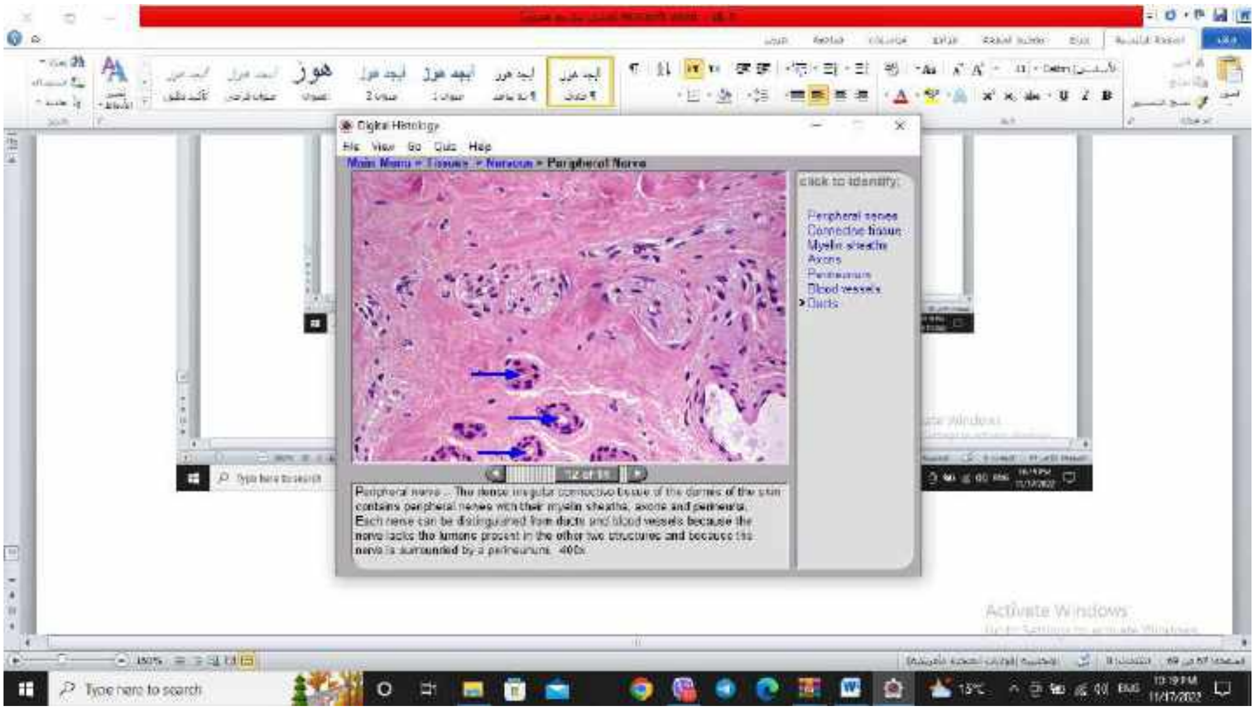
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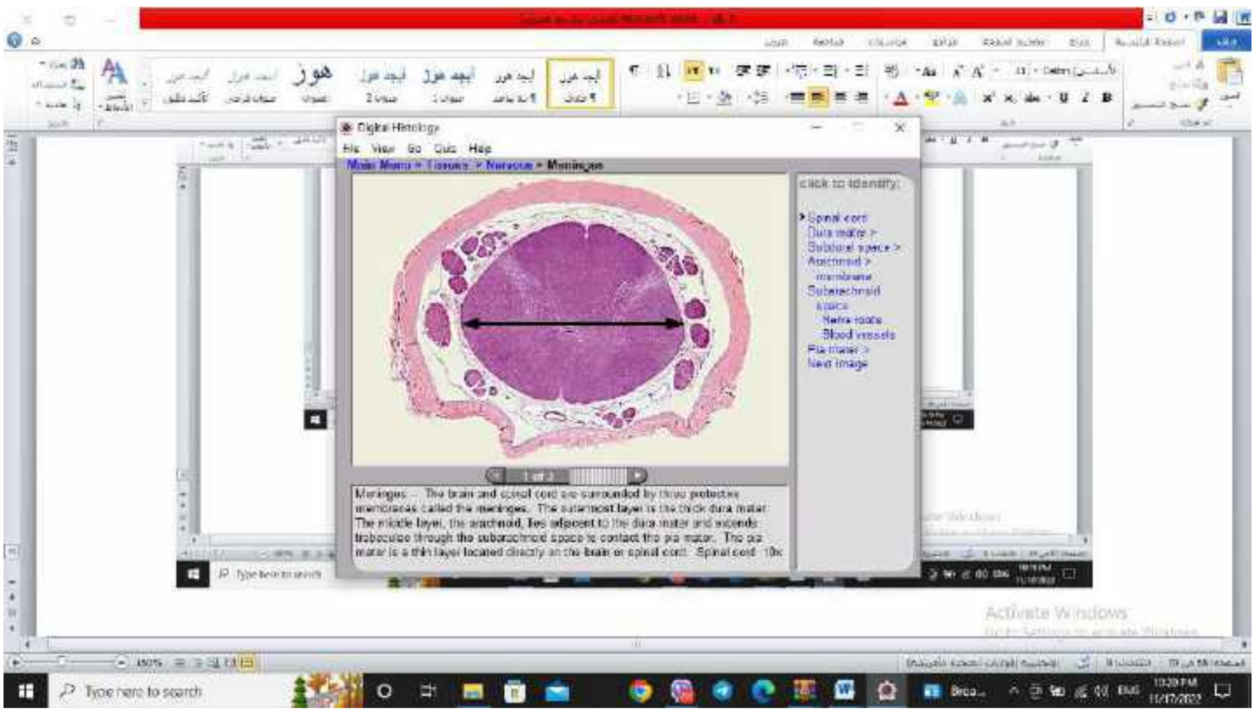
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Subdural space >
Arachnoid > membrane
Subarachnoid space
Nerve roots
Blood vessels
Pia mater >
Next image
Meninges ... The brain and spinal cord are surrounded by three protective membranes called the meninges. The outermost layer is the thick dura mater. The middle layer, the arachnoid, lies adjacent to the dura mater and extends trabeculae through the subarachnoid space to contact the pia mater. The pia mater is a thin layer located directly on the brain or spinal cord. Spinal cord 10x
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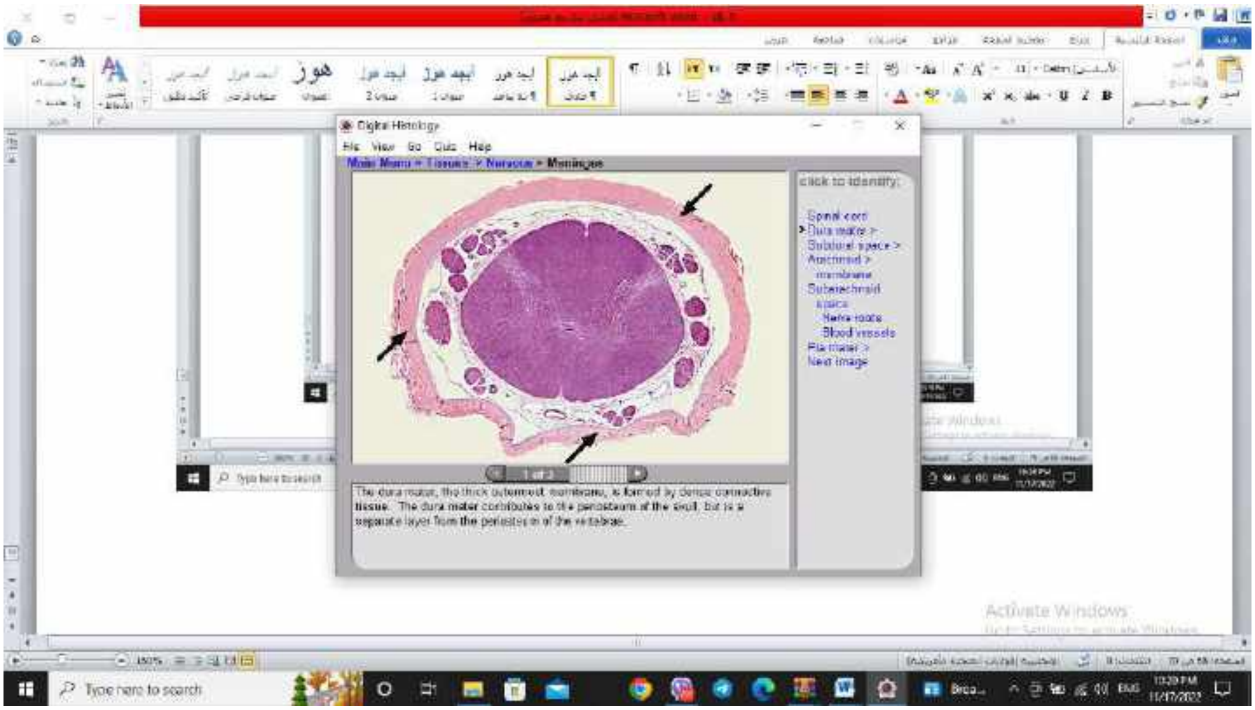
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Subdural space >
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Subarachnoid space
Nerve roots
Blood vessels
Pia mater >
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1 of 2
The dura mater, the thick outermost membrane, is formed by dense connective tissue. The dura mater contributes to the periosteum of the skull, but is a separate layer from the periosteum of the vertebrae.
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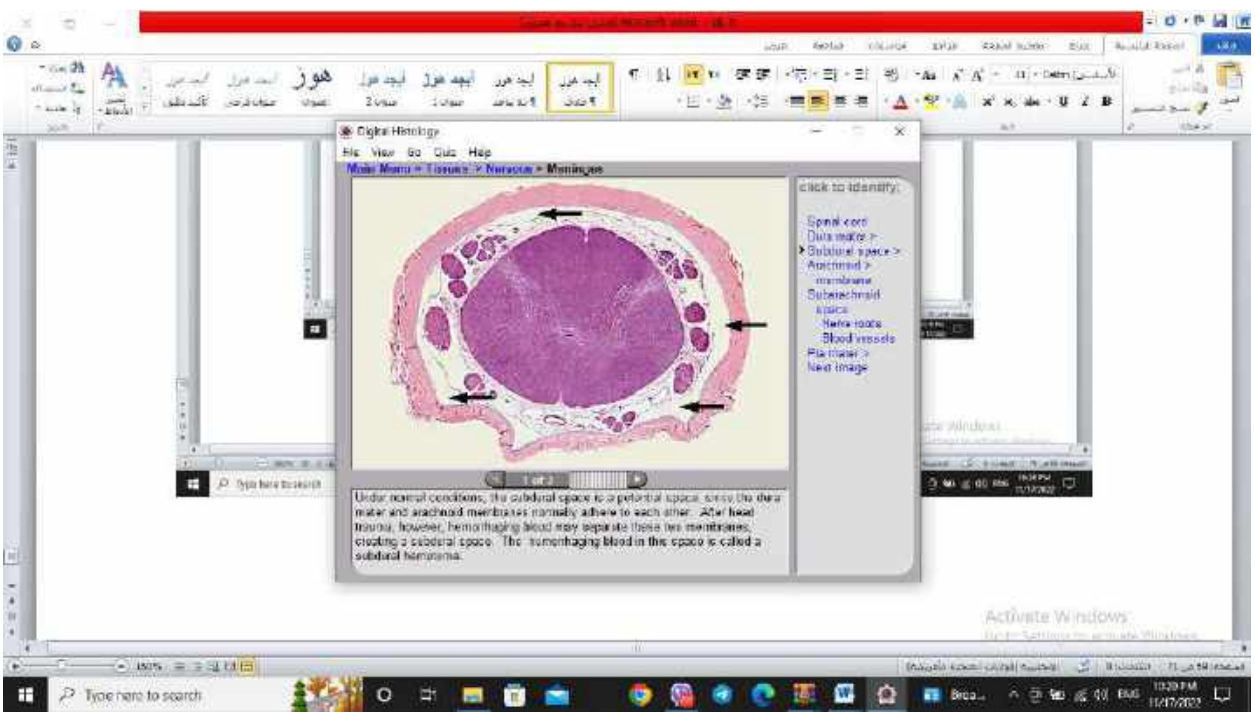
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Nerve roots
Blood vessels
Pia mater >
Next image
1 of 2
Under normal conditions, the subdural space is a potential space since the dura mater and arachnoid membranes normally adhere to each other. After head trauma, however, hemorrhaging blood may separate these two membranes, creating a subdural space. The hemorrhaging blood in this space is called a subdural hematoma.
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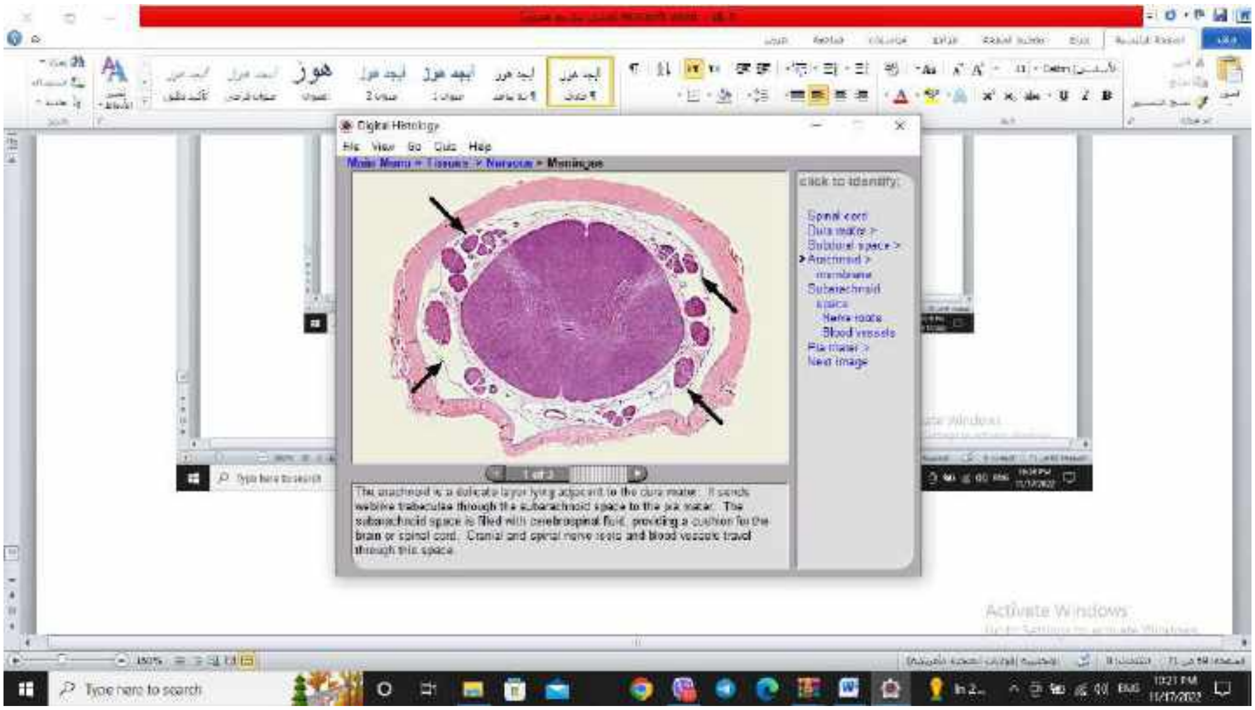
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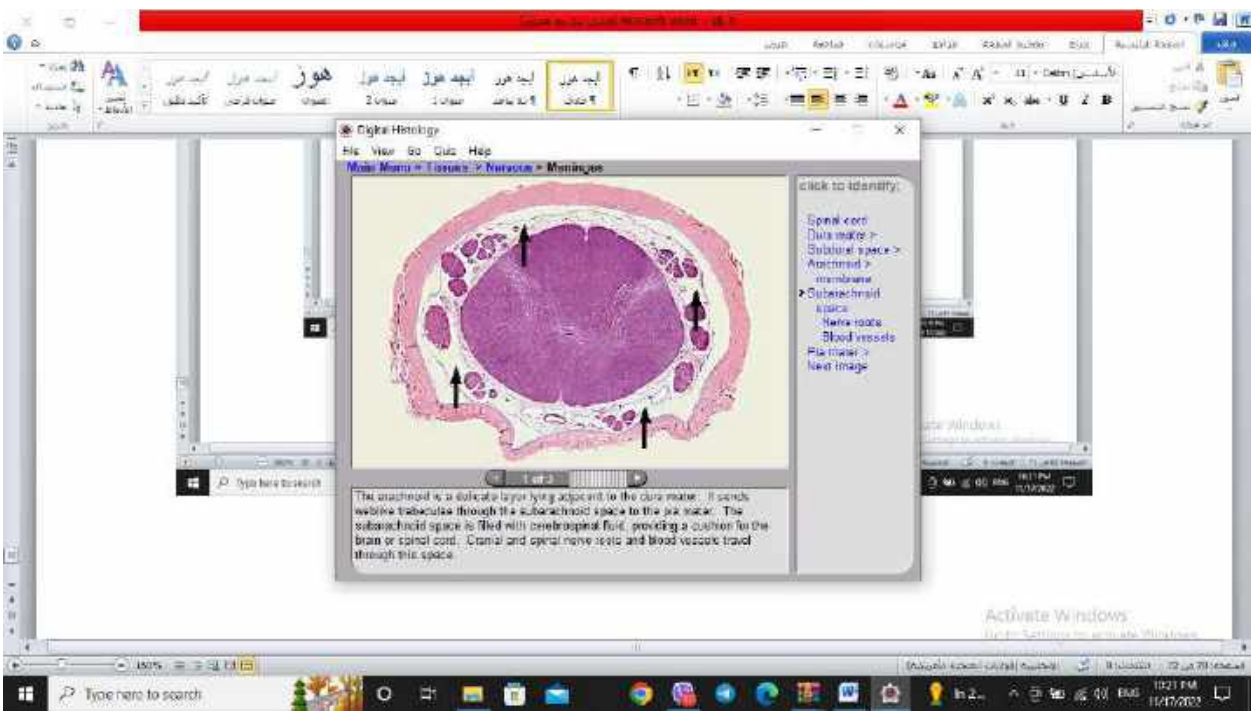
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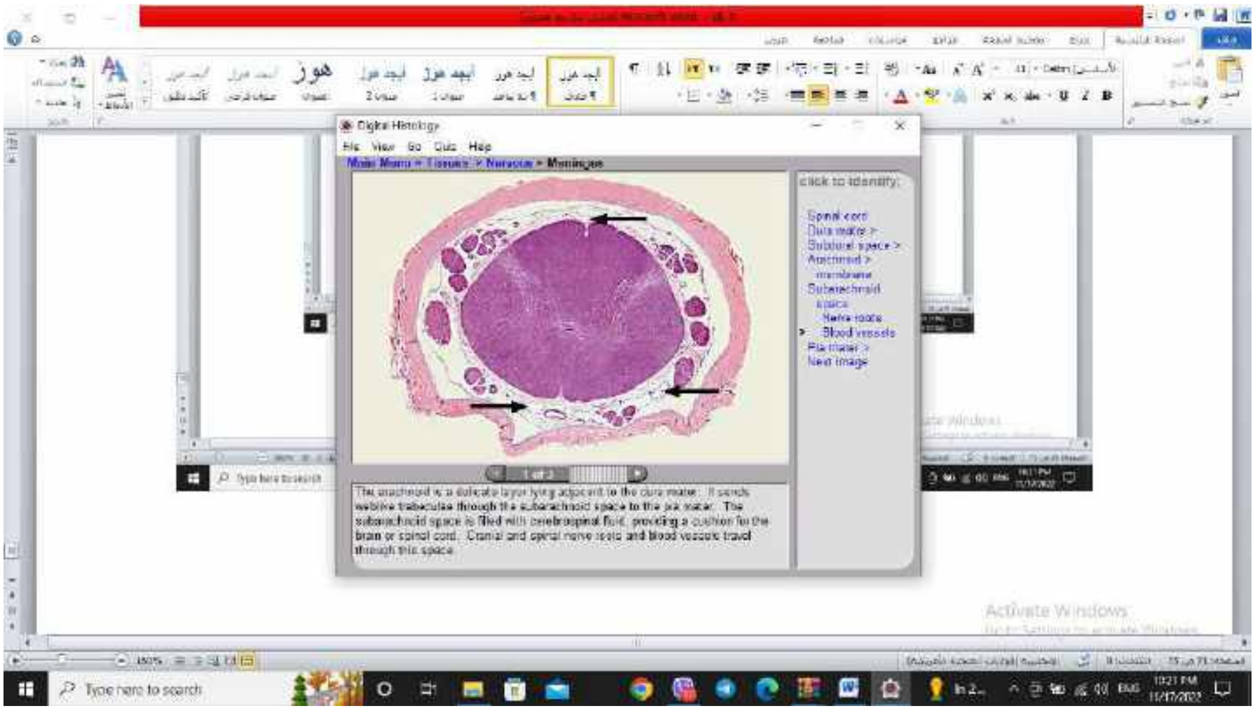
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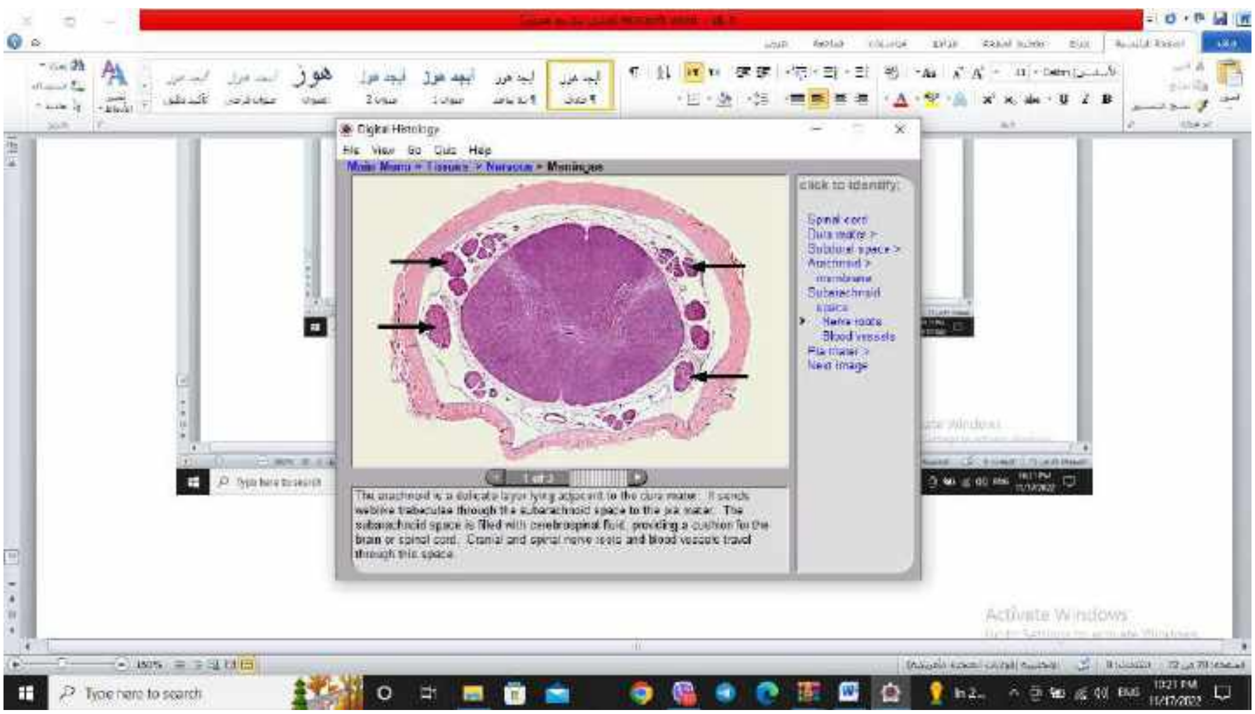
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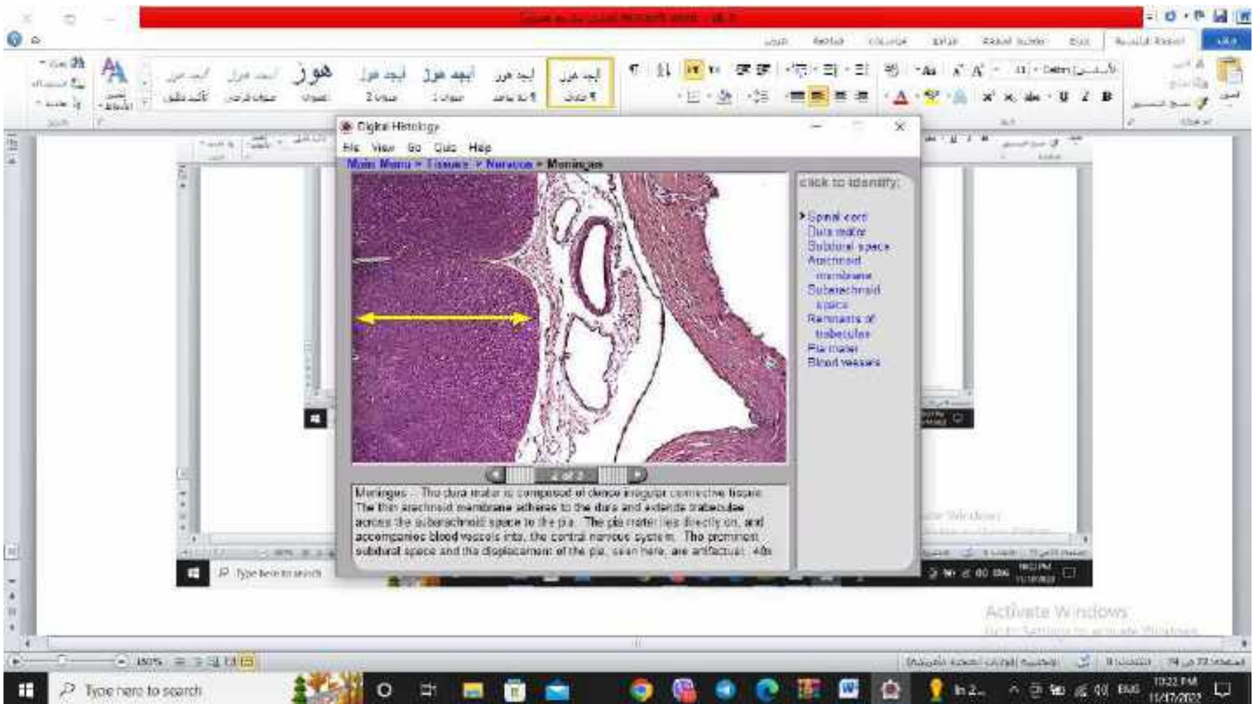
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Subarachnoid space
Remnants of trabeculae
Pia mater
Blood vessels
2 of 2
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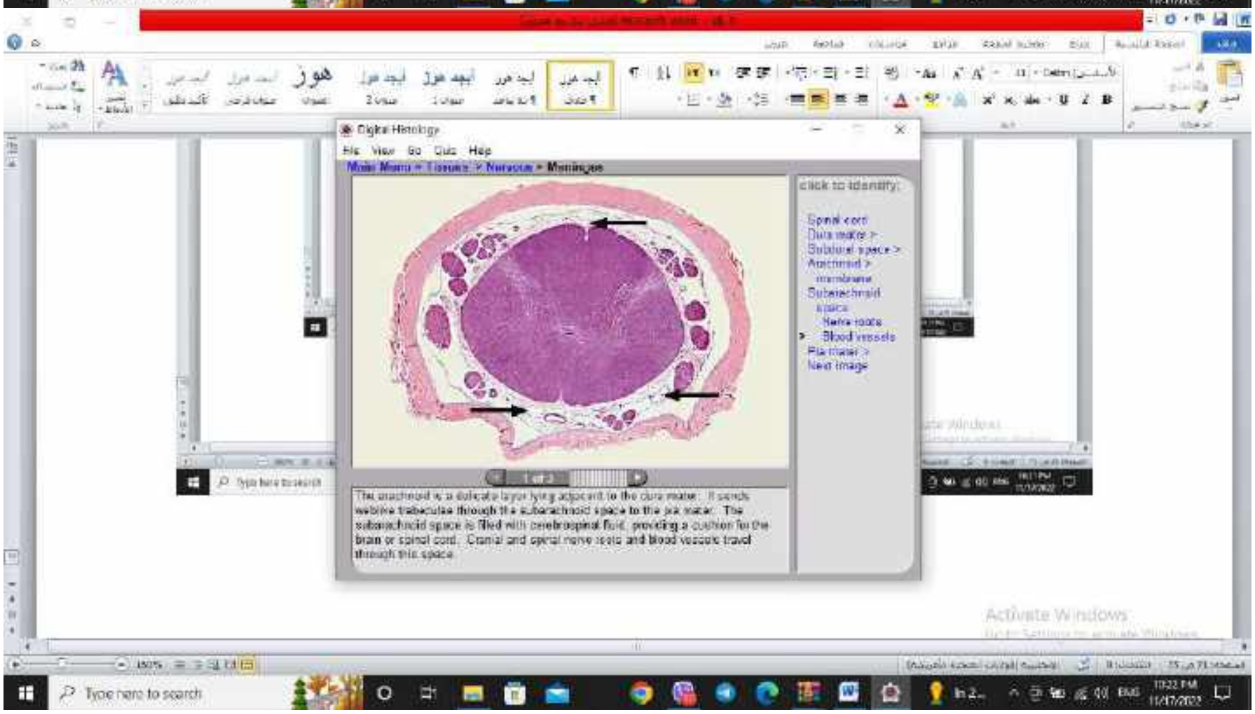
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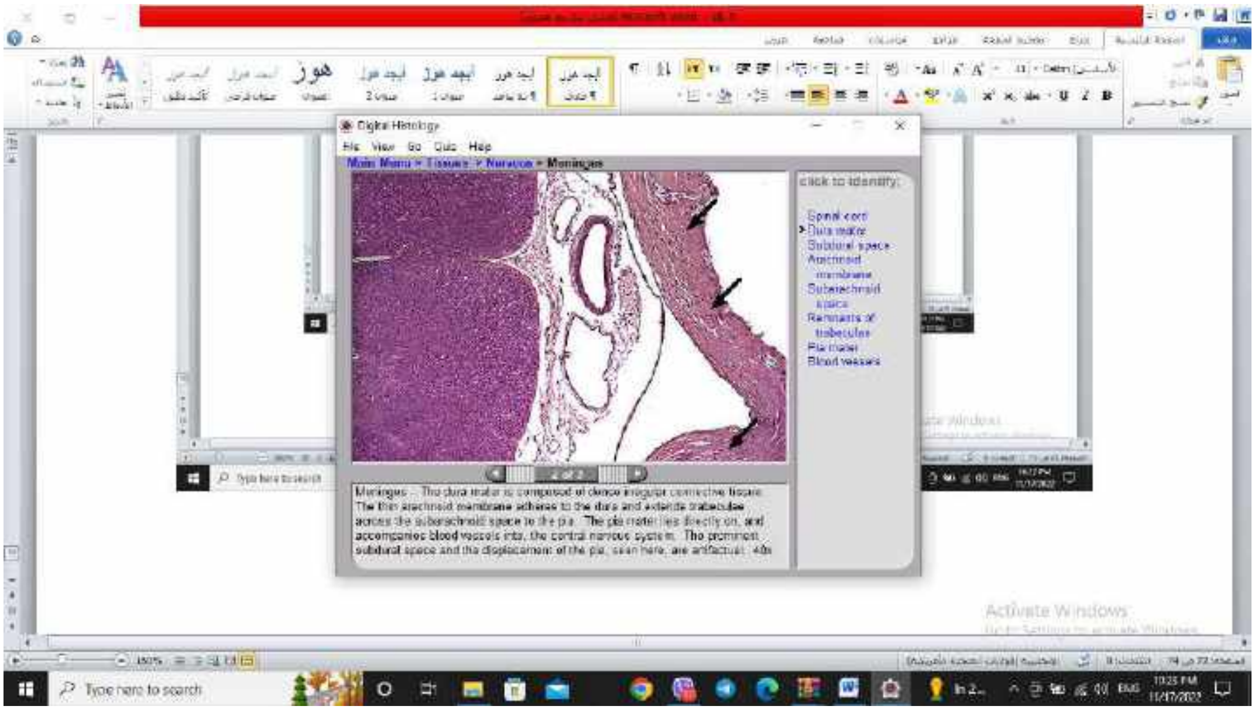
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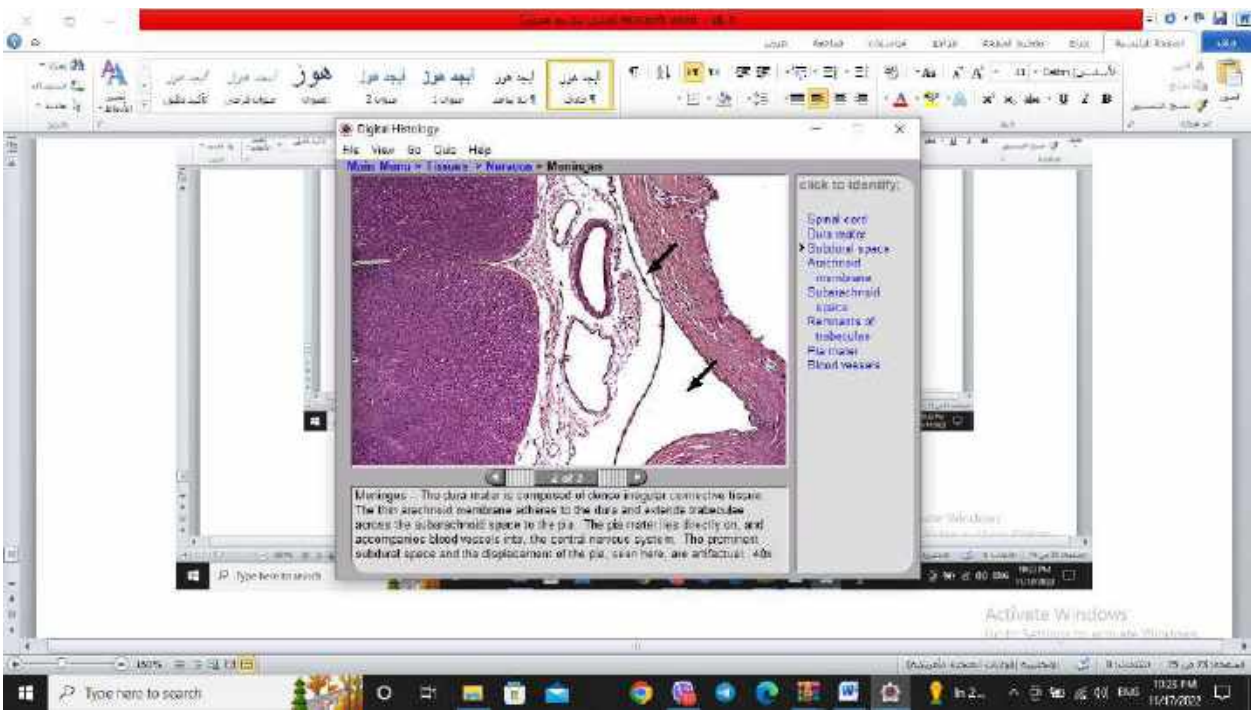
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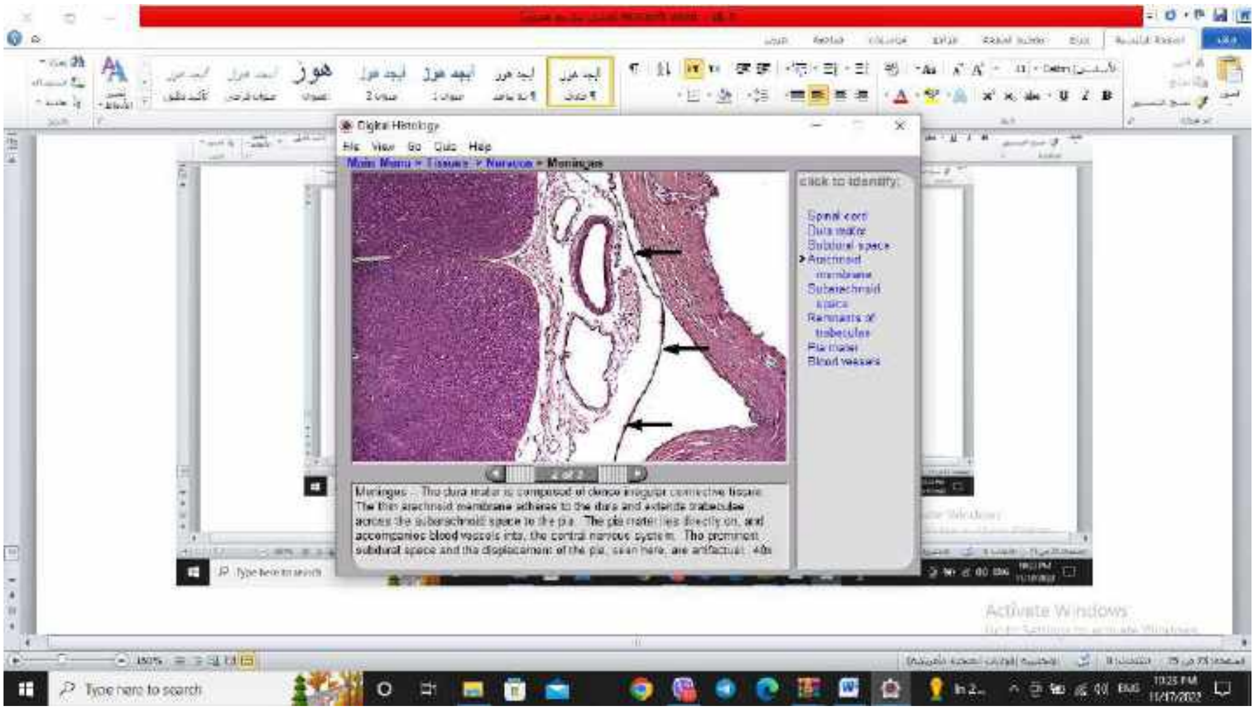
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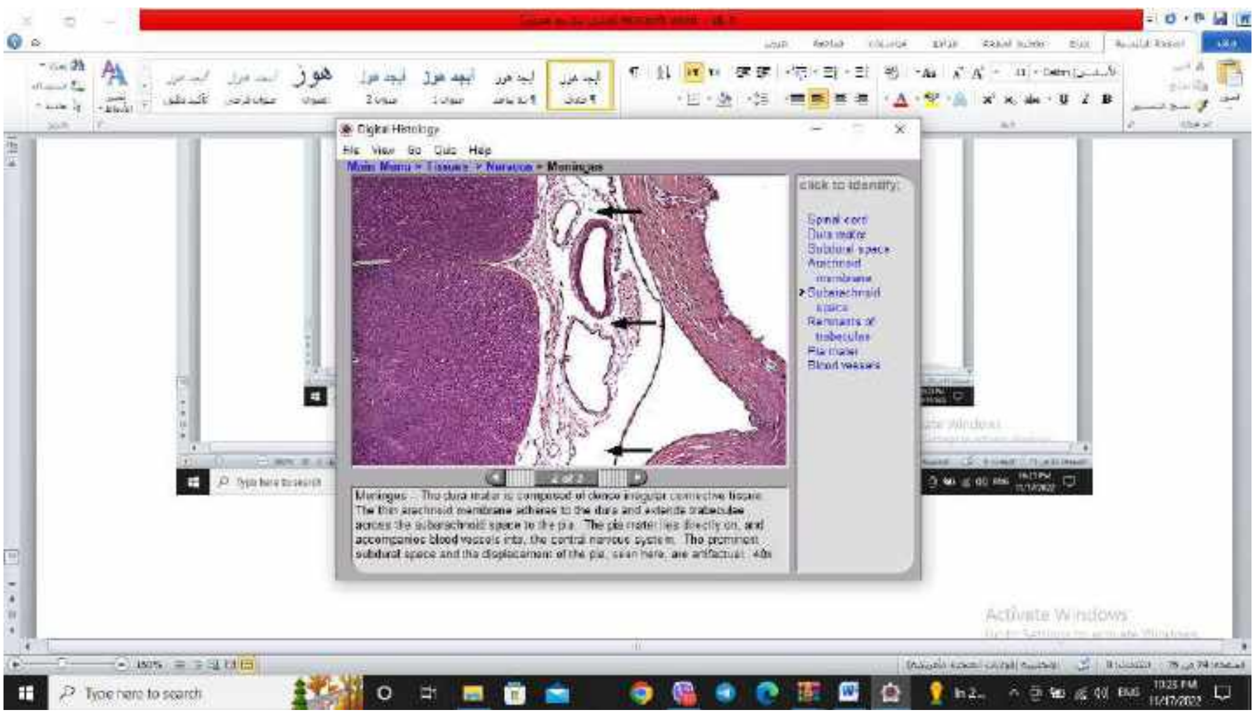
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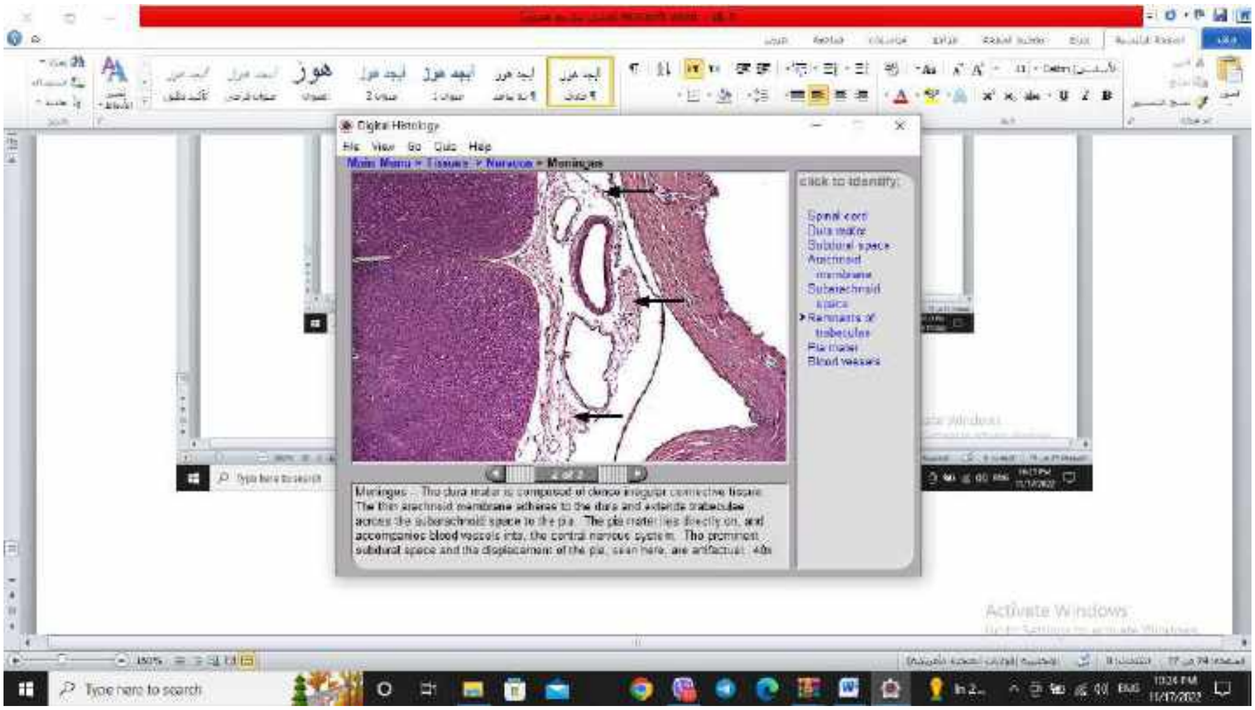
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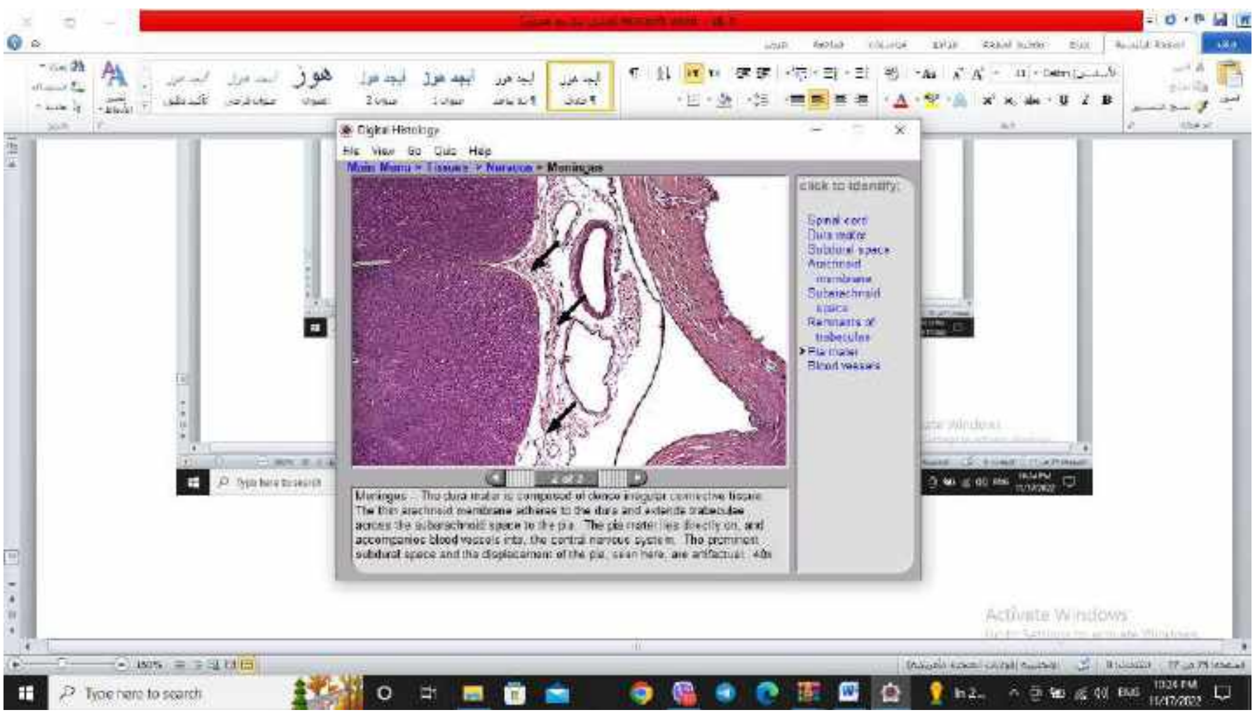
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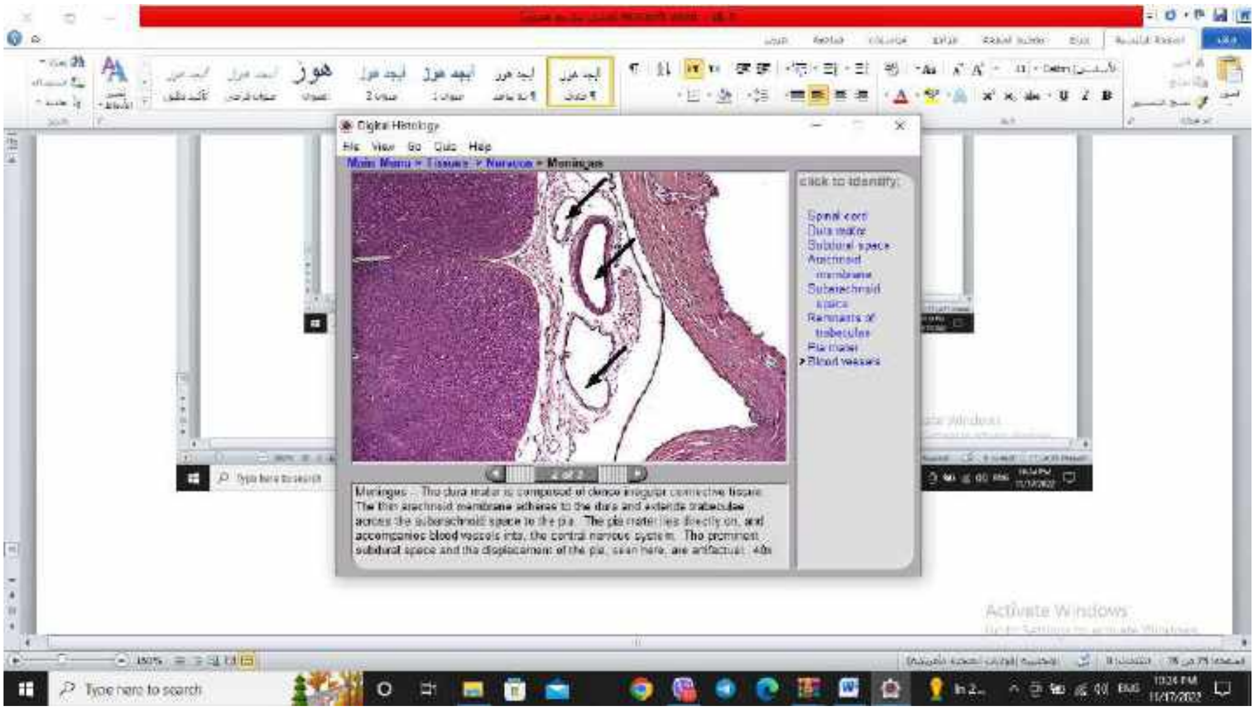
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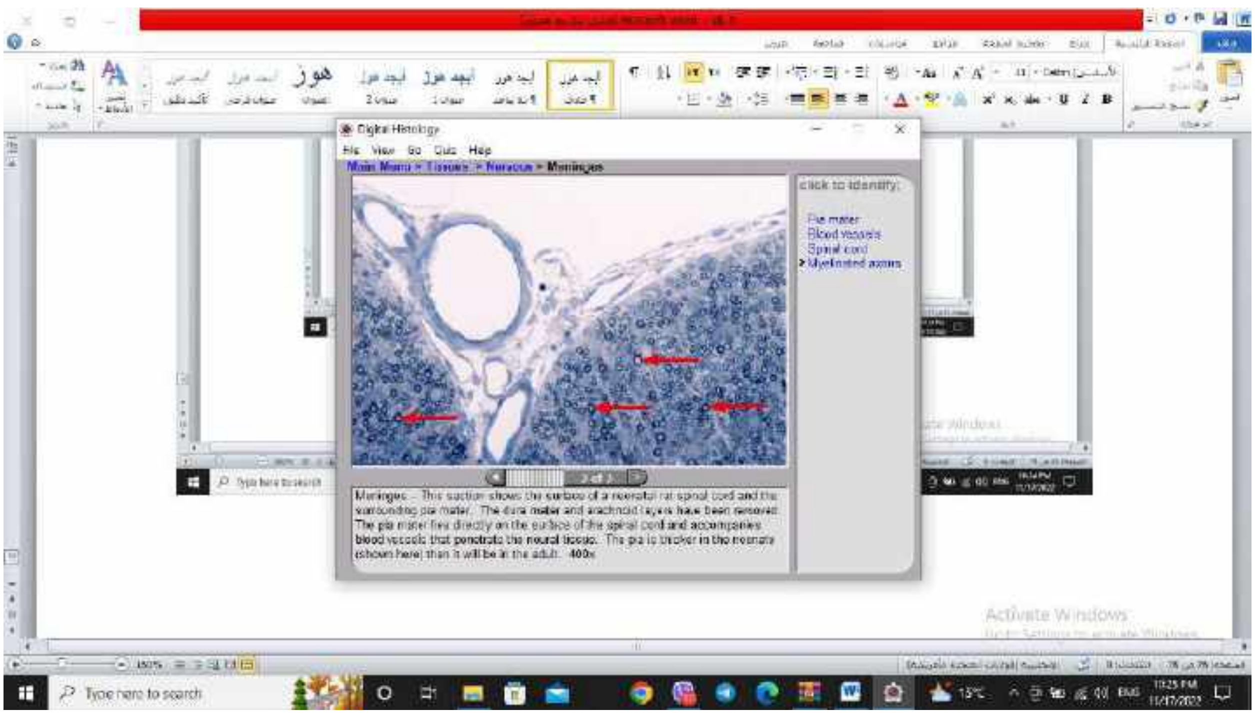
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Pia mater
Blood vessels
Spinal cord
> Myelinated axons
Meninges – This section shows the surface of a neonatal rat spinal cord and the surrounding pia mater. The dura mater and arachnoid layers have been removed. The pia mater lies directly on the surface of the spinal cord and accompanies blood vessels that penetrate the neural tissue. The pia is thicker in the neonate (shown here) than it will be in the adult. 400x
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Chapter 14

The Respiratory System

The respiratory system consists of:
- Respiratory part that includes the lungs
- Conducting part that includes the nasal cavities, the pharynx, the trachea, the bronchi and their intrapulmonary continuations.

The conducting part is responsible for providing passage of air and conditioning the inspired air. The respiratory part is involved in the exchange of oxygen and carbon dioxide between blood and inspired air.

COMMON FEATURES OF AIR PASSAGES

The passages in the conducting part have some features in common. Their walls have a skeletal basis made up variably of bone, cartilage, and connective tissue. The skeletal basis keeps the passages always patent. Smooth muscle present in the walls of the trachea and bronchi enables some alterations in the size of the lumen. The interior of the passages is lined over most of its extent by pseudostratified, ciliated and columnar epithelium. The epithelium is kept moist by the secretions of numerous serous glands. Numerous goblet cells and mucous glands cover the epithelium with a protective mucoid secretion that serves to trap dust particles present in inhaled air. This mucous (along with the dust particles in it) is constantly moved towards the pharynx by action of cilia. When excessive mucous accumulates it is brought out by coughing, or is swallowed. Deep to the mucosa there are numerous blood vessels that serve to warm the inspired air.

THE NASAL CAVITIES

The nasal cavity is the beginning of the respiratory system. These are paired chambers separated by septum. It extends from the nostrils in front to the posterior nasal apertures behind. Each nasal cavity is a hollow organ composed of bone, cartilage and connective tissue covered by mucous membrane.

Histologically, the wall of each half of the nasal cavity is divisible into three distinct regions.
- Vestibule
- Olfactory mucosa
- Respiratory mucosa

Vestibule

It is the anterior dilated part of the nasal cavity. The ***vestibule*** is lined by skin continuous with that on the exterior of the nose. Hair and sebaceous glands are present.

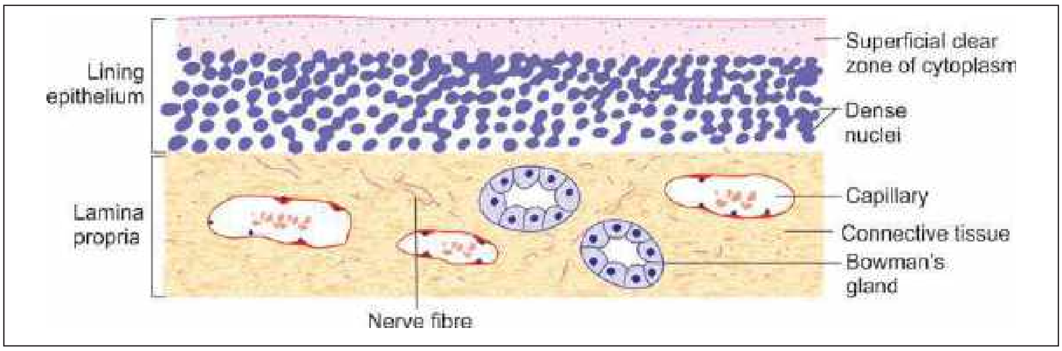


Fig. 14.1: Olfactory mucosa seen in section stained by routine methods (Schematic representation)

Olfactory Mucosa

Apart from their respiratory function the nasal cavities serve as end organs for smell. Receptors for smell are located in the ***olfactory mucosa*** which is confined to a relatively small area on the superior nasal concha, and on the adjoining part of the nasal septum.

Olfactory mucosa is yellow in colour, in contrast to the pink colour of the respiratory mucosa. It is responsible for the sense of smell. It consists of a lining epithelium and a lamina propria.

Olfactory Epithelium

The ***olfactory epithelium*** is pseudostratified. It is much thicker than the epithelium lining the respiratory mucosa (about 100 µm). Within the epithelium there is a superficial zone of clear cytoplasm below which there are several rows of nuclei (Fig. 14.1). Using special methods three types of cells can be recognised in the epithelium (Fig. 14.2).

- The ***olfactory cells*** are modified neurons. Each cell has a central part containing a rounded nucleus. Two processes, distal and proximal, arise from this central part. The distal process (representing the dendrite) passes towards the surface of the olfactory epithelium**.** It ends in a thickening (called the ***rod*** or ***knob***) from which a number of non-motile olfactory cilia arise and project into a layer of fluid covering the epithelium. (Some of them pass laterally in between the microvilli of adjacent sustentacular cells). The proximal process of each olfactory cell represents the axon. It passes into the subjacent connective tissue where it forms one fibre of the olfactory nerve. The nuclei of olfactory cells lie at various levels in the basal two-third of the epithelium.

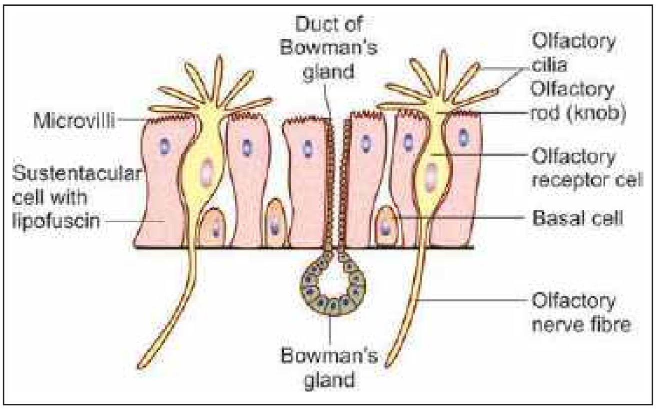


Fig. 14.2: Cells to be seen in olfactory epithelium (Schematic representation)

- The ***sustentacular cells*** support the olfactory cells. Their nuclei are oval, and lie near the free surface of the epithelium. The free surface of each cell bears numerous microvilli (embedded in overlying mucous). The cytoplasm contains yellow pigment (lipofuscin) that gives olfactory mucosa its yellow colour. In addition to their supporting function sustentacular cells may be phagocytic, and the pigment in them may represent remnants of phagocytosed olfactory cells.
- The ***basal cells*** lie deep in the epithelium and do not reach the luminal surface. They divide to form new olfactory cells to replace those that die. Some basal cells have a supporting function.

Added Information

- In vertebrates, olfactory cells are unique in being the only neurons that have cell bodies located in an epithelium.
- Olfactory cells are believed to have a short life. Dead olfactory cells are replaced by new cells produced by division of basal cells. This is the only example of regeneration of neurons in mammals.

Lamina Propria

The lamina propria, lying deep to the olfactory epithelium consists of connective tissue within which blood capillaries, lymphatic capillaries and olfactory nerve bundles are present. It also contains serous glands (of Bowman) the secretions of which constantly 'wash' the surface of the olfactory epithelium. This fluid may help in transferring smell carrying substances from air to receptors on olfactory cells. The fluid may also offer protection against bacteria.

Respiratory Mucosa

The rest of the wall of each half of the nasal cavity is covered by ***respiratory mucosa*** lined by pseudostratified ciliated columnar epithelium.

This mucosa is lined by a pseudostratified ciliated columnar epithelium resting on a basal lamina. In the epithelium, the following cells are present (Fig. 14.3):

- ***Ciliated cells*** are the columnar cells with cilia on their free surfaces and are the most abundant cell type.
- ***Goblet cells*** (flask-shaped cells) scattered in the epithelium produce mucous.
- ***Non-ciliated columnar cells*** with microvilli on the free surface probably secrete a serous fluid that keeps the mucosa moist.
- ***Basal cells*** lying near the basal lamina probably give rise to ciliated cells to replace those lost.

At places the respiratory mucosa may be lined by a simple ciliated columnar epithelium, or even a cuboidal epithelium.

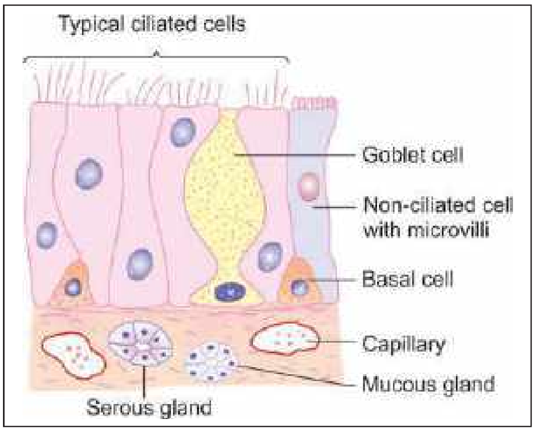


Fig. 14.3: Structure of respiratory part of nasal mucosa (Schematic representation)

Deep to the basal lamina supporting the epithelium lining, the mucosa contains a layer of fibrous tissue, through which the mucosa is firmly connected to underlying periosteum or perichondrium. The fibrous tissue may contain numerous lymphocytes. It also contains mucous and serous glands that open on to the mucosal surface. Some serous cells contain basophilic granules, and probably secrete amylase. Others with eosinophilic granules produce lysozyme.

The deeper parts of the mucosa contain a rich capillary network that constitutes a ***cavernous tissue***. Blood flowing through the network warms inspired air. Variations in blood flow can cause swelling or shrinkage of the mucosa.

Respiratory mucosa also lines the paranasal air sinuses. Here it is closely bound to underlying periosteum forming a ***mucoperiosteum***.

Lamina Propria

The lamina propria of nasal mucosa contains lymphocytes, plasma cells, macrophages, a few neutrophils and eosinophils. Eosinophils increase greatly in number in persons suffering from allergic rhinitis.

Clinical Correlation

- **Acute Rhinitis (Common Cold):** Acute rhinitis or common cold is the common inflammatory disorder of the nasal cavities that may extend into the nasal sinuses. It begins with rhinorrhoea, nasal obstruction and sneezing. Initially, the nasal discharge is watery, but later it becomes thick and purulent.
- **Nasal Polyps:** Nasal polyps are common and are pedunculated grape-like masses of tissue. They are the end-result of prolonged chronic inflammation causing polypoid thickening of the mucosa. They may be allergic or inflammatory. They are frequently bilateral and the middle turbinate is the common site.

THE PHARYNX

The pharynx consists of nasal, oral and laryngeal parts. The nasal part is purely respiratory in function, but the oral and laryngeal parts are more intimately concerned with the alimentary system. The wall of the pharynx is fibromuscular.

Epithelium

In the nasopharynx the epithelial lining is ciliated columnar, or pseudostratified ciliated columnar. Over the inferior surface of the soft palate, and over the oropharynx and laryngopharynx the epithelium is stratified squamous (as these parts come in contact with food during swallowing).

Lymphoid Tissue

Subepithelial aggregations of lymphoid tissue are present specially on the posterior wall of the nasopharynx, and around the orifices of the auditory tubes, forming the nasopharyngeal and tubal tonsils. The palatine tonsils are present in relation to the oropharynx.

Submucosa

Numerous mucous glands are present in the submucosa, including that of the soft palate.

Clinical Correlation

- **Ludwig's Angina:** This is a severe, acute streptococcal cellulitis involving the neck, tongue and back of the throat. The condition was more common in the pre-antibiotic era as a complication of compound fracture of the mandible and periapical infection of the molars. The condition often proves fatal due to glottic oedema, asphyxia and severe toxaemia.
- **Diphtheria:** Diphtheria is an acute communicable disease caused by *Corynebacterium diphtheriae*. It usually occurs in children and results in the formation of a yellowish-grey pseudomembrane in the mucosa of nasopharynx, oropharynx, tonsils, larynx and trachea.
- **Tonsillitis:** Tonsillitis caused by staphylococci or streptococci may be acute or chronic. Acute tonsillitis is characterised by enlargement, redness and inflammation. Acute tonsillitis may progress to acute follicular tonsillitis in which crypts are filled with debris and pus giving it follicular appearance. Chronic tonsillitis is caused by repeated attacks of acute tonsillitis in which case the tonsils are small and fibrosed. Acute tonsillitis may pass on to tissues adjacent to tonsils to form peritonsillar abscess or quinsy.

THE LARYNX

Larynx is a specialised organ responsible for production of voice. It houses the vocal cords. The wall of the larynx has a complex structure made up of a number of cartilages, membranes and muscles.

Mucous Membrane

The epithelium lining the mucous membrane of the larynx is predominantly pseudostratified ciliated columnar. However, over some parts that come in contact with swallowed food the epithelium is stratified squamous. These parts include the epiglottis (anterior surface and upper part of the posterior surface), and the upper parts of the aryepiglottic folds. The vocal folds do not come in contact with swallowed food, but their lining epithelium is exposed to considerable stress during vibration of the folds. These folds are also covered with stratified squamous epithelium.

Numerous goblet cells and subepithelial mucous glands provide a mucous covering to the epithelium. Mucous glands are specially numerous over the epiglottis; in the lower part of the aryepiglottic folds (where they are called ***arytenoid glands***); and in the saccule. The glands in the saccule provide lubrication to the vocal folds. Serous glands and lymphoid tissue are also present.

EM studies have shown that epithelial cells lining the vocal folds bear microvilli and ridge-like foldings of the surface plasma membrane (called ***microplicae***). It is believed that these help to retain fluid on the surface of the cells keeping them moist.

Added Information

The connective tissue subjacent to the epithelial lining of vocal folds is devoid of lymph vessels. This factor slows down lymphatic spread of cancer arising in the epithelium of the vocal folds.

Cartilages of the Larynx

The larynx has a cartilaginous framework which is made of nine cartilages (3 paired and 3 unpaired) that are connected to each other by membranes and ligaments (Fig. 14.4). The cartilages are either hyaline or elastic in nature. These are:

- ***Hyaline cartilages***
  - Thyroid (unpaired)
  - Cricoid (unpaired)
  - Arytenoid (paired)
- ***Elastic cartilages***
  - Epiglottis (unpaired)
  - Cuneiform (paired)
  - Corniculate (paired)

With advancing age, calcification may occur in hyaline cartilage, but not in elastic cartilage.

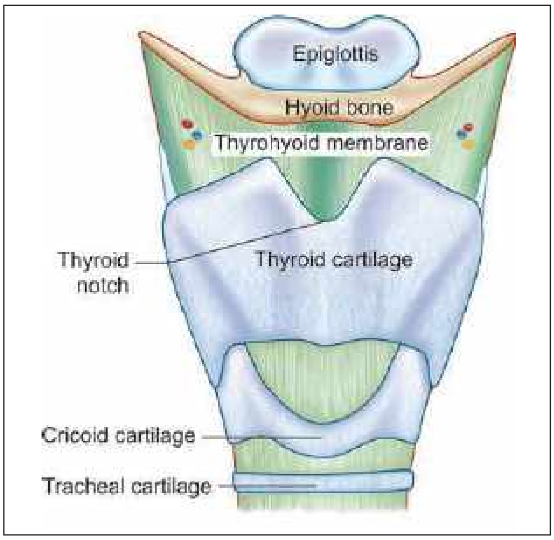


Fig. 14.4: Anterior view of the larynx (Schematic representation)

The Epiglottis

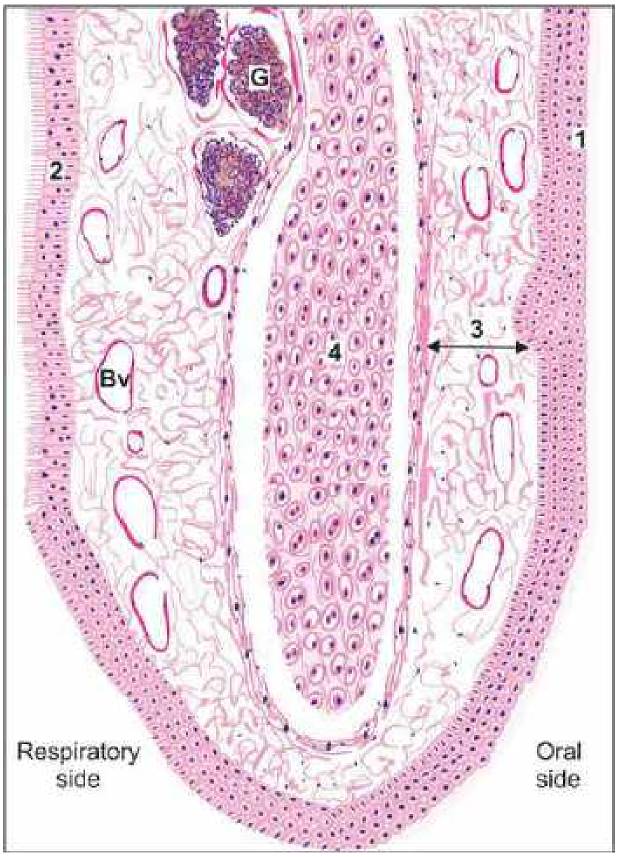
The epiglottis is considered separately because sections through it are usually included in sets of class slides. The epiglottis has a central core of elastic cartilage. Overlying the cartilage there is mucous membrane. The greater part of the mucous membrane is lined by stratified squamous epithelium (non-keratinising). The mucous membrane over the lower part of the posterior surface of the epiglottis is lined by pseudostratified ciliated columnar epithelium (Plate 14.1). This part of the epiglottis does not come in contact with swallowed food as it is overlapped by the aryepiglottic folds. Some taste buds are present in the epithelium of the epiglottis. (A few taste buds may be seen in the epithelium elsewhere in the larynx).

Numerous glands, predominantly mucous, are present in the mucosa deep to the epithelium. Some of them lie in depressions present on the epiglottic cartilage.

Clinical Correlation

- **Acute Laryngitis:** This may occur as a part of the upper or lower respiratory tract infection. Atmospheric pollutants like cigarette smoke, exhaust fumes, industrial and domestic smoke, etc, predispose the larynx to acute bacterial and viral infections. Streptococci and *H. influenzae* cause acute epiglottitis which may be life-threatening.
- **Chronic Laryngitis:** Chronic laryngitis may occur from repeated attacks of acute inflammation, excessive smoking, chronic alcoholism or vocal abuse. The surface is granular due to swollen mucous glands. There may be extensive squamous metaplasia due to heavy smoking, chronic bronchitis and atmospheric pollution.

PLATE 14.1: Epiglottis



Epiglottis. (As seen in drawing)

- The surface of epiglottis is covered on oral side by stratified squamous epithelium and on respiratory side by pseudostratified ciliated columnar epithelium
- The core of the epiglottis is made up of a plate of elastic cartilage covered by connective tissue in which there are numerous blood vessels and glands.

Note: This figure shows the appearance of elastic cartilage when stained by haematoxylin and eosin.

Key

1. Stratified squamous epithelium
2. Pseudostratified ciliated columnar epithelium
3. Connective tissue
4. Elastic cartilage

G. Gland
Bv. Blood vessel

THE TRACHEA AND PRINCIPAL BRONCHI

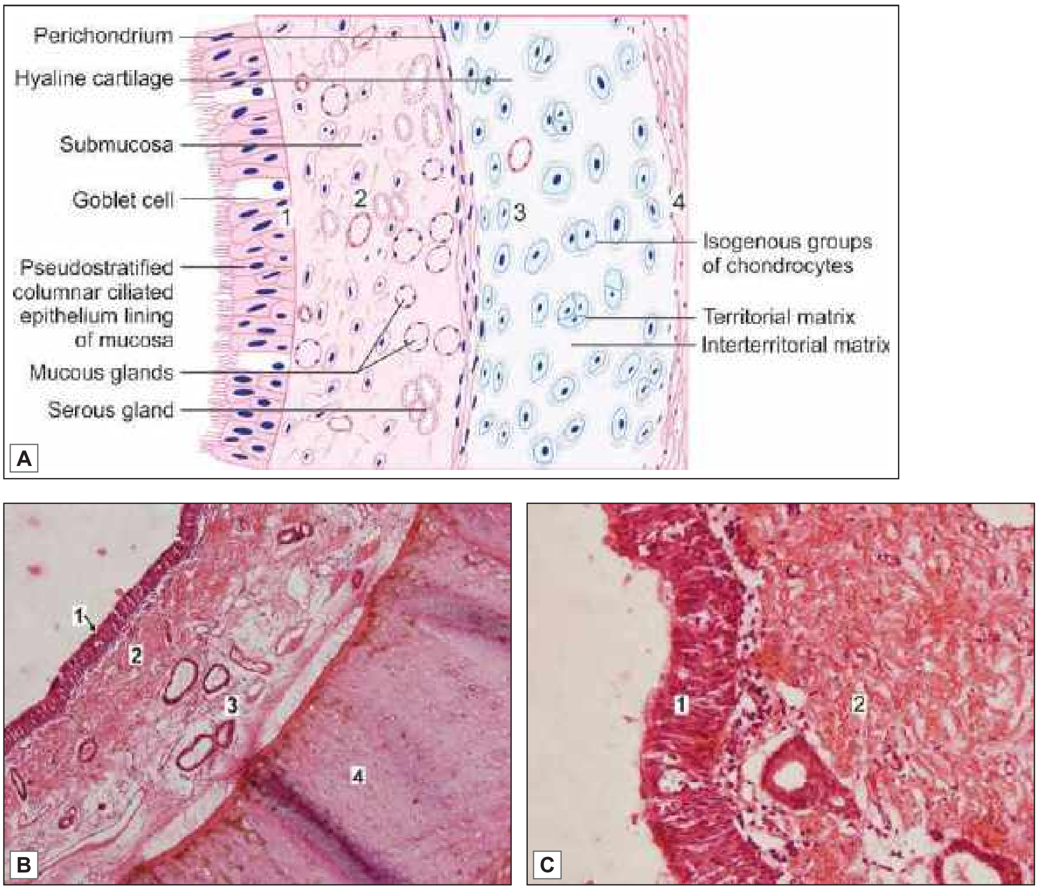
Trachea

The trachea is a fibroelastic cartilaginous tube. It extends from the lower border of cricoid cartilage (C_6) to its level of bifurcation (T_4) into right and left bronchi. The trachea consists of four layers (Plate 14.2).

Mucosa

The lumen of the trachea is lined by mucous membrane that consists of a lining epithelium and an underlying layer of connective tissue. The lining epithelium is pseudostratified ciliated columnar. It contains numerous goblet cells, and basal cells that lie next to the basement membrane. Numerous lymphocytes are seen in deeper parts of the epithelium.

Plate 14.2: Trachea



Trachea. A. As seen in drawing; B. Photomicrograph (low magnification); C. Photomicrograph (high magnification)

From within outwards the wall of trachea consists of:

- **Mucosa** formed by pseudostratified ciliated columnar epithelium with goblet cells and the underlying lamina propria
- **Submucosa** made up of loose connective tissue containing mucous glands and serous glands, blood vessels and ducts
- A 'C' shaped plate of **hyaline cartilage**. Perichondrium has outer fibrous and inner chondrogenic layers. Chondrocytes increase in size from periphery to centre. They may appear as isogenous groups surrounded by darkly stained territorial matrix
- Adventitia consisting of collagen fibres (Not shown here).

Key

1. Pseudostratified ciliated columnar epithelium with goblet cells } Mucosa
2. Lamina propria
3. Submucosa
4. Hyaline cartilage

Submucosa

The subepithelial connective tissue contains numerous elastic fibres. It contains serous glands that keep the epithelium moist; and mucous glands that provide a covering of mucous in which dust particles get caught. The mucous is continuously moved towards the larynx by ciliary action. Numerous aggregations of lymphoid tissue are present in the subepithelial connective tissue. Eosinophil leucocytes are also present.

Cartilage and Smooth Muscle Layer

The skeletal basis of the trachea is made up of 16 to 20 tracheal cartilages. Each of these is a C-shaped mass of hyaline cartilage. The open end of the 'C' is directed posteriorly. Occasionally, adjoining cartilages may partly fuse with each other or may have Y-shaped ends. The intervals between the cartilages are filled by fibrous tissue that becomes continuous with the perichondrium covering the cartilages. The gaps between the cartilage ends, present on the posterior aspect, are filled in by smooth muscle and fibrous tissue. The connective tissue in the wall of the trachea contains many elastic fibres.

Adventitia

It is made of fibroelastic connective tissue containing blood vessels and nerves.

Principal Bronchi

The trachea divides at the level of T_4 into right and left principal bronchi (primary or main bronchi). They have a structure similar to that of the trachea.

THE LUNGS

The lungs are the principal respiratory organs that are situated one on either side of mediastinum in the thoracic cavity. They are covered by visceral pleura (Plate 14.3).

The structure of the lungs has to be understood keeping in mind their function of oxygenation of blood. The following features are essential for this purpose.

- A surface at which air (containing oxygen) can be brought into close contact with circulating blood. The barrier between air and blood has to be very thin to allow oxygen (and carbon dioxide) to pass through it. The surface has to be extensive enough to meet the oxygen requirements of the body.
- A system of tubes to convey air to and away from the surface at which exchanges take place.
- A rich network of blood capillaries present in intimate relationship to the surface at which exchanges take place.

Intrapulmonary Passages

On entering the lung the principal bronchus divides into secondary, or ***lobar bronchi*** (one for each lobe). Each lobar bronchus divides into tertiary, or ***segmental bronchi*** (one for each segment of the lobe). The segmental bronchi divide into smaller and smaller bronchi, which ultimately end in ***bronchioles***.

The lung substance is divided into numerous lobules each of which receives a ***lobular bronchiole***. The lobular bronchiole gives off a number of ***terminal bronchioles*** (Fig. 14.5).

As indicated by their name the terminal bronchioles represent the most distal parts of the conducting passage.

Each terminal bronchiole ends by dividing into ***respiratory bronchioles***. These are so called because they are partly respiratory in function as some air sacs (see below) arise from them.

Each respiratory bronchiole ends by dividing into a few ***alveolar ducts***. Each alveolar duct ends in a passage, the ***atrium***, which leads into a number of rounded ***alveolar sacs***. Each alveolar sac is studded with a number of air sacs or ***alveoli***.

The alveoli are blind sacs having very thin walls through which oxygen passes from air into blood, and carbon dioxide passes from blood into air.

The structure of the larger intrapulmonary bronchi is similar to that of the trachea. As these bronchi divide into smaller ones the following changes in structure are observed.

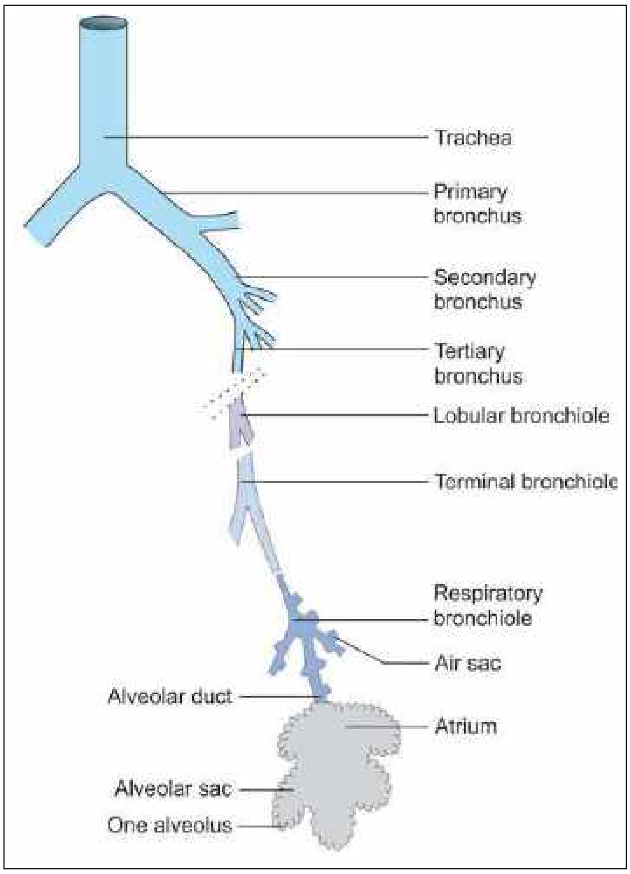
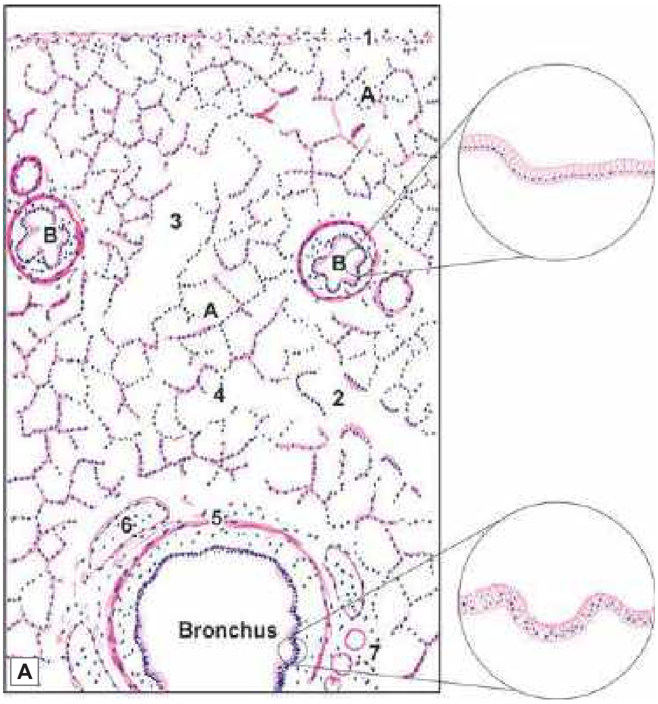


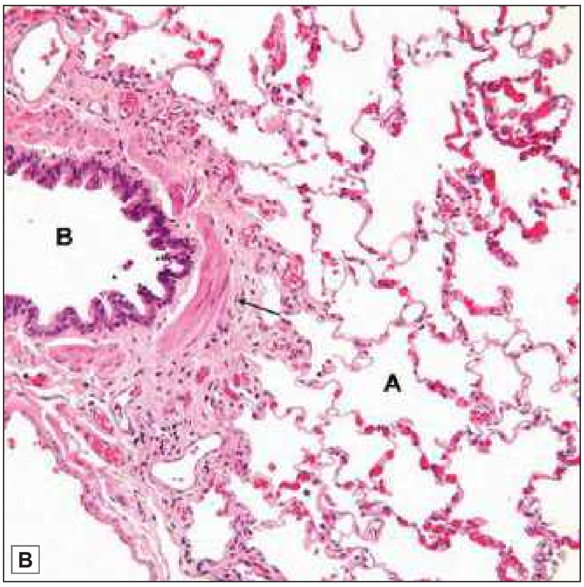
Fig. 14.5: Some terms used to describe the terminal ramifications of the bronchial tree (Schematic representation)

- The cartilages in the walls of the bronchi become irregular in shape, and are progressively smaller. Cartilage is absent in the walls of bronchioles: this is the criterion that distinguishes a bronchiole from a bronchus.
- The amount of muscle in the bronchial wall increases as the bronchi become smaller. The presence of muscle in the walls of bronchi is of considerable clinical significance. Spasm of this muscle constricts the bronchi and can cause difficulty in breathing.
- Subepithelial lymphoid tissue increases in quantity as bronchi become smaller. Glands become fewer, and are absent in the walls of bronchioles.
- The trachea and larger bronchi are lined by pseudostratified ciliated columnar epithelium. As the bronchi become smaller the epithelium first becomes simple ciliated columnar, then non-ciliated columnar, and finally cuboidal (in respiratory bronchioles). The cells contain lysosomes and numerous mitochondria. Plate 14.3 illustrates the salient microscopic features of the lung parenchyma.

EM studies have shown that apart from typical ciliated columnar cells, various other types of cells are to be seen in the epithelium lining the air passages. Some of the cells encountered are as follows (Fig. 14.6):

PLATE 14.3: Lung





Lung. A. As seen in drawing; B. Photomicrograph.
Courtesy: Atlas of Histopathology, 1st Edition. Ivan Damjanov. Jaypee Brothers. 2012. p37

- The lung surface is covered by pleura. It consists of a lining of mesothelium resting on a layer of connective tissue
- The lung parenchyma is made up of numerous thin-walled spaces or alveoli
- The alveoli give a honey comb appearance and are lined by flattened squamous cells. They are filled with air
- The intrapulmonary bronchus is lined by pseudostratified ciliated columnar epithelium with few goblet cells. Its structure is similar to trachea i.e. it has smooth muscles, cartilage and glands present in its wall
- The bronchiole is lined by simple columnar or cuboidal epithelium surrounded by bundles of smooth muscle cells (see arrow in photomicrograph)
- Bronchioles subdivide and when their diameter is approximately 1 mm or less, they are called terminal bronchiole.
- Arteries are seen near the bronchioles
- Respiratory bronchiole, alveolar duct and atrium are also present
- This slide shows a medium size bronchiole surrounded by alveoli

Key

1. Mesothelium resting on connective tissue
2. Respiratory bronchiole
3. Alveolar duct
4. Atrium
5. Smooth muscle
6. Plates of cartilage
7. Glands

A. Alveoli
B. Bronchus bronchiole

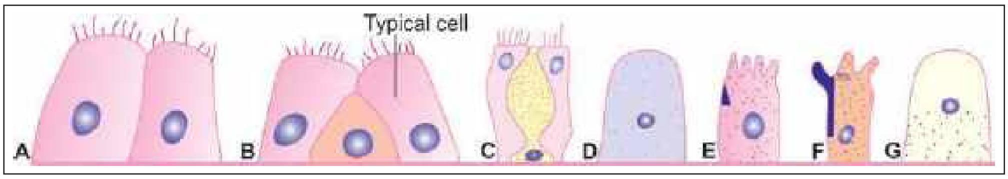


Fig. 14.6: Various types of cells to be seen lining the respiratory passages. A-Typical ciliated columnar, B-Basal, C-Goblet, D-Serous, E-Brush, F-Clara, G-Argyrophil (Schematic representation)

- Goblet cells are numerous. They provide mucous which helps to trap dust entering the passages and is moved by ciliary action towards the larynx and pharynx.
- Non-ciliated serous cells secrete fluid that keeps the epithelium moist.
- Basal cells multiply and transform into other cell types to replace those that are lost.
- Some non-ciliated cells present predominantly in terminal bronchioles (see below) produce a secretion that spreads over the alveolar cells forming a film that reduces surface tension. These include the ***cells of Clara***.
- Cells similar to diffuse endocrine cells of the gut, and containing argyrophil granules are present. They secrete hormones and active peptides including serotonin and bombesin.
- Lymphocytes and other leucocytes may be present in the epithelium. They migrate into the epithelium from surrounding tissues.

The differences between bronchus and bronchioles are given in Table 14.1.

Added Information

Some other functions attributed to cells of Clara include:
- Protection against harmful substances that are inhaled.
- Protection against development of emphysema by opposing the action of substances (proteases) that tend to destroy walls of lung alveoli.
- Stem cell function.

Alveoli

There are about 200 million alveoli in a normal lung. The total area of the alveolar surface of each lung is extensive. It has been estimated to be about 75 square meters. The total capillary surface area available for gaseous exchanges is about 125 square meters.

Structure of Alveolar Wall

Each alveolus has a very thin wall. The wall is lined by an epithelium consisting mainly of flattened squamous cells. The epithelium rests on a basement membrane. Deep to the basement membrane there is a layer of delicate connective tissue through which pulmonary capillaries run. These capillaries have the usual endothelial lining that rests on a basement membrane.

The barrier between air and blood is made up of the epithelial cells and their basement membrane; by endothelial cells and their basement membrane; and by intervening connective tissue. At many places the two basement membranes fuse greatly reducing the thickness of the barrier.

The endothelial cells lining the alveolar capillaries are remarkable for their extreme thinness. With the EM they are seen to have numerous projections extending into the capillary lumen.

Table 14.1: Differences between Bronchus and Bronchiole		
Characteristics	**Bronchus**	**Bronchiole**
Diameter	Larger diameter (more than 1 mm)	Smaller diameter (less than 1 mm)
Lining epithelium	Pseudostratified ciliated columnar epithelium with goblet cells	• Large size bronchioles: simple columnar cells with few cilia and few goblet cells • Small size bronchioles: simple columnar or simple cuboidal cells with no cilia or no goblet cells
Smooth muscle layer	Present between mucosa and cartilage layer	Smooth muscles and elastic fibres form a well-defined layer beneath mucosa
Cartilage	Present in irregular patches	Absent
Glands in submucosa	Both serous and mucous acini present between cartilage and muscle layer	Absent

These projections greatly increase the surface of the cell membrane that is exposed to blood and is, therefore, available for exchange of gases. At many places the basement membrane of the endothelium fuses with that of the alveolar epithelium greatly reducing the thickness of the barrier between blood and air in alveoli.

Pneumocytes

EM studies have shown that the cells forming the lining epithelium of alveoli (***pneumocytes***) are of various types (Fig. 14.7).

- The most numerous cells are the squamous cells already referred to. They are called ***type I alveolar epithelial cells***. Except in the region of the nucleus, these cells are reduced to a very thin layer (0.05 to 0.2 μm). The edges of adjoining cells overlap and are united by tight junctions (preventing leakage of blood from capillaries into the alveolar lumen). They form the lining of 90% of the alveolar surface.
- Scattered in the epithelial lining there are rounded secretory cells bearing microvilli on their free surfaces. These are designated ***type II alveolar epithelial cells*** (Figs 14.7 and 14.8). Their cytoplasm contains secretory granules that appear to be made up of several layers (and are, therefore, called ***multilamellar bodies***). These cells are believed to produce a secretion that forms a film over the alveolar epithelium. This film or ***pulmonary surfactant*** reduces surface tension

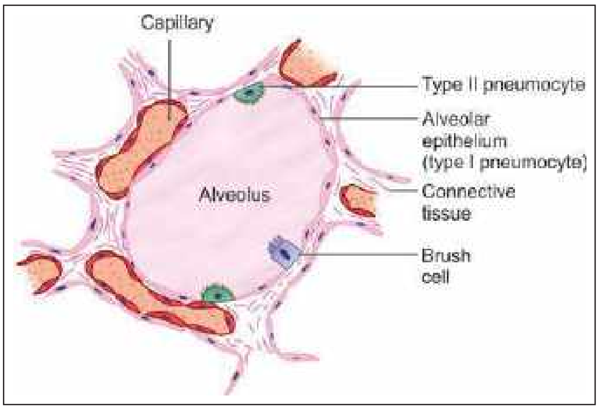
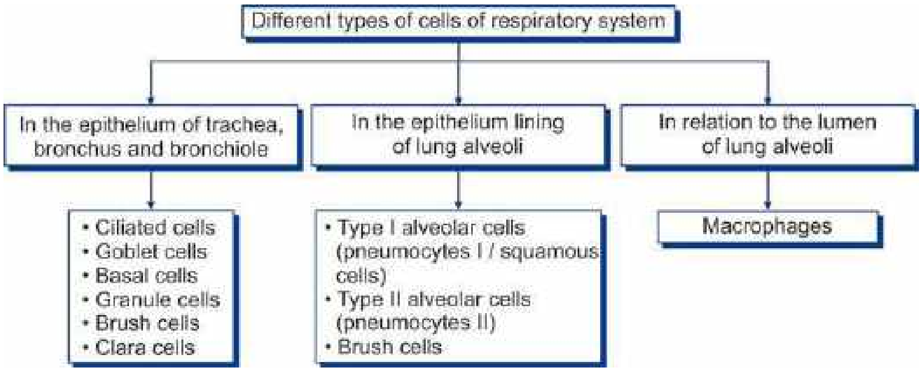


Fig. 14.7: Some cells to be seen in relation to an alveolus (Schematic representation)

Flow chart 14.1: Different types of cells of respiratory system



and prevents collapse of the alveolus during expiration.

Surfactant contains phospholipids, proteins and glycosaminoglycans produced in type II cells (A similar fluid is believed to be produced by the cells of Clara present in bronchial passages).

Type II cells may multiply to replace damaged type I cells.

- ***Type III alveolar cells***, or ***brush cells***, of doubtful function, have also been described.

Different types of cells present in the respiratory system are summarised in Flow chart 14.1.

Connective Tissue

The connective tissue in the wall of the alveolus contains collagen fibres and numerous elastic fibres continuous with those of bronchioles. Fibroblasts, histiocytes, mast cells, lymphocytes and plasma cells may be present. Pericytes are present in relation to capillaries.

Some macrophages enter the connective tissue from blood and pass through the alveolar epithelium to reach its luminal surface. Dust particles phagocytosed by them are seen in their cytoplasm. They are therefore called ***dust cells***. These dust cells are expelled to the outside through the respiratory passages. In congestive heart failure (in which pulmonary

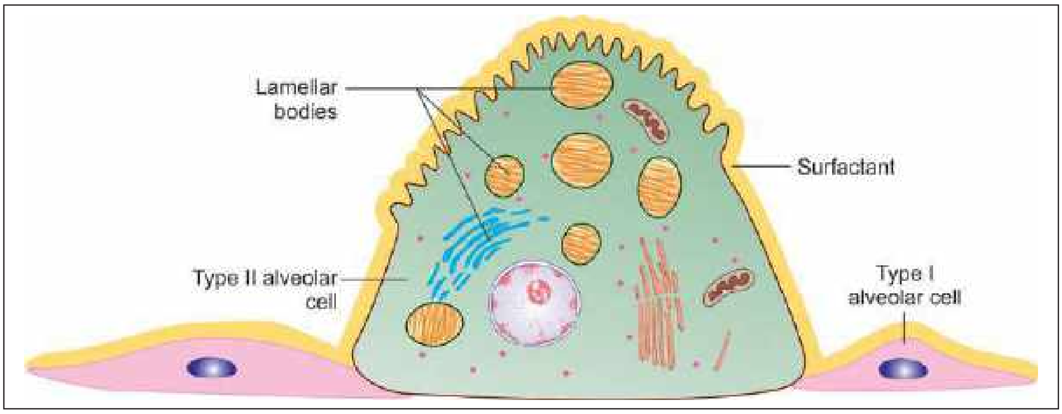


Fig. 14.8: Type II pneumocytes (Schematic representation)

capillaries become overloaded with blood) these macrophages phagocytose erythrocytes that escape from capillaries. The cells, therefore, acquire a brick red colour and are then called ***heart failure cells***. Macrophages also remove excessive surfactant, and secrete several enzymes.

Connective Tissue Basis of the Lung

The greater part of the surface of the lung is covered by a serous membrane, the visceral pleura. This membrane consists of a layer of flattened mesothelial cells, supported on a layer of connective tissue.

Deep to the pleura there is a layer of subserous connective tissue. This connective tissue extends into the lung substance along bronchi and their accompanying blood vessels, and divides the lung into lobules. Each lobule has a lobular bronchiole and its ramifications, blood vessels, lymphatics and nerves.

The epithelial lining of air passages is supported by a basal lamina deep to which there is the connective tissue of the lamina propria. Both in the basal lamina and in the lamina propria there are numerous elastic fibres. These fibres run along the length of respiratory passages and ultimately become continuous with elastic fibres present in the walls of air sacs. This elastic tissue plays a very important role by providing the physical basis for elastic recoil of lung tissue. This recoil is an important factor in expelling air from the lungs during expiration. Elastic fibres passing between lung parenchyma and pleura prevent collapse of alveoli and small bronchi during expiration.

Pleura

The pleura is lined by flat mesothelial cells that are supported by loose connective tissue rich in elastic fibres, blood vessels, nerves and lymphatics. There is considerable adipose tissue under parietal pleura.

Blood Supply of Lungs

The lungs receive deoxygenated blood from the right ventricle of the heart through pulmonary arteries. Within the lung the arteries end in an extensive capillary network in the walls of alveoli. Blood oxygenated here is returned to the left atrium of the heart through pulmonary veins.

Oxygenated blood required for nutrition of the lung itself reaches the lungs through bronchial arteries. They are distributed to the walls of bronchi as far as the respiratory bronchioles. Blood reaching the lung through these arteries is returned to the heart partly through bronchial veins, and partly through the pulmonary veins.

Plexuses of lymph vessels are present just deep to the pleura and in the walls of bronchi.

Nerve Supply of Lungs

The lungs receive autonomic nerves, both sympathetic and parasympathetic, and including both afferent and efferent fibres. Efferent fibres supply the bronchial musculature. Vagal stimulation produces bronchoconstriction. Efferent fibres also innervate bronchial glands. Afferent fibres are distributed to the walls of bronchi and of alveoli. Afferent impulses from the lungs play an important role in control of respiration through respiratory reflexes.

Clinical Correlation

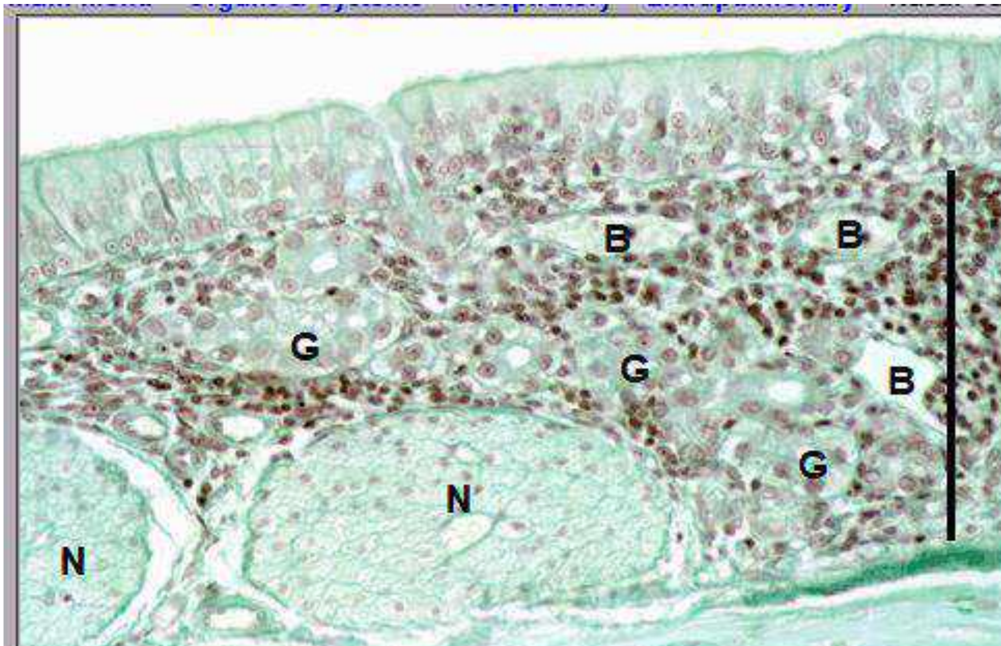
- **Acute respiratory distress syndrome (ARDS)** is a severe, at times life-threatening, form of progressive respiratory insufficiency which involves pulmonary tissues diffusely, i.e. involvement of the alveolar epithelium, alveolar lumina and interstitial tissue. ARDS exists in 2 forms: neonatal and adult type. Both have the common morphological feature of formation of hyaline membrane in the alveoli, and hence, is also termed as hyaline membrane disease (HMD).
- **Bacterial pneumonia:** Bacterial infection of the lung parenchyma is the most common cause of pneumonia or consolidation of one or both the lungs. Two types of acute bacterial pneumonias are distinguished—lobar pneumonia and broncho-(lobular-) pneumonia, each with distinct aetiologic agent and morphologic changes.
- **Chronic bronchitis** is a common condition defined clinically as persistent cough with expectoration on most days for at least three months of the year for two or more consecutive years. The cough is caused by oversecretion of mucous. In spite of its name, chronic inflammation of the bronchi is not a prominent feature. The condition is more common in middle-aged males than females.
- **Asthma** is a disease of airways that is characterised by increased responsiveness of the tracheobronchial tree to a variety of stimuli resulting in widespread spasmodic narrowing of the air passages which may be relieved spontaneously or by therapy. Asthma is an episodic disease manifested clinically by paroxysms of dyspnoea, cough and wheezing. However, a severe and unremitting form of the disease termed status asthmaticus may prove fatal.
- **Immotile cilia syndrome** that includes Kartagener's syndrome (bronchiectasis, situs inversus and sinusitis) is characterised by ultrastructural changes in the microtubules causing immotility of cilia of the respiratory tract epithelium, sperms and other cells. Males in this syndrome are often infertile.

2 of 6

The epithelium lining most of the nasal cavities is a thin, respiratory epithelium: pseudostratified columnar epithelium (bar) with cilia (arrows) and goblet cells (which are not readily visible here, probably because this is fetal tissue and these cells are not functional yet).

click to identify:

› Pseudostratified › columnar epithelium
CT ›
Bone ›



2 of 6

Because the nasal cavity lacks a muscularis mucosae, the connective tissue (bar) beneath the epithelium is a combination of lamina propria in continuity with submucosa. Numerous glands (G) (mixed glands, when functional after birth) are seen, as are numerous blood vessels (B) to moderate air temperature. Sensory, peripheral nerves (N) also traverse this layer.

click to identify:

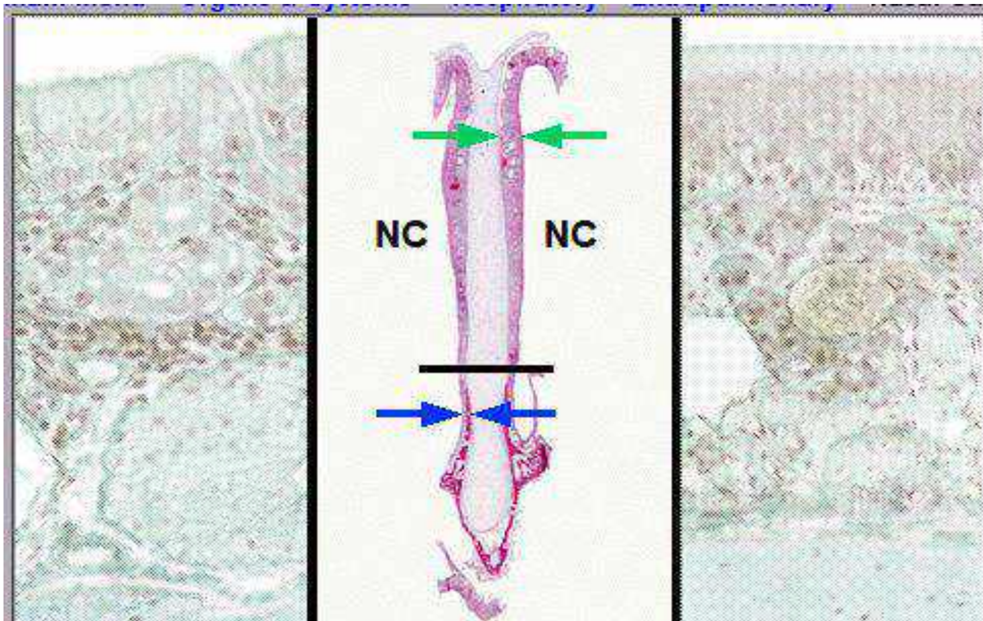
Pseudostratified › columnar epithelium
› CT ›
Bone ›

click to identify:

Pseudostratified > columnar epithelium
CT >
> Bone >

2 of 6

All the extra-pulmonary structures of the respiratory system are supported by either bone or cartilage to maintain patency. In the nasal cavity both cartilage and bone are present in different locations to keep this passageway open.

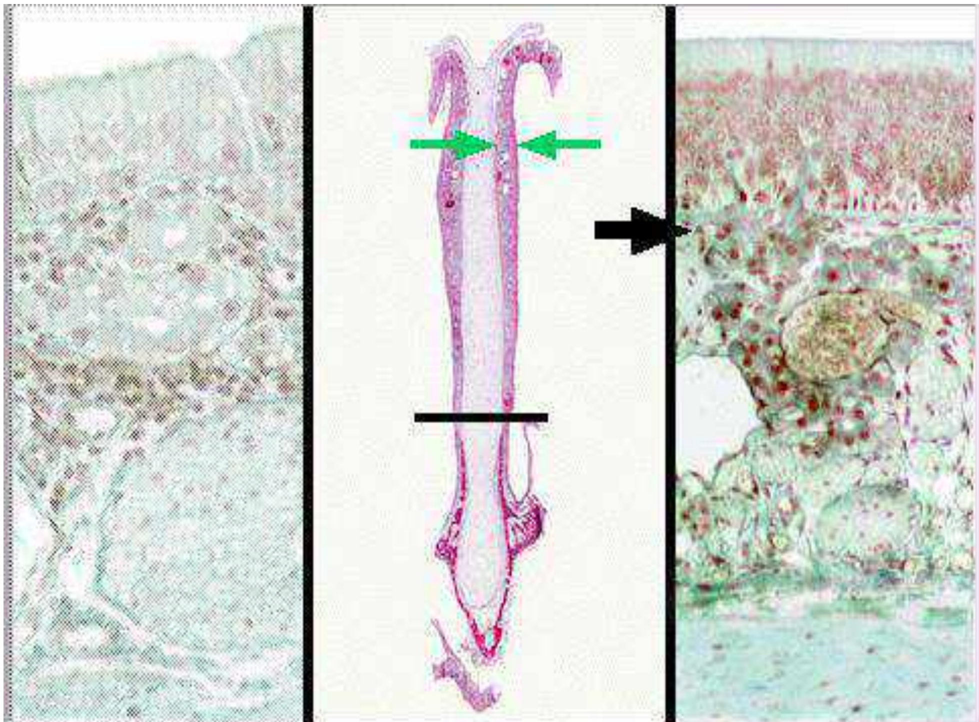


click to identify:

> Nasal septum >
Respiratory > mucosa
Olfactory > mucosa
Cartilage / bone >

3 of 6

The nasal septum separates the two nasal cavities (nasal fossae, NC). Cartilage forms the central frame of this fetal septum. Note that the olfactory mucosa (green arrows) above the horizontal bar is much thicker than the respiratory mucosa (blue arrows) below the bar.

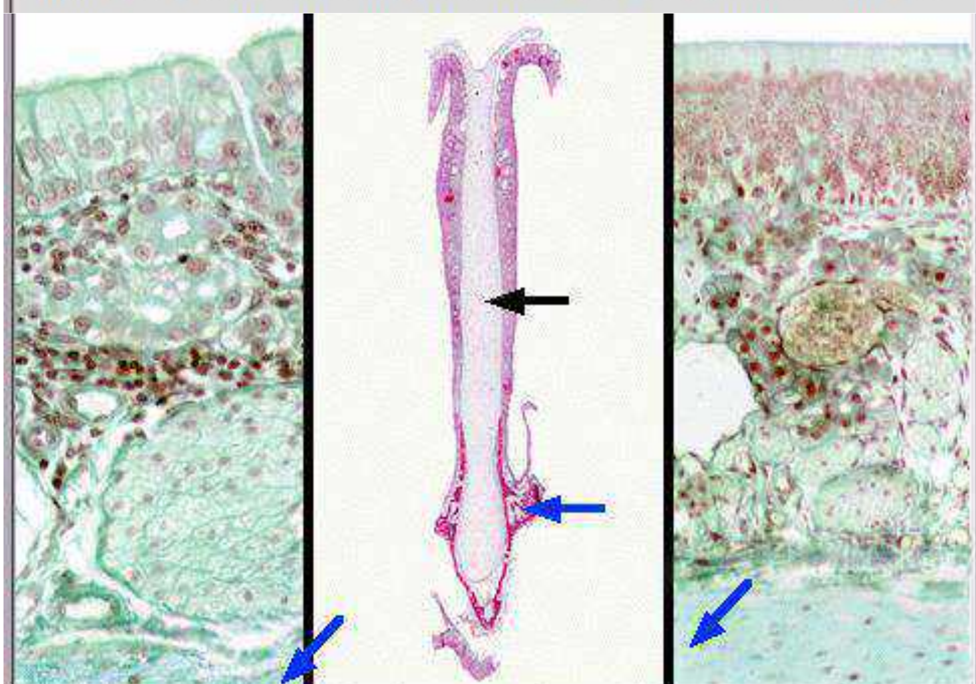


3 of 6

The thicker olfactory mucosa, above the bar, lines the superior portion of the septum and is seen at higher magnification on the right and in the next image.

click to identify:

Nasal septum >
Respiratory > mucosa
> Olfactory > mucosa
Cartilage / bone >

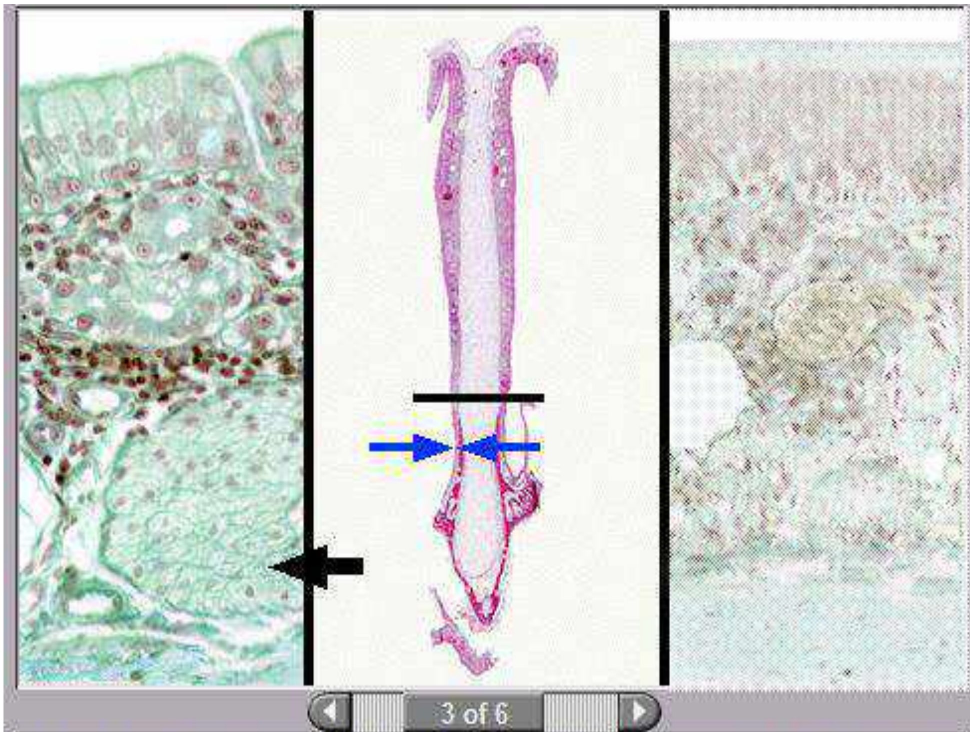


3 of 6

Cartilage (black arrow) forms the framework for the septum at this stage of fetal development. Bone (blue arrows) is already being deposited along the inferior border of the septum and will replace the cartilage over time.

click to identify:

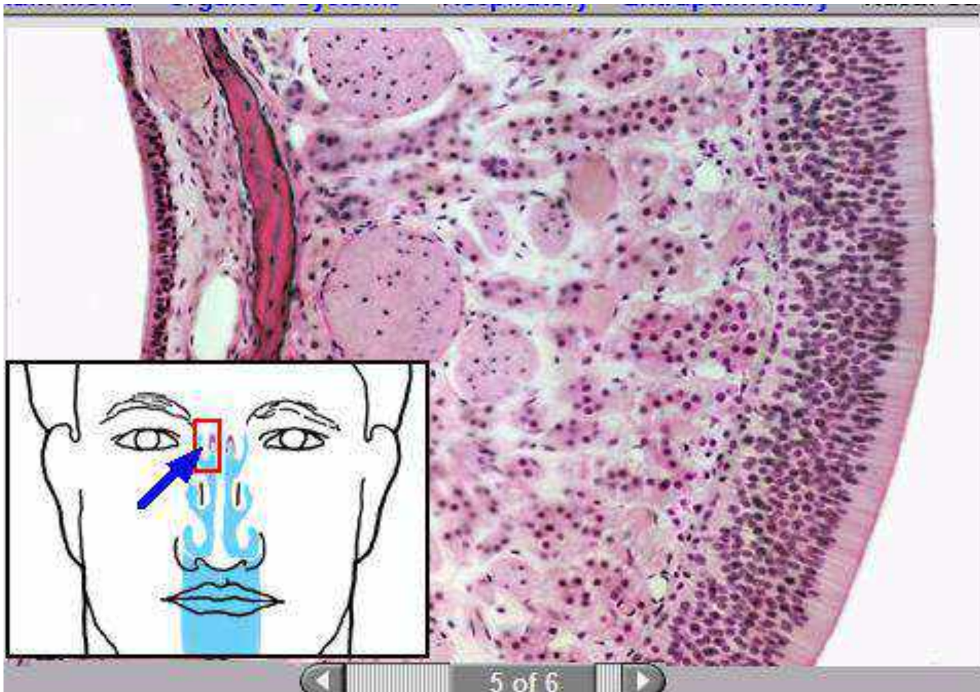
Nasal septum >
Respiratory > mucosa
Olfactory > mucosa
> Cartilage / bone >



Respiratory mucosa, lining the nasal septum below the bar, is seen at higher magnification on the left and in the previous image.

click to identify:

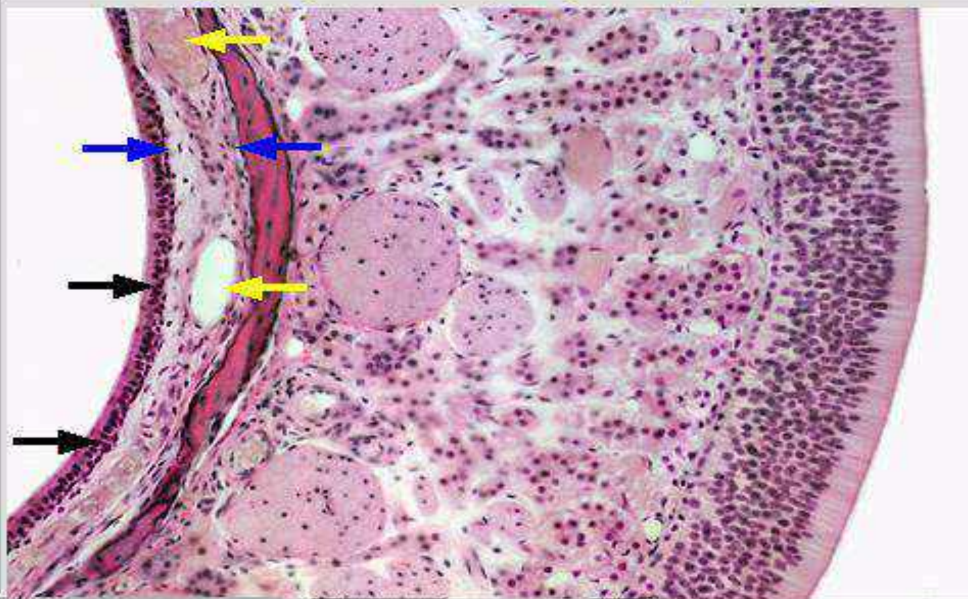
Nasal septum >
> Respiratory > mucosa
Olfactory > mucosa
Cartilage / bone >



The outline in the inset shows the location from which this section was taken, including the superior concha (arrow) extending into the superior region of the nasal cavity. The location of the olfactory epithelium covering the medial surface of this concha is colored purple; non-olfactory epithelium lines the lateral surface of the concha.

click to identify:

> Orientation >
Respiratory > mucosa
Ethmoid bone >
Olfactory > mucosa
Bowman's glands
Sensory nerves

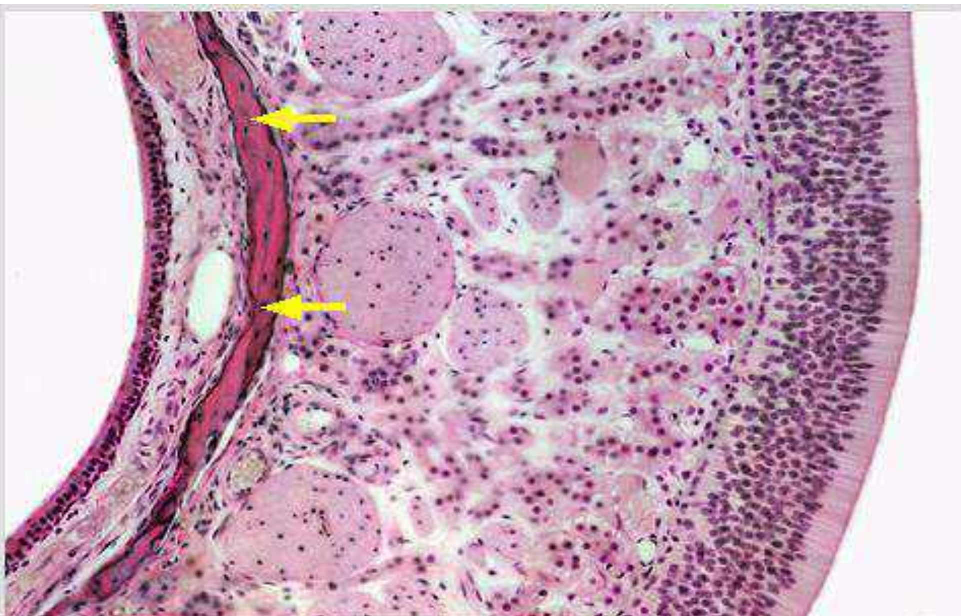


5 of 6

Respiratory mucosa lines the non-olfactory region of the nasal fossae, represented here by the lateral surface of a superior concha. This mucosa possesses a pseudostratified columnar epithelium (black arrows) with cilia and goblet cells. The underlying connective tissue (between blue arrows) is rich in blood vessels (yellow arrows) to moderate air temperature.

click to identify:

- Orientation >
- Respiratory > mucosa
- Ethmoid bone >
- Olfactory > mucosa
- Bowman's glands
- Sensory nerves

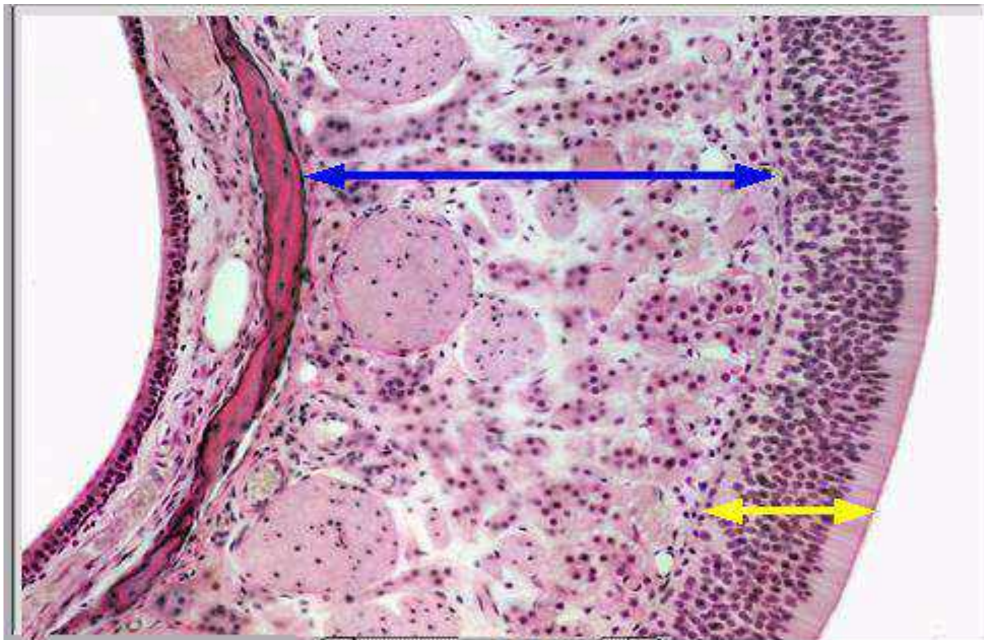


5 of 6

An extension of the ethmoid bone, the superior concha, provides internal support.

click to identify:

- Orientation >
- Respiratory > mucosa
- Ethmoid bone >
- Olfactory > mucosa
- Bowman's glands
- Sensory nerves

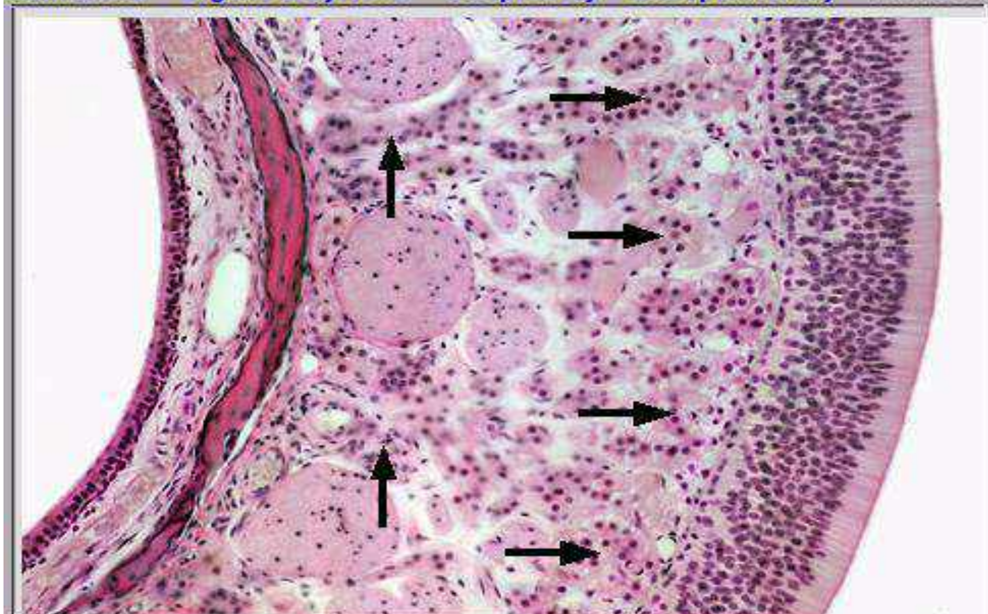


5 of 6

Olfactory mucosa lines the medial surface of the superior concha. Its epithelium, pseudostratified columnar with cilia (yellow arrow), is markedly thicker than that of respiratory mucosa. The underlying connective tissue (blue arrow) is also thicker, filled with serous-secreting Bowman's glands and cranial sensory nerves supplying both general and special sensations.

click to identify:

- Orientation >
- Respiratory > mucosa
- Ethmoid bone >
- › Olfactory > mucosa
- Bowman's glands
- Sensory nerves



5 of 6

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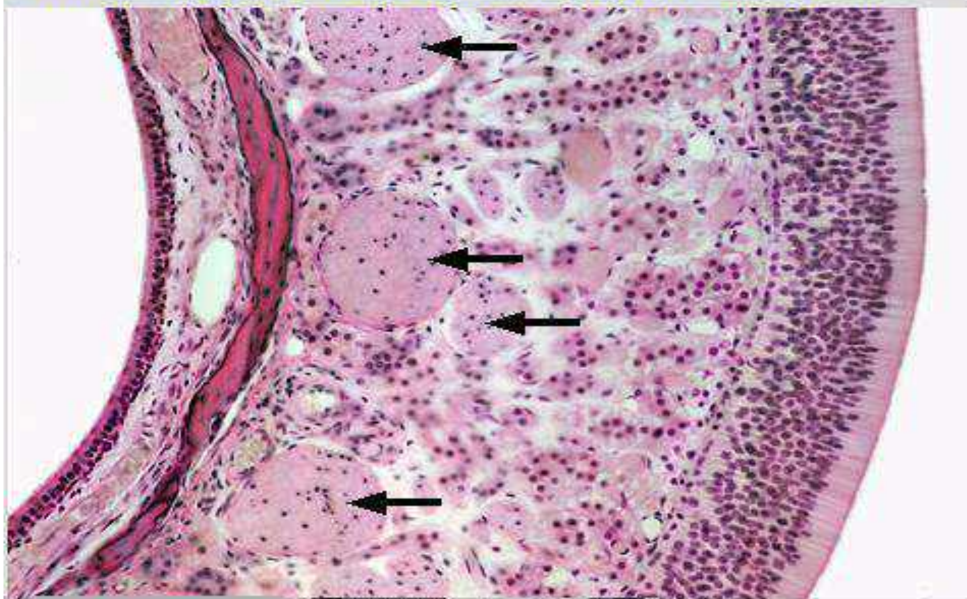
click to identify:

- Orientation >
- Respiratory > mucosa
- Ethmoid bone >
- Olfactory > mucosa
- › Bowman's glands
- Sensory nerves



click to identify:

- Orientation >
- Respiratory > mucosa
- Ethmoid bone >
- Olfactory > mucosa
- Bowman's glands
- Sensory nerves

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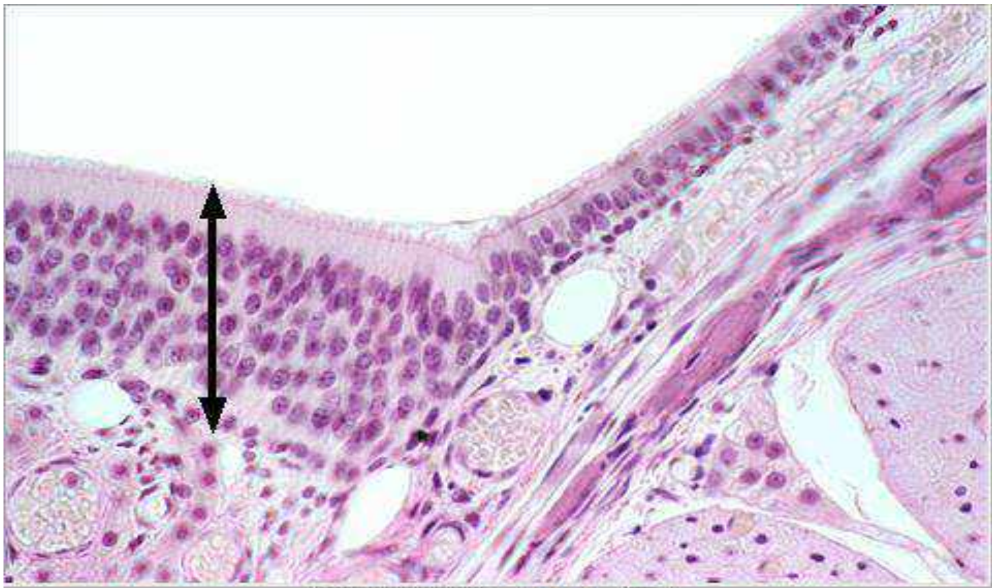
Main Menu > Organs & Systems > Respiratory > Extrapulmonary > Nasal cavity

click to identify:

- Respiratory epithelium
- Olfactory epithelium
- Blood vessels
- Bone
- Basal bodies

Nasal cavity -- This particular section shows the junction of respiratory with olfactory epithelia, demonstrating the difference in their thicknesses. Numerous blood vessels are present to moderate air temperature. The superior concha of the ethmoid bone provides support. 400x



click to identify:

Respiratory epithelium
› Olfactory epithelium
Blood vessels
Bone
Basal bodies

6 of 6

Nasal cavity -- This particular section shows the junction of respiratory with olfactory epithelia, demonstrating the difference in their thicknesses. Numerous blood vessels are present to moderate air temperature. The superior concha of the ethmoid bone provides support. 400x

click to identify:

Respiratory epithelium
Olfactory epithelium
Blood vessels
› Bone
Basal bodies

6 of 6

Nasal cavity -- This particular section shows the junction of respiratory with olfactory epithelia, demonstrating the difference in their thicknesses. Numerous blood vessels are present to moderate air temperature. The superior concha of the ethmoid bone provides support. 400x

6 of 6

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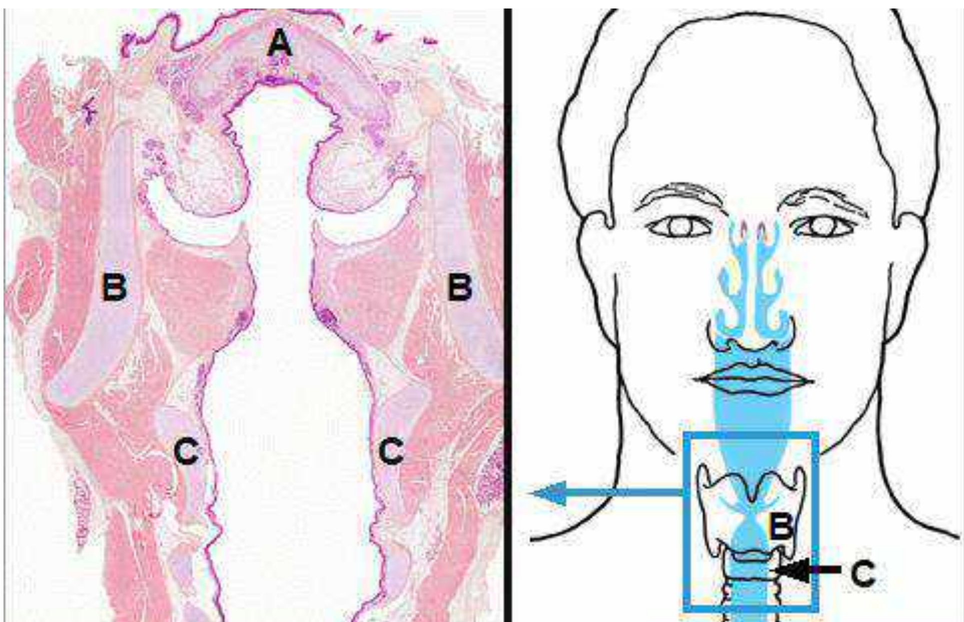
click to identify:

- Respiratory epithelium
- Olfactory epithelium
- Blood vessels
- Bone
- Basal bodies

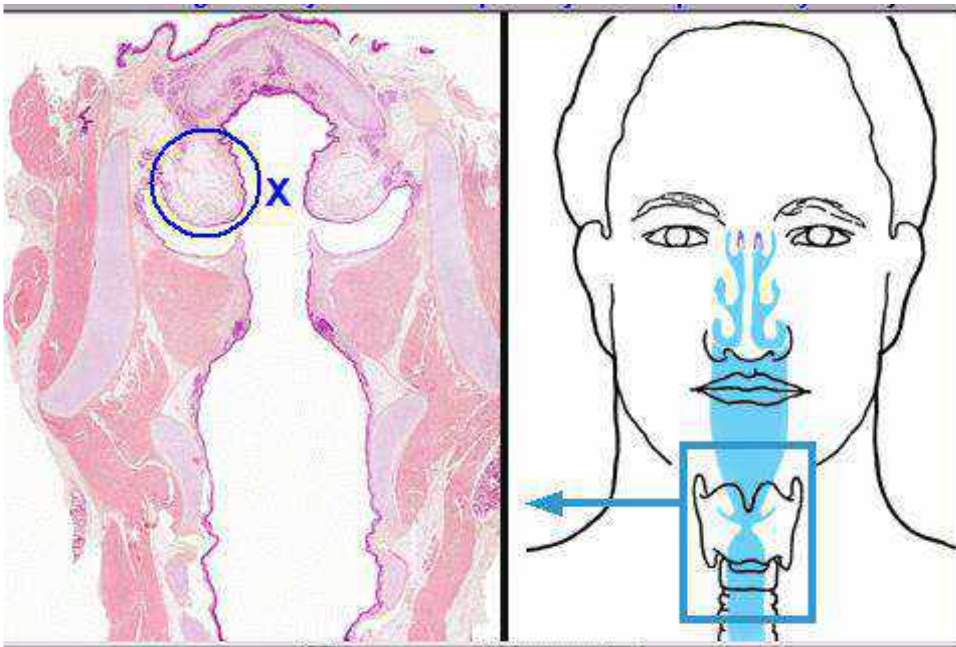


1 of 2

Cartilagenous support for the larynx is provided by three large cartilages and multiple smaller ones (not seen here). The epiglottis (A, elastic cartilage) guards the entrance to the larynx. The large thyroid cartilage (B, hyaline) protects the anterior and lateral sides, and the cricoid (C) cartilage (hyaline) encircles the larynx, providing the major posterior support.

click to identify:

- Cartilages >
- False vocal fold >
- Ventricle >
- True vocal folds >
- Epithelium >
- Trachea >

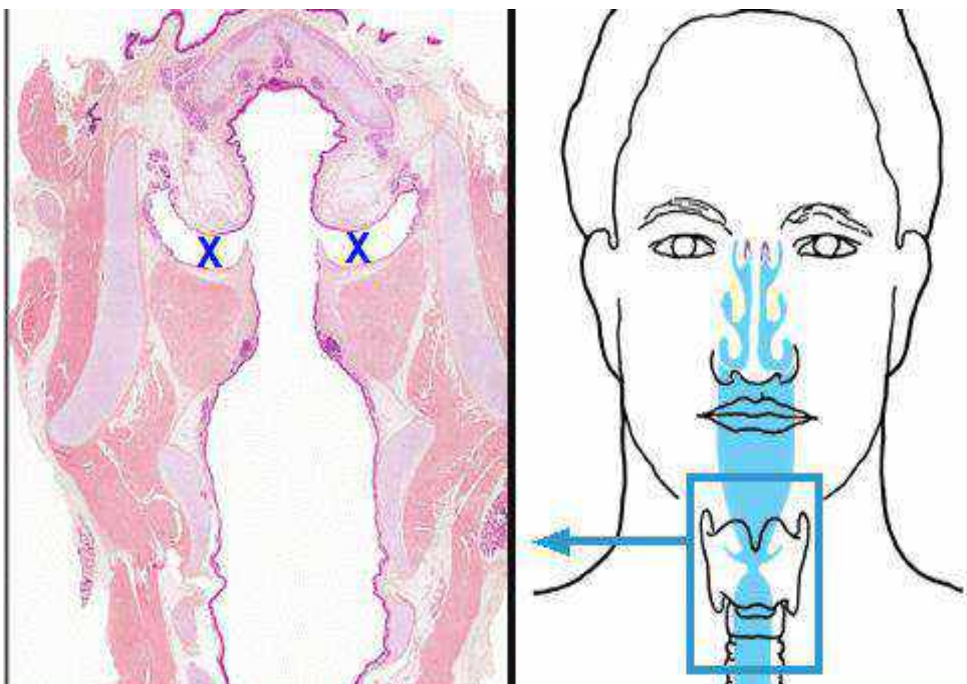


1 of 2

The paired false vocal folds lie superior to the true vocal folds. The false folds are covered by pseudostratified columnar epithelium overlying a connective tissue containing adipose tissue and mixed, mucoserous glands. The vestibule (X) separates the two false vocal folds.

click to identify:

- Cartilages >
- › False vocal fold >
- Ventricle >
- True vocal folds >
- Epithelium >
- Trachea >

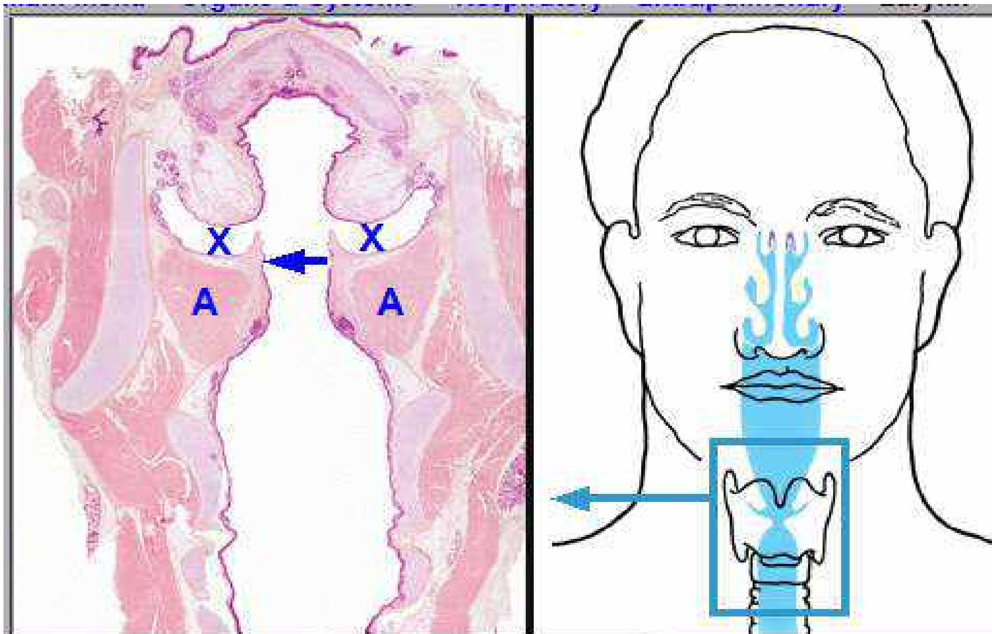


1 of 2

The space beneath the false vocal folds is the ventricle, separating the false and true vocal folds.

click to identify:

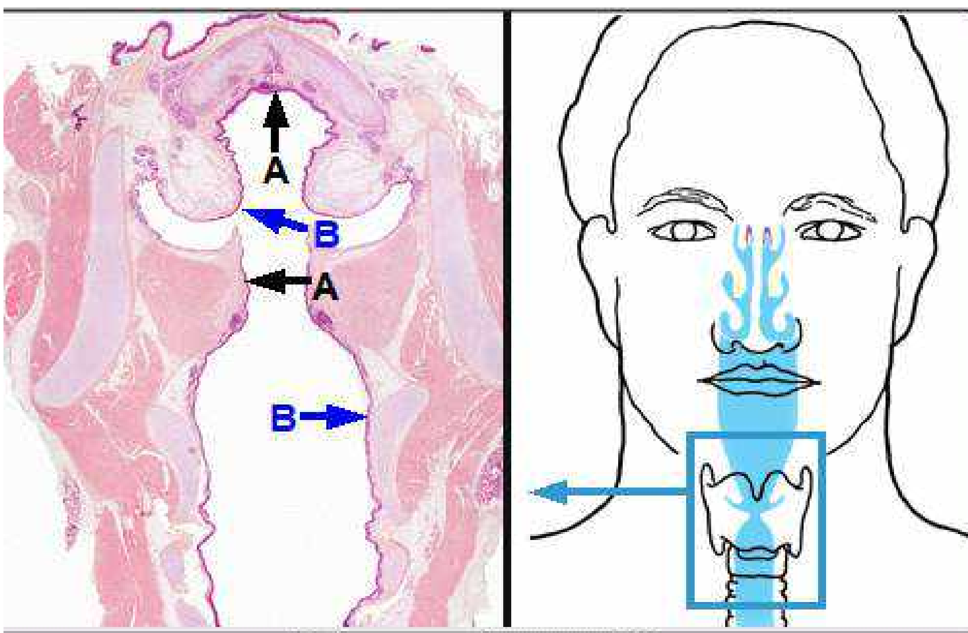
- Cartilages >
- False vocal fold >
- › Ventricle >
- True vocal folds >
- Epithelium >
- Trachea >



click to identify:

Cartilages >
False vocal fold >
Ventricle >
True vocal folds >
Epithelium >
Trachea >

Each true vocal fold houses a vocalis muscle (A, skeletal) that alters the length of the fold. The vocal ligament (dense regular elastic connective tissue) maintains tautness in the edge of the fold but cannot be differentiated from collagen with this H and E stain. Stratified squamous moist epithelium (arrow) covers the fold. The ventricle (X) lies between the two folds.



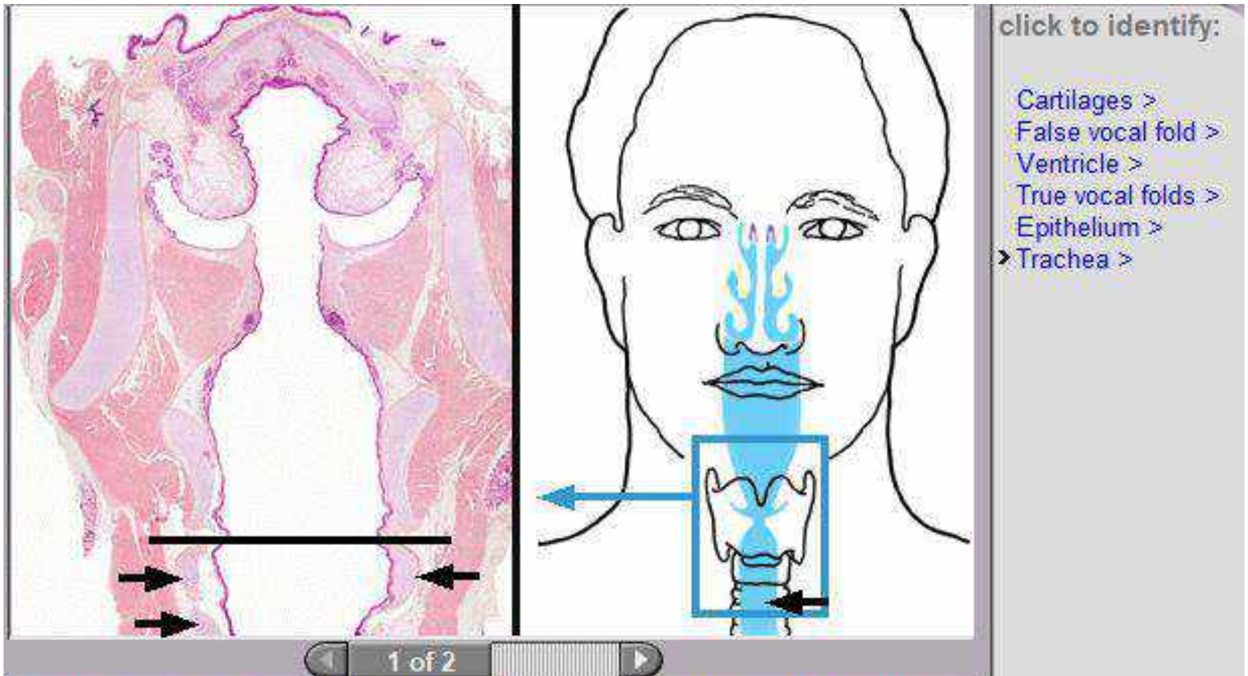
click to identify:

Cartilages >
False vocal fold >
Ventricle >
True vocal folds >
Epithelium >
Trachea >

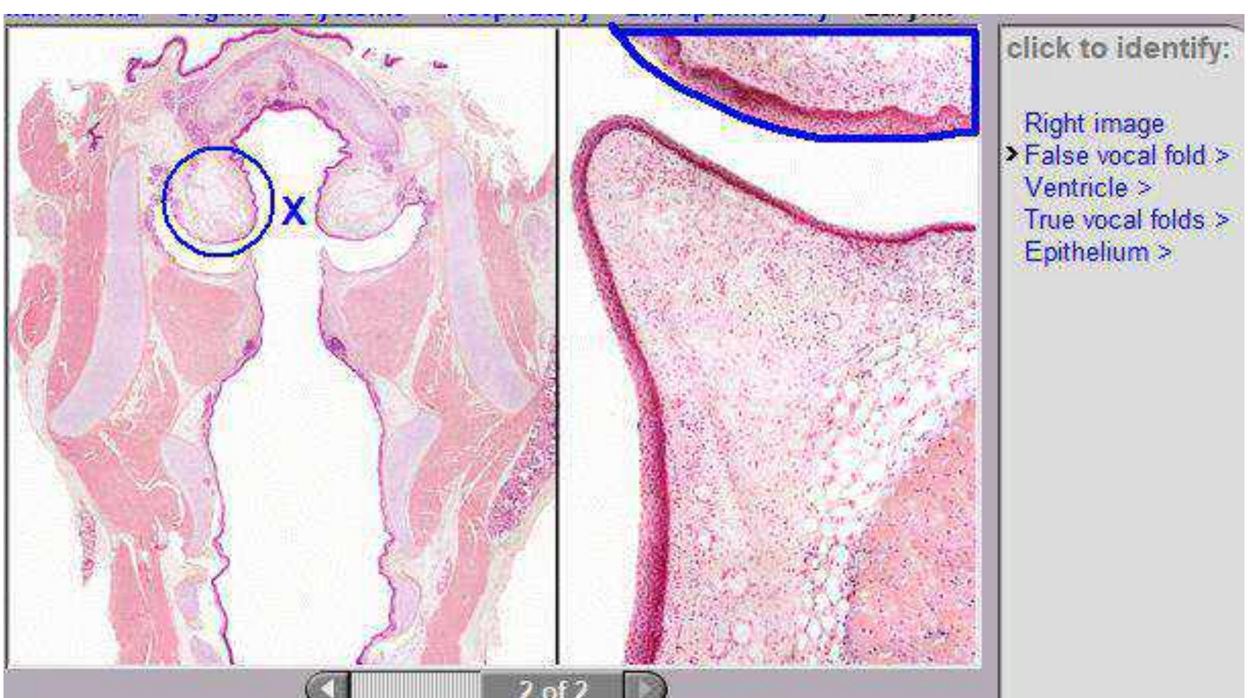
1 of 2

Laryngeal epithelium varies depending on the stress it undergoes. Stratified squamous moist epithelium (A) normally lines the epiglottis and the true vocal folds, areas that undergo continual stress. Respiratory epithelium (B), lining the remainder of the larynx, may be converted to stratified squamous moist in cases of irritation, such as in the larynx of a smoker.

0



The trachea (below line) begins at the inferior border of the larynx just beneath the cricoid cartilage. The patency of the trachea is maintained by C-shaped, hyaline-cartilage rings (arrows).



The paired false vocal folds lie superior to the true vocal folds. The false folds are covered by pseudostratified columnar epithelium overlying a connective tissue layer containing adipose tissue and mixed, mucoserous glands. A muscularis mucosae is lacking. The vestibule (X) separates the two false vocal folds.

click to identify:

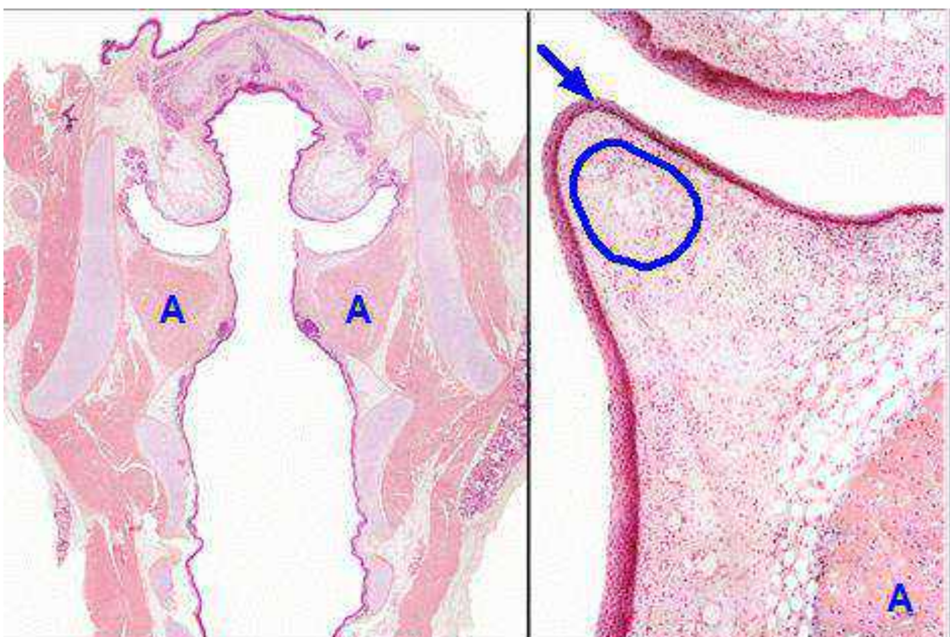
Right image
False vocal fold >
Ventricle >
True vocal folds >
Epithelium >

2 of 2

The space beneath the false vocal folds is the ventricle, separating the false and true vocal folds.

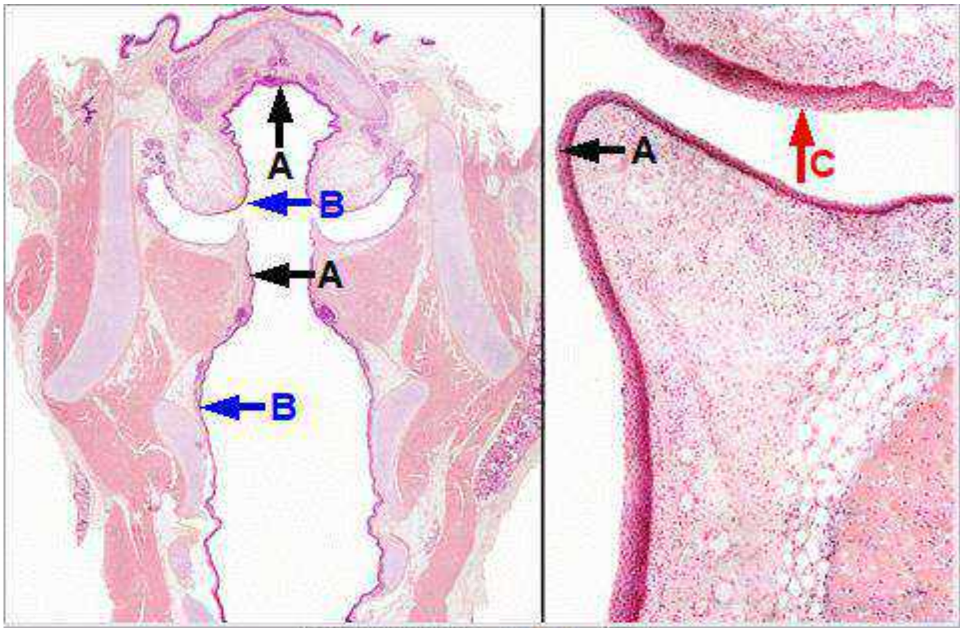
click to identify:

Right image
False vocal fold >
Ventricle >
True vocal folds >
Epithelium >



2 of 2

ach true vocal fold houses a vocalis muscle (A, skeletal) that alters the length f the fold. The vocal ligament (circle, dense regular elastic connective tissue) naintains tautness, but is hard to distinguish because elastic fibers stain imilarly to collagen with H and E. Stratified squamous moist epithelium (blue rrow) covers the fold; a muscularis mucosae is lacking.



click to identify:

Right image
False vocal fold >
Ventricle >
True vocal folds >
Epithelium >

2 of 2

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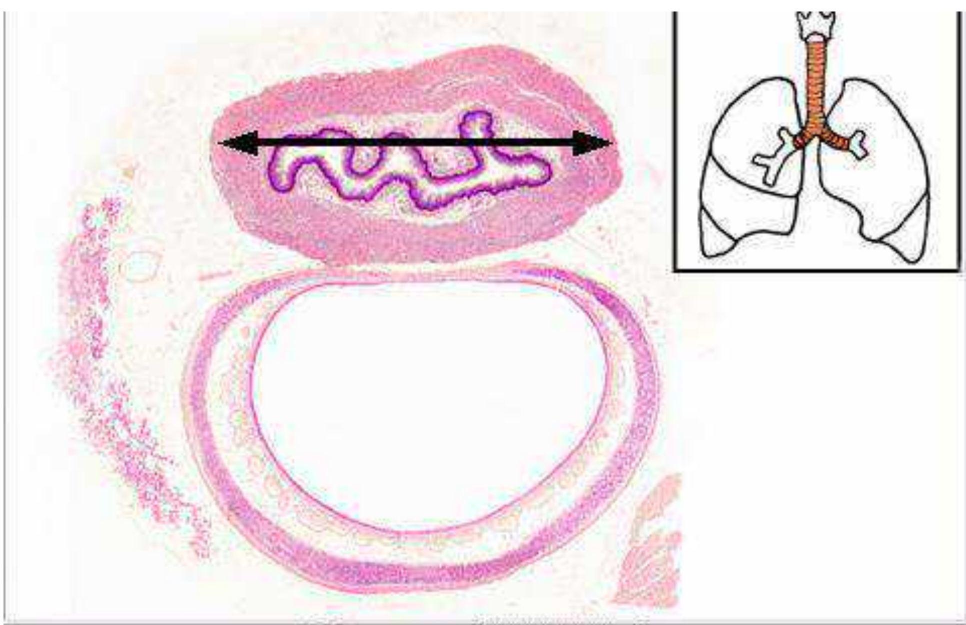
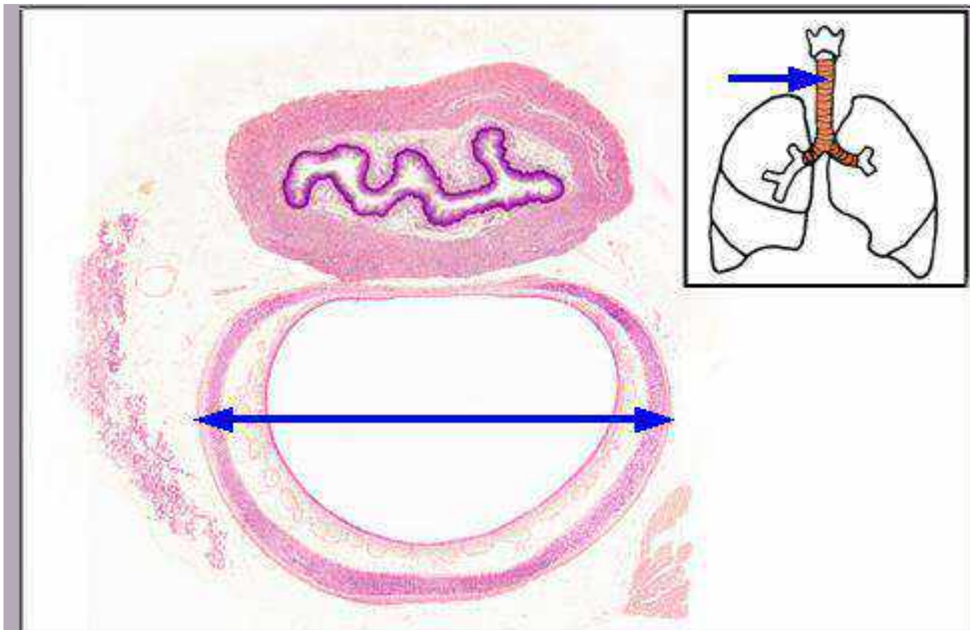


Esophagus
Trachea
Primary bronchi
Cartilage ring
Cartilage ring opening
Next image

1 of 9

Trachea -- The trachea and primary bronchi are extrapulmonary and part of the conducting portion of the system. The trachea, continuing inferiorly from the larynx, lies anterior to the esophagus. The patency of these respiratory organs is maintained by C-shaped cartilage rings, whose openings face the esophagus. These passageways cannot be distinguished from each other histologically. 10x



1 of 9

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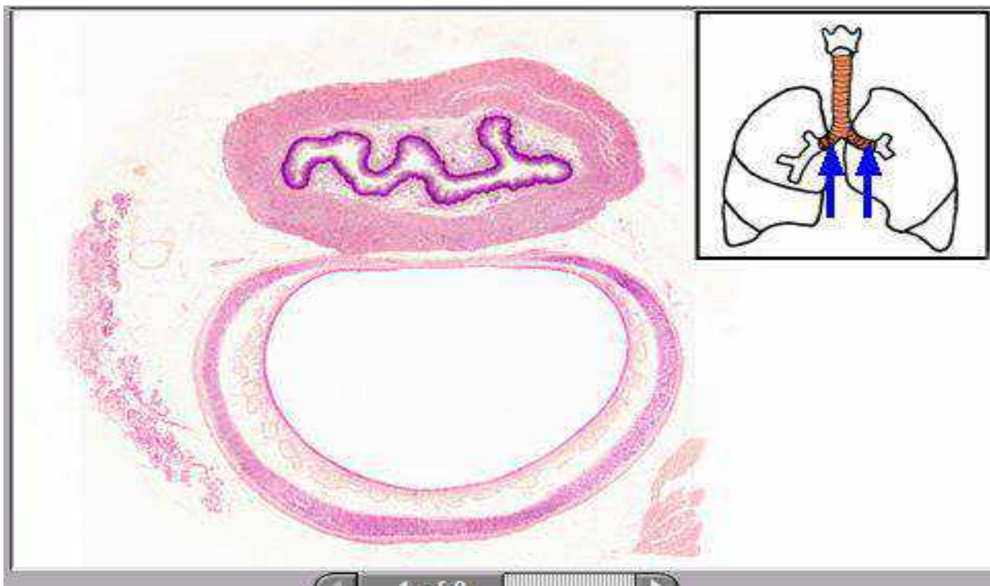
click to identify:

- Esophagus
- › Trachea
- Primary bronchi
- Cartilage ring
- Cartilage ring opening
- Next image



1 of 9

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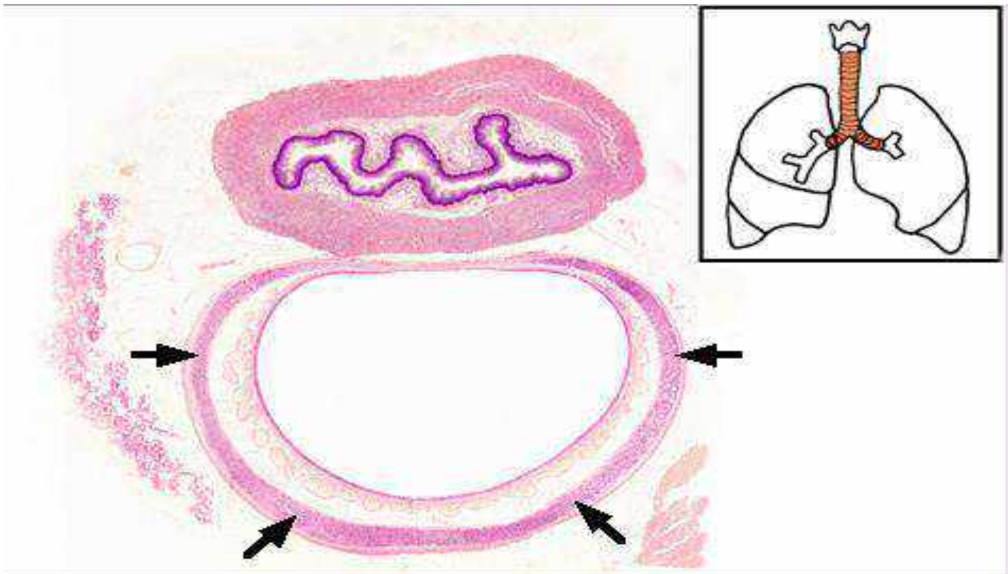
click to identify:

- Esophagus
- Trachea
- › Primary bronchi
- Cartilage ring
- Cartilage ring opening
- Next image



click to identify

Esophagus
Trachea
Primary bronchi
› Cartilage ring
Cartilage ring opening
Next image

1 of 9

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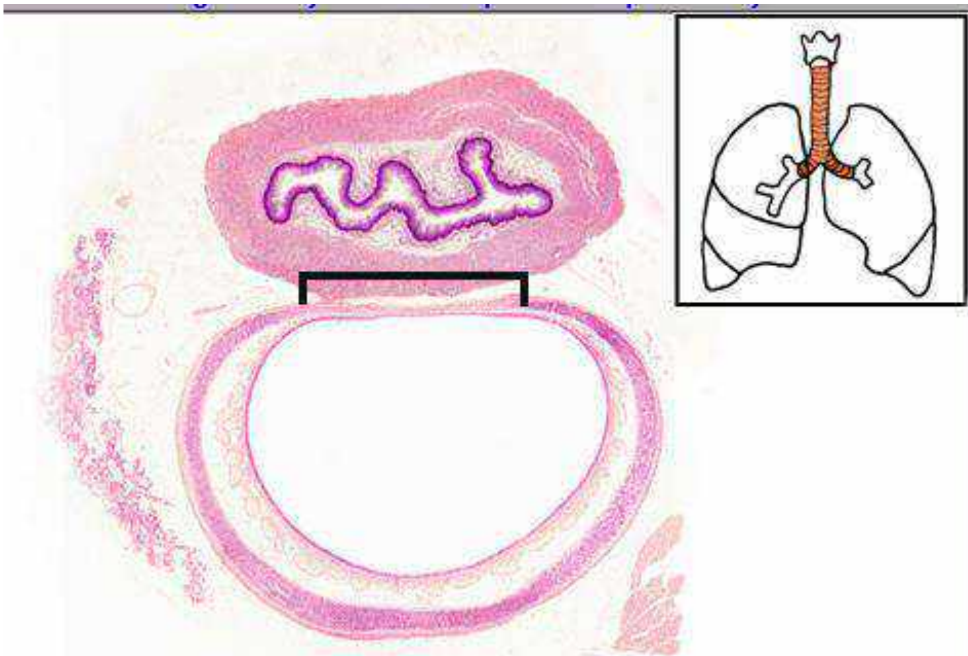

click to identify:

Esophagus
Trachea
Primary bronchi
Cartilage ring
› Cartilage ring opening
Next image

1 of 9

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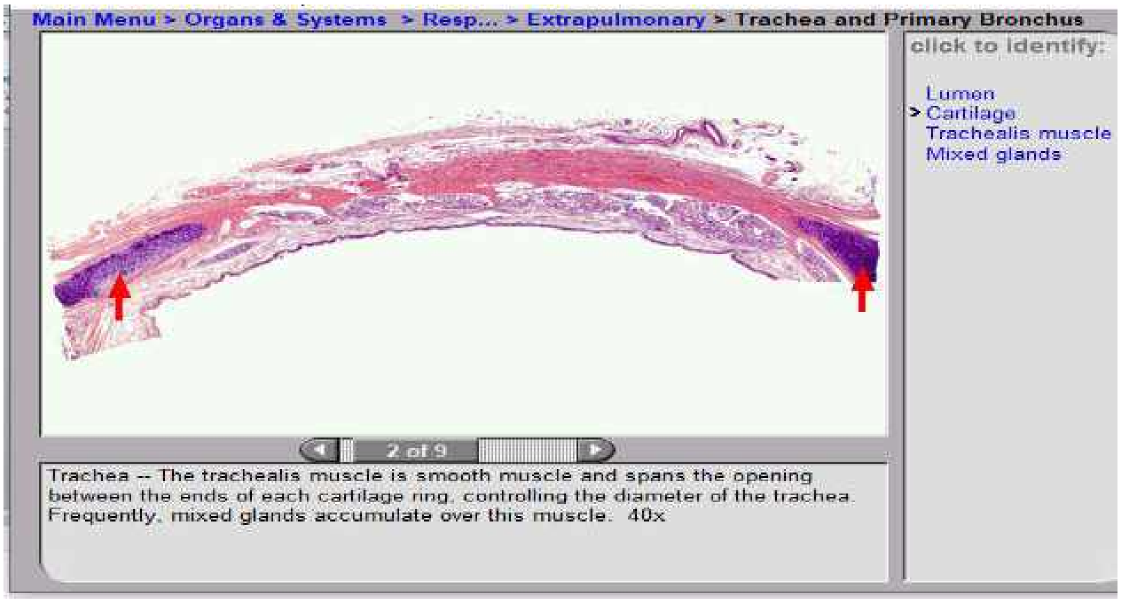
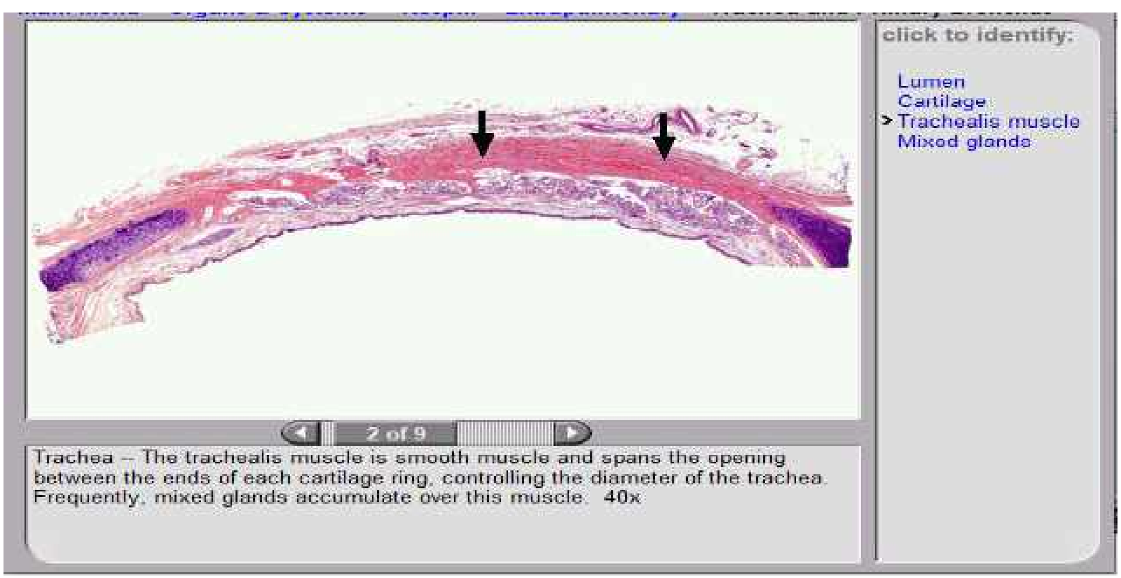

Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
Lumen
> Cartilage
Trachealis muscle
Mixed glands
2 of 9
Trachea -- The trachealis muscle is smooth muscle and spans the opening between the ends of each cartilage ring, controlling the diameter of the trachea. Frequently, mixed glands accumulate over this muscle. 40x


click to identify:
Lumen
Cartilage
> Trachealis muscle
Mixed glands
2 of 9
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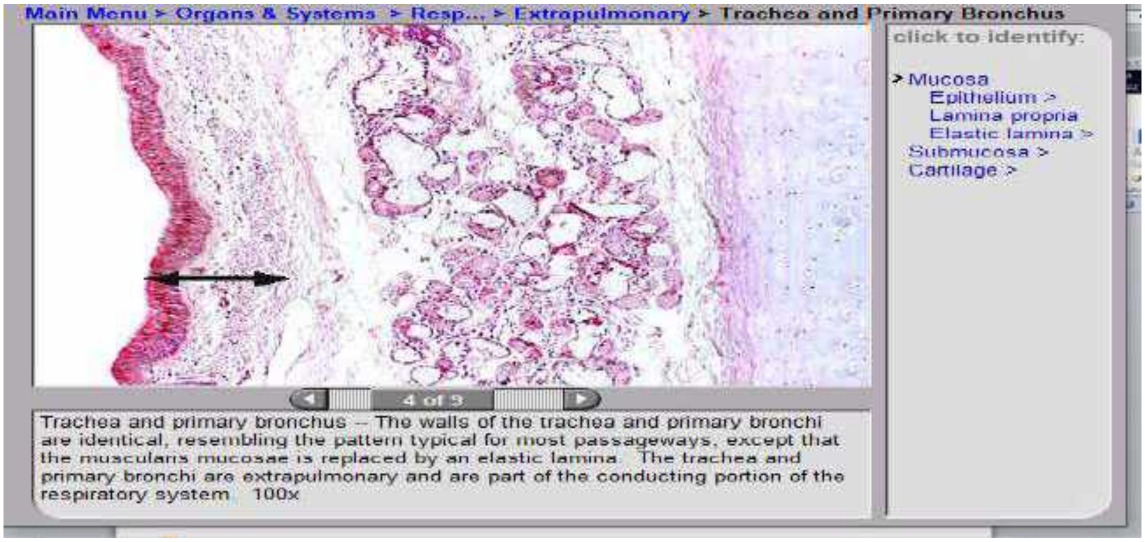
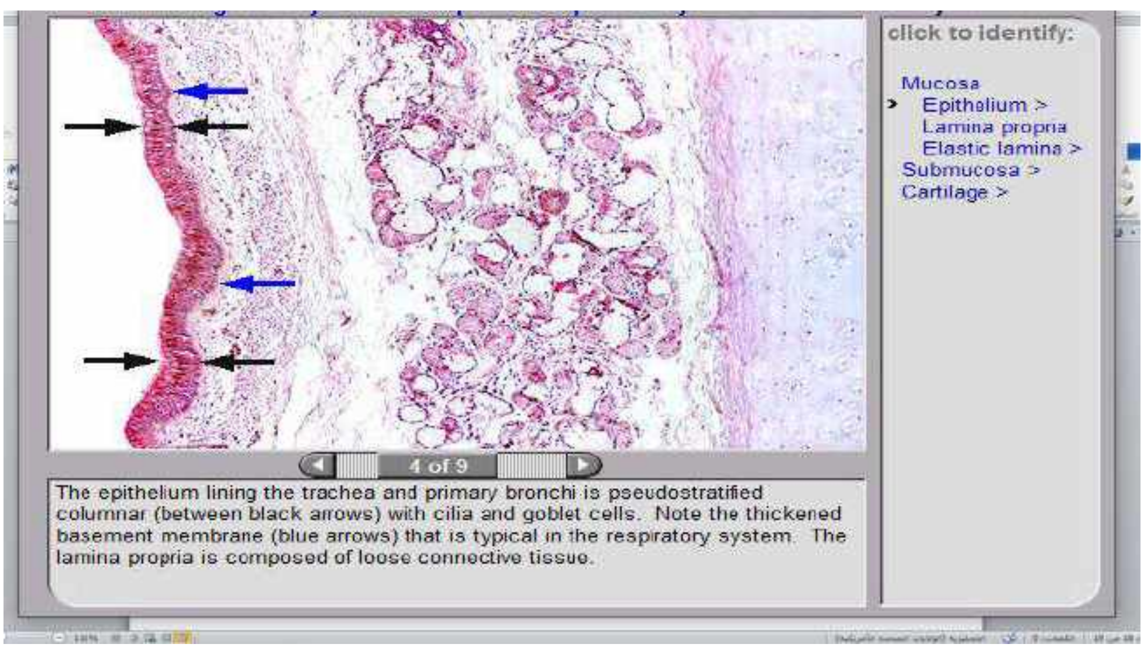
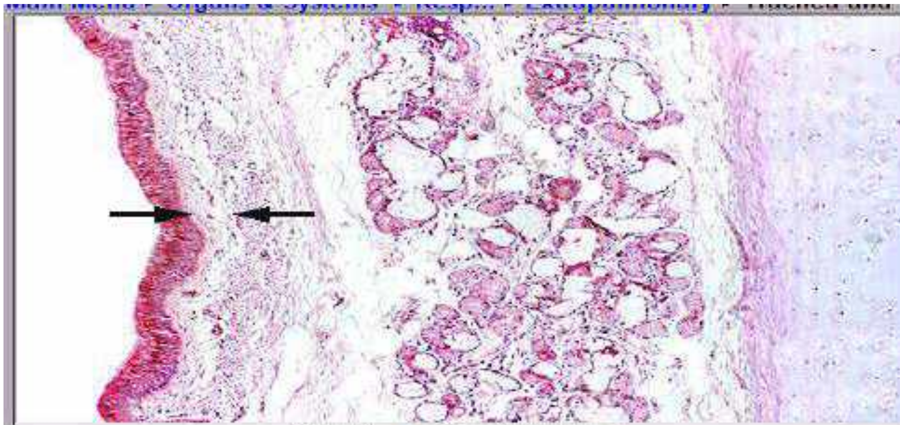

Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
> Mucosa
Epithelium >
Lamina propria
Elastic lamina >
Submucosa >
Cartilage >
4 of 9
Trachea and primary bronchus -- The walls of the trachea and primary bronchi are identical, resembling the pattern typical for most passageways, except that the muscularis mucosae is replaced by an elastic lamina. The trachea and primary bronchi are extrapulmonary and are part of the conducting portion of the respiratory system. 100x


click to identify:
Mucosa
> Epithelium >
Lamina propria
Elastic lamina >
Submucosa >
Cartilage >
4 of 9
The epithelium lining the trachea and primary bronchi is pseudostratified columnar (between black arrows) with cilia and goblet cells. Note the thickened basement membrane (blue arrows) that is typical in the respiratory system. The lamina propria is composed of loose connective tissue.



click to identify:

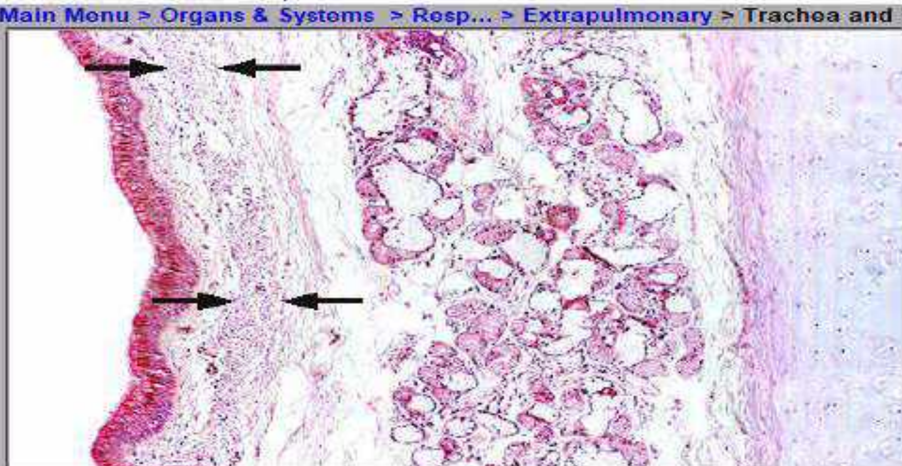
Mucosa
Epithelium >
> Lamina propria
Elastic lamina >
Submucosa >
Cartilage >

4 of 9

The epithelium lining the trachea and primary bronchi is pseudostratified columnar (between black arrows) with cilia and goblet cells. Note the thickened basement membrane (blue arrows) that is typical in the respiratory system. The lamina propria is composed of loose connective tissue.

File View Go Quiz Help

Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus

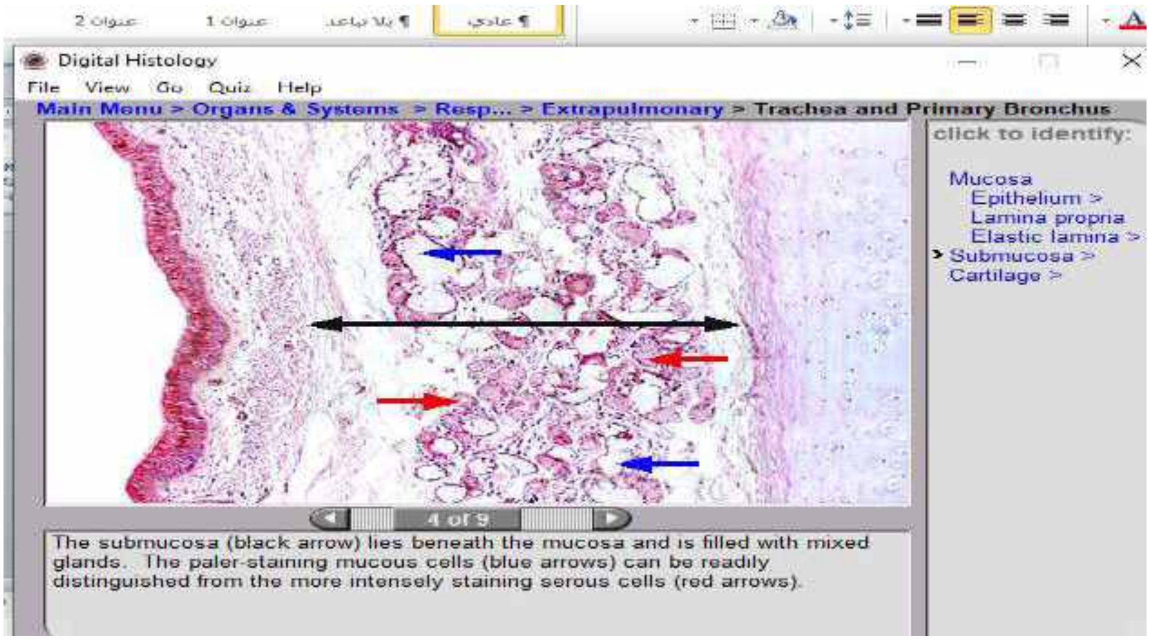


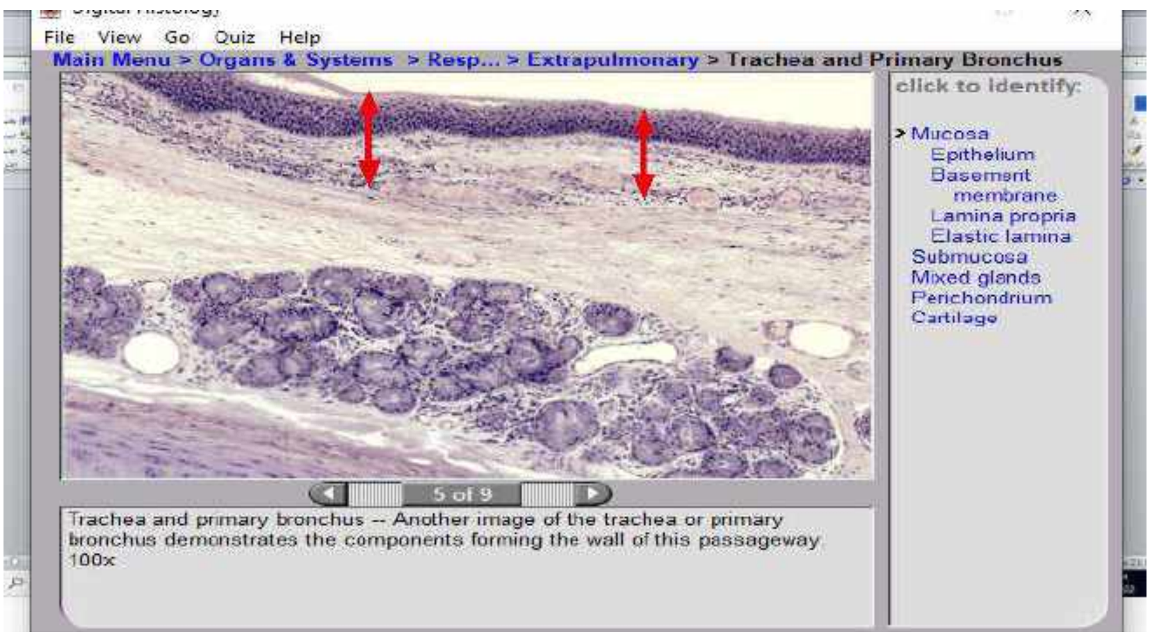
click to identify:

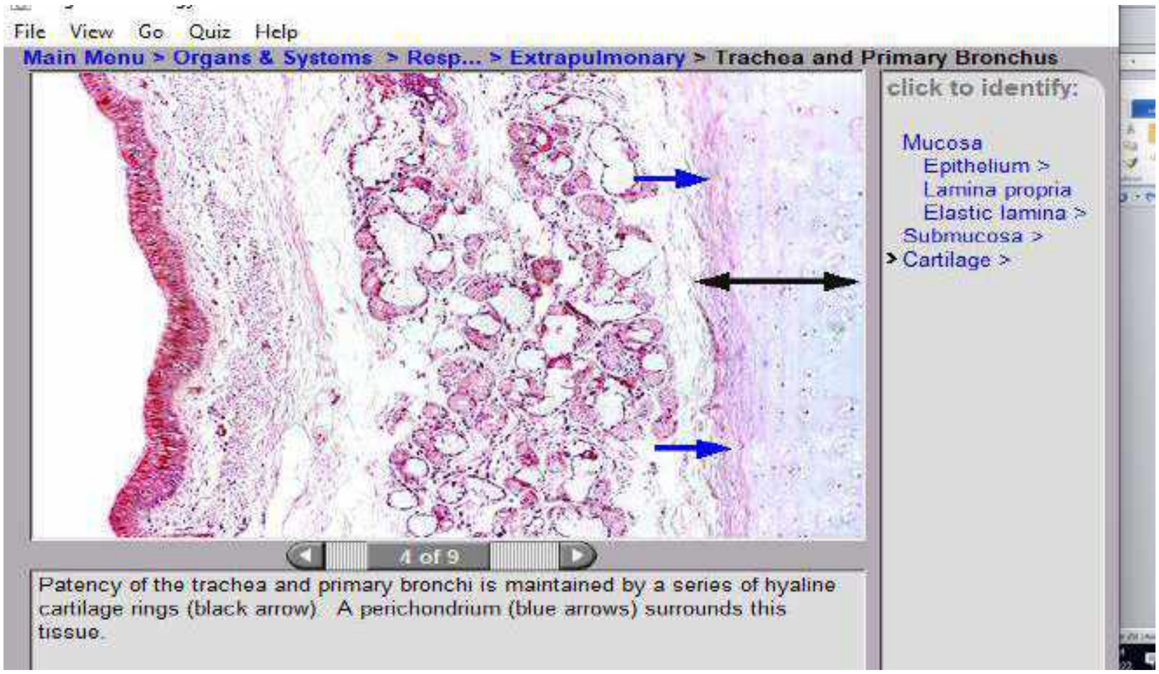
Mucosa
Epithelium >
Lamina propria
> Elastic lamina >
Submucosa >
Cartilage >

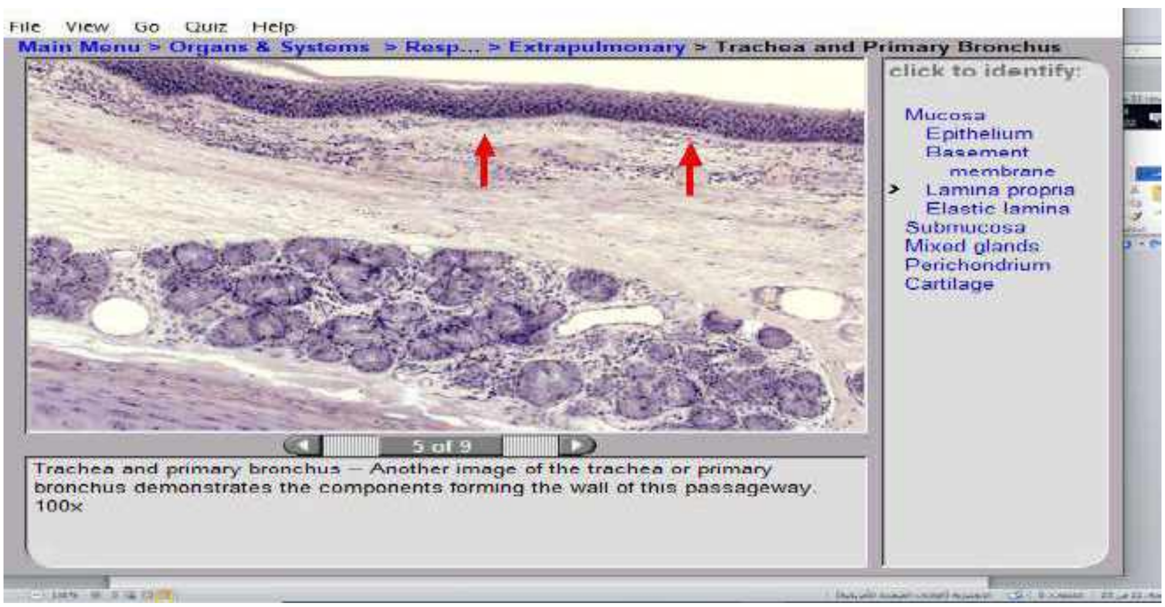
4 of 9

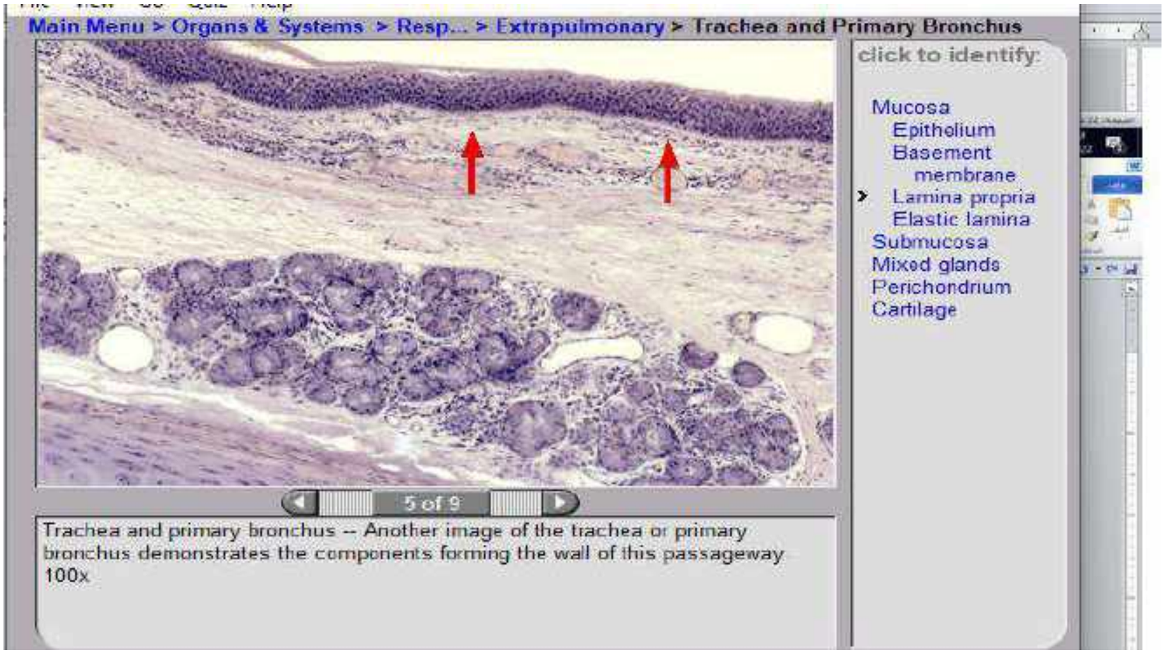
The deepest layer of the mucosa is a band of elastic fibers, the elastic lamina. Elastic fibers run longitudinally throughout the respiratory passageways, but are only organized into a definitive layer, the elastic lamina, in the trachea and primary bronchi. Elastic fibers aid in passive expiration of air from the lungs and respiratory passageways.


عنوان 2
عنوان 1
¶ بلا تباعد
¶ عادي
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
Mucosa
Epithelium >
Lamina propria
Elastic lamina >
> Submucosa >
Cartilage >
4 of 9
The submucosa (black arrow) lies beneath the mucosa and is filled with mixed glands. The paler-staining mucous cells (blue arrows) can be readily distinguished from the more intensely staining serous cells (red arrows).


File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
> Mucosa
Epithelium
Basement membrane
Lamina propria
Elastic lamina
Submucosa
Mixed glands
Perichondrium
Cartilage
5 of 9
Trachea and primary bronchus -- Another image of the trachea or primary bronchus demonstrates the components forming the wall of this passageway. 100x


File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
Mucosa
Epithelium >
Lamina propria
Elastic lamina >
Submucosa >
Cartilage >
4 of 9
Patency of the trachea and primary bronchi is maintained by a series of hyaline cartilage rings (black arrow). A perichondrium (blue arrows) surrounds this tissue.


File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
Mucosa
Epithelium
Basement membrane
Lamina propria
Elastic lamina
Submucosa
Mixed glands
Perichondrium
Cartilage
5 of 9
Trachea and primary bronchus -- Another image of the trachea or primary bronchus demonstrates the components forming the wall of this passageway. 100x


Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
Mucosa
Epithelium
Basement membrane
Lamina propria
Elastic lamina
Submucosa
Mixed glands
Perichondrium
Cartilage
5 of 9
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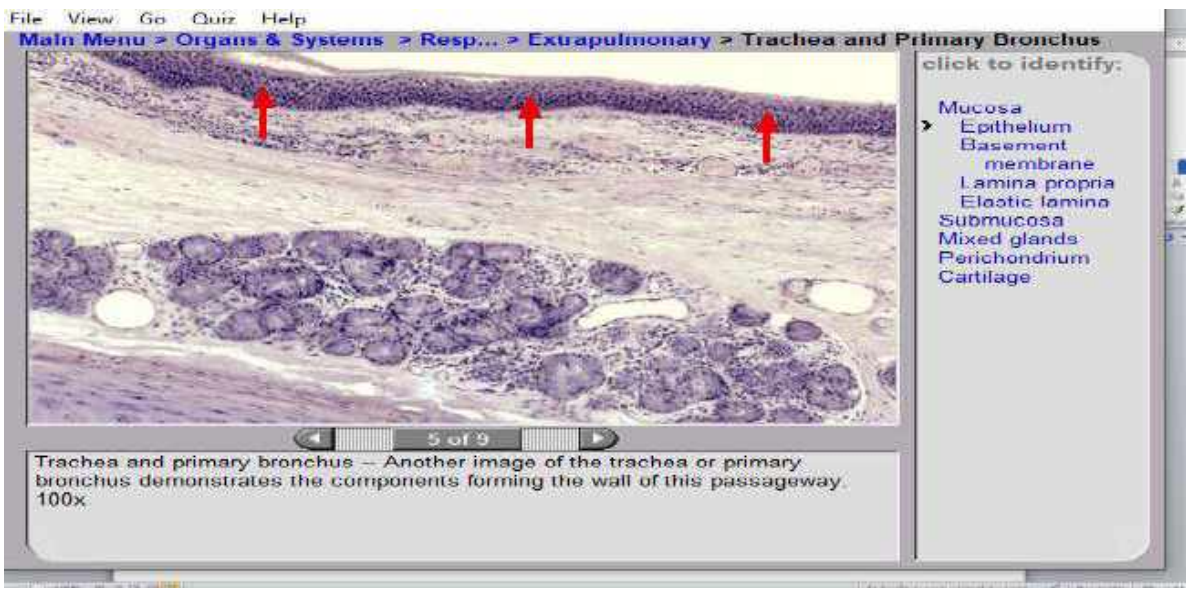
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
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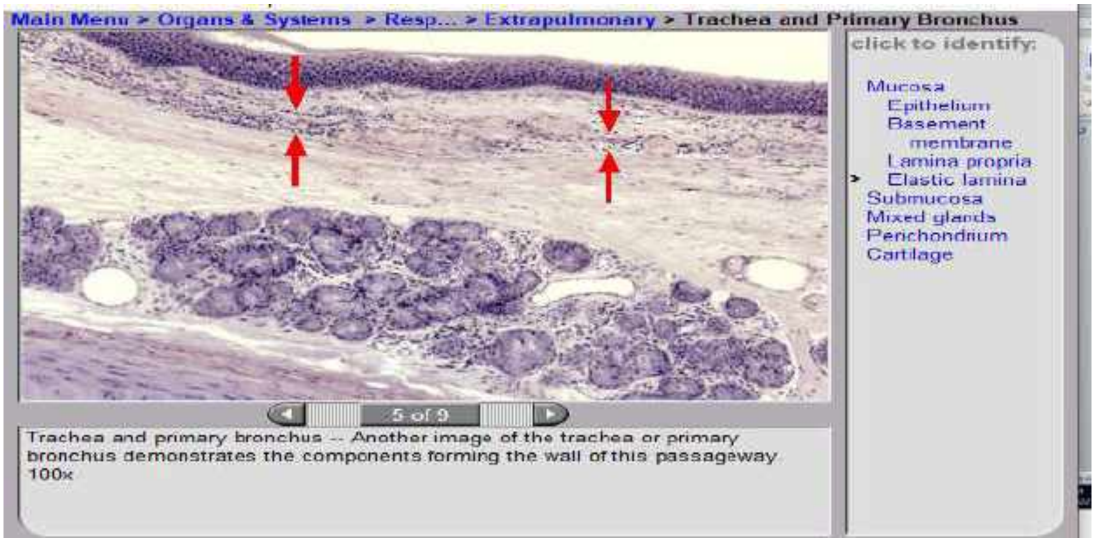
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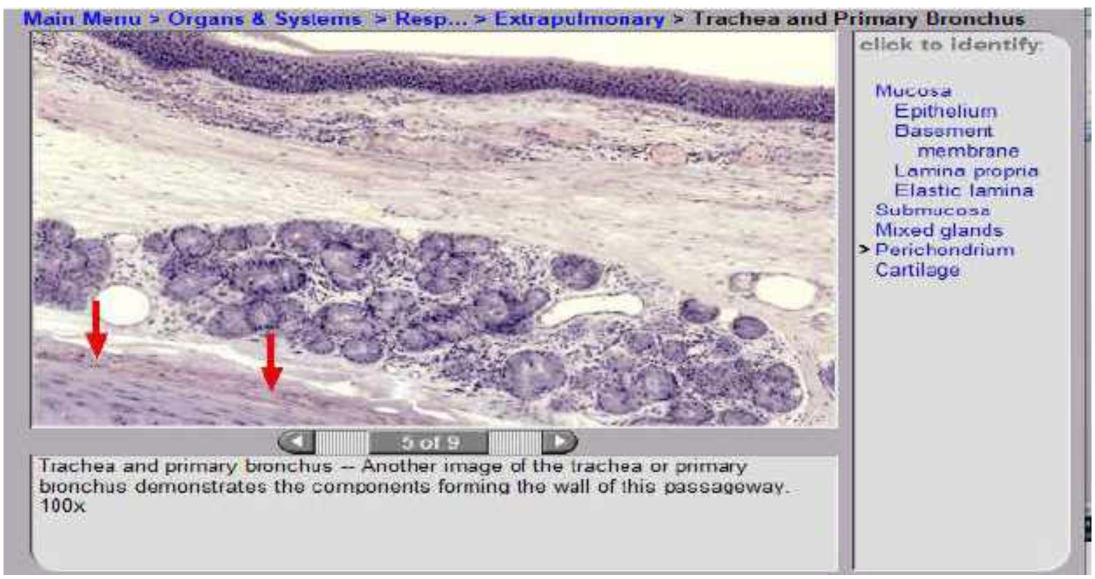
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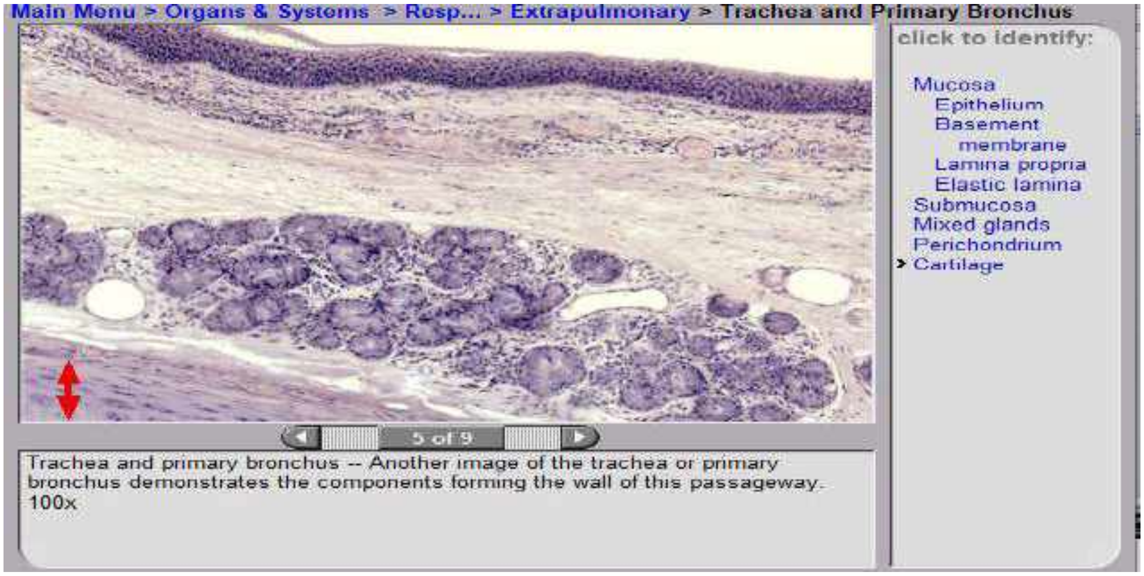
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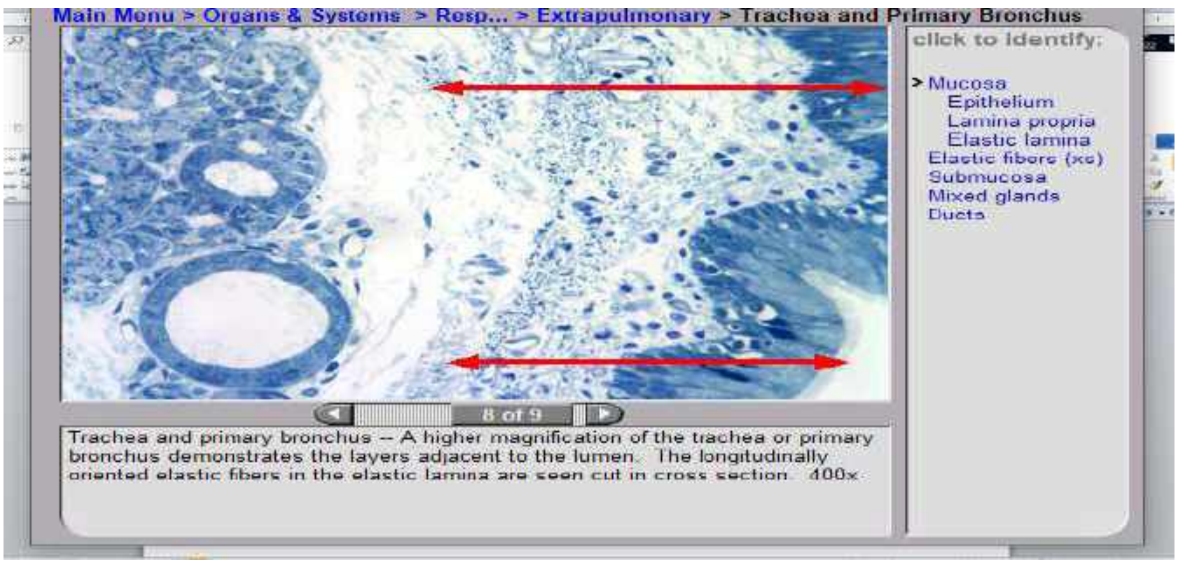
Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus
click to identify:
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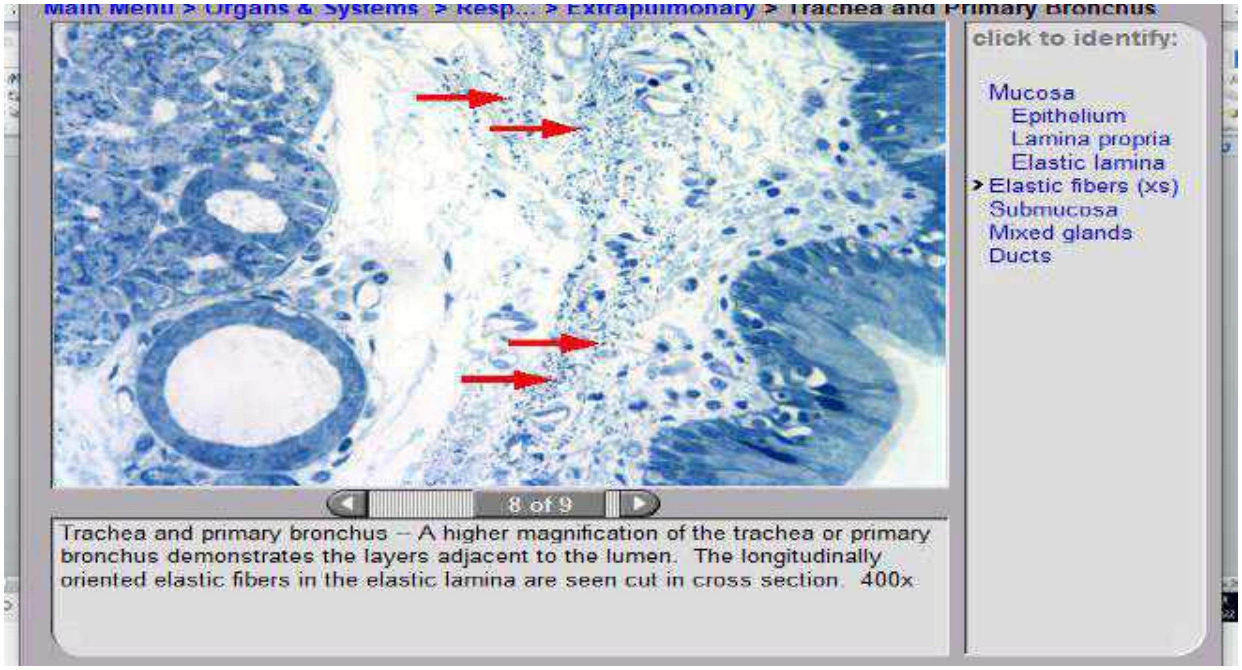
Epithelium
Lamina propria
Elastic lamina
Elastic fibers (xs)
Submucosa
Mixed glands
Ducts
8 of 9
Trachea and primary bronchus -- A higher magnification of the trachea or primary bronchus demonstrates the layers adjacent to the lumen. The longitudinally oriented elastic fibers in the elastic lamina are seen cut in cross section. 400x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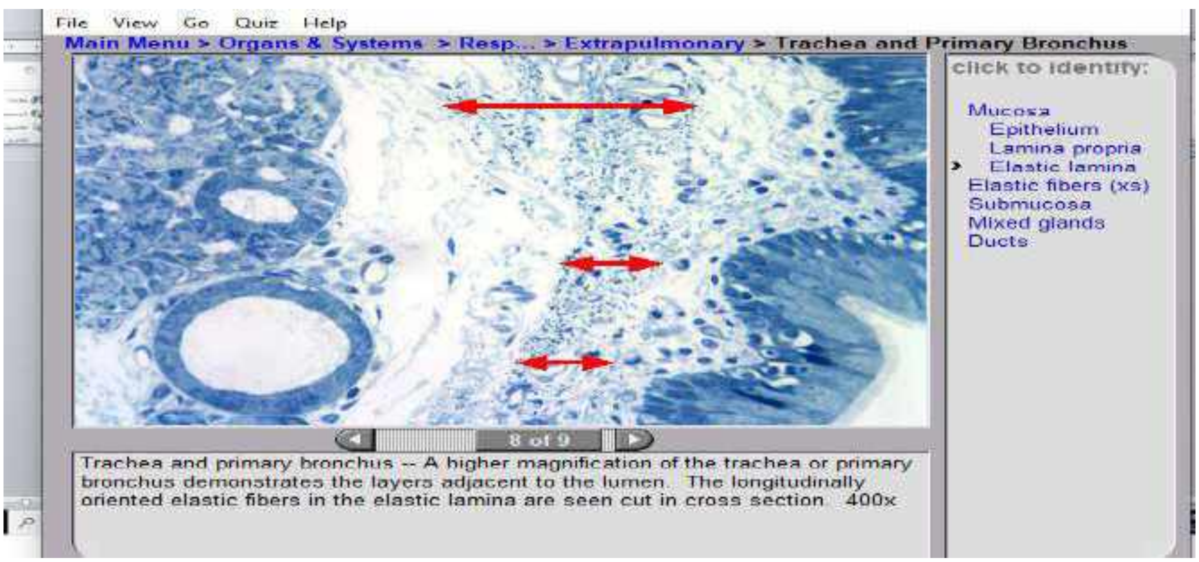
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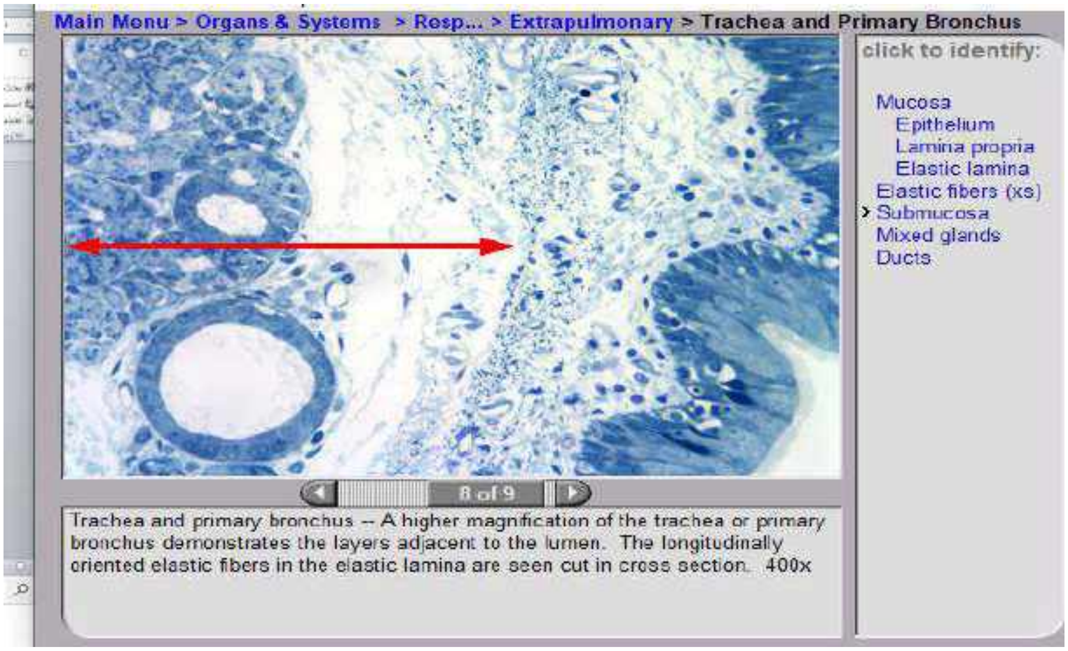
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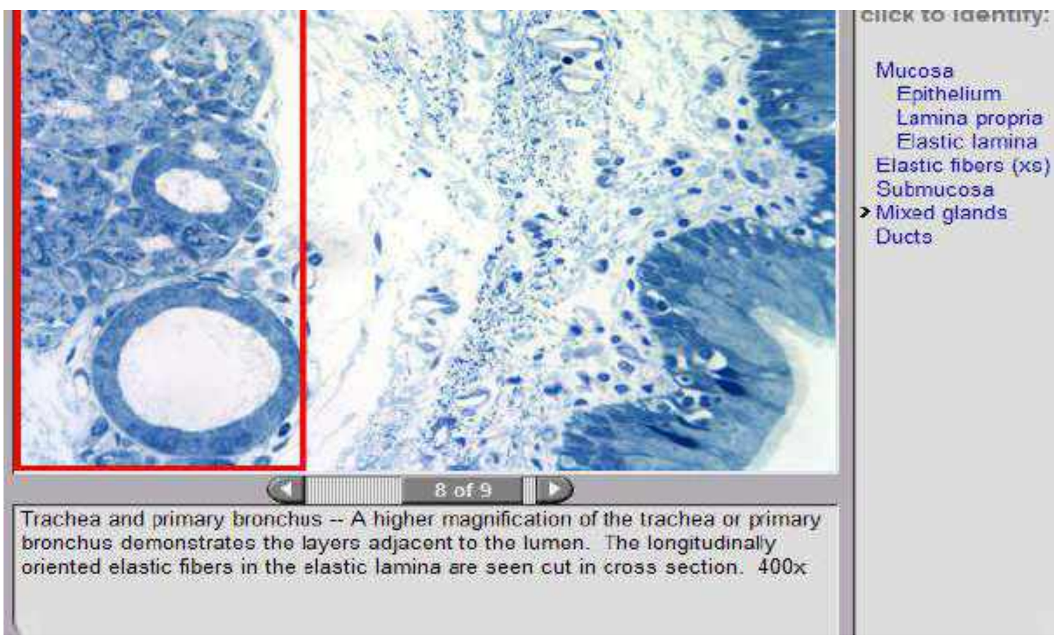
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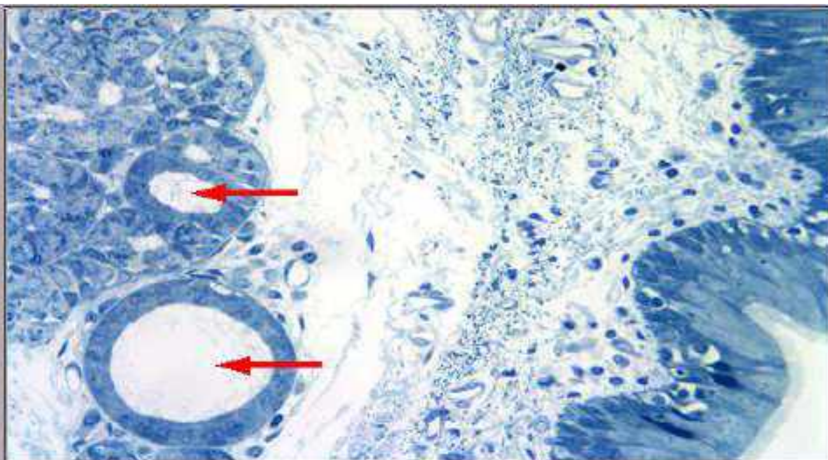
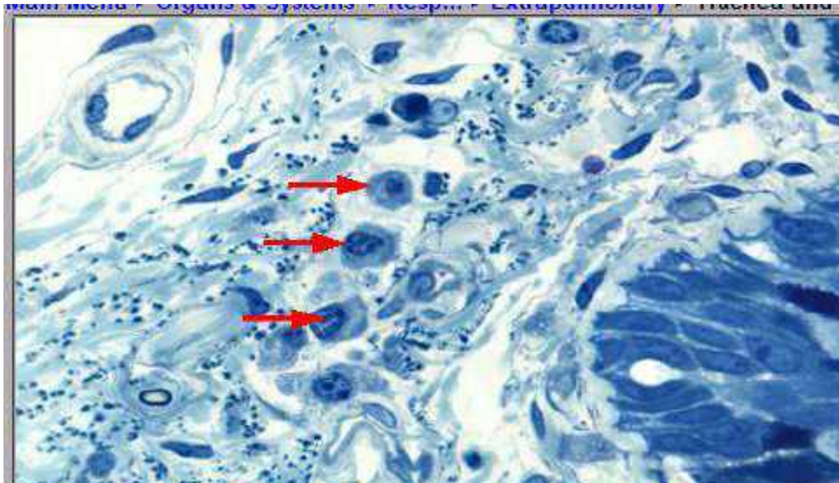


click to identify:

- Mucosa
  - Epithelium
  - Lamina propria
  - Elastic lamina
- Elastic fibers (xs)
- Submucosa
- Mixed glands
- › Ducts

8 of 9

Trachea and primary bronchus -- A higher magnification of the trachea or primary bronchus demonstrates the layers adjacent to the lumen. The longitudinally oriented elastic fibers in the elastic lamina are seen cut in cross section. 400x



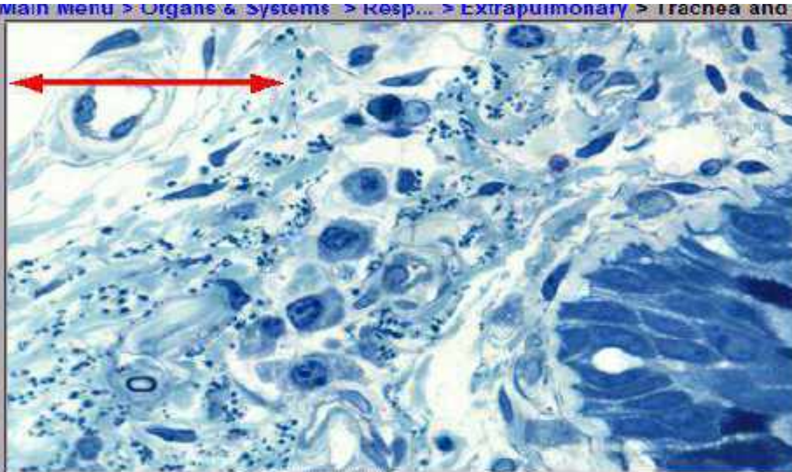
click to identify:

- Respiratory epithelium
- Lamina propria
- Elastic lamina
- Elastic fibers
- › Plasma cells
- Submucosa

9 of 9

Trachea and primary bronchus -- The elastic lamina that forms the deepest layer of the mucosa of the trachea and primary bronchi is composed of longitudinally oriented elastic fibers that are organized into a discrete band, the elastic lamina. Cells of the immune system, such as the plasma cells seen here, are prevalent in the connective tissue of the respiratory system. 1000x

Main Menu > Organs & Systems > Resp... > Extrapulmonary > Trachea and Primary Bronchus



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click to identify:

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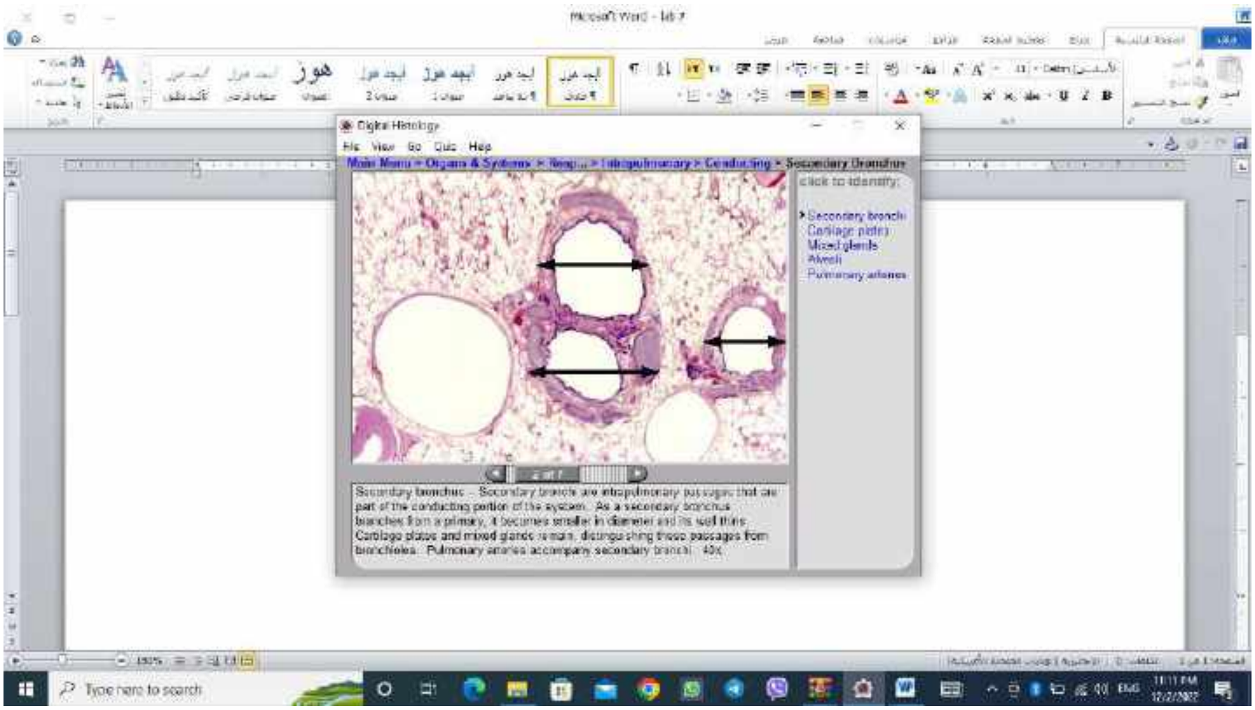
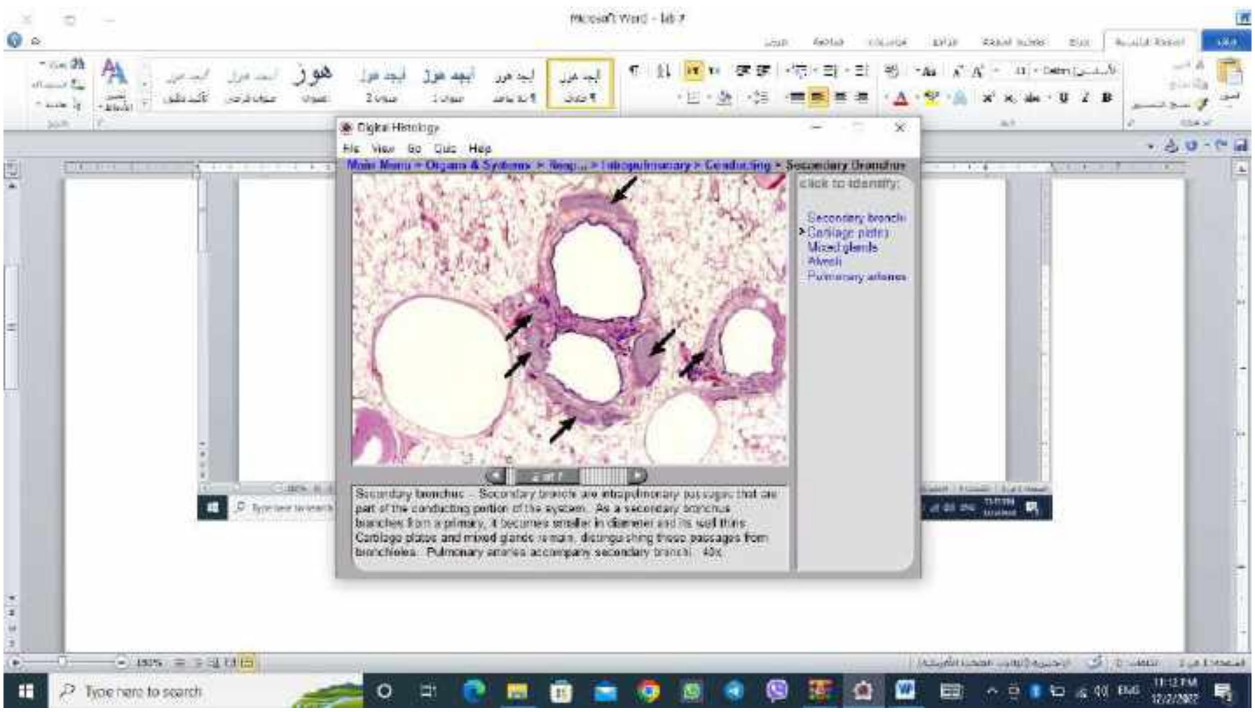
- Lamina propria
- Elastic lamina
- Elastic fibers
- Plasma cells
- > Submucosa


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Secondary Bronchus
click to identify:
Secondary bronchi
Cartilage plates
Mixed glands
Alveoli
Pulmonary arteries
Secondary bronchus – Secondary bronchi are intrapulmonary passages that are part of the conducting portion of the system. As a secondary bronchus branches from a primary, it becomes smaller in diameter and its wall thins. Cartilage plates and mixed glands remain, distinguishing these passages from bronchioles. Pulmonary arteries accompany secondary bronchi. 40x
Type here to search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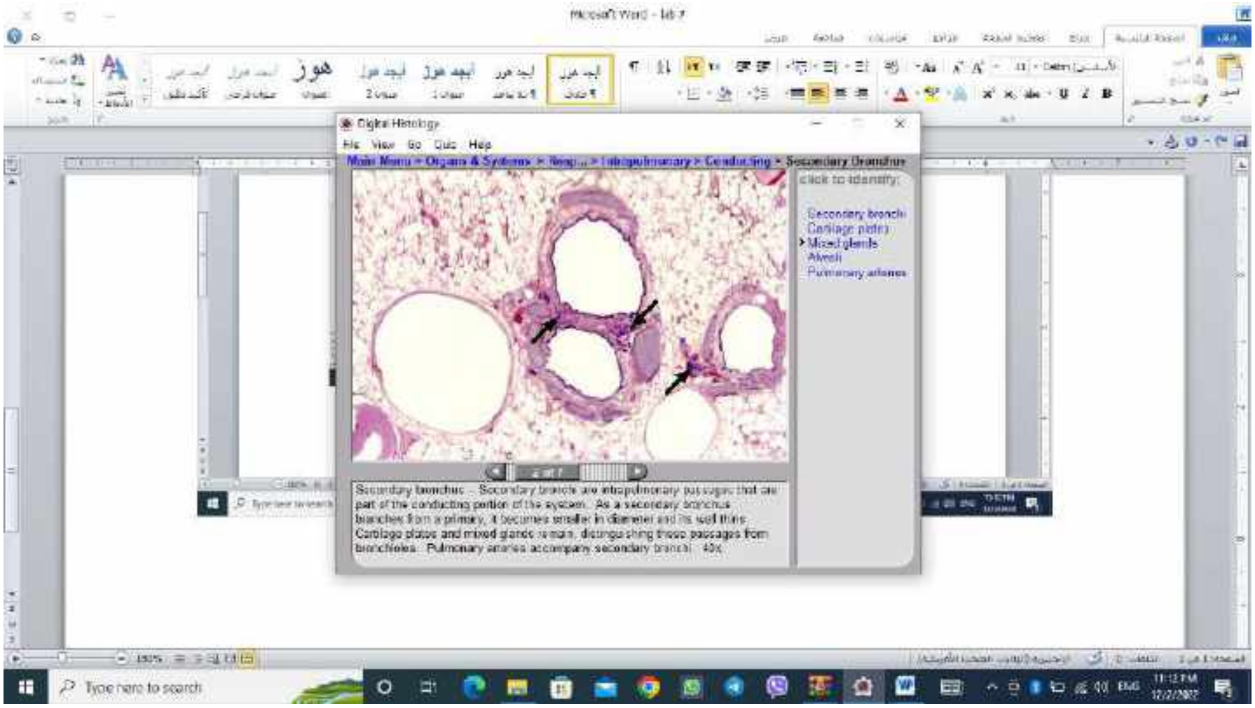
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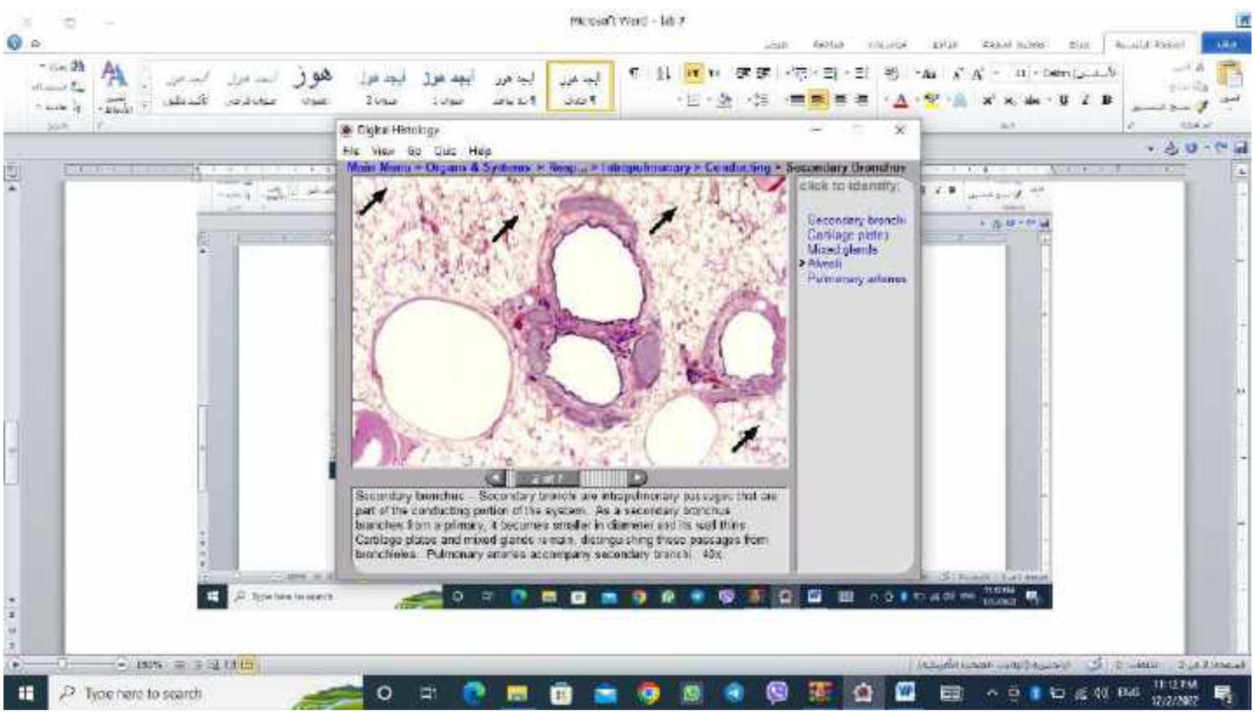
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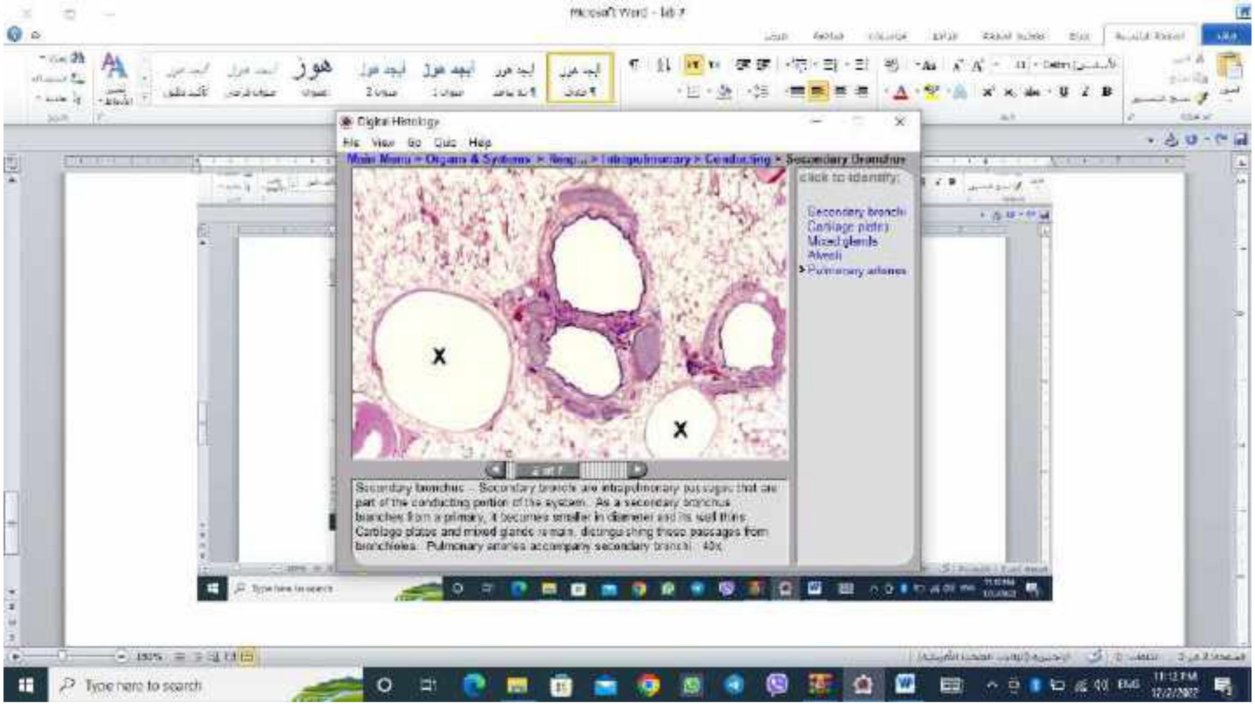
Microsoft Word - lab 7
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X
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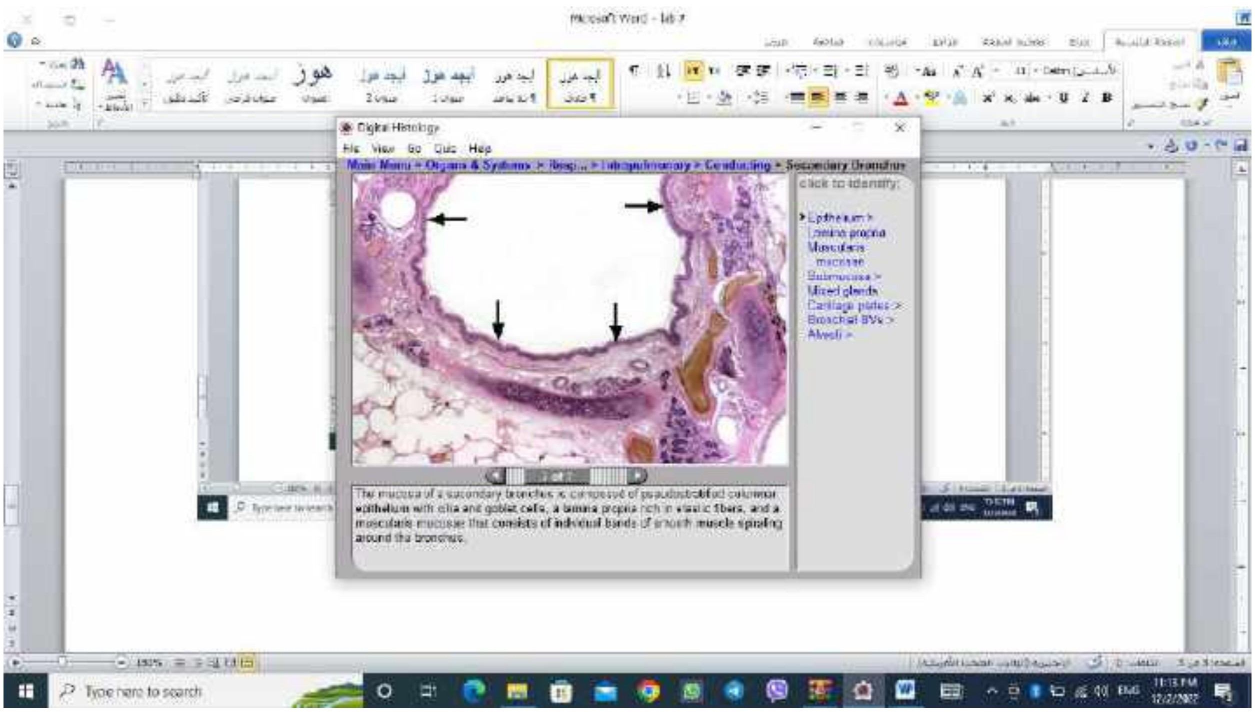
Microsoft Word - lab 7
Digital Histology
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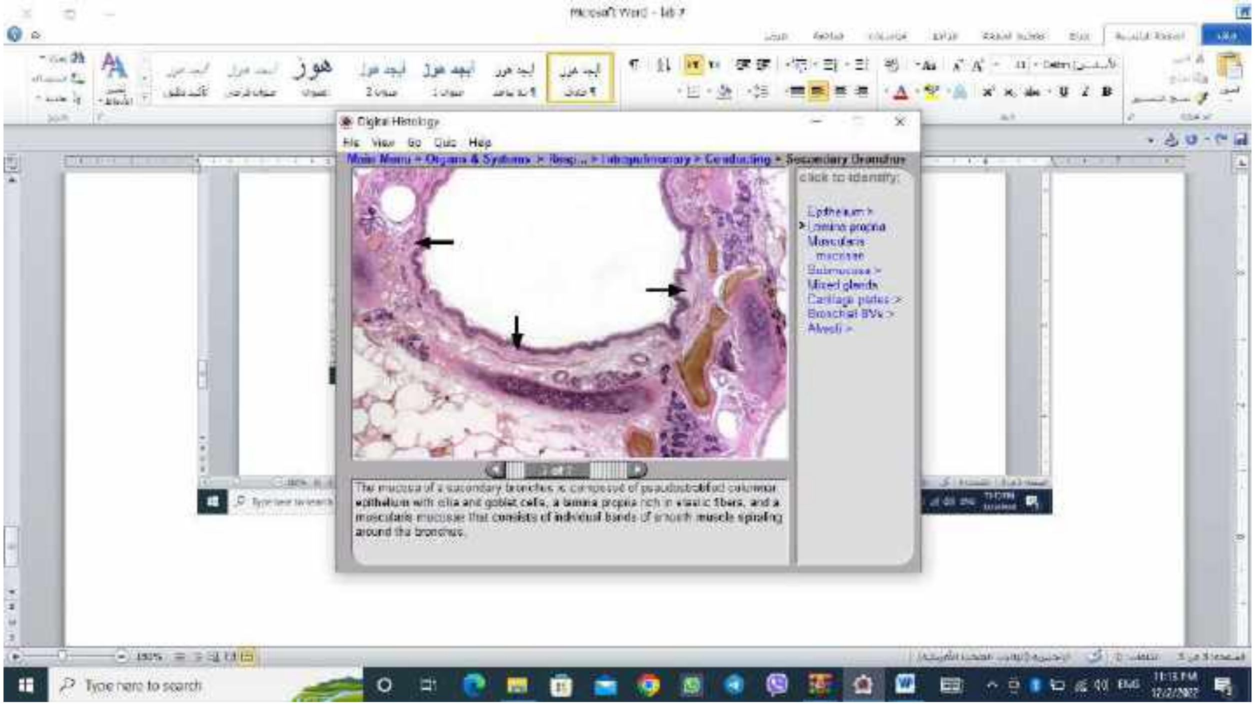
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Secondary Bronchus
click to identify:
Epithelium >
Lamina propria
Muscularis mucosae
Submucosa >
Mixed glands
Cartilage plates >
Bronchial BVs >
Alveoli >
The mucosa of a secondary bronchus is composed of pseudostratified columnar epithelium with cilia and goblet cells, a lamina propria rich in elastic fibers, and a muscularis mucosae that consists of individual bands of smooth muscle spiraling around the bronchus.
Type here to search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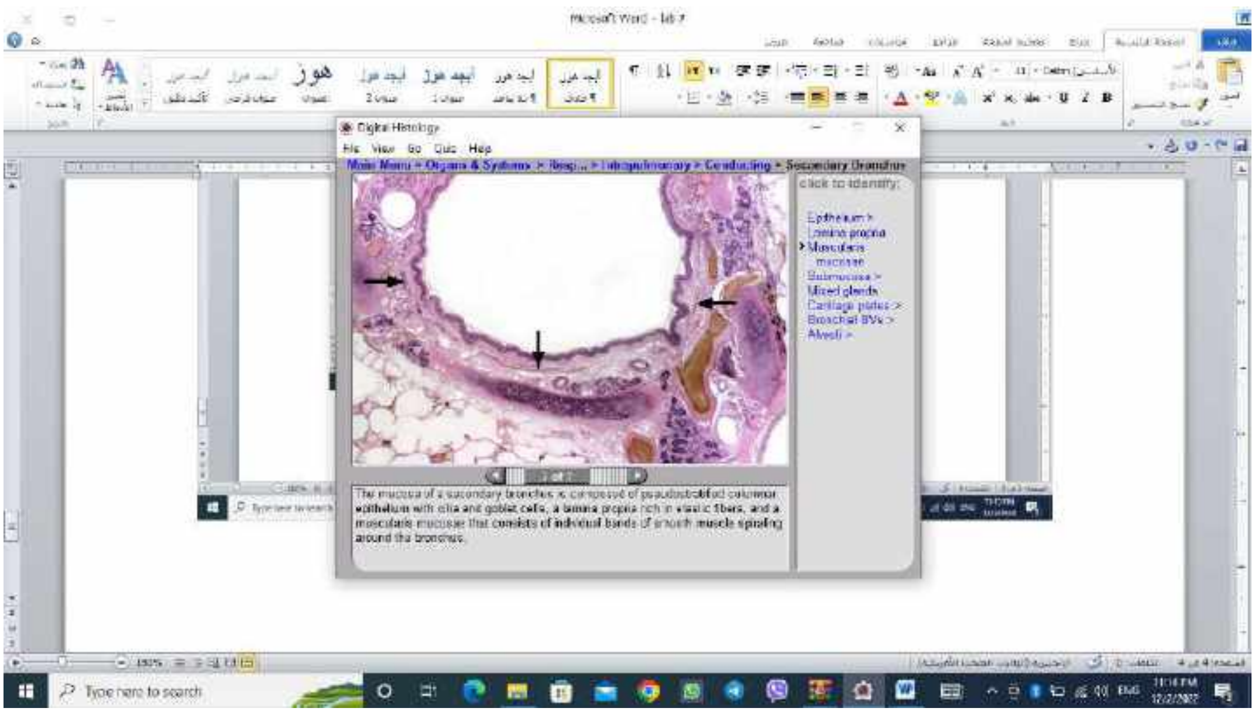
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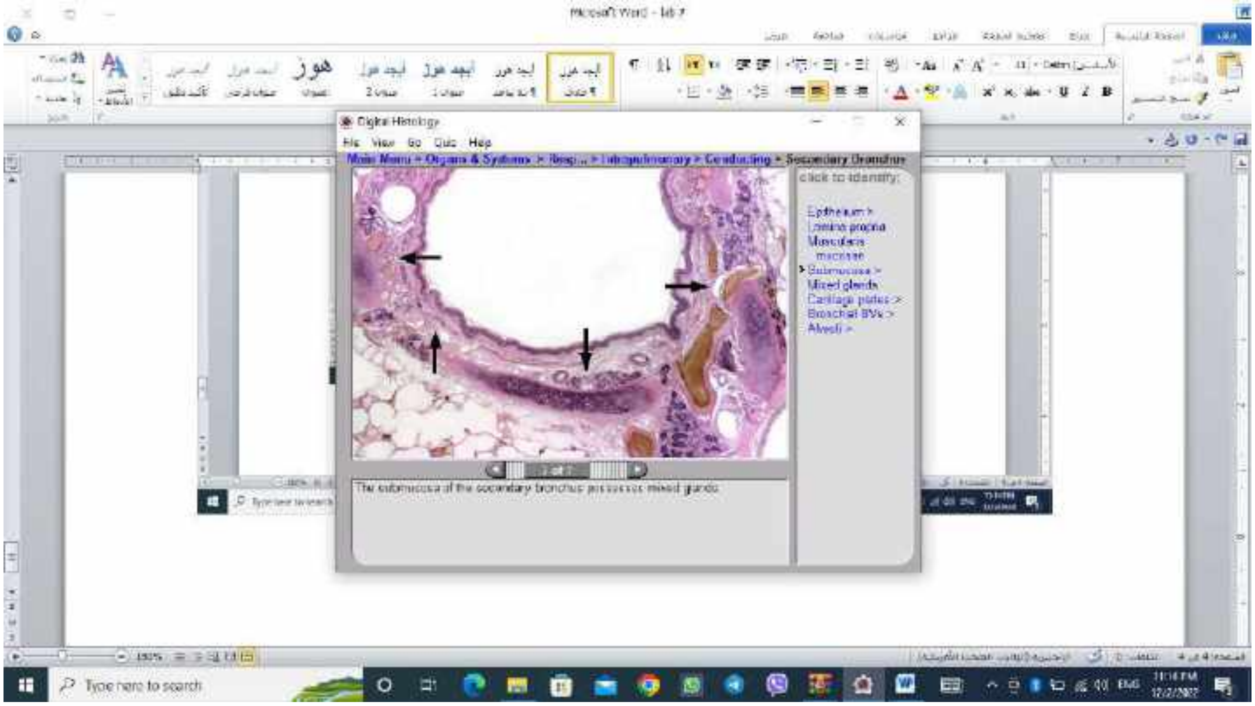
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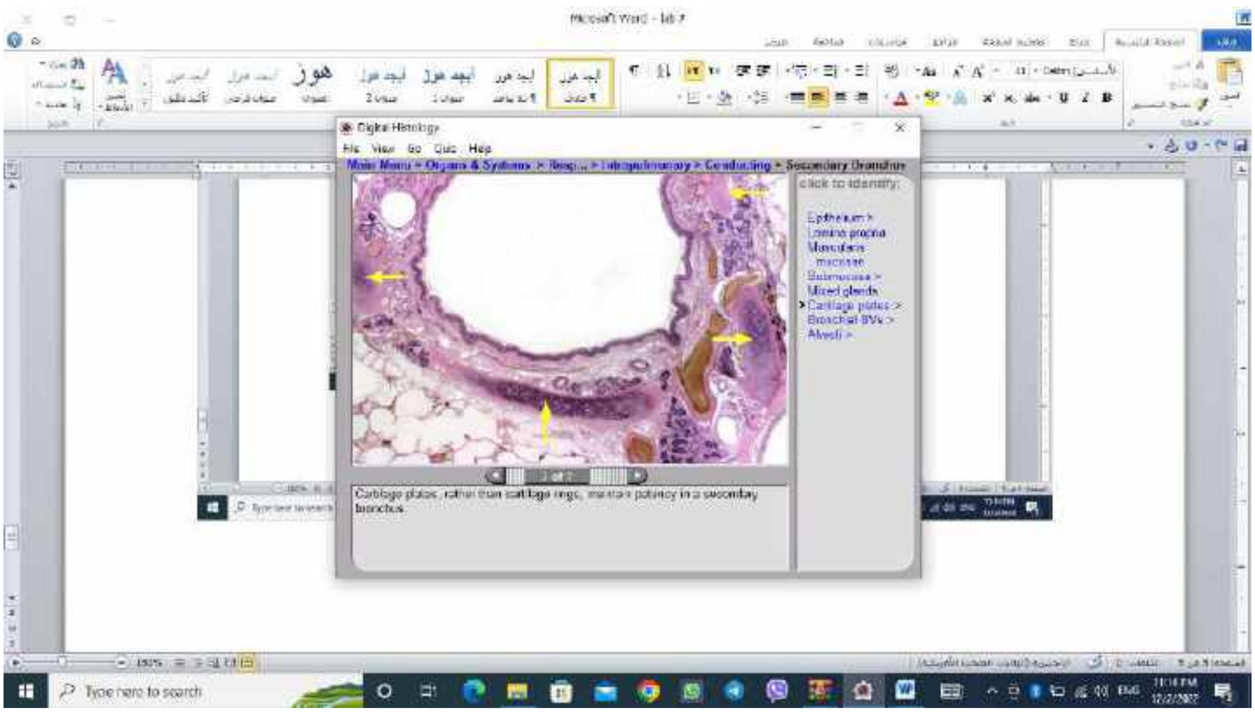
click to identify:
Epithelium >
Lamina propria
Muscularis mucosae
Submucosa >
Mixed glands
Cartilage plates >
Bronchial BVs >
Alveoli >
The submucosa of the secondary bronchus possesses mixed glands
Type here to search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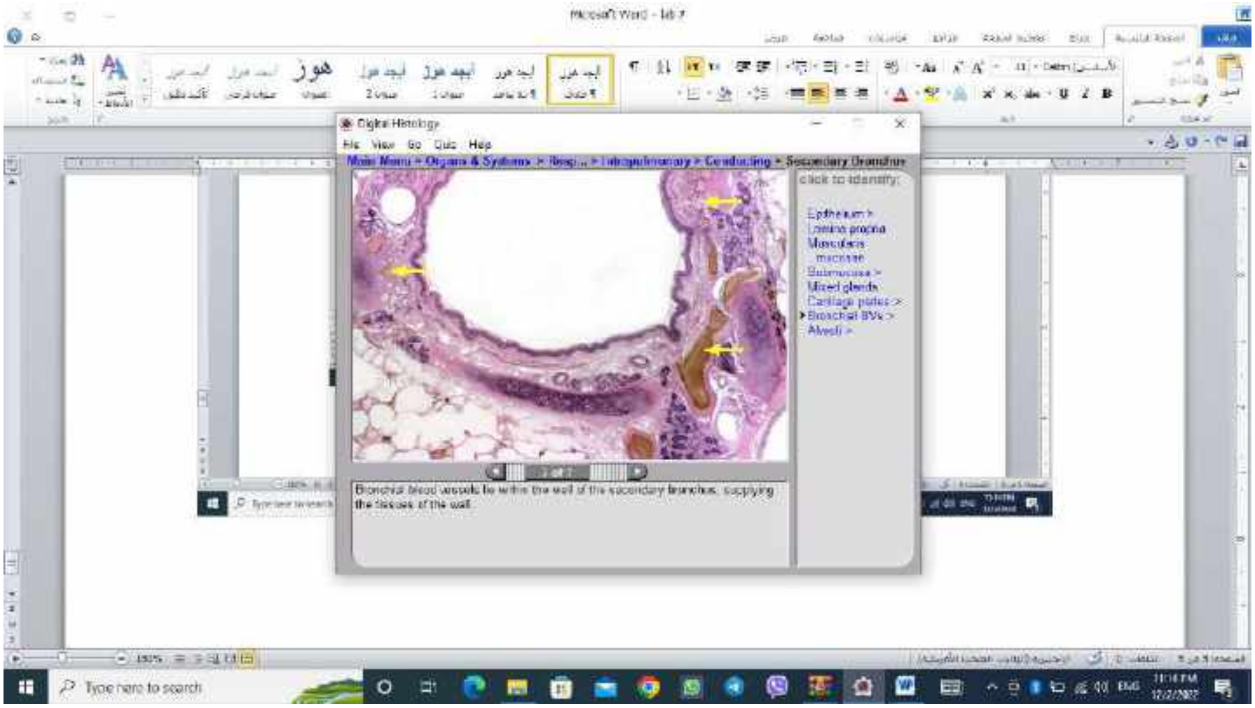
Lamina propria
Muscularis mucosae
Submucosa >
Mixed glands
Cartilage plates >
Bronchial BVs >
Alveoli >
Cartilage plates, rather than cartilage rings, maintain patency in a secondary bronchus.
Type here to search



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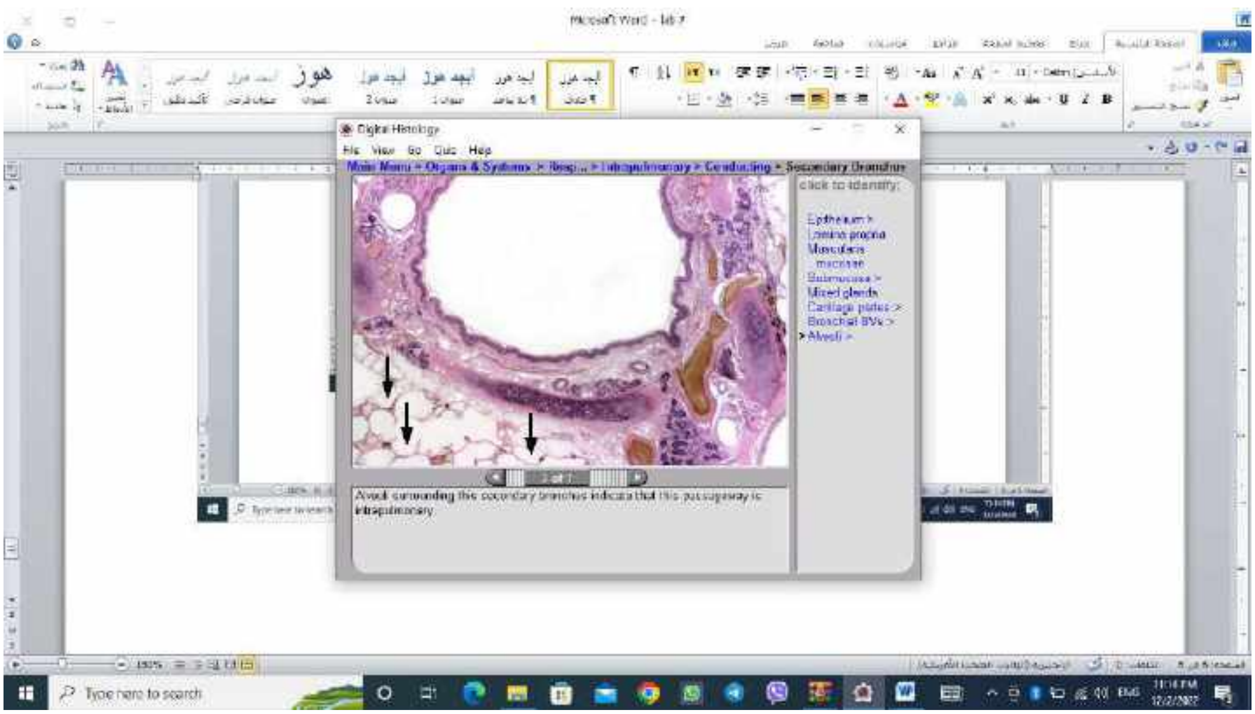
Submucosa >
Mixed glands
Cartilage plates >
Bronchial BVs >
Alveoli >
Bronchial blood vessels lie within the wall of the secondary bronchus, supplying the tissues of the wall.
Type here to search



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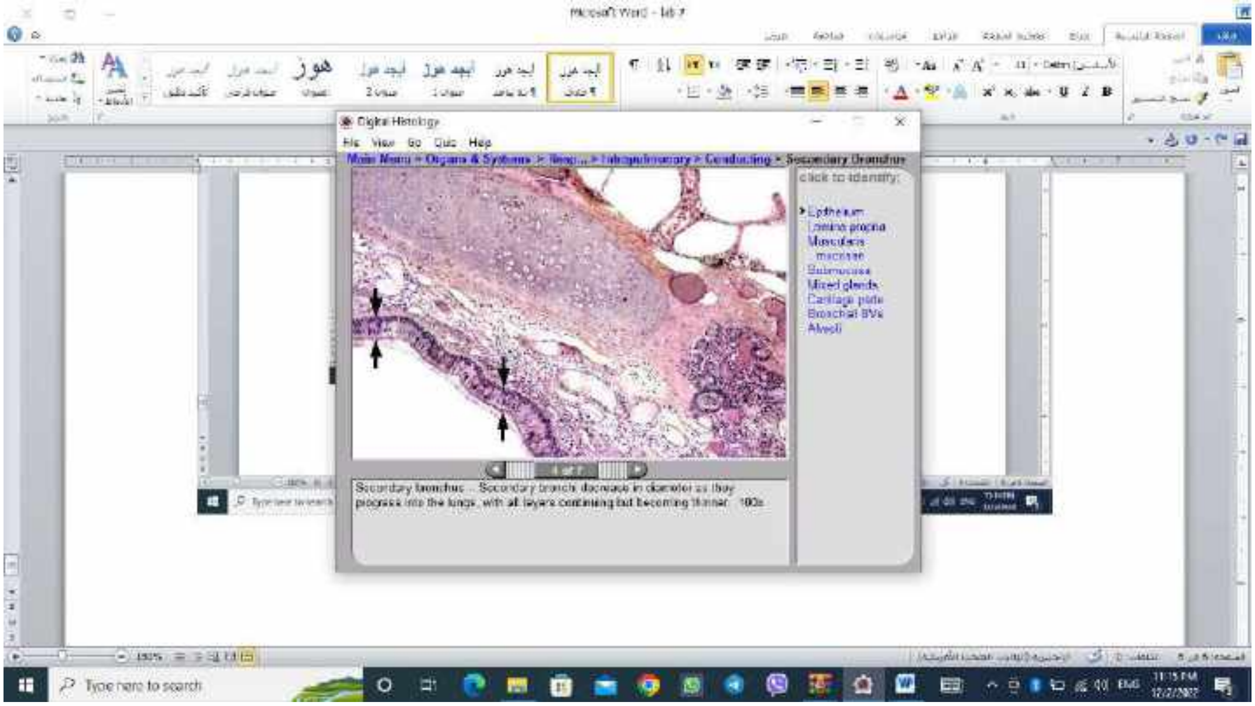
Lamina propria
Muscularis mucosae
Submucosa >
Mixed glands
Cartilage plates >
Bronchial BVs >
Alveoli >
Alveoli surrounding this secondary bronchus indicate that this passageway is intrapulmonary.
Type here to search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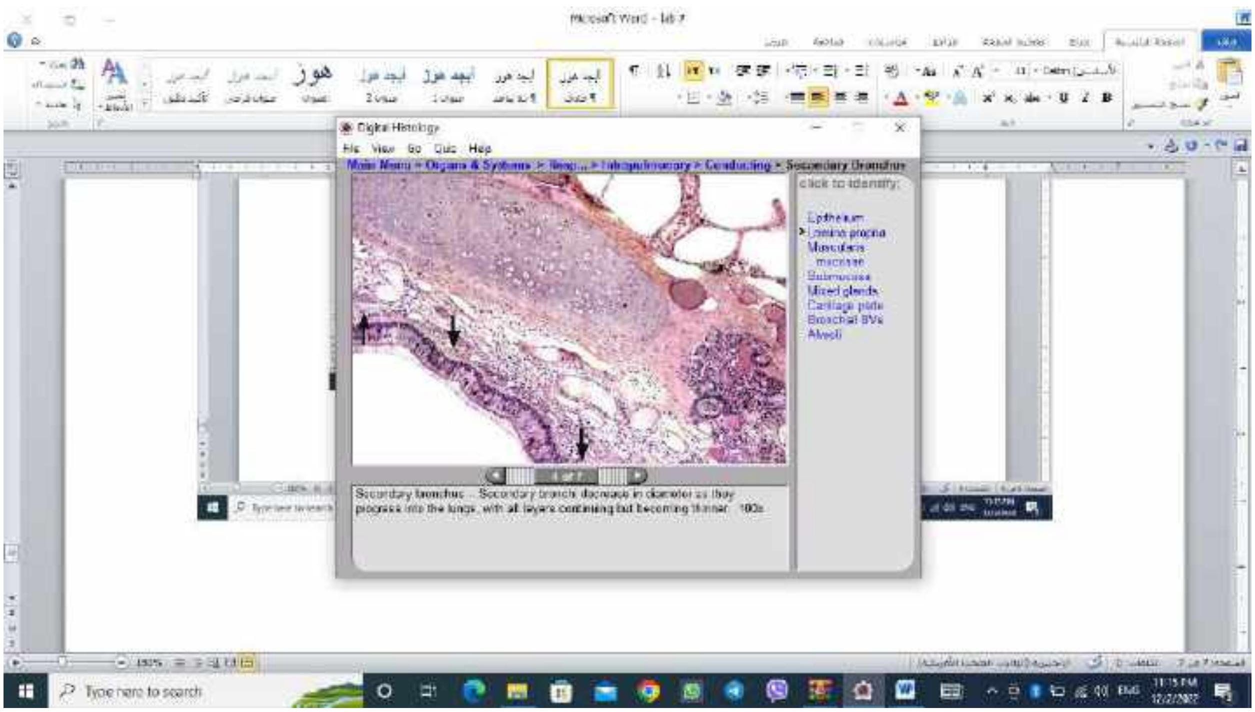
Lamina propria
Muscularis mucosae
Submucosa
Mixed glands
Cartilage plate
Bronchial BVs
Alveoli
Secondary bronchus ... Secondary bronchi decrease in diameter as they progress into the lungs, with all layers continuing but becoming thinner. 100x
Type here to search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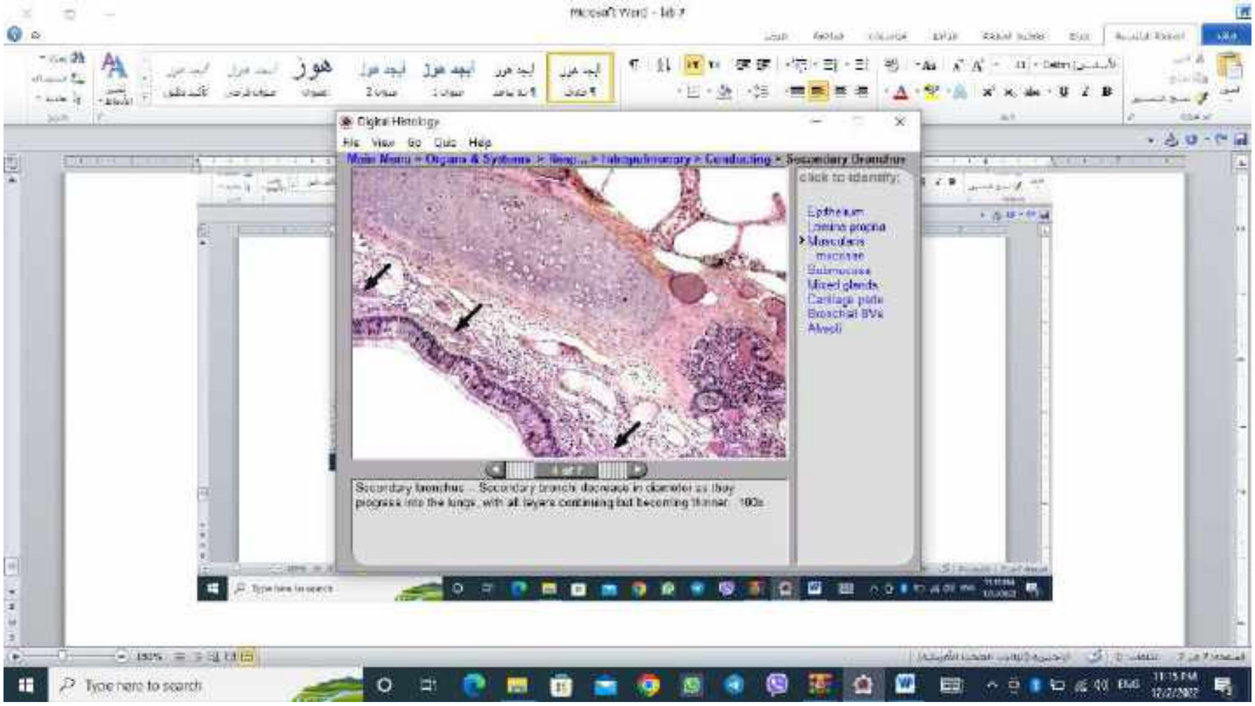
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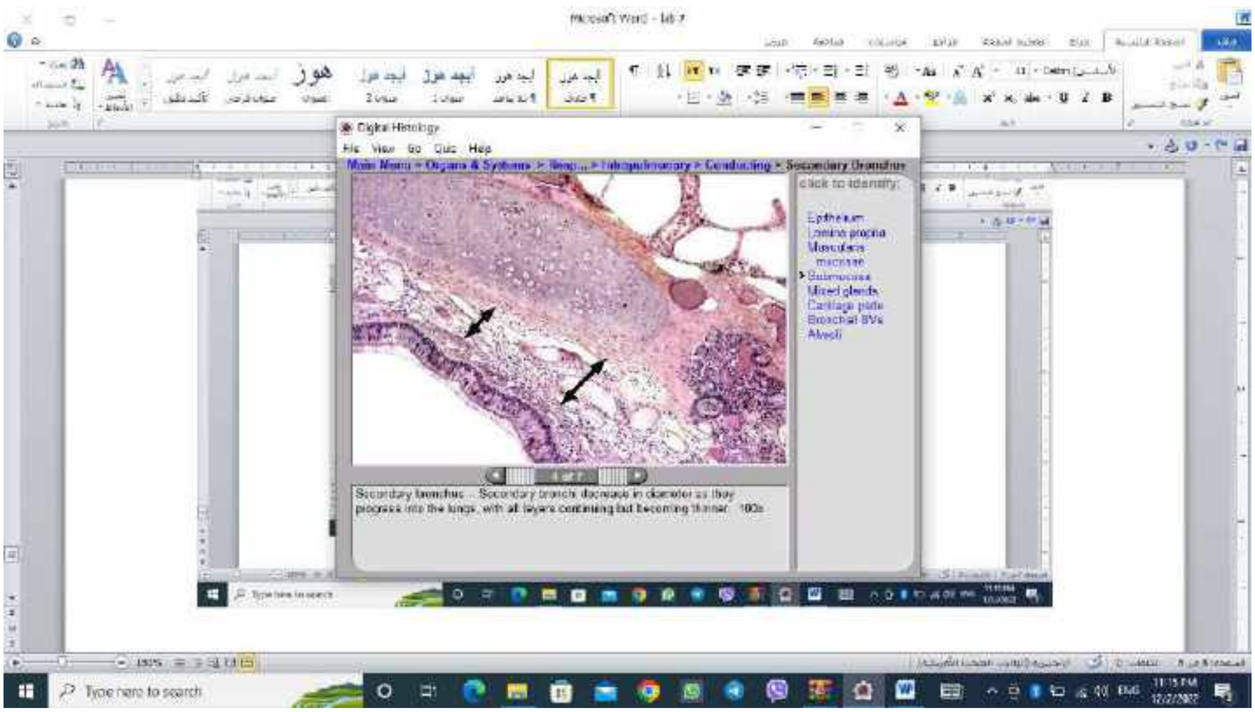
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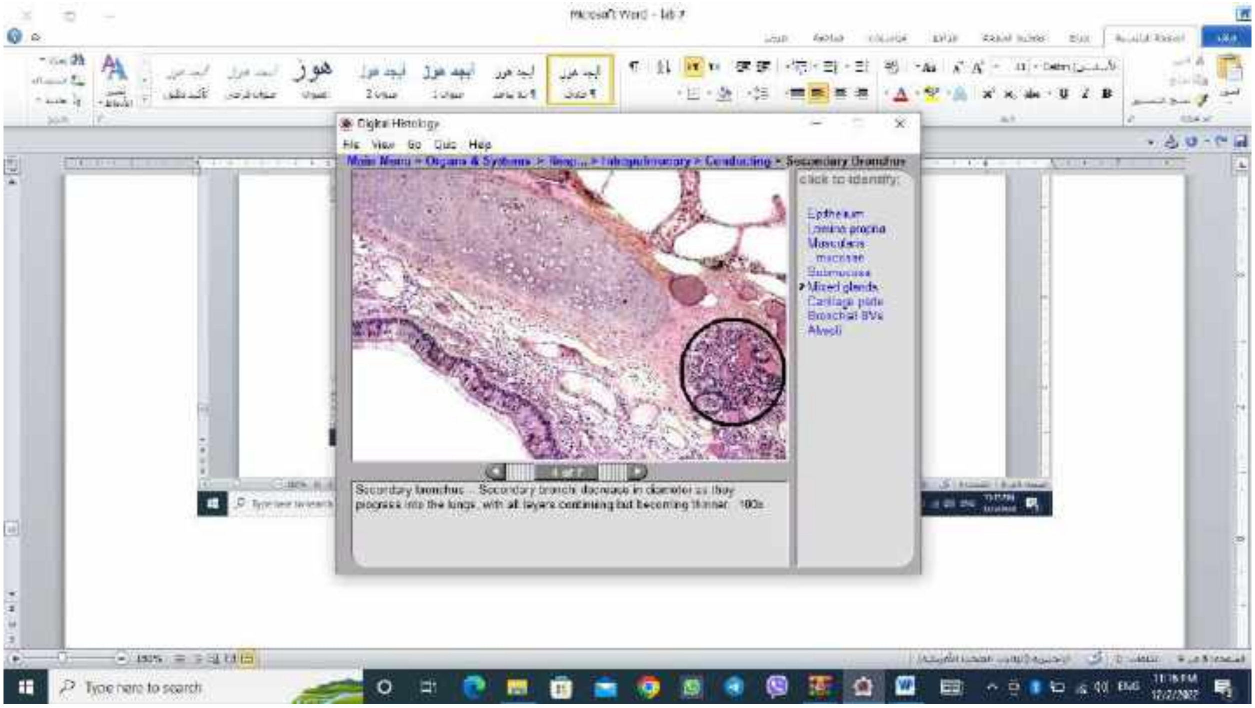
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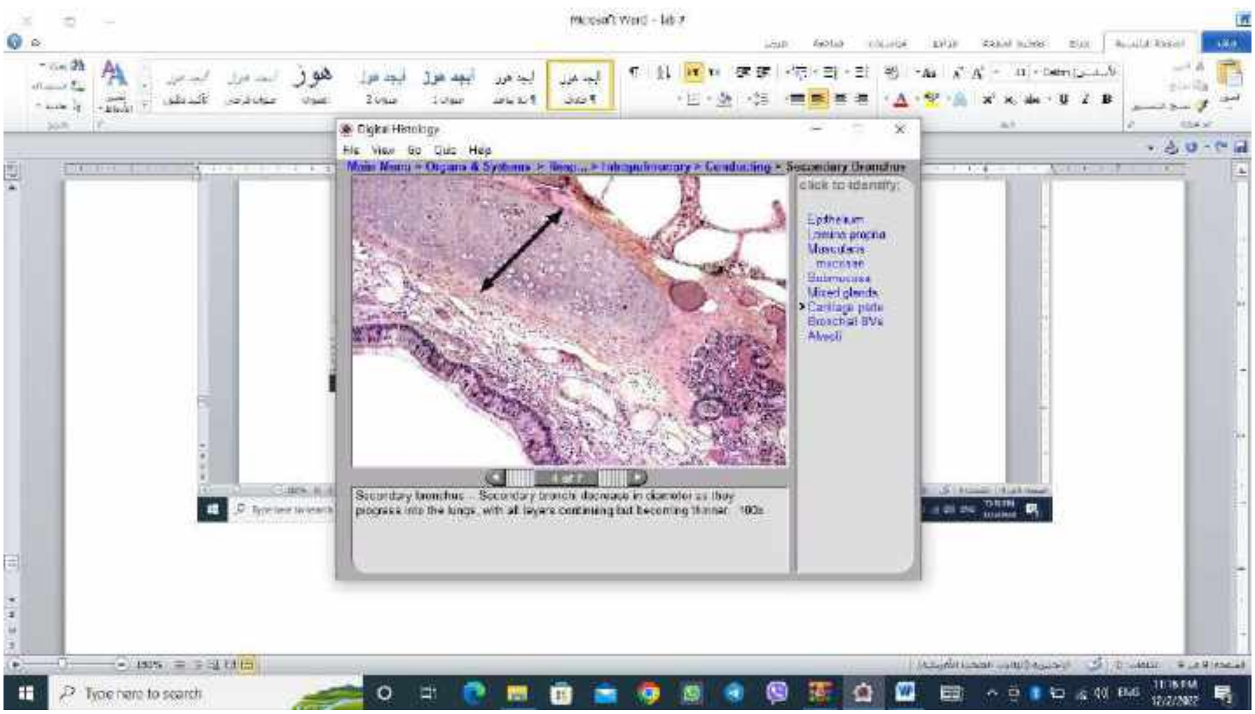
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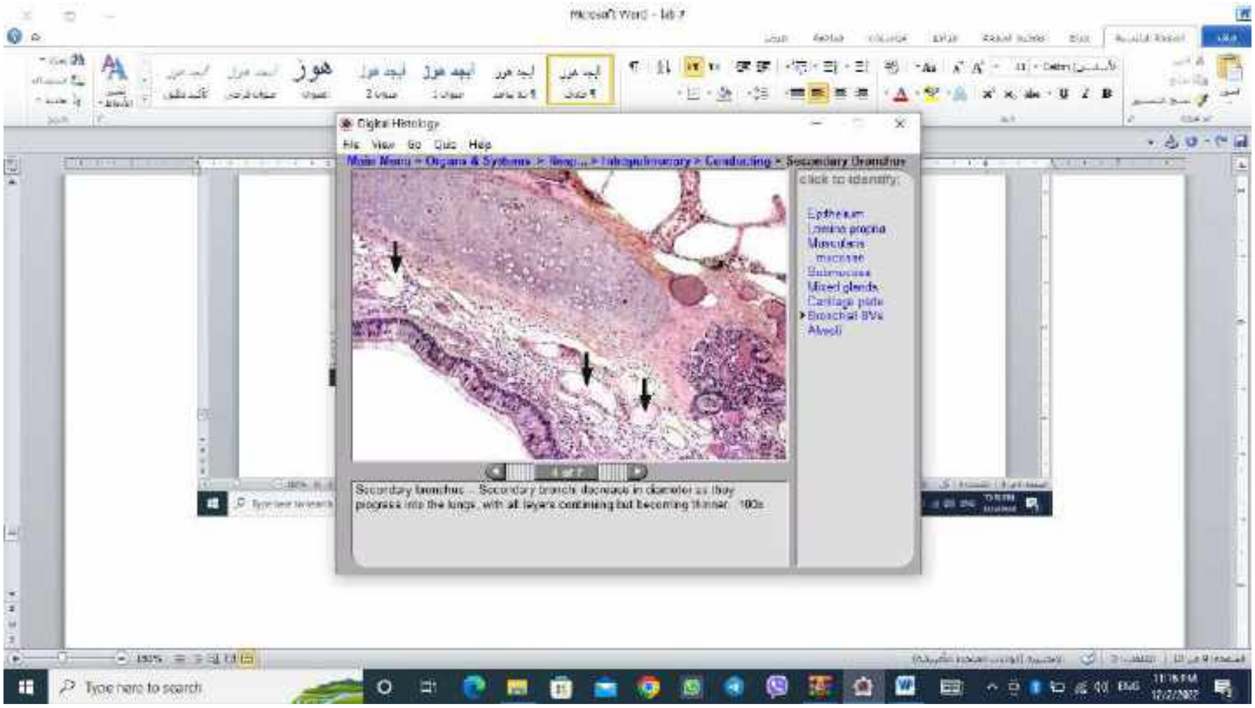

Microsoft Word - lab 7
Digital Histology
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Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Secondary Bronchus
click to identify:
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Lamina propria
Muscularis mucosae
Submucosa
Mixed glands
Cartilage plate
Bronchial BVs
Alveoli
Secondary bronchus - Secondary bronchi decrease in diameter as they progress into the lungs, with all layers continuing but becoming thinner. 100x
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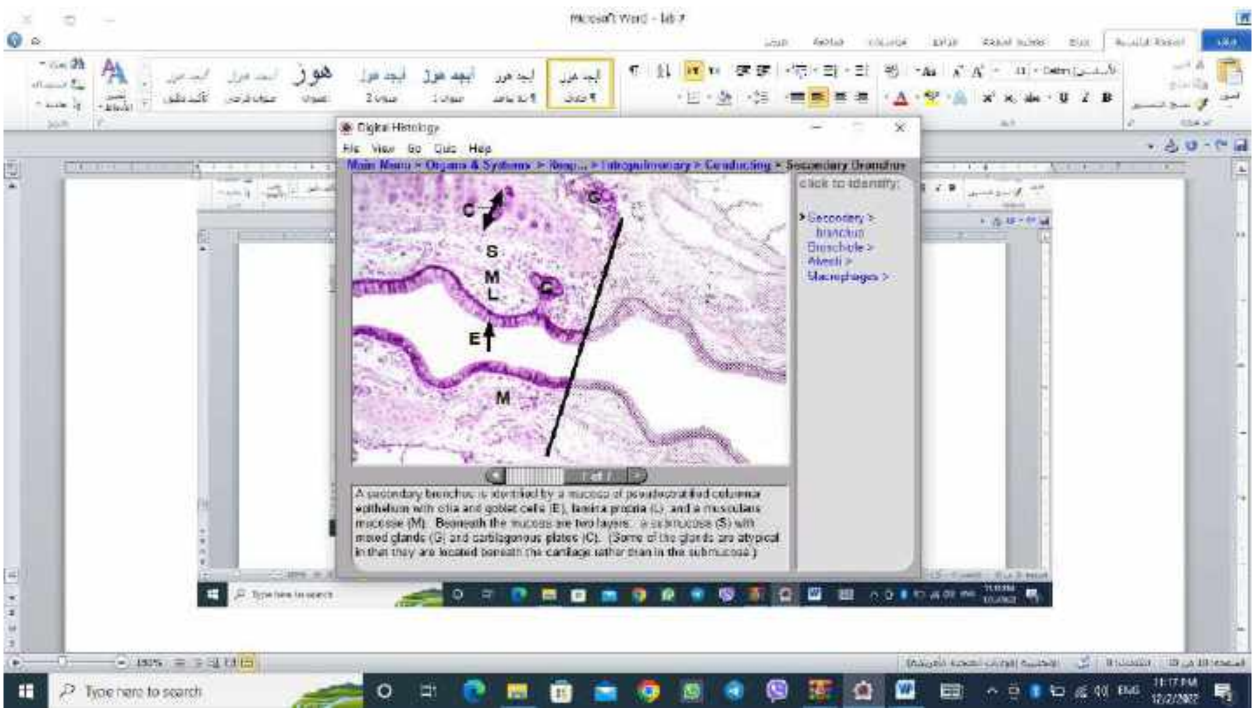
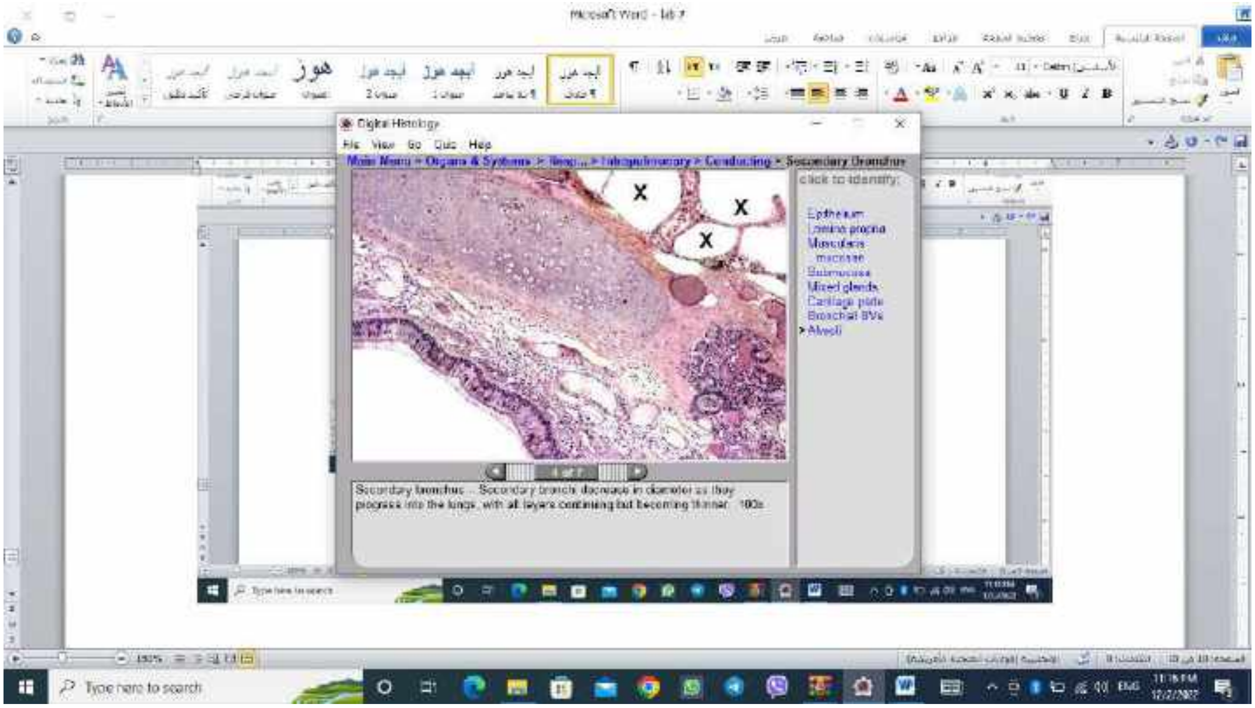


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Secondary Bronchus
click to identify:
Secondary bronchus >
Bronchiole >
Alveoli >
Macrophages >
C
G
S
M
L
G
E
M
A secondary bronchus is identified by a mucosa of pseudostratified columnar epithelium with cilia and goblet cells (E), lamina propria (L), and a muscularis mucosae (M). Beneath the mucosa are two layers: a submucosa (S) with mixed glands (G) and cartilaginous plates (C). (Some of the glands are atypical in that they are located beneath the cartilage rather than in the submucosa.)
Type here to search


Digital Histology
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click to identify:
Epithelium
Lamina propria
Muscularis mucosae
Submucosa
Mixed glands
Cartilage plate
Bronchial BVs
Alveoli
X
X
X
Secondary bronchus – Secondary bronchi decrease in diameter as they progress into the lungs, with all layers continuing but becoming thinner. 100x
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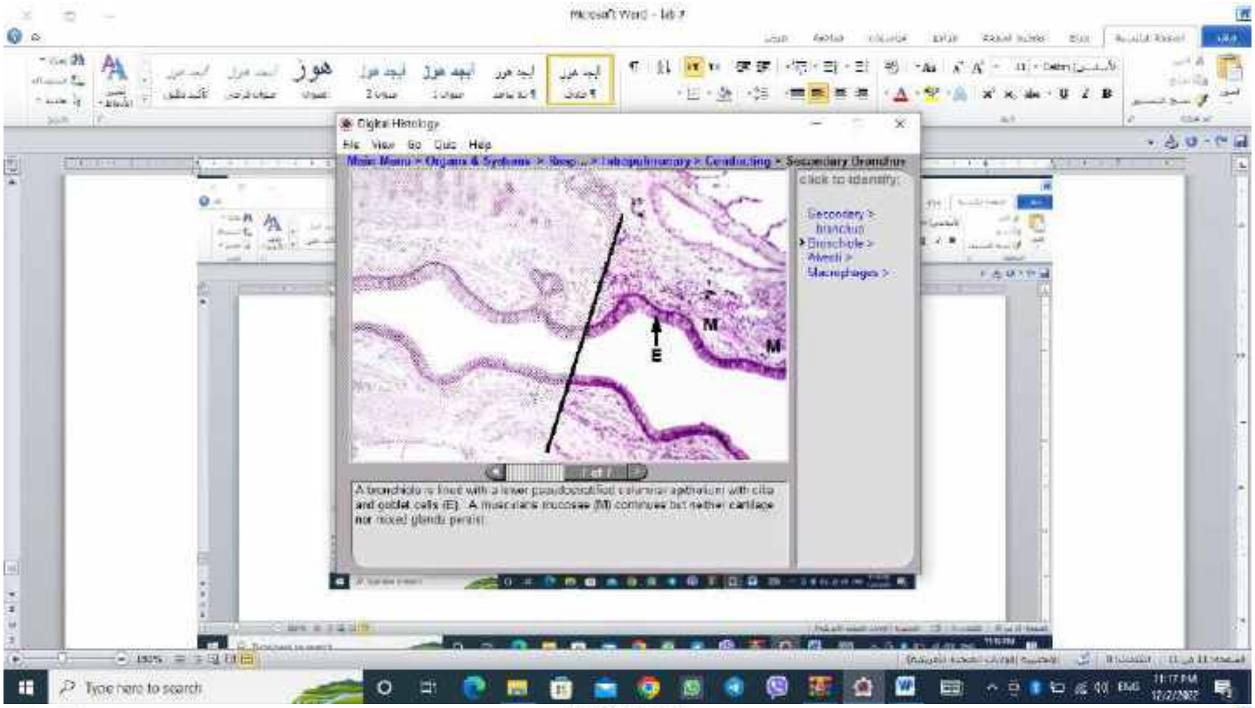
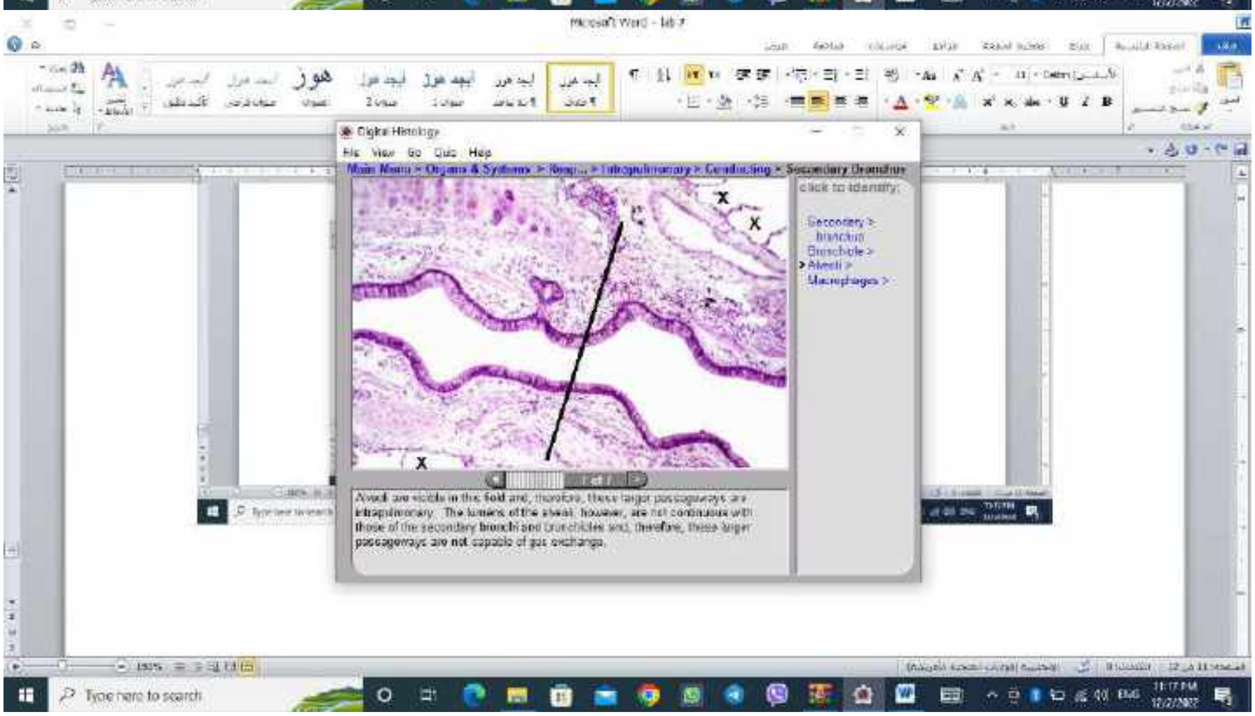
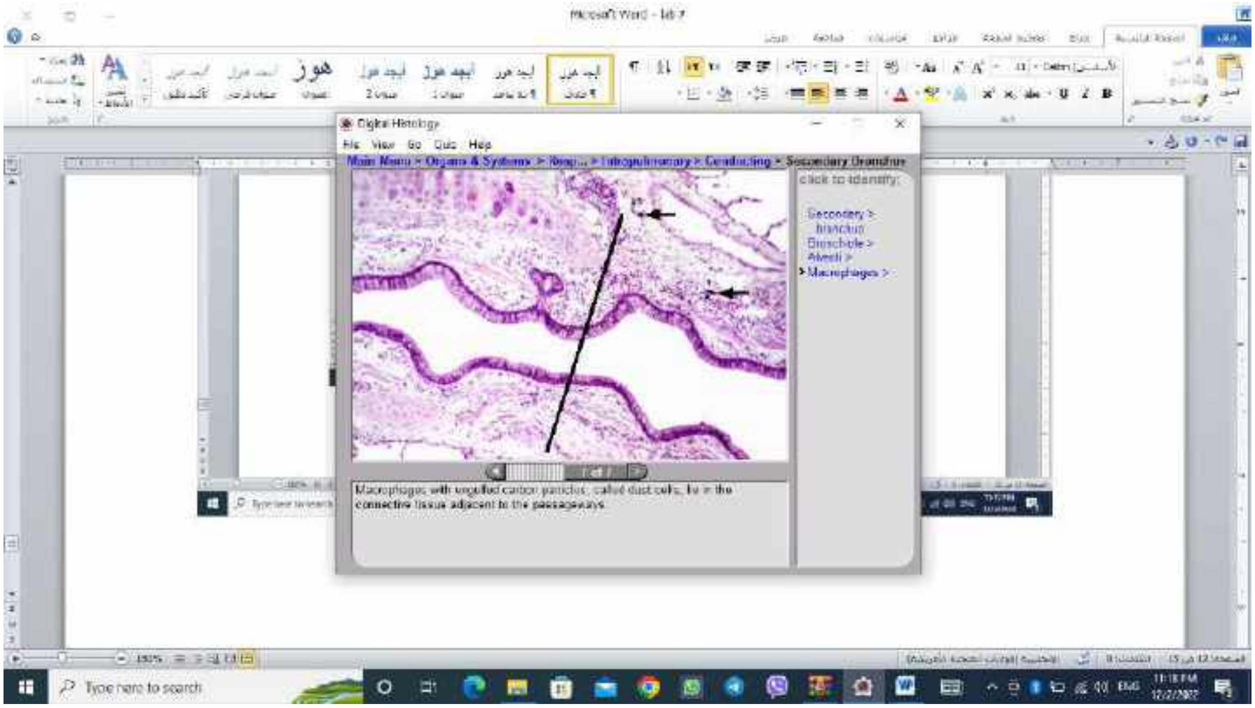
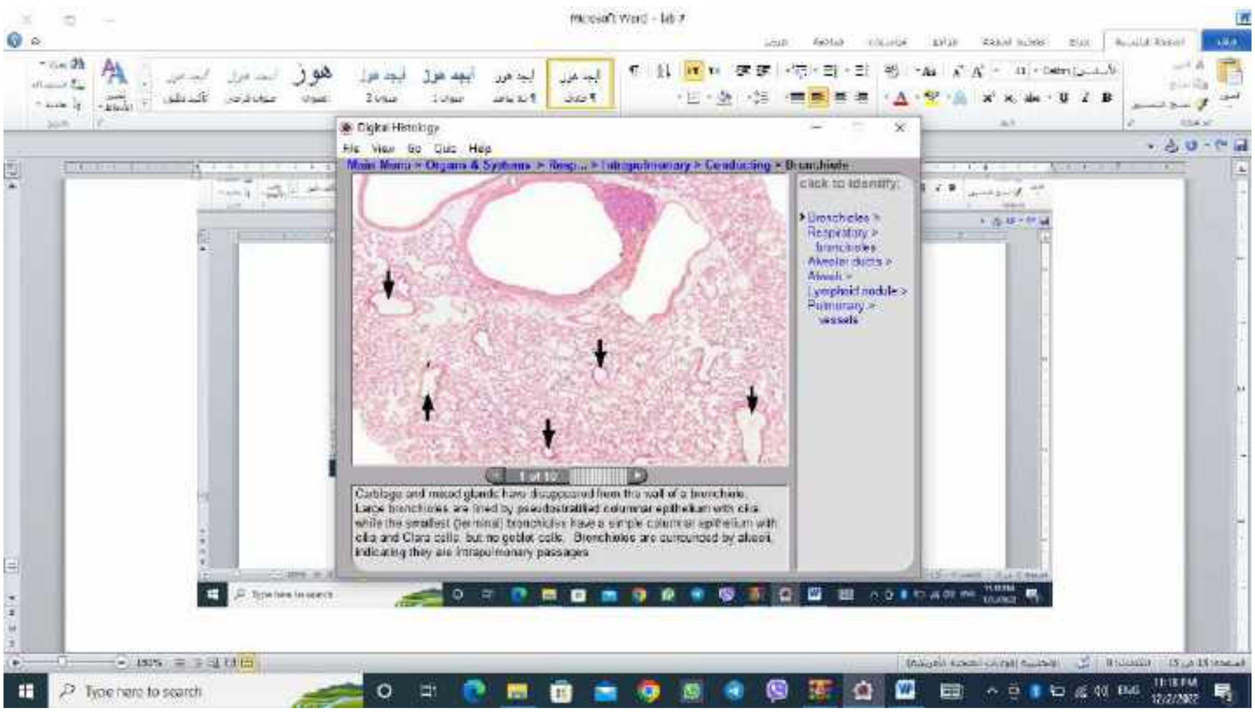
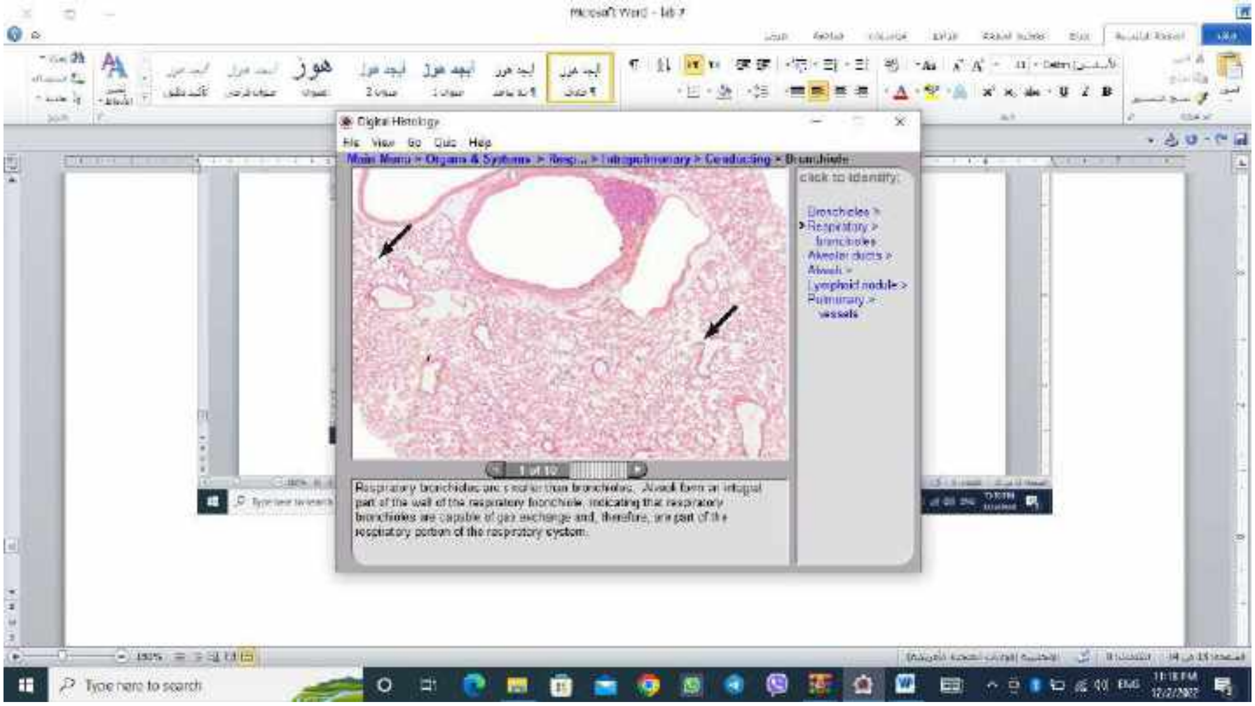
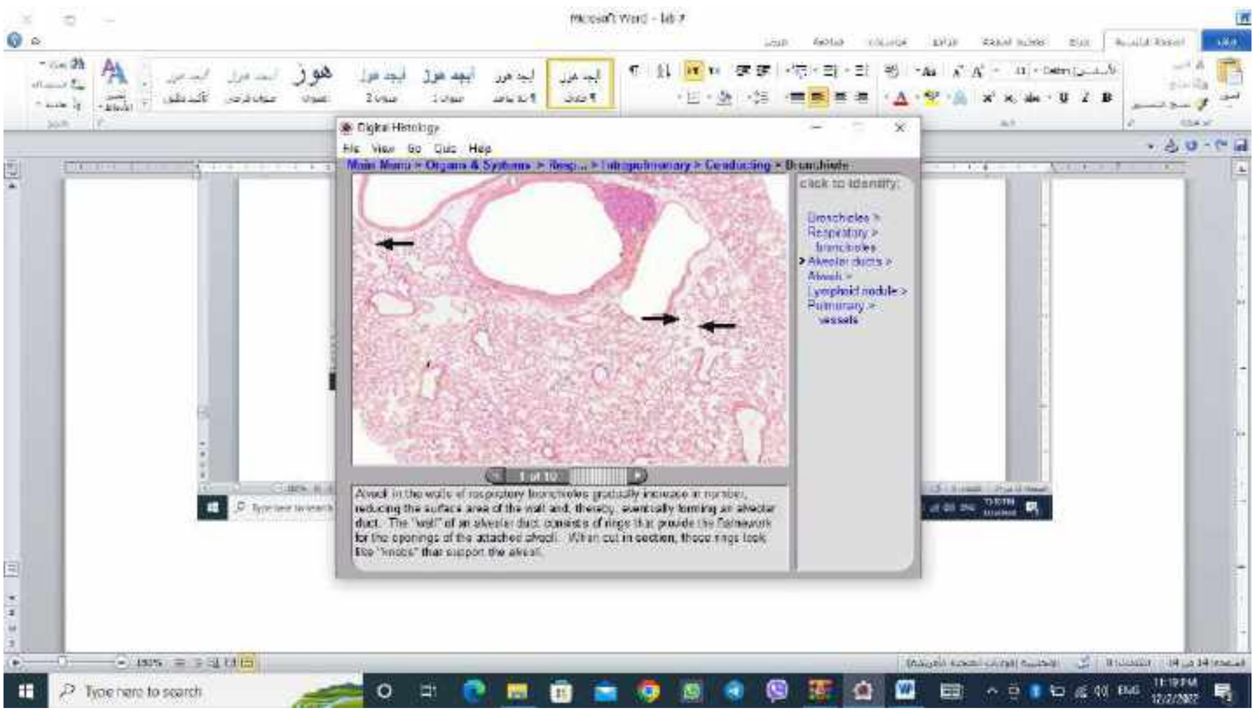

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Secondary > bronchus
Bronchiole >
Alveoli >
Macrophages >
M
M
E
A bronchiole is lined with a lower pseudostratified columnar epithelium with cilia and goblet cells (E). A muscularis mucosae (M) continues but neither cartilage nor mixed glands persist.
Type here to search

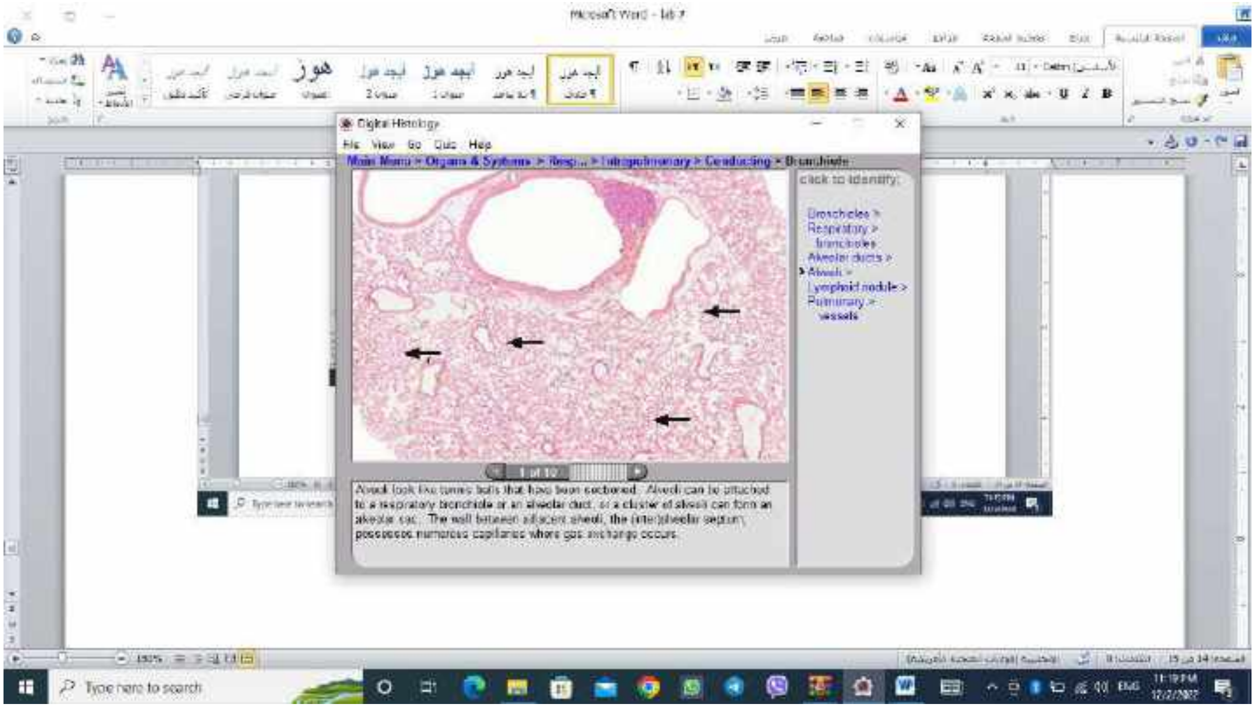

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Secondary > bronchus
Bronchiole >
Alveoli >
Macrophages >
X
X
X
Alveoli are visible in this field and, therefore, these larger passageways are intrapulmonary. The lumens of the alveoli, however, are not continuous with those of the secondary bronchi and bronchioles and, therefore, these larger passageways are not capable of gas exchange.
Type here to search

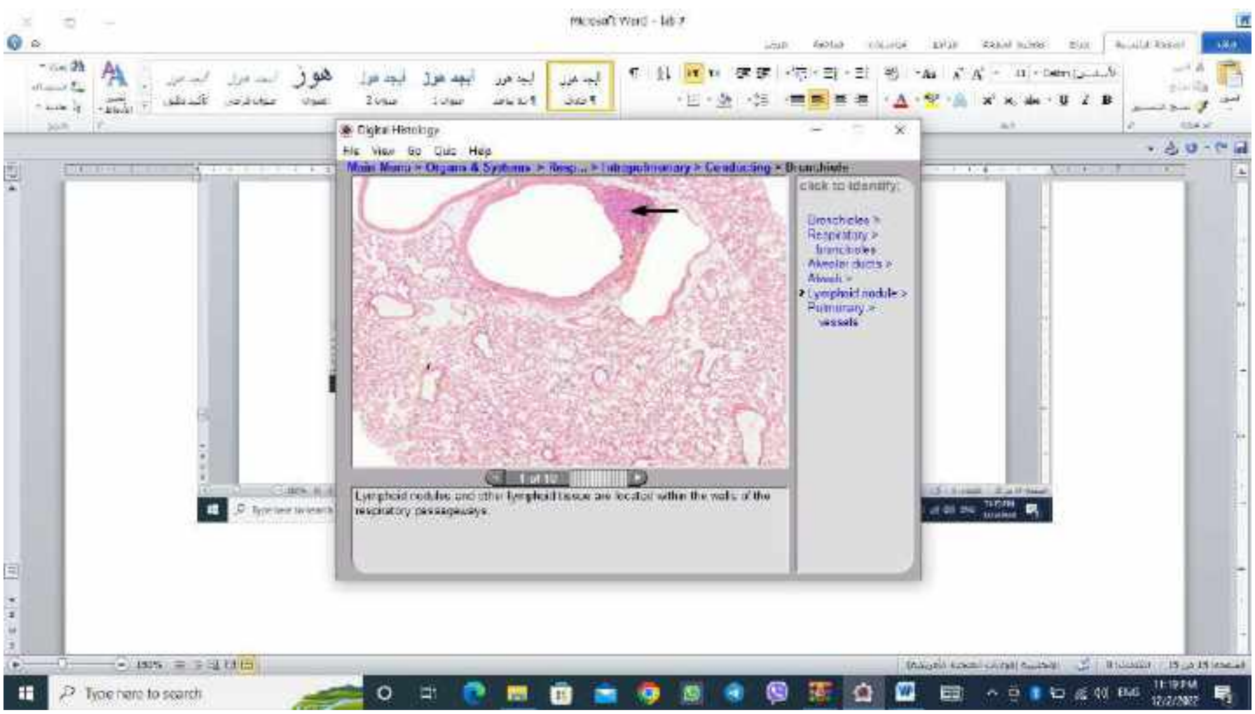

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Secondary Bronchus
click to identify:
Secondary > bronchus
Bronchiole >
Alveoli >
Macrophages >
Macrophages with engulfed carbon particles, called dust cells, lie in the connective tissue adjacent to the passageways.
Type here to search

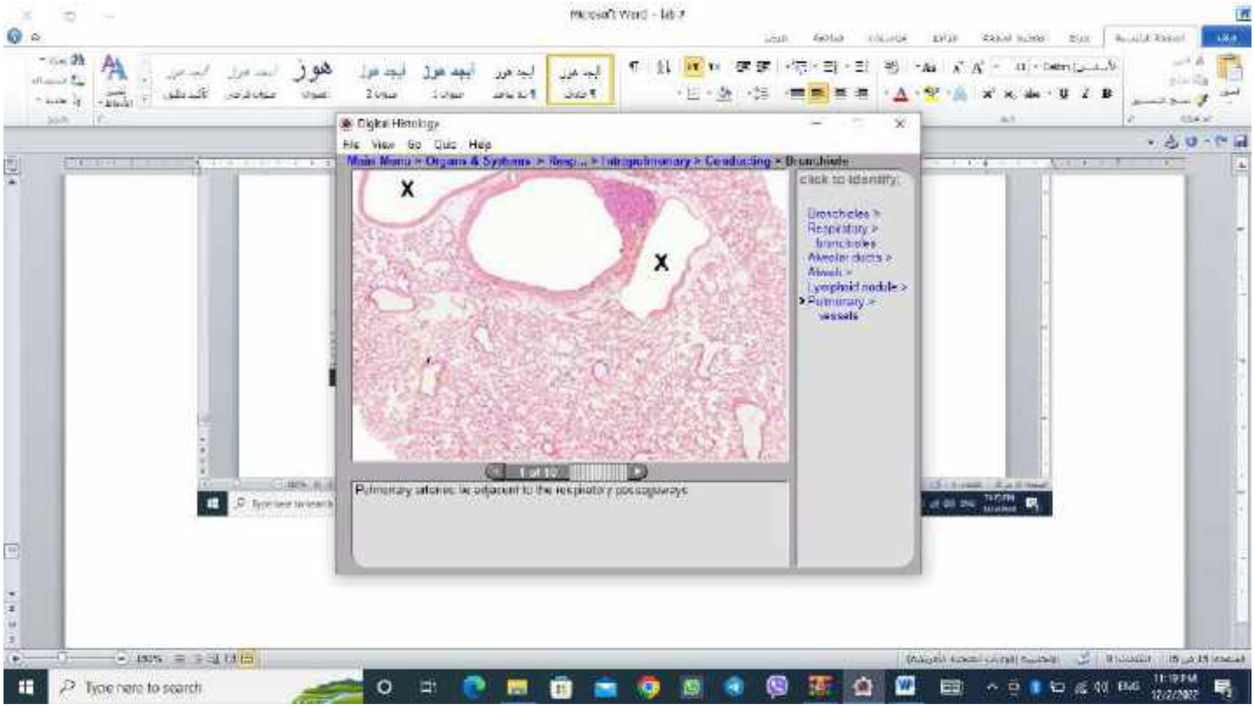

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Bronchiole
click to identify:
Bronchioles >
Respiratory > bronchioles
Alveolar ducts >
Alveoli >
Lymphoid nodule >
Pulmonary > vessels
1 of 10
Cartilage and mixed glands have disappeared from the wall of a bronchiole. Large bronchioles are lined by pseudostratified columnar epithelium with cilia while the smallest (terminal) bronchioles have a simple columnar epithelium with cilia and Clara cells, but no goblet cells. Bronchioles are surrounded by alveoli indicating they are intrapulmonary passages.
Type here to search


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Bronchiole
click to identify:
Bronchioles >
Respiratory > bronchioles
Alveolar ducts >
Alveoli >
Lymphoid nodule >
Pulmonary > vessels
1 of 10
Respiratory bronchioles are smaller than bronchioles. Alveoli form an integral part of the wall of the respiratory bronchiole, indicating that respiratory bronchioles are capable of gas exchange and, therefore, are part of the respiratory portion of the respiratory system.
Type here to search

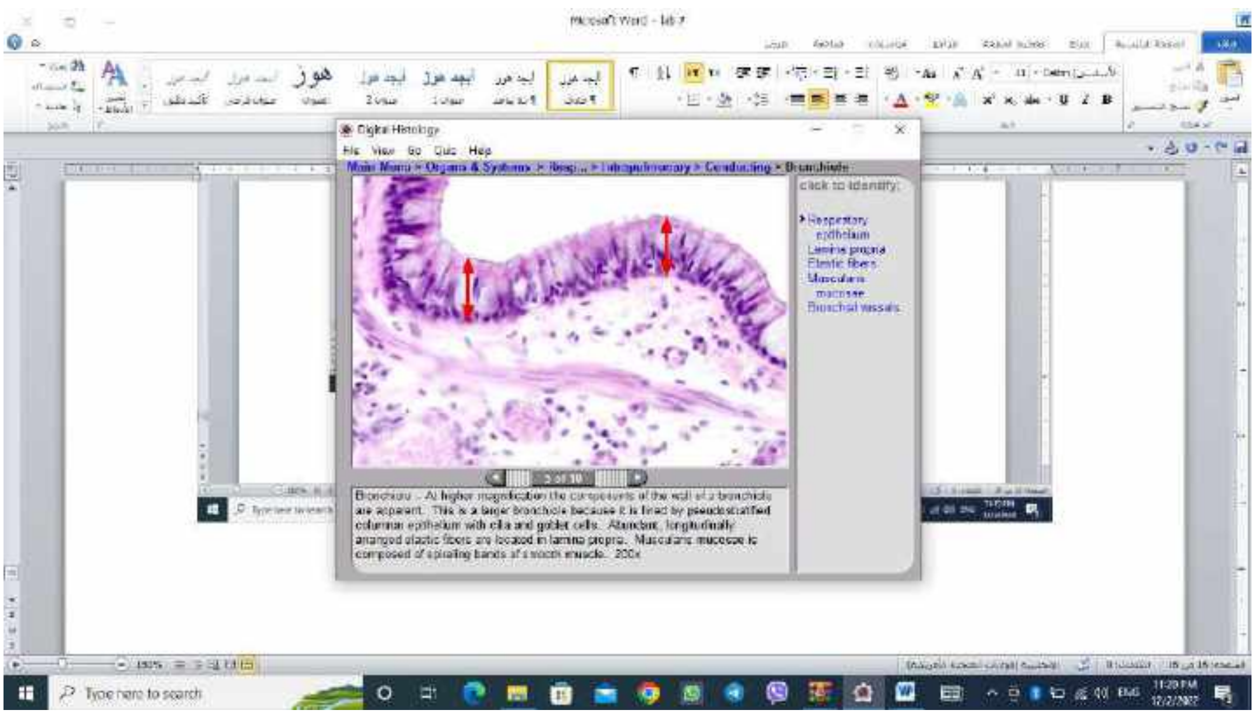

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Bronchiole
click to identify:
Bronchioles >
Respiratory > bronchioles
Alveolar ducts >
Alveoli >
Lymphoid nodule >
Pulmonary > vessels
1 of 10
Alveoli in the walls of respiratory bronchioles gradually increase in number, reducing the surface area of the wall and, thereby, eventually forming an alveolar duct. The "wall" of an alveolar duct consists of rings that provide the framework for the openings of the attached alveoli. When cut in section, these rings look like "knobs" that support the alveoli.
Type here to search

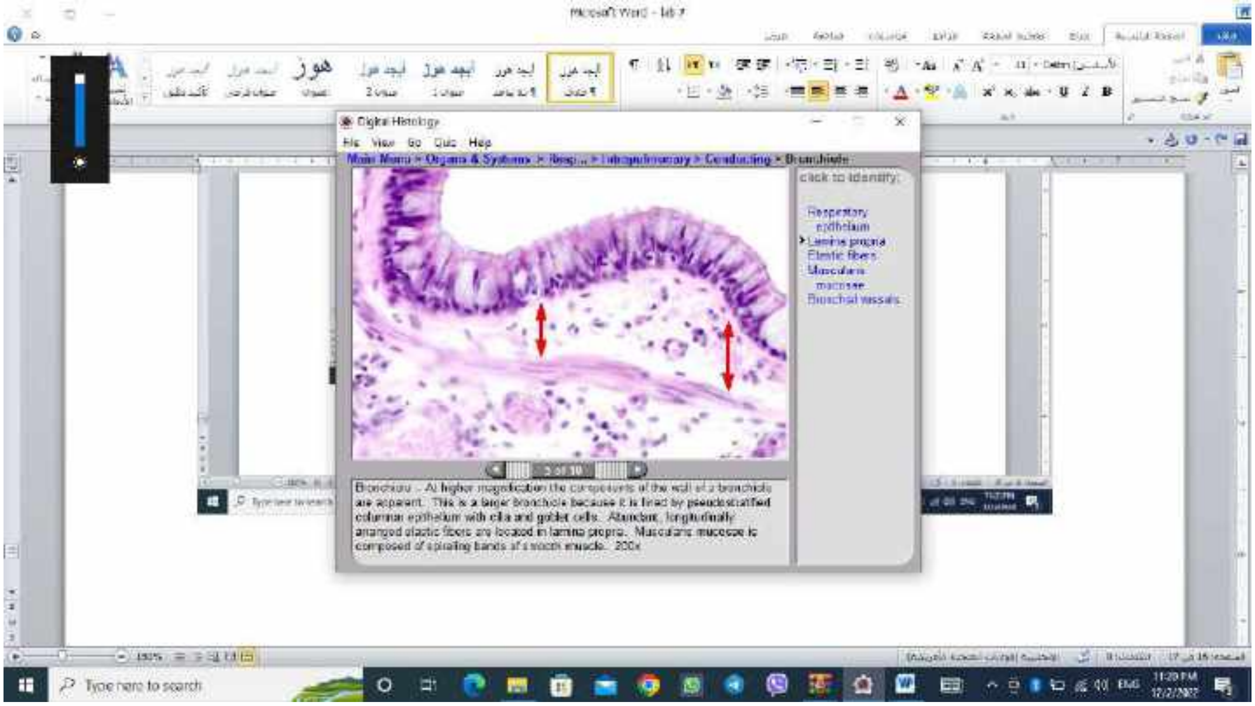

Digital Histology
File View Go Quiz Help
click to identify:
Bronchioles >
Respiratory > bronchioles
Alveolar ducts >
Alveoli >
Lymphoid nodule >
Pulmonary > vessels
Alveoli look like tennis balls that have been sectioned. Alveoli can be attached to a respiratory bronchiole or an alveolar duct, or a cluster of alveoli can form an alveolar sac. The wall between adjacent alveoli, the (inter)alveolar septum, possesses numerous capillaries where gas exchange occurs.

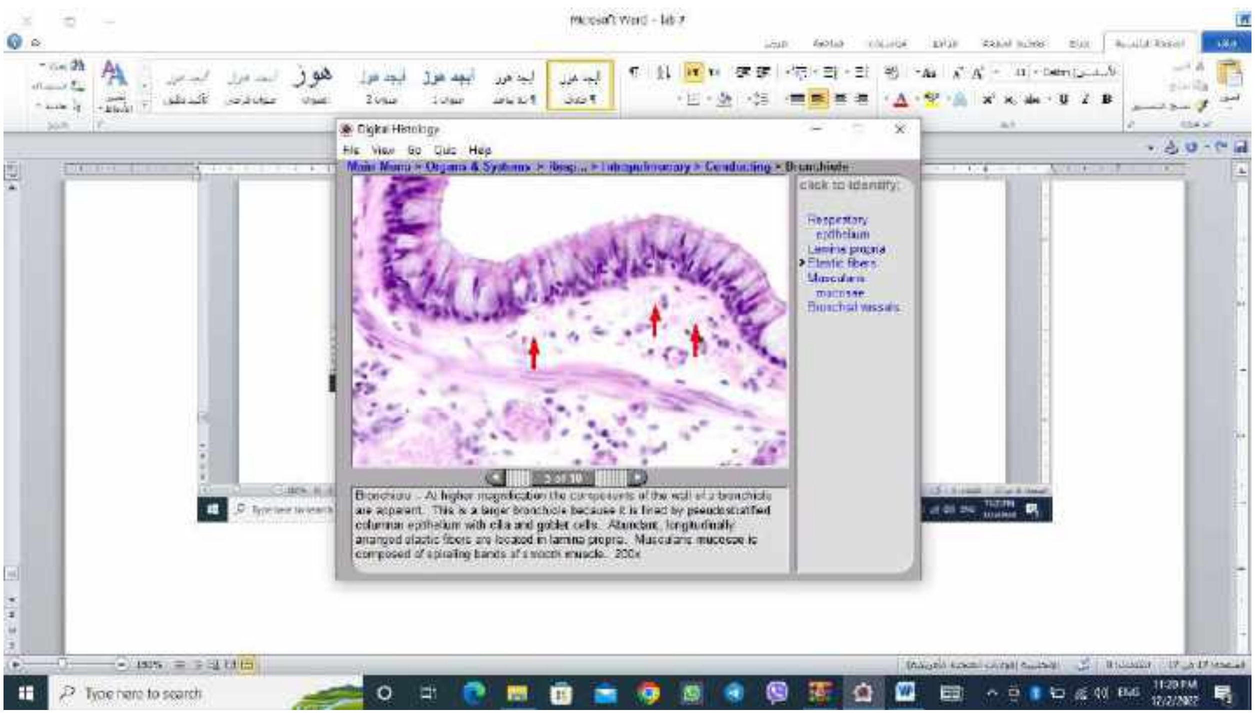

Digital Histology
File View Go Quiz Help
click to identify:
Bronchioles >
Respiratory > bronchioles
Alveolar ducts >
Alveoli >
Lymphoid nodule >
Pulmonary > vessels
Lymphoid nodules and other lymphoid tissue are located within the walls of the respiratory passageways.


Digital Histology
File View Go Quiz Help
click to identify:
Bronchioles
Respiratory bronchioles
Alveolar ducts
Alveoli
Lymphoid nodule
Pulmonary vessels
X
X
1 of 10

0


Digital Histology
File View Go Quiz Help
click to identify:
Respiratory epithelium
Lamina propria
Elastic fibers
Muscularis mucosae
Bronchial vessels
3 of 10


Digital Histology
File View Go Quiz Help
click to identify:
Respiratory epithelium
Lamina propria
Elastic fibers
Muscularis mucosae
Bronchial vessels
Bronchiole - At higher magnification the components of the wall of a bronchiole are apparent. This is a larger bronchiole because it is lined by pseudostratified columnar epithelium with cilia and goblet cells. Abundant, longitudinally arranged elastic fibers are located in lamina propria. Muscularis mucosae is composed of spiraling bands of smooth muscle. 200x
Type here to search


Digital Histology
File View Go Quiz Help
click to identify:
Respiratory epithelium
Lamina propria
Elastic fibers
Muscularis mucosae
Bronchial vessels
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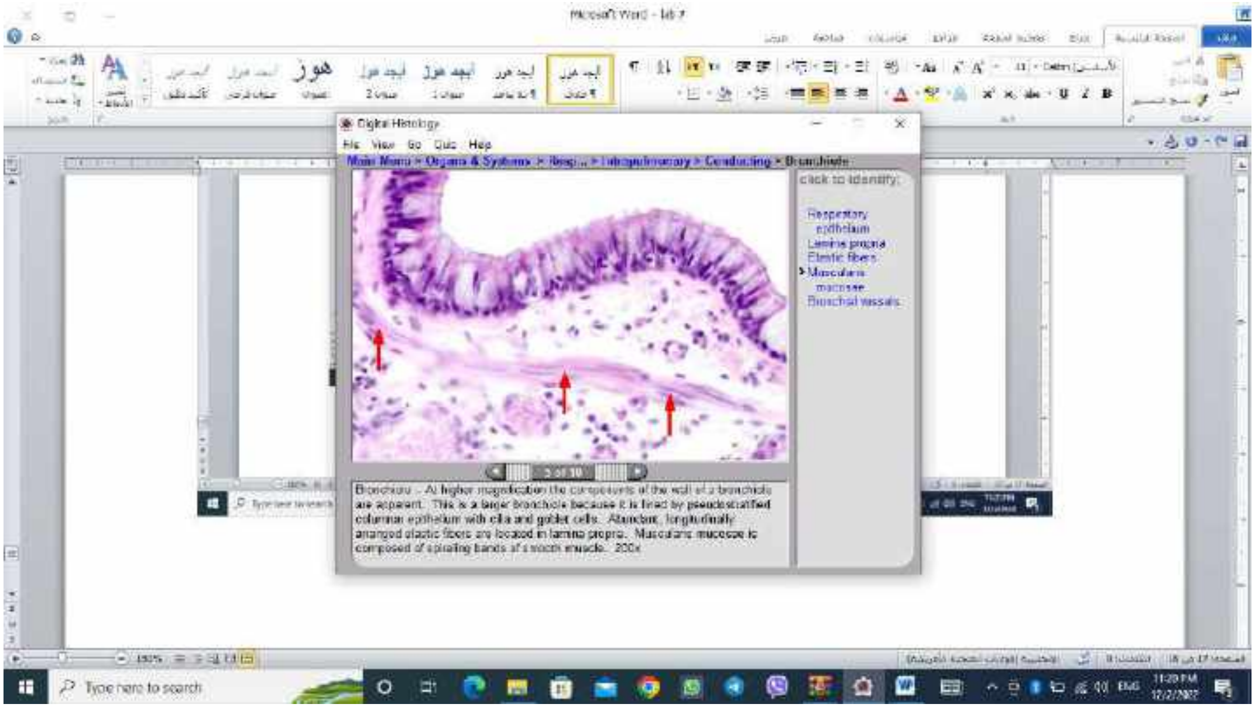
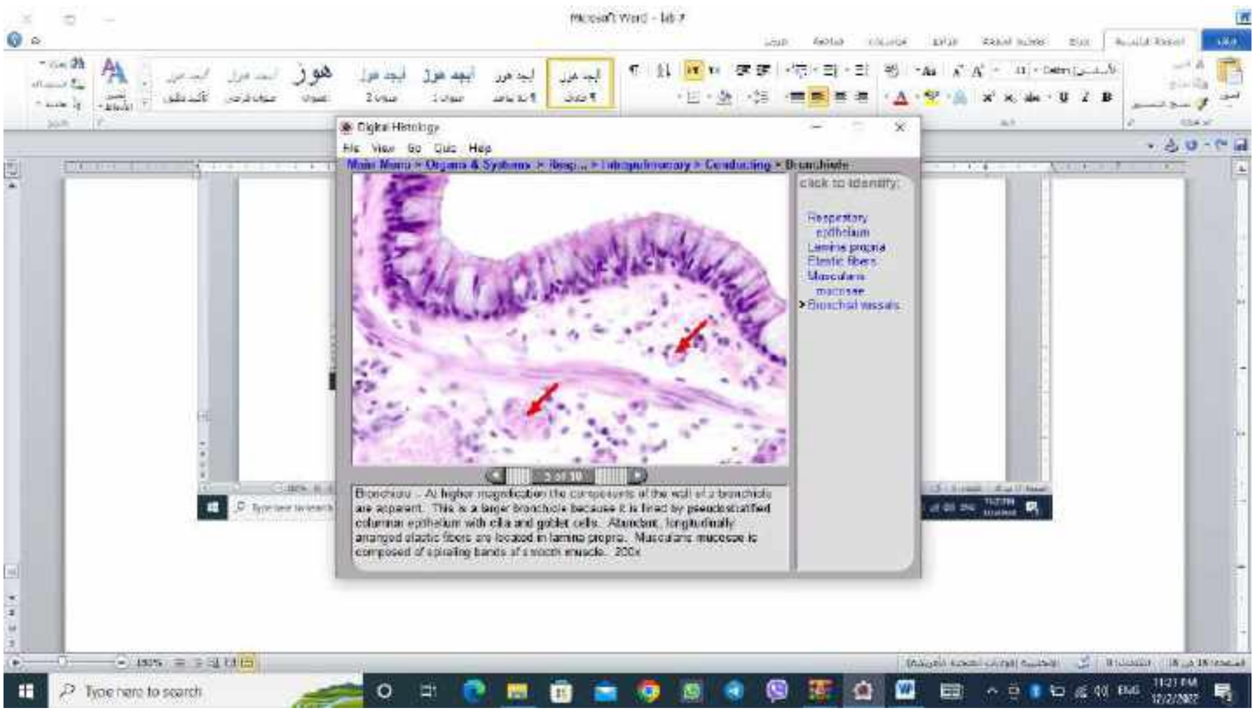
Type here to search



Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Bronchiole
click to identify:
Respiratory epithelium
Lamina propria
Elastic fibers
Muscularis mucosae
Bronchial vessels
Bronchiole - At higher magnification the components of the wall of a bronchiole are apparent. This is a larger bronchiole because it is lined by pseudostratified columnar epithelium with cilia and goblet cells. Abundant, longitudinally arranged elastic fibers are located in lamina propria. Muscularis mucosae is composed of spiraling bands of smooth muscle. 200x
Type here to search



Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Bronchiole
click to identify:
Respiratory epithelium
Lamina propria
Elastic fibers
Muscularis mucosae
Bronchial vessels
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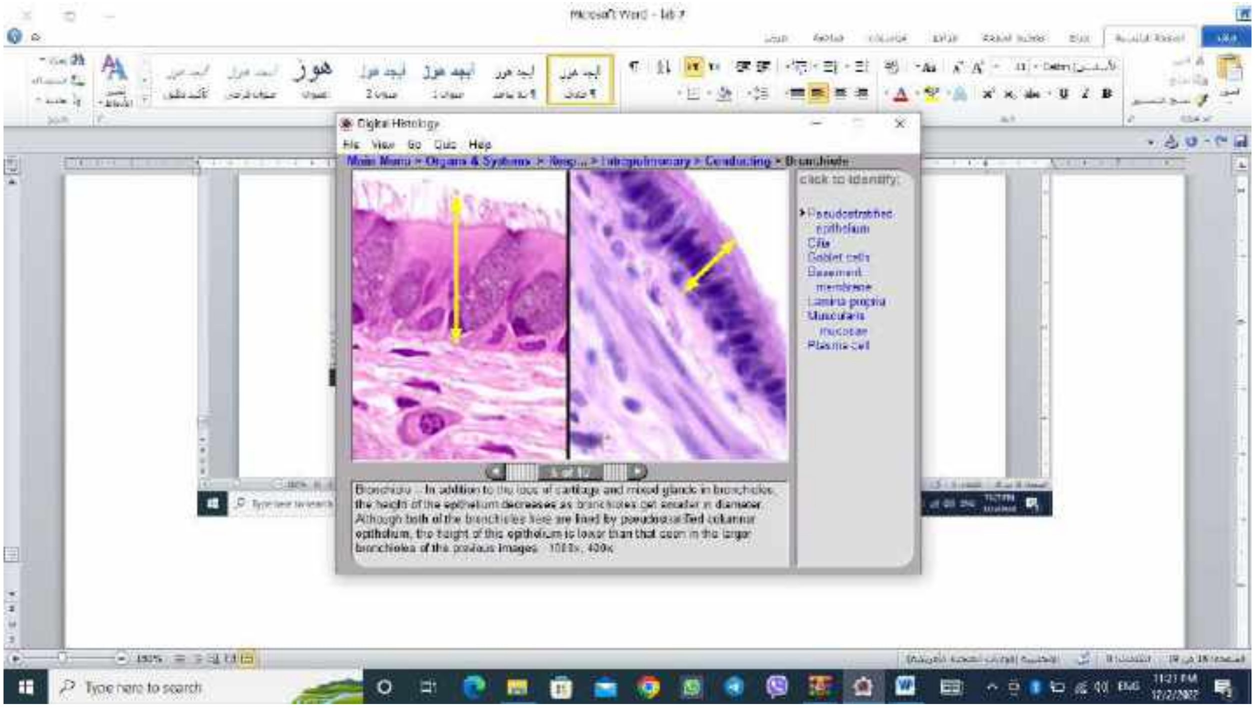
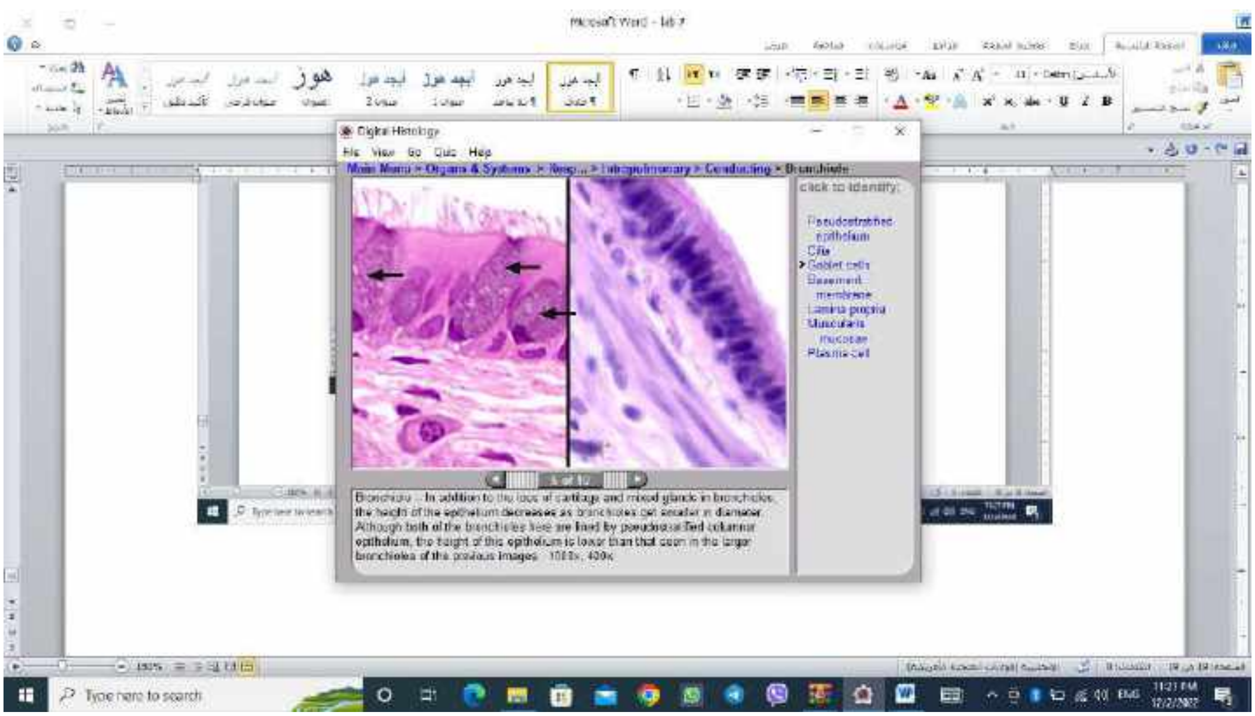
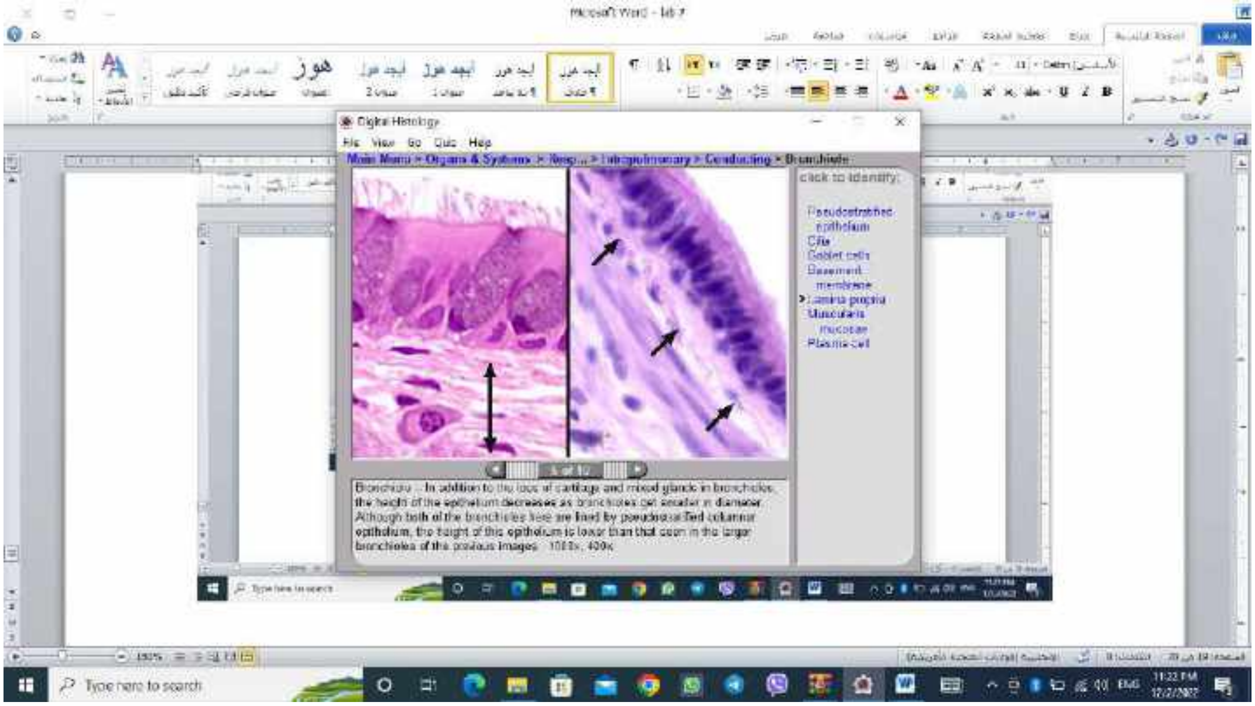
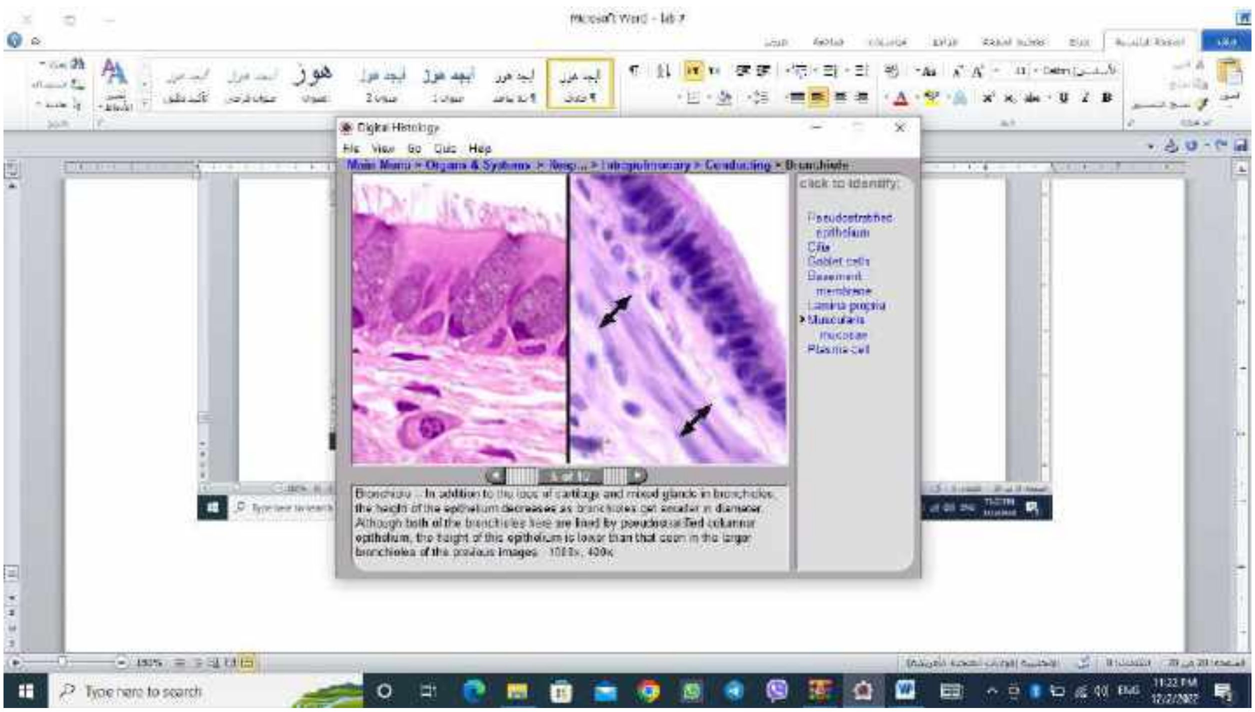
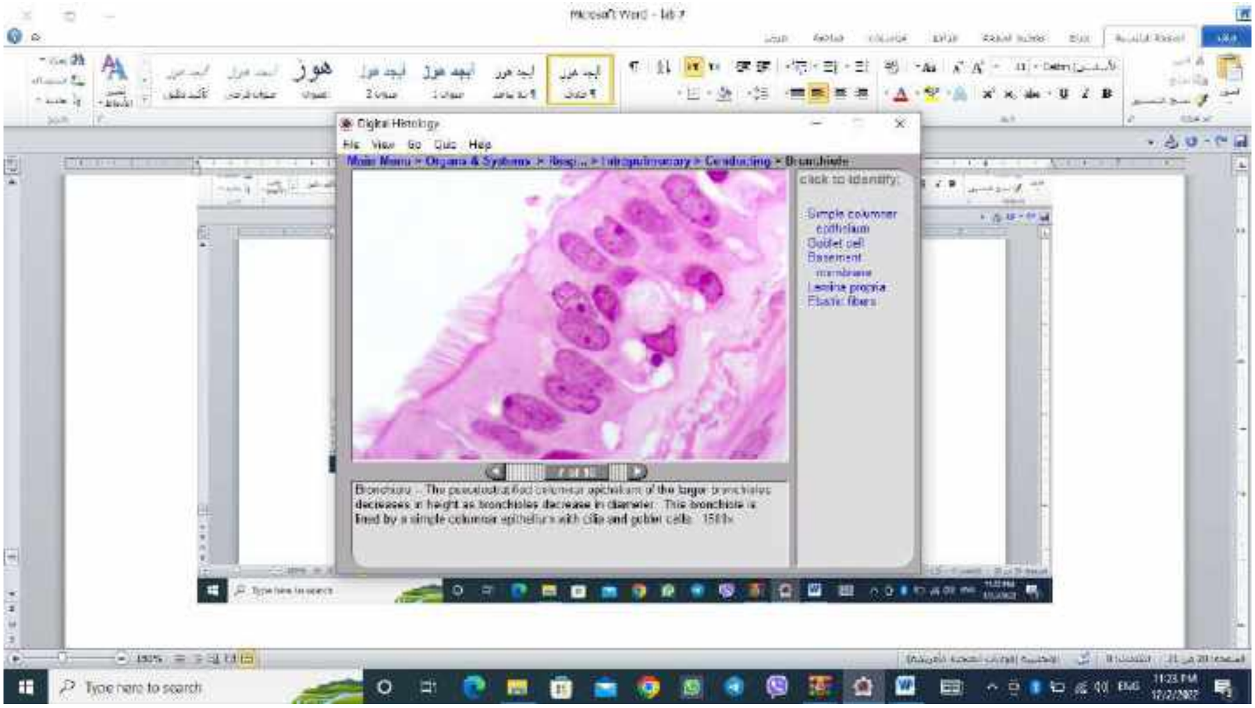
Type here to search

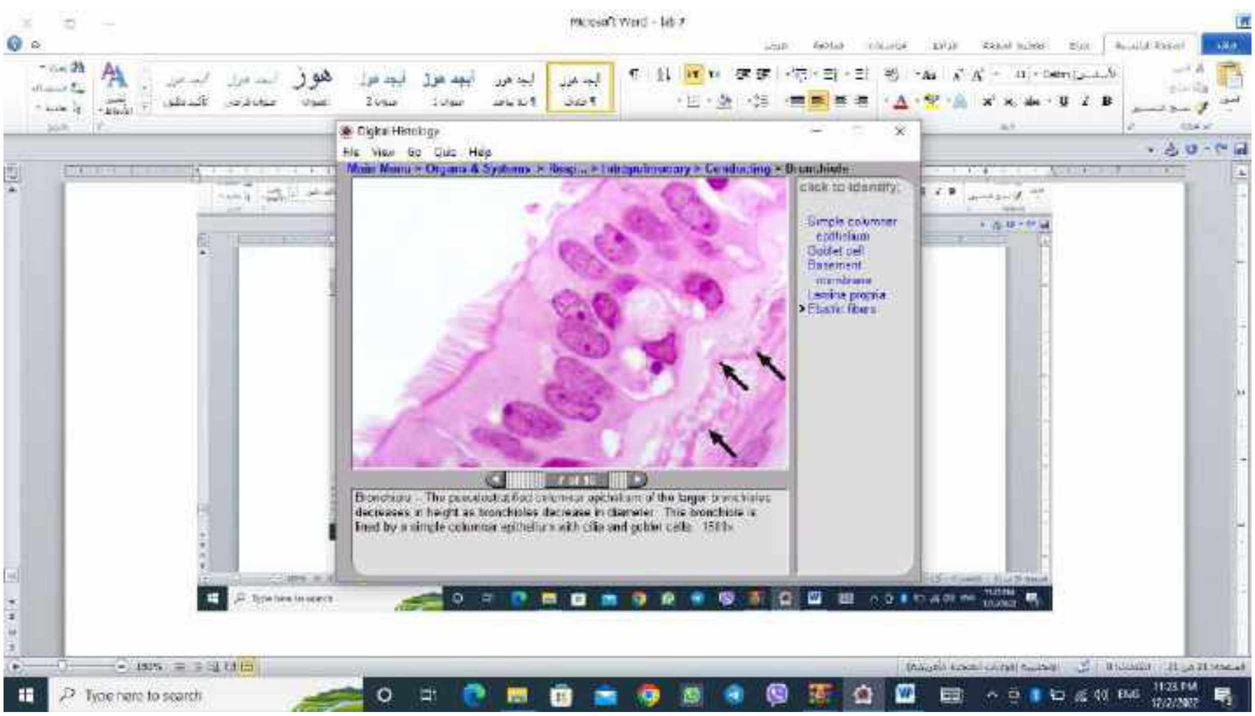

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Cilia
Goblet cells
Basement membrane
Lamina propria
Muscularis mucosae
Plasma cell
Type here to search


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Cilia
Goblet cells
Basement membrane
Lamina propria
Muscularis mucosae
Plasma cell
Type here to search

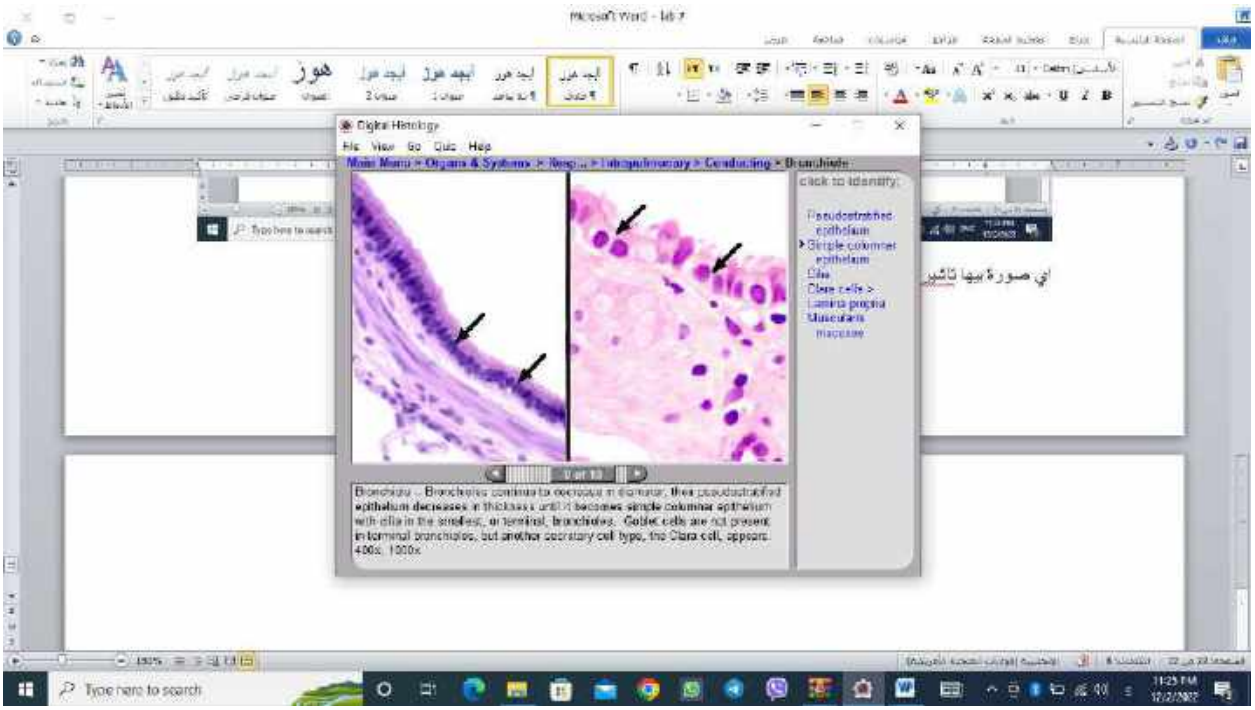

Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Cilia
Goblet cells
Basement membrane
Lamina propria
Muscularis mucosae
Plasma cell

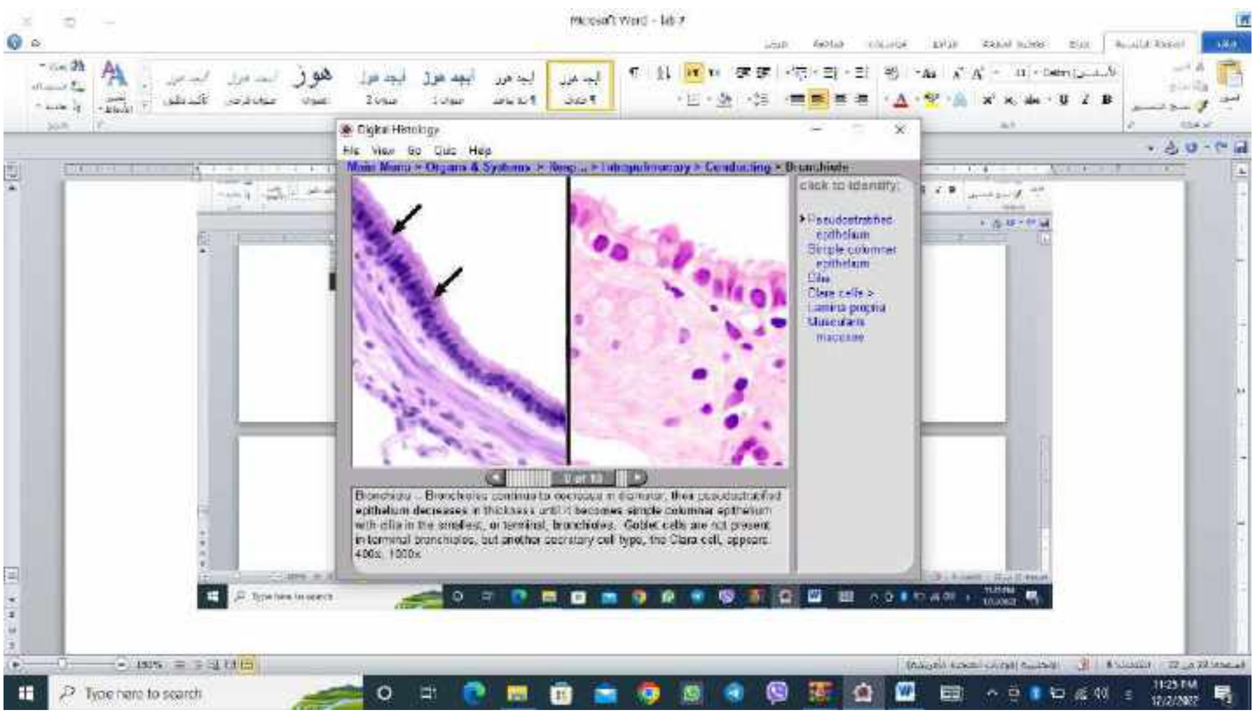

Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Cilia
Goblet cells
Basement membrane
Lamina propria
Muscularis mucosae
Plasma cell

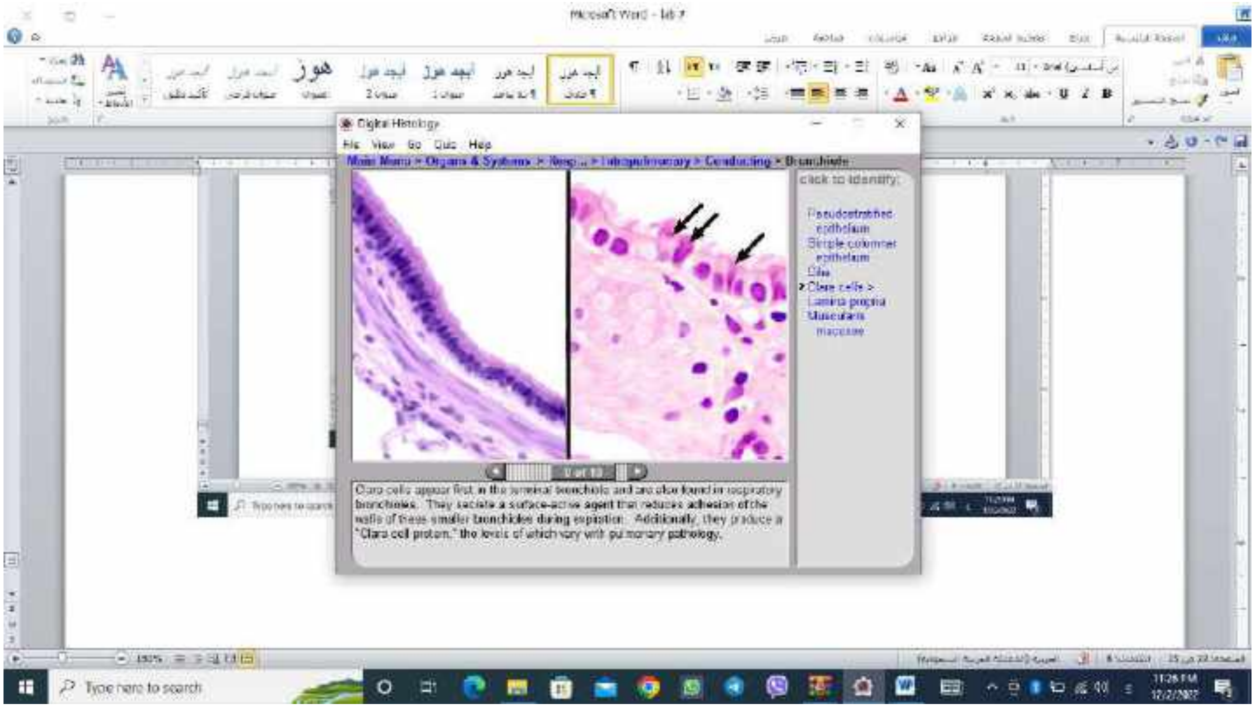


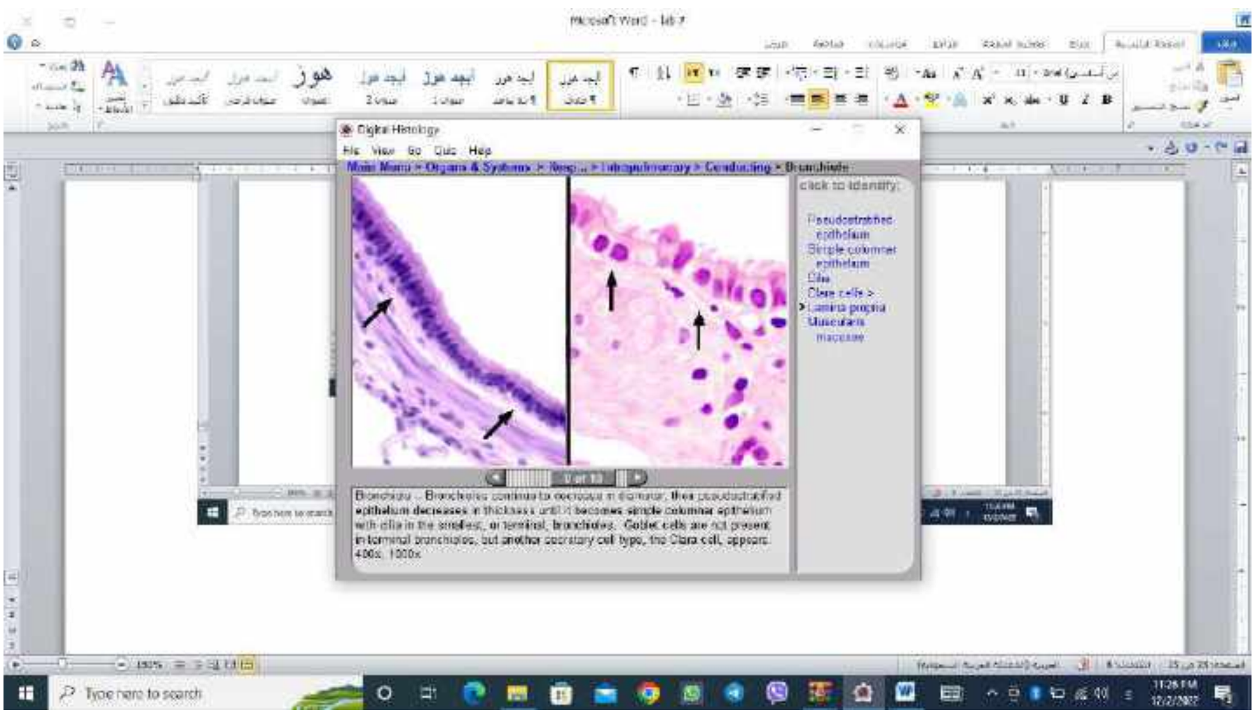


اي صورة بيها تاشيرات لم تذكر هي مطلوبة


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Simple columnar epithelium
Cilia
Clara cells >
Lamina propria
Muscularis mucosae
Bronchiole .. Bronchioles continue to decrease in diameter, the pseudostratified epithelium decreases in thickness until it becomes simple columnar epithelium with cilia in the smallest, or terminal, bronchioles. Goblet cells are not present in terminal bronchioles, but another secretory cell type, the Clara cell, appears. 400x, 1000x
Type here to search


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Simple columnar epithelium
Cilia
Clara cells >
Lamina propria
Muscularis mucosae
Bronchiole .. Bronchioles continue to decrease in diameter, the pseudostratified epithelium decreases in thickness until it becomes simple columnar epithelium with cilia in the smallest, or terminal, bronchioles. Goblet cells are not present in terminal bronchioles, but another secretory cell type, the Clara cell, appears. 400x, 1000x
Type here to search


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Simple columnar epithelium
Cilia
Clara cells >
Lamina propria
Muscularis mucosae
Clara cells appear first in the terminal bronchiole and are also found in respiratory bronchioles. They secrete a surface-active agent that reduces adhesion of the walls of these smaller bronchioles during expiration. Additionally, they produce a "Clara cell protein," the levels of which vary with pulmonary pathology.
Type here to search


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Pseudostratified epithelium
Simple columnar epithelium
Cilia
Clara cells >
Lamina propria
Muscularis mucosae
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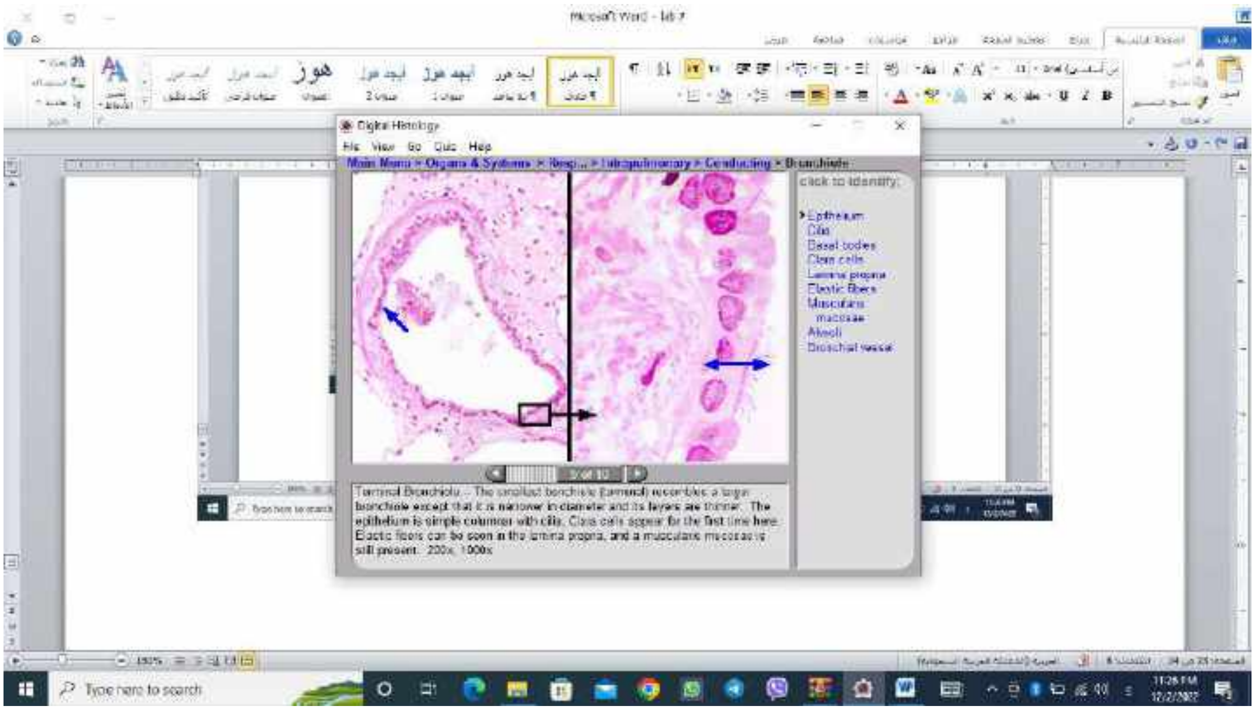
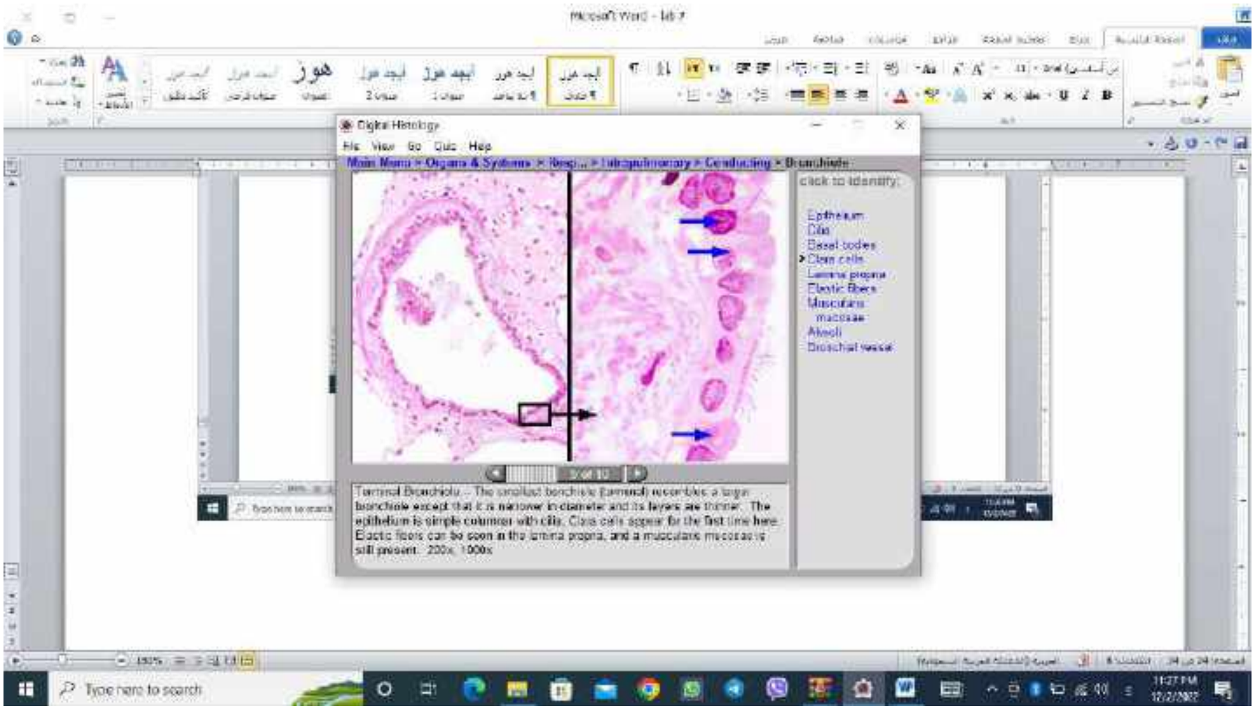
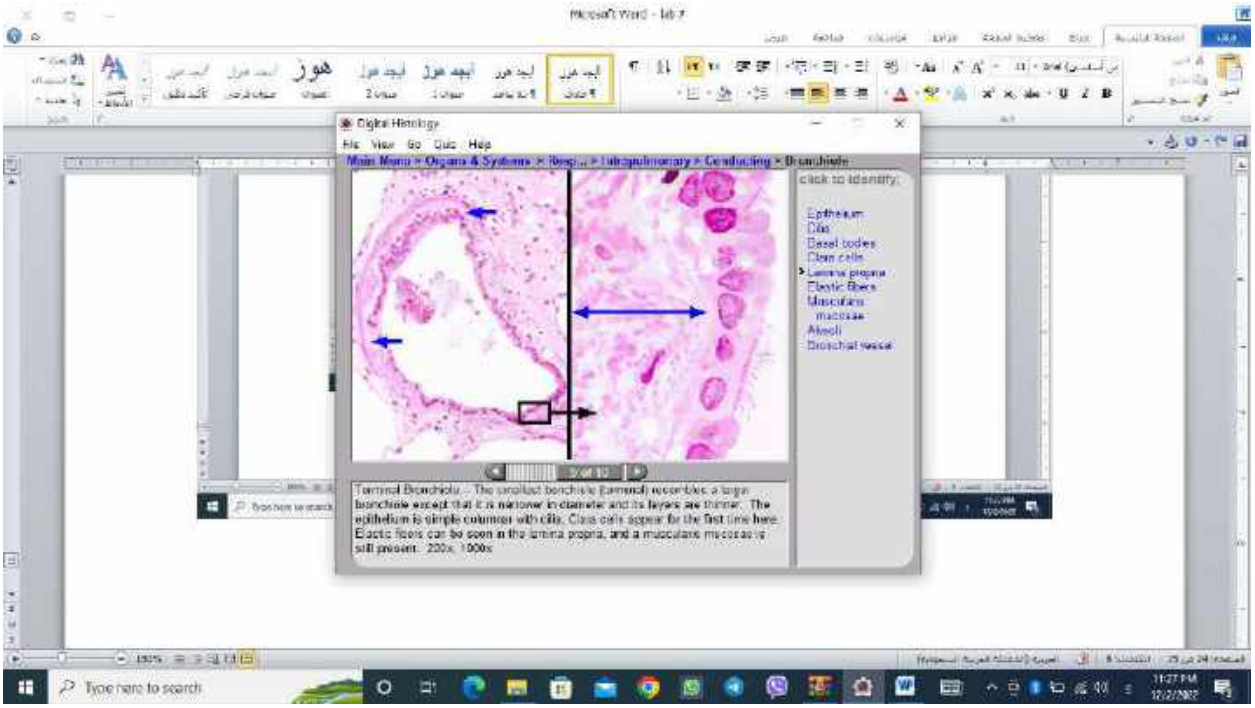
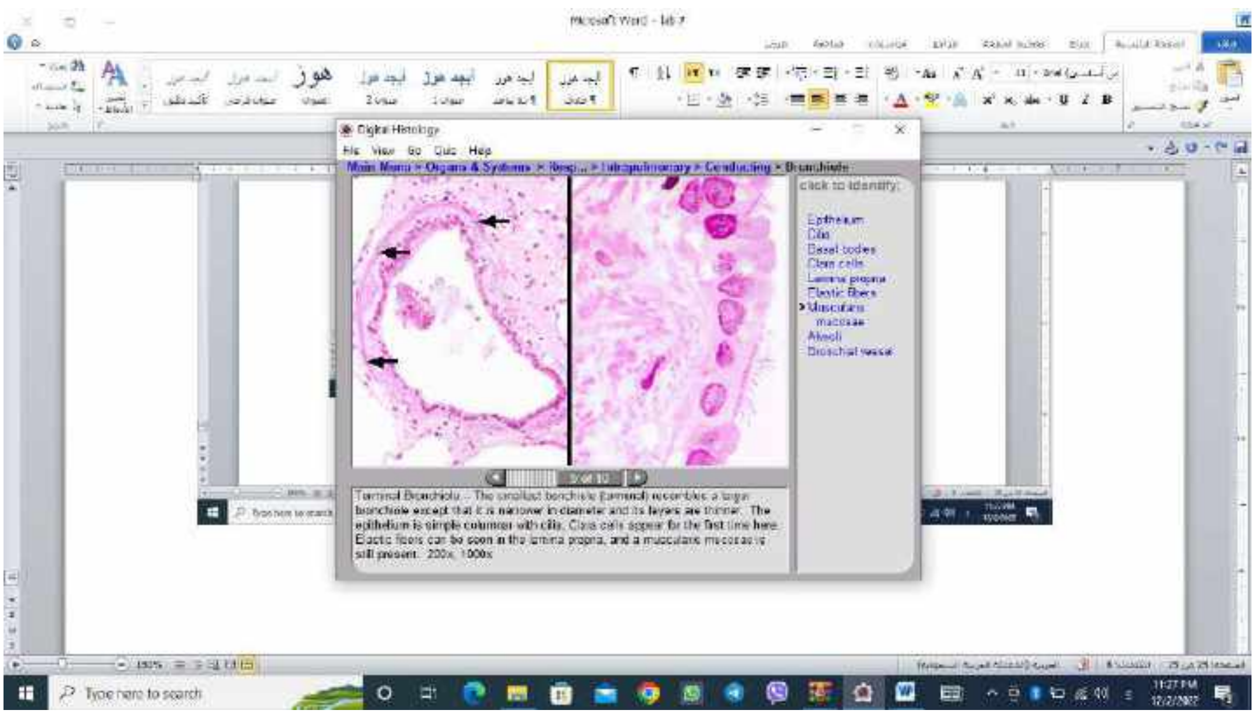
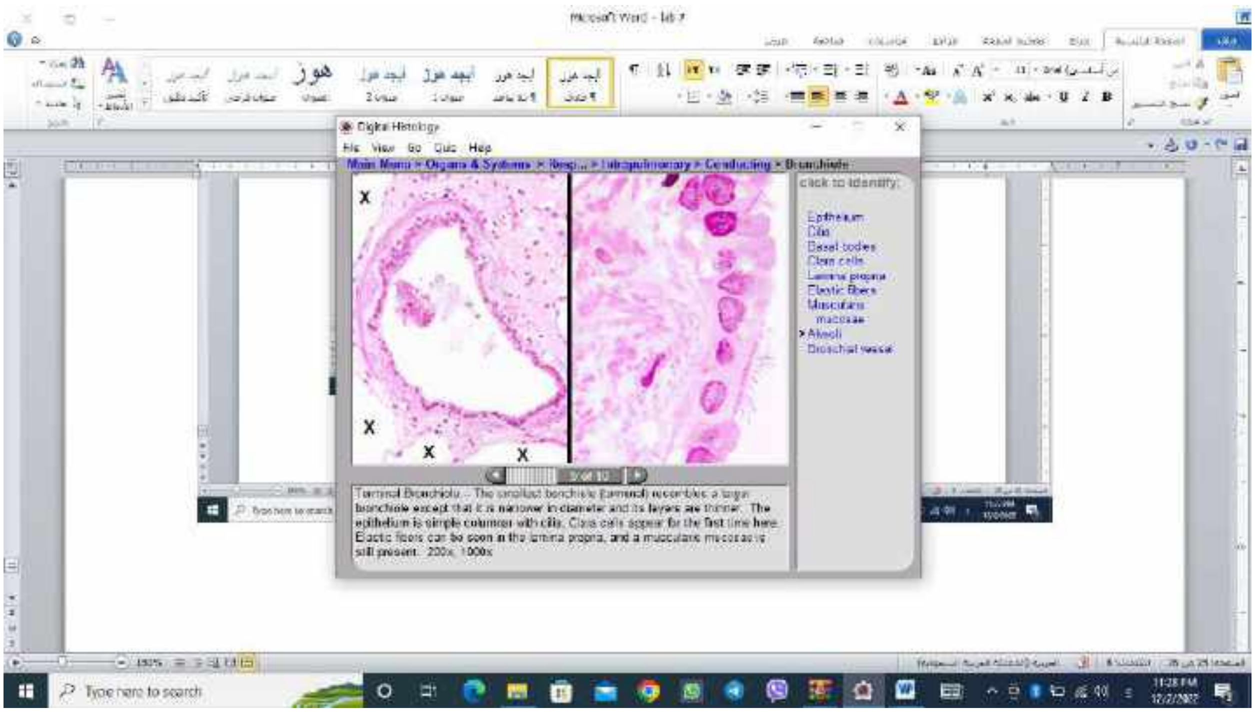
400x, 1000x
Type here to search

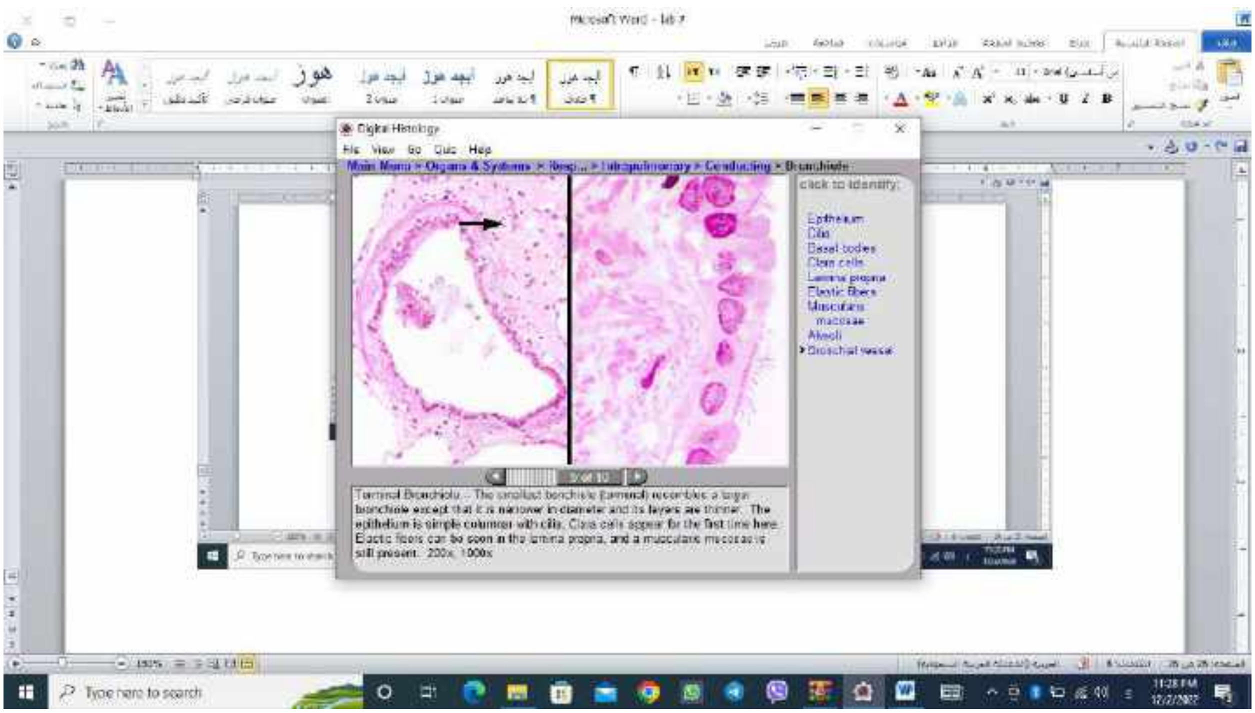

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Epithelium
Cilia
Basal bodies
Clara cells
Lamina propria
Elastic fibers
Muscularis
mucosae
Alveoli
Bronchial vessel
Type here to search

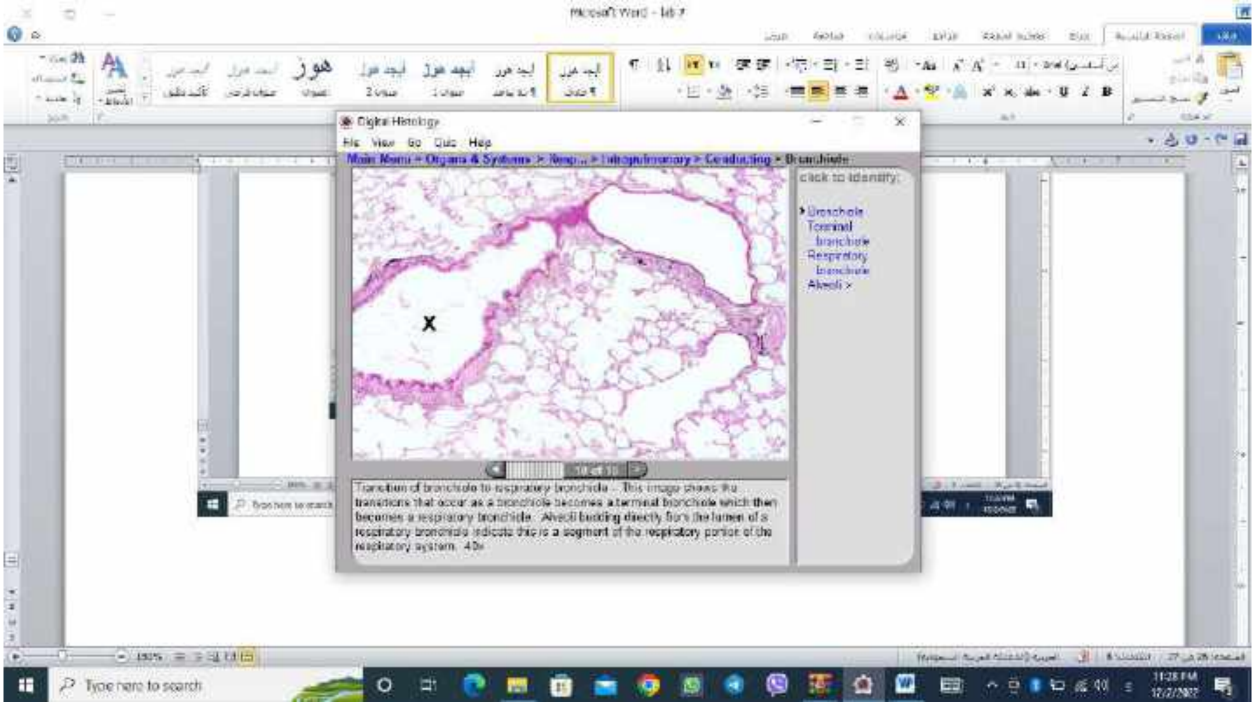

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Epithelium
Cilia
Basal bodies
Clara cells
Lamina propria
Elastic fibers
Muscularis
mucosae
Alveoli
Bronchial vessel
Type here to search

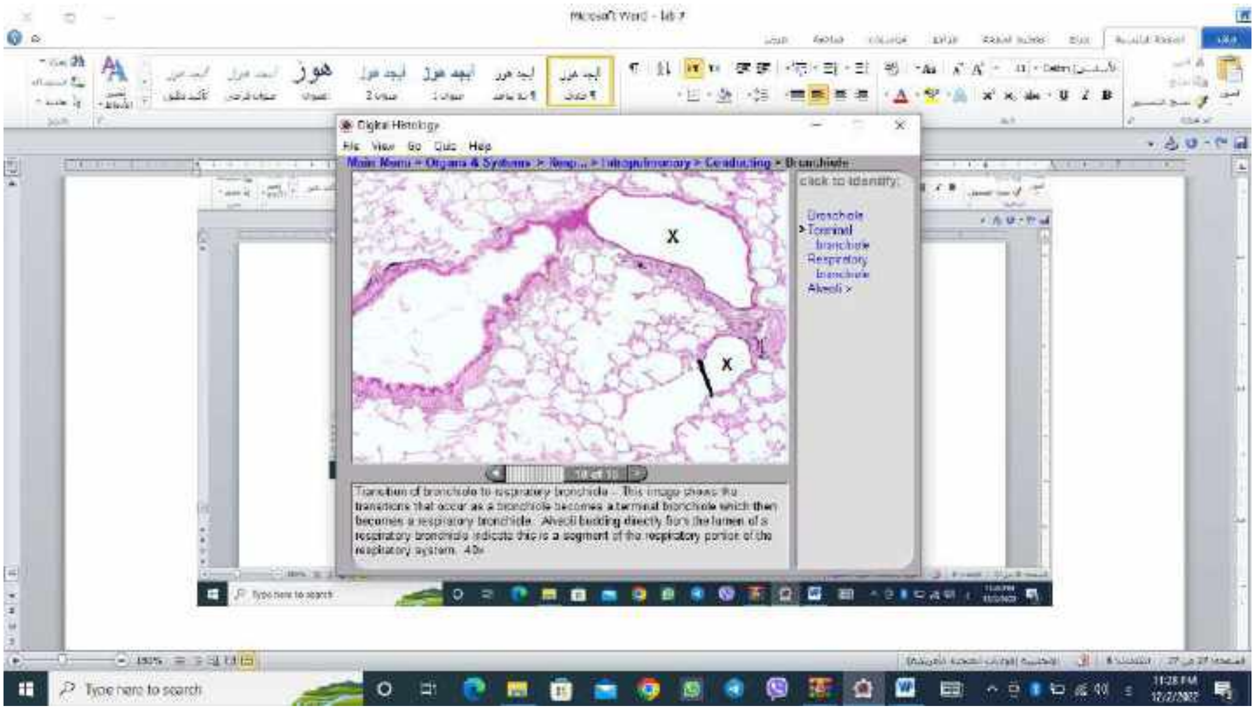

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Bronchiole
click to identify:
Epithelium
Cilia
Basal bodies
Clara cells
Lamina propria
Elastic fibers
Muscularis mucosae
Alveoli
Bronchial vessel
bronchiole except that it is narrower in diameter and its layers are thinner. The epithelium is simple columnar with cilia. Clara cells appear for the first time here.
still present. 200x, 1000x
Type here to search

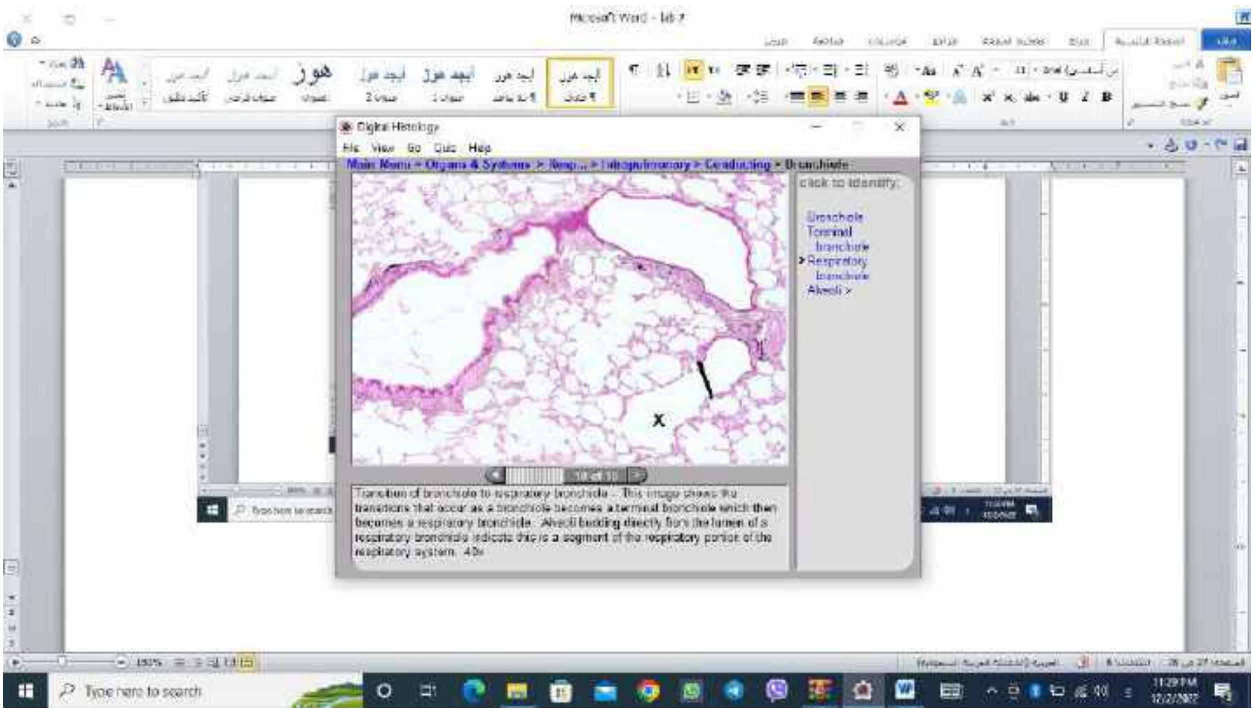

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Conducting > Bronchiole
click to identify:
Epithelium
Cilia
Basal bodies
Clara cells
Lamina propria
Elastic fibers
Muscularis mucosae
Alveoli
Bronchial vessel
bronchiole except that it is narrower in diameter and its layers are thinner. The epithelium is simple columnar with cilia. Clara cells appear for the first time here.
still present. 200x, 1000x
Type here to search

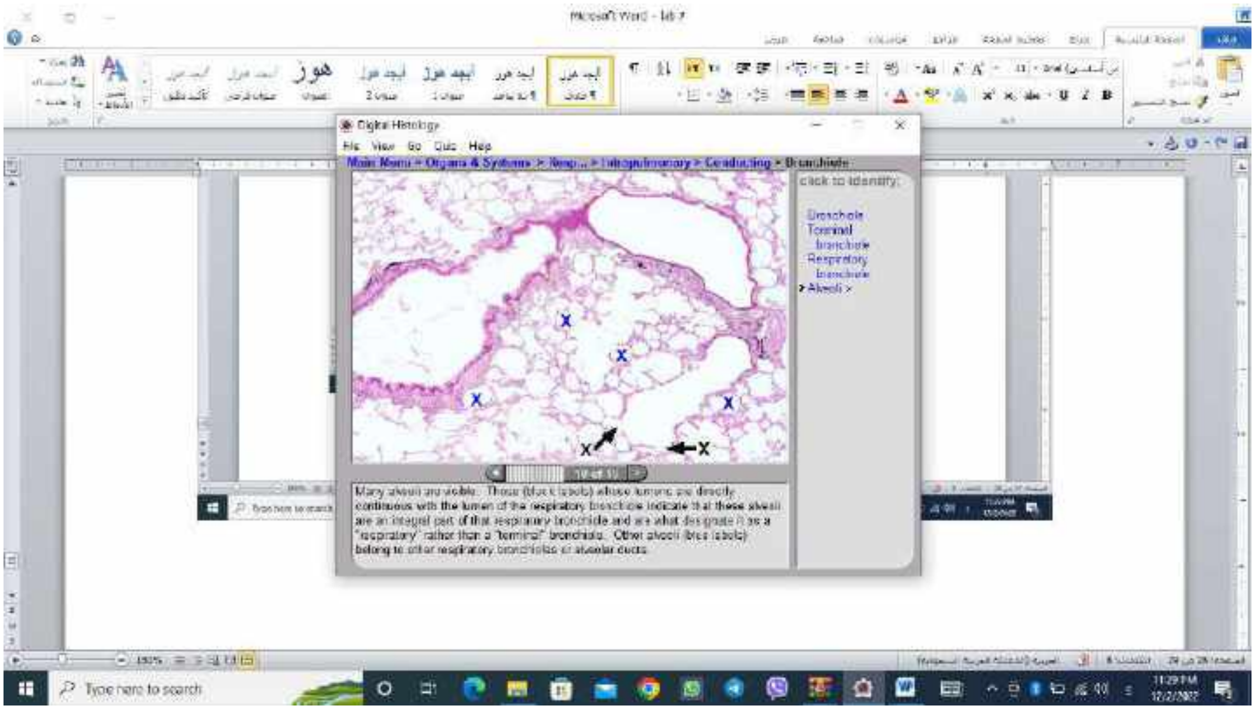

Digital Histology
File View Go Quiz Help
click to identify:
Epithelium
Cilia
Basal bodies
Clara cells
Lamina propria
Elastic fibers
Muscularis mucosae
Alveoli
Bronchial vessel
X
X
X
X
Terminal Bronchiole – The smallest bronchiole (terminal) resembles a larger bronchiole except that it is narrower in diameter and its layers are thinner. The epithelium is simple columnar with cilia. Clara cells appear for the first time here. Elastic fibers can be seen in the lamina propria, and a muscularis mucosae is still present. 200x, 1000x
Type here to search

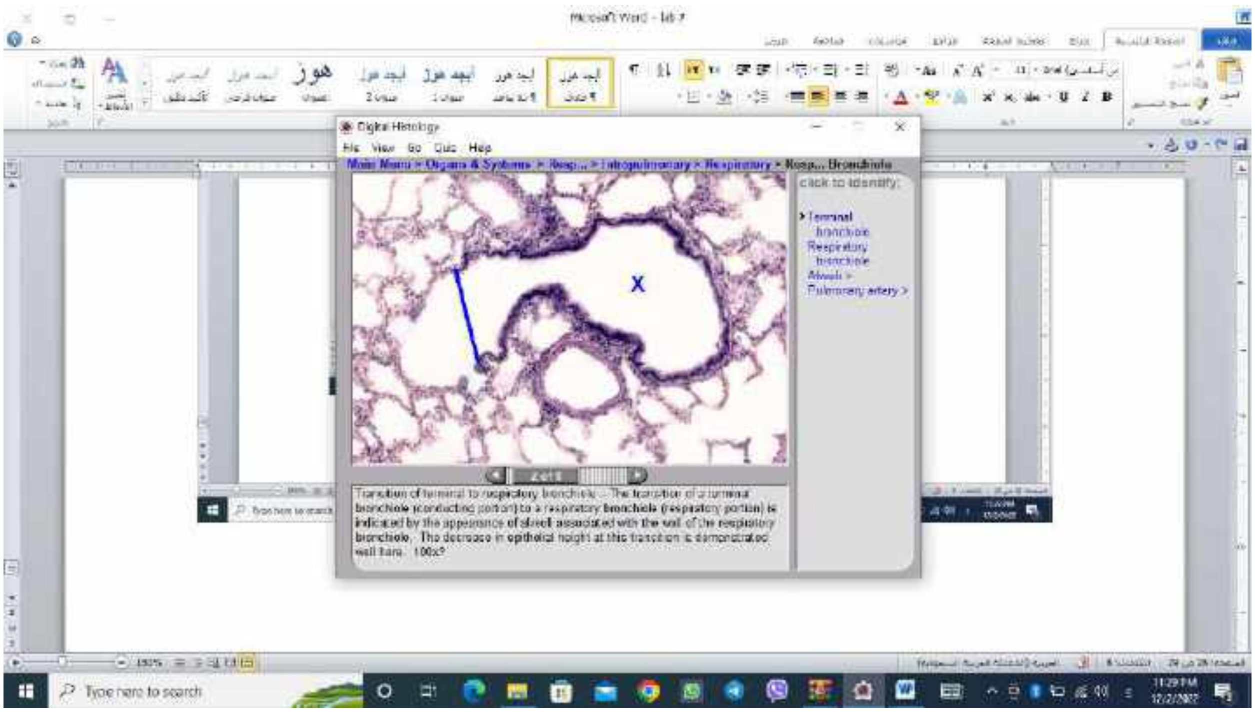

Digital Histology
File View Go Quiz Help
click to identify:
Epithelium
Cilia
Basal bodies
Clara cells
Lamina propria
Elastic fibers
Muscularis mucosae
Alveoli
Bronchial vessel
Terminal Bronchiole – The smallest bronchiole (terminal) resembles a larger bronchiole except that it is narrower in diameter and its layers are thinner. The epithelium is simple columnar with cilia. Clara cells appear for the first time here. Elastic fibers can be seen in the lamina propria, and a muscularis mucosae is still present. 200x, 1000x
Type here to search

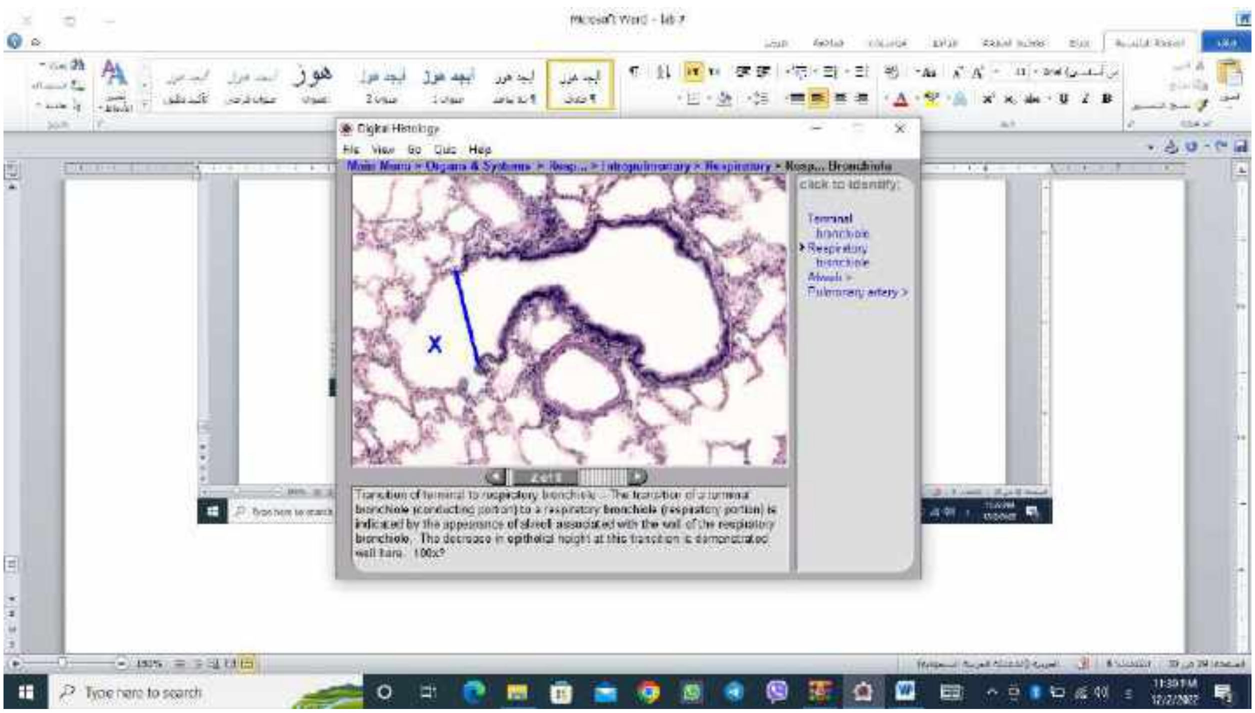

Digital Histology
File View Go Quiz Help
click to identify:
Bronchiole
Terminal bronchiole
Respiratory bronchiole
Alveoli >
X
Transition of bronchiole to respiratory bronchiole – This image shows the transitions that occur as a bronchiole becomes a terminal bronchiole which then becomes a respiratory bronchiole. Alveoli budding directly from the lumen of a respiratory bronchiole indicate this is a segment of the respiratory portion of the respiratory system. 40x

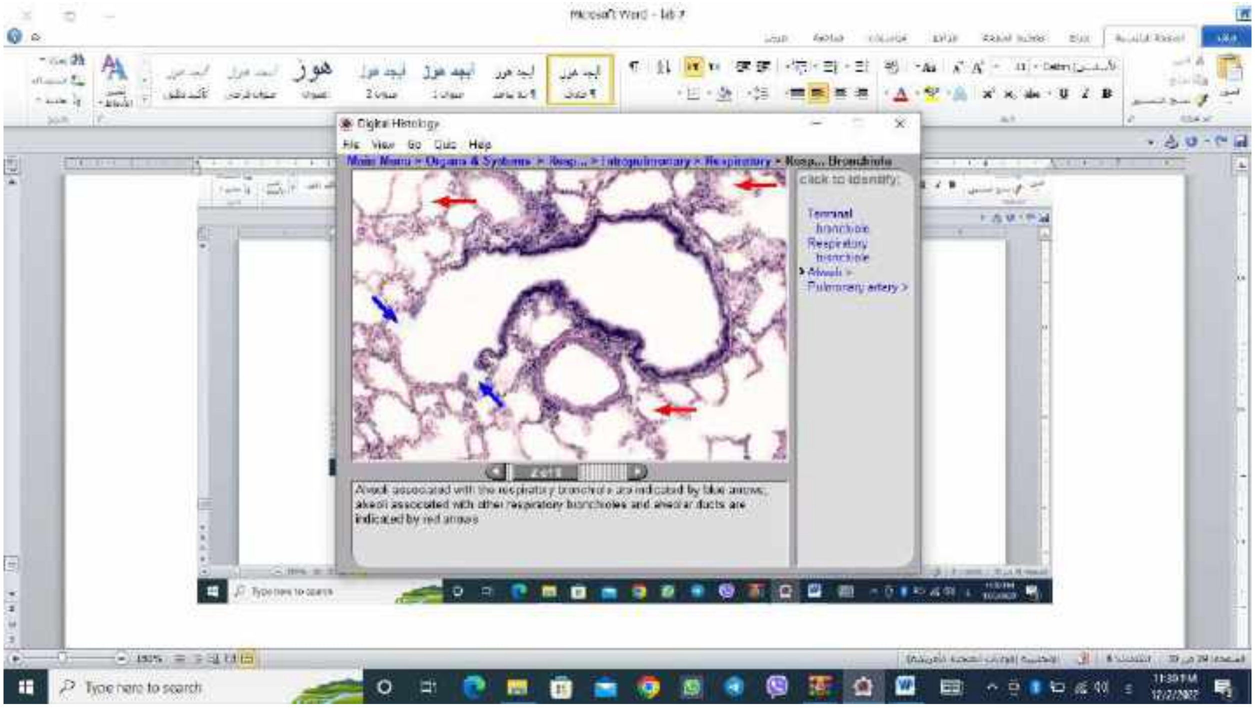

Digital Histology
File View Go Quiz Help
click to identify:
Bronchiole
Terminal bronchiole
Respiratory bronchiole
Alveoli >
X
X
Transition of bronchiole to respiratory bronchiole – This image shows the transitions that occur as a bronchiole becomes a terminal bronchiole which then becomes a respiratory bronchiole. Alveoli budding directly from the lumen of a respiratory bronchiole indicate this is a segment of the respiratory portion of the respiratory system. 40x

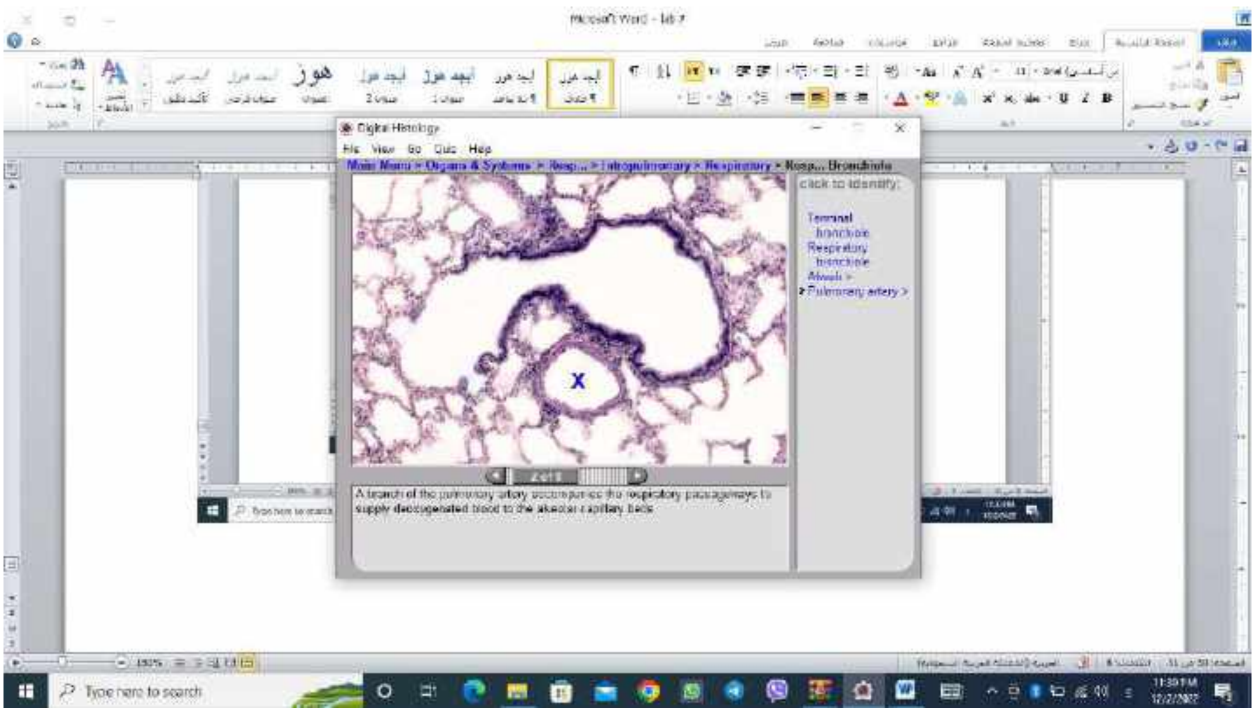

Digital Histology
File View Go Quiz Help
click to identify:
Bronchiole
Terminal bronchiole
Respiratory bronchiole
Alveoli
X
Transition of bronchiole to respiratory bronchiole. This image shows the transitions that occur as a bronchiole becomes a terminal bronchiole which then becomes a respiratory bronchiole. Alveoli budding directly from the lumen of a respiratory bronchiole indicate this is a segment of the respiratory portion of the respiratory system. 40x
Type here to search

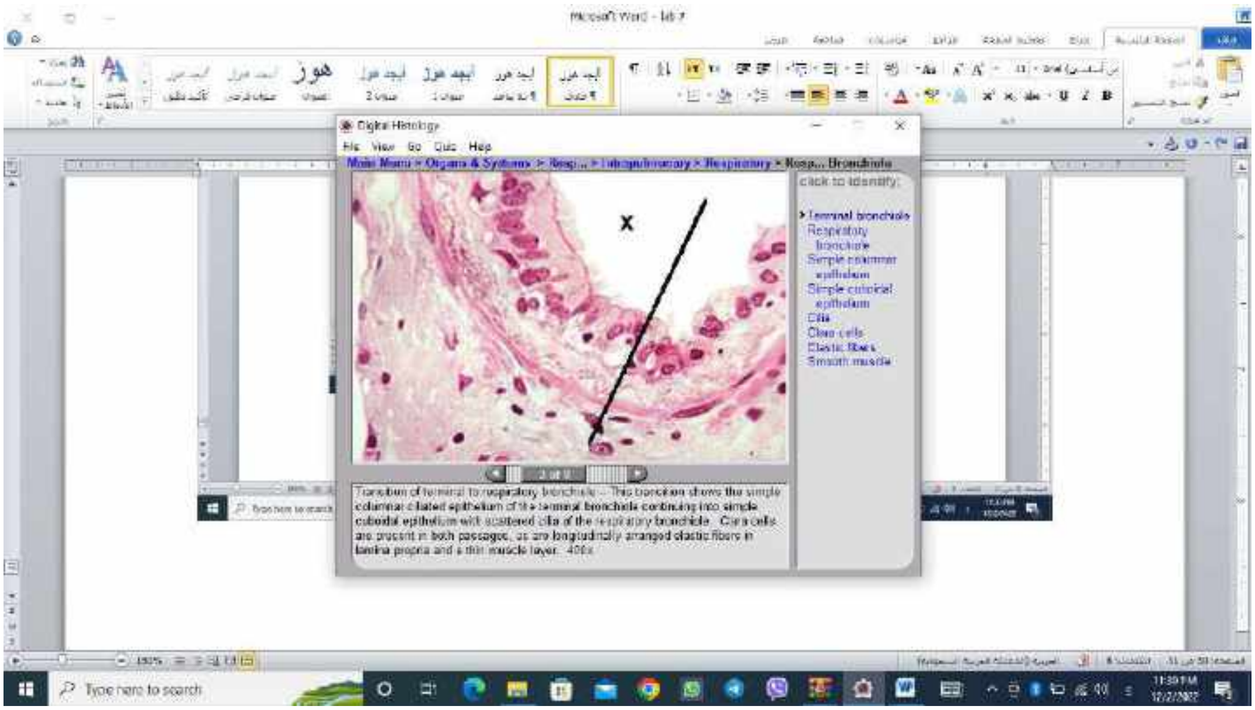

Digital Histology
File View Go Quiz Help
click to identify:
Bronchiole
Terminal bronchiole
Respiratory bronchiole
Alveoli
X
X
X
X
X
X
Many alveoli are visible. Those (black labels) whose lumens are directly continuous with the lumen of the respiratory bronchiole indicate that these alveoli are an integral part of that respiratory bronchiole and are what designate it as a "respiratory" rather than a "terminal" bronchiole. Other alveoli (blue labels) belong to other respiratory bronchioles or alveolar ducts.
Type here to search

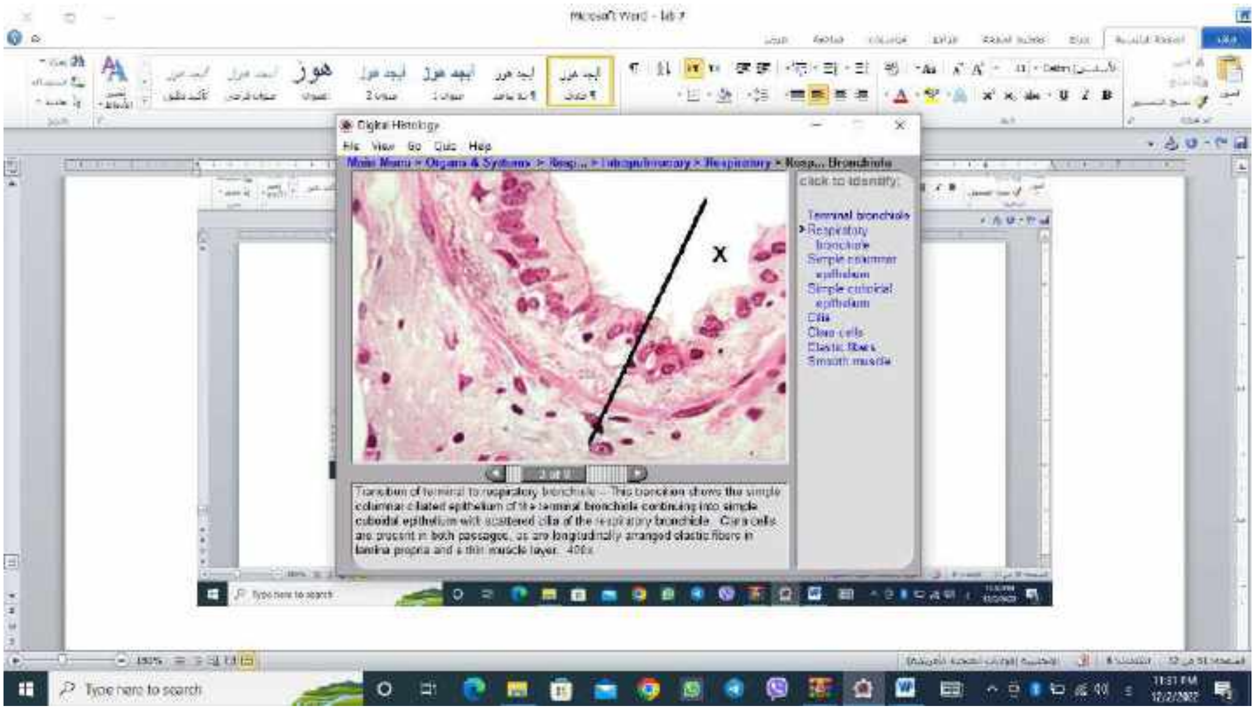

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Terminal bronchiole
Respiratory bronchiole
Alveoli >
Pulmonary artery >
X
Transition of terminal to respiratory bronchiole – The transition of a terminal bronchiole (conducting portion) to a respiratory bronchiole (respiratory portion) is indicated by the appearance of alveoli associated with the wall of the respiratory bronchiole. The decrease in epithelial height at this transition is demonstrated well here. 100x?
Type here to search


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Terminal bronchiole
Respiratory bronchiole
Alveoli >
Pulmonary artery >
X
Transition of terminal to respiratory bronchiole – The transition of a terminal bronchiole (conducting portion) to a respiratory bronchiole (respiratory portion) is indicated by the appearance of alveoli associated with the wall of the respiratory bronchiole. The decrease in epithelial height at this transition is demonstrated well here. 100x?
Type here to search


Digital Histology
File View Go Quiz Help
click to identify:
Terminal bronchiole
Respiratory bronchiole
Alveoli >
Pulmonary artery >
Alveoli associated with the respiratory bronchiole are indicated by blue arrows; alveoli associated with other respiratory bronchioles and alveolar ducts are indicated by red arrows
Type here to search


Digital Histology
File View Go Quiz Help
click to identify:
Terminal bronchiole
Respiratory bronchiole
Alveoli >
Pulmonary artery >
X
A branch of the pulmonary artery accompanies the respiratory passageways to supply deoxygenated blood to the alveolar capillary beds
Type here to search


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
X
click to identify:
Terminal bronchiole
Respiratory bronchiole
Simple columnar epithelium
Simple cuboidal epithelium
Cilia
Clara cells
Elastic fibers
Smooth muscle
Transition of terminal to respiratory bronchiole -- This transition shows the simple columnar ciliated epithelium of the terminal bronchiole continuing into simple cuboidal epithelium with scattered cilia of the respiratory bronchiole. Clara cells are present in both passages, as are longitudinally arranged elastic fibers in lamina propria and a thin muscle layer. 400x
Type here to search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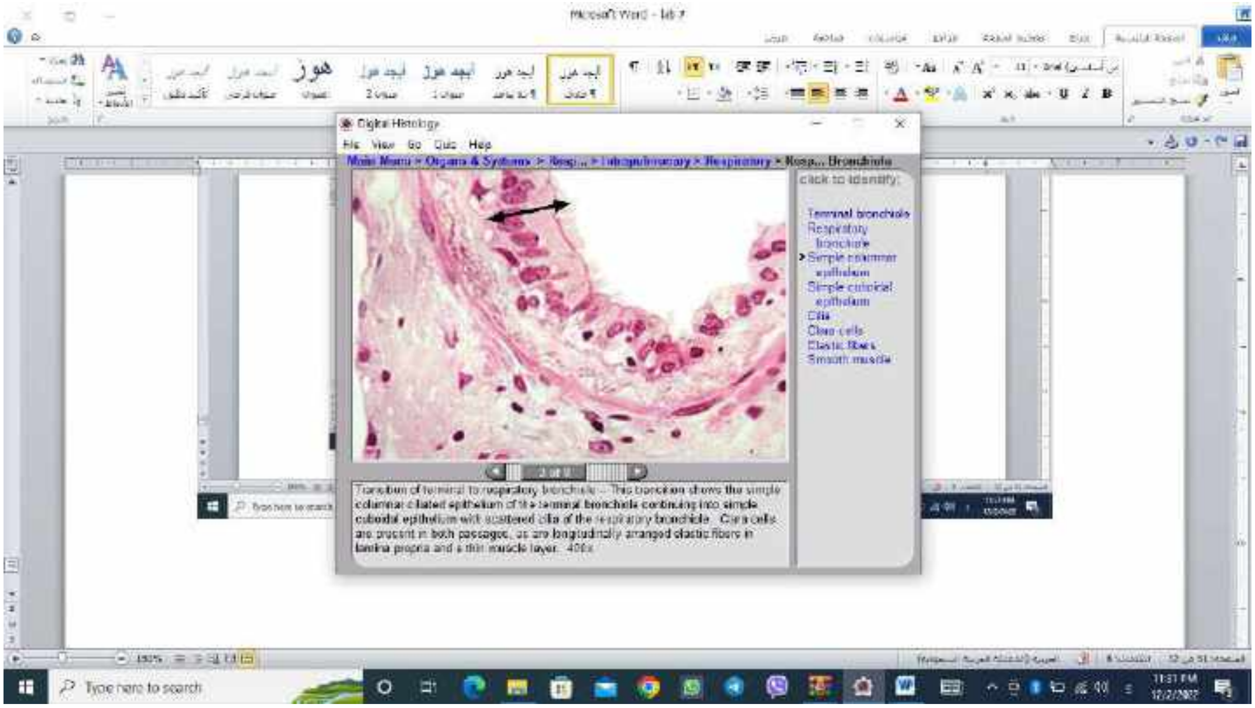
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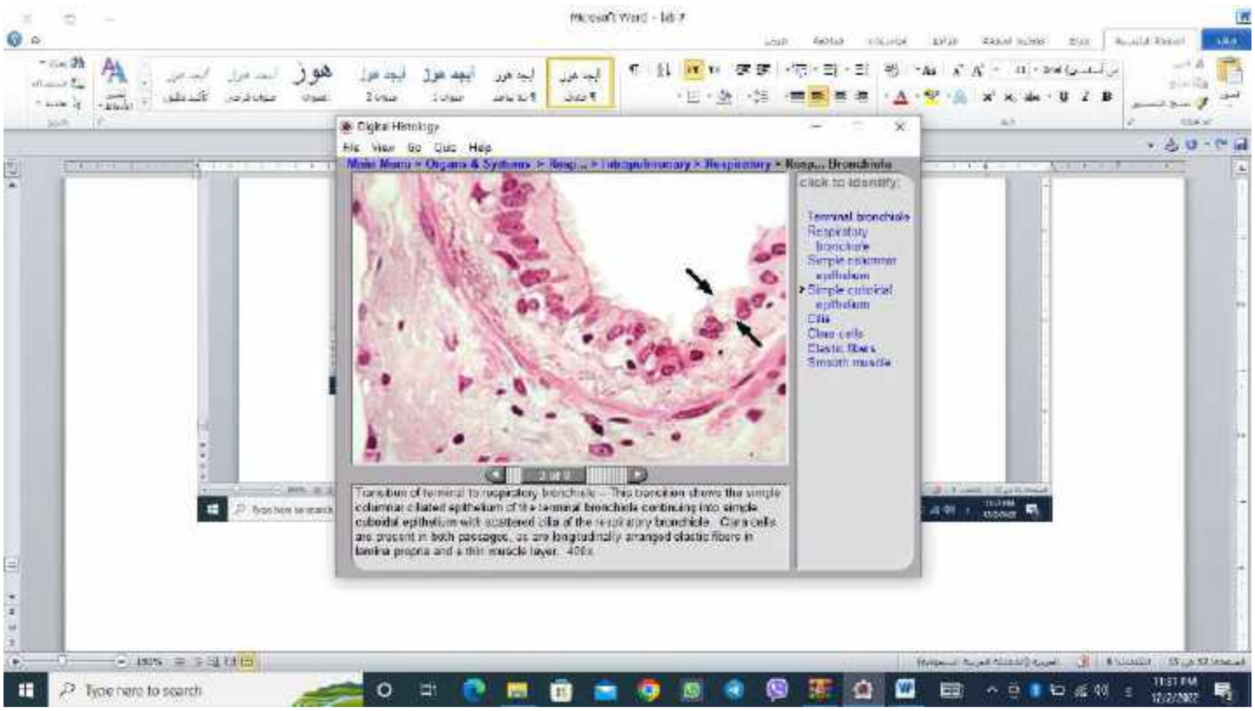
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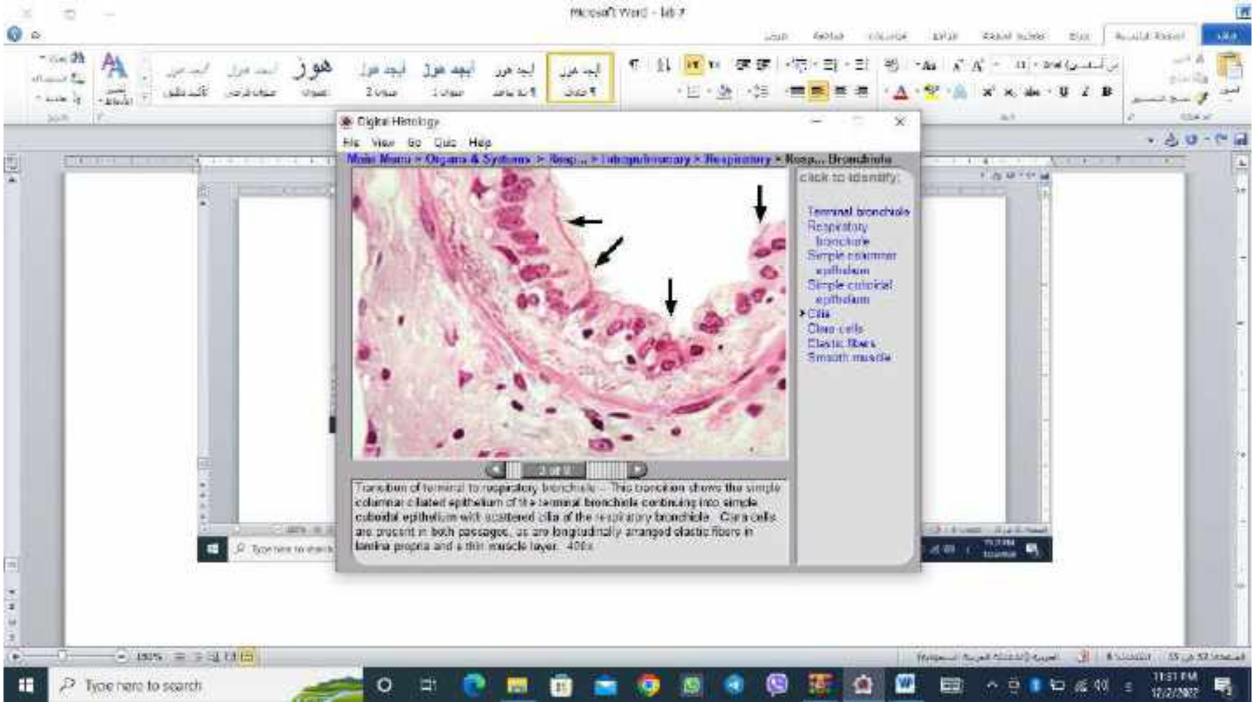
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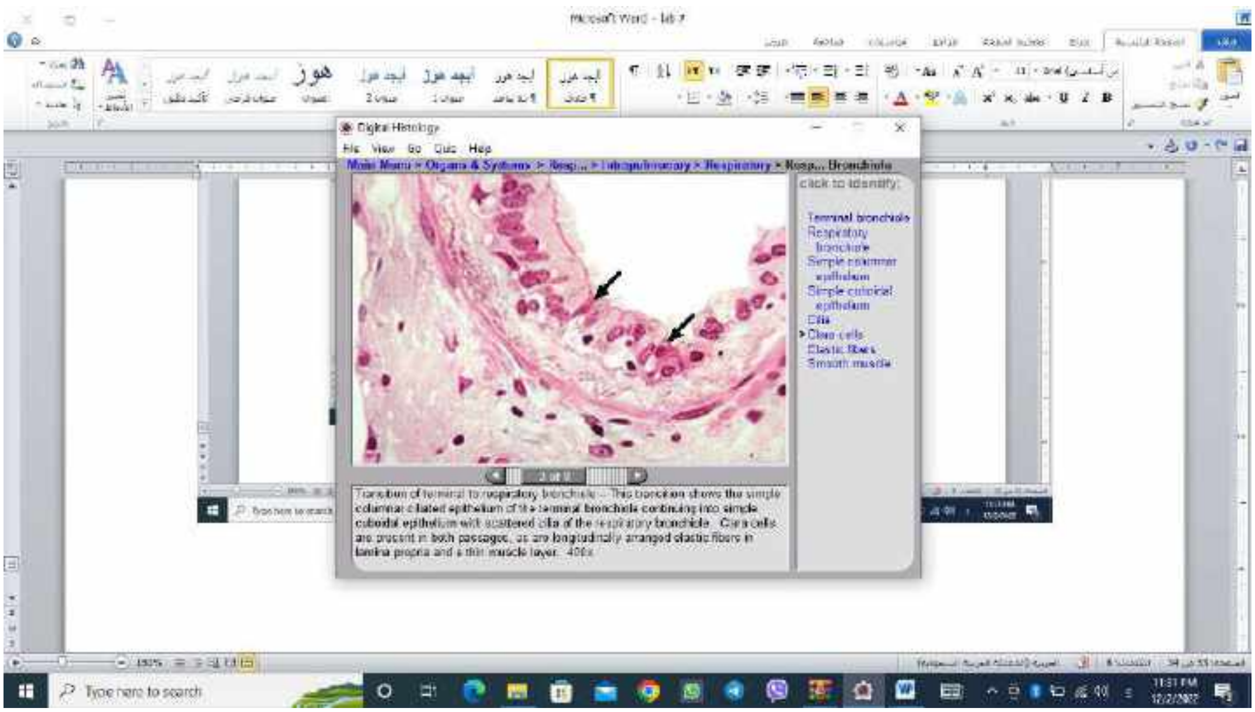
Type here to search
11:51 PM
12/2/2022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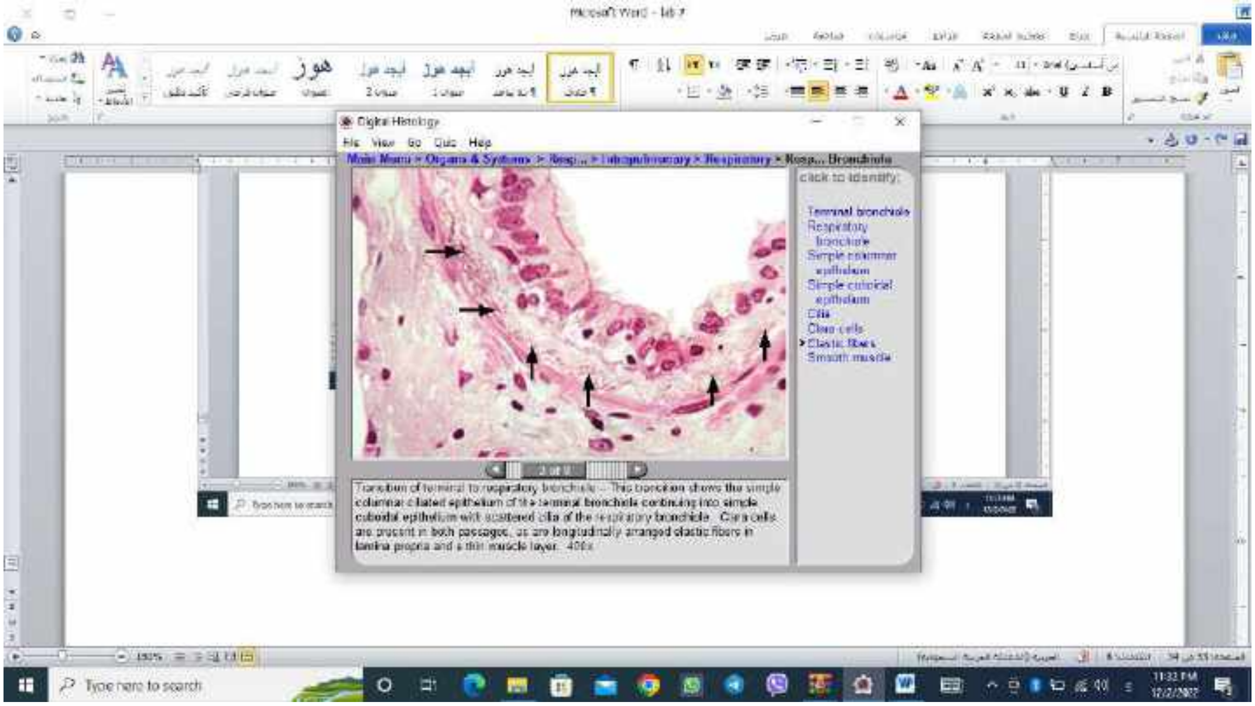
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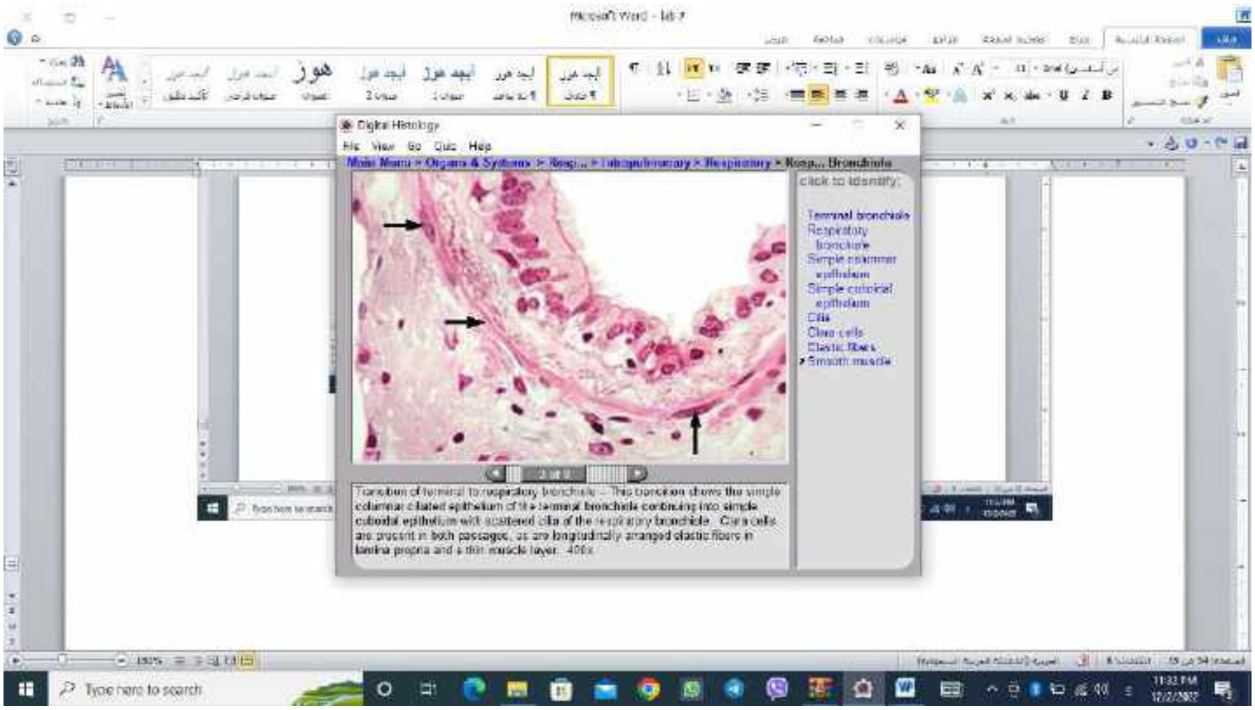
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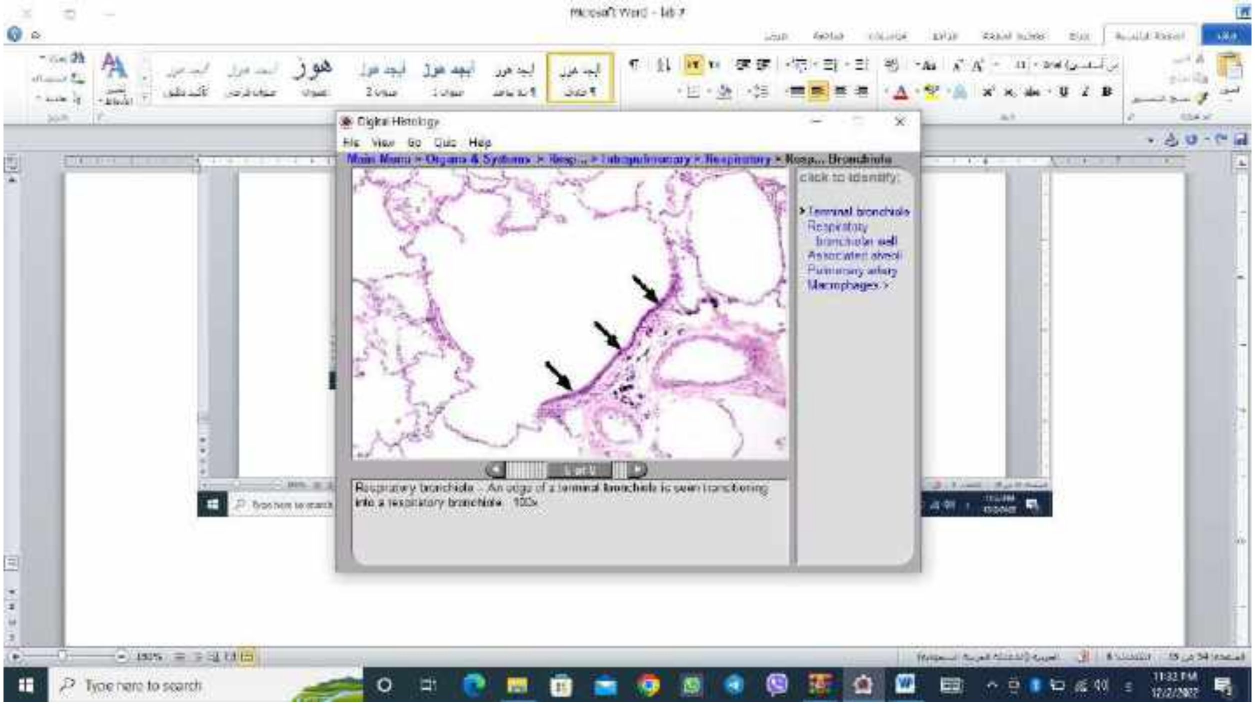
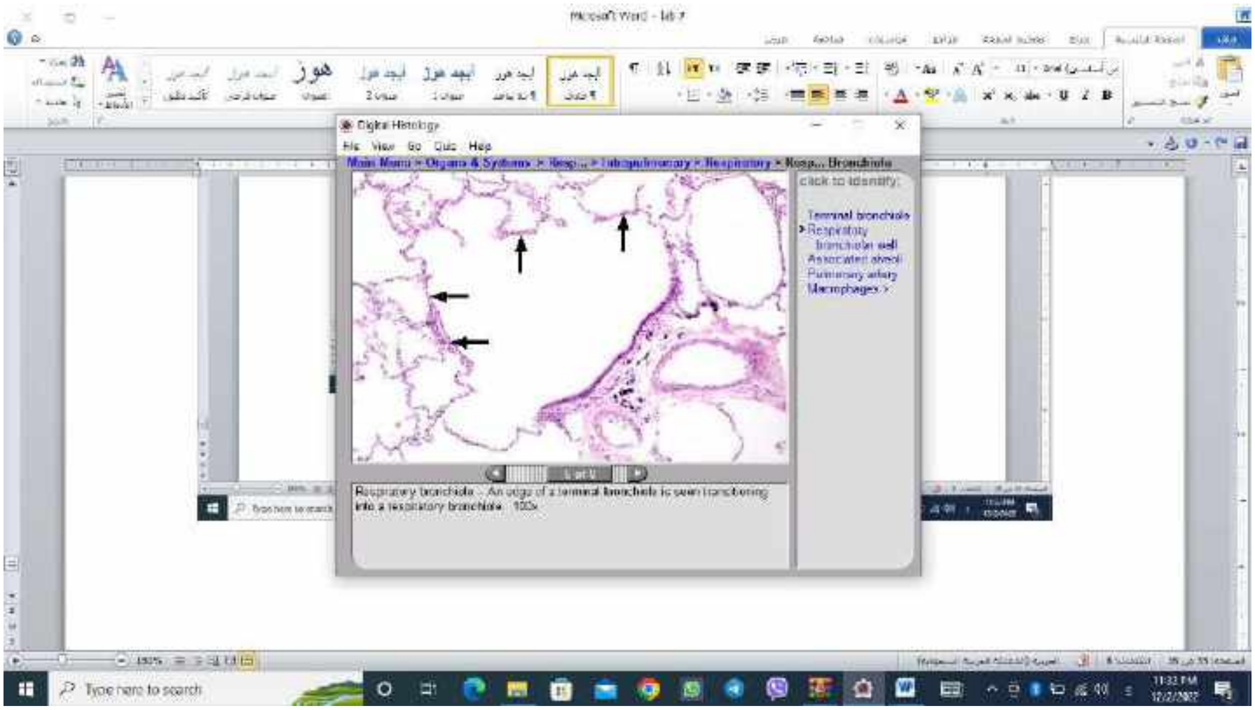

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
click to identify:
Terminal bronchiole
Respiratory bronchiolar wall
Associated alveoli
Pulmonary artery
Macrophages >
Respiratory bronchiole - An edge of a terminal bronchiole is seen transitioning into a respiratory bronchiole. 100x
Type here to search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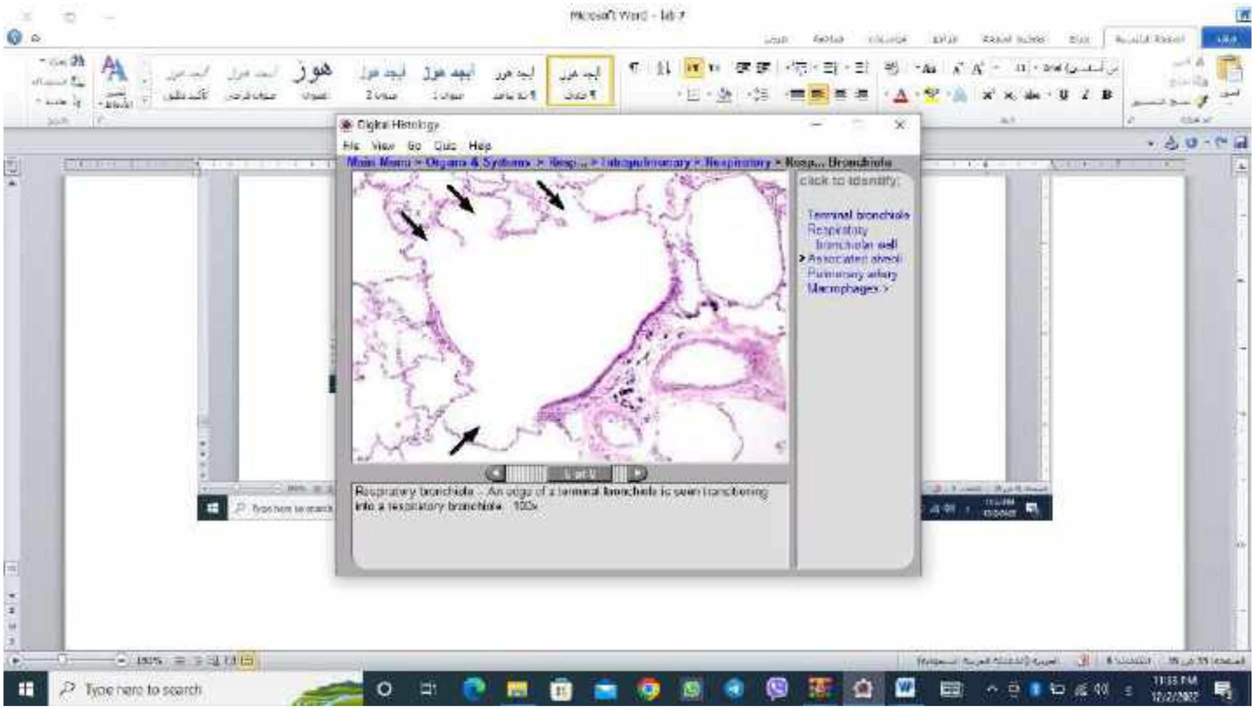
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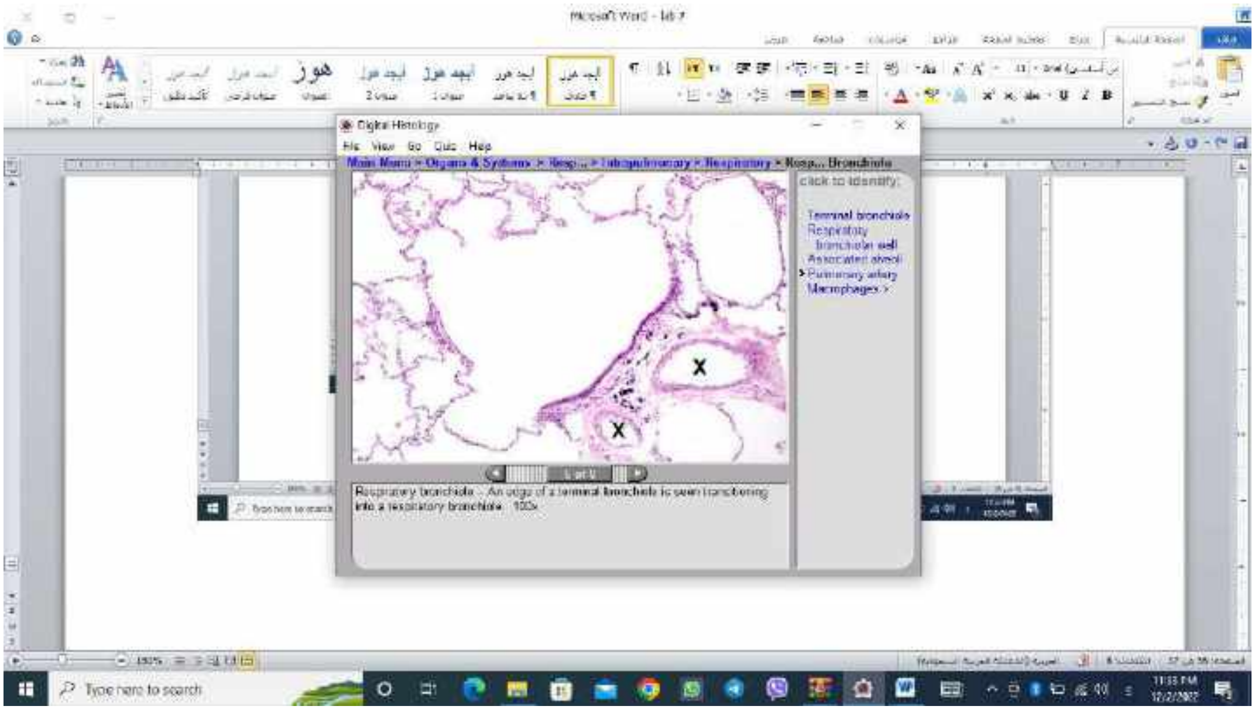
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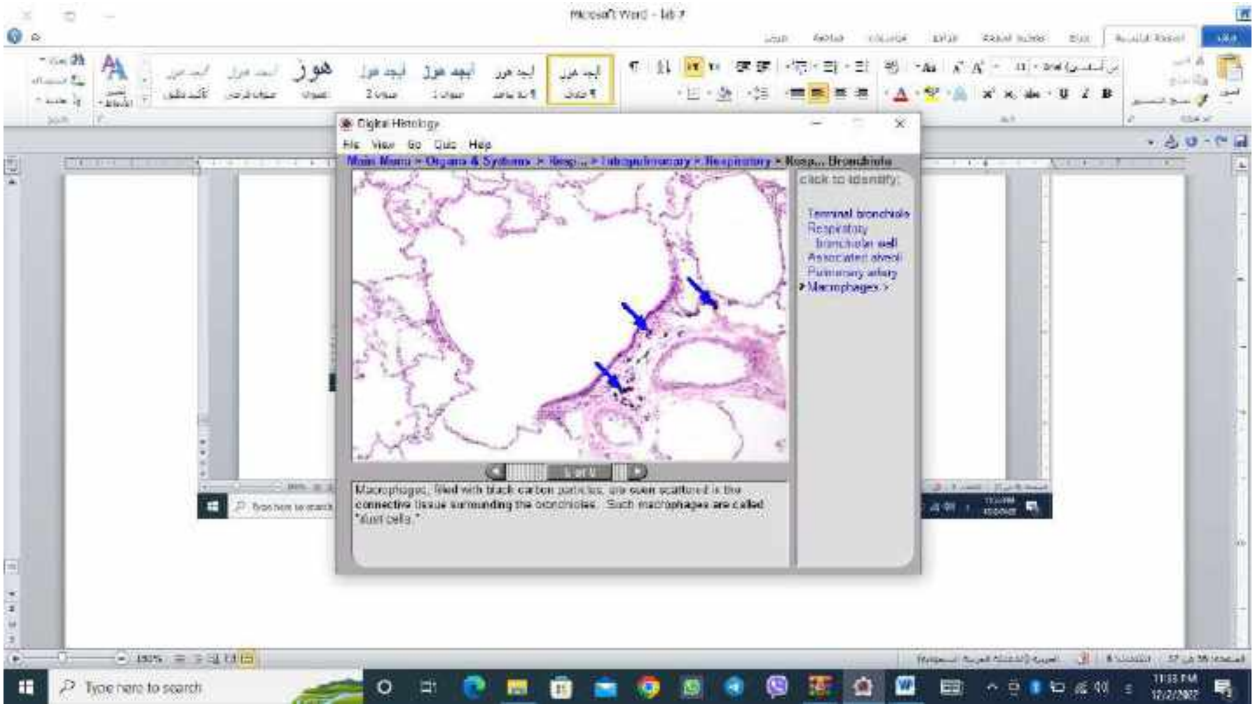
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click to identify:
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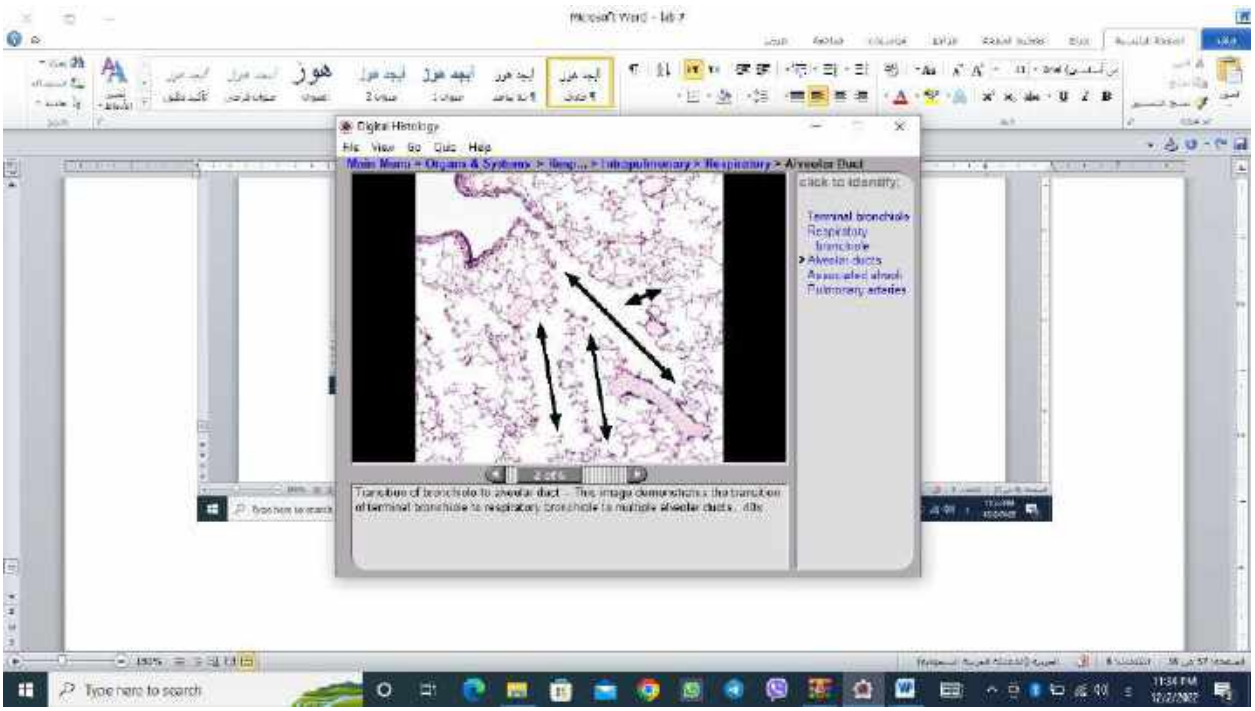
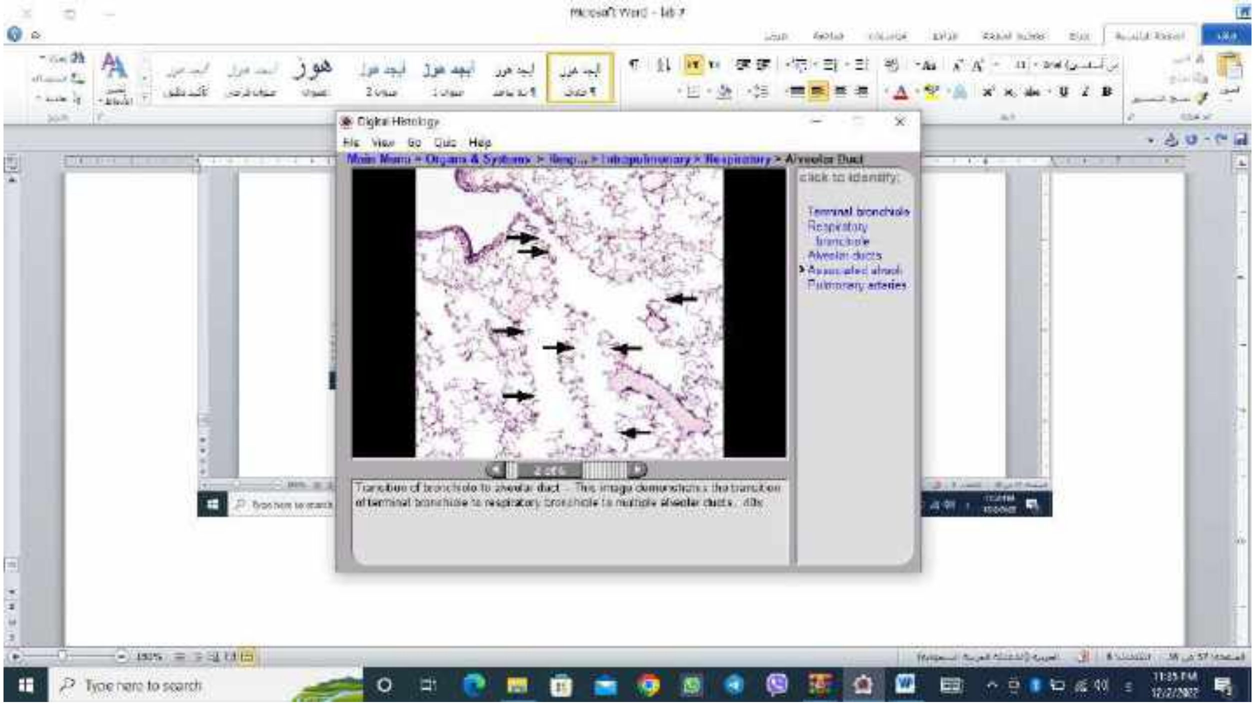
Associated alveoli
Pulmonary artery
> Macrophages >
Macrophages, filled with black carbon particles, are seen scattered in the connective tissue surrounding the bronchioles. Such macrophages are called "dust cells."
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Resp... > Intrapulmonary > Respiratory > Alveolar Duct
click to identify:
Terminal bronchiole
Respiratory bronchiole
> Alveolar ducts
Associated alveoli
Pulmonary arteries
Transition of bronchiole to alveolar duct - This image demonstrates the transition of terminal bronchiole to respiratory bronchiole to multiple alveolar ducts. 40x
Type here to search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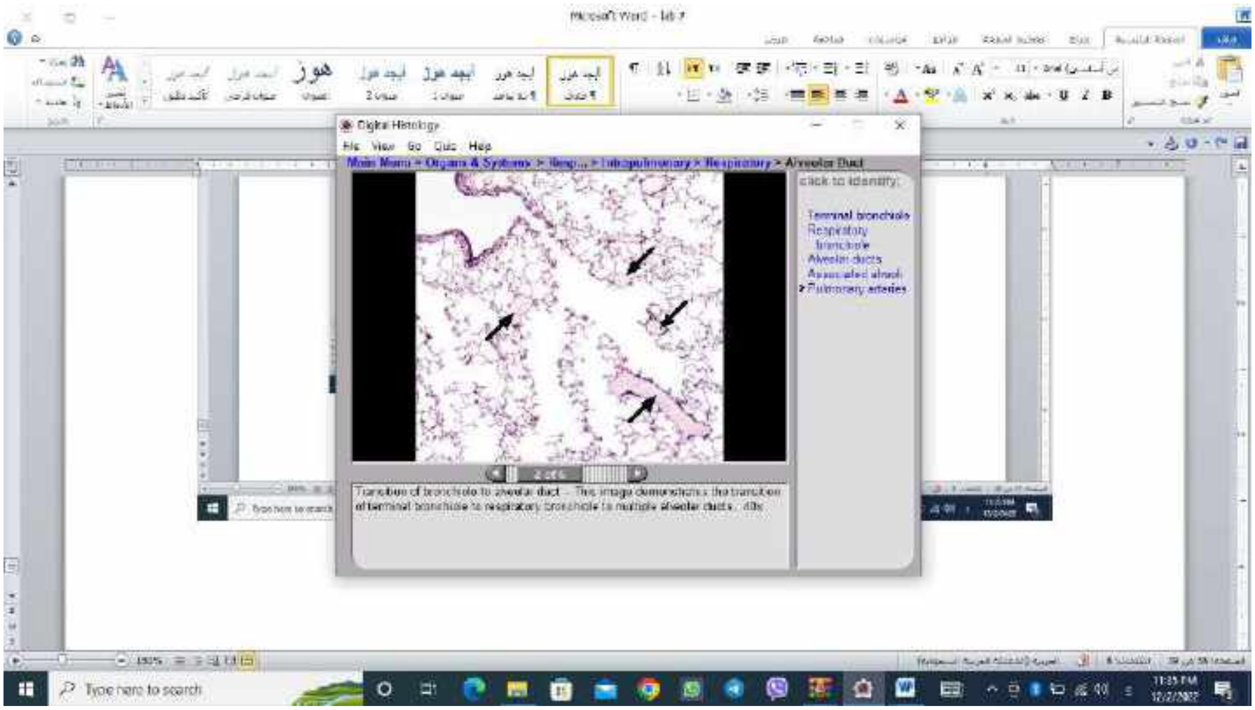
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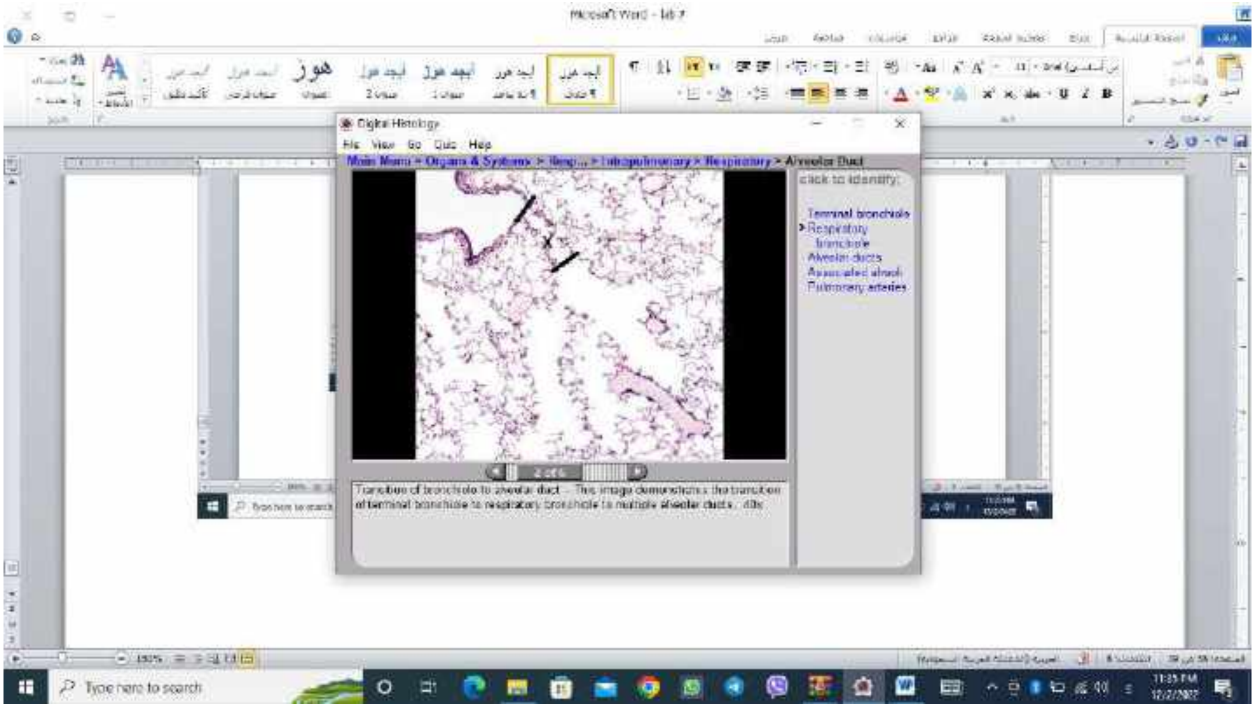
Digital Histology
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Alveolar Duct
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X
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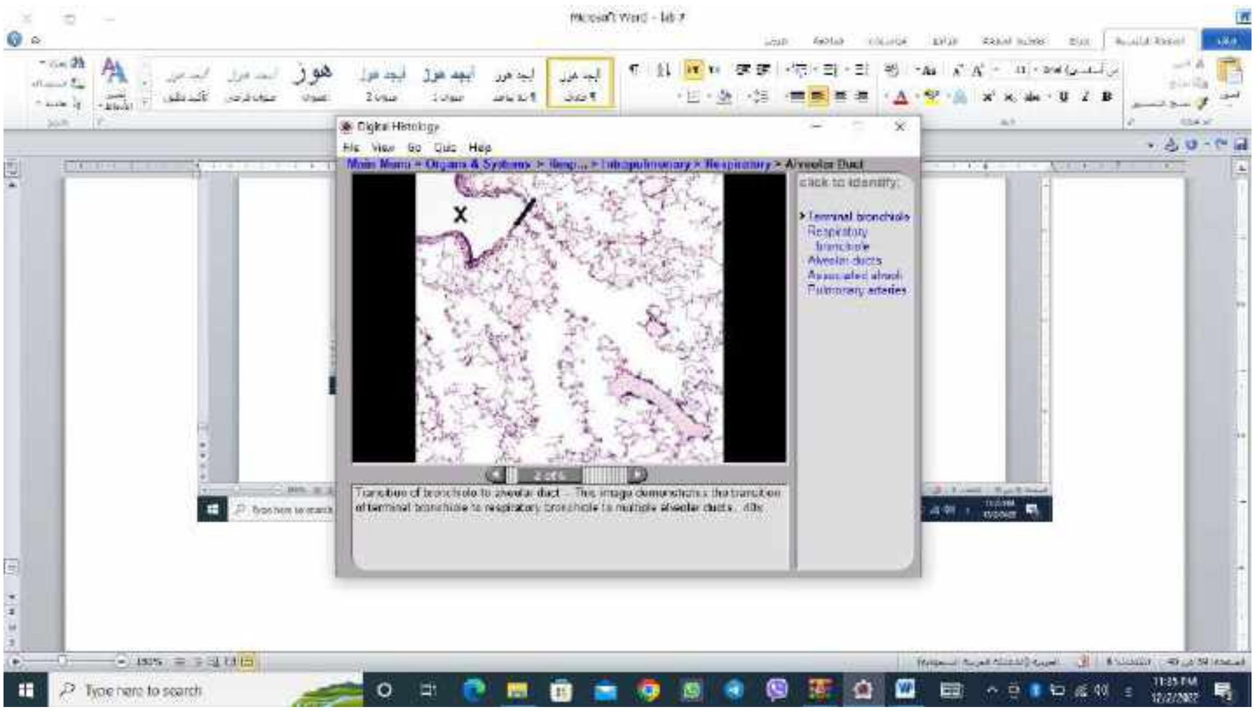
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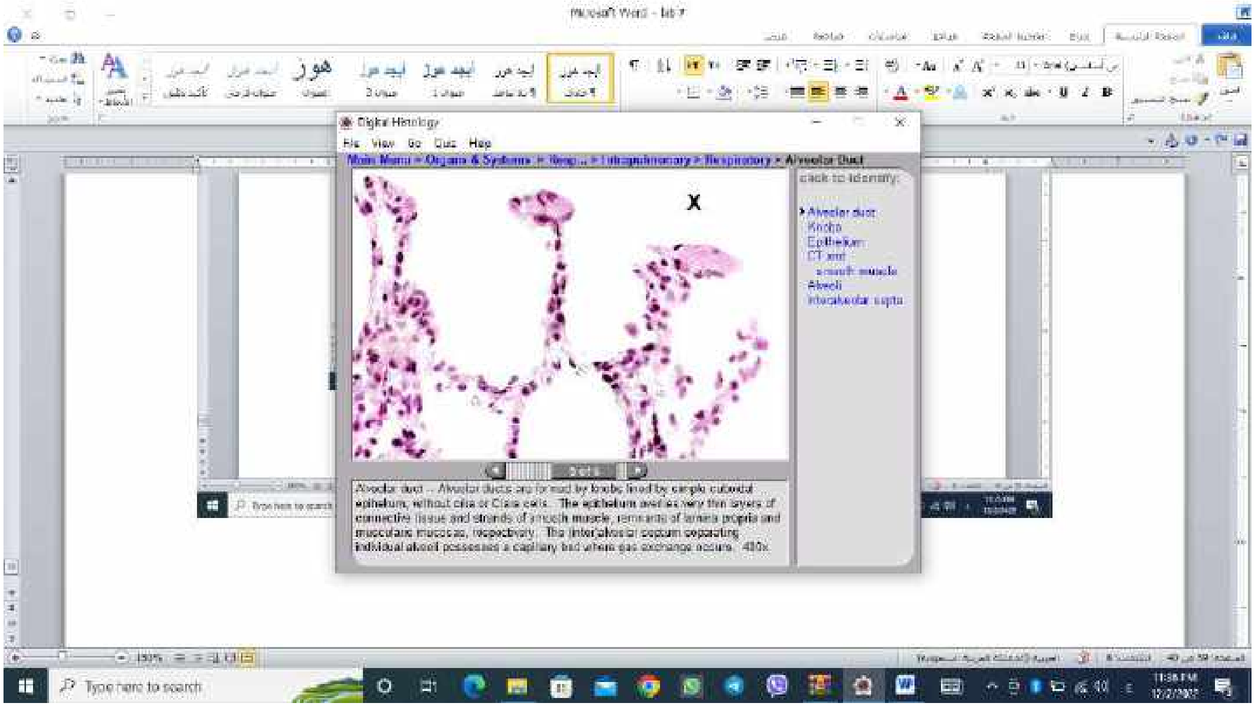
Microsoft Word - lab 7
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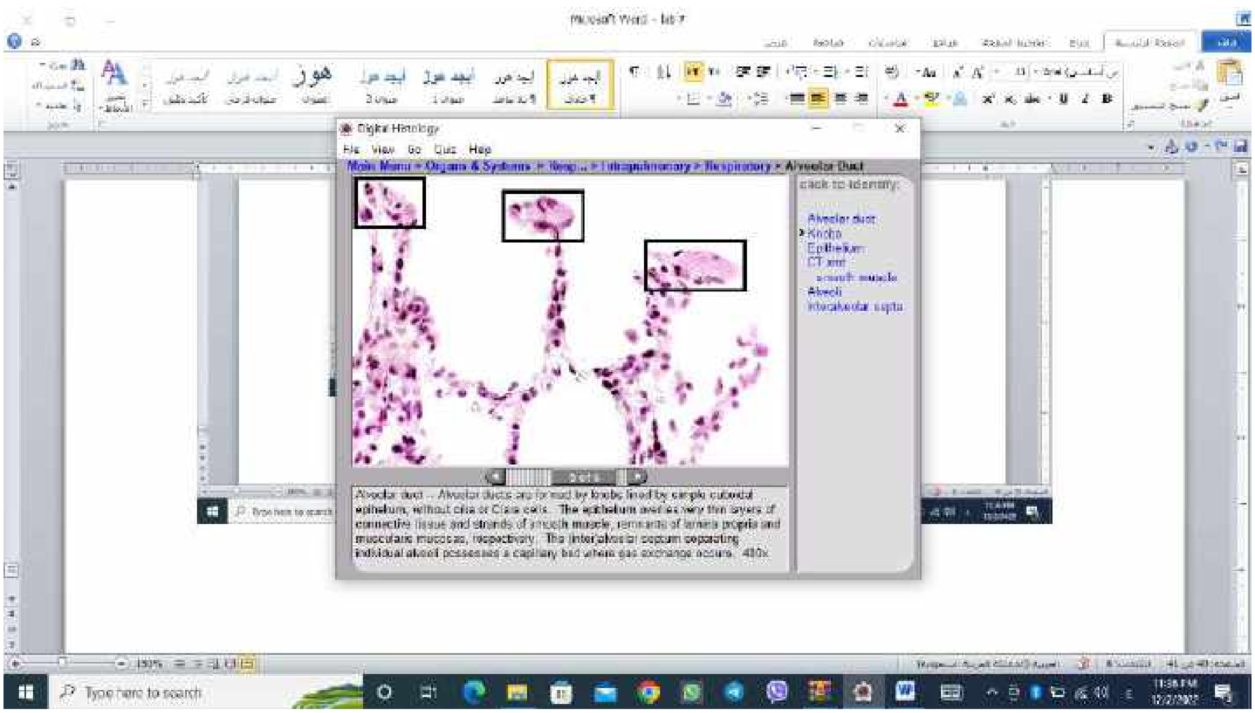
Alveolar Duct
X
click to identify:
Alveolar duct
Knobs
Epithelium
CT and
smooth muscle
Alveoli
Interalveolar septa
Alveolar duct -- Alveolar ducts are formed by knobs lined by simple cuboidal epithelium, without cilia or Clara cells. The epithelium overlies very thin layers of connective tissue and strands of smooth muscle, remnants of lamina propria and muscularis mucosae, respectively. The (inter)alveolar septum separating individual alveoli possesses a capillary bed where gas exchange occurs. 400x.
Type here to search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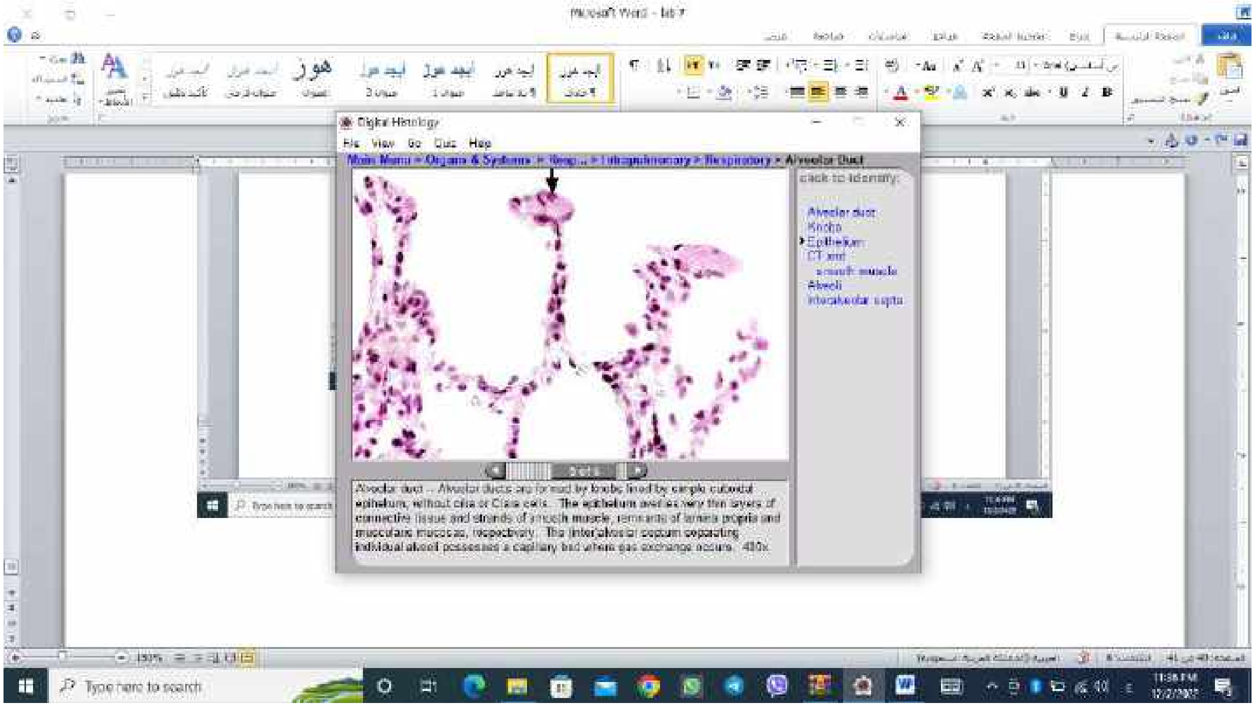
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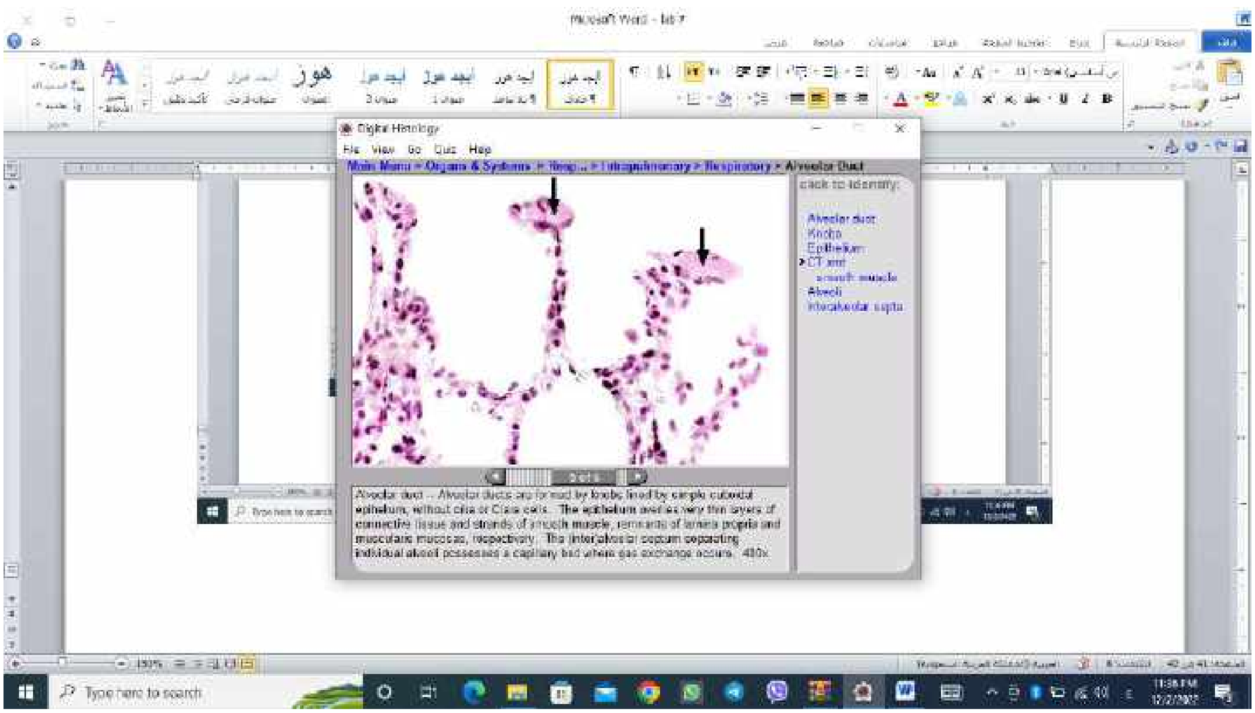
Type here to search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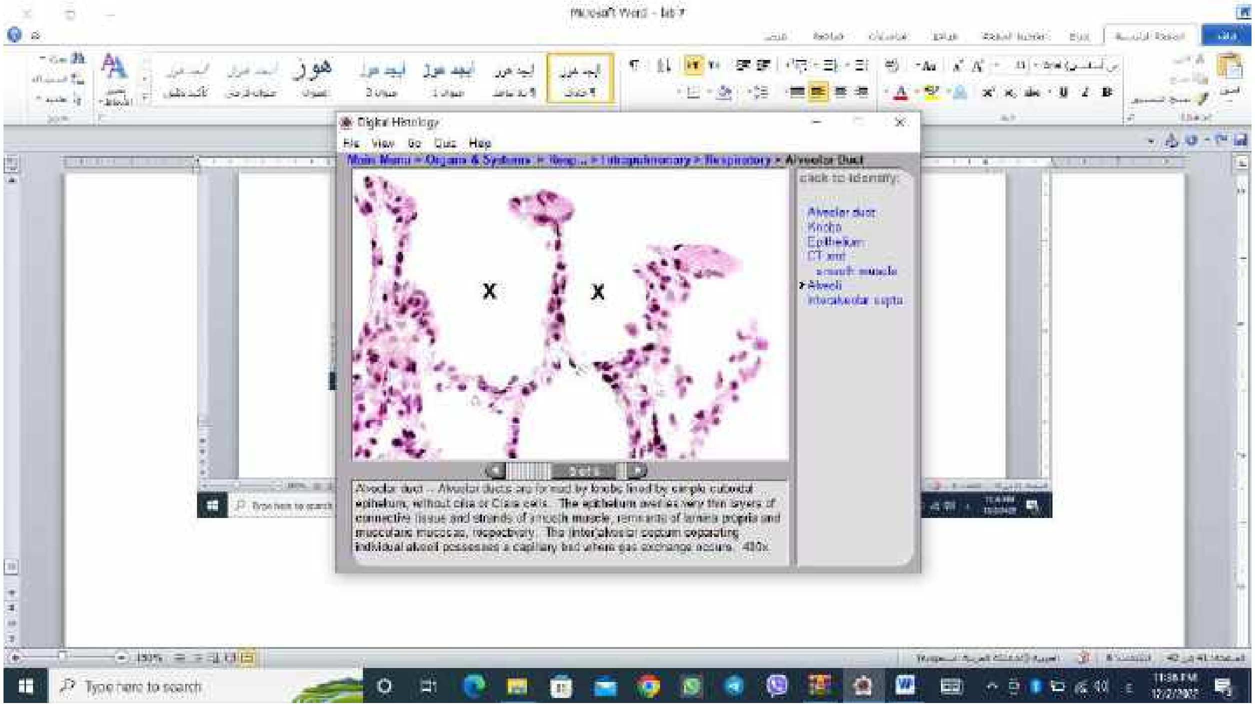
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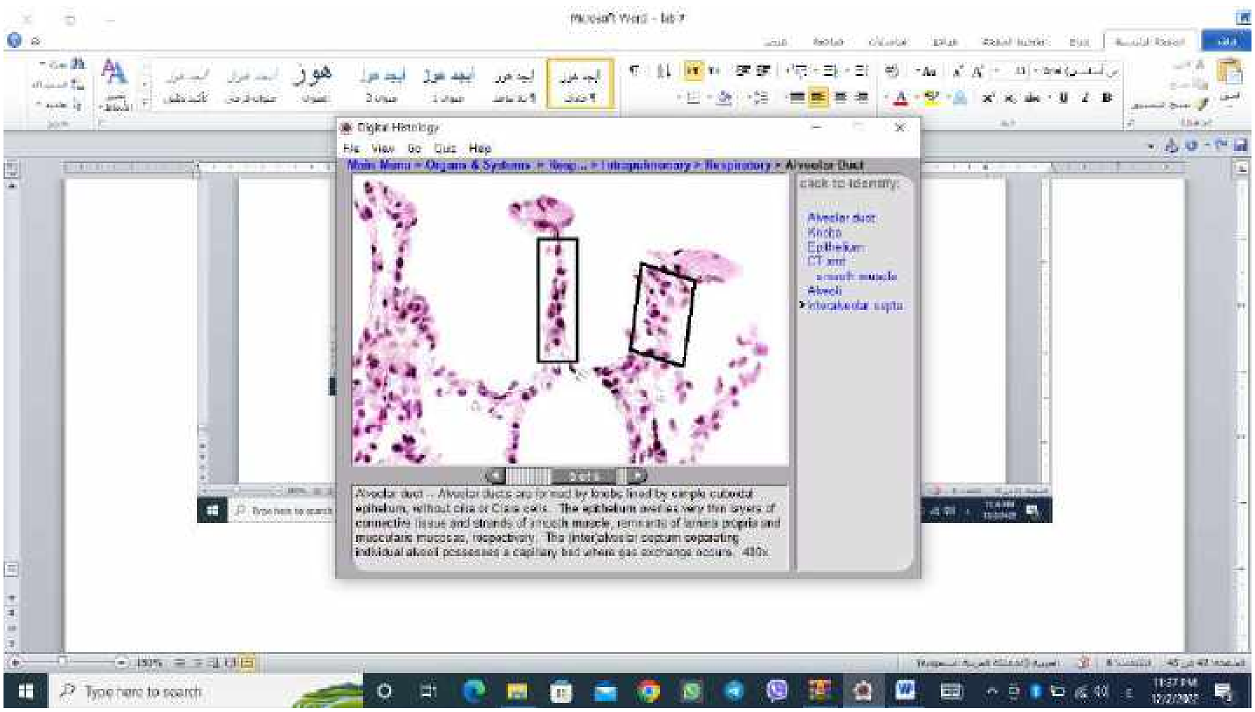
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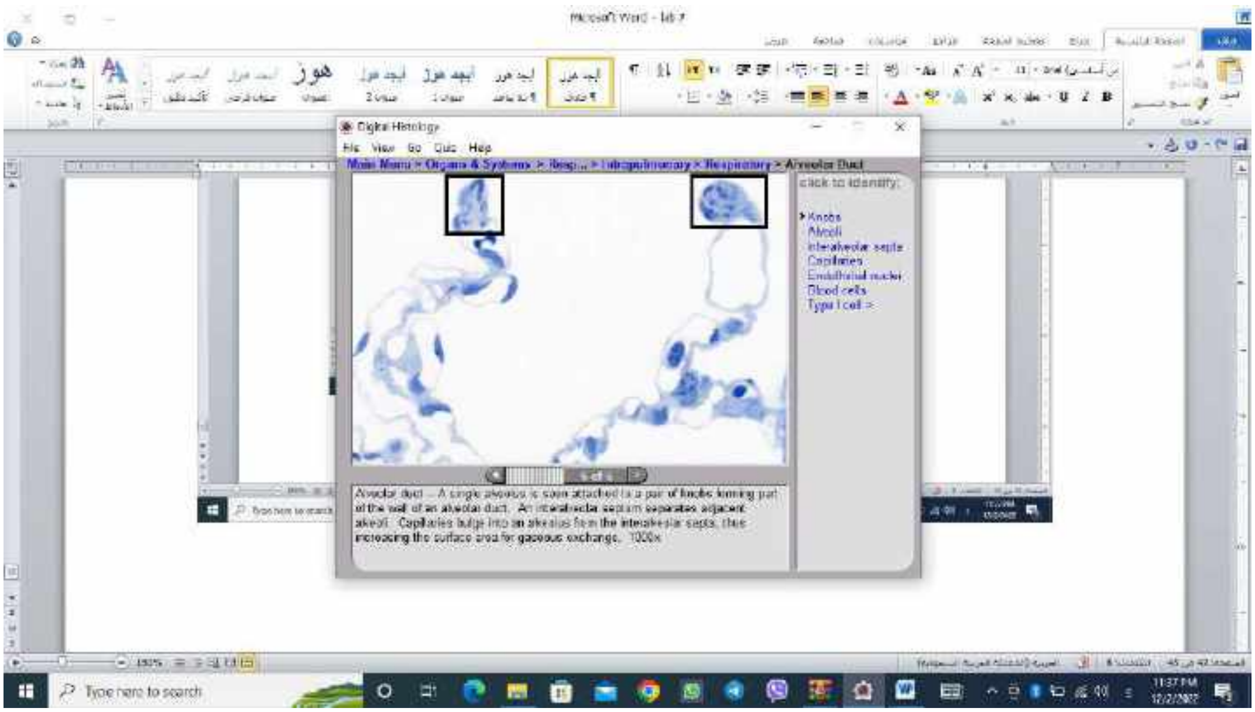
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Alveoli
Interalveolar septa
Capillaries
Endothelial nuclei
Blood cells
Type I cell >
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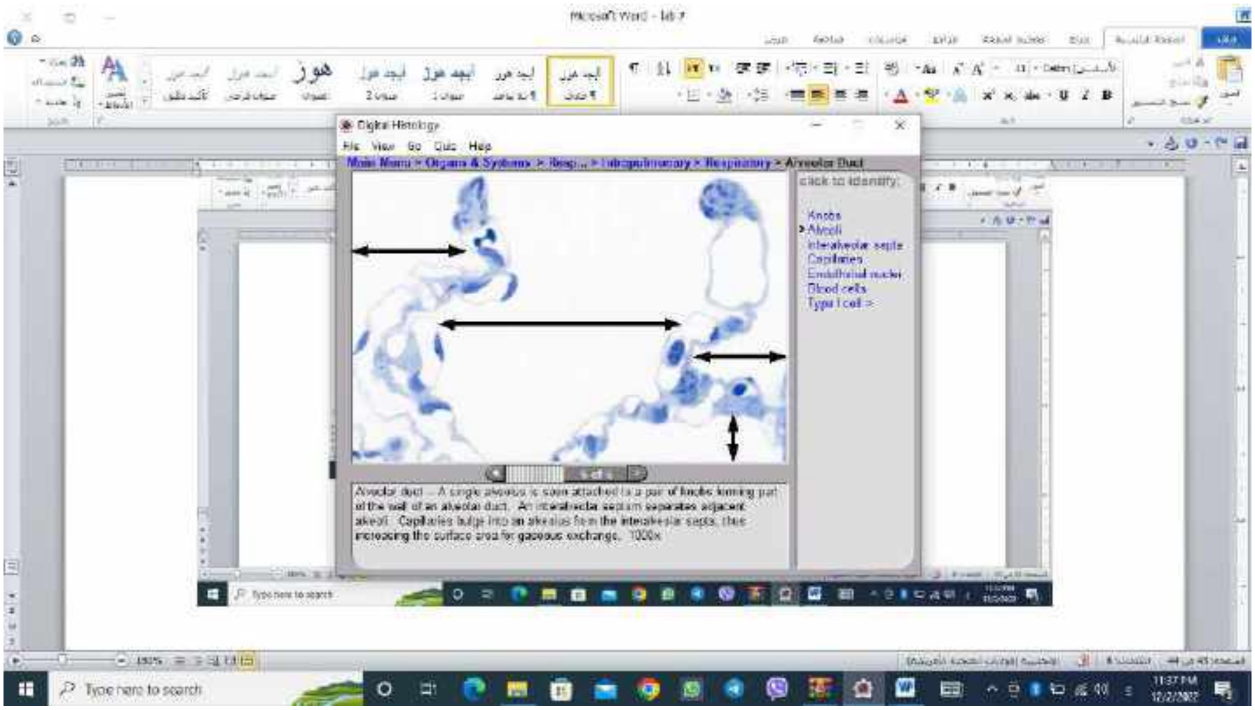
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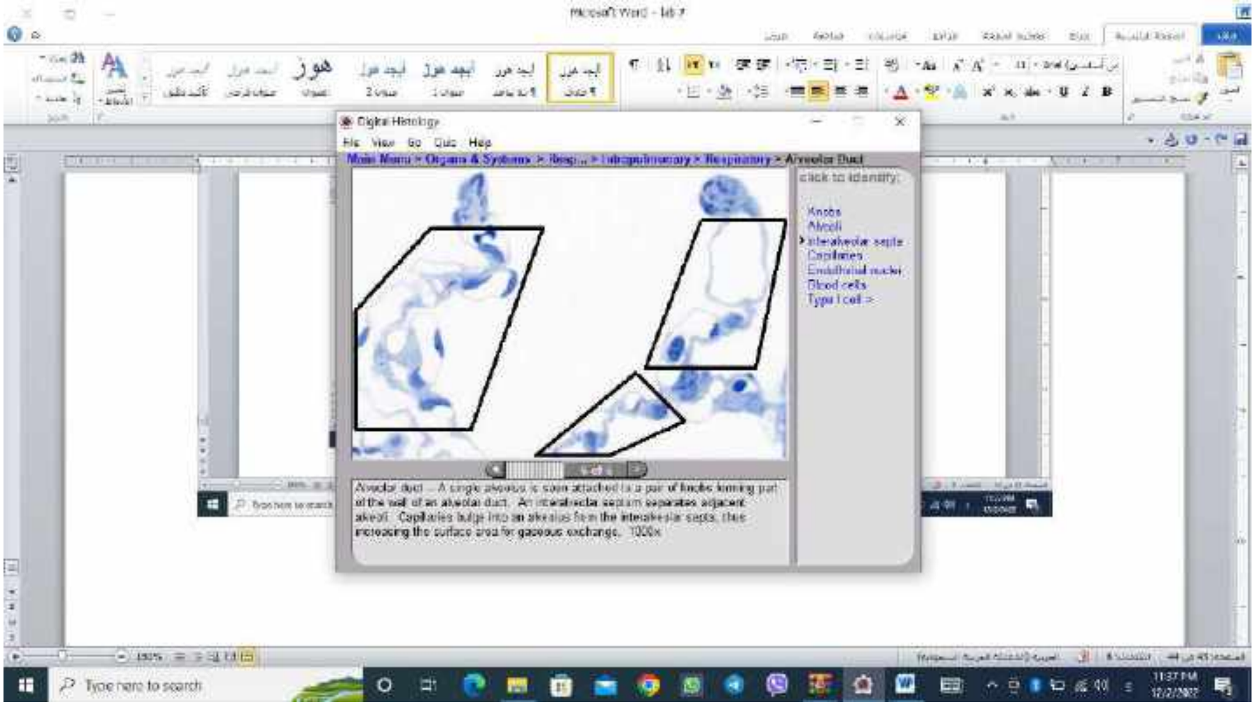
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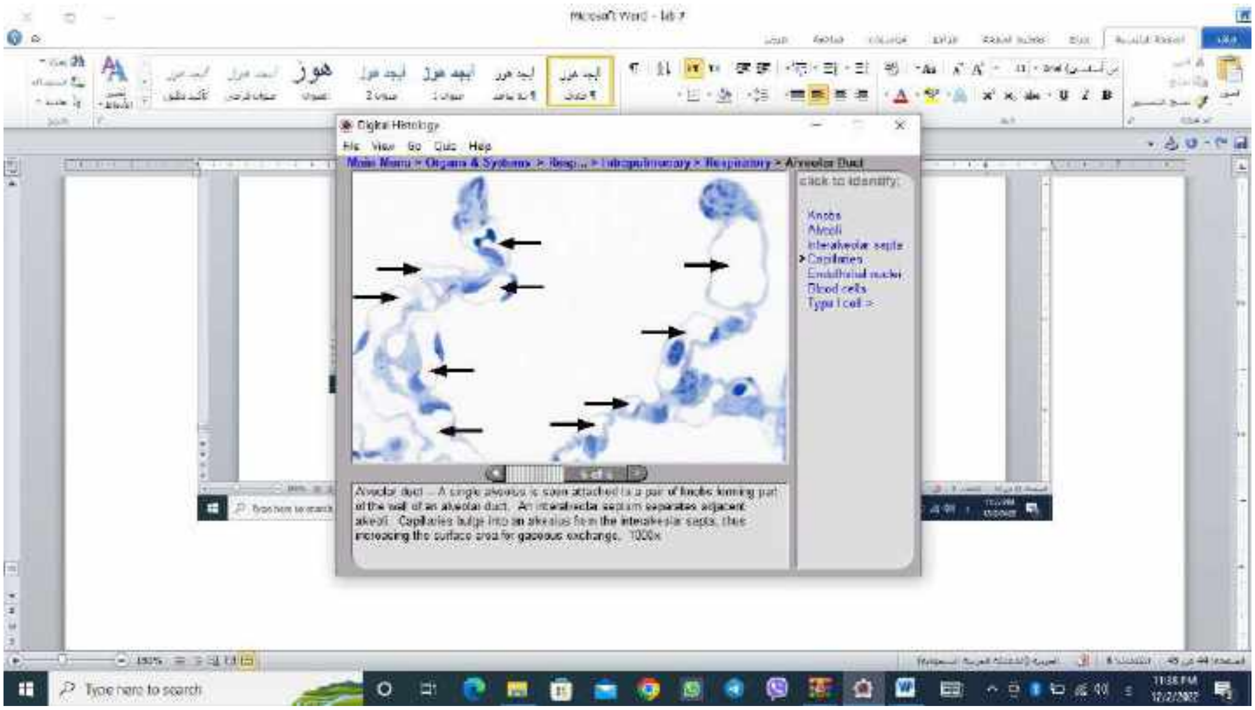
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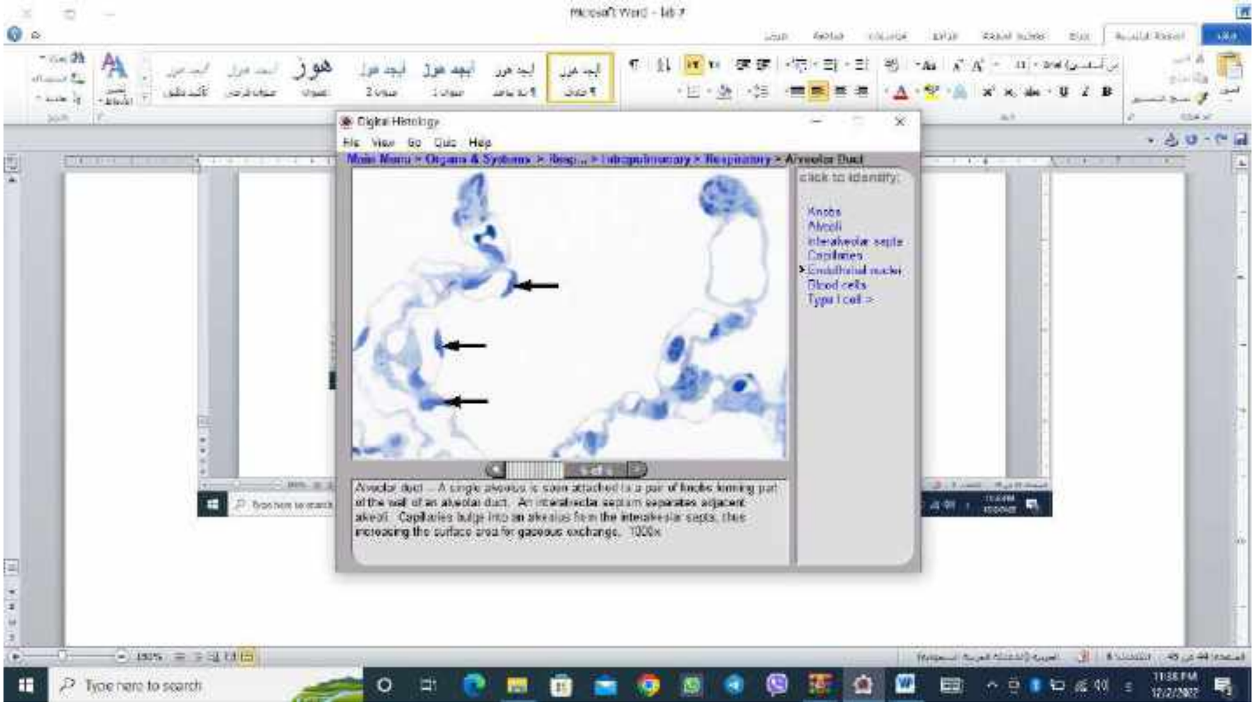
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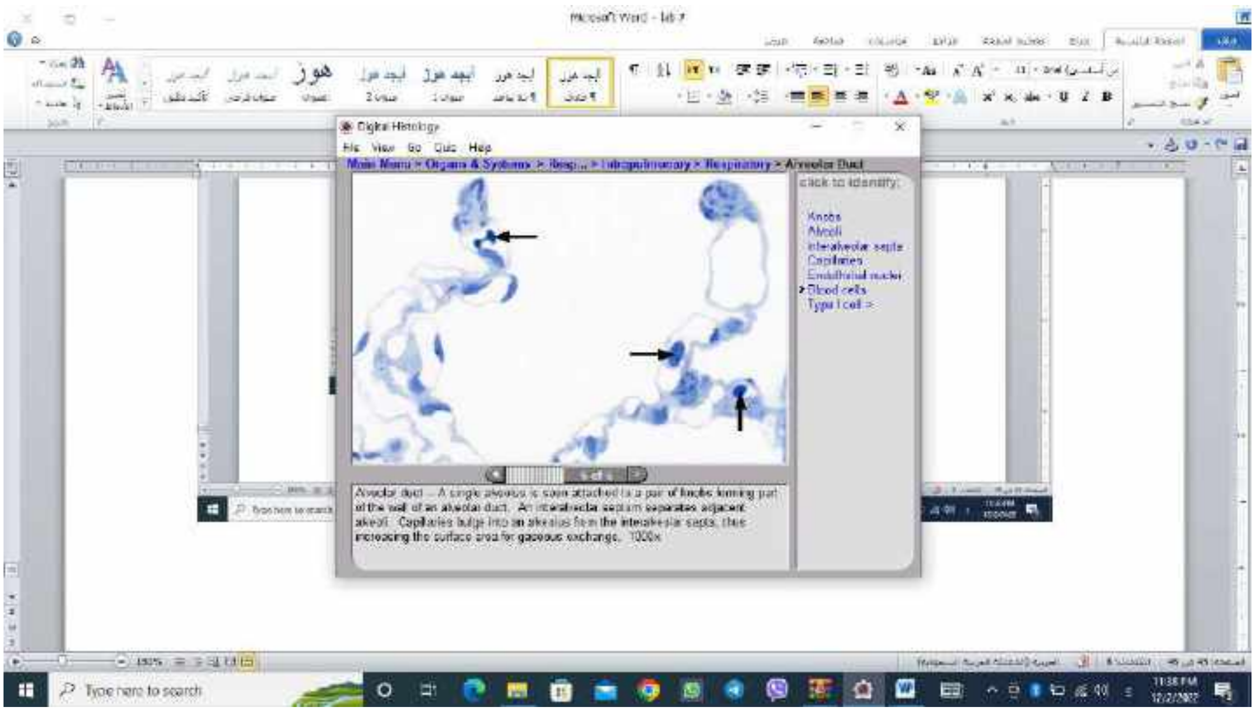
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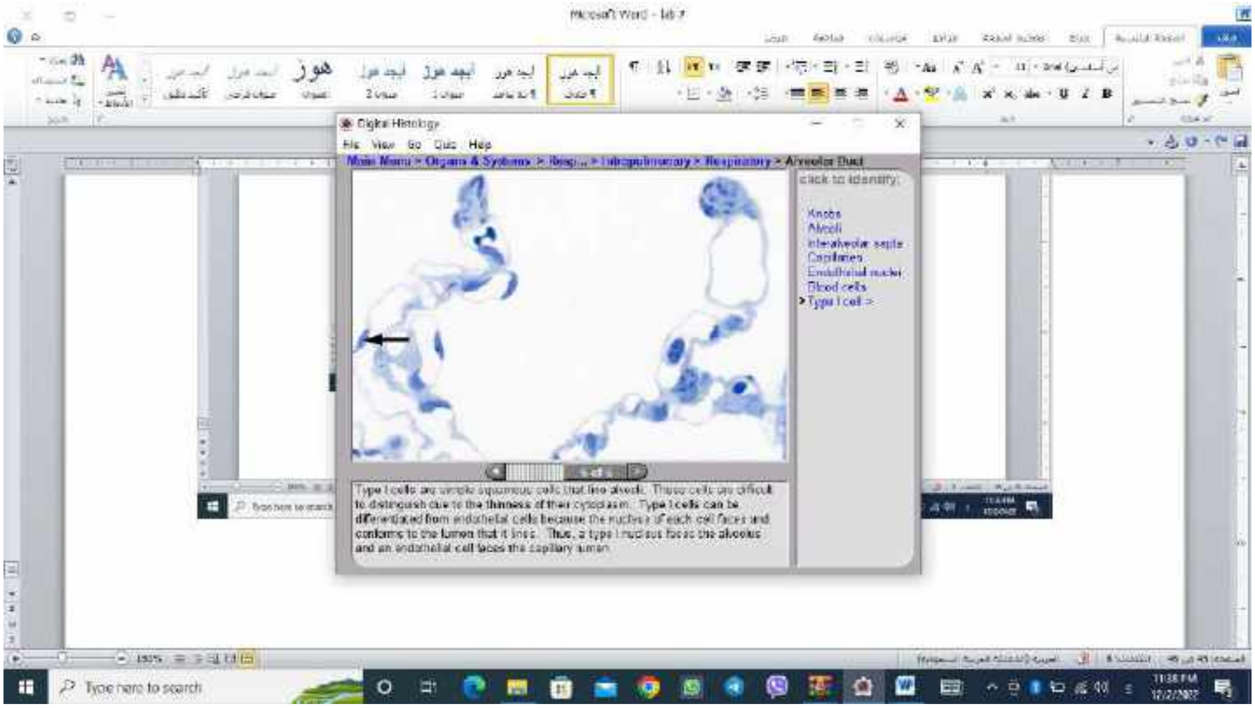
Digital Histology
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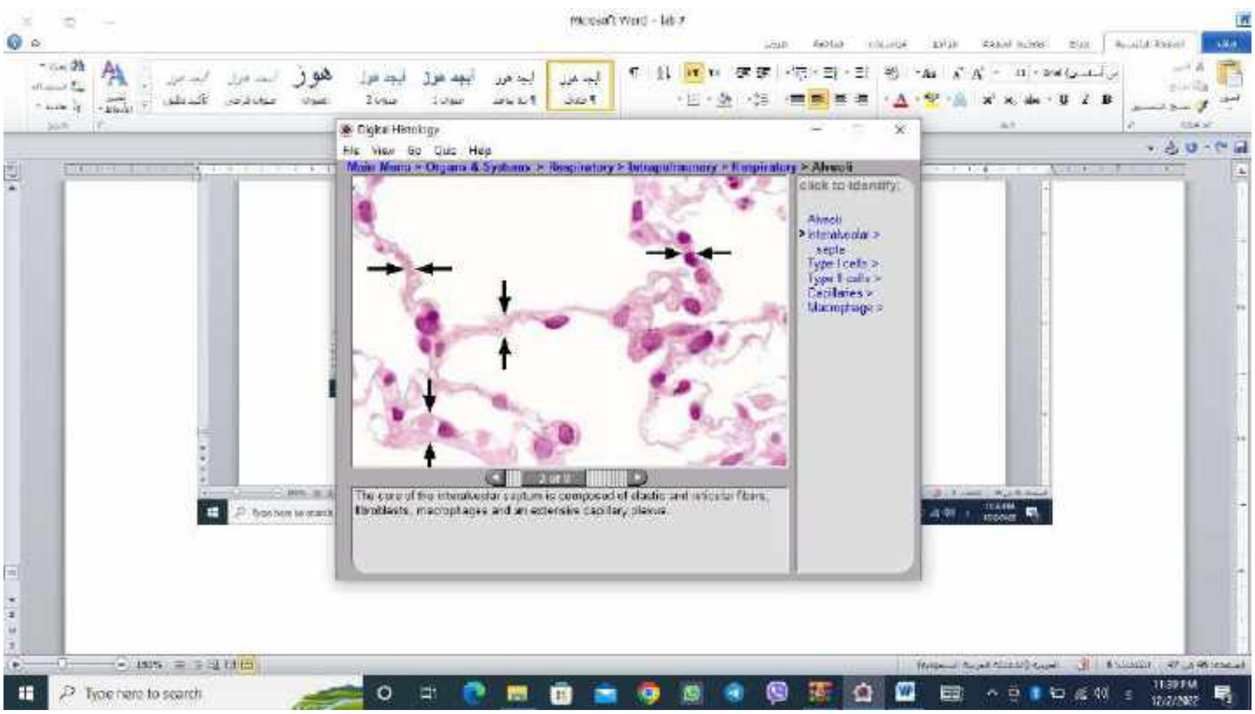
click to identify:
Alveoli
Blood cells
Type I cells are simple squamous cells that line alveoli. These cells are difficult to distinguish due to the thinness of their cytoplasm. Type I cells can be differentiated from endothelial cells because the nucleus of each cell faces and conforms to the lumen that it lines. Thus, a type I nucleus faces the alveolus and an endothelial cell faces the capillary lumen.


Digital Histology
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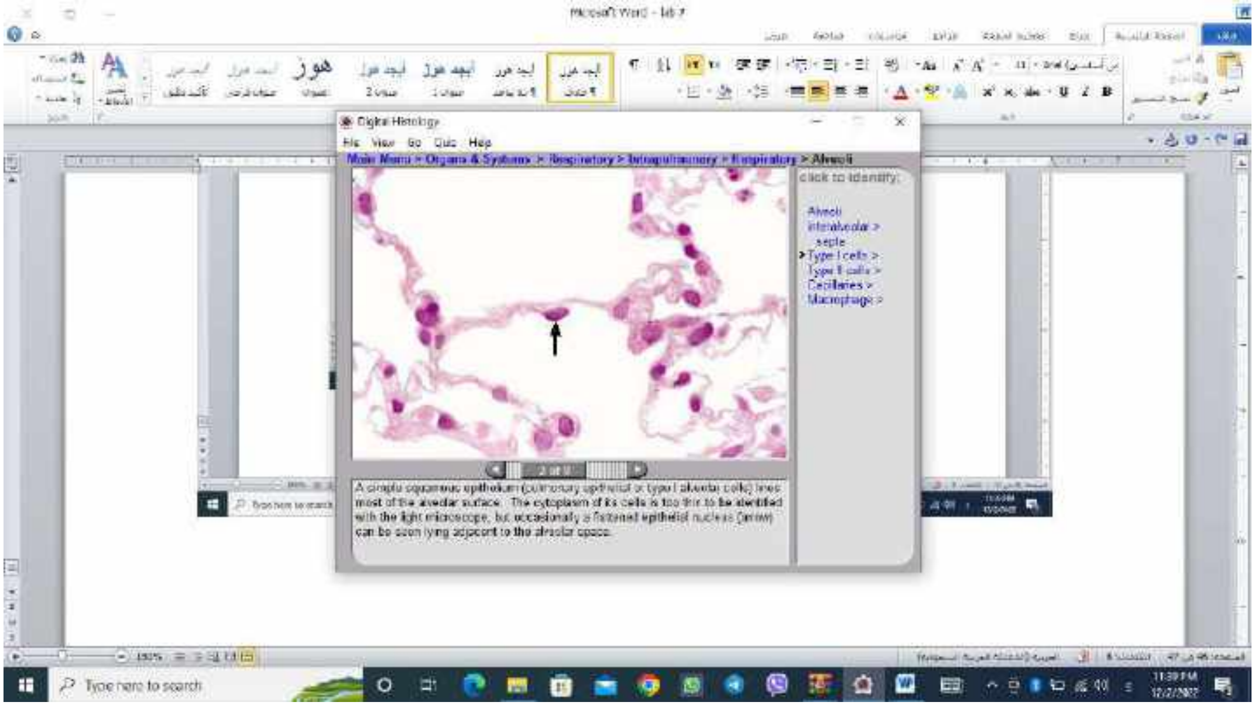
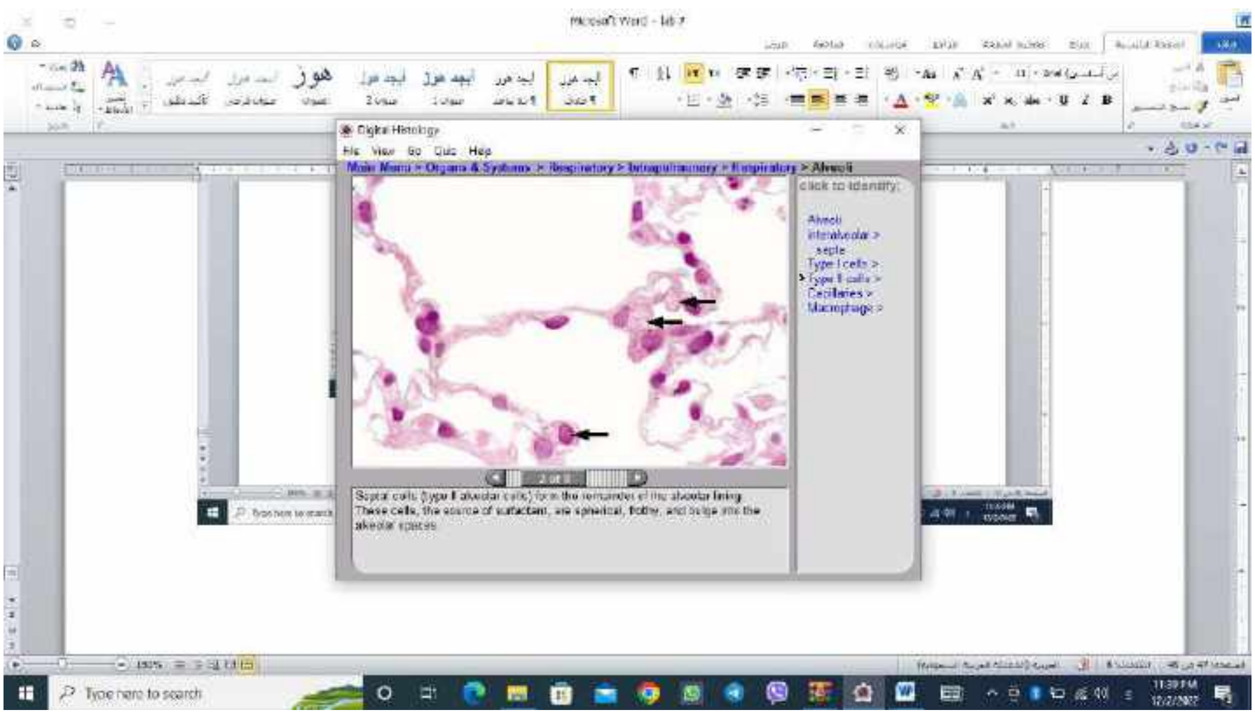
click to identify:
Alveoli
The core of the interalveolar septum is composed of elastic and reticular fibers, fibroblasts, macrophages and an extensive capillary plexus.


Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveoli
interalveolar > septa
Type I cells >
Type II cells >
Capillaries >
Macrophage >
A simple squamous epithelium (pulmonary epithelial or type I alveolar cells) lines most of the alveolar surface. The cytoplasm of its cells is too thin to be identified with the light microscope, but occasionally a flattened epithelial nucleus (arrow) can be seen lying adjacent to the alveolar space.
Type here to search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Alveoli
interalveolar > septa
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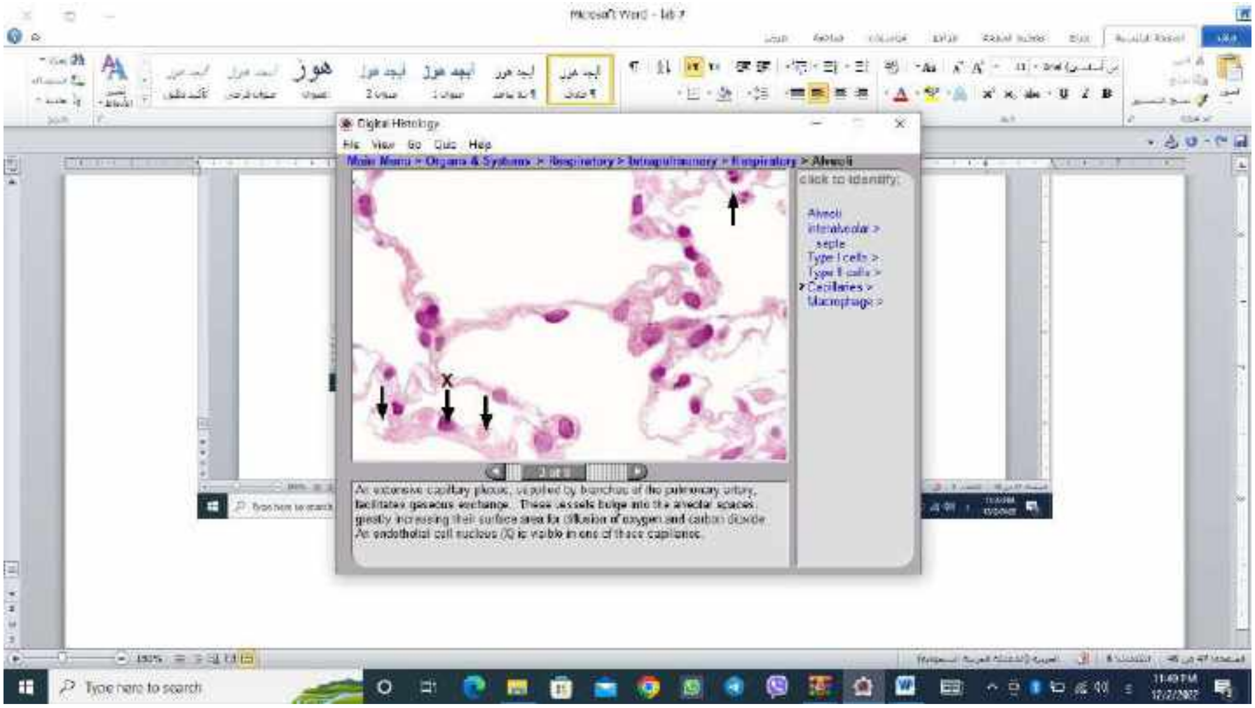
Type II cells >
Capillaries >
Macrophage >
Septal cells (type II alveolar cells) form the remainder of the alveolar lining. These cells, the source of surfactant, are spherical, frothy, and bulge into the alveolar spaces.
Type here to search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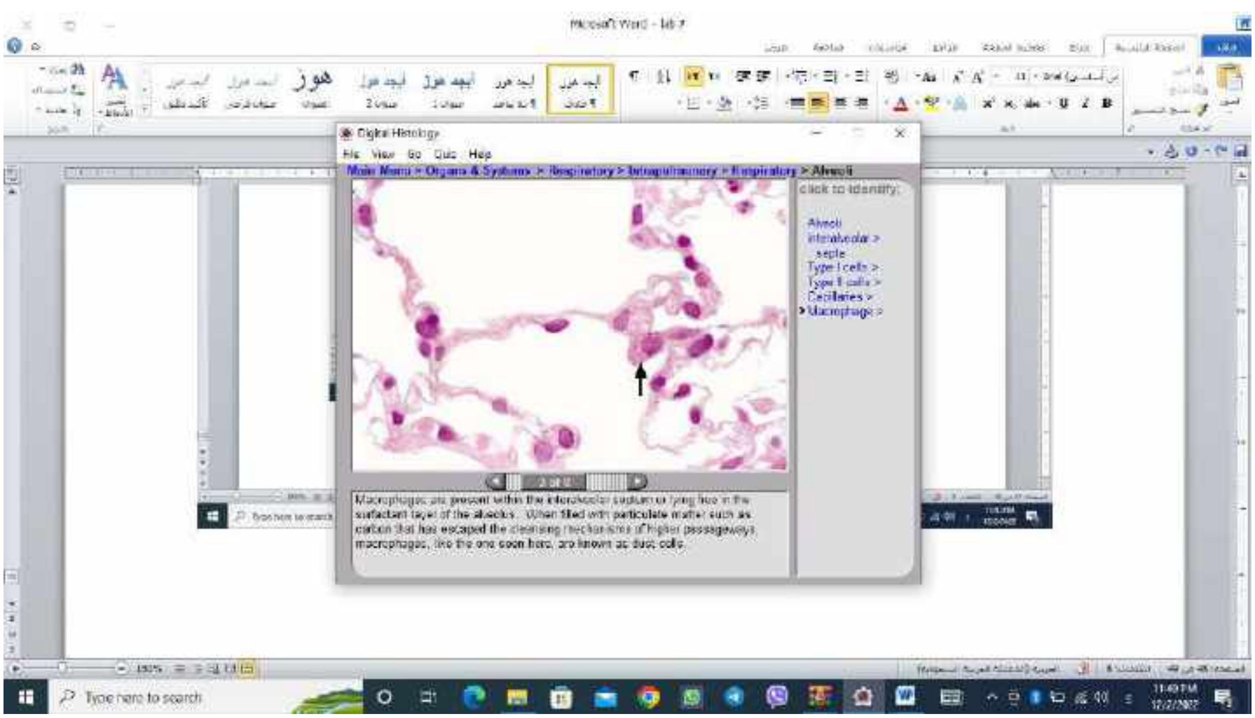
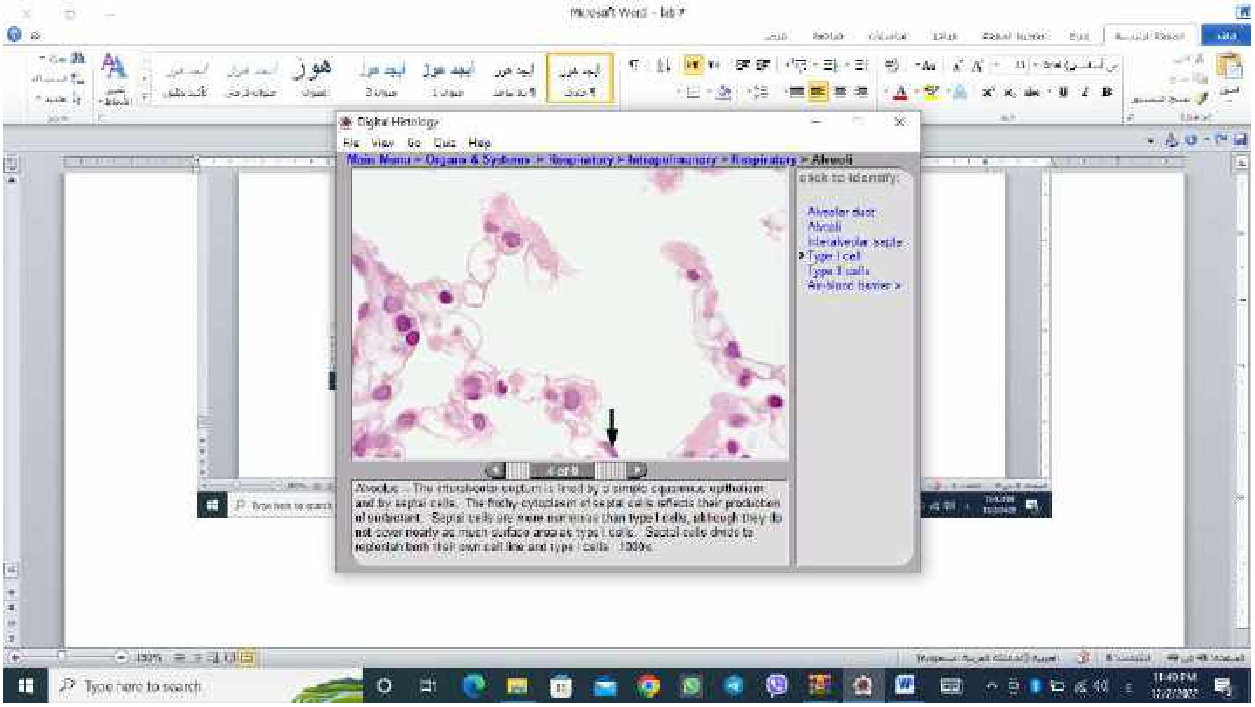
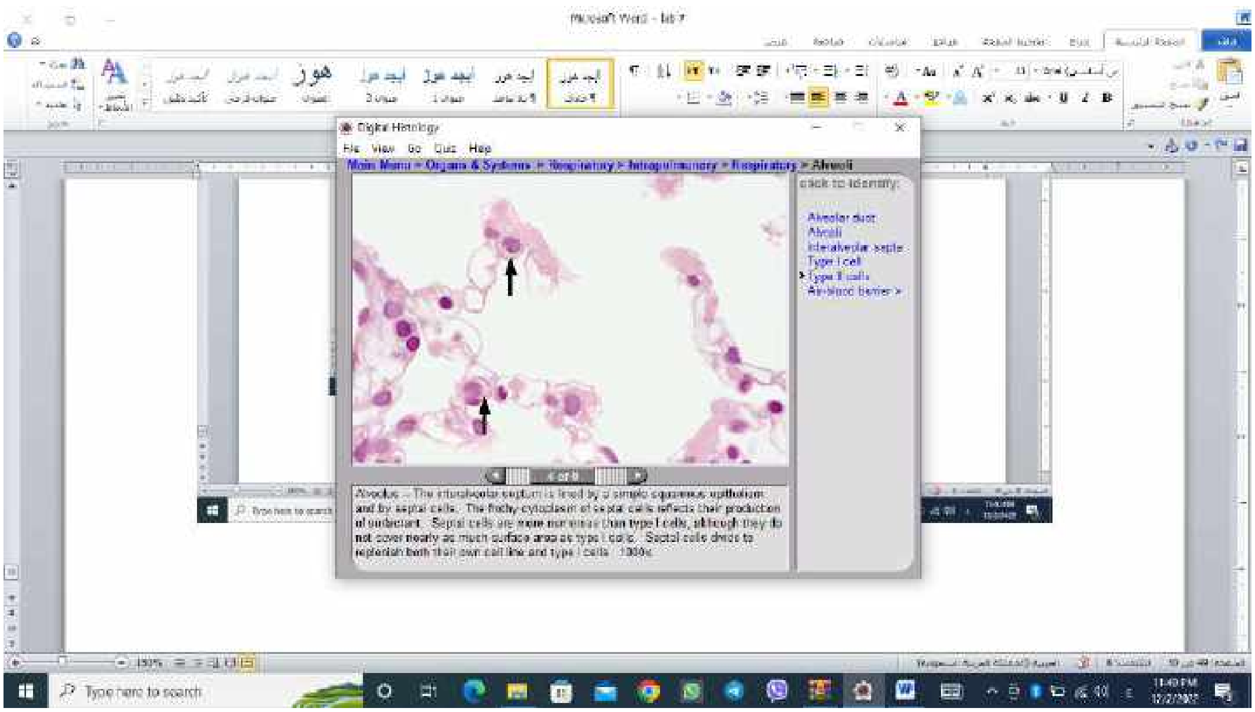
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveoli
interalveolar >
septa
Type I cells >
Type II cells >
Capillaries >
Macrophage >
X
An extensive capillary plexus, supplied by branches of the pulmonary artery, facilitates gaseous exchange. These vessels bulge into the alveolar spaces greatly increasing their surface area for diffusion of oxygen and carbon dioxide. An endothelial cell nucleus (X) is visible in one of these capillaries.


Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveoli
interalveolar >
septa
Type I cells >
Type II cells >
Capillaries >
Macrophage >
Macrophages are present within the interalveolar septum or lying free in the surfactant layer of the alveolus. When filled with particulate matter such as carbon that has escaped the cleansing mechanisms of higher passageways macrophages, like the one seen here, are known as dust cells.


Digital Histology
File View Go Quiz Help
Alveoli
click to identify:
Alveolar duct
Alveoli
Interalveolar septa
Type I cell
Type II cells
Air-blood barrier >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Alveoli
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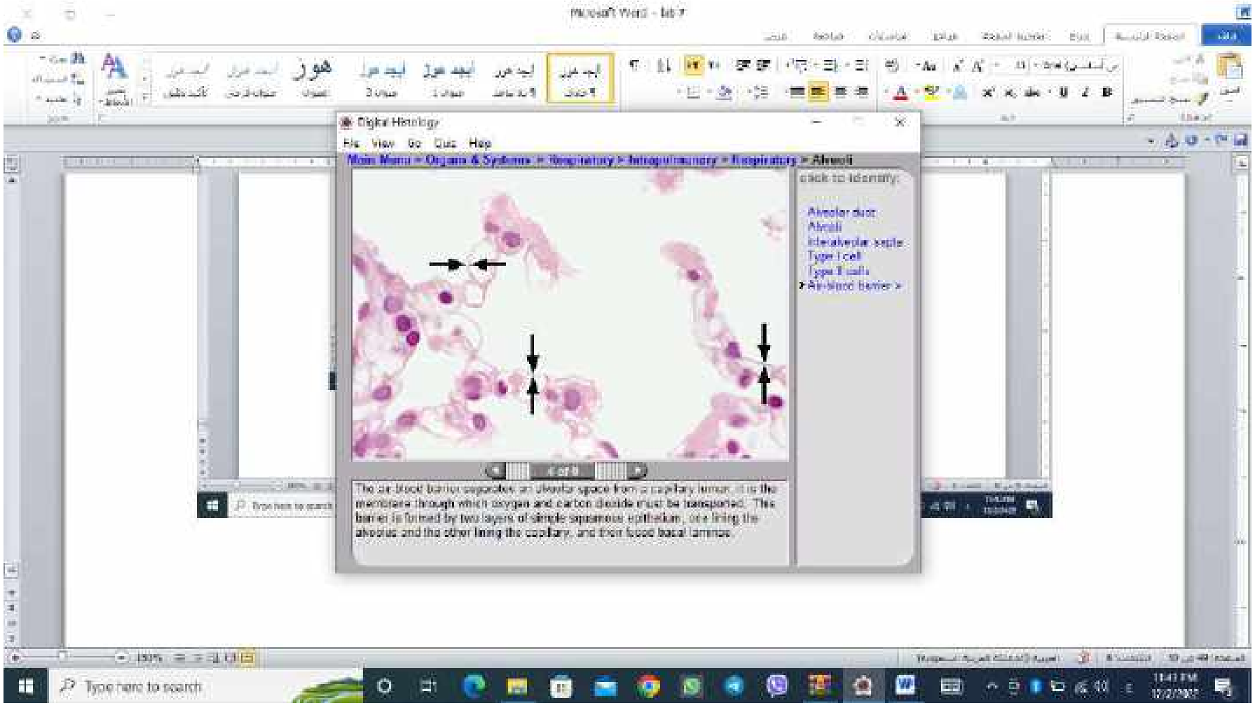
Alveolar duct
Alveoli
Interalveolar septa
Type I cell
Type II cells
Air-blood barrier >


Microsoft Word - lab 7
Digital Histology
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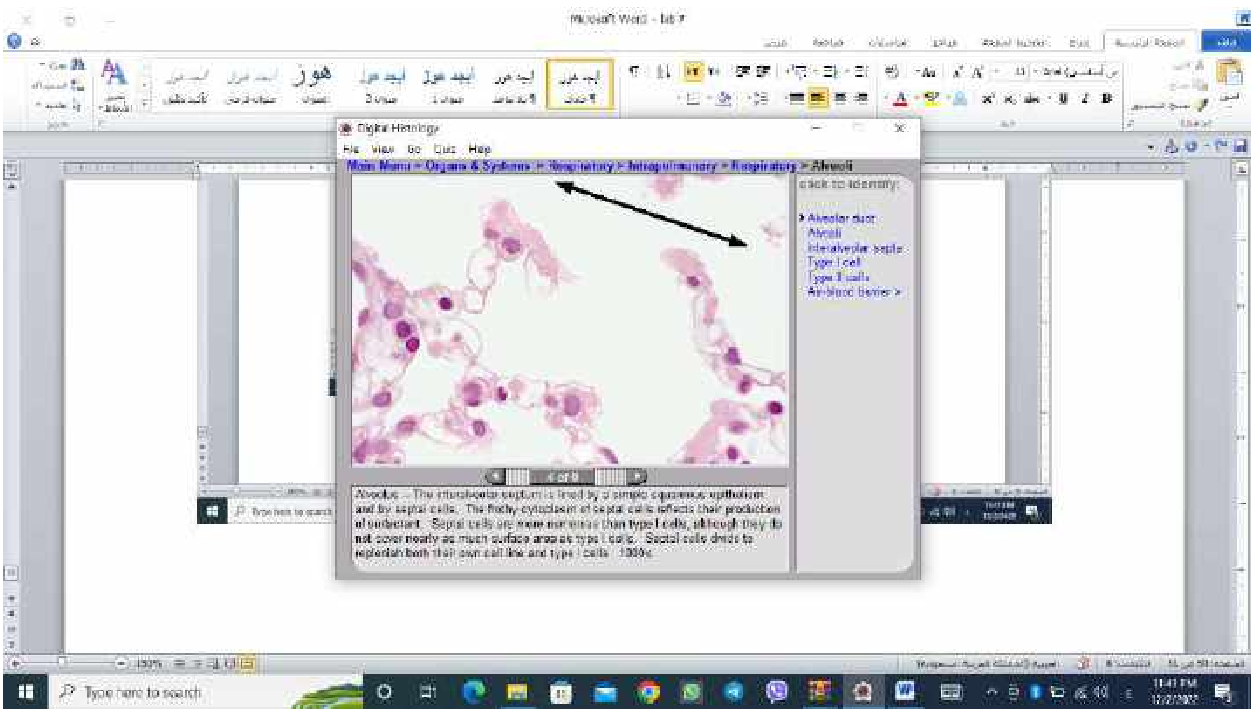
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveolar duct
Alveoli
Interalveolar septa
Type I cell
Type II cells
Air-blood barrier >
The air-blood barrier separates an alveolar space from a capillary lumen. It is the membrane through which oxygen and carbon dioxide must be transported. This barrier is formed by two layers of simple squamous epithelium, one lining the alveolus and the other lining the capillary, and their fused basal laminae.
Type here to search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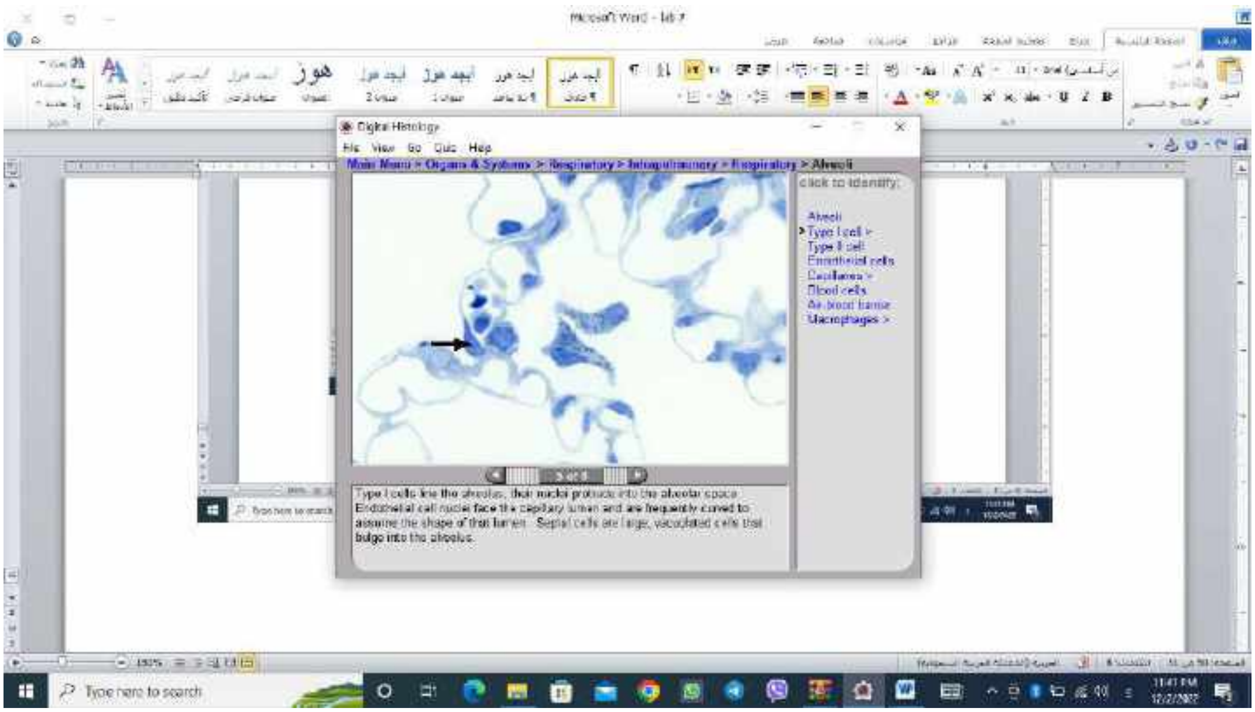
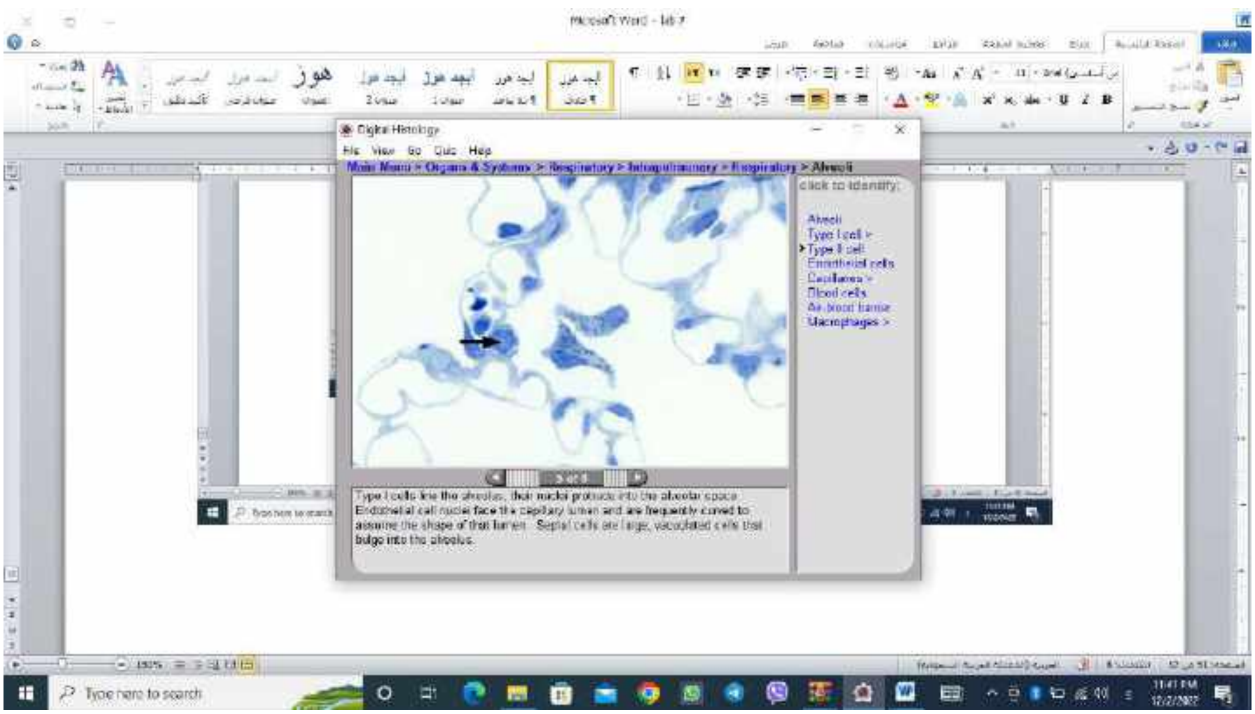
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveolar duct
Alveoli
Interalveolar septa
Type I cell
Type II cells
Air-blood barrier >
Alveolus – The interalveolar septum is lined by a simple squamous epithelium and by septal cells. The frothy cytoplasm of septal cells reflects their production of surfactant. Septal cells are more numerous than type I cells, although they do not cover nearly as much surface area as type I cells. Septal cells divide to replenish both their own cell line and type I cells. 1000x.
Type here to search


Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveoli
Type I cell >
Type II cell
Endothelial cells
Capillaries >
Blood cells
Air-blood barrier
Macrophages >
Type I cells line the alveolus, their nuclei protrude into the alveolar space. Endothelial cell nuclei face the capillary lumen and are frequently curved to assume the shape of that lumen. Septal cells are large, vacuolated cells that bulge into the alveolus.
Type here to search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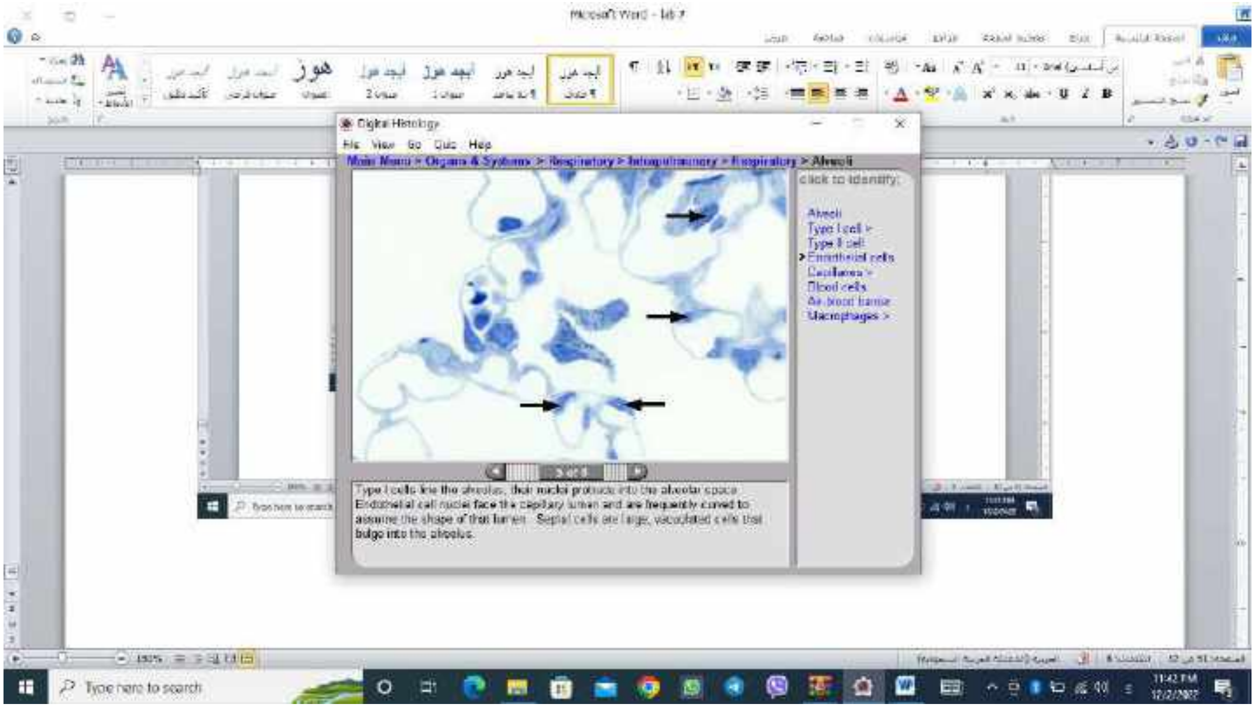
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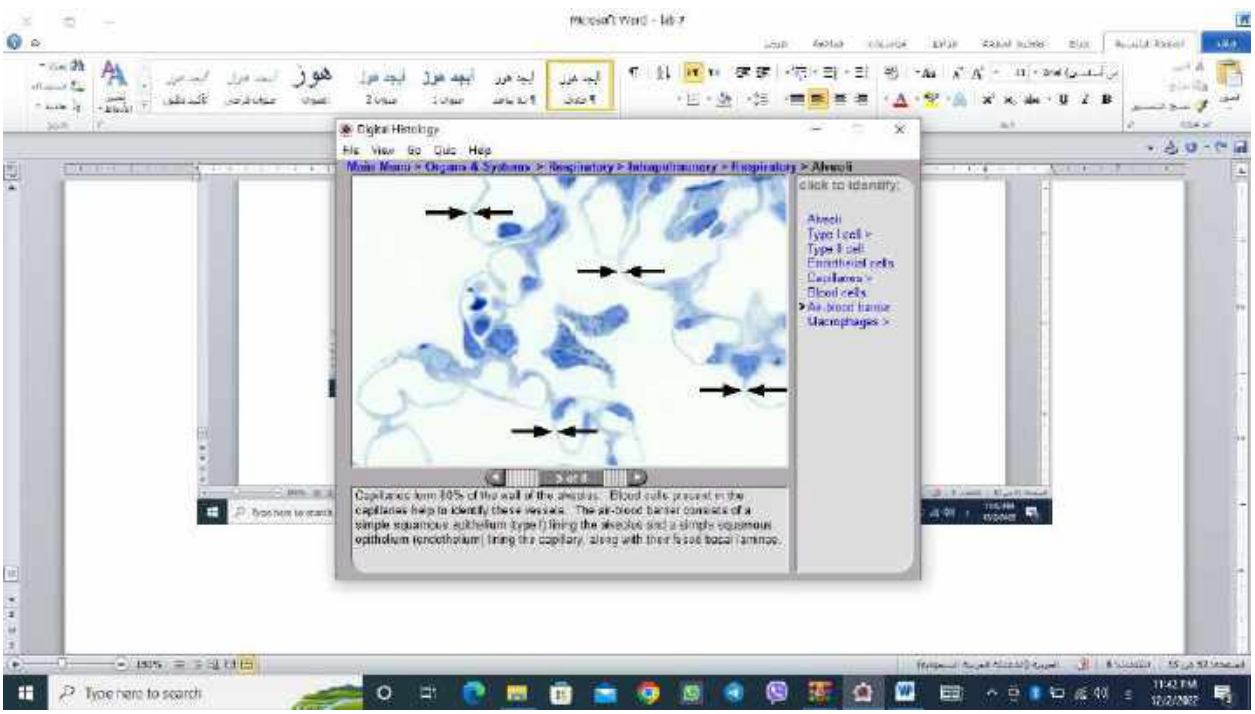
11:42 PM
12/2/2022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Digital Histology
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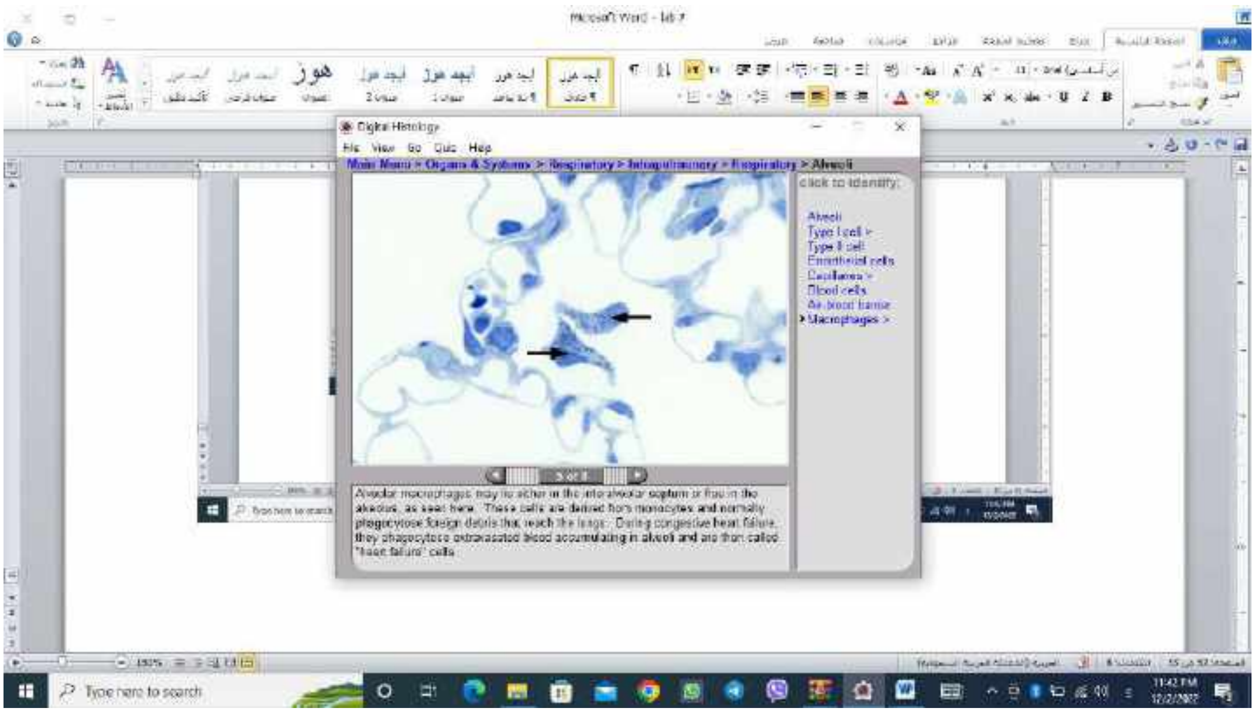
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveoli
Type I cell >
Type II cell
Endothelial cells
Capillaries >
Blood cells
Air-blood barrier
Macrophages >
Capillaries form 80% of the wall of the alveolus. Blood cells present in the capillaries help to identify these vessels. The air-blood barrier consists of a simple squamous epithelium (type I) lining the alveolus and a simple squamous epithelium (endothelium) lining the capillary, along with their fused basal laminae.
Type here to search
11:42 PM
12/2/2022



Microsoft Word - lab 7
Digital Histology
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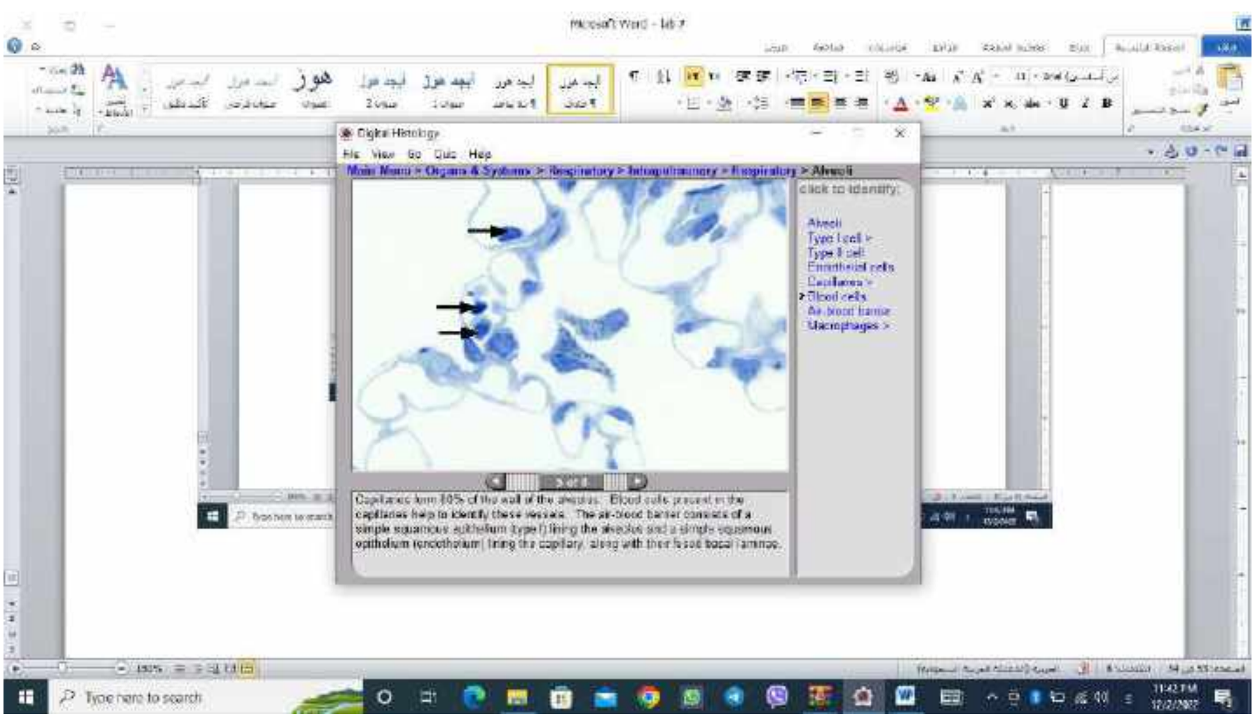
click to identify:
Alveoli
Type I cell >
Type II cell
Endothelial cells
Capillaries >
Blood cells
Air-blood barrier
Macrophages >
Alveolar macrophages may lie either in the interalveolar septum or free in the alveolus, as seen here. These cells are derived from monocytes and normally phagocytose foreign debris that reach the lungs. During congestive heart failure, they phagocytose extravasated blood accumulating in alveoli and are then called "heart failure" cells.
Type here to search
11:42 PM
12/2/2022



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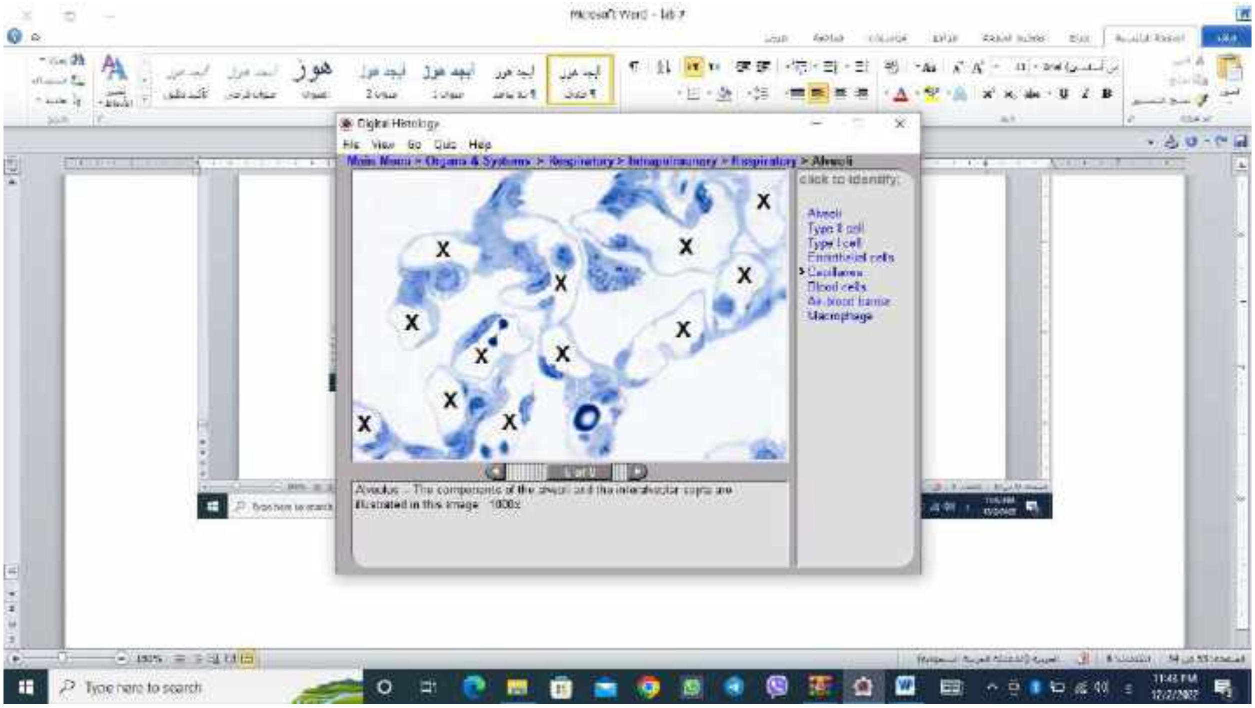
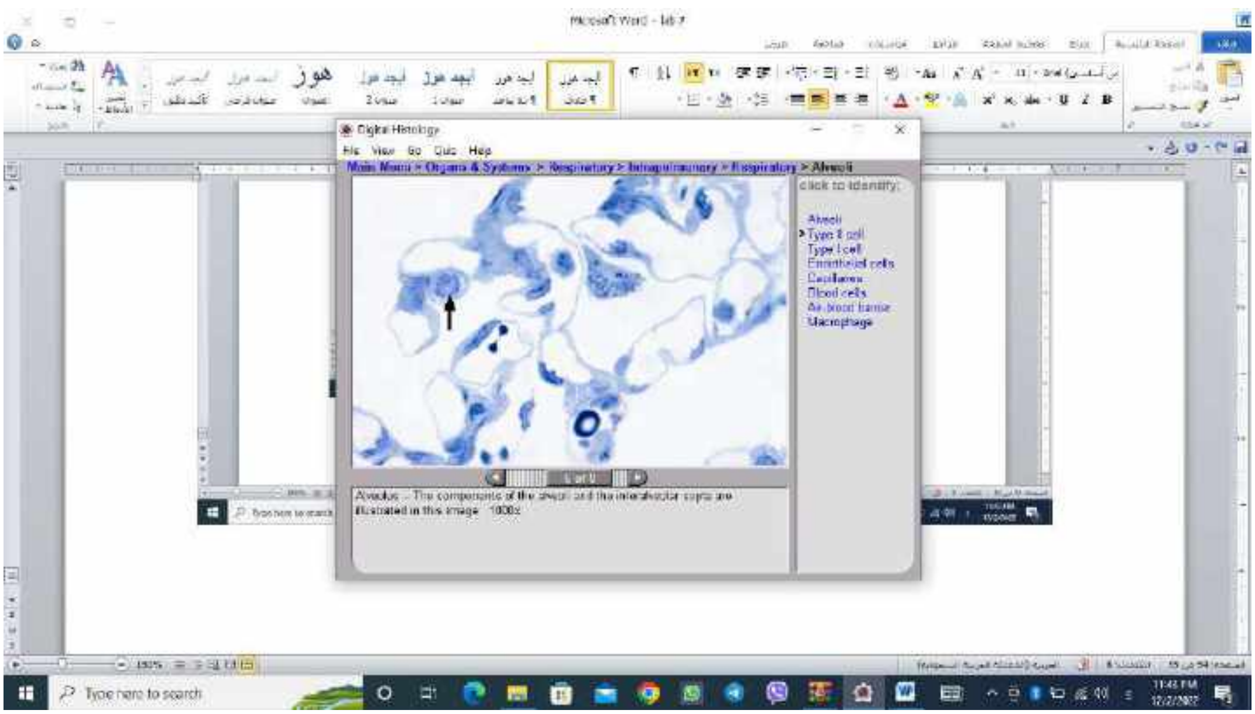

Microsoft Word - lab 7
Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Respiratory > Intrapulmonary > Respiratory > Alveoli
click to identify:
Alveoli
Type II cell
Type I cell
Endothelial cells
Capillaries
Blood cells
Air-blood barrier
Macrophage
X
Alveolus -- The components of the alveoli and the interalveolar septa are illustrated in this image. 1000x
Type here to search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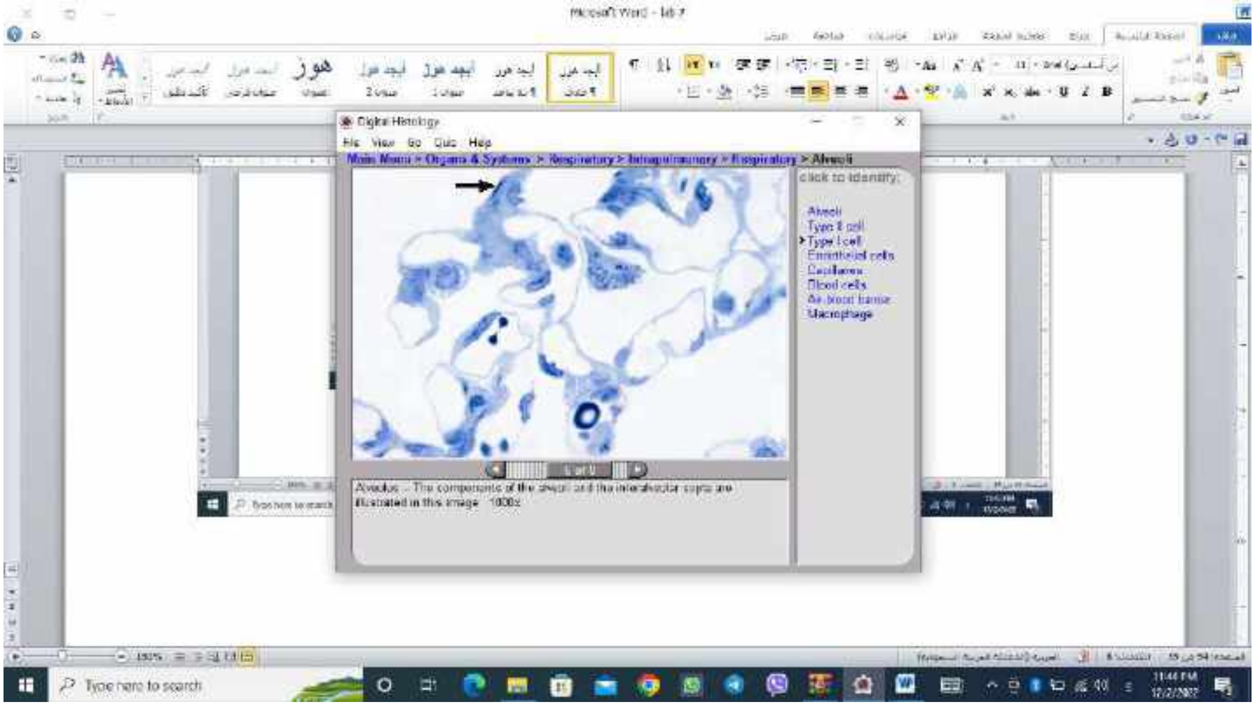
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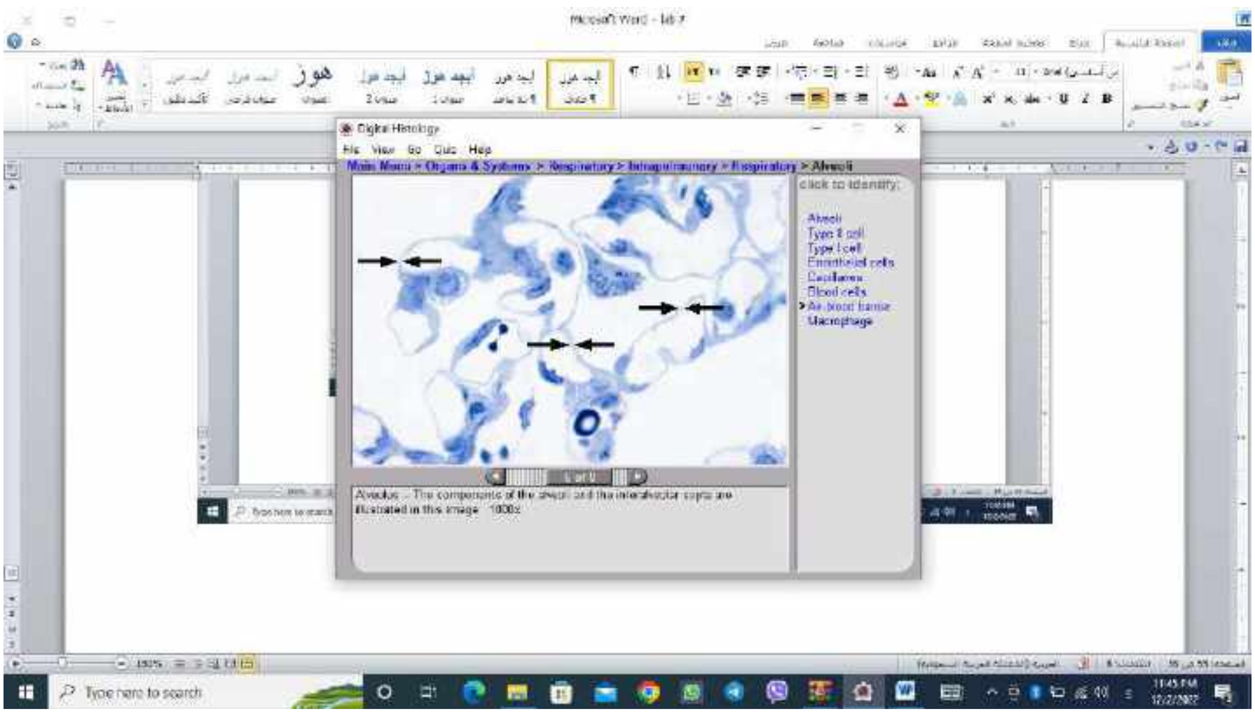
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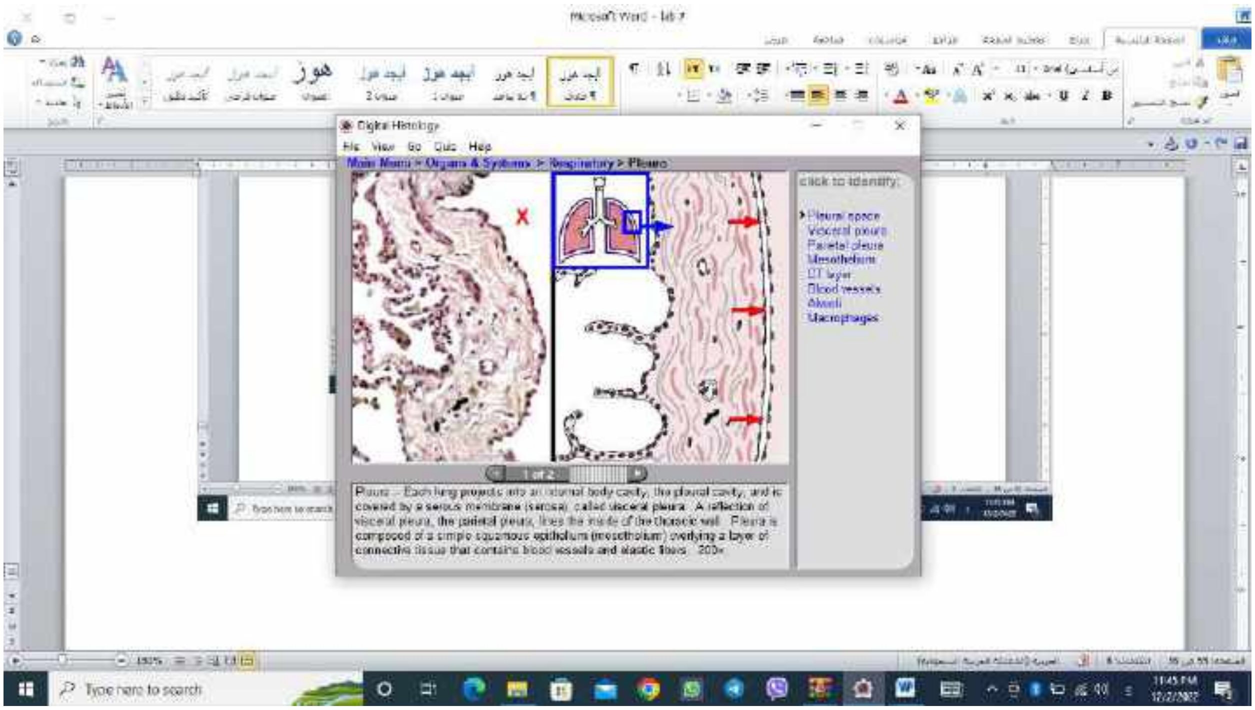
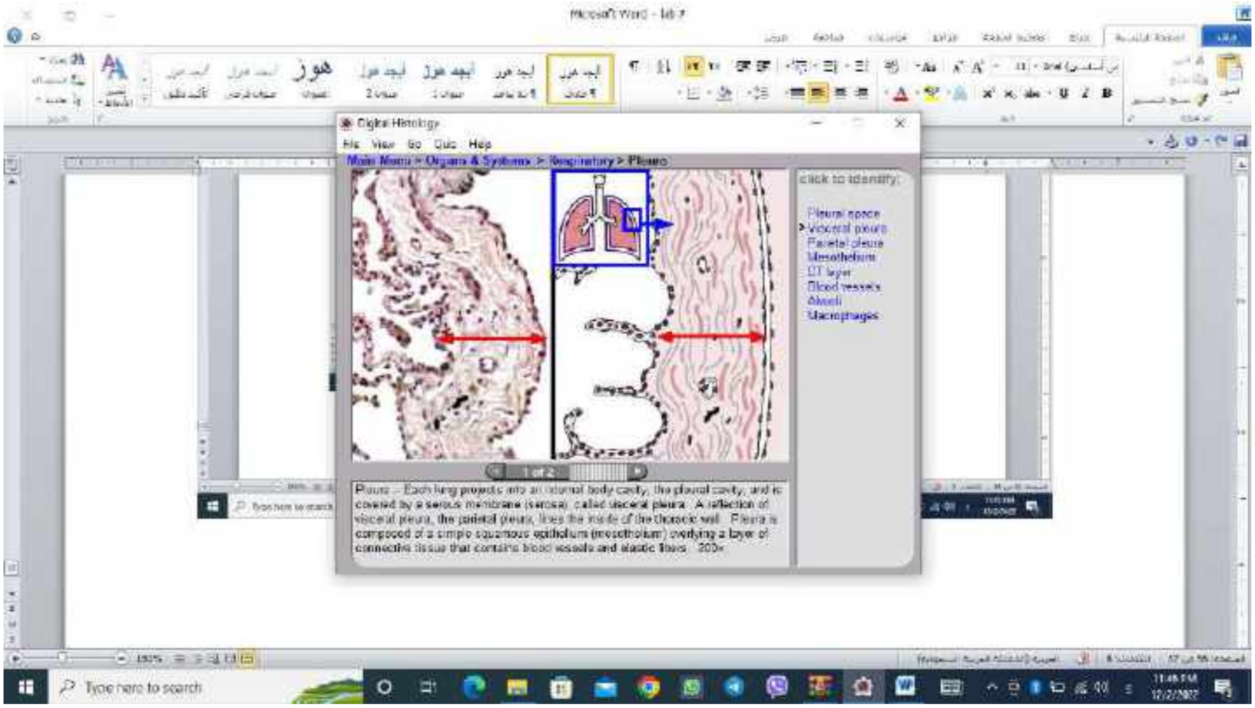

Digital Histology
File View Go Quiz Help
Main Menu > Organs & Systems > Respiratory > Pleura
click to identify:
Pleural space
Visceral pleura
Parietal pleura
Mesothelium
CT layer
Blood vessels
Alveoli
Macrophages
1 of 2
Pleura - Each lung projects into an internal body cavity, the pleural cavity, and is covered by a serous membrane (serosa) called visceral pleura. A reflection of visceral pleura, the parietal pleura, lines the inside of the thoracic wall. Pleura is composed of a simple squamous epithelium (mesothelium) overlying a layer of connective tissue that contains blood vessels and elastic fibers. 200x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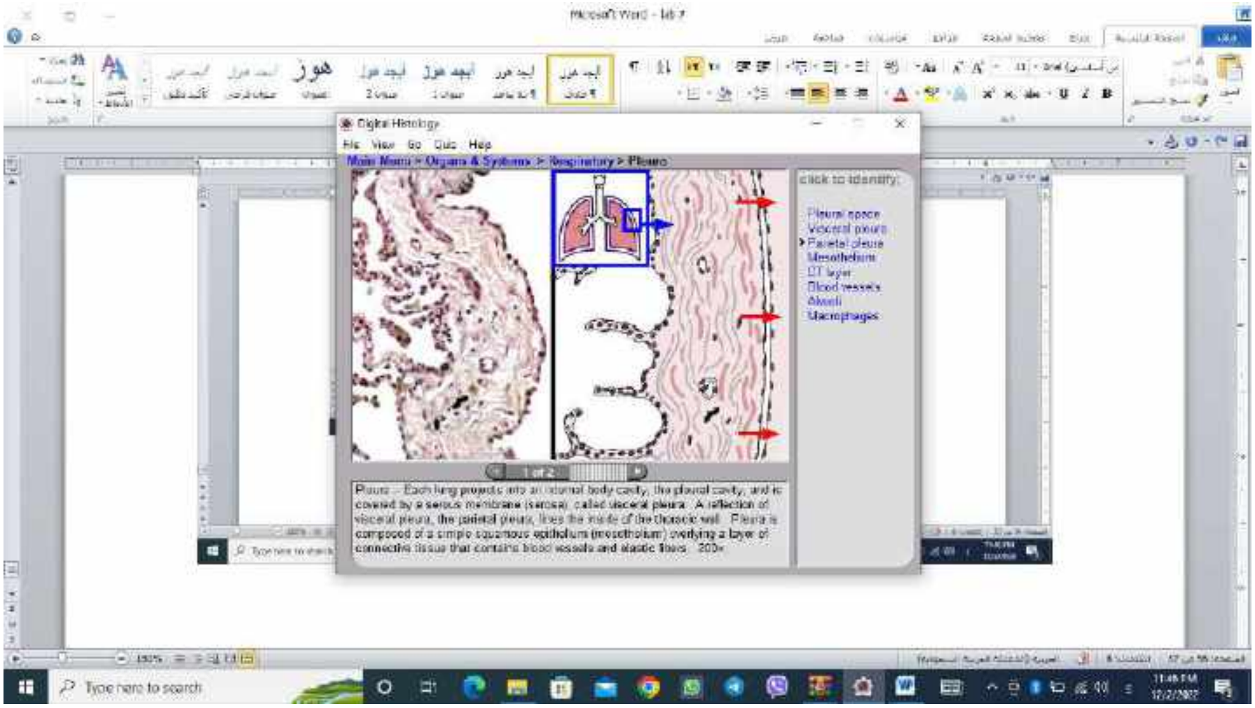

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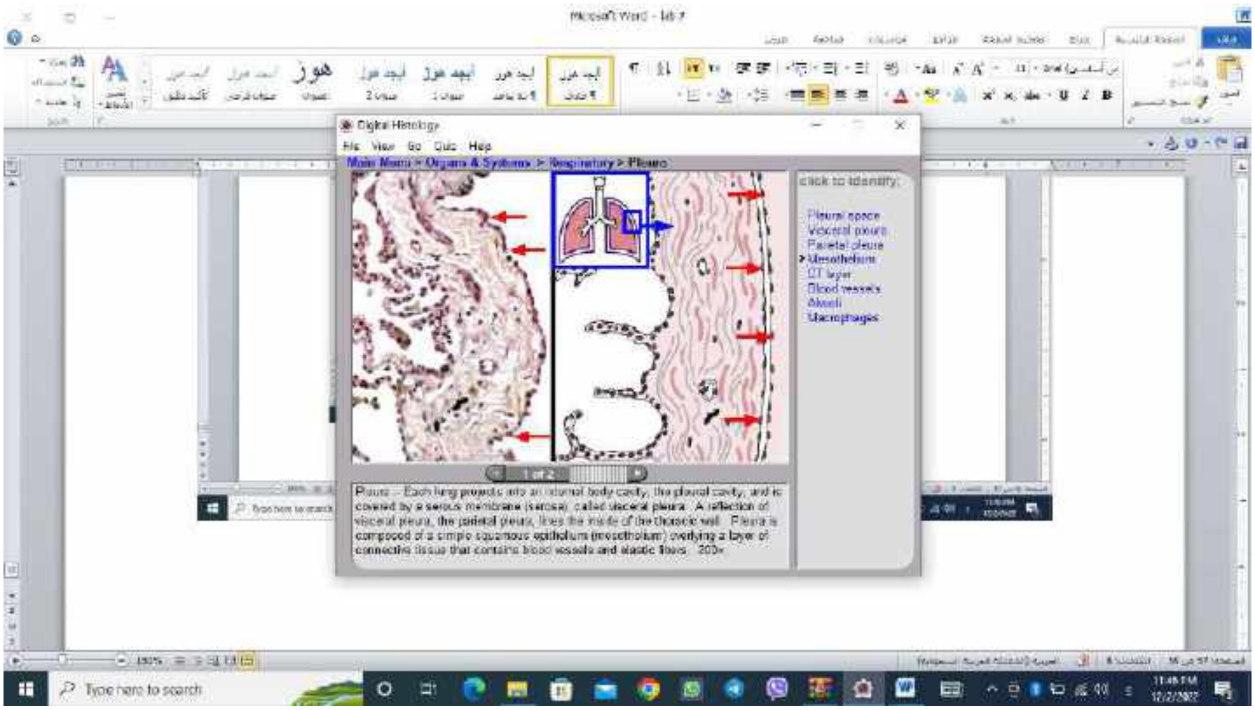

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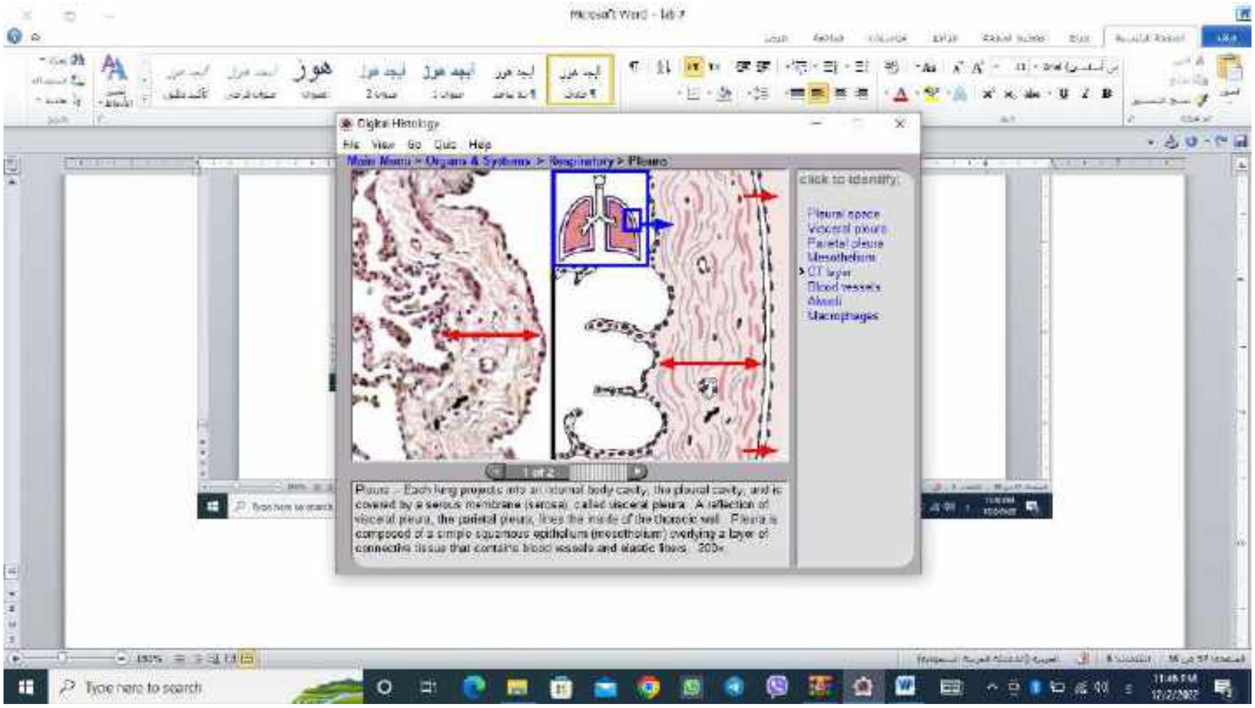
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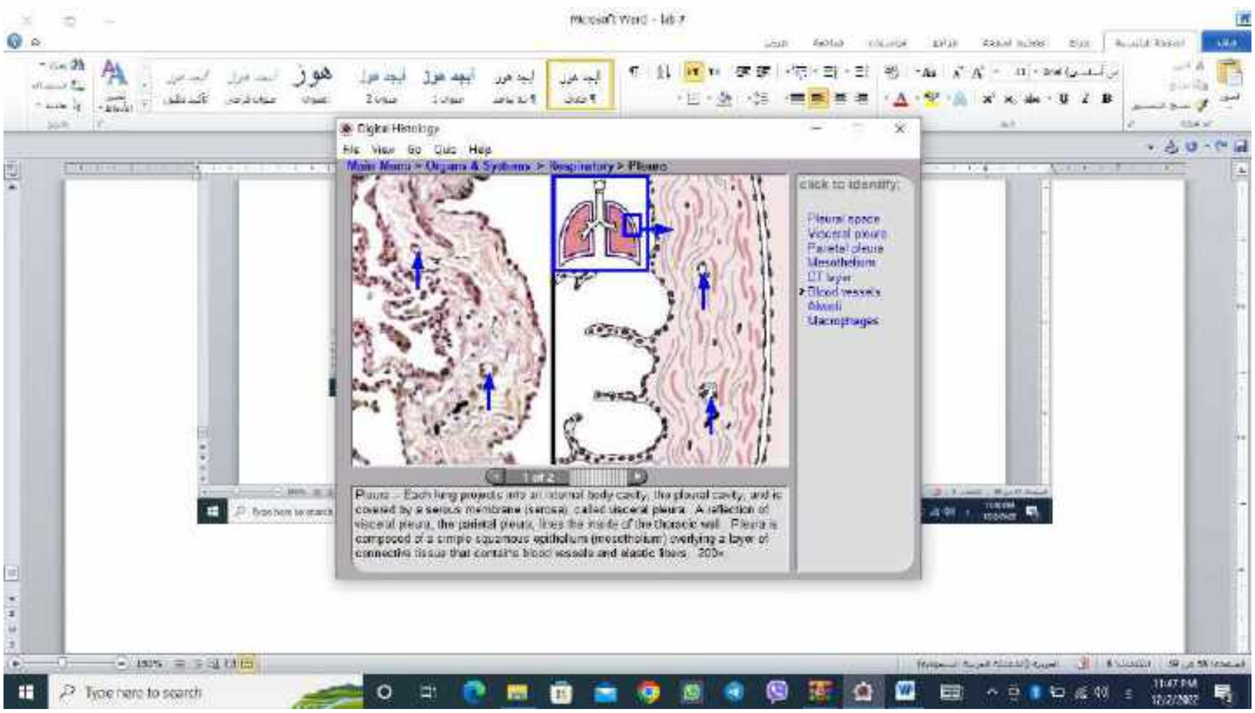
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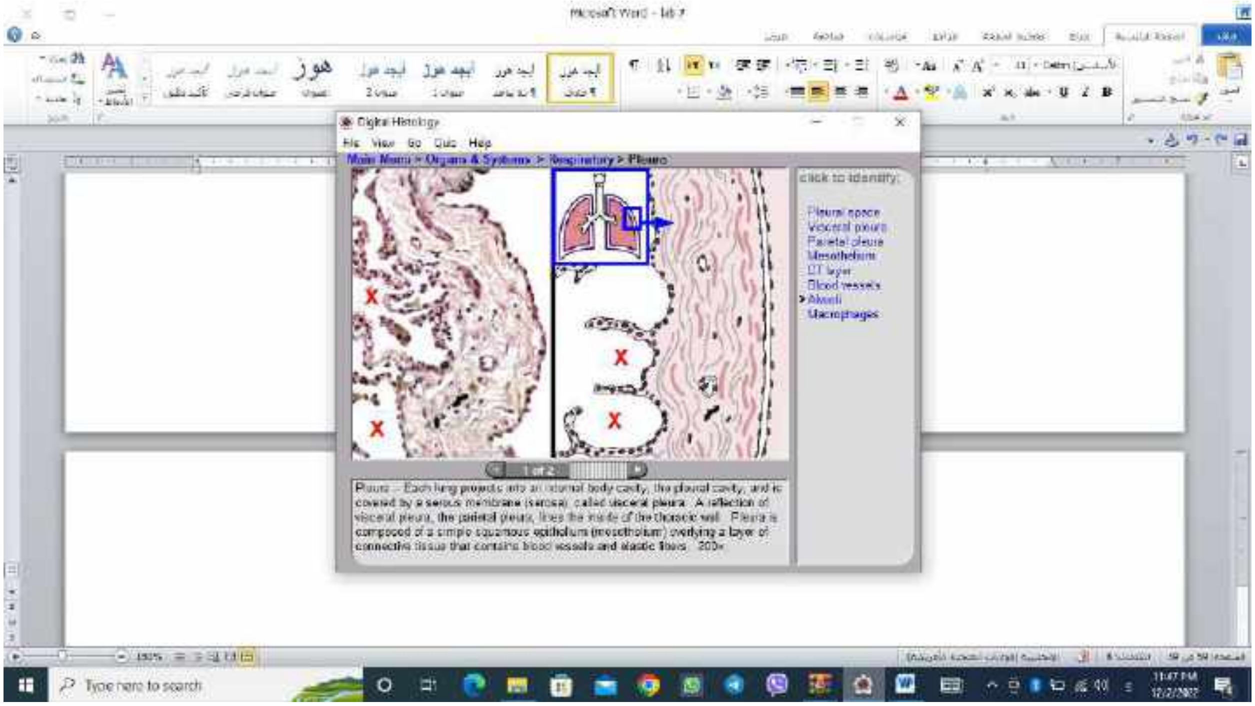
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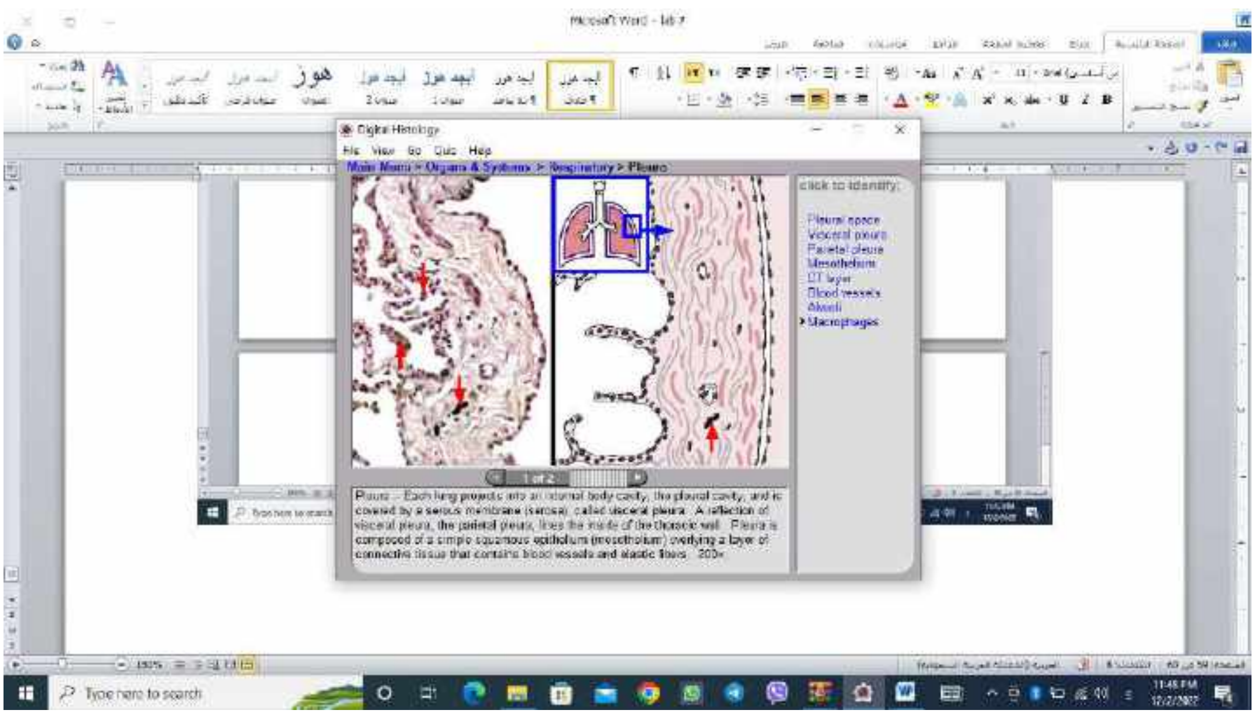
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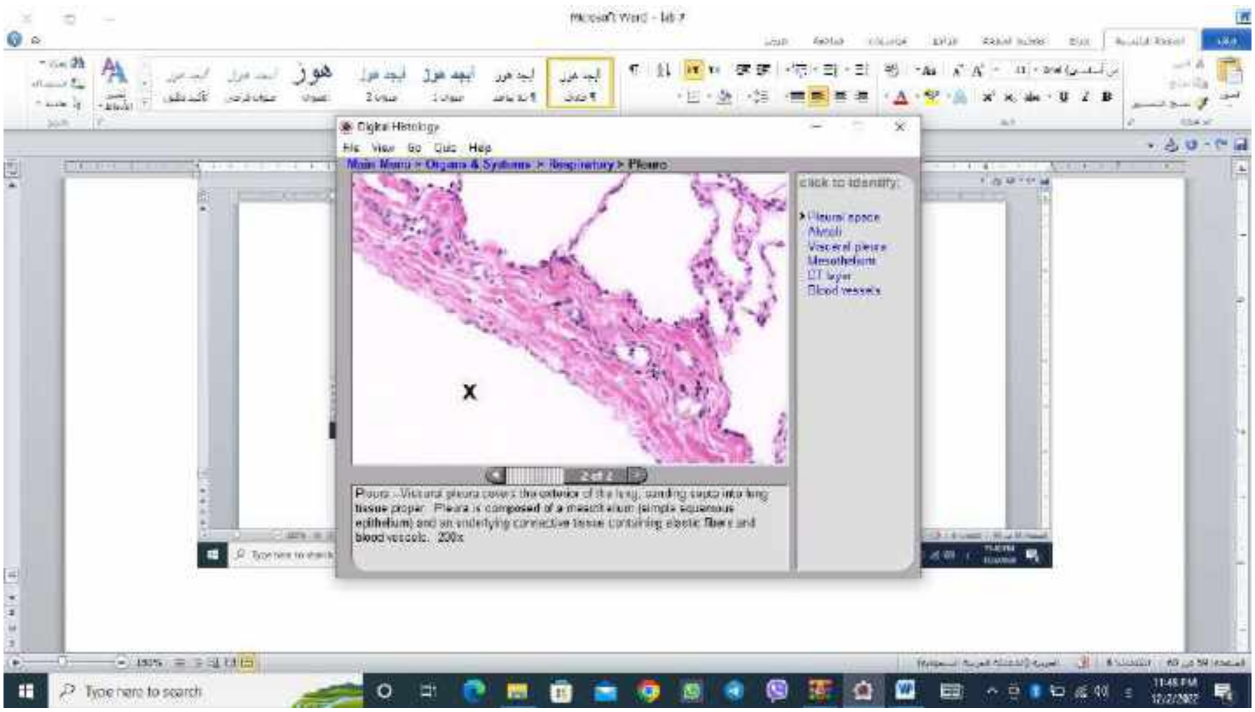
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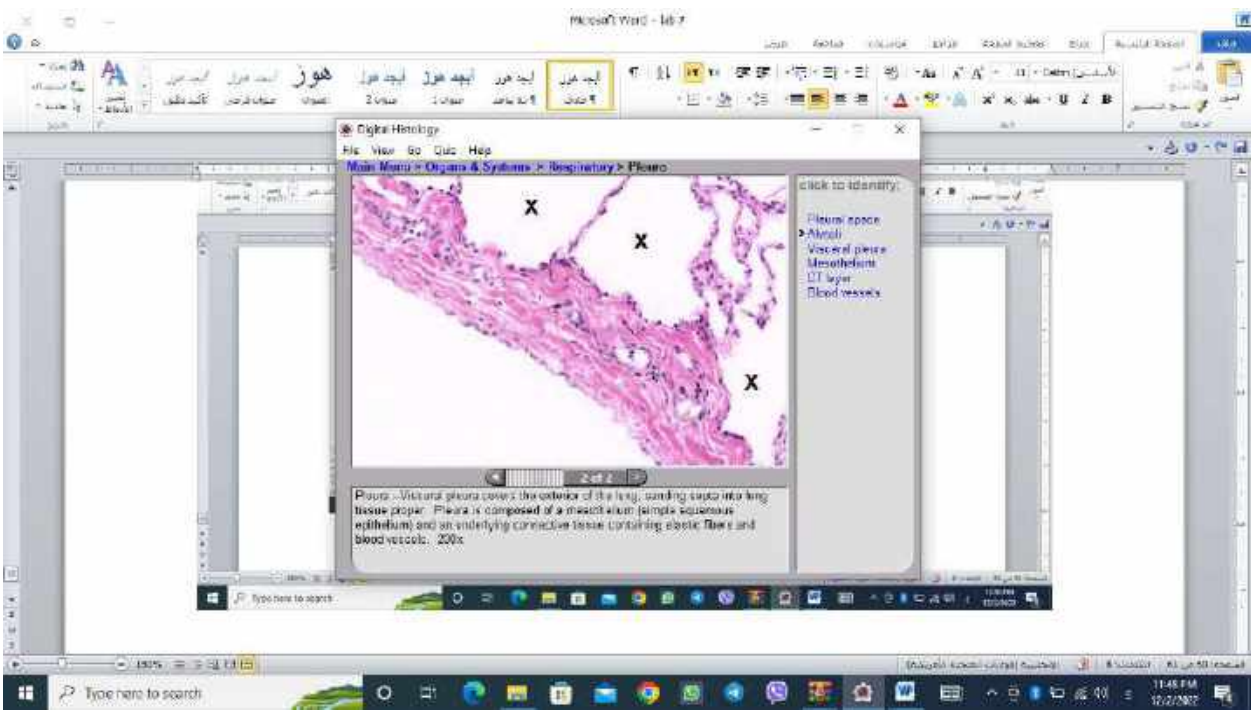
click to identify:
Pleural space
Alveoli
Visceral pleura
Mesothelium
CT layer
Blood vessels
X
2 of 2
Pleura - Visceral pleura covers the exterior of the lung, sending septa into lung tissue proper. Pleura is composed of a mesothelium (simple squamous epithelium) and an underlying connective tissue containing elastic fibers and blood vessels. 200x
Type here to search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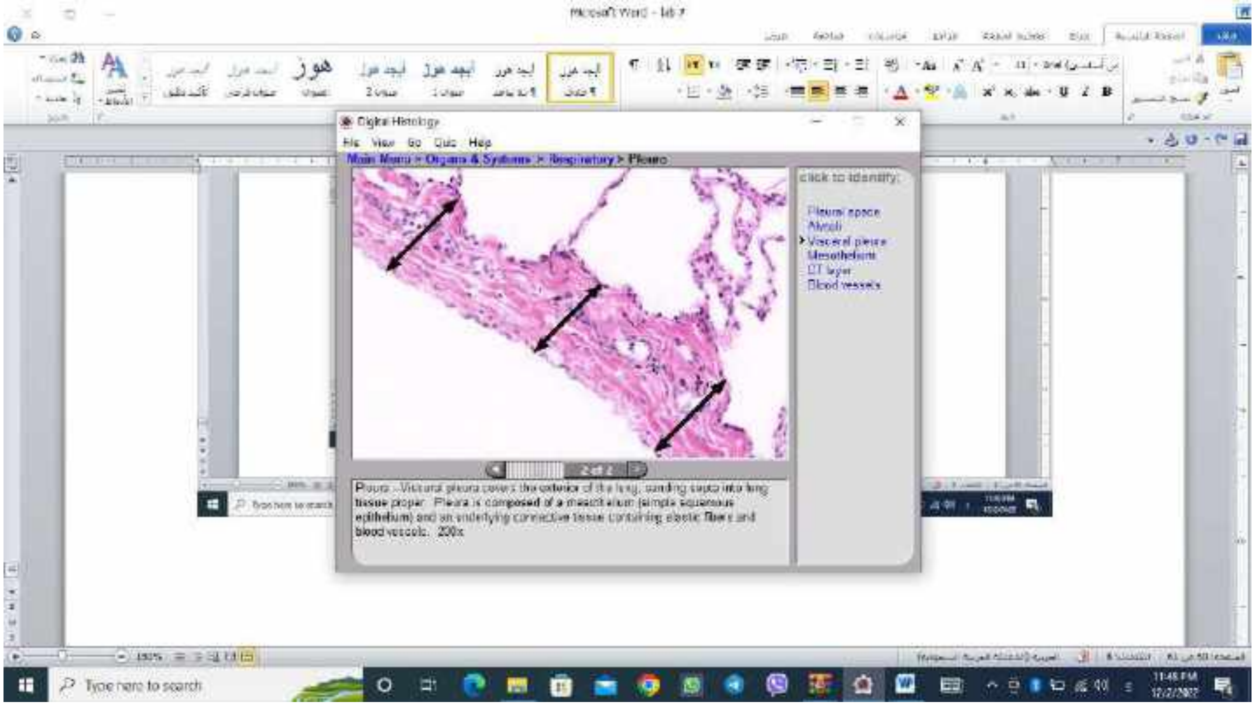
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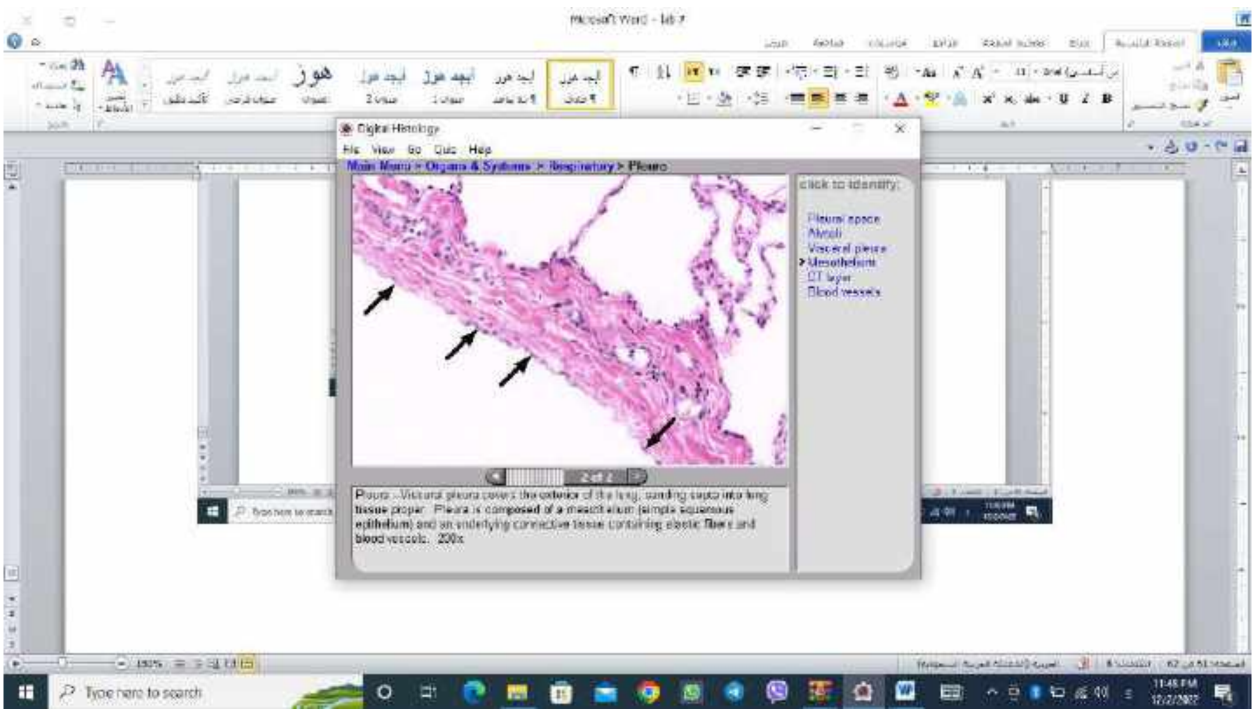
11:48 PM
12/2/2022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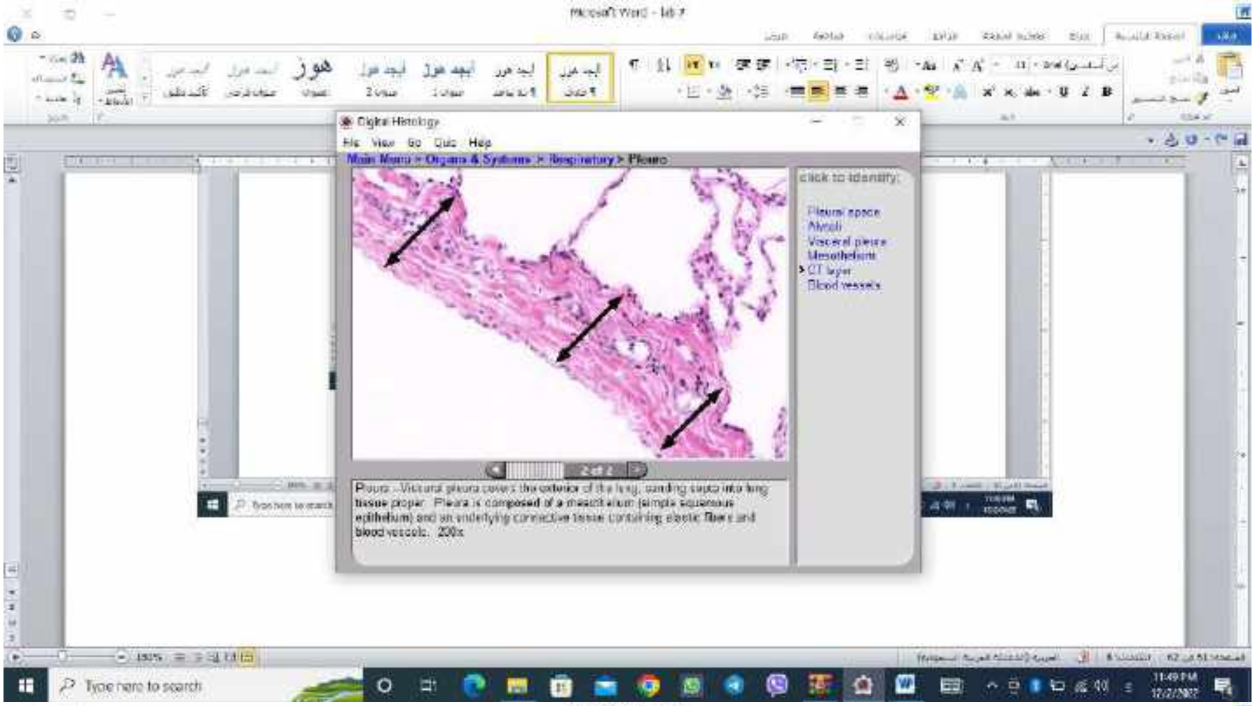
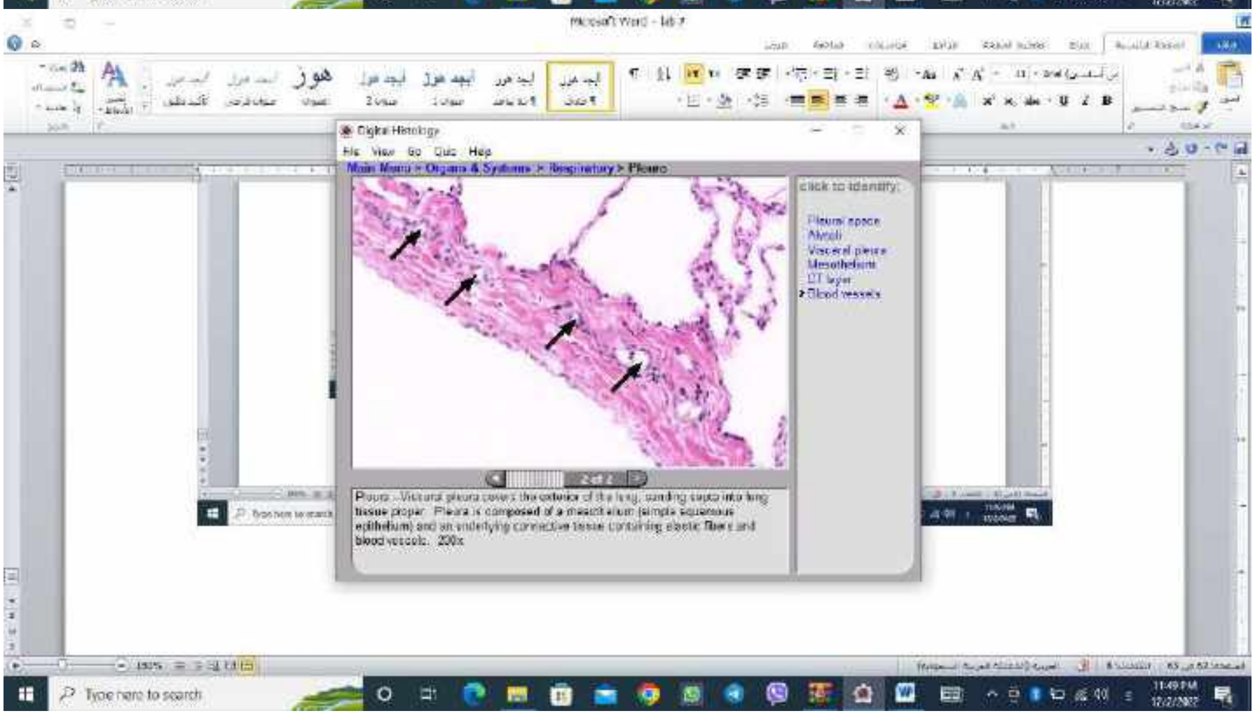
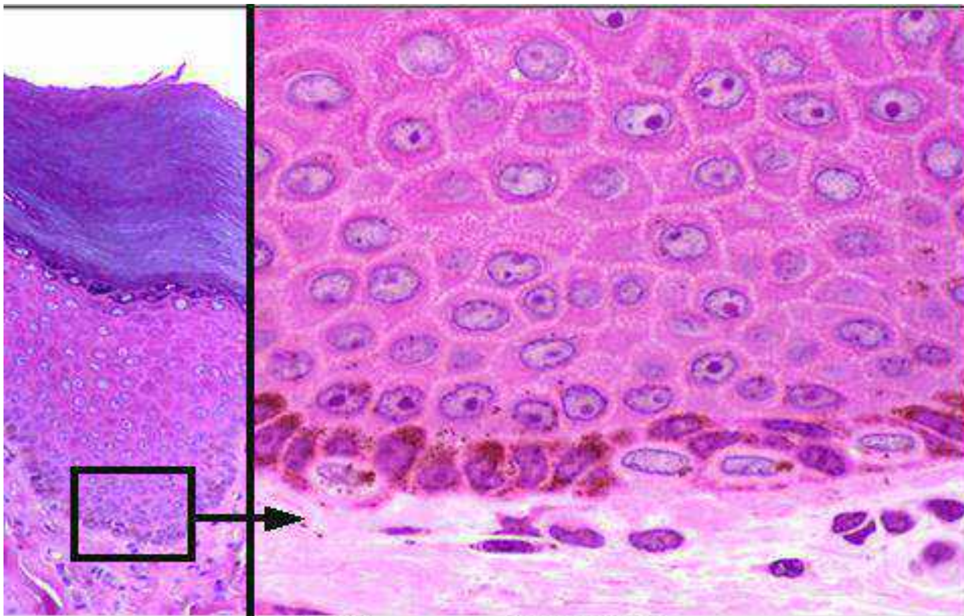




كل التاشيرات مطلوبة

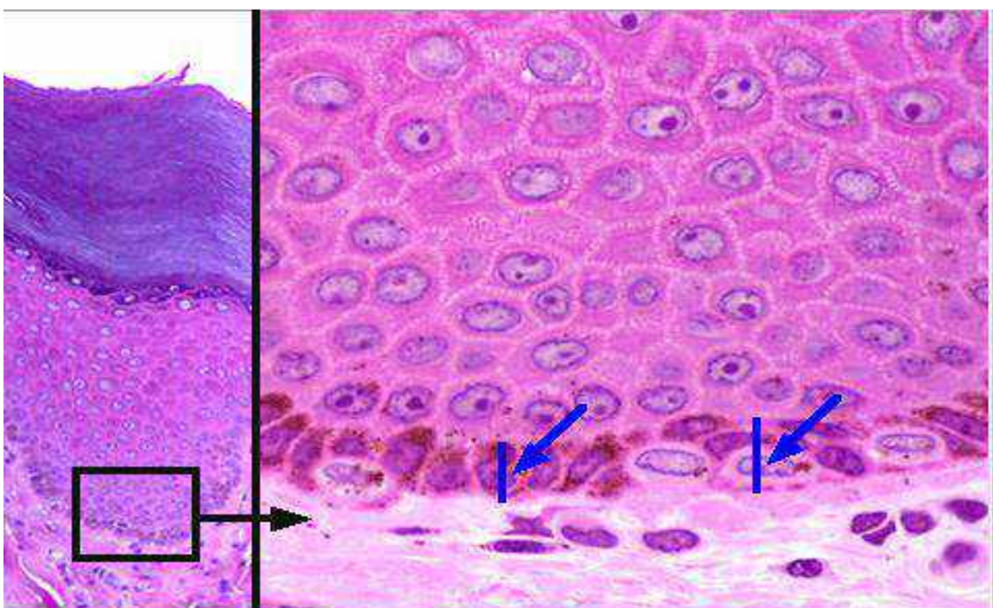


4 of 19

Stratum basale -- Stratum basale (germinativum) is the deepest layer of the epidermis and rests directly on the basal lamina. Cell division occurs primarily in the stratum basale, forming daughter cells which undergo keratinization while moving up to form the more superficial layers. Stratum basale is composed primarily of keratinocytes. 200x, 1000x

click to identify:

Stratum basale >
Melanocytes >
Melanin granules
Stratum >
spinosum

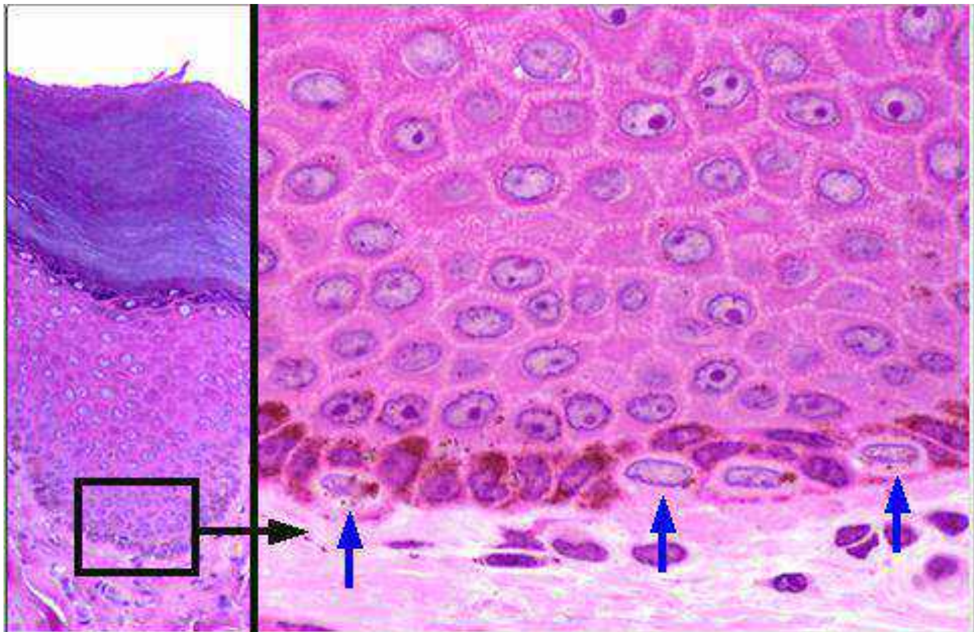


4 of 19

The stratum basale consists of a single layer of cuboidal to columnar shaped cells and rests on the basement of the epidermis. These cells accumulate melanin granules which are synthesized by neighboring melanocytes. The majority of keratinocyte proliferation occurs in stratum basale.

click to identify:

› Stratum basale >
Melanocytes >
Melanin granules
Stratum >
spinosum

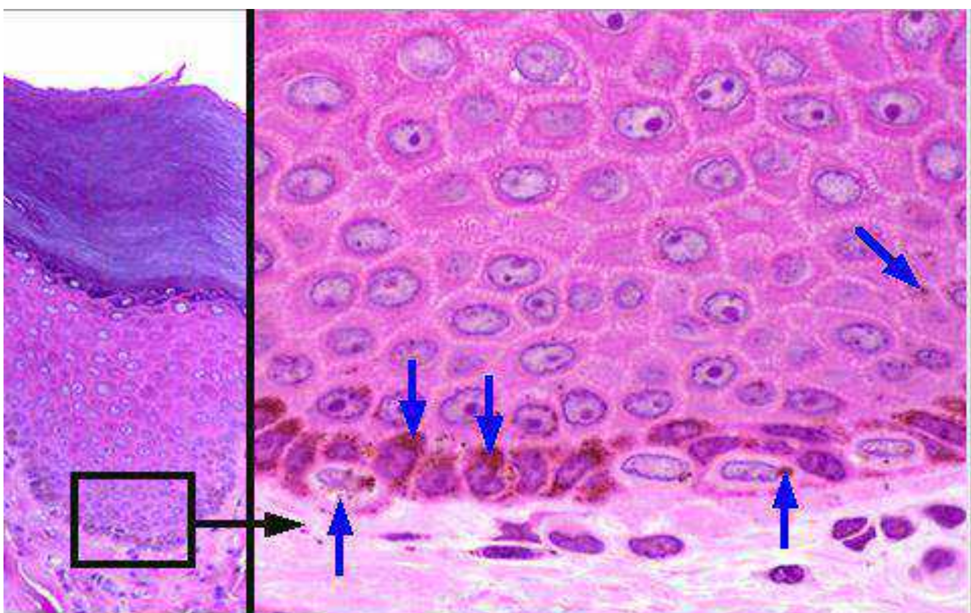


4 of 19

click to identify:

Stratum basale >
Melanocytes >
Melanin granules
Stratum >
spinosum

Melanocytes are located primarily in the stratum germinativum, although they can also be found in the stratum spinosum. Melanocytes synthesize melanin pigment, which they package into melanosomes (melanin granules) that are transferred to neighboring keratinocytes. Melanin protects nuclear DNA in keratinocytes against ultraviolet light.



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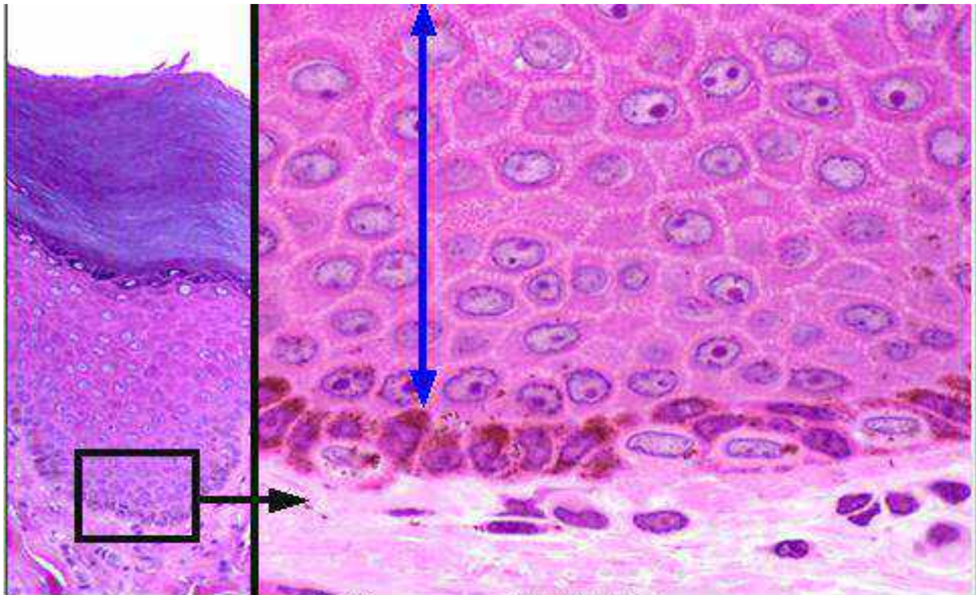

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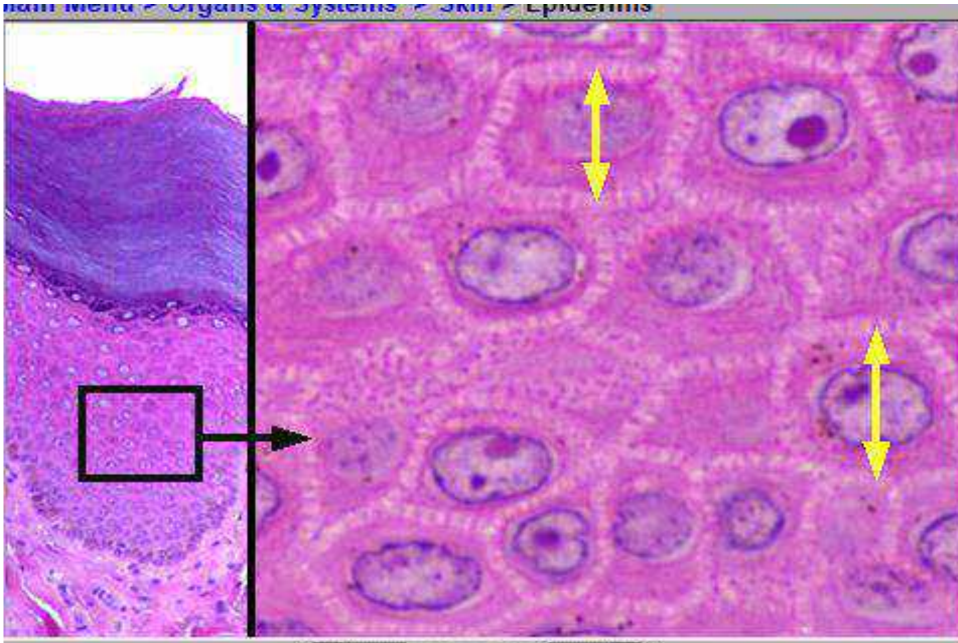
Melanocytes >
Melanin granules
> Stratum >
spinosum

4 of 19

Stratum spinosum, the layer immediately above stratum basale, consists of 3-10 layers of cells and is the major site of keratin filament synthesis in the epidermis. Cells of the stratum spinosum are securely bound to each other by desmosomes, which aid the epidermis in resisting frictional trauma and account for the spiny appearance of these cells.

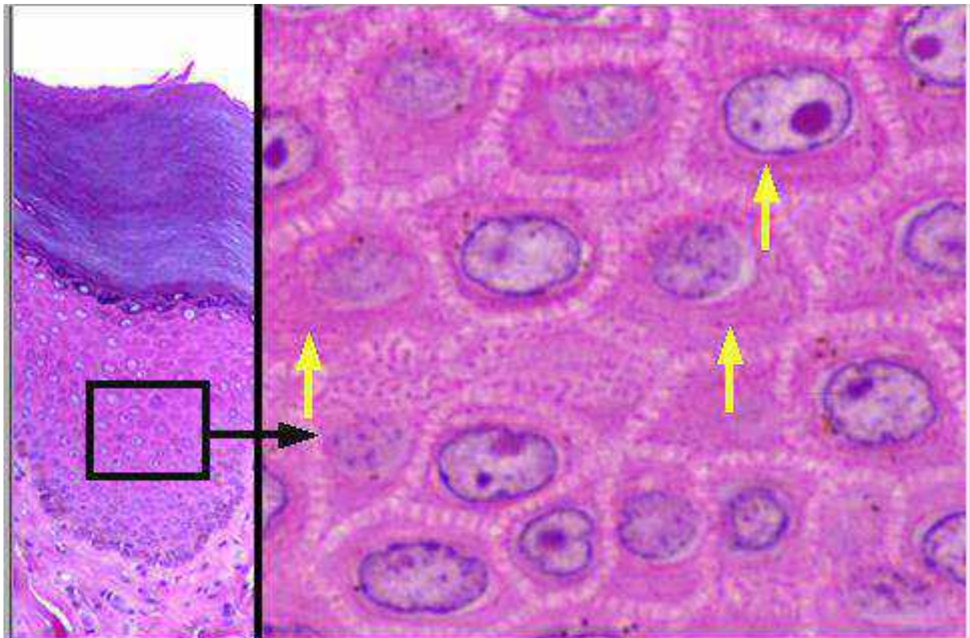


click to identify:

> Stratum spinosum
cells
Tonofibrils

10 of 19

Stratum spinosum -- The stratum spinosum contains 3-10 layers of polygonal keratinocytes with euchromatic nuclei. These cells contain prominent bundles of intermediate filaments (tonofibrils) containing keratin tonofilaments. These keratinocytes are attached to one another by numerous desmosomes, which account for the spiny appearance around their periphery. 200x, 2000x



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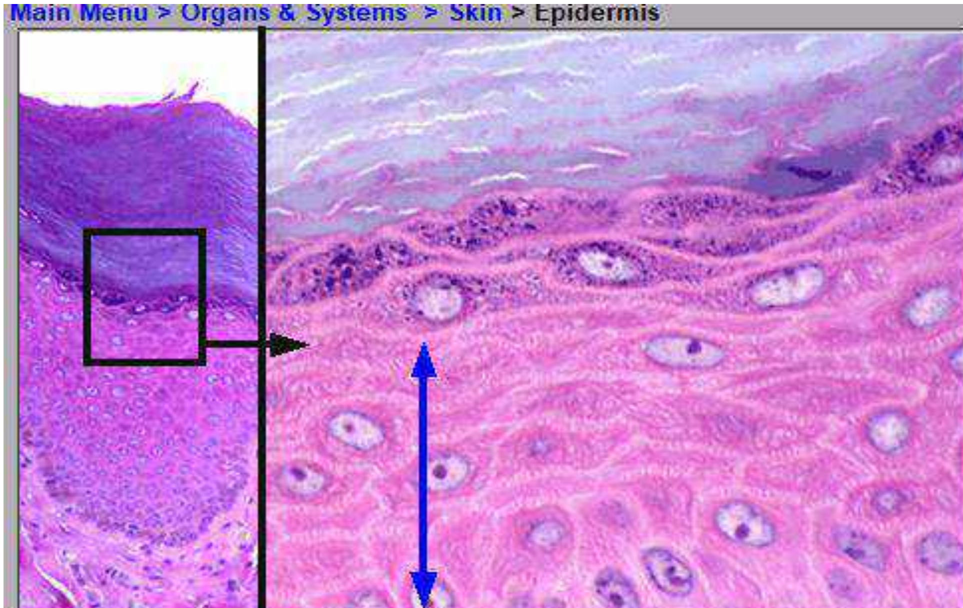
click to identify:

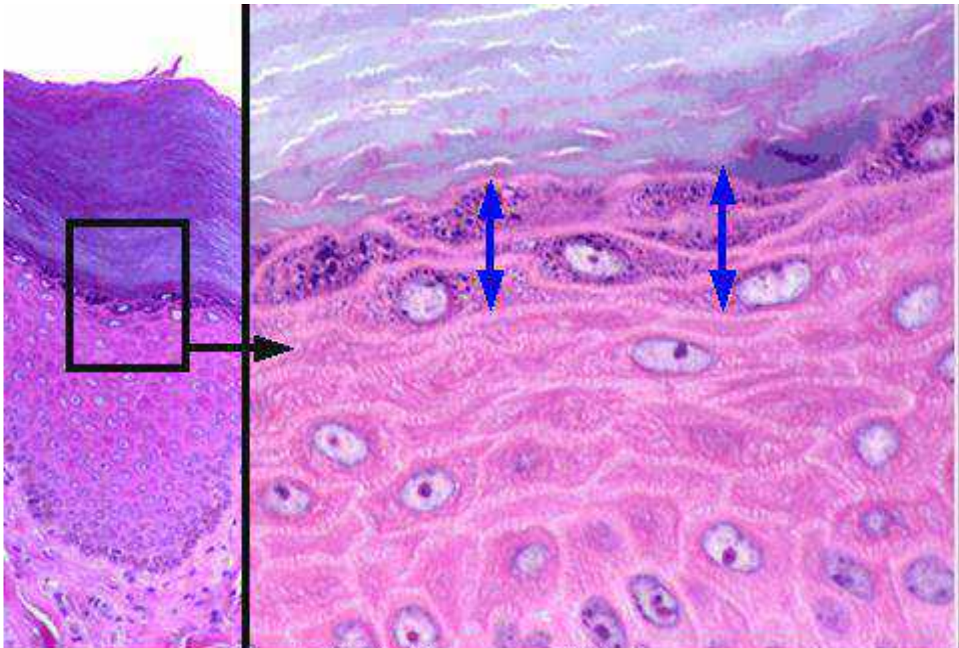
- Stratum spinosum cells
- › Tonofibrils



Stratum granulosum -- The stratum granulosum is three to five cell layers thick with prominent, basophilic, keratohyalin granules. These granules combine with the tonofilaments (keratin intermediate filaments) to produce keratin. At the same time, the organelles in these cells degenerate, resulting in keratinized scales which form the stratum corneum. 200x, 1000x

click to identify:

- › Stratum spinosum
- Stratum granulosum
- Keratohyalin granules
- Stratum lucidum >
- Stratum corneum >



14 of 19

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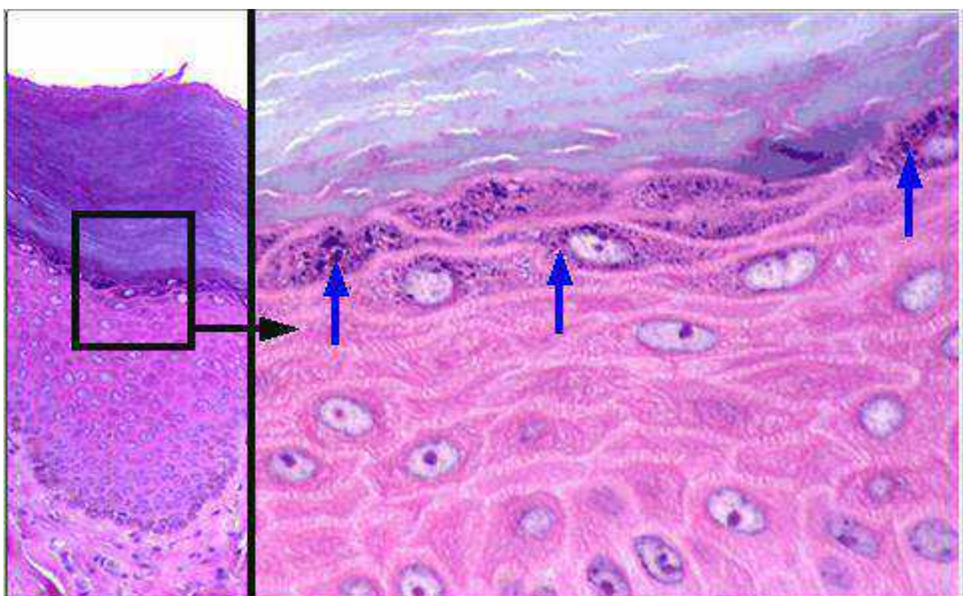
- Stratum corneum >



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- › Keratohyalin granules
- Stratum lucidum >
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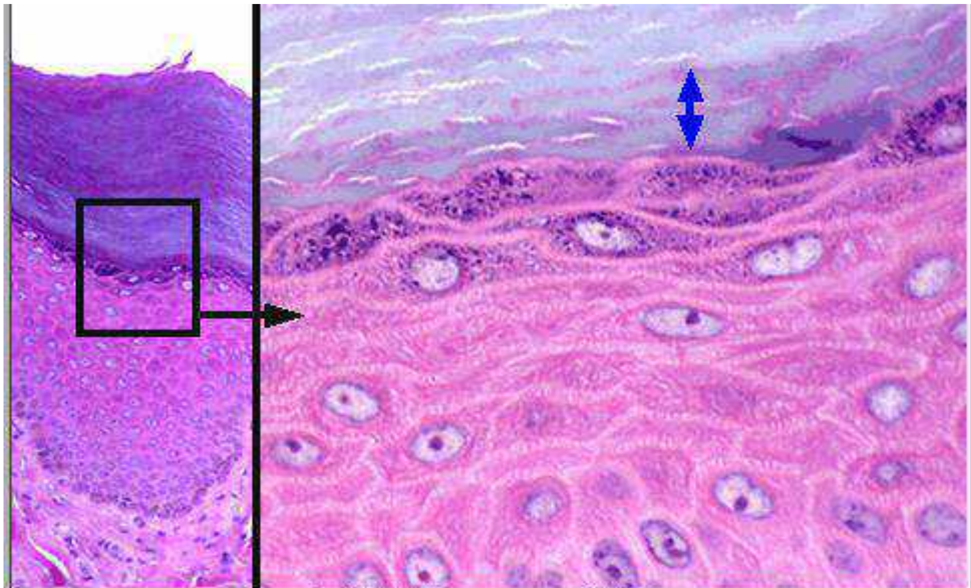
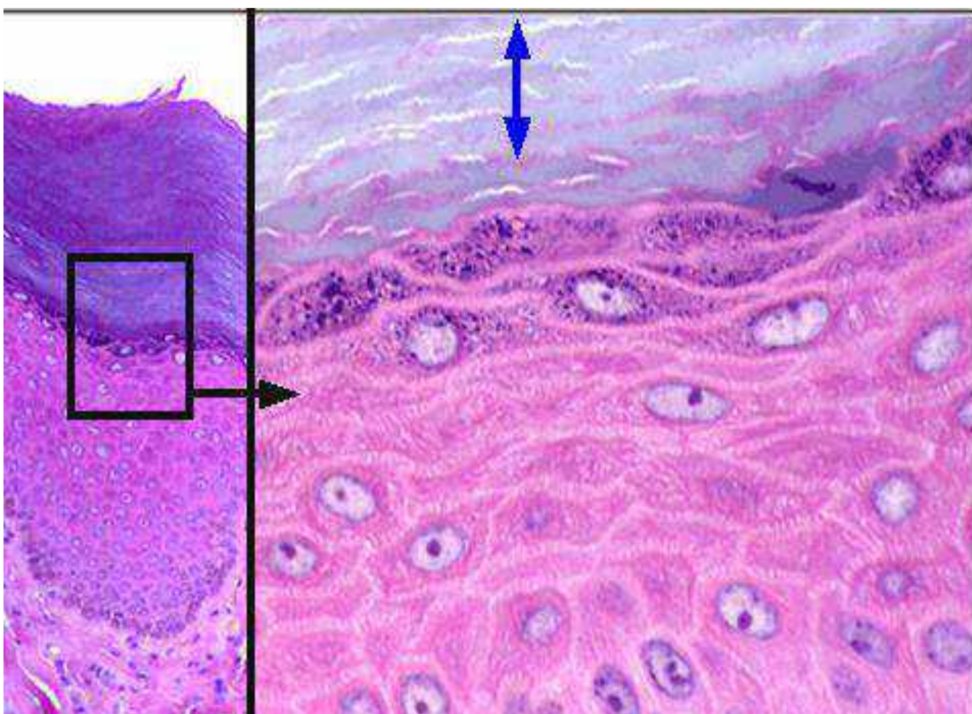


click to identify:

Stratum spinosum
Stratum granulosum
Keratohyalin granules
Stratum lucidum >
Stratum corneum >

14 of 19

The stratum lucidum is a clear layer of non-nucleated, flattened cells where the proteins contained in the keratohyalin granules mediate the aggregation of bundles of tonofilaments.

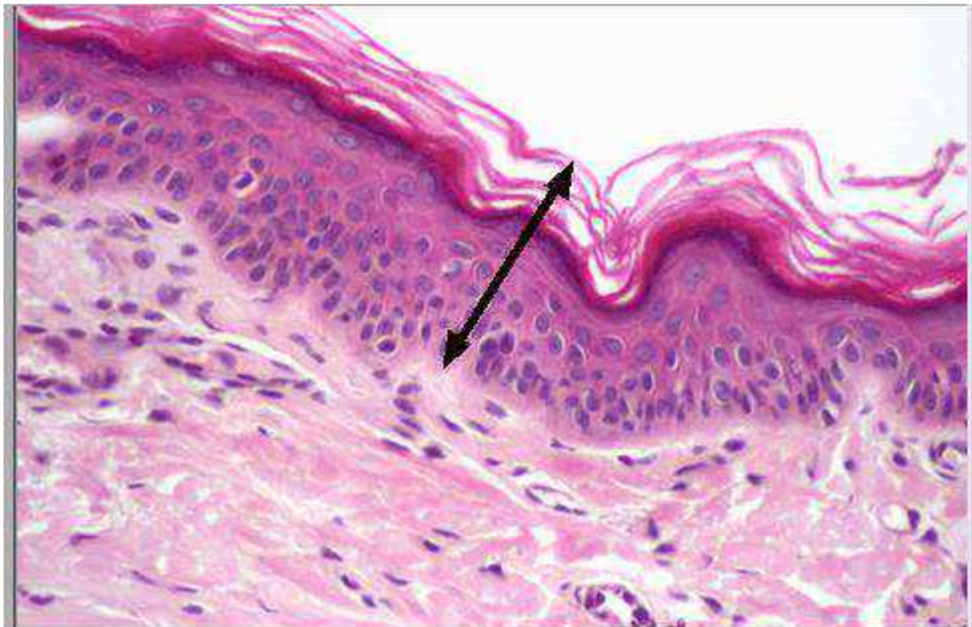


click to identify:

Stratum spinosum
Stratum granulosum
Keratohyalin granules
Stratum lucidum >
Stratum corneum >

14 of 19

As the keratohyalin granules combine with the tonofilaments, the nuclei and organelles in the cells degenerate, resulting in keratinized scales which form the stratum corneum.

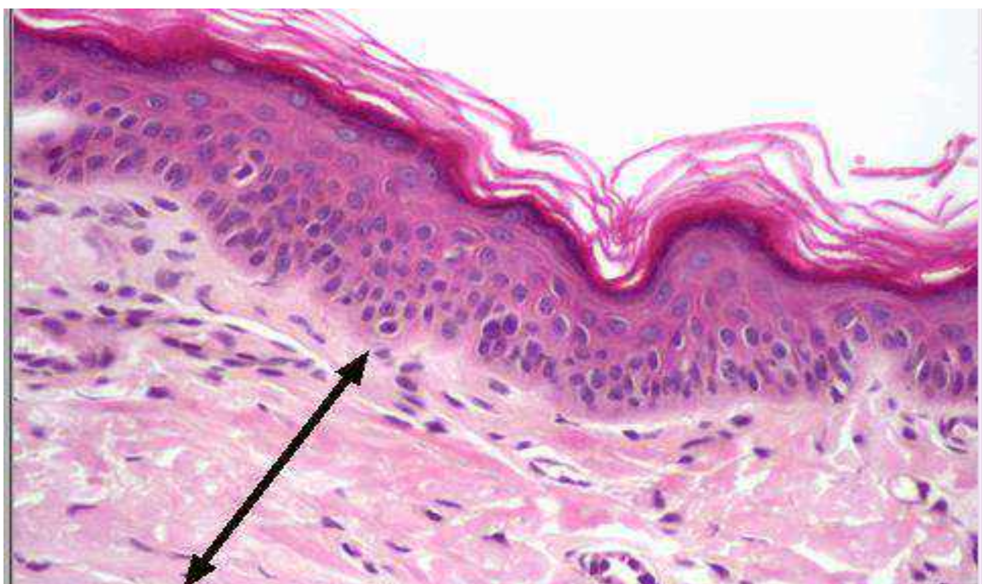


18 of 19

Stratum corneum -- Stratum corneum consists of squamous cells containing keratin protein surrounded by a thickened plasma membrane. These cells are continuously shed from the surface of the epidermis and are replenished through the upward migration and ongoing keratinization of epidermal keratinocytes. Stratum lucidum does not form a discrete layer in thin skin, as seen here. 400x

click to identify:

- › Epidermis
- Dermis
- Stratum basale
- Stratum spinosum
- Stratum granulosum
- Stratum corneum



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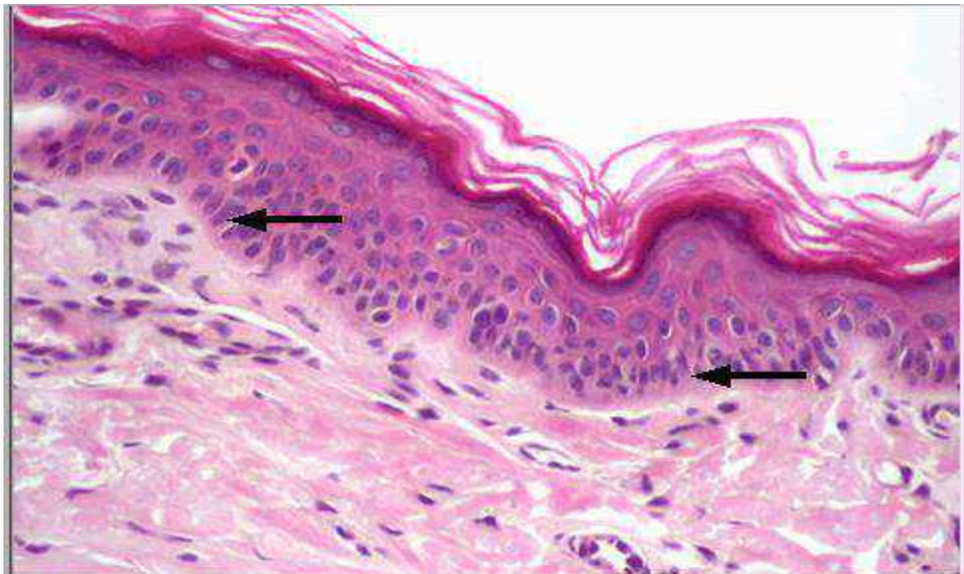

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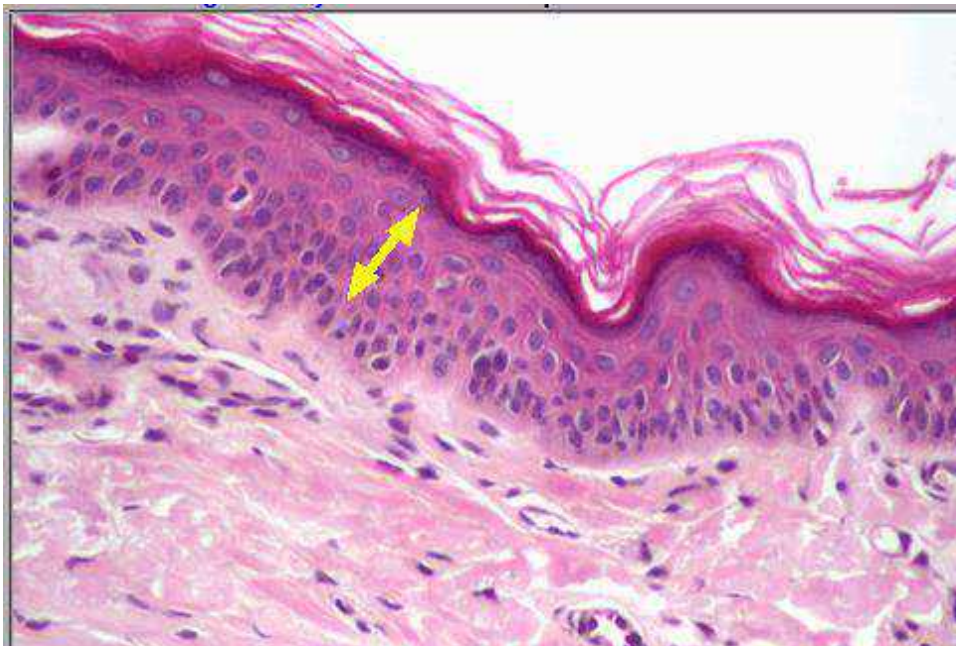

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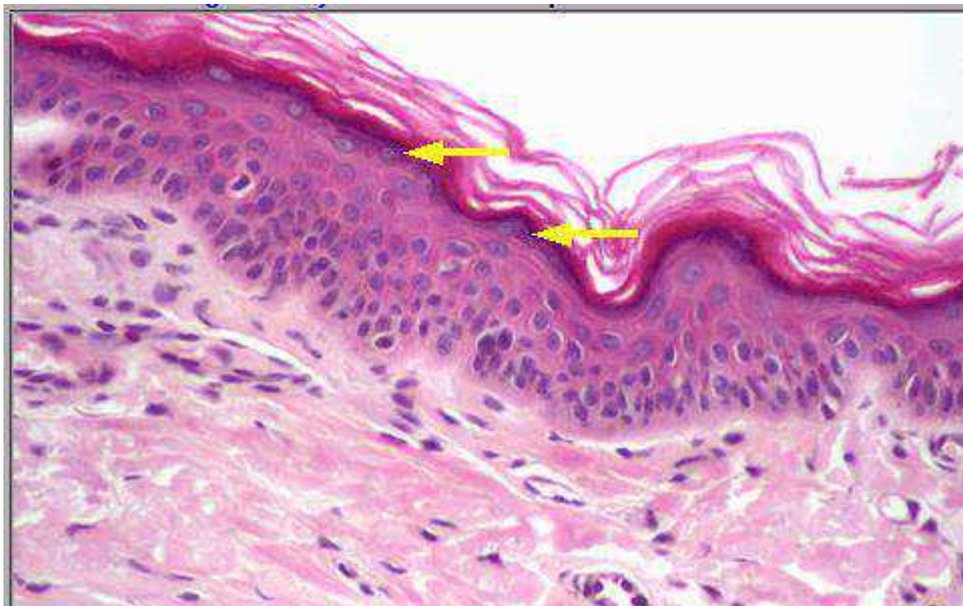

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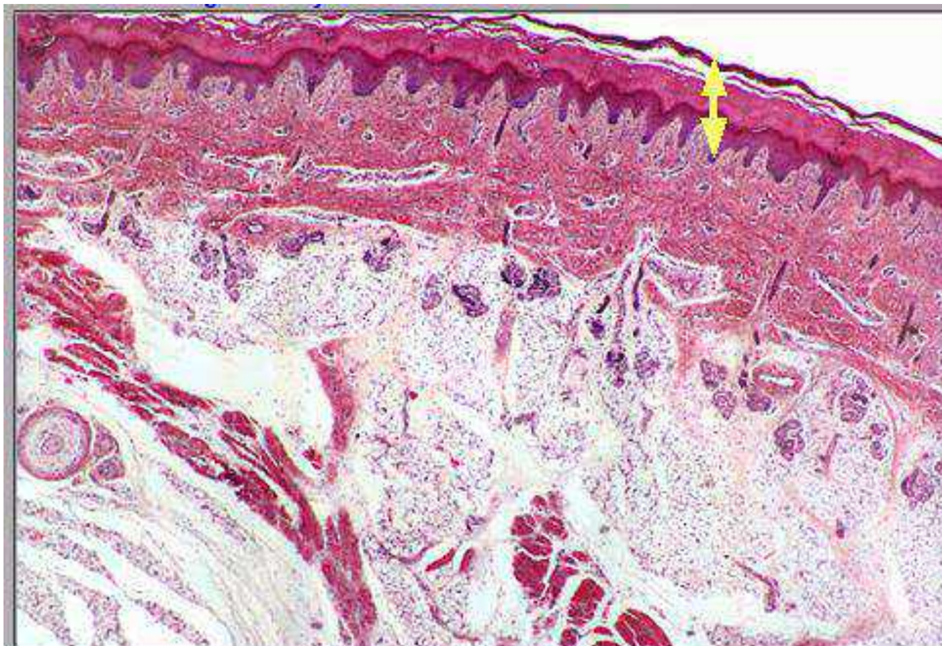
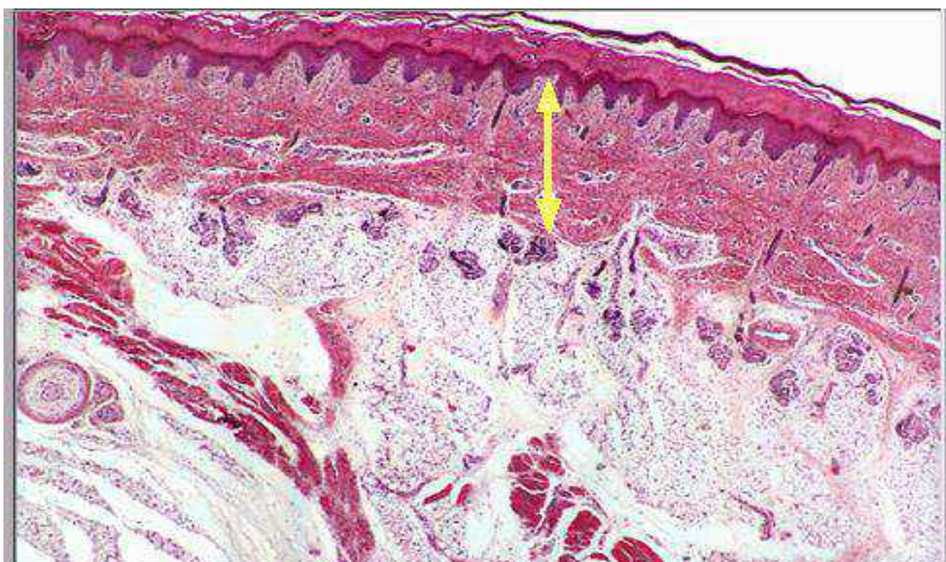


1 of 10

click to identify:

- Epidermis
- Dermis
- Hypodermis
- Sweat glands
- Ducts of sweat glands
- Blood vessels
- Pacinian corpuscle
- Next image

Dermis -- The dermis of skin consists of two layers, a thin papillary layer immediately beneath the epidermis and a thick reticular layer. The hypodermis lies beneath the skin but is not part of it. Sweat glands, their ducts, blood vessels and sensory receptors, Pacinian corpuscles, are located deep in the dermis or in the adjacent hypodermis. Thick skin 40x



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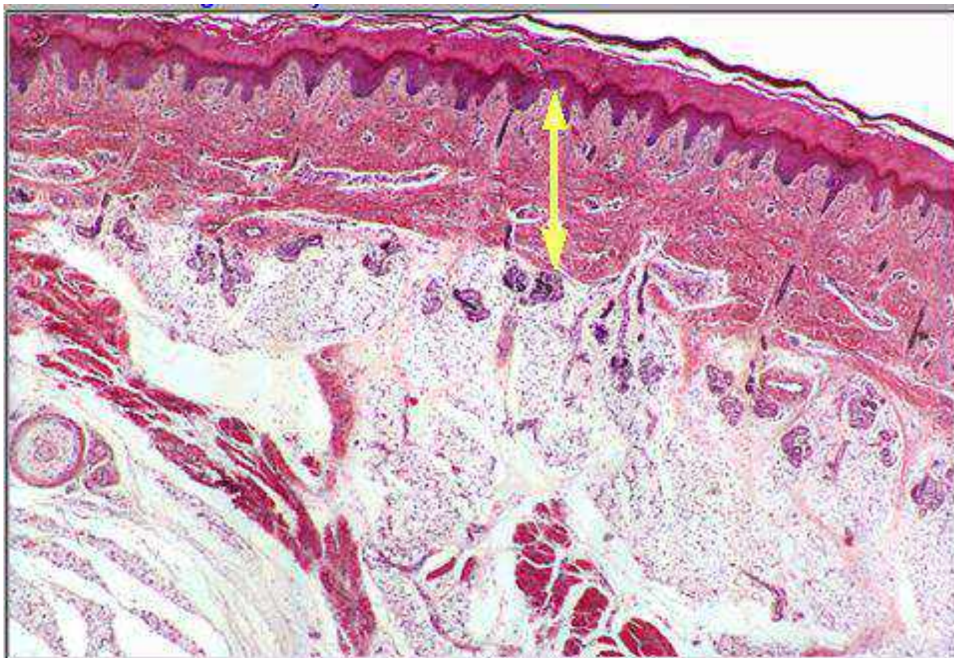

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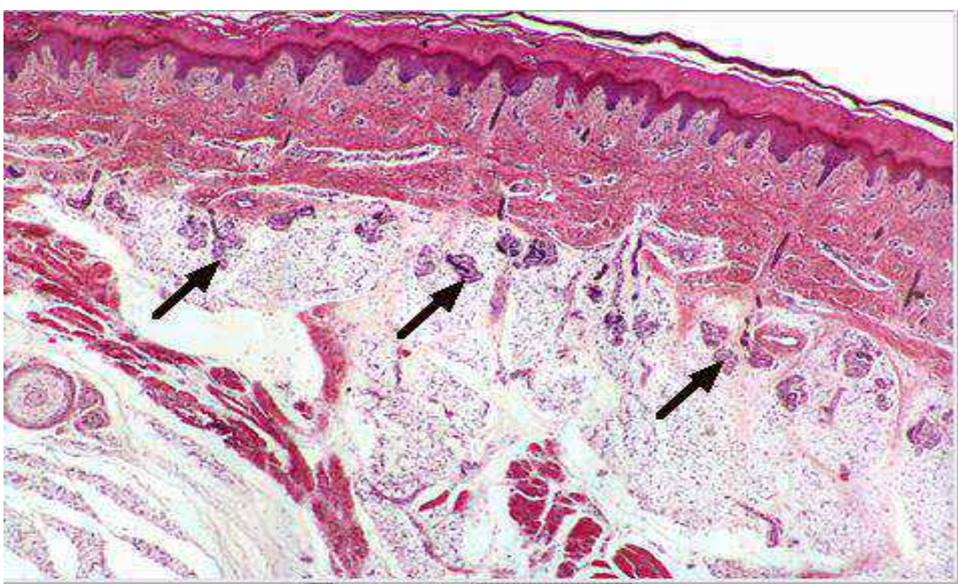

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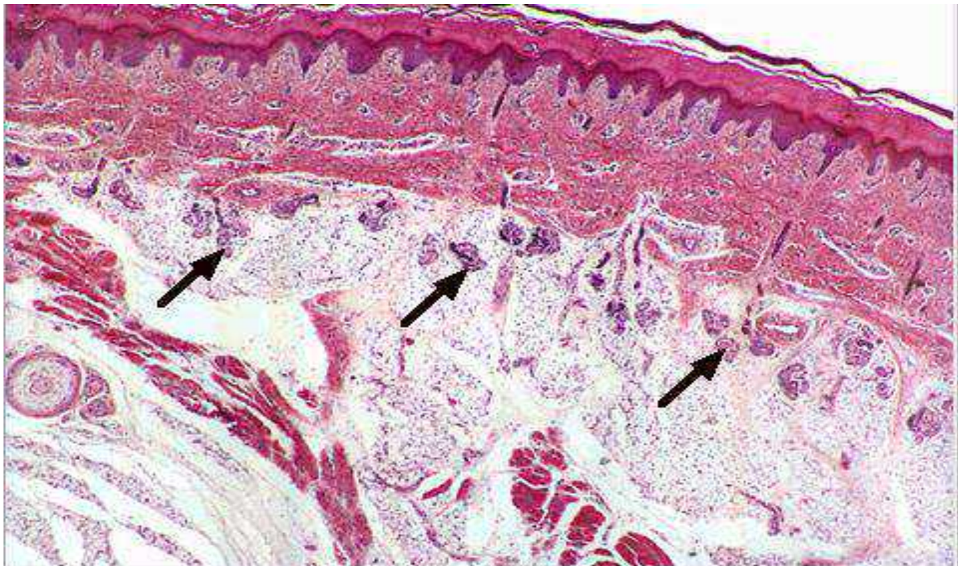

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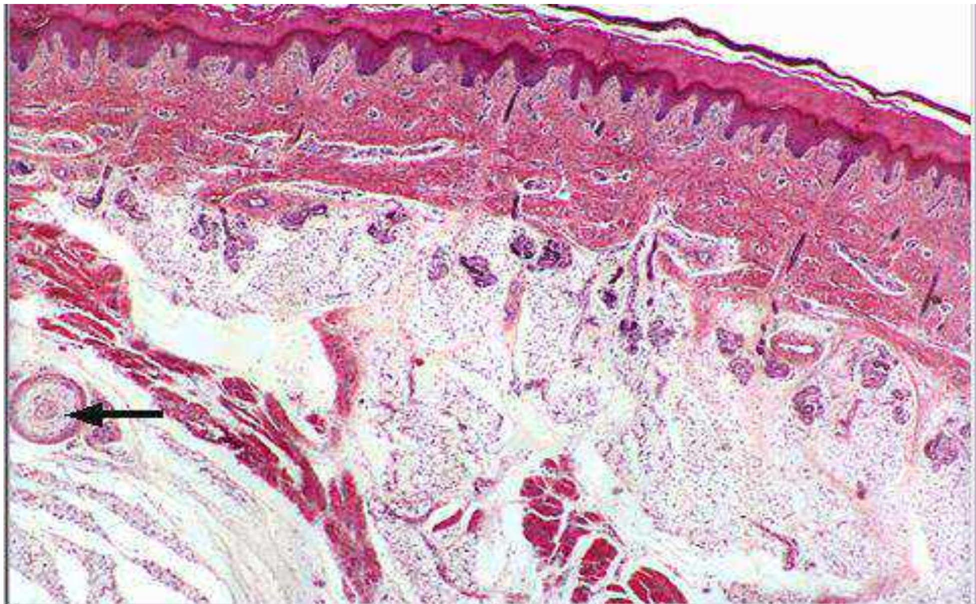

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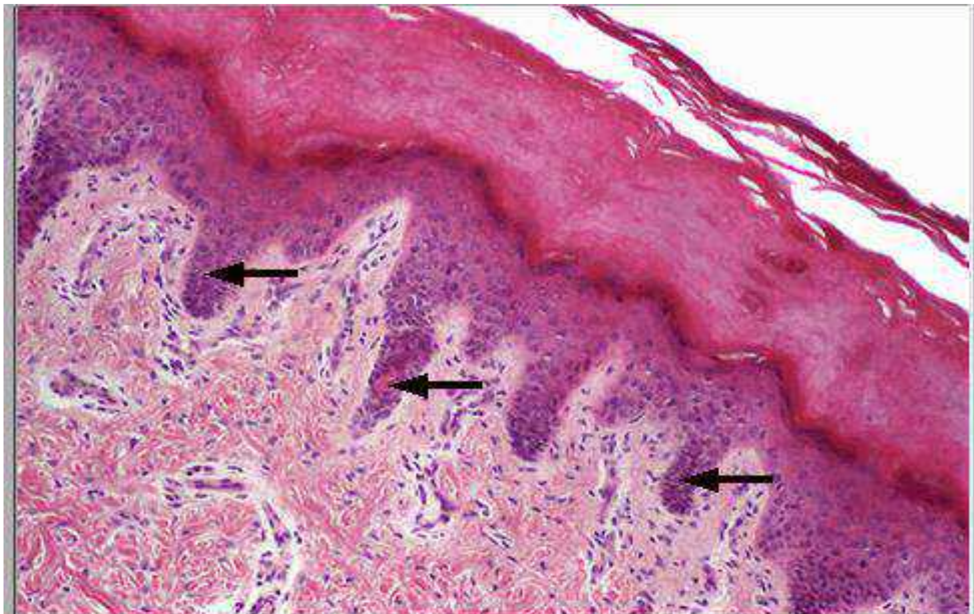
- Hypodermis
- Sweat glands
- Ducts of sweat glands
- Blood vessels
- › Pacinian corpuscle
- Next image

3 of 10

Dermis -- The papillary layer of the dermis, composed of loose connective tissue, forms an undulating interface with the overlying epidermis. At this junction, dermal papillae alternate with epidermal pegs projecting downward from the epidermis. The thicker reticular layer of dermis is composed of dense irregular connective tissue. 200x

click to identify:

- › Epidermis
- Epidermal pegs
- Dermis
- Papillary layer
- Dermal papillae
- Reticular layer



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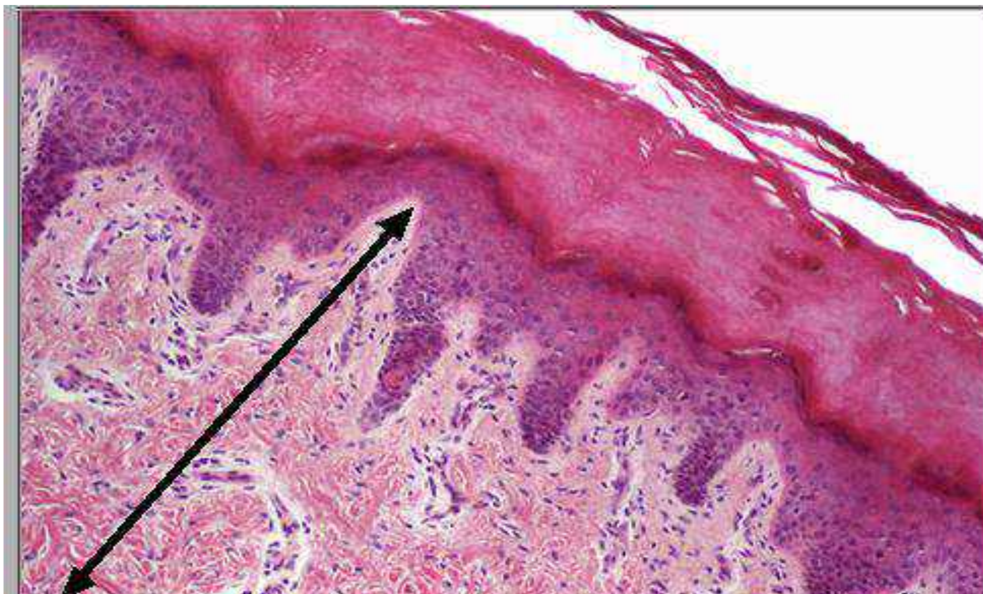

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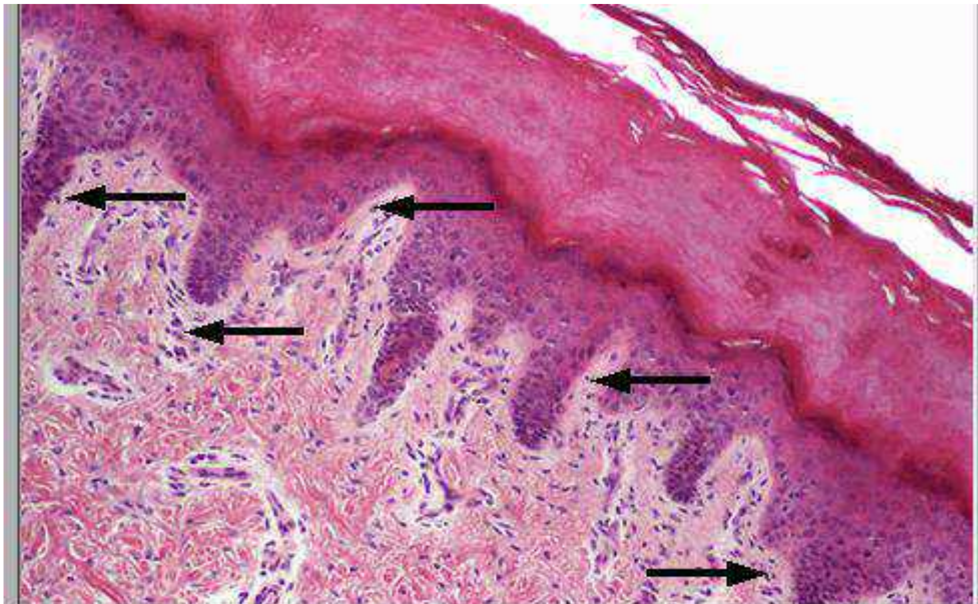
- Epidermal pegs
- › Dermis
- Papillary layer
- Dermal papillae
- Reticular layer



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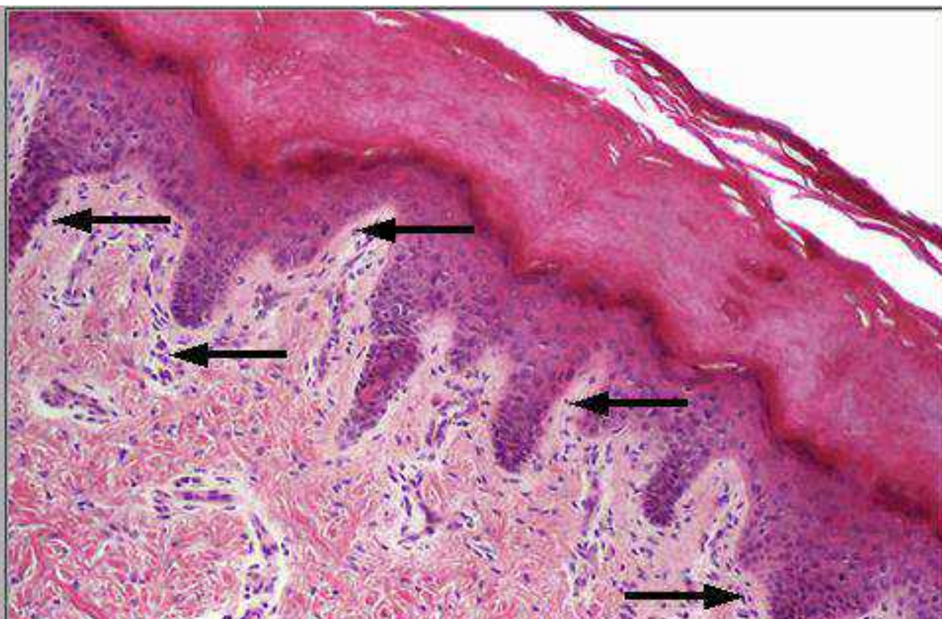

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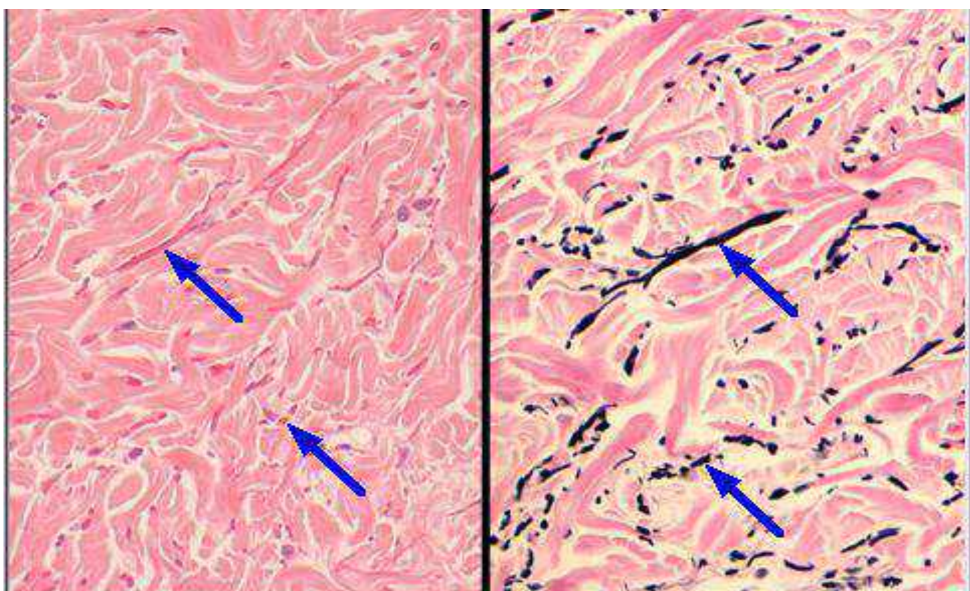
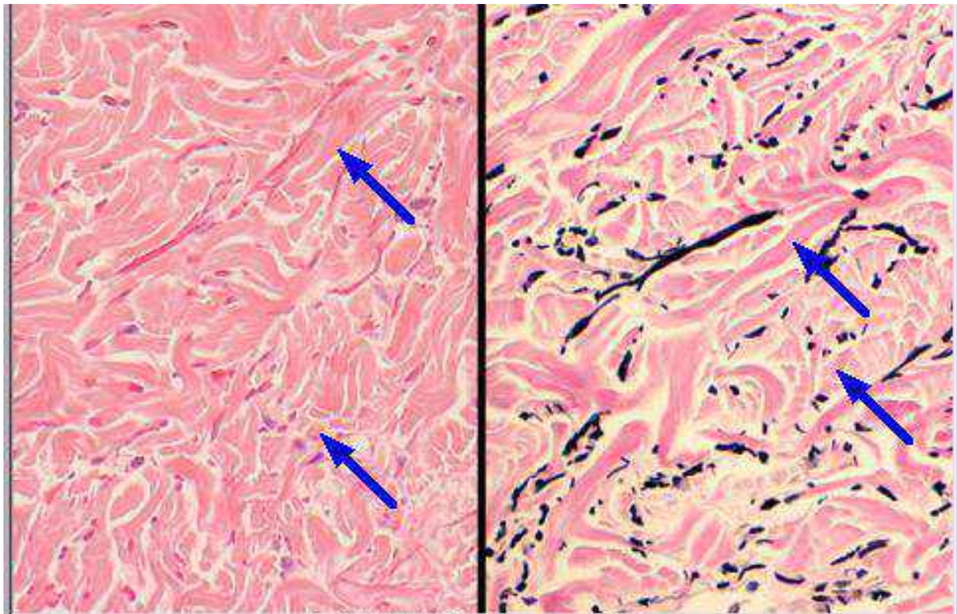


9 of 10

Dermis -- These images of dense irregular connective tissue in the reticular layer compare the appearance of elastic fibers stained with eosin and with a special elastin stain. In some preparations elastic fibers can be demonstrated with eosin, as shown here. In most cases however, a special elastin stain is required. 200x, 200x

click to identify:

- › Elastic fibers
- Collagen fibers
- Ground substance
- Hematoxylin and eosin stain
- Elastin stain



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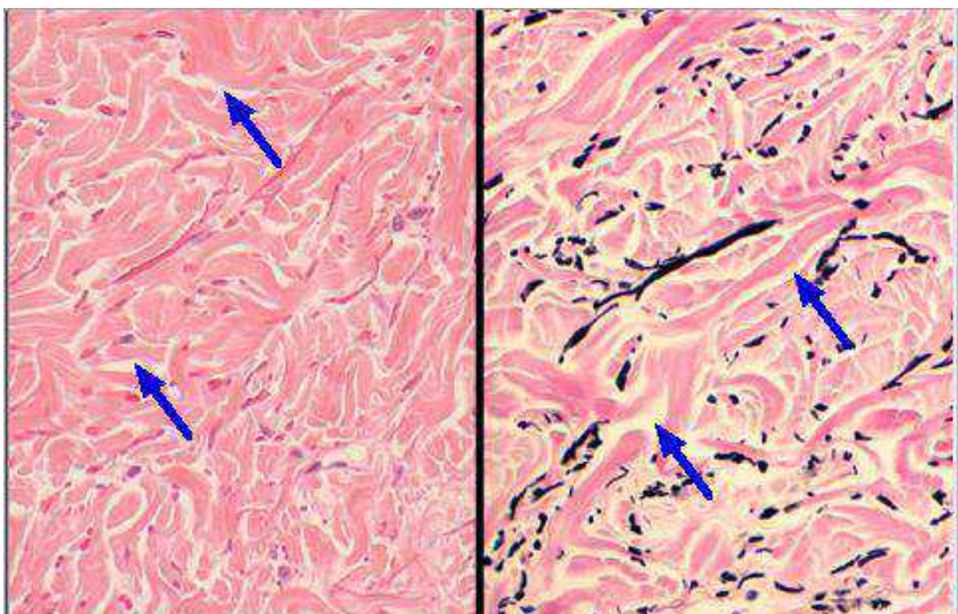

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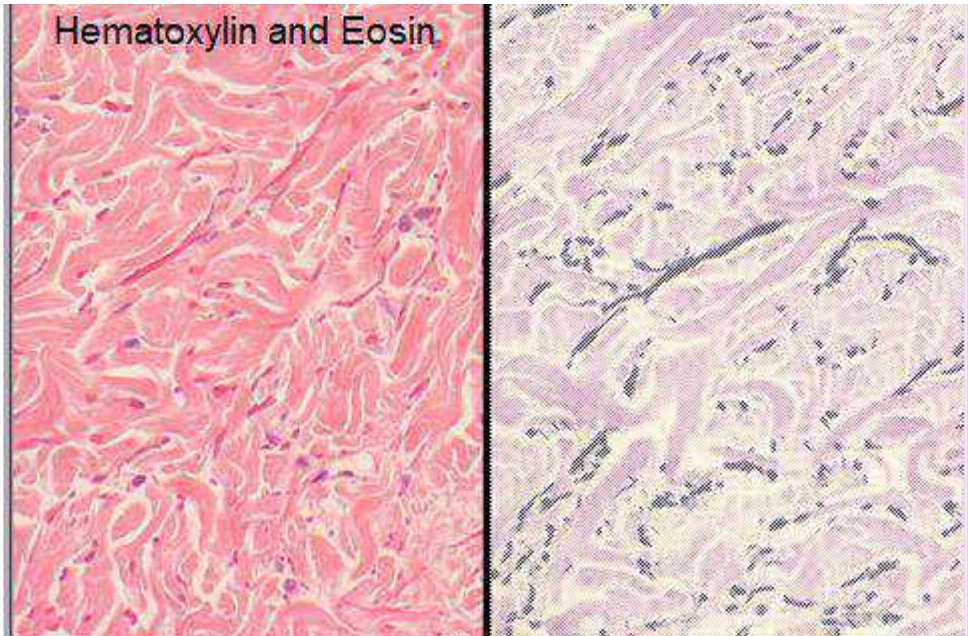

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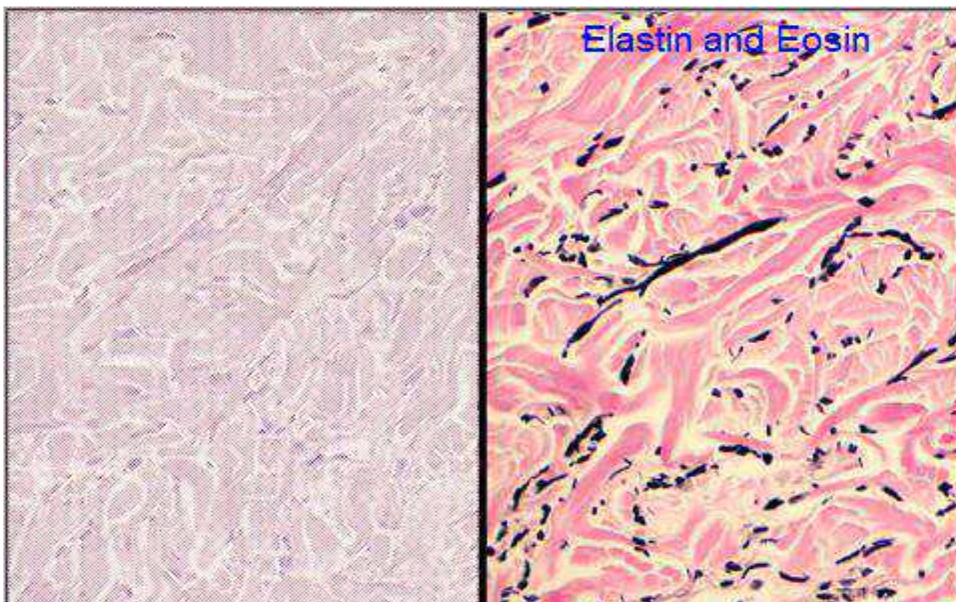

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