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Assignment Question(s): Explain the histological basis of the upper respiratory system(conducting portion of the respiratory system) attacked by corona virus

Solution

Histology of the upper respiratory tract

Histology of the upper respiratory tract: want to learn more about it?

The respiratory tract is the pathway through which much needed oxygen enters the body. It begins at the nostrils of the nose, continuing into the nasal cavity. From here, it passes through the pharynx, larynx, trachea, bronchi, bronchioles and ends in the alveoli. The airway as a whole can be divided into two segments: a conducting segment (from the nostrils to the terminal bronchiole) and a respiratory segment (from the respiratory bronchioles to the alveoli).

Along the respiratory pathway, the epithelial lining changes to accommodate different functions. This article reviews changes in the epithelia and supporting cells of the upper respiratory tract (from the nasal cavity to the pharynx)

Nasal cavity

The nose, as the primary mode of entry of air into the airway, has both respiratory and olfactory functions. In its respiratory capacity, it modifies the air so that gaseous exchange will occur more efficiently in the lungs, while in its olfactory capacity, it detects various odors and transmits those impulses to the brain for interpretation.

Nasal vestibule

Entering the nares, or nostrils, the nasal vestibule is lined by keratinized stratified squamous epithelium – a continuation of the cutaneous lining from the external nose. It is also equipped with modified hairs, called vibrissae that filter out larger particles from inspired air. The membrane transitions from keratinized stratified squamous epithelium to pseudostratified columnar ciliated epithelium with goblet cells (also called respiratory epithelium) at a point known as the limen nasi.

Limen nasi - medial view

Limen nasi (medial view)

Floor and walls of nasal cavity

The respiratory epithelium covers the floor, medial and lateral walls (just below the superior concha) of the nasal cavity to the choana (posterior boundary of the nasal cavity). Additionally, there are seromucous glands dispersed throughout the mucous membranes. Their secretions aid in respiration by moistening the inspired air and trapping unwanted particles. The trapped particles are propelled by the cilia to the pharynx where they can be expelled orally, or swallowed and digested.

Roof of nasal cavity

Olfactory mucus layer (green), with psuedostratified columnar epithelia and Bowman's gland. Cribriform plate of ethmoid bone in center.

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The roof of the nasal cavity in the region of the cribriform plate of the ethmoid bone, the superior concha and the superior aspect of the nasal septum (composed of the perpendicular plate of the ethmoid bone) are covered with pseudostratified columnar epithelium without goblet cells and motile ciliae (olfactory epithelium).

It should also be noted that the olfactory portion of the nasal cavity is less vascularized than the lower respiratory portion.

Although it is rather abrupt, the transition from respiratory to olfactory epithelium can be noted grossly by the change in colour (from pink respiratory to yellow olfactory epithelium) and histologically by the change in cell types and morphology. The columnar cells in the olfactory epithelium are generally taller than those in the respiratory epithelium.

Cell types

There are several cell types found in the epithelium that make olfaction possible. Air is first directed towards the olfactory epithelium by the turbinates (bones in the conchae that support the mucosa).

In the lamina propria, Bowman's glands (also called olfactory glands) produce serous secretions that dissolve odiferous particles so that they can interact with the olfactory cilia. The olfactory cilia are short hair-like projections that extend into the mucous lining to detect and transmit odors through the olfactory nerve cells.

Olfactory nerve cells are bipolar neurons span the thickness of the epithelium. The impulses from the olfactory cilia are transmitted by nerve fibers from the olfactory cells that travel through the cribriform plate of the ethmoid bone. The afferent fibers then enter the cranial cavity and synapse with mitral cells in the olfactory bulb (CN I).

Sustentacular (supportive) cells distributed throughout the epithelium are interspersed with olfactory nerve cells and basal cells proximal to the cribriform plate of the ethmoid bone. The cell shapes are hard to distinguish; so the position and shape of the nuclei are used to distinguish the cell types.

The nuclei of the basal cells are spherical and proximal to the cribriform plate of the ethmoid bone.

The nuclei of sustentacular cells are more elongated and distal to the cribriform plate of the ethmoid bone.

The nuclei of the olfactory nerve cells are seen between those of the basal and sustentacular cells.

The mucosa of the paranasal sinuses is also respiratory epithelium. The only difference is that the epithelium is thinner and has fewer goblet cells and serous and mucous glands. The

paranasal sinuses are typically devoid of lymphoid tissue.

Pharynx and epiglottis

Pharynx

The epithelia of the pharyngeal portion of the conducting zone changes with respect to each pharyngeal segment. In the nasopharynx, the epithelium is continuous with that of the nasal cavity. The ciliae here continues to wharf foreign particles through the pharynx to be swallowed.

In the oropharynx and laryngopharynx, the epithelium transitions to non-keratinized stratified squamous epithelium. This durable epithelium is better suited to accommodate friction associated with swallowing food. Additionally, lymphatic aggregates (distributed throughout the mucosa) act as a first contact point for the immune system to sort through particles entering the body (see Waldeyer's Ring).

Epiglottis

Epiglottis (histological section)

The epiglottis is a cartilaginous structure located cranial to the larynx. It projects posteriosuperiorly to separate the pharynx from the larynx and prevents food from entering the lower airway during swallowing. The mucosa of its lingual surface (and half of its laryngeal surface) is continuous with that of the laryngopharynx (lingual mucosa). The other half of its laryngeal surface is lined by pseudostratified ciliated columnar epithelium with seromucous glands distributed throughout its mucous lining (laryngeal mucosa).

Elastic cartilage of epiglottis (histological slide)

Elastic cartilage in the center of the epiglottis provides scaffolding for the epithelia. Both surfaces of the epiglottis are equipped with lymphatic nodules and taste buds.

Clinical correlates

Inflammation of the nasal cavity

Inflammation of the nasal mucosa is referred to as rhinitis. The inflammatory process may be of viral or allergenic aetiology. Hypersecretion of mucous will manifest as rhinorrhoea (runny nose). In the case of allergic rhinitis, symptomaticly can be chronic or seasonal, depending on the allergens that initiate the inflammatory process.

Inflammation restricted to the mucous membrane of the paranasal sinuses is specifically referred to as sinusitis. It results from bacterial proliferation subsequent to obstruction of the ostium that drains the sinus.

Inflammation of the pharynx

The pharynx is also susceptible to inflammation (called pharyngitis). Also associated with pharyngitis, are cases of tonsillitis. These inflammatory processes can be cause by communicable bacterial infections as well as non-infectious entities. However, streptococcus A bacteria are the primary agents implicated in these pathogenesis. Viruses, such as the respiratory syncytial virus, influenza virus and rhinovirus may also cause generalized nasopharyngeal inflammation.

Inflammation of the epiglottis

Epiglottitis is a more serious inflammatory condition usually caused by a type B Haemophilus influenzae infection. The infection usually occurs in young children and infants. Consequent to the swelling of the epiglottis, the airway can be obstructed. Loud inspiratory wheezing is a classic symptom of this pathology. Appearance of cyanosis indicates the need for a tracheostomy.

Corona Virus and the Upper Respiratory Tract

Coronaviruses are a large family of viruses that are common in people and many different species of animals including camels, cattle, cats, and bats. Rarely, animal coronaviruses can infect people and then spread between people such as with MERS-COV, SARS-COV and now with this new virus (named SARS-COV-2).

This SARS-COV-2 virus is a beta coronavirus, like MERS-COV, SARS-COV. On February 11, 2020, the World Health Organization announced an official name for this disease that is causing the 2019 novel coronavirus outbreak, first identified in Wuhan, China. The new name of this disease is coronavirus disease 2019, abbreviated as COVID-19. In COVID-19, “CO” stands for “Corona”, “VI” stands for “Viruses” and “D” for “Disease”.

There are many types of human coronaviruses including some that commonly cause mild upper respiratory tract illness, like coronaviruses 229 E, NL 63, OC 43 or HKU1 but SARS-COV-2 is a new strain of coronaviruses that have not been previously identified in humans.

The Clinical spectrum of COVID-19 ranges from mild disease with non-specific signs and symptoms of acute respiratory illness to severe pneumonia with respiratory failure and septic shock. There have also been reports of asymptomatic infection with COVID-19.

Current estimates of the incubation period range from 1 to 14 days, according to the WHO and the US Centers for disease control and precautions. The median incubation period has been estimated to be 5 days. Transmission may be possible during the incubation period.

Preliminary reports suggest that the reproductive numbers (RO), the numbers of people who acquire the infection from an infected person, is approximately 2.2. However, as the situation is still evolving, the RO may be higher or lower.

While the pathophysiology of the condition is currently unknown, structural analysis suggests that the viruses may be able to bind to the angiotensin-converting enzyme 2 (ACE2) receptor in humans, which suggests that it may have similar pathogenesis to SARS. However, a unique structural feature of the spike glycoprotein receptors binding domain of SARS-COV- 2 (which is responsible for the entry of the virus into host cells) confesses a potentially higher binding affinity for ACE2 on host cells compared to SARS-COV. Furin like cleavage site has been identified in the spike protein of the viruses; this does not exist in other SARS-like coronaviruses.

Based on an early analysis of case series, the most common symptoms are fever, dyspnoea, myalgia, fatigue, and less common include anorexia, sputum production, sore throat, confusion, etc.

Approximately 90% of patients present with more than one symptom and 15% of patients present with fever, cough, and dyspnoea.

The most common laboratory abnormalities in patients hospitalized with pneumonia include leucopenia, lymphopenia, leupocytosis, and elevated liver enzymes. Other abnormalities include neutrophilia, thrombocytopenia, decreased haemoglobin, decreased albumin and renal impairment. Pulse oximetry may reveal low oxygen saturation ($SpO2<90\%$).

In Chest X-Ray unilateral lung infiltrates are found in 25% of patients and bilateral lung infiltrates are found in 75% of patients.

CT scan of the chest is particularly helpful in patients with suspected pneumonia who have a normal chest X-Ray in order to detect infiltrates with greater sensitivity.

Patients with asthma should never stop taking their preventer inhaler unless asked to do so by a medical professional. Stopping your steroid inhaler could put you at a higher risk of complications with COVID-19 due to making your asthma worse.

People with bronchiectasis might be at higher risk of complications if they get the COVID-19. So there are some suggestions to reduce your risk of getting the infection and the risk of complications if you do.

Along with all preventive measure as suggested to all common people, peoples with bronchiectasis should follow:

Make sure you take all of your regular medications.

Ensure you do your airway clearance exercise regularly, this clears regularly mucus from the lungs and reduces the risk of a flare-up.

If you develop a fever and cough but feel well try to increase the frequency of your airway clearance and take paracetamol to reduce fever. If you become more unwell, seek medical

advice.