INTRODUCTION TO UPPER RESPIRATORY TRACT DISEASES

**General Goal:** To know the major mechanisms of defense in the URT, the major mechanisms invaders use to avoid the defenses of the LRT, the common modes of transmission and the most common microbes that infect a particular location of the respiratory tract.

**Specific Educational Objectives:** The student should be able to:

1. describe defense mechanisms the body uses to protect itself from infections.
2. identify the microbes normally found in the respiratory tract (normal flora).
3. the mechanisms microbes use to infect the respiratory tract.
4. The common microbial pathogens and the locations they usually infect.

**Reading:** Mosby's Color Atlas and Text of *Infectious Diseases* by Christopher P. Conlon and David R. Snydman. pp. 53-67.

**Lecture:** Dr. Neal R. Chamberlain

**References:**

The respiratory tract is the most common site of infection by pathogens. Each year, children acquire between two and five upper respiratory tract infections and adults acquire one or two infections. The respiratory tract is a frequent site of infection because it comes in direct contact with the physical environment and is exposed to airborne microorganisms. A wide range of organisms can infect the respiratory tract, including viruses, bacteria, fungi, and parasites (Table R-1).

The anatomy of the upper respiratory tract is composed of many features that help to rid the system of particles and pathogens. The nasal cavity has a mucociliary lining similar to that of the lower respiratory tract. The inside of the nose is lined with hairs, which act to filter larger particles that are inhaled. The turbinate bones (“baffle plates”) are covered with mucus that collects particles not filtered by nasal hairs. Usually, particles 5–10 µm in diameter are either trapped by nasal hairs or impinge on the nasal mucosal surfaces.

After inhaled air moves through the nasal passages, the anatomy of the upper airway changes direction and causes many of the larger airborne particles to impinge on the back of the throat. The adenoids and tonsils are lymphoid organs in the upper respiratory tract that are important in developing an immune response to pathogens and are located in an area where many of these airborne particles are in contact with the mucosal surface.

A layer of mucus and ciliated cells covers the lower portion of the respiratory tract. Both single and subepithelial cells
secrete mucus. Respiratory pathogens that reach the lower respiratory tract are trapped in the mucous layer and are driven upwards by ciliary action (the mucociliary elevator) to the back of the throat. The sneeze and cough reflexes are important mechanisms for clearing material that accumulates in or irritates the respiratory tract.

Table R-1. Common Causes of Various Respiratory Diseases by Location

<table>
<thead>
<tr>
<th>Disease Location</th>
<th>Disease</th>
<th>Group of Pathogen</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper respiratory tract</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Nasal passages</td>
<td>Common cold</td>
<td>Viruses</td>
<td>Most common cause rhinovirus</td>
</tr>
<tr>
<td>Nasal sinuses</td>
<td>Rhinosinusitis</td>
<td>Viruses, Bacteria</td>
<td>Viruses are most common cause of rhinosinusitis</td>
</tr>
<tr>
<td>Pharynx</td>
<td>Pharyngitis</td>
<td>Viruses, Streptococcus pyogenes and Corynebacterium diphtheriae</td>
<td>Viruses cause 90% of these infections</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Respiratory airways</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epiglottis</td>
<td>Epiglottitis</td>
<td>Bacteria</td>
<td>Usually Haemophilus influenzae type b</td>
</tr>
<tr>
<td>Trachea and bronchi</td>
<td>Bronchitis,</td>
<td>Viruses</td>
<td>Usually caused by viruses</td>
</tr>
<tr>
<td></td>
<td>tracheobronchitis, croup, laryngitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchioles</td>
<td>Bronchiolitis</td>
<td>Viruses</td>
<td>Most common cause is respiratory syncytial virus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower respiratory tract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alveoli and alveolar sacs</td>
<td>Pneumonia</td>
<td>Bacteria</td>
<td>Most common cause in adults is Streptococcus pneumoniae</td>
</tr>
</tbody>
</table>

Most of the surfaces of the upper respiratory tract (including nasal and oral passages, nasopharynx, oropharynx, and trachea) are colonized by normal flora, which are regular inhabitants and rarely cause disease. The normal flora of the upper respiratory tract has two main functions that are important in maintaining the healthy state of the host: (1) These organisms compete with pathogenic organisms for potential attachment sites, and (2) they can produce substances that are bactericidal and prevent infection by pathogens.

There are no resident bacteria in the lower respiratory tract. Organisms that manage to enter the alveoli are usually eliminated by alveolar macrophages. Alveolar macrophages are considered the most important means of eliminating the organisms when they enter the lungs. Most bacteria (e.g., Streptococcus pneumoniae, Klebsiella pneumoniae, Haemophilus influenzae) that cause lung infections (e.g., pneumonia) produce a capsule that can prevent phagocytosis by the alveolar macrophage.
I. The respiratory tract is the most common site for infection by pathogens.

A. This site becomes infected frequently because it comes into direct contact with the physical environment and is exposed to microorganisms in the air.

B. The human respiratory tract is exposed to many potential pathogens via the smoke, soot, and dust that is inhaled from the air. It has been calculated that the average individual ingests about 8 microorganisms per minute or 10,000 per day.

II. The anatomy of the respiratory tract includes many features which help to rid the system of particles and potential pathogens.

A. The nasal cavity has a mucociliary lining similar to that of the lower respiratory tract. The inside of the nose is lined with hair which act to filter larger particles which are inhaled. The turbinate bones("baffle plates") are covered with mucus which collect particles not filtered by nasal hairs. Usually, particles 5-10 µm in diameter are either trapped by nasal hairs, or impinged on the nasal mucosal surfaces.

B. The change in direction of the airway from the sinuses to the pharynx causes a large number of larger particles to impinge on the back of the throat. The adenoids and tonsils are lymphoid organs in the upper respiratory tract that are quite important in developing an immune response to pathogens.

C. A layer of mucus and ciliated cells covers the lower portion of the lower respiratory tract. Mucus is secreted by both single and subepithelial mucus-secreting cells.

D. Particles or respiratory pathogens which reach the lower respiratory tract are first trapped in the mucus
layer and are driven upwards by ciliary action (the ciliary elevator) to the back of the throat.

E. There are two main obstacles a bacterium or virus must overcome in order to initiate an infection in the respiratory tract.

1. The microorganism must avoid being caught up in the mucus layers of the upper respiratory tract, being transported to the back of the throat, and eventually being swallowed.
2. If the invader has avoided the physical defense mechanisms of the upper respiratory tract, and is deposited in the lower respiratory tract or lung, it must either avoid phagocytosis, or be able to survive and multiply in the phagocytic cell.

III. Normal Flora Organisms of the Nose, Nasopharynx, and Oropharynx

A. Most of the surfaces of the upper respiratory tract (including nasal and oral passages, nasopharynx, oropharynx, and trachea) are colonized by normal flora. These organisms are usually regular inhabitants of these surfaces and rarely cause disease. The regular inhabitants of the nose include:

1. The most common bacteria found in the nose are staphylococci. These organisms are found just inside the nares and include Staphylococcus aureus and S. epidermidis.
2. In addition to the staphylococci, aerobic corynebacteria ("diphtheroids") can be cultured from the nasal surfaces.
3. Small numbers of Streptococcus pneumoniae, Neisseria meningitidis, and Haemophilus influenzae can also be found in the nasopharynx. However, most of these strains are not encapsulated or virulent. It should be noted that nonencapsulated, nontypable H. influenzae has been shown to play a significant role in the pathogenesis of otitis media.

B. The normal flora of the oropharynx also contains a large number of regular bacterial inhabitants.
1. The nose and the oropharynx contains large numbers of S. aureus and S. epidermidis.
2. The most important group of microorganisms native to this body niche are the alpha-hemolytic streptococci or viridans streptococci. This group includes S. mitis, S. mutans, S. milleri, and S. salivarius. It is believed that these bacteria act as antagonists against invasion by pathogenic streptococci.
3. Additionally, cultures from this region usually show large numbers of diphtheroids, Moraxella (formerly Branhamella) catarrhalis, and small Gram-negative coccoid related to Neisseria species.

C. The normal flora of these areas have two main functions that play a role in maintaining the healthy state of the host.

1. The organisms compete with pathogenic organisms for potential attachment sites.
2. These organisms often produce substances (toxins or acids) which are bactericidal.

IV. Mechanisms Used By Respiratory Tract Pathogens To Initiate Disease
A. Before a respiratory disease can be established, the following conditions need to be met.
   1. There must be a sufficient number or sufficient "dose" of infectious agent inhaled.
   2. The infectious particles must be airborne.
   3. The infectious organism must remain alive and viable while in the air.
   4. The organism must be deposited on susceptible tissue in the host.

B. Once a respiratory tract pathogen is in the respiratory tract, it is essential that it colonize these surfaces before it can cause obvious disease. Most microorganisms cause disease by only a few pathogenic mechanisms. A few of these mechanisms, especially those used by respiratory tract pathogens are discussed below.

   1. Bacterial adherence factors = F and M proteins of *Strep. pyogenes*, Hemagglutinins of *B. pertussis*.
   2. Extracellular toxins = diphtheria toxin; pertussis toxin.
   3. Growth in host tissue = viruses, chlamydia sp.
   4. Evasion of host defense mechanism = capsules of *Strep. pyogenes* (also M protein), *S. pneumoniae* and *H. influenzae* by inhibiting phagocytosis.

V. Respiratory Tract Pathogens = Wide Ranges of Organisms

   1. Viruses = Rhinoviruses, RSV, Adenoviruses, Influenza, Parainfluenza
   2. Group A streptococci = pharyngitis
   3. Other streptococci = *S. pneumoniae* = sinusitis, Group B = pneumonia of infants
   4. Other microorganisms = *C. diphtheriae*, *M. pneumoniae*, Fungi Parasites

VI. Upper Respiratory Tract Pathogens

   1. Common cold = mostly viruses
   2. Acute otitis media = Dr. Tritz has mentioned.
   3. Sinusitis = Bacteria = *S. pneumoniae*, *H. influenza*
   4. Pharyngitis = 90% viruses, important bacteria = *S. pyogenes* and *C. diphtheriae*

VII. Respiratory Airway Diseases = mostly viral bronchitis, tracheobronchitis, bronchiolitis (croup; epiglotitis)

VIII. Parenchymal Lung Disease Pneumonia = large number of bacterial infections in adults