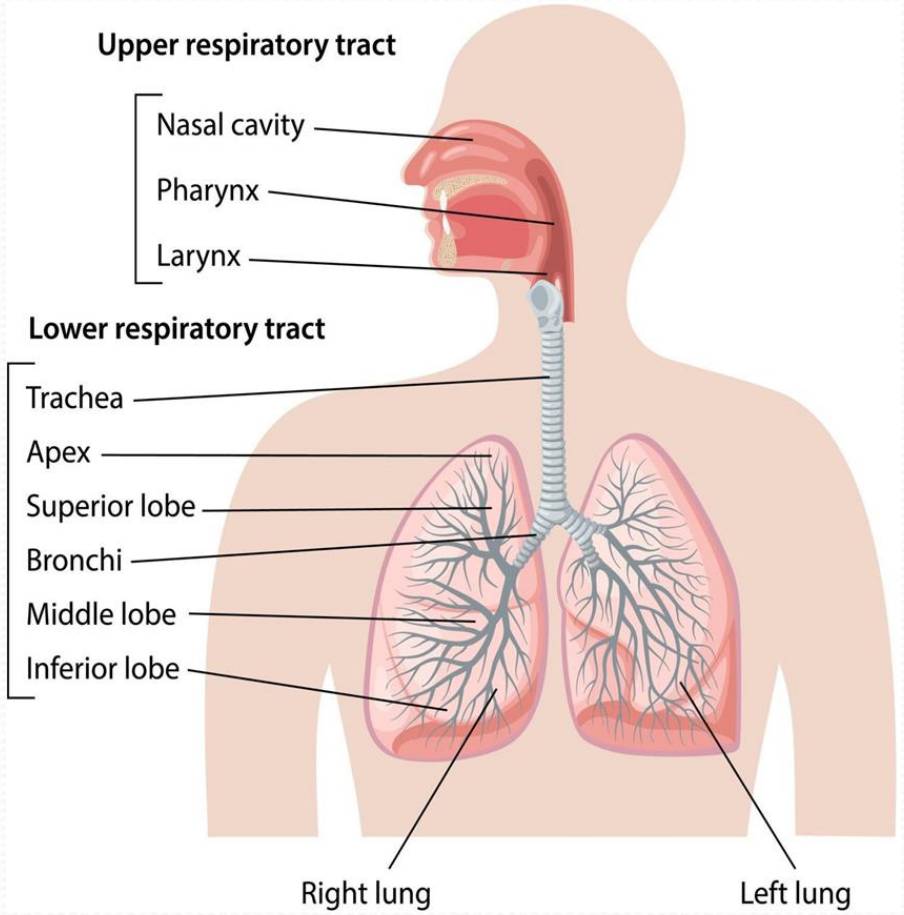
Respiratory System Infections

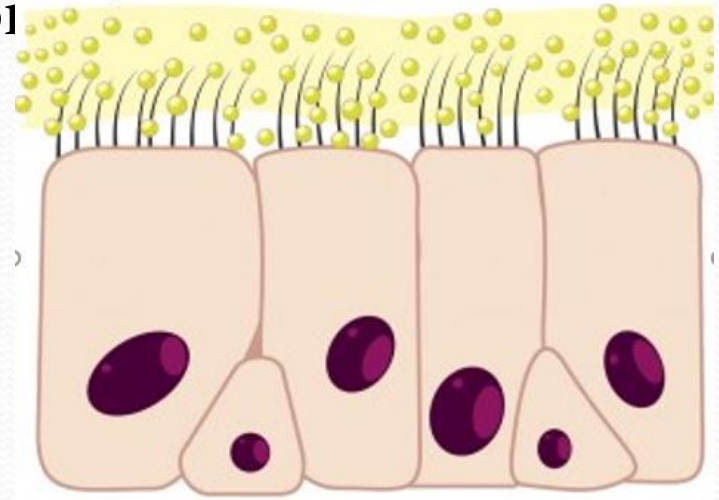
Anatomy of the Upper Respiratory System

- The respiratory system can be conceptually divided into upper and lower regions at the point of the **larynx**



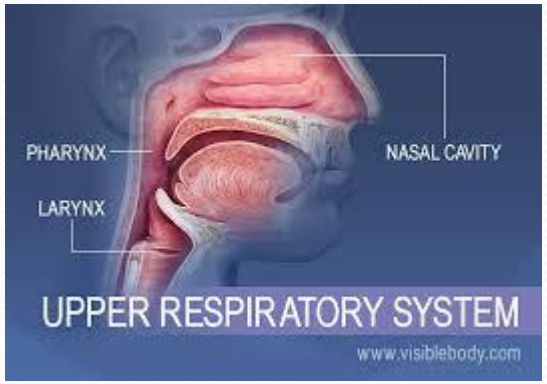
The nares (nostrils)

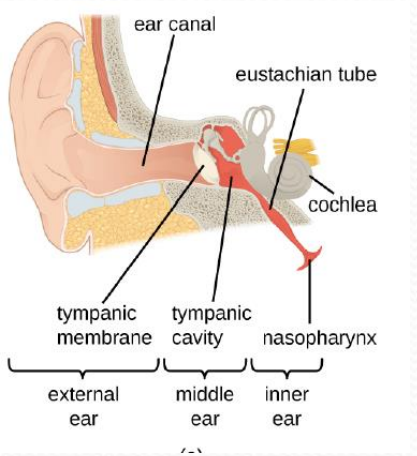
- The nares (or nostrils) are the external openings of the nose that lead back into the nasal cavity
  - The primary opening and first section of the respiratory tract
  - **Lined with hairs** that trap large particles, like dust and pollen, and prevent their access to deeper tissues.
  - **Lined with a mucous membrane** and Bowman's glands that produce mucus to help trap particles and microorganisms fo



The nasal cavity

- Connected to several other air-filled spaces.
  - The sinuses
  - The nasopharynx (upper throat)
  - The middle ear (through the eustachian tube).
  - The lacrimal glands through the nasolacrimal ducts (tear ducts).
- The open connections between these sites allow microorganisms to move from the nasal cavity to the sinuses, middle ears (and back), and down into the lower respiratory tract from the nasopharynx.



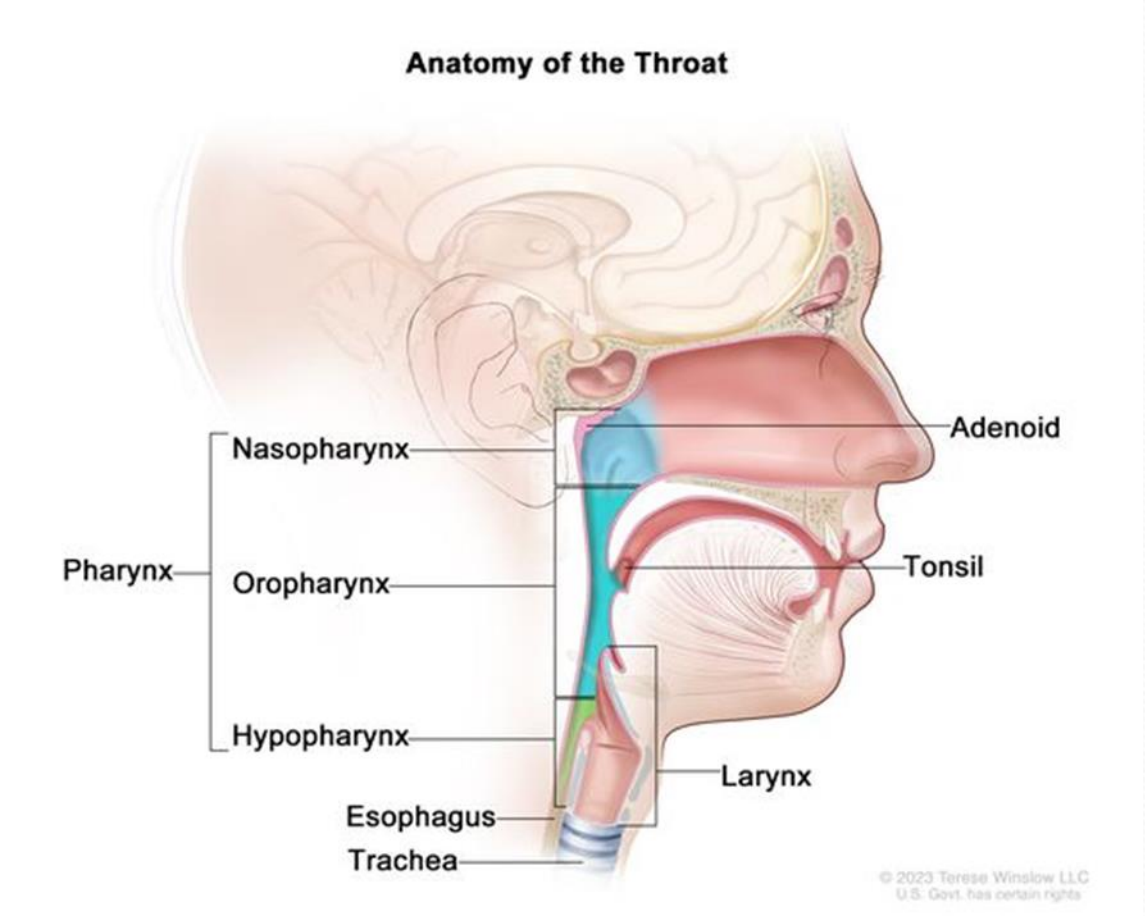


The oral cavity

- The oral cavity is a secondary opening for the respiratory tract. The oral and nasal cavities connect to the pharynx, or throat.

The pharynx

- The pharynx
  - The nasopharynx, the oropharynx, and the laryngopharynx.
  - The palatine tonsils, which consist of lymphoid tissue, are located within the oropharynx.
  - The laryngopharynx, the last portion of the pharynx, connects to the larynx, which contains the vocal fold



The Lower Respiratory System

- Below the epiglottis in the larynx or voice box
  - The trachea, or windpipe
  - The left and right bronchi
  - The bronchioles.
  - The alveoli.

Defenses of the Respiratory System

- The inner lining of the respiratory system consists of **mucous membranes** and is protected by multiple immune defenses.
  - The goblet cells within the respiratory epithelium secrete a layer of **sticky mucus**.
    - The viscosity and acidity of this secretion inhibits microbial attachment to the underlying cells.

Defenses of the Respiratory System

- The respiratory tract contains **ciliated epithelial cells**.
  - The beating cilia dislodge and propel the mucus, and any trapped microbes, upward to the epiglottis, where they will be swallowed (**The mucociliary escalator**)
  - Prevents inhaled microorganisms from migrating further into the lower respiratory tract.

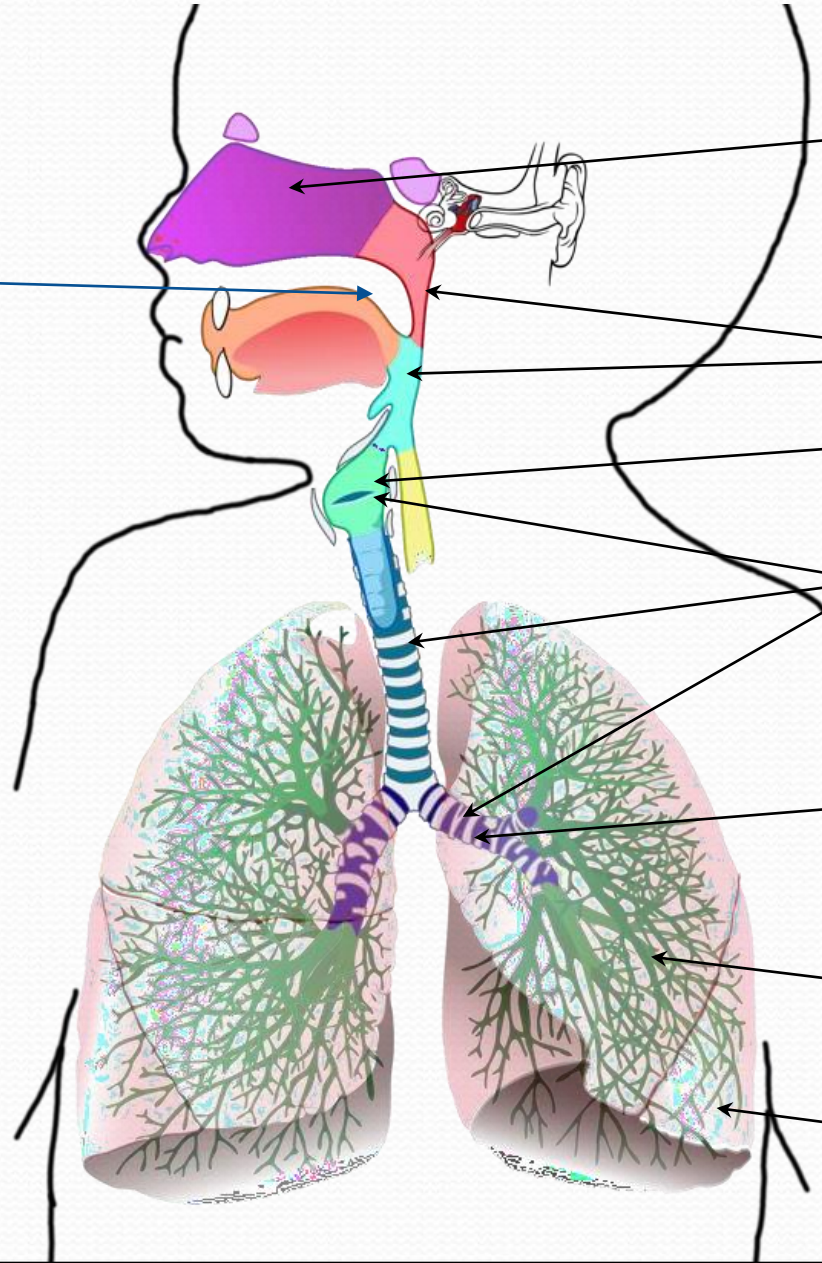
- The upper respiratory system is under constant surveillance by mucosa-associated lymphoid tissue (MALT)
  - Including the **adenoids** and **tonsils**.
  - Mucosal defenses include secreted antibodies (IgA), lysozyme, surfactant, and antimicrobial peptides called defensins.
- The lower respiratory tract is protected by alveolar macrophages.

Microbiota of the Respiratory System

- The nasal passages and sinuses
  - Staphylococcus epidermidis, viridans group streptococci (VGS), Corynebacterium spp., diphtheroids, Propionibacterium spp., and Haemophilus spp.
  - As much as 20% of the population carry **Staphylococcus aureus** in their nostrils.
- The oropharynx
  - Same isolates as the nose and sinuses, Prevotella, Fusobacterium, Moraxella, and Eikenella, as well as some Candida
  - The pharynx
    - Streptococcus, Haemophilus, and Neisseria

- The lower respiratory tract
  - Scantily populated with microbes.
  - Pseudomonas, Streptococcus, Prevotella, Fusobacterium, and Veillonella are the most common.
- Many members of the respiratory system's normal microbiota are opportunistic pathogens.
- To proliferate and cause host damage, they first must overcome the immune defenses of respiratory tissues.

Anatomical Location of Viral Syndromes



EBV,CMV

Rhinitis
Common Cold
Rhinovirus, Coronavirus
Influenza

Pharyngitis
Sore Throat
Laryngitis
Adenovirus, Parainfluenza
Influenza

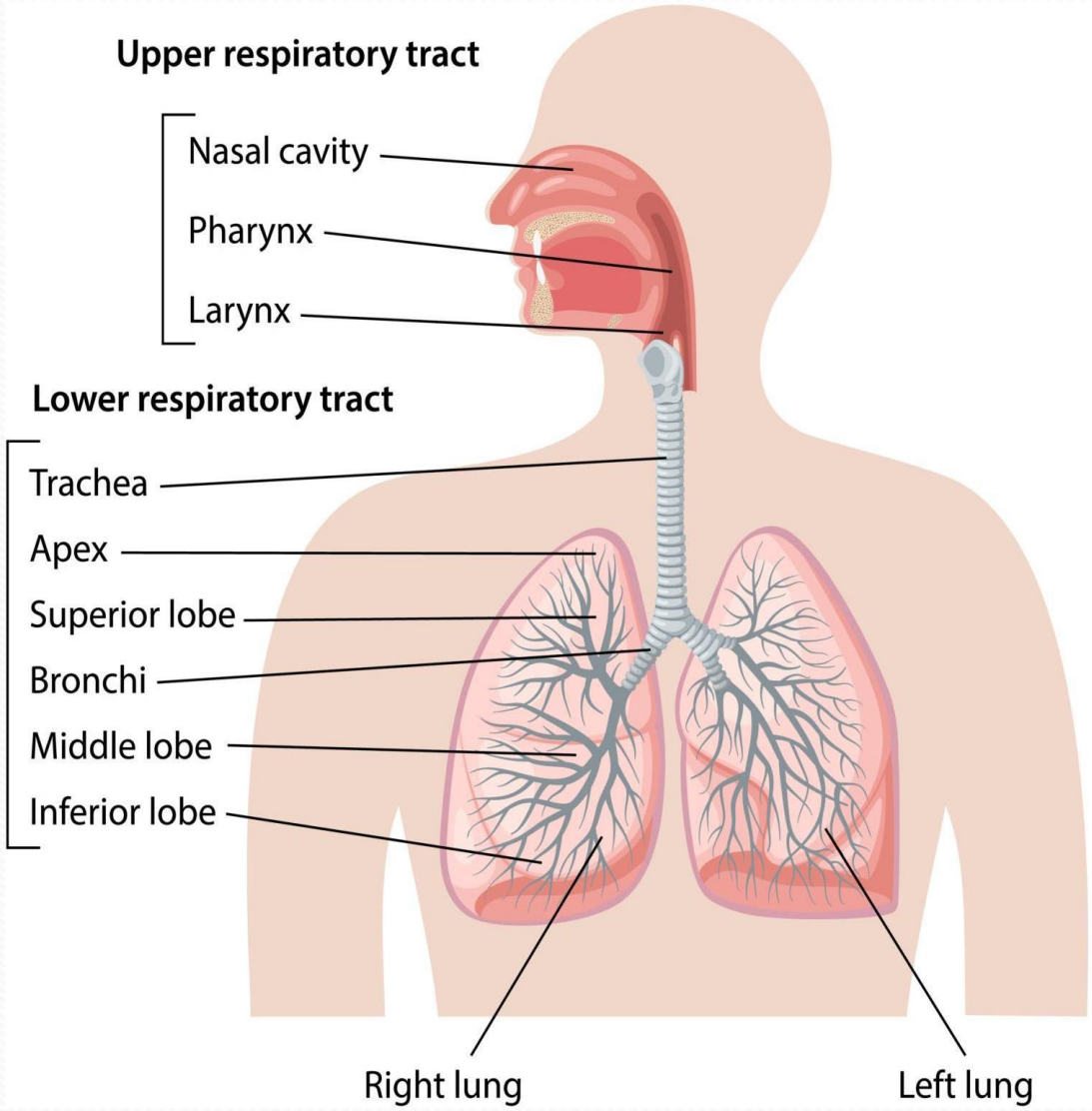
Laryngotracheobronchitis
Croup
Parainfluenza
Influenza

Bronchitis
Rhinovirus, Parainfluenza,
Adenovirus, Metapneumovirus
RSV, Coronavirus **Influenza**

Bronchiolitis
RSV (single serotype)
Metapneumovirus
Adenovirus **Influenza**

Pneumonia
All viruses **Influenza**

Bacterial Respiratory tract infections



Sinusitis

Streptococcus pneumoniae
Haemophilus influenzae

Upper respiratory tract infections

Streptococcus pyogenes
Haemophilus influenzae

Tracheitis

Staphylococcus aureus

Bronchitis

Mycoplasma pneumoniae
Streptococcus pneumoniae
Haemophilus influenzae
Mycoplasma catarrhalis

Pneumonia

Streptococcus pneumoniae
Haemophilus influenzae
Staphylococcus aureus

Atypical Pneumonia

Mycoplasma pneumoniae
Chlamydia pneumoniae
Legionella pneumonia

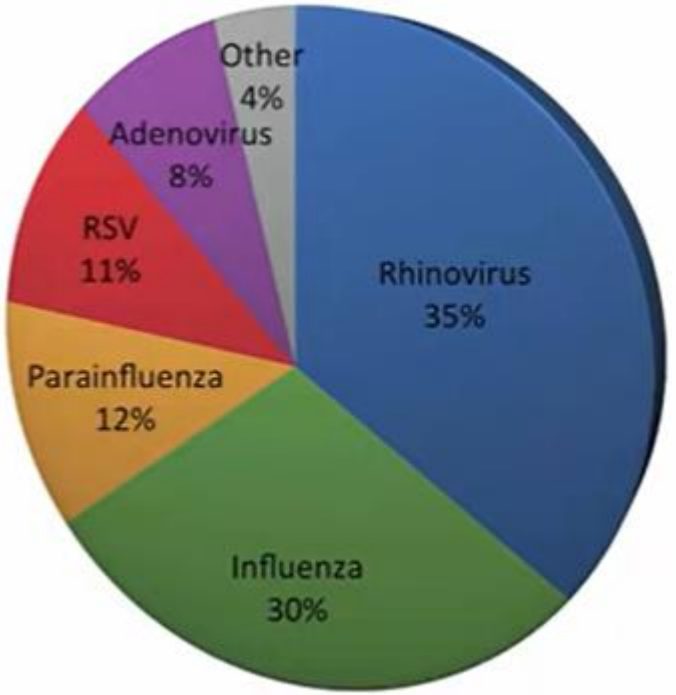
Tuberculosis

Mycobacterium tuberculosis

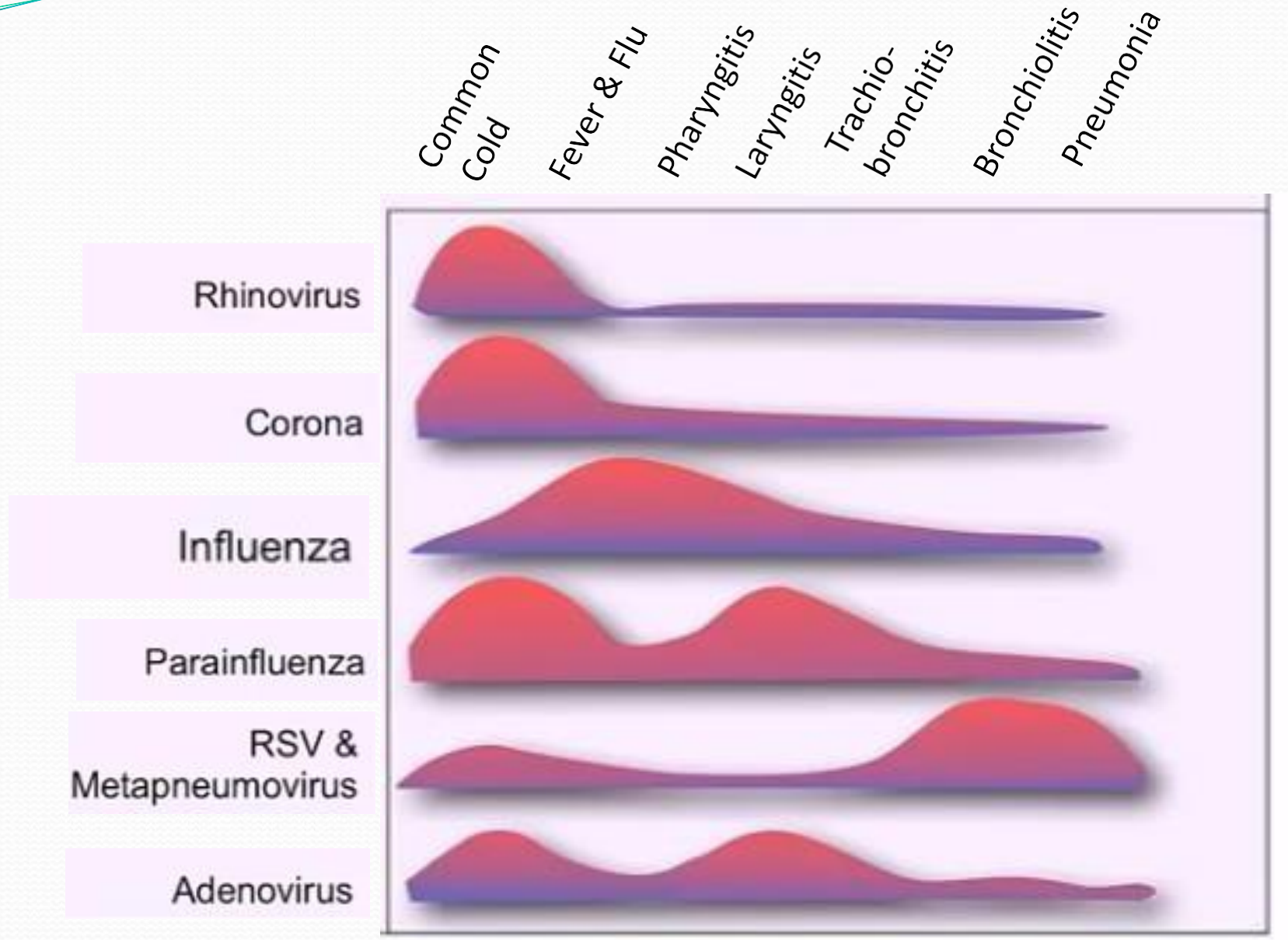
Viral Infections of the Respiratory Tract

- Viruses are the most frequent cause of respiratory tract infections.
- Few effective therapies to combat viral respiratory infections.
- Many of these diseases are mild and self-limiting.
- A few respiratory infections manifest their primary symptoms at other locations in the body.

- Most common illness in the United States
- Most common reason for physician office visits
- Most common cause of misuse of antibiotics
- Some can lead to respiratory failure and secondary bacterial infections



Matrix of Respiratory Associated Viral Infections



The Common Cold

- The common cold is a generic term for a variety of mild viral infections of the nasal cavity.
  - **Rhinoviruses, coronaviruses, and adenoviruses.**

- These infections are widely disseminated in the human population and are transmitted through **direct contact and droplet transmission**.
  - Coughing and sneezing

Common Cold

- More than 200 different viruses are known to cause the common cold.
- **Rhinoviruses** are responsible for 30-50% of common colds
- The rest are due to **adenoviruses, coronaviruses, enteroviruses, RSV, influenza, and parainfluenza viruses,** which may cause symptoms indistinguishable to those of rhinoviruses.

Rhinoviruses

- Rhinoviruses are responsible for 30- 50% of common colds.
- More than 100 serologic types of rhinoviruses (No vaccine)
- Naked virus, sensitive to gastric pH
- The primary site of rhinovirus infection is in the nasal epithelium.
- Rhinoviruses tend to replicate best between 33 °C (91.4 °F) and 35 °C (95 °F),
  - They tend to infect the cooler tissues of the nasal cavities
- Rhinoviruses rarely cause lower respiratory infection

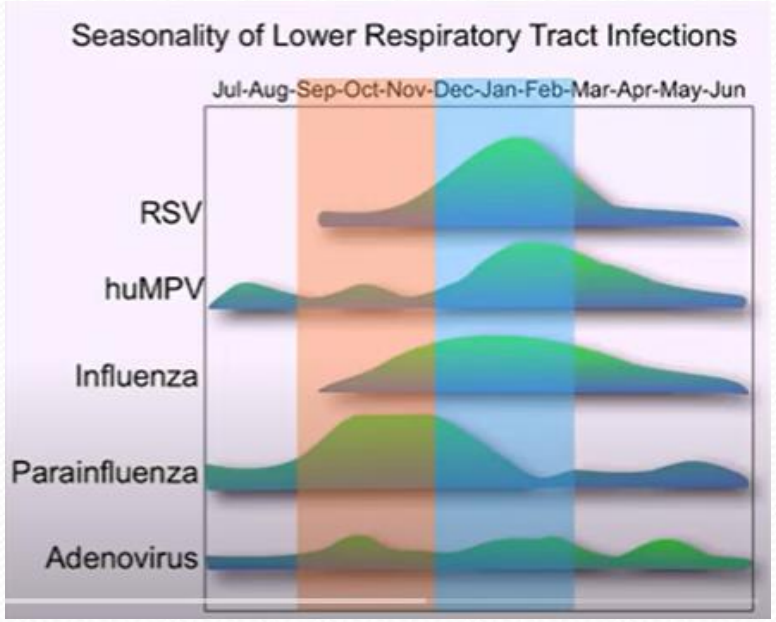
Drinking cold water

- **Vasoconstriction of Throat Vessels**
  - Reduces blood flow
- **Irritation of the Mucosal Lining**
  - exacerbate pre-existing conditions
- **Increased Risk of Infections**
  - Pathogens a better chance to cause an infection.
- **Triggering Cough or Reflex Actions**
  - Minor trauma or irritation of the pharynx
- **Dehydration Risk**
  - dry out the throat, weakening its natural protective mucus barrier against infections.

Cold weather

- Cold temperatures can impair the immune system's ability to fight infections.
- Nasal Cooling may reduce the efficiency of the mucociliary clearance system
- Increased Viral Survival
  - Many viruses, such as the common cold virus (rhinovirus) and influenza, thrive in cold, dry conditions. The lower humidity in winter air helps viruses survive longer outside the body, increasing the likelihood of transmission.
- Indoor Crowding
- Poor ventilation in indoor
- Dry Air and Mucosal Dryness
  - more prone to small cracks, which can provide entry points for pathogens.

- Reduced exposure to sunlight
- People are less physically active
- Virus-Specific Patterns
  - Influenza viruses peak in winter because of favorable environmental conditions and host factors.
  - Rhinoviruses are more active during seasonal transitions but can persist in winter as well.



- Cold weather **indirectly** increases the risk of URTIs through environmental, physiological, and behavioral changes rather than directly causing infections. The **strongest evidence** exists for the role of cold, dry air in enhancing viral survival and transmission, as well as for winter behaviors that increase pathogen exposure. The **evidence is weaker** for the direct effects of cold weather on immune suppression or infection risk.

Transmission of common cold

- Viral contact with the nasal mucosa or eyes can lead to infection.
- Directly from person to person via respiratory droplets
- Indirectly in which droplets are deposited on the hands or on a surface such as table and then transported by fingers to the nose or eyes.

Clinical presentation

- IP: 2-3 days
- URIs caused by rhinoviruses usually begin with sneezing, followed soon by rhinorrhea.
- The rhinorrhea increases and is then accompanied by symptoms of nasal obstruction.
- Cough and sore throat.
- Headache, malaise and the “chills” (rigors).
- The illness peaks in three to four days and last up to 7 days.

Symptoms

- The **absence of high fever** is typically used to differentiate common colds from other viral infections, like influenza.
- Some colds may progress to cause otitis media, pharyngitis, or laryngitis, and patients may also experience headaches and body aches.
- Self-limiting and typically resolves within 1–2 weeks.

Laboratory diagnosis

- Usually, common cold **does not require laboratory investigation**
- Cell culture isolation from nasal secretion
- Direct detection of rhinovirus antigen - an ELISA has been developed for the detection of rhinovirus antigen in nasal washings.
- Serology - virus neutralization tests remain the best method

Treatments

- There are no effective antiviral treatments for the common cold
- Antibacterial drugs should not be prescribed unless secondary bacterial infections have been established.
- Many of the viruses that cause colds are related, so immunity develops throughout life.
- Given the number of viruses that cause colds, however, individuals are never likely to develop immunity to all causes of the common cold.

Prevention and Treatment (common cold)

- Wait it out
- **No antiviral drug** has been proved useful.
- **Supportive care**: sleep, rest, warm air, nasal saline
- Cold treatment recommended include the following:
  - Antihistamines (it is not histamine mediated ?????)
  - Nonsteroidal antinflammatory drugs
  - Decongestants e.g Pseudoephedrine (vasoconstrictors)
  - Cough suppressants (narcotics)
  - Maybe: zinc, vitamin C
- **No vaccine.** The multiplicity of serotypes and the fleeting immunity pose major problems for the development of vaccines.
- **Hand Hygiene** is the most potent method of prevention and control

Other causes of common cold

- **Coxsackievirus**
  - Herpangina (severe sore throat with vesiculoulcerative lesions) an infection of the throat, causes red-ringed blisters and ulcers on the tonsils and soft palate, the fleshy back portion of the roof of the mouth.,
  - Painful blisters in the mouth, throat, hands, feet, or in all these areas. Hand, foot, and mouth disease (HFMD)
  - Common cold

Complication Common cold

- **Acute bacterial sinusitis**
- **Acute bacterial otitis media**
  - mainly a problem in children
- **Asthma attacks in children**
- **Exacerbation of chronic bronchitis**