Ch16: Respiratory System

Function: To exchange gas between the external environment and the blood

- O_2 in and CO_2 out of the blood vessels in the lungs
- O_2 out and CO_2 into the blood vessels around the cells

- Gas exchange happens in alveoli
- Other organs purify, humidify, and warm the incoming air
    - also act as conducting passageways

Cells, Tissues, and Membranes

- **Cells**
  - Surfactant secreting cells
  - Macrophage
- **Epithelial**
  - Simple squamous – alveoli
  - Pseudostratified columnar – respiratory passageway
- **Connective**
  - Hyaline cartilage in the larynx and nose
  - Elastic cartilage in the larynx
- **Membranes**
  - Mediastinum
  - Pleural – visceral and parietal

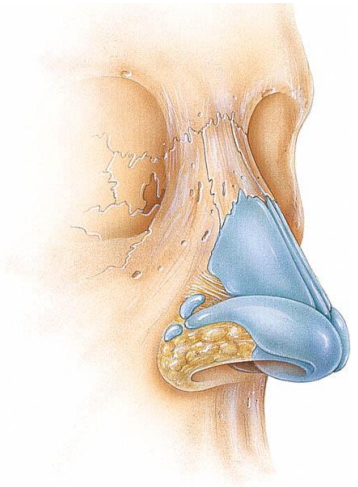
Development

- Lungs are one of the last organ systems to develop
  - Surfactant levels are not large until late in pregnancy
  - Surfactant = fatty molecule that lowers the surface tension of water in the lining of alveoli to keep them open
- Fetus – lungs filled with fluid
  - All respiratory gas exchange made by placenta
- At birth – passageways are drained and alveoli inflate for the first time
- Lungs are not fully inflated until 2 weeks

Anatomy of the Respiratory System

- Consists of the nose, pharynx (throat), larynx (voice box), trachea (windpipe), bronchi, and lungs with alveoli.

Nose



Function = warming, filtering, and moistening inhaled air; detecting smells; and modifying the sounds of speech

Externally:

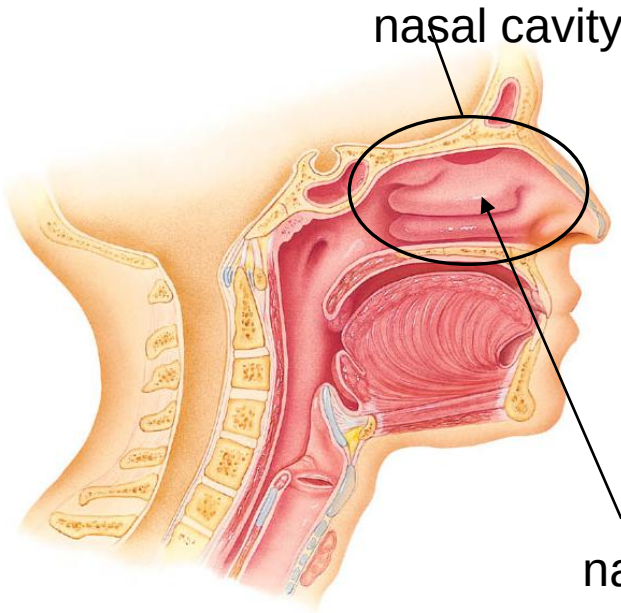
- Framework of bone and hyaline cartilage covered with muscle, skin, and mucosa (on the inner surface)
- Air enters external nares (nostrils)

Internally:

- Divided into right and left sides by the ***nasal septum or vomer bone***
- Space within = ***nasal cavity***

Nose

- ***Nasal Conchae* =** three shelves within the nasal cavity lined with mucosa
  - Swirls the air through the cavity and traps particles, as well as warms the air



- Cilia within the nasal cavity wave mucus to the throat, where it, along with trapped particles, is swallowed and/or spit out.

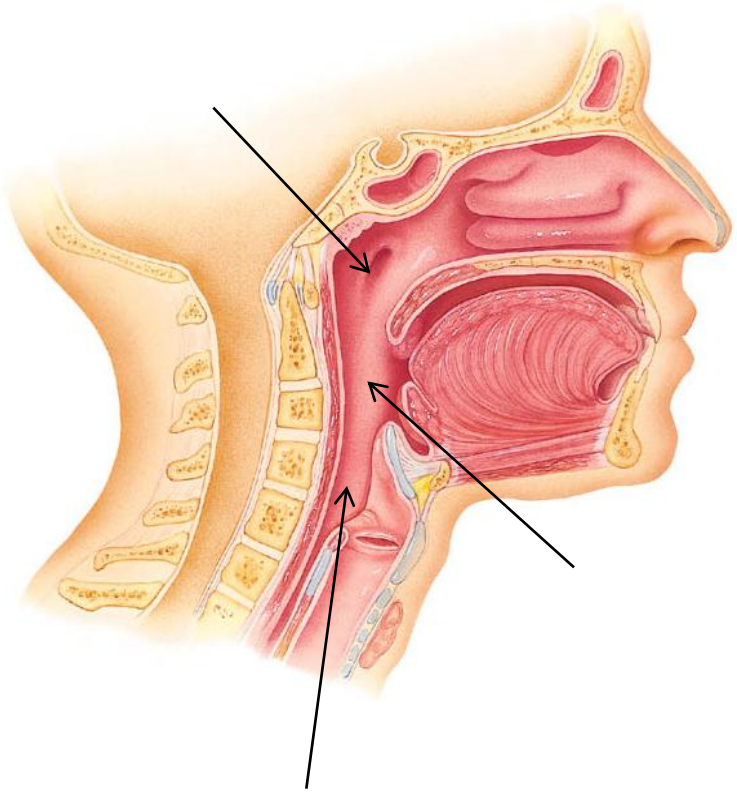
Nose

- The nasal cavity is separated from the oral cavity below by a partition called the palate
  - Hard palate – anterior part that is supported by bone
  - Soft palate – unsupported posterior part

- The nasal cavity is surrounded by a ring of paranasal sinuses
  - **Function**: lighten skull, add resonance chambers for speech, produce mucus which drains into the nasal cavity
  - Nose blowing helps clear sinuses

Pharynx

- Funnel-shaped tube from the end of the nasal cavity to the superior border of the larynx
- **Function** = passageway for air, food, and liquid, provides a resonating chamber for voice, and houses the tonsils, which are lymphatic organs

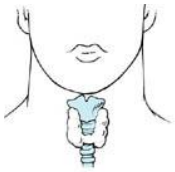


Pharynx

- ***Nasopharynx*** (uppermost portion) = Air travels from the nasal cavities into the nasopharynx
  - Also, the *auditory tubes* open into the nasopharynx, allowing pressure equalization in the middle ear

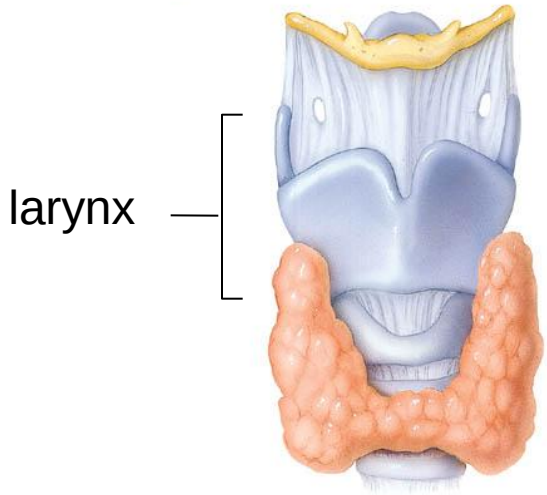
- ***Oropharynx*** (middle portion) = Has openings into the mouth and nasopharynx; passage for air and food

- ***Laryngopharynx*** (lowermost portion) = Connects with the esophagus, oropharynx, and the larynx



Larynx

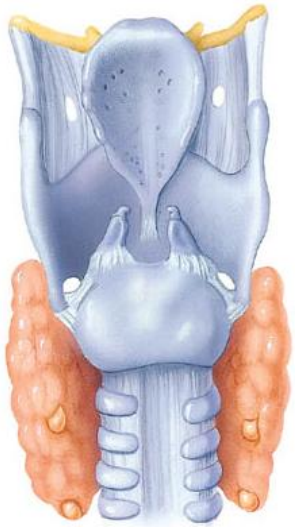
- ***Larynx*** *(*Adam's Apple) = rigid cartilage structure (hyaline and elastic) that connects the pharynx with the trachea (windpipe)
- **Function** = voice box



anterior


anterior

- Hyaline cartilage forms the anterior wall of the larynx.
- Present in both genders, but is larger and more pronounced in males.


posterior

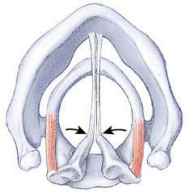
Larynx

- ***Epiglottis*** = large flap of elastic cartilage which attaches to the anterior rim of the thyroid cartilage and the hyoid bone
  - As you swallow, the larynx and pharynx rise and the pharynx widens as it rises to accommodate the swallowed food
  - As the larynx rises, the epiglottis moves down and forms a lid over the opening to the trachea, preventing food and/or liquid from getting into the airways

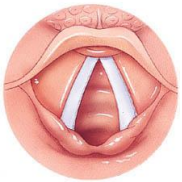
Voice Production

- The structures that allow for vocalization are folds in the larynx
  - Two pairs of folds: ***false vocal cords*** and ***true vocal cords***
- **False vocal cords** = allow you to “hold your breath against pressure”, as when you pick up something heavy
- **True vocal cords** = vibrate to give your voice resonance and pitch. Without them, you’d be forced to whisper. The space between the cords is called the *glottis*

superior view: muscles and cartilage



superior view: as if through a laryngoscope



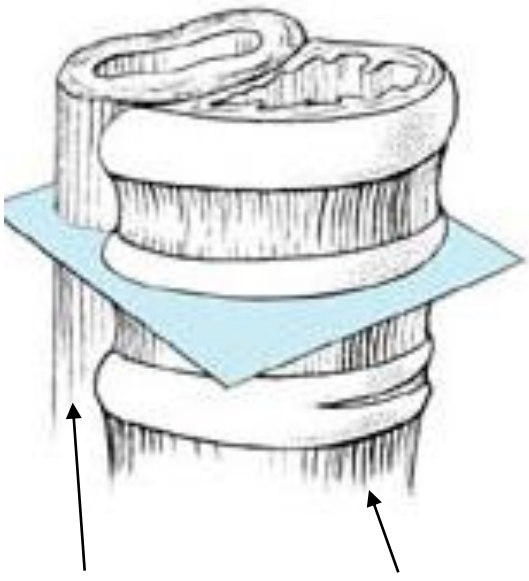
Voice Production

- Tiny muscles within the larynx move the cords closer together, farther apart.
  - There are also muscles that adjust the tension on the vocal cords
  - These adjustments, coupled with the airflow from the lungs, allow you to control the pitch and volume of your voice.

- Males tend to have deeper voices because their vocal cords are usually thicker and longer than those of females. Thus, they naturally vibrate more slowly

Trachea

- Also known as the **Windpipe**
- Tubular air passage that runs about 12 cm from the bottom of the larynx downward to about T5 vertebrae, at which point it splits in to ***right and left bronchi***.
  - Wall is lined with mucosa (pseudostratified columnar epithelium with cilia)
  - Cilia in the trachea move mucus upward to the throat to remove the trapped particles from the respiratory tract



Trachae

- Supported by C-shaped rings of cartilage to keep trachea from collapsing
- The gap in the C faces the esophagus, which is posterior to the trachea.
  - This accommodates the expansion of the esophagus as food is swallowed and sent down to the stomach

Which part of the respiratory system shares a passageway with the digestive system?

A. Nasal cavity
B. Pharynx
C. Larynx
D. Trachea

Bronchi and Bronchioles

- Trachea divides into the right and left ***primary bronchus*** = entryways into each lung
  - Right primary bronchus is wider, shorter, and straighter than the left
    - more common site for an inhaled object to become lodged
  - By the time air gets to bronchi, it is warmed, cleansed, and well humidified

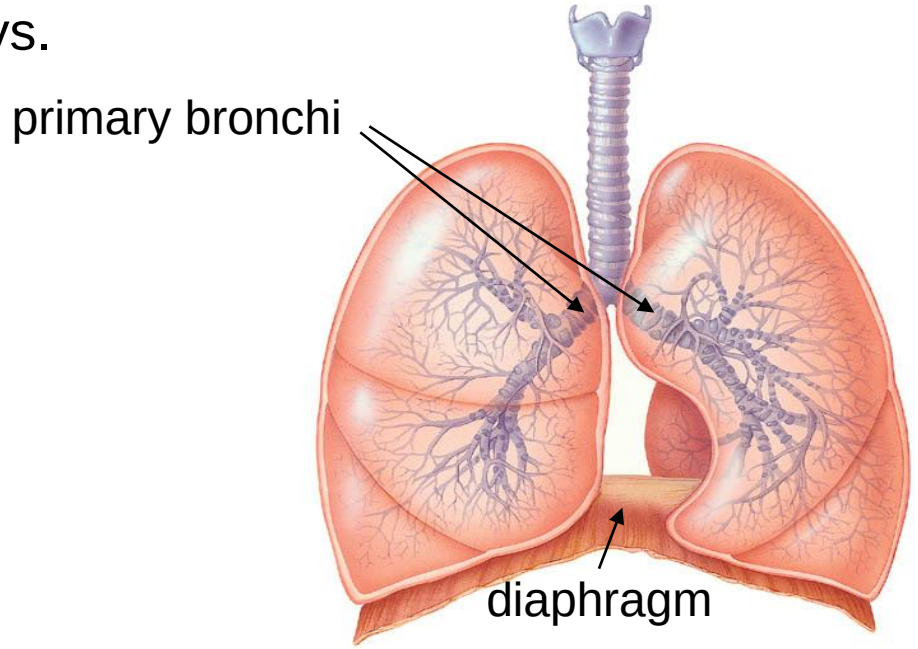
Bronchi and Bronchioles

- Once in the lung, the primary bronchi split into ***secondary bronchi*** – one for each lobe of the lung (two on the left, three on the right)

- Secondary bronchi divide into *tertiary bronchi*, which continue to “divide” into smaller and smaller tubes known as ***bronchioles***

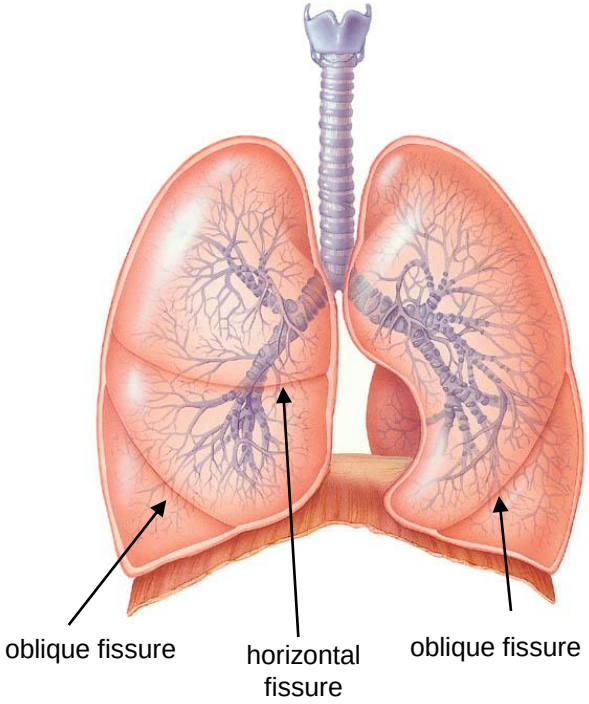
Bronchi and Bronchioles

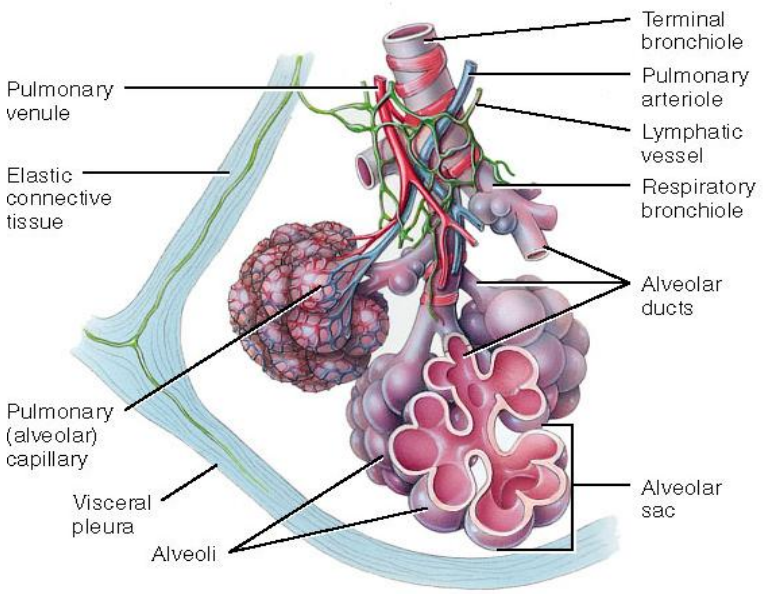
- As branching increases:
  - Cartilage rings decreases, then ultimately vanish
  - Smooth muscle increases – this can dilate or constrict airways due to demand
    - ***Asthma attacks*** involve spasms of this smooth muscle, constricting the airways.



Lungs

- Spongy, cone shaped organ in the thoracic cavity that is separated by the heart and other structures in the mediastinum
- Surrounded by the ***pleural membrane*** which has a visceral side and a parietal side. In between the layers is filled with fluid to ease friction.





(a) Diagram of a portion of a lobule of the lung

Lungs

- The smallest organizational unit of the lung is a ***lobule***.
  - A lobule consists of a lymphatic vessel, arteriole, capillary, venule, and a branch from a terminal bronchiole.
  - All wrapped in connective tissue
- Terminal bronchioles subdivide into ***respiratory bronchioles***, which are capable of gas exchange.
- These further subdivide into ***alveolar ducts*** and eventually into ***alveoli***.

Alveoli

- Cup-shaped section of an alveolar sac which is the main site of gas exchange by diffusion between the lungs and the bloodstream
  - Walls are extremely thin simple squamous tissue
  - The lungs contain about 300 million alveoli. Ultimately, this provides a surface area for gas exchange about 35 times the surface area of your own skin. About half the size of a tennis court.
- **The Respiratory Membrane:** combination of capillary and alveolar walls that separate gas in the lungs from the bloodstream.
  - Consists of five layers, but is still only 0.5 micrometers thick (significantly thinner than tissue paper) – thus gases can exchange very quickly

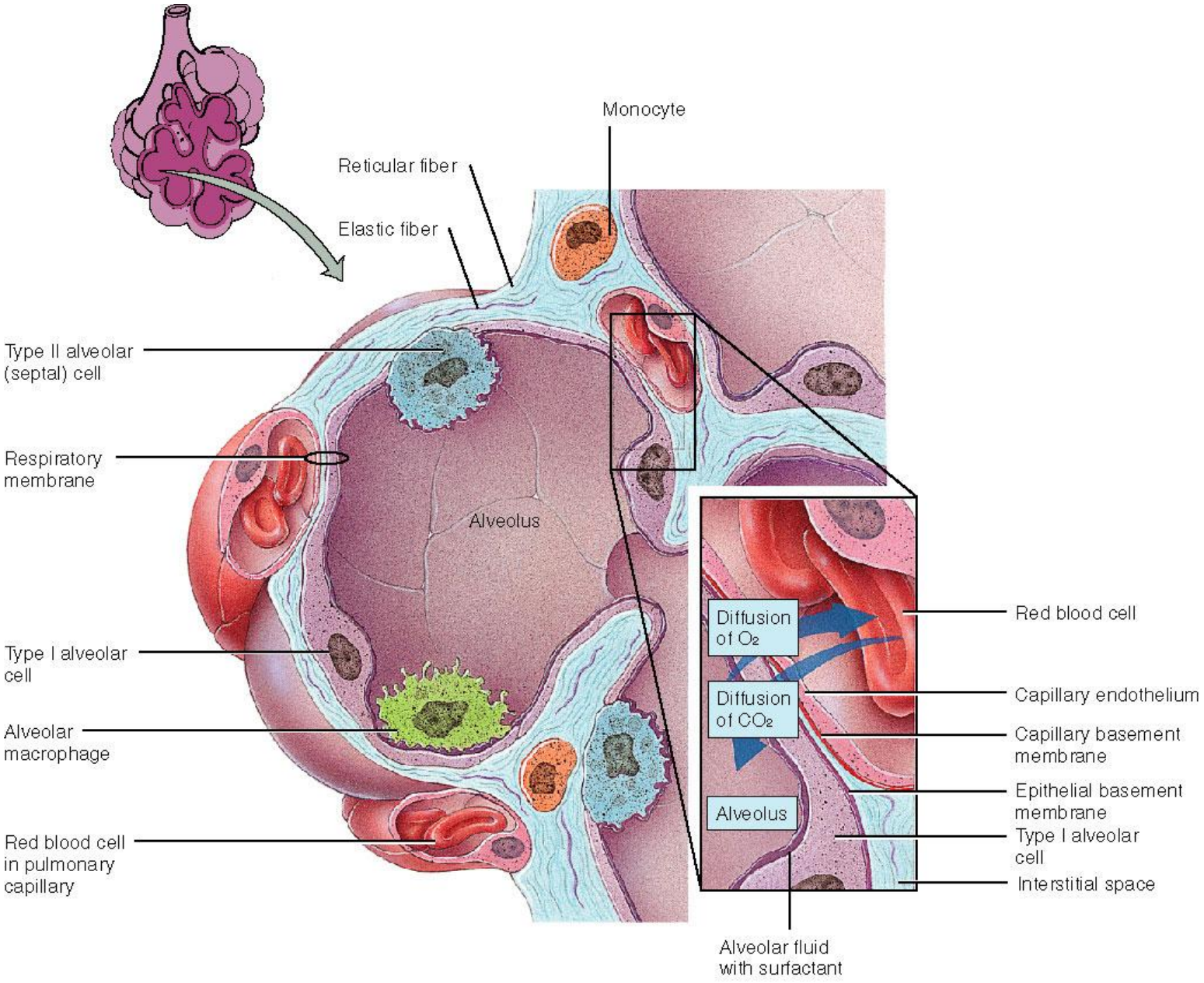
Alveoli

- Within the alveoli are cells called ***surfactant secreting cells***, which keep the inner surface of the alveoli moist by secreting a fluid known as ***alveolar fluid***.

- Contained within alveolar fluid is **surfactant** – a fatty substance that helps prevent the alveoli from collapsing.

- Also have ***alveolar macrophages*** that are present to help remove particulates and other debris in the alveolar spaces.

Close view of an Alveolus:



What type of transport is used to move oxygen and carbon dioxide across the alveoli membrane?

A. Active
B. Osmosis
C. Diffusion
D. Endocytosis and Exocytosis

List the correct order of air movement through the entire respiratory passageway.

A. Nasal/Oral Cavity, Pharynx, Larynx, Trachea, Bronchi, Lungs
B. Nasal/Oral Cavity, Larynx, Pharynx, Trachea, Bronchi, Lungs
C. Larynx, Trachea, Bronchi, Lungs
D. Nasal/Oral Cavity, Larynx, Trachea, Lungs