Respiratory system
Functions of the respiratory system

- Ventilation-air is warmed, humidify, filtered.
- Gas exchange- $O_2$ & $CO_2$
- Permit vocal communication
- Defend respiratory system from pathogens
- pH regulation of blood
  - Exhalation of $CO_2$
Fig 24.1
• Conduction zone
  – Ventilation of air-movement of air from the environment towards the alveoli
  – Humidify & cleans air
  – Environment > terminal bronchioles

• Respiratory zone
  – Gas exchange at the alveoli
  – Respiratory bronchioles > alveoli
Respiratory Epithelium

- Lines majority of respiratory tract
- Pseudostratified ciliated columnar epithelium (PSCC) with many goblet cells
  - Produces mucus to trap foreign particles
- Lamina propria (connective tissue layer)
  - Epithelium and lamina propria = mucus membrane
cilia rhythmically ‘sweeps’ debris up to be swallowed at pharynx

Fig 24.2

(a) Respiratory epithelium of trachea

(b) Respiratory epithelium (LM × 932)
The Nose

- Primary airway for respiration
- Moistens and warms air
- Filters inhaled air (mucus)
- Resonating chamber for speech
- Houses olfactory receptors

- It would be healthier to smoke cigarettes through the nose!
• External nares
  – Open into nasal cavity
  – nose hairs

• Nasal cavity
  – Superior, middle and inferior meati
    • Narrow grooves and conchal surfaces (ethmoid bone)

• Hard palate-divides nasal and oral cavities

• Internal nares
  – Between nasal cavity and nasopharynx
PARANASAL SINUSES
The Pharynx

Shared by digestive and respiratory systems

Nasopharynx
from Internal nares to uvula.

Oropharynx
From soft palate to the epiglottis

Laryngopharynx
Between hyoid and entrance to esophagus
Nasopharynx

- Only an air passageway
- Closed off during swallowing
- Pharyngeal tonsil-(lymphatic system)
- Contains the opening to the auditory tube (special senses)
Oropharynx

- Extends from soft palate to the epiglottis
- Epithelium is stratified squamous epithelium
- Two types of tonsils in the oropharynx
  - Palatine tonsils
  - Lingual tonsils
Laryngopharynx

- Passageway for both food and air
- Continuous with the esophagus and larynx
The length & thickness of the vocal folds help determine the sound of one’s voice.
Trachea

- From C₆ to T₅
- “C” rings of cartilage
  - Tracheal cartilages
  - Stiffen tracheal walls and protect airway
  - Posterior wall distorts allowing food passage through esophagus
Left and Right primary ($1^\circ$) Bronchi

- Right and left ($1^\circ$) bronchi
  - Trachea branches within mediastinum
- Bronchial tree – extensively branching respiratory passageways
- ($1^\circ$) bronchi – largest bronchi
- Right ($1^\circ$) bronchi – wider and shorter than the left (foreign object more likely to lodge in right ($1^\circ$) bronchi)
• Secondary (lobar) bronchi
  – Three on the right
  – Two on the left

• Tertiary (segmental) bronchi
  – Branch into each lung segment

• Bronchioles – little bronchi, less than 1 mm in diameter

• Terminal bronchioles – less than 0.5 mm in diameter
• Bronchopulmonary segments
  – 10 in right lung; 8-9 in left lung
  – Gives rise to 50-80 terminal bronchioles
How many lobes and secondary bronchi are present in each lung?
(d) The bronchial tree
Lungs

Held within Pleural Cavities
visceral / parietal pleura
Diaphragmatic surface- diaphragm forms floor
Costal surface- rib cage forms outer wall
Mediastinal Surface-medial surface
Right Lung= 3 lobes; Left lung= 2 lobes
Lungs

• Separated by fissures
  – Right lung has three lobes
  – Left lung has two lobes

• Costal surface
  – Anterior surface
  – Follows contours of rib cage

• Mediastinal surface
  – hilus-pulmonary vessels, (1°) bronchi, nerves
Bronchioles

- Do not contain cartilage
- Have smooth muscle
- Are Innervated by ANS
  - Parasympathetic
    - constrict airways
  - Sympathetic
    - dilate airways
• Alveoli 150 million per lung
• Surrounded by capillaries & elastic fibers
• Capillaries cover 90% of surface
• Elastic fibers-for recoil to push air out (assists ventilation).
• Internal surfaces
  • A site for free movement of alveolar macrophages
Cells of alveoli
Alveolar type I cells – simple squamous epithelium
more numerous
makes ‘walls’ of alveoli
provides surface area for gas exchange
thin-good for diffusion
Alveolar type II/surfactant cells – release surfactant

Produce surfactant to reduce surface tension
Prevents alveolar collapse during exhalation
Begin at 7-8 months of fetal development
Alveolar Macrophages – defense and protection of alveolar surface.
• **Respiratory Membrane** (blood-air Barrier)
• “point of gas exchange”
• **Aveolar Epithelium simple squamous epithelia**
• **Fused basement membrane**

Capillary endothelium simple squamous epithelia

![Diagram of respiratory membrane and alveoli](image)
normal quite breathing at rest.

Inspiration:
↑ volume of thoracic cavity.

Muscle activity required:
Diaphragm
External Intercostals
Sternocleidomastoid
To increase depth and frequency of breaths use:

*Sternocleidomastoid*

*Scalenes*

Expiration: ↓ volume of thoracic cavity.

No Muscular activity required
When Forcefully exhaling

Muscles used:
*Internal Intercostals*
*Rectus abdominis*
*Transverse abdominis,*
*Internal and External obliques.*
Sensory Receptors - regulate respiration.

**Mechanoreceptors**
detect changes in lung volume or arterial blood pressure

**Chemoreceptors**
Changes in $P_{CO_2}$, pH, $P_{O_2}$ of blood and CSF

*Central chemoreceptors* - in medulla

*Peripheral chemoreceptors*
  - Aortic bodies (in aorta)
  - Carotid bodies (in carotids)
CNS control

**Respiratory rhythmicity center** - Sets respiratory pace. in medulla oblongata.

**Apneustic center** - used for ‘overdrive’ when breathing deep.

**Pneumotaxic center** - sets limits to over inflation of lung.
• **Bronchial asthma** – an allergic inflammation
  A hypersensitivity to irritants in the air or to stress

  Asthma attacks characterized by: Contraction of bronchiole smooth muscle. Secretion of mucus in airways.

• **Cystic fibrosis (CF)** – inherited disease
  – Exocrine gland function is disrupted
  – Respiratory system affected by:
    • Oversecretion of viscous mucus
Smoking dries air, contaminates air and damages respiratory membrane nicotine, tar, carcinogens
Respiratory tracing

- **Air**
- External Nares
- Nasal cavity
- Nasopharynx
- Oropharynx
- Laryngopharynx
- Larynx
- Trachea
- Rt./Lt. primary bronchi
- Secondary (lobar) bronchi
- Tertiary (segmental) bronchi
- Terminal bronchioles
- Respiratory bronchioles
- Alveolar duct
- Alveolar sac
- Alveolus

**Epithelial tissue**
- Stratified squamous
- psc
- psc
- Stratified squamous
- Stratified squamous
- Stratified squamous
- psc
- psc
- psc
- Simple cubodial
- Simple cubodial
- Simple squamous
- Simple squamous
- Simple squamous
Interactive CD
• Break
• Trachea slide
Ep = pscc
Sumb = tunica submucosa
Cart = tracheal ring
Adv = tunica adventitia
Fig 24.4

(a) Larynx, anterior view

(b) Larynx, posterior view
Fig 24.4

(c) Posterior view of laryngeal cartilages

(d) Larynx, sagittal section
Fig 24.8
Fig 24.8

The left and right lungs

MEDIASTINAL SURFACE
RIGHT LUNG

MEDIASTINAL SURFACE
LEFT LUNG
Fig 24.12

(a) Alveolar organization