The Respiratory System

References

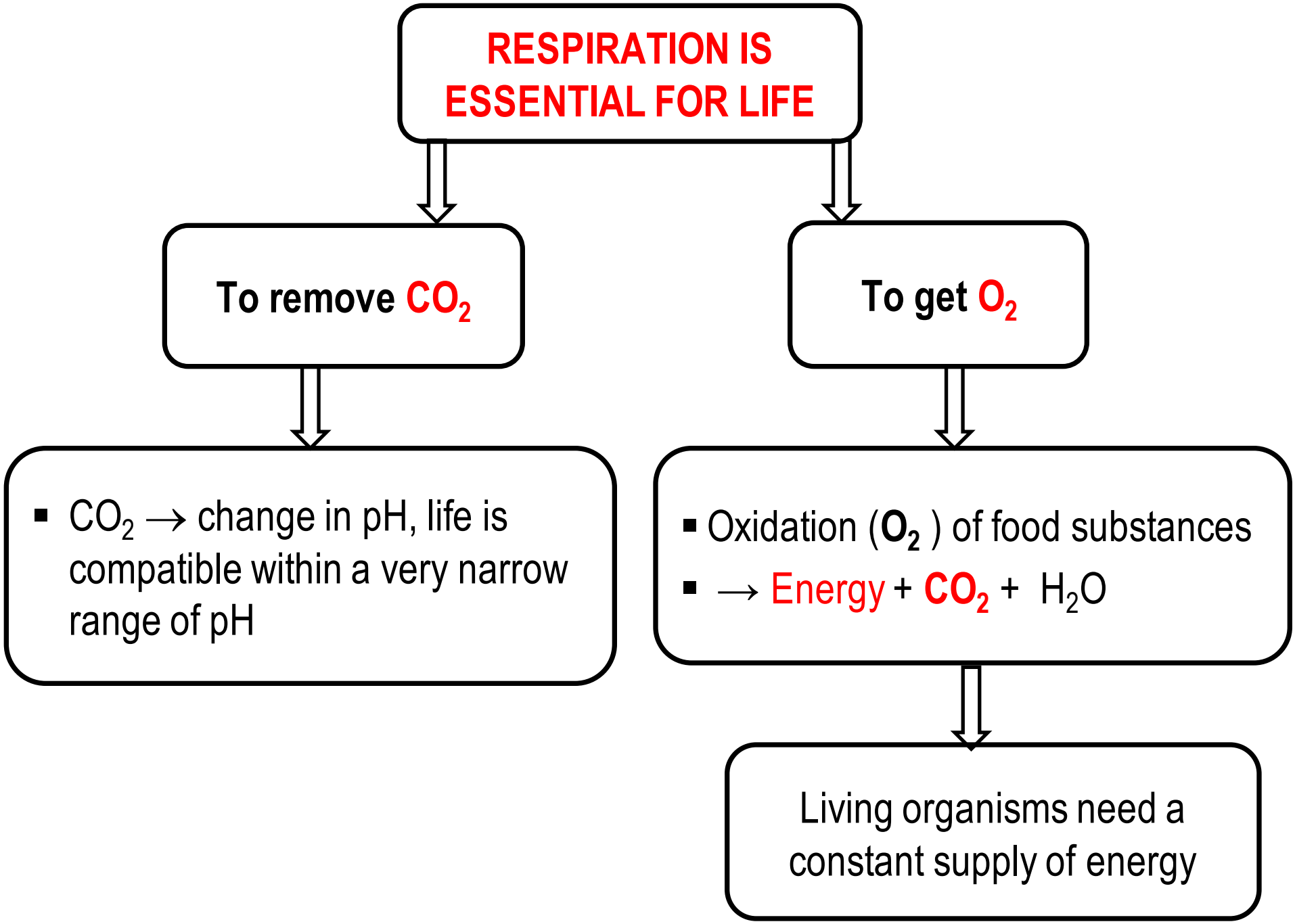
1. Ganong's review of medical physiology 24rd edition
2. Textbook of medical physiology. GUYTON 11th edition
3. Textbook of medical physiology N. Geetha 2nd edition

Lecture 1

INTRODUCTION

Objectives

- Define partial pressure and calculate the partial pressure of each of the important gases in the atmosphere at sea level.
- Function of the respiratory tract.
- Non respiratory function of the lung.
- The passages through which air passes from exterior to the alveoli
- Factors affecting bronchial tone.


RESPIRATION IS ESSENTIAL FOR LIFE
To remove CO_2
To get O_2
▪ CO_2 → change in pH, life is compatible within a very narrow range of pH
▪ Oxidation (O_2) of food substances
▪ → Energy + CO_2 + H_2O
Living organisms need a constant supply of energy

Non respiratory functions of lungs (resp. system)

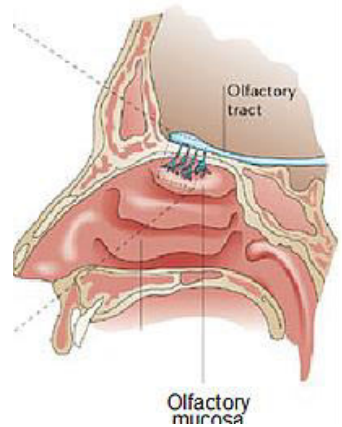
1) Regulation acid base balance
2) Regulation H_2O balance
3) Regulation of heat loss
4) Defense against pathogens and foreign particles in airways:
   - Remove foreign particles (mucus and cilia)
   - Neutrophils, lymphocytes and macrophages in alveoli
   - Immunoglobulin (IgA)
5) Helps venous return (respiratory pump)
6) Activation of angiotensin I to angiotensin II
7) Anticoagulant
   - Heparin from mast cells
   - Fibinolytic system remove small emboli

8) Endocrine and metabolic function

- Lungs synthesize hormones like PG, serotonin, histamine etc.
- Bradykinin, norepinephrine, serotonin, PG are degraded by the lungs

9) Olfaction

- Olfactory mucosa (5cm^2 upper nasal mucosa)



10) Vocalization

During swallowing resp. system protected from food entry

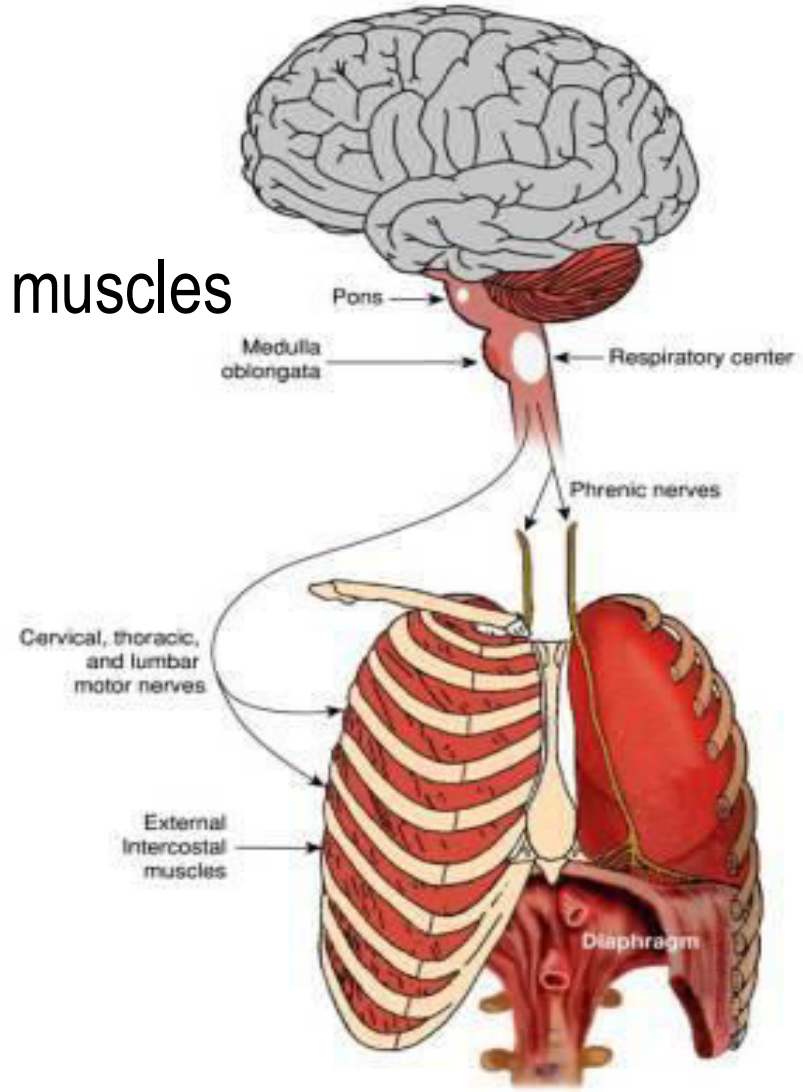
- Nose
  - Elevation of soft palate closes posterior nasal opening
- Larynx
  - Elevation of larynx to be closed by epiglottis
  - Closure of glottis (vocal cords)
  - Stop of breathing (deglutition apnea)

FUNCTIONAL ANATOMY OF THE RESPIRATORY SYSTEM

A. Lungs (gas exchanging organs)

B. Pump that ventilates the lungs

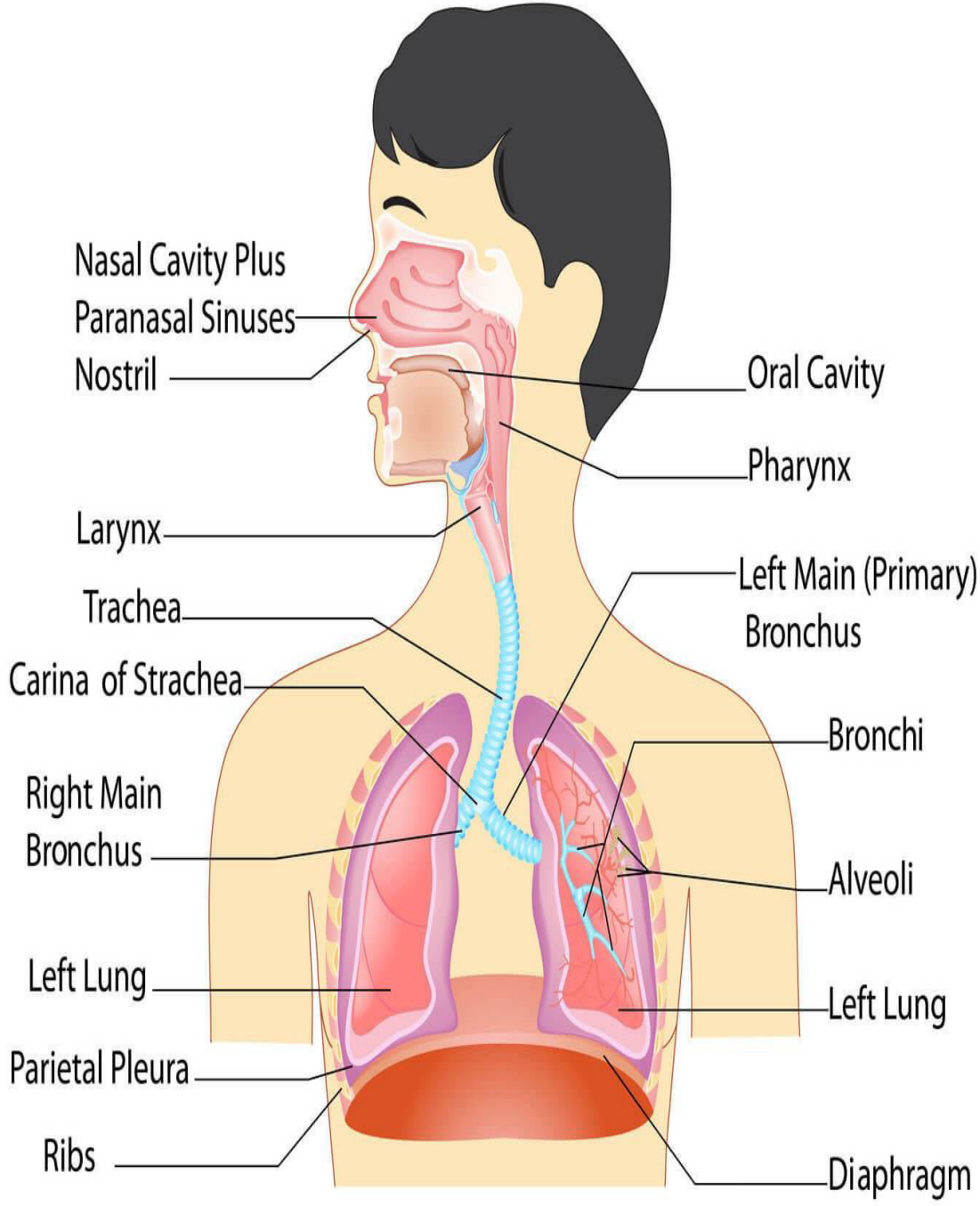
1) Chest wall
2) Respiratory muscles
3) Areas in the brain than control the muscles
4) Tracts and nerves



- **Upper respiratory tract**
  - Nose
  - Mouth
  - Pharynx
  - Larynx
- **Lower respiratory tract**

(Tracheobronchial tree)

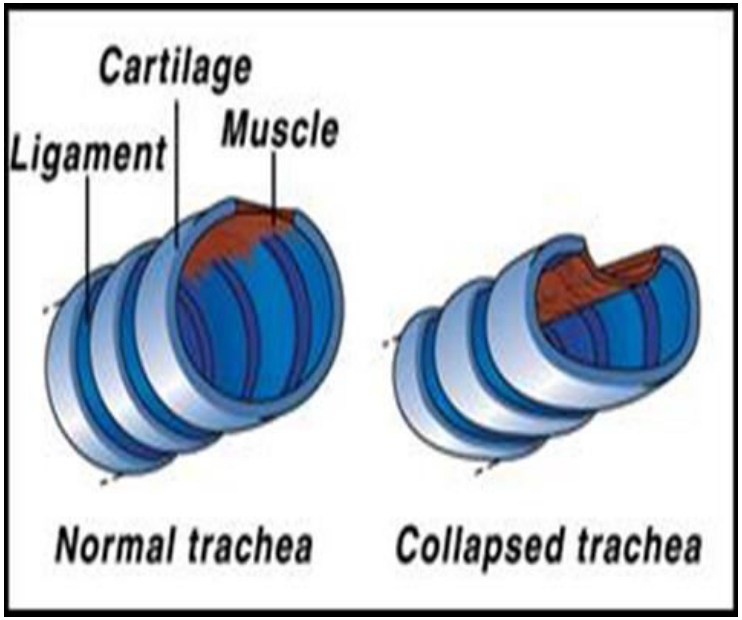
  - Trachea
  - Bronchi
  - Bronchioles
  - Alveoli

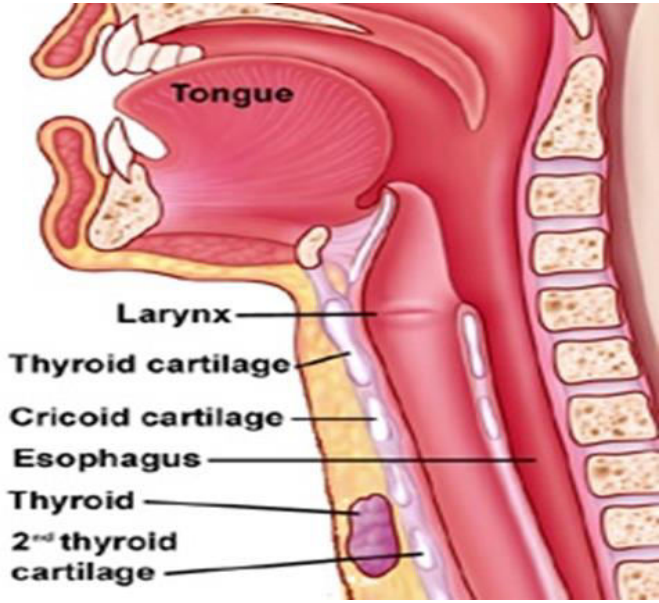


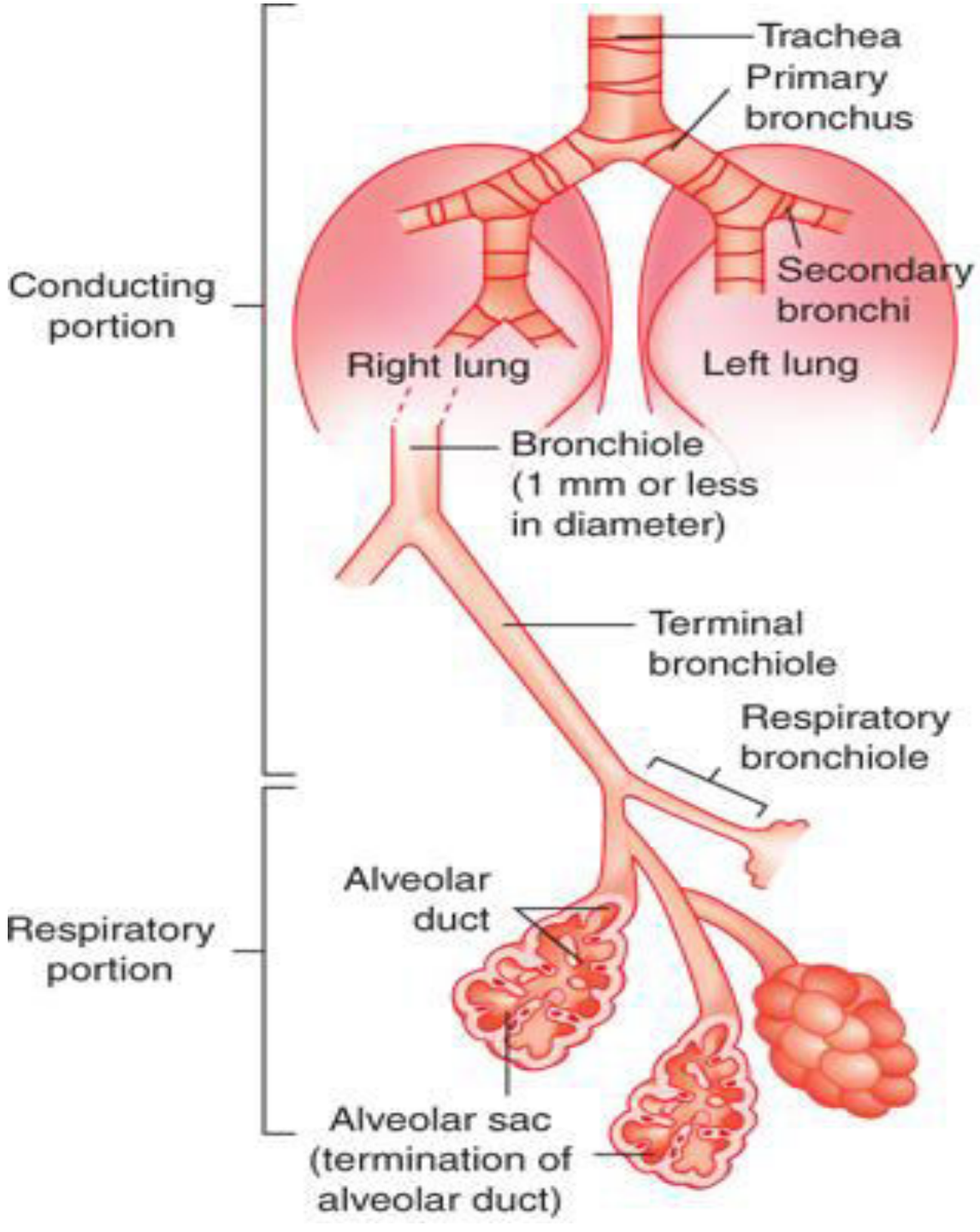
Trachea-bronchial tree

Trachea

- Inner diameter ≈1.5cm
- Length ≈ 11cm
- 15-20 incomplete C-shaped cartilage
  1. The trachealis muscle contracts during coughing →↓lumen of the trachea →↑ rate of air flow
  2. The esophagus lies posteriorly to the trachea. The cartilaginous rings are incomplete to allow the trachea to collapse slightly so that food can pass down the esophagus
- Trachea splits into two primary (main) bronchi

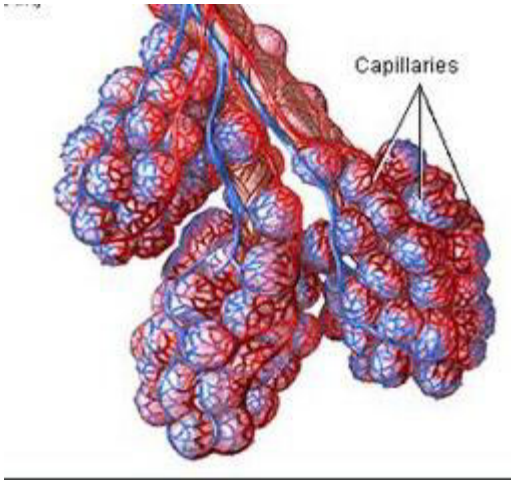




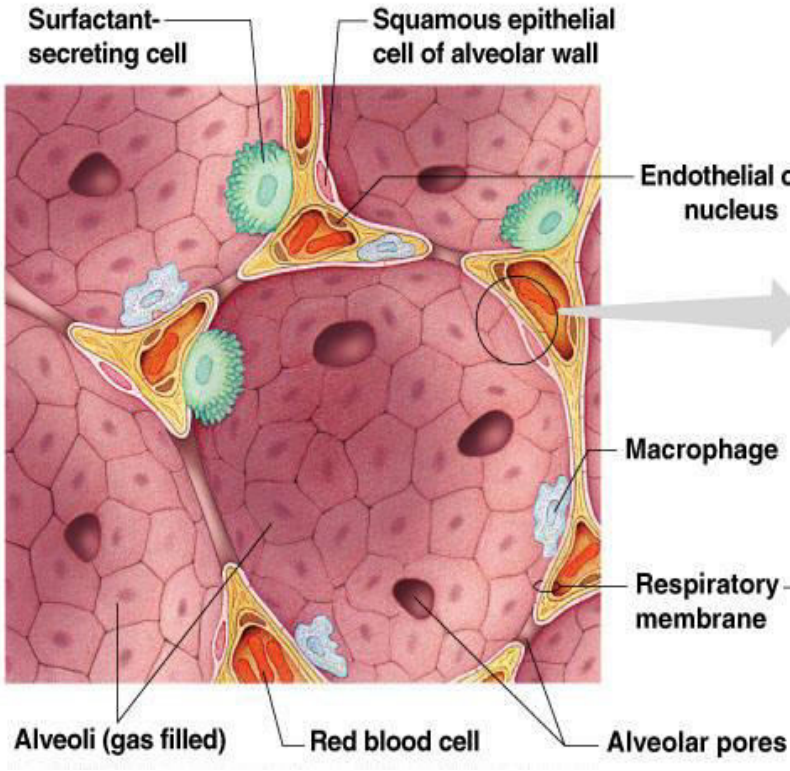

Trachea
Primary bronchus
Secondary bronchi
Right lung
Left lung
Conducting portion
Bronchiole (1 mm or less in diameter)
Terminal bronchiole
Respiratory bronchiole
Alveolar duct
Respiratory portion
Alveolar sac (termination of alveolar duct)

Alveoli

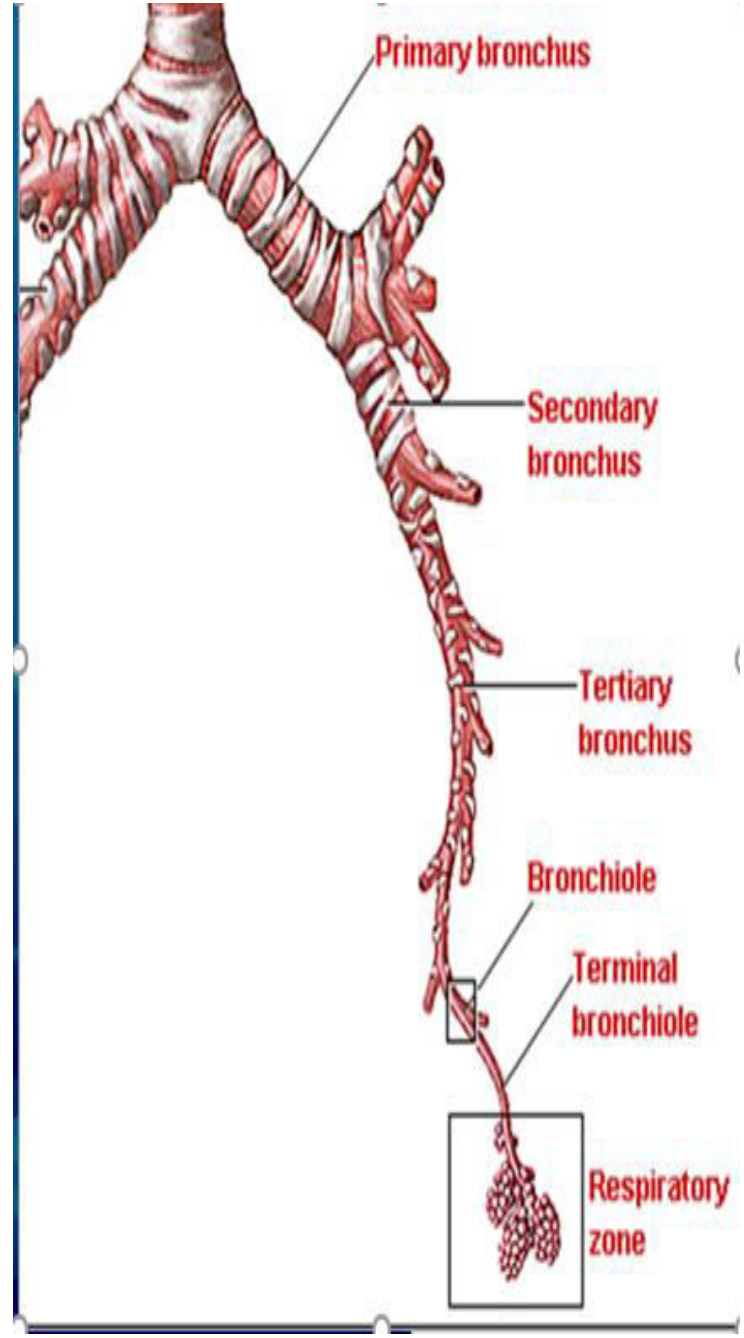
- 300 million alveoli in both lungs
- 70m^2 surface area
- Alveolar diameter =200μm



- Lined by 2 types of epithelial cells
  - ☛ Type I pneumocytes (flat cells) → gas exchange
  - ☛ Type II pneumocytes (granular cells) → secrete surfactant
  - ☛ Other cells (pulmonary alveolar macrophages & mast cells)

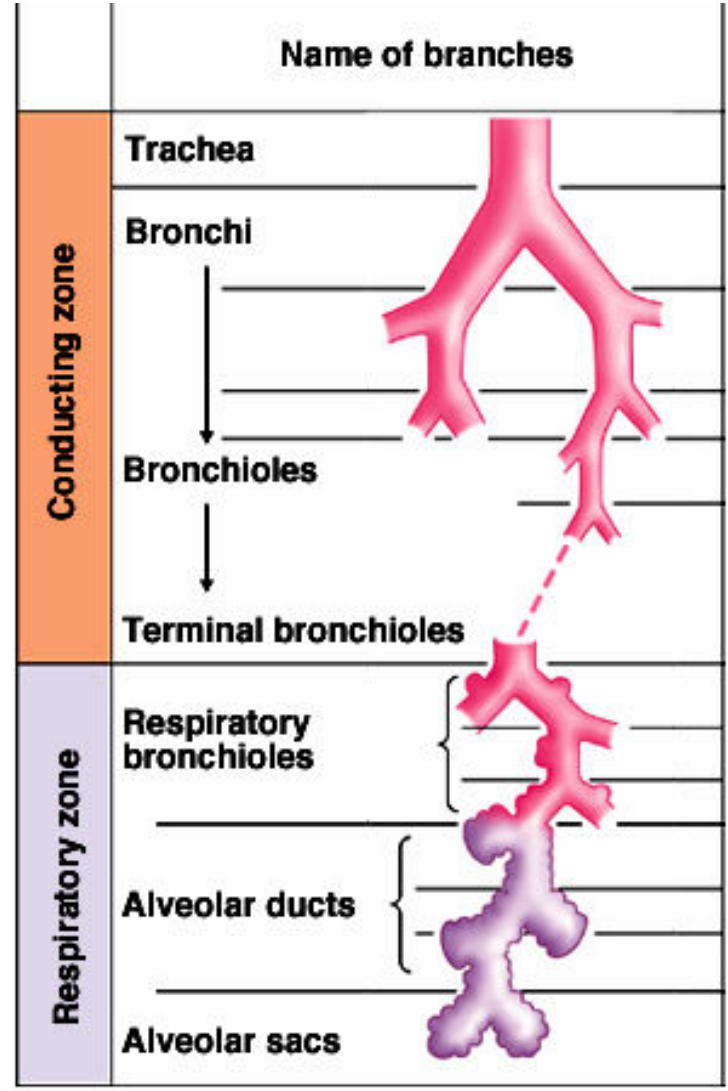


Structure	Cartilage	Glands	Cilia	Smooth muscle
Trachea	Ring	+	+	+
1◦ Bronchi	Ring	+	+	+
2◦ Bronchi	Plate	+	+	+
3◦ Bronchi	Plate	+	+	+
Bronchiole	No	-	+	++
Terminal	No	-	+	+++
Respiratory	No	-	±	++
Alveolar duct	No	-	-	±
Alveolar sac	No	-	-	-



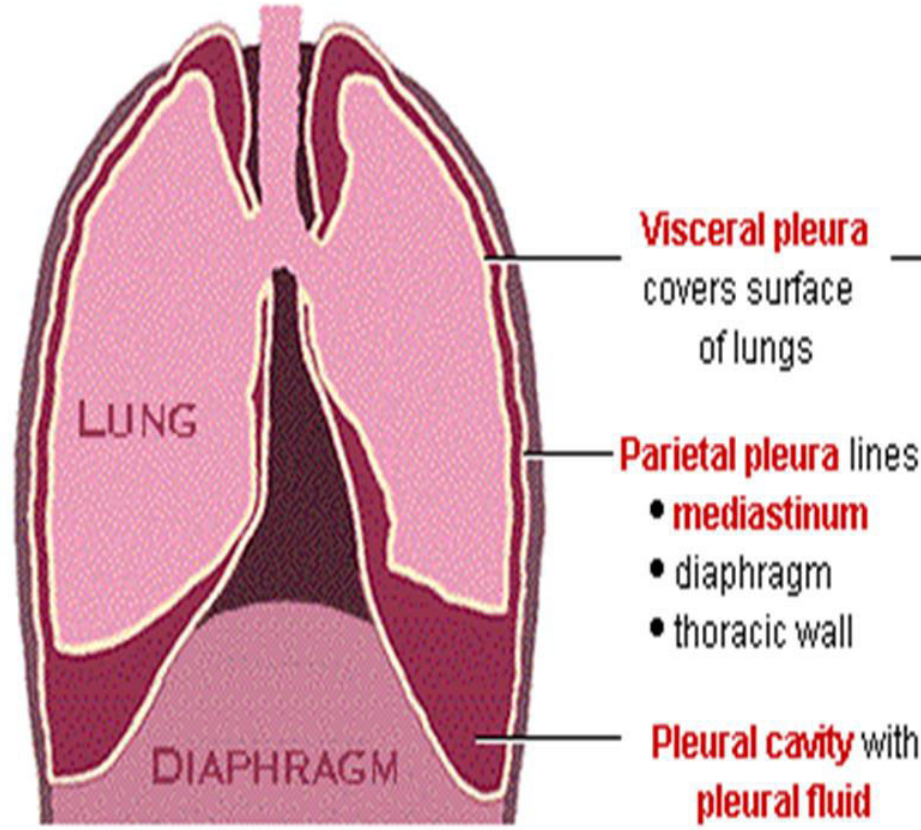
Trachea → alveoli (23 divisions)

Conducting zone (dead space)	Respiratory zone
▪ 1st 16 divisions	▪ Last 7 divisions
▪ End by terminal bronchiole	▪ Begin by respiratory bronchiole
▪ No alveoli	▪ There is alveoli
▪ Function 1. Distribute air to respiratory zone 2. Air conditioning function (warm, humidify and filtering of inspired air)	▪ Function 1. Gas exchange (type 1) 2. Surfactant (type 2) 3. Defensive (alveolar macrophages
▪ Blood supply Systemic circulation (bronchial)	▪ Blood supply Pulmonary circulation



Pleura

- Visceral pleura: covers surface of lungs
- Parietal pleura: lines mediastinum, diaphgram & chest wall
- Pleural cavity contains pleural fluid (few millileters) produced mostly by the parietal pleura and reabsorbed by pulmonary capillaries the lymphatic system



- Functions of pleural Fluid
  1) Pleural fluid keeps the two pleural layers together
  2) Acts as a lubricant and helps in the sliding movements between the two layers

Bronchial tone

1) **Nervous control:** bronchi & bronchioles innervated by

- Autonomic nervous system:
  - Parasympathetic (Ach) → M receptors →bronchoconstriction
  - Sympathetic (noradrenaline) → β2 → bronchodilation
- Non cholinergic non adrenergic innervation (VIP)→ bronchodilation
- Substance P (some nerve ending) → bronchoconstriction

2) Homurol control:

- Histamine and slow reacting substance of anaphylaxis (from mast cells) →↑bronchiolar tone.
- Leukotrienes → bronchoconstriction (Leukotrienes receptors blocker useful in bronchial asthma)

3) Circadian rhythm:

- Maximum constriction at about 6:00AM and maximum dilation at about 6:00PM.

4) Irritants and chemicals

- e.g. sulfur dioxide produces reflex bronchoconstriction

5) Cool air

- Causes bronchoconstriction, exercise also causes bronchoconstriction (increased respiration cools the airways).