



## Unit 2: Anatomy of the Respiratory and Circulatory Systems

### Subject: Human Anatomy

### Unit 2: Anatomy of the Respiratory and Circulatory Systems

(Respiratory System • Organs of the Respiratory Tract • Circulatory System – Structure of the Heart • Major Arteries & Veins with Applied Anatomy)

## 2.1 Respiratory System – Overview and Functions

The **respiratory system** sustains life by exchanging gases between air and blood and by supporting voice and smell. It works as a two-zone conduit:

- **Conducting zone:** nose → pharynx → larynx → trachea → bronchi → terminal bronchioles (warms, filters, humidifies air; no gas exchange).
- **Respiratory zone:** respiratory bronchioles → alveolar ducts → **alveoli** (site of gas exchange across a thin blood-air barrier).

### Core functions

- **Ventilation:** mechanical movement of air by the thoracic pump (diaphragm & intercostals).
- **Gas exchange:** O<sub>2</sub> in, CO<sub>2</sub> out at **alveoli**.
- **Air conditioning & defense:** cilia, mucus, IgA, cough/sneeze reflexes.
- **Phonation:** laryngeal vocal folds.
- **Olfaction:** nasal cavity roof (olfactory epithelium).
- **Acid-base balance:** CO<sub>2</sub> regulation influences blood pH.

## 2.2 Structure of the Organs of the Respiratory Tract

### 2.2.1 Nose & Paranasal Sinuses

- **External nose** with **nares** opens into the **nasal cavity**, divided by a septum (vomer + perpendicular plate + cartilage).
- **Turbinates (conchae):** create turbulence → warming & humidification.
- **Epithelium:** respiratory (ciliated pseudostratified columnar with goblet cells); **olfactory** mucosa at roof.
- **Sinuses:** frontal, ethmoidal, sphenoidal, maxillary—lighten skull, condition air, resonate voice.  
**Applied:** deviated septum, sinusitis, epistaxis; **Jala Neti** (saline rinse) improves nasal hygiene when done correctly.

### 2.2.2 Pharynx (nasopharynx, oropharynx, laryngopharynx)

Muscular tube shared by **respiratory & digestive** systems; houses **tonsils** (immune role).

**Applied:** sleep-disordered breathing (enlarged tonsils), aspiration risks.

### 2.2.3 Larynx (voice box)

- **Cartilages:** single (thyroid, cricoid, epiglottis) and paired (arytenoid, corniculate, cuneiform).
- **Vocal folds:** true (phonation) vs false (vestibular).
- **Muscles & nerves:** intrinsic muscles adjust tension and glottis; chiefly innervated by branches of **vagus nerve** (superior laryngeal & recurrent laryngeal).  
**Applied:** hoarseness (recurrent laryngeal injury), laryngospasm, safe voice use in teaching.

### 2.2.4 Trachea & Bronchial Tree

- **Trachea:** C-shaped hyaline cartilage rings; posterior muscular wall (trachealis); lined by **ciliated respiratory epithelium**.
- Bifurcates at **carina** → **right main bronchus** (shorter, wider, more vertical) & **left main bronchus**.
- Further divides: lobar (secondary) → segmental (tertiary) bronchi → bronchioles → **terminal bronchioles** → **respiratory bronchioles**.

#### Conducting vs respiratory portions

Feature	Conducting	Respiratory
Structures	Nose to terminal bronchioles	Respiratory bronchioles → alveoli
Epithelium trend	Ciliated → simple cuboidal	Simple squamous (Type I pneumocytes)
Function	Air conditioning & defense	Gas exchange

### 2.2.5 Lungs, Pleura & Segments

- **Right lung:** 3 lobes (upper, middle, lower); **Left lung:** 2 lobes + lingula.
- **Pleura:** visceral (on lung) & parietal (lining thoracic wall) with **pleural cavity** (thin fluid film).
- **Bronchopulmonary segments (surgical units):** pyramidal, each with its own segmental bronchus & artery; disease can be localized/resected by segments.

### 2.2.6 Alveoli & the Blood-Air Barrier

- **Alveolar wall cells:**
  - **Type I pneumocytes:** thin squamous; gas diffusion.
  - **Type II pneumocytes:** produce **surfactant** (reduces surface tension, prevents collapse).
  - **Alveolar macrophages:** phagocytosis.
- **Blood-air barrier:** surfactant → Type I cell → fused basement membrane → capillary endothelium.

**Applied:** neonatal respiratory distress (surfactant deficiency), pneumonia (alveolar exudate), pulmonary edema (thickened barrier).

### 2.2.7 Pulmonary & Bronchial Circulation; Lymph & Nerves

- **Pulmonary arteries** carry **deoxygenated** blood from right ventricle → capillaries around alveoli → **pulmonary veins** return **oxygenated** blood to left atrium.
  - **Bronchial arteries** (from aorta) nourish airway walls; bronchial veins drain partly to azygos system.
  - **Lymphatics:** superficial & deep networks → hilar nodes → tracheobronchial nodes.
  - **Innervation:**
    - **Parasympathetic (vagus):** bronchoconstriction, mucus ↑.
    - **Sympathetic:** bronchodilation, mucus ↓.
- Applied:** asthma (bronchoconstriction & inflammation) responds to bronchodilators and controlled breathing techniques.

### 2.2.8 Mechanics of Breathing

- **Primary muscle: diaphragm** (domes descend → thoracic volume ↑).
- **External intercostals:** elevate ribs (inspiration).
- **Internal intercostals (interosseous):** forced expiration.
- **Accessory inspiratory muscles:** sternocleidomastoid, scalenes (in distress or effort).

Phase	What happens	Energy
Quiet inspiration	Diaphragm contracts; ribs elevate	Active
Quiet expiration	Elastic recoil of lungs & chest wall	Passive
Forced expiration	Abdominals + internal intercostals	Active



**Yoga/clinical link: diaphragmatic (abdominal) breathing** improves lower-lobe ventilation, reduces accessory neck muscle overuse, supports vagal tone. Avoid prolonged breath-holds in **uncontrolled hypertension, cardiac disease, glaucoma**.

## 2.3 Circulatory System — Structure of the Heart

### 2.3.1 Position & Coverings

- **Location:** mediastinum; 2/3 left of midline; apex at 5th left intercostal space, mid-clavicular line.
- **Pericardium: fibrous** (outer) + **serous** (parietal & visceral/epicardium).

### 2.3.2 Layers of the Heart Wall

**Epicardium** (visceral pericardium) → **Myocardium** (cardiac muscle; thickest) → **Endocardium** (endothelium + CT).

### 2.3.3 Chambers, Valves & Flow

- **Right atrium** (from SVC/IVC/coronary sinus) → **tricuspid valve** → **right ventricle** → **pulmonary valve** → pulmonary trunk/arteries.
- **Left atrium** (from pulmonary veins) → **mitral valve** → **left ventricle** → **aortic valve** → aorta.
- **Chordae tendineae** + **papillary muscles** prevent AV valve prolapse.

**Heart sounds: S1** (AV valves close; start systole), **S2** (semilunar close; start diastole).

**Murmurs** = turbulent flow (e.g., regurgitation/stenosis).

### 2.3.4 Conduction System

**SA node** (pacemaker, RA) → **AV node** (delay) → **Bundle of His** → **right & left bundle branches** → **Purkinje fibers** (ventricular depolarization).

**Autonomics:** sympathetic ↑ rate & force; parasympathetic (vagus) ↓ rate.

### 2.3.5 Coronary Circulation

- **Right coronary artery (RCA):** SA nodal branch (often), right marginal, **posterior interventricular** (PDA in right-dominant hearts).
- **Left coronary artery (LCA):** **LAD** (anterior interventricular) & **circumflex**.
- **Venous drainage:** great/middle/small cardiac veins → **coronary sinus** → RA.

**Applied:** LAD occlusion = “widow-maker” myocardial infarction; angina (ischemia), revascularization options.

### 2.3.6 Cardiac Cycle (overview)

- **Diastole:** ventricular filling (passive → atrial kick); AV valves open.
- **Systole:** isovolumetric contraction → ejection; semilunar valves open.
- **Stroke volume (SV) × Heart rate (HR) = Cardiac output (CO).**

**Practitioner note:** avoid intense **kumbhaka** or strong **bandhas** in unstable cardiac conditions; favor gentle, paced breathing and low-intensity movement with medical clearance.

## 2.4 Major Arteries and Veins of the Body — with Applied Anatomy

## 2.4.1 Arterial Tree (high-yield map)

### Aorta

- **Ascending aorta** → coronary arteries.
- **Arch of aorta** →
  1. **Brachiocephalic trunk** → right common carotid & right subclavian,
  2. **Left common carotid**,
  3. **Left subclavian**.
- **Thoracic aorta:** intercostals, bronchial, esophageal branches.
- **Abdominal aorta:**
  - **Unpaired viscera:** Celiac trunk (foregut), **SMA** (midgut), **IMA** (hindgut).
  - **Paired:** renal, suprarenal, gonadal, lumbar.
  - Ends as **common iliac** arteries → **external iliac** (→ femoral) & **internal iliac** (pelvic).

**Upper limb pathway:** subclavian → axillary → brachial (→ radial & ulnar).

**Lower limb pathway:** external iliac → femoral → popliteal → anterior tibial (→ dorsalis pedis) & posterior tibial (→ plantar).

### Palpable pulse points (exam & clinic)

Site	Artery	Note
Neck	<b>Carotid</b>	Palpate one side at a time
Arm	<b>Brachial</b>	BP cuff placement (mid-arm, artery alignment)
Wrist	<b>Radial</b>	Common pulse check; <b>Allen test</b> before cannulation
Groin	<b>Femoral</b>	Central pulse; hemorrhage control
Knee	<b>Popliteal</b>	Deep; knee slightly flexed
Ankle/Foot	<b>Posterior tibial, Dorsalis pedis</b>	Peripheral vascular check (diabetes)

## 2.4.2 Venous System (deep vs superficial; key conduits)

- **Superior vena cava (SVC):** returns blood from head, neck, upper limbs, thorax; formed by **brachiocephalic** veins (internal jugular + subclavian). **Azygos** drains thoracic wall to SVC.
- **Inferior vena cava (IVC):** returns from abdomen, pelvis, lower limbs; tributaries include **common iliac, renal, hepatic** veins.

**Portal system:** portal vein = splenic + superior mesenteric; carries nutrient-rich blood to liver → hepatic veins → IVC.

**Porto-systemic anastomoses:** esophageal, umbilical, rectal (varices risk in portal hypertension).

### Superficial veins of clinical use

- **Upper limb:** cephalic, basilic, median cubital (common venipuncture).
- **Lower limb:** great saphenous (medial; graft source), small saphenous (posterior calf).  
**Applied:** varicose veins (valve failure), **DVT** (calf pain, swelling; risk → pulmonary embolism); early mobilization, calf pumps, hydration help prevention.

## 2.5 Integrated Applied Anatomy — From Lab to Mat

- **Breathing practice:** prioritize **diaphragmatic** & **long exhale** patterns to mobilize lower ribs and favor vagal tone. Avoid strong breath retentions in uncontrolled **hypertension/ischemia**.
- **Posture & lungs:** upright/seated postures improve **functional residual capacity** vs prolonged slumped sitting; gentle thoracic extension aids ventilation.
- **Pulse/BP skills:** know **radial** (routine), **brachial** (BP), and **carotid** (emergency) pulse sites; correct cuff size &



placement prevent false readings.

- **Vascular care:** during long sessions, encourage **ankle pumps** and **walking breaks** in at-risk participants to reduce venous stasis.

## Unit Summary

The **respiratory system** conducts, conditions, and exchanges gases: air travels from nose to alveoli, where a microscopic **blood-air barrier** enables O<sub>2</sub>-CO<sub>2</sub> exchange. Mechanics depend on the **diaphragm, intercostals**, chest wall, and lung elasticity. The **heart**—a valved, four-chambered pump with its own conduction and coronary blood supply—drives circulation. From the **aorta** flow the great arteries; blood returns via the **caval** and **portal** systems, supported by deep and superficial veins. Applied understanding guides safe breathing practices, accurate pulse/BP assessment, and vascular health during yoga and community work.

## Key Terms

- **Conducting zone / Respiratory zone** • **Alveolus (Type I/II), Surfactant**
- **Pleura (visceral/parietal)** • **Diaphragm** • **Bronchoconstriction/Bronchodilation**
- **Pericardium (fibrous/serous)** • **SA/AV node, Purkinje** • **Coronary arteries (RCA, LCA, LAD, Circumflex)**
- **Systole/Diastole, S1/S2** • **Aorta (arch branches, abdominal branches)**
- **SVC/IVC** • **Portal vein & porto-systemic anastomoses** • **DVT, Varicose veins**
- **Pulse sites** • **Allen test** • **Functional residual capacity**

## Self-Assessment

### MCQs

1. **Surfactant** is produced by:  
a) Type I pneumocytes   b) Type II pneumocytes   c) Alveolar macrophages   d) Goblet cells
2. The **right main bronchus** is:  
a) Longer and narrower   b) Shorter, wider, more vertical   c) Longer and more horizontal   d) Absent in many people
3. **S1** corresponds to closure of:  
a) Aortic & pulmonary valves   b) Mitral & tricuspid valves   c) Only aortic valve   d) Only mitral valve
4. The **widow-maker** infarct typically involves the:  
a) Circumflex artery   b) Right marginal artery   c) LAD (anterior interventricular)   d) Posterior interventricular artery
5. **Great saphenous vein** drains into the:  
a) Popliteal vein   b) Femoral vein   c) External iliac vein   d) IVC directly

**Answer key:** 1-b, 2-b, 3-b, 4-c, 5-b

### Short Answer

1. Trace the airflow from **nares to alveoli** and name two defenses that condition/clean the air.
2. Describe the **blood-air barrier** and explain why edema impairs gas exchange.
3. Sketch the pathway of blood through the **heart** starting from the SVC/IVC to the aorta, naming all valves.
4. List the **arch of aorta** branches and two **abdominal aorta** unpaired branches with their territories.
5. Name **four pulse points** and one clinical use for each.



### Reflective/Application

1. In a seated breathing practice, place one hand on the **upper chest** and one on the **abdomen**. Describe how the movement changes when you shift to **diaphragmatic breathing**. How does your perceived calm change after 3 minutes?
  2. During community screening, you palpate a **weak dorsalis pedis** pulse on one side. What **history questions** and **follow-up checks** will you perform next?
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*End of Unit 2: Anatomy of the Respiratory and Circulatory Systems*

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