

KARACHI EDU

CLASS 10 BIOLOGY NOTES • SINDH TEXTBOOK BOARD

Chapter 1: Gaseous Exchange

Complete Board Exam Lecture Notes • Plant Stomata • Human Respiratory System • Breathing Mechanics • Cellular Gas Exchange & Disorders

Targeted for BISE Karachi, Sukkur, Hyderabad & Sindh Board Examinations

Photosynthesis vs. Respiration

Photosynthesis

Anabolic Process: Synthesizes glucose from inorganic inputs.

Gas Exchange: Absorbs CO_2 gas and releases O_2 by-product.

Timing: Occurs strictly during daytime under sunlight.

Requirement: Requires chlorophyll pigment in autotrophs.

Respiration

Catabolic Process: Breaks down organic food to liberate ATP.

Gas Exchange: Absorbs O_2 gas and releases CO_2 waste.

Timing: Continuous process occurring 24/7 in all living cells.

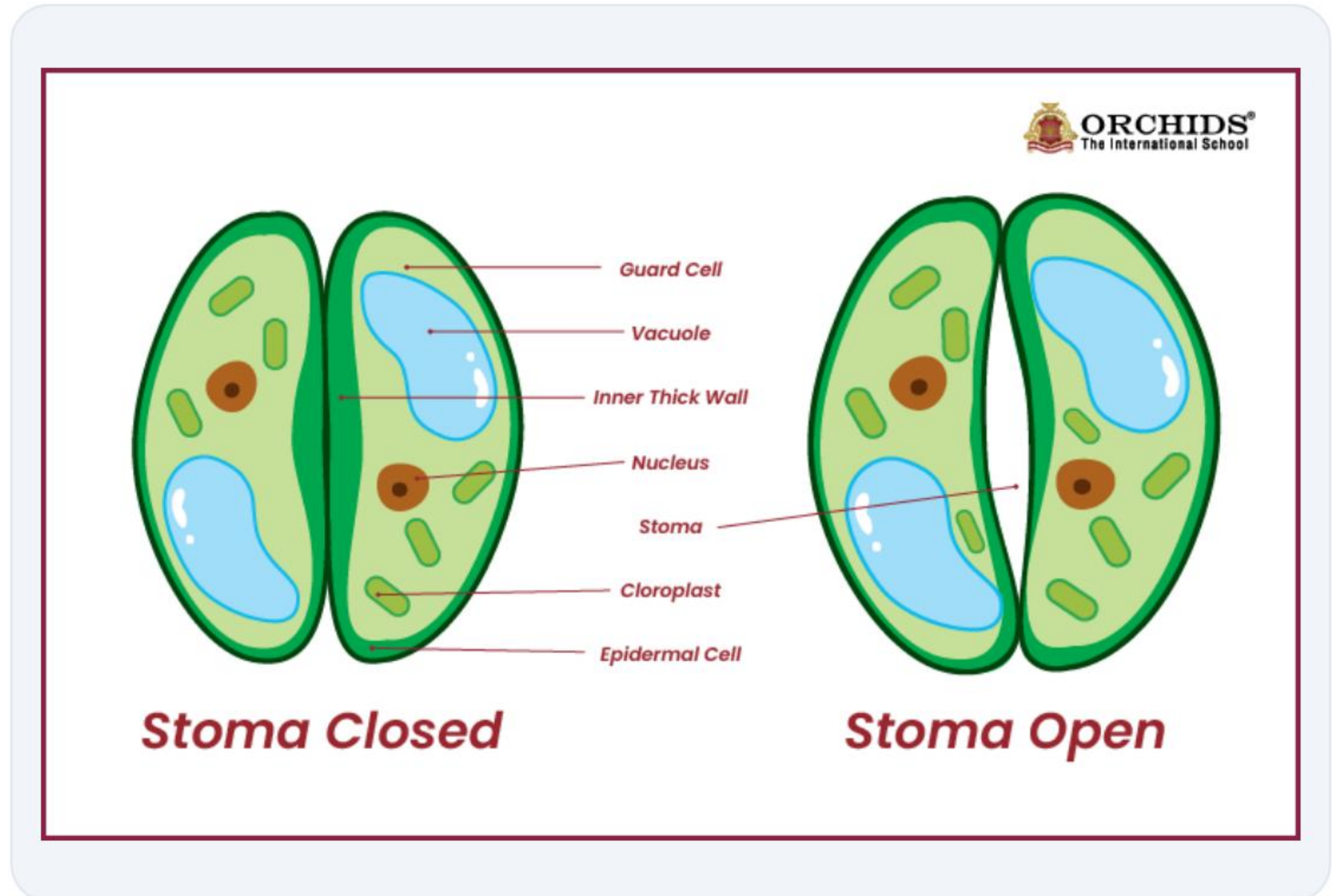
Requirement: Independent of chlorophyll and light energy.

Stomata Structure & Guard Cell Dynamics

Guard Cell Turgidity

Inner cell walls are thick and inelastic, while outer walls are thin and elastic. Daytime solute accumulation creates osmotic turgor pressure.

- ✓ **Stomatal Opening (Day):** High photosynthetic solutes $\rightarrow$ water enters guard cells $\rightarrow$ cells swell outward $\rightarrow$ pore opens.
- ✓ **Stomatal Closing (Night):** Solute levels drop $\rightarrow$ guard cells lose water $\rightarrow$ flaccid state seals the pore.
- ✓ **Alternative Pathways:** Roots exchange gases with soil air spaces; woody stems exchange via lenticels.



Respiratory Media & Surface Adaptations

Respiratory Media Comparison

Terrestrial air contains **21% molecular oxygen**, whereas aquatic water contains only **5% dissolved oxygen**, requiring efficient gills or high ventilation rates.

Essential Surface Properties

Must be **Thin** (rapid diffusion path), **Moist/Wet** (gas solution phase), **Permeable** (unrestricted molecular passage), and **Highly Vascularized**.

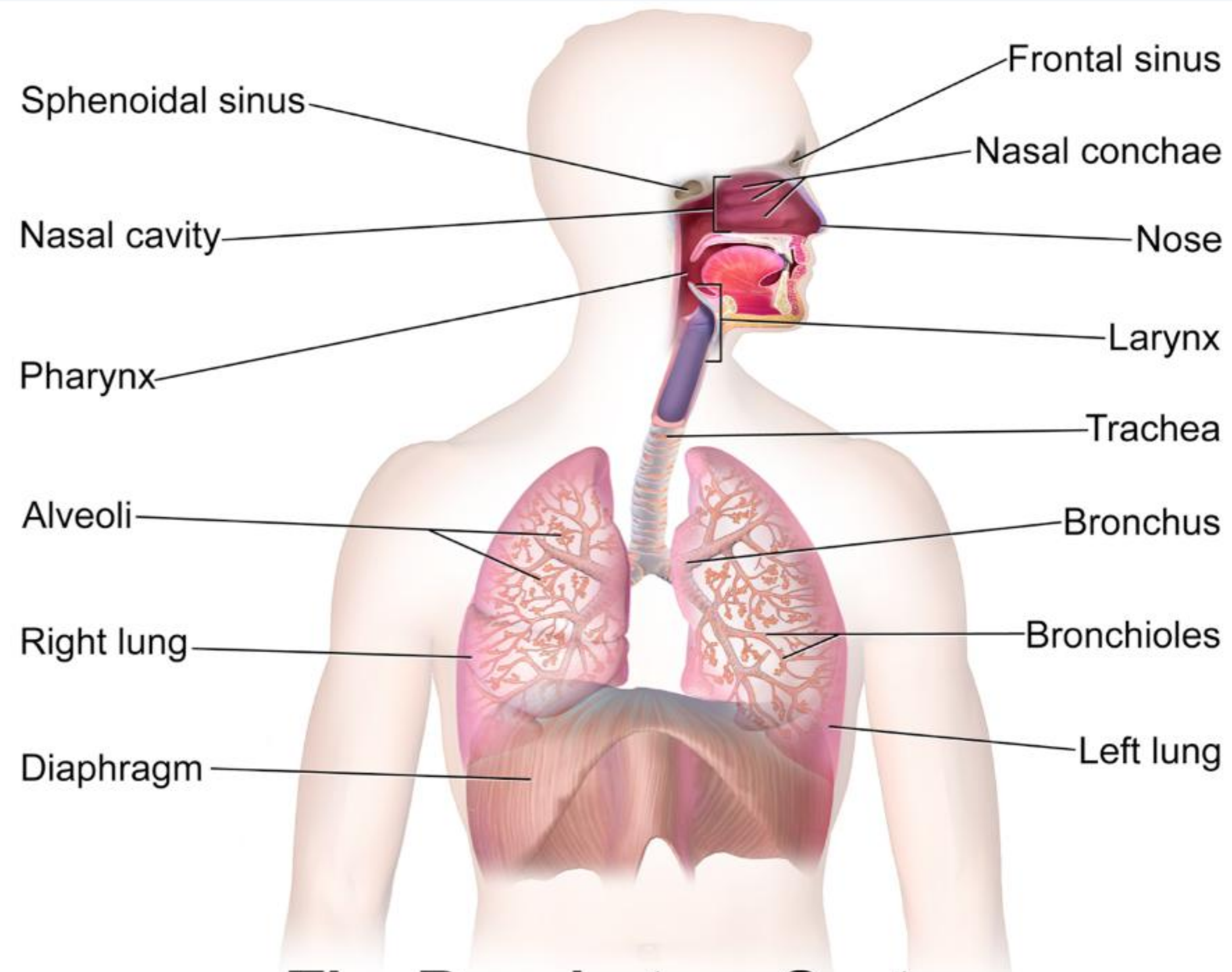
Surface Area Proportion

Respiratory surface area must compensate for small surface-area-to-volume ratio in complex bodies. In humans, alveolar surface is **20 times larger than total body surface area**.

Evolutionary Adaptations

Unicellular Protozoa utilize plasma membrane diffusion directly. Multicellular organisms evolve specialized internal lungs or external branchial gills.

Human Respiratory System & Thoracic Cage



The Respiratory System

Anatomical Lungs & Pleural Cavity

Paired spongy, pinkish organs wrapped in double-layered **Pleural Membranes**. Interstitial pleural fluid lubricates breathing movements and prevents mechanical friction.

Thoracic Protection: Enclosed by flat sternum anteriorly, 12 pairs of ribs, intercostal muscles, and vertebral column posteriorly.

Diaphragm: Dome-shaped muscular sheet separating thoracic cavity from abdominal cavity.

Alveolar Units: Lungs house millions of microscopic, single-cell thick alveolar air sacs surrounded by capillary nets.

1.4.1 CONDUCTIVE PATHWAY

Sequential Pathway of Inhaled Air

STEP 1

Nasal Cavity

External nostrils open into nasal sacs lined by mucous-secreting ciliated cells & blood capillaries to warm, moisten, and filter dust/germs.

STEP 2

Pharynx & Larynx

Passage to voice box (larynx). Glottis opening guarded by leaf-like flap **Epiglottis** to prevent food entry during swallowing.

STEP 3

Trachea (Windpipe)

Tubular structure supported by **C-shaped cartilaginous rings** that prevent tracheal collapse during negative thoracic pressure.

STEP 4

Bronchi & Bronchioles

Trachea bifurcates into right & left primary bronchi. Inside lungs, bronchi divide into narrow, cartilage-free **Bronchioles**.

STEP 5

Alveolar Sacs

Terminal bronchioles culminate in pouch-like **Alveoli**—the primary functional site of gaseous diffusion into capillaries.

1.4.2 BREATHING MECHANICS

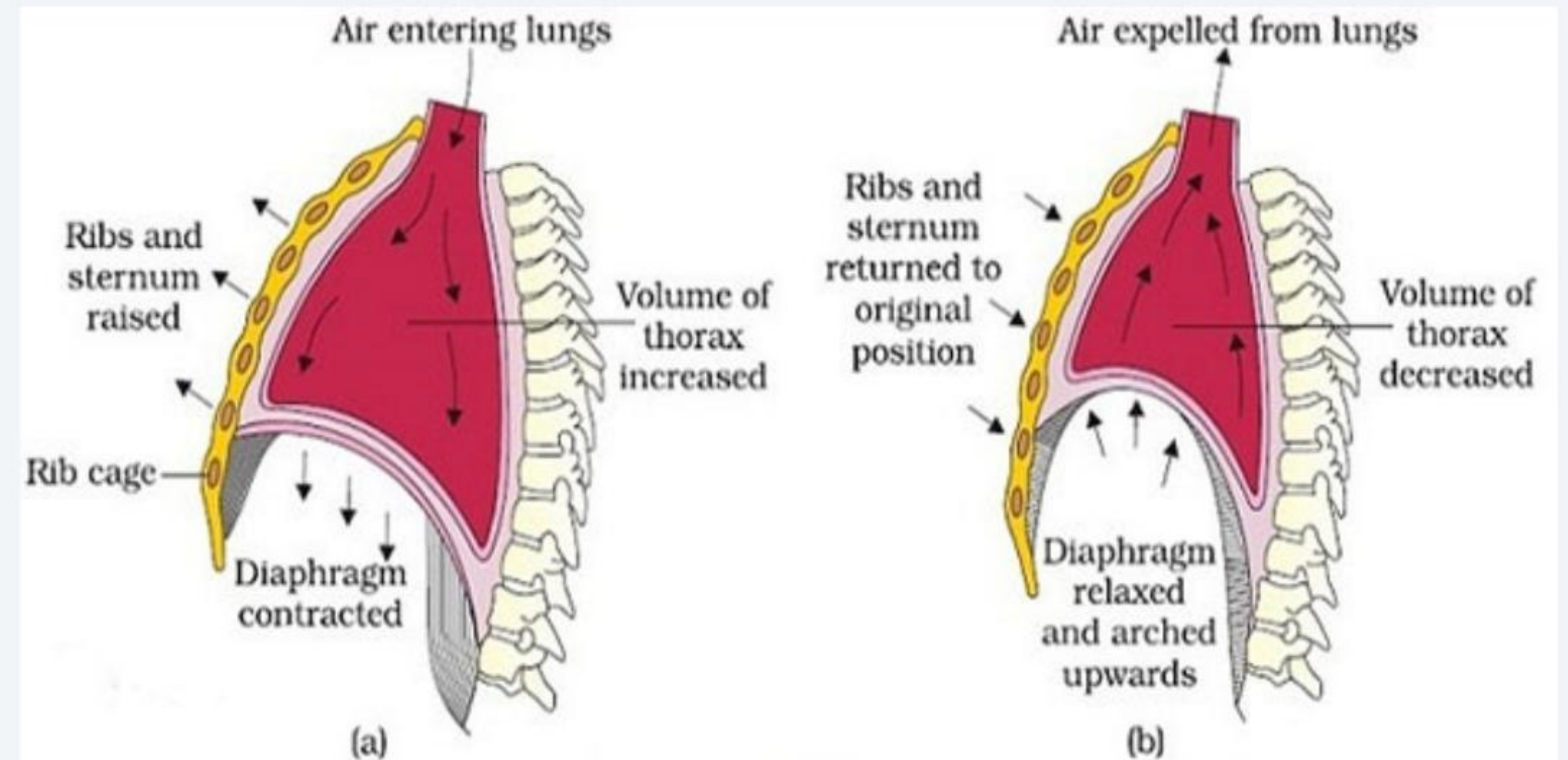
Ventilation: Inspiration vs. Expiration

Inspiration (Inhalation) — Active Phase

Intercostal muscles contract (ribs move up & out) + Diaphragm contracts (flattens dome down) $\rightarrow$ Thoracic volume increases $\rightarrow$ Internal lung pressure drops below atmospheric level $\rightarrow$ External air rushes in.

Expiration (Exhalation) — Passive Phase

Intercostals & Diaphragm relax $\rightarrow$ Ribs move in & down, diaphragm returns to dome shape $\rightarrow$ Thoracic volume decreases $\rightarrow$ Intrapulmonary pressure increases $\rightarrow$ Air forced outwards.



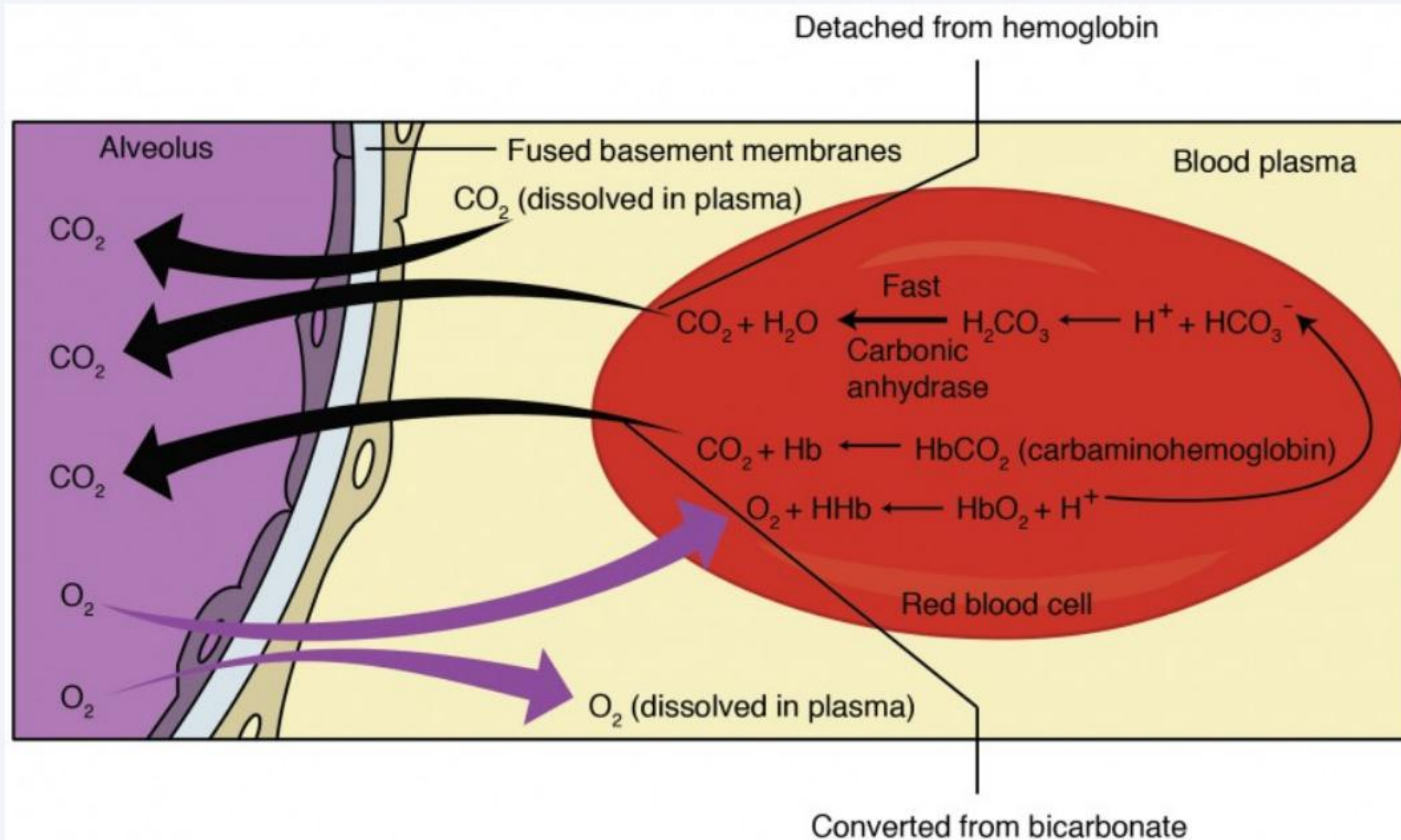
Mechanism of Breathing

a. Inspiration

b. Expiration

1.5 DIFFUSION DYNAMICS

Alveolar Diffusion & Hemoglobin Binding



Single-Cell Diffusion Barrier

Both alveolar epithelial membrane and capillary endothelial membrane are only **one cell thick**, creating a minimal diffusion pathway ($\approx 0.5 \mu m$).

Oxygen Uptake: High partial pressure of O_2 in alveoli diffuses across membranes into blood plasma, binding with RBC **Hemoglobin** to form Oxyhemoglobin.

CO_2 Clearance: High concentration of metabolic CO_2 brought in venous blood diffuses down concentration gradient into alveolar lumen to be exhaled.

Inspired vs. Expired Air Composition

Gas Component	Inspired Air (%)	Expired Air (%)
Oxygen (O_2)	About 21%	About 16%
Carbon Dioxide (CO_2)	About 0.03%	About 4.0%
Nitrogen (N_2)	About 79%	About 79% (Unchanged)
Water Vapour	Variable	Saturated
Temperature	Atmospheric	Body Temp ($37^{\circ}C$)



Limewater Demonstration

Blowing exhaled air into clear Limewater $[Ca(OH)_2]$ turns it **milky white** rapidly due to $CaCO_3$ precipitation. Air pumped with a syringe takes significantly longer, proving higher CO_2 concentration in exhaled breath.

Major Respiratory Disorders

1. Bronchitis

Inflammation of bronchial pathways caused by bacterial infection or smoking. Characterized by excessive mucous secretion, severe cough, low fever, and airway constriction.

2. Emphysema

Progressive destruction of alveolar walls due to long-term pollutant exposure. Reduces total surface area for diffusion, causing laborious breathing and phlegm production.

3. Pneumonia

Infectious inflammation of alveoli (bacterial/viral/fungal). Alveolar sacs fill with fluid or pus, triggering high fever, chills, sharp chest pain, and severe breathlessness.

4. Asthma

Allergic inflammatory response of airways triggered by pollens, dust, feathers, or smoke. Causes sudden bronchial spasms, severe wheezing during exhalation, and dyspnea.

Lung Cancer & Global Pollution Burden

7 Million

Premature deaths annually due to household & outdoor air pollution globally.

Lung Cancer Etiology & Clinical Signs

Associated strongly with tobacco smoking and industrial carcinogens. Uncontrolled, abnormal cellular proliferation in pulmonary tissues metastasizes to surrounding structures.

Primary Symptoms: Persistent hemoptysis (coughing blood), chest pain, rapid weight loss, hoarseness, bone aches, and chronic weakness.

Chapter 1 Key Board Exam Review Points

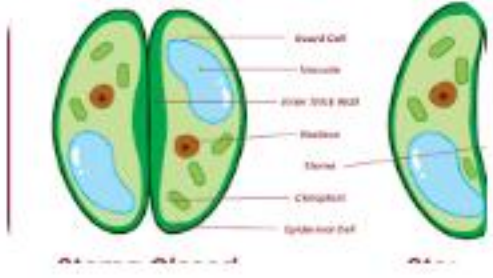
 **Plants:** Stomata exchange gases (CO_2/O_2).
Turgidity in guard cells controls opening and closing.

 **Respiratory Surface:** Must be thin, moist, permeable, and have a large surface area (e.g. Alveoli).

 **Inspiration vs Expiration:** Driven by thoracic pressure changes via intercostals and diaphragm.

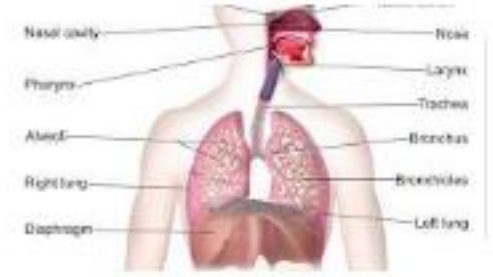
 **Pathology:** Bronchitis (airway inflammation), Emphysema (wall breakdown), Pneumonia (pus/fluid), Asthma (allergy).

Image Sources



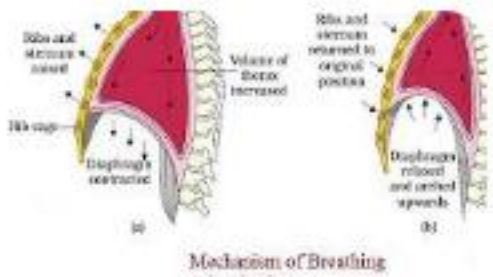
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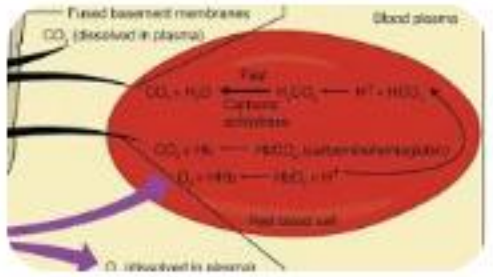
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