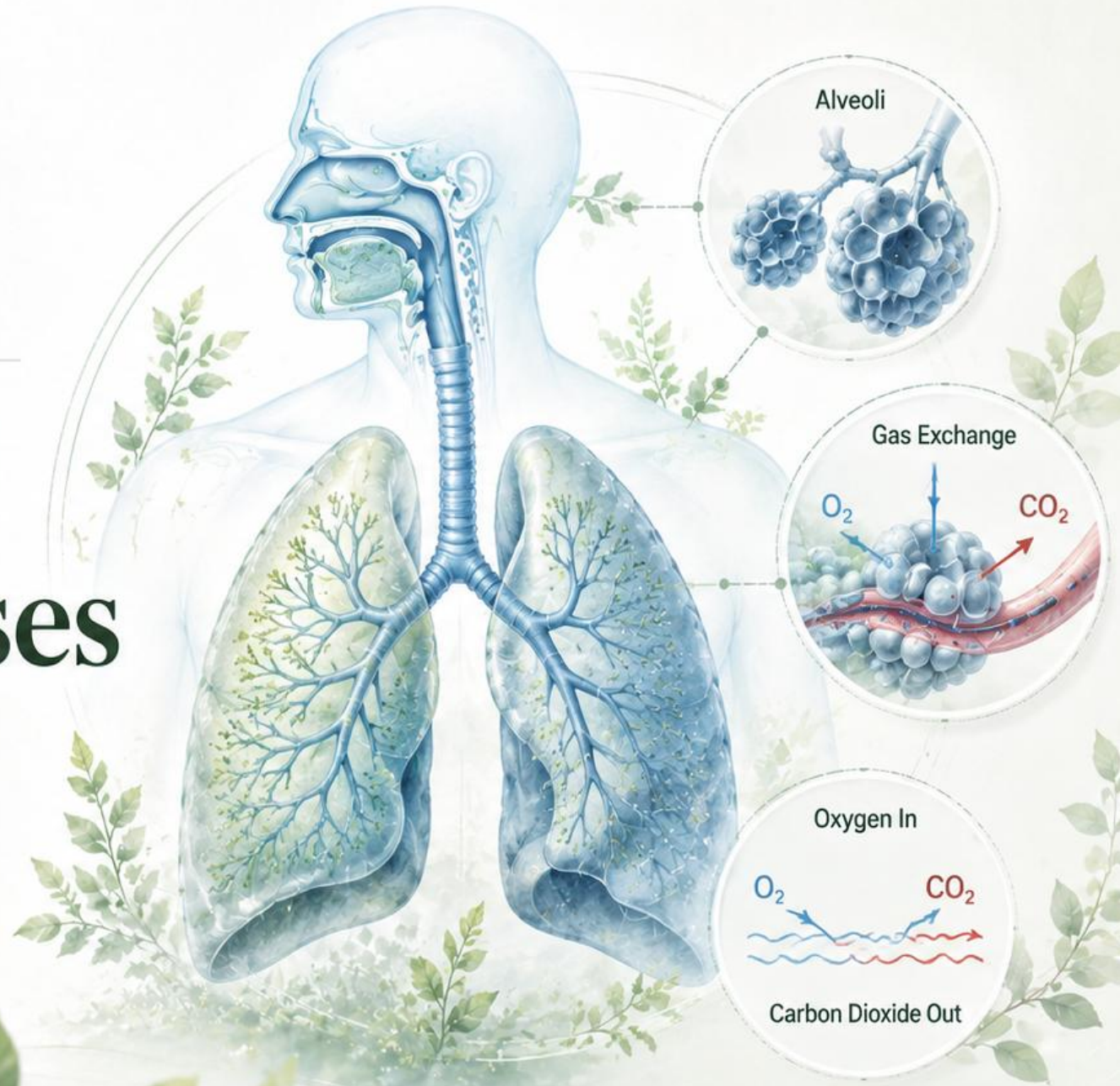


Chapter 14 : Breathing and Exchange of Gases

Biology Notes | Class 11



RESPIRATION: PURPOSE & FIVE LINKED STAGES

STAGES 1-3

Cells require a continuous supply of O_2 for aerobic metabolism. During catabolic reactions, CO_2 is produced as a waste product and is continuously removed.

* BREATHING / PULMONARY VENTILATION = movement of air between atmosphere and lungs.

* CELLULAR RESPIRATION = enzyme-controlled intracellular oxidation that uses O_2 and releases energy, CO_2 and H_2O .

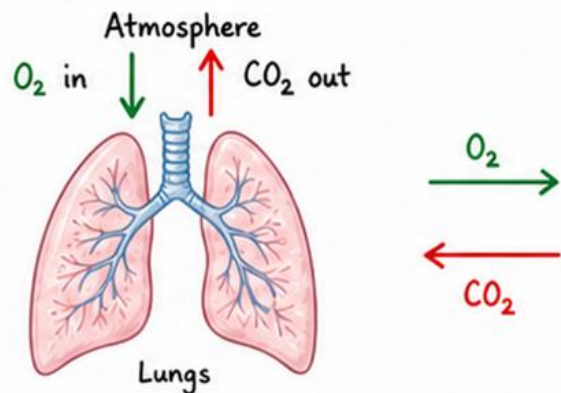
OVERALL DIRECTION OF GASES

O_2 : atmosphere $\rightarrow$ alveoli $\rightarrow$ blood
 $\rightarrow$ tissues $\rightarrow$ cells

CO_2 : cells $\rightarrow$ tissues/blood $\rightarrow$ alveoli
 $\rightarrow$ atmosphere

① VENTILATION

Atmospheric air enters and leaves lungs by ventilation.



LOCATION

Nose / mouth, trachea, bronchi, lungs

INPUT / OUTPUT

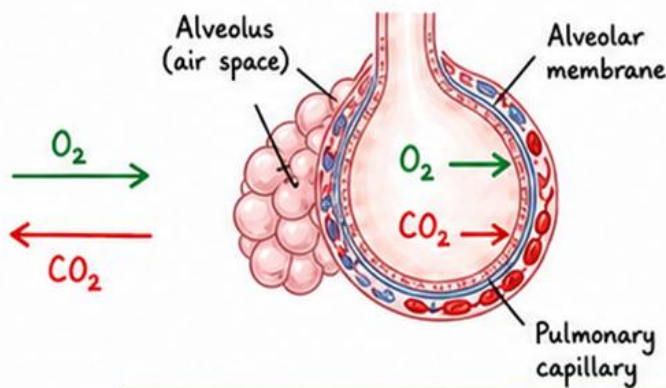
Input: Air (O_2)
 Output: Air (CO_2)

BIOLOGICAL SIGNIFICANCE

Brings O_2 to alveoli and removes CO_2 from lungs.

② GAS EXCHANGE AT ALVEOLI

O_2 and CO_2 diffuse across the alveolar membrane.



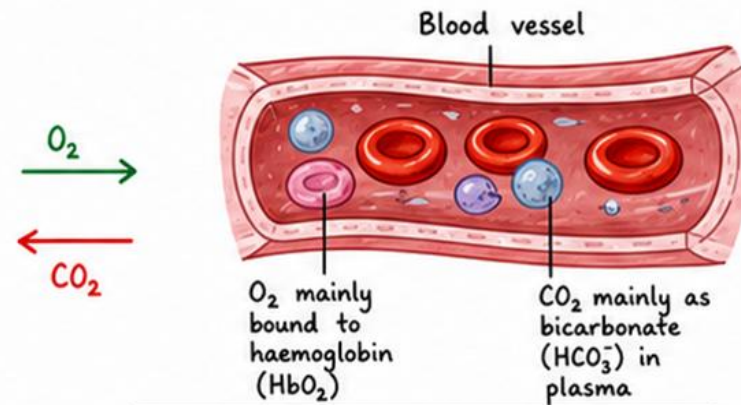
Alveoli and pulmonary capillaries

Input: O_2 (from alveoli)
 Output: CO_2 (to alveoli)

O_2 enters blood; CO_2 enters alveoli for elimination.

③ TRANSPORT IN BLOOD

Blood transports respiratory gases between lungs and tissues.



Blood and cardiovascular system

Input: O_2 (from lungs)
 Output: CO_2 (from tissues)

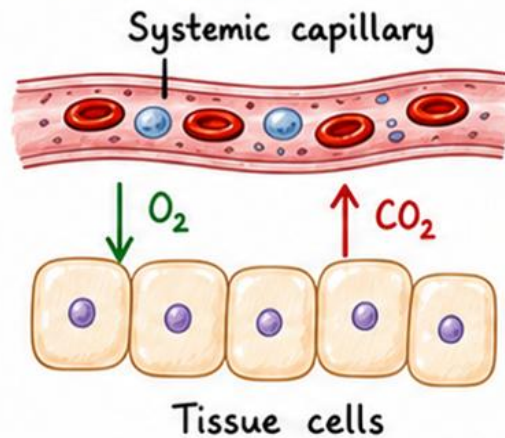
Distributes O_2 to tissues and carries CO_2 back to lungs.

RESPIRATION: PURPOSE & FIVE LINKED STAGES

STAGES 4-5

④ GAS EXCHANGE AT TISSUES

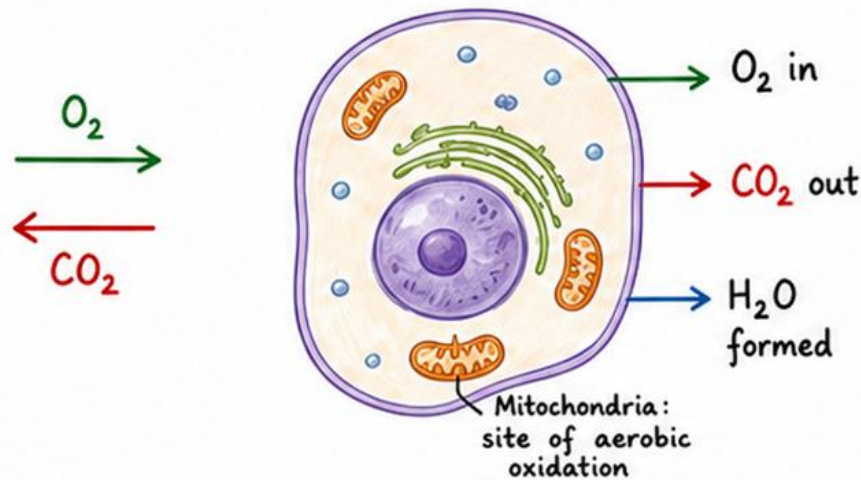
Gases diffuse between systemic blood and tissue fluid.



LOCATION	Systemic capillaries and tissue fluid
INPUT/OUTPUT	Input: O_2 (from blood) Output: CO_2 (to blood)
BIOLOGICAL SIGNIFICANCE	Delivers O_2 to cells; removes CO_2 from tissues.

⑤ CELLULAR RESPIRATION

Cells utilise O_2 in aerobic metabolism and produce CO_2 (and H_2O).



LOCATION	Cells (mitochondria inside cytoplasm)
INPUT/OUTPUT	Input: O_2 Output: CO_2 , H_2O , Energy
BIOLOGICAL SIGNIFICANCE	Releases energy (ATP) for life processes; CO_2 and H_2O are by-products.

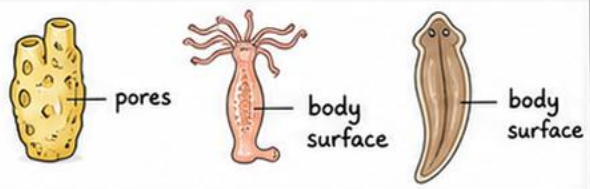
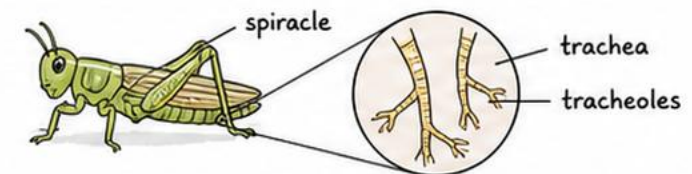
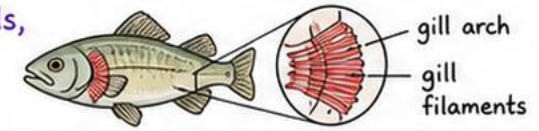
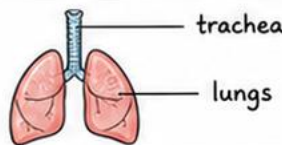
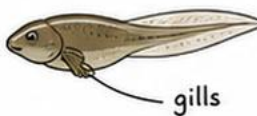
OVERALL DIRECTION OF GASES

O_2 : atmosphere $\rightarrow$ alveoli $\rightarrow$ blood $\rightarrow$ tissues $\rightarrow$ cells

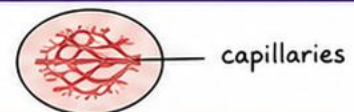
CO_2 : cells $\rightarrow$ tissues/blood $\rightarrow$ alveoli $\rightarrow$ atmosphere

Aerobic cellular respiration (overall): $C_6H_{12}O_6 + 6 O_2 \rightarrow 6 CO_2 + 6 H_2O + \text{Energy (ATP)}$ Occurs continuously in living cells.

RESPIRATORY ORGANS ACROSS ANIMALS

REPRESENTATIVE ANIMAL	RESPIRATORY SURFACE / ORGAN	MEDIUM OR HABITAT	TRANSPORT ROUTE
Sponges, Cnidarians / Coelenterates and Flatworms 	Body-surface diffusion Gases diffuse across the thin, moist body surface.	Mostly aquatic (shallow water forms)	Gases diffuse directly between environment and cells. No specialised transport system.
Earthworm 	Moist cuticle Gases diffuse through the moist skin.	Terrestrial (in moist soil)	Gases diffuse into capillaries in the skin. Carried by blood.
Insects 	Tracheal-tube system Air enters through spiracles and travels in tracheae and tracheoles to reach cells near tissues.	Terrestrial (air)	Air reaches body cells directly through tracheoles. Blood is not the main O₂ carrier.
Most aquatic arthropods, molluscs and fishes 	Gills Gases diffuse across thin, moist gill filaments.	Aquatic	Gases diffuse into capillaries in gills. Carried by blood.
Terrestrial vertebrates including reptiles, birds and mammals 	Lungs Gases diffuse across thin, moist alveolar (air-sac) walls.	Terrestrial (air)	Gases diffuse into capillaries around alveoli. Carried by blood.
Amphibians (Frog) Larval stage (tadpole)  Adult stage 	Larval stage: Gills Adult stage: Lungs and moist skin	Both aquatic and terrestrial	Larval stage: Gases diffuse into capillaries in gills. Carried by blood. Adult stage: Gases diffuse in lungs and moist skin into capillaries. Carried by blood.

- Effective respiratory structures are thin, moist and sufficiently exposed to the respiratory medium. When blood carries gases, these surfaces are richly vascularised (have many blood capillaries).



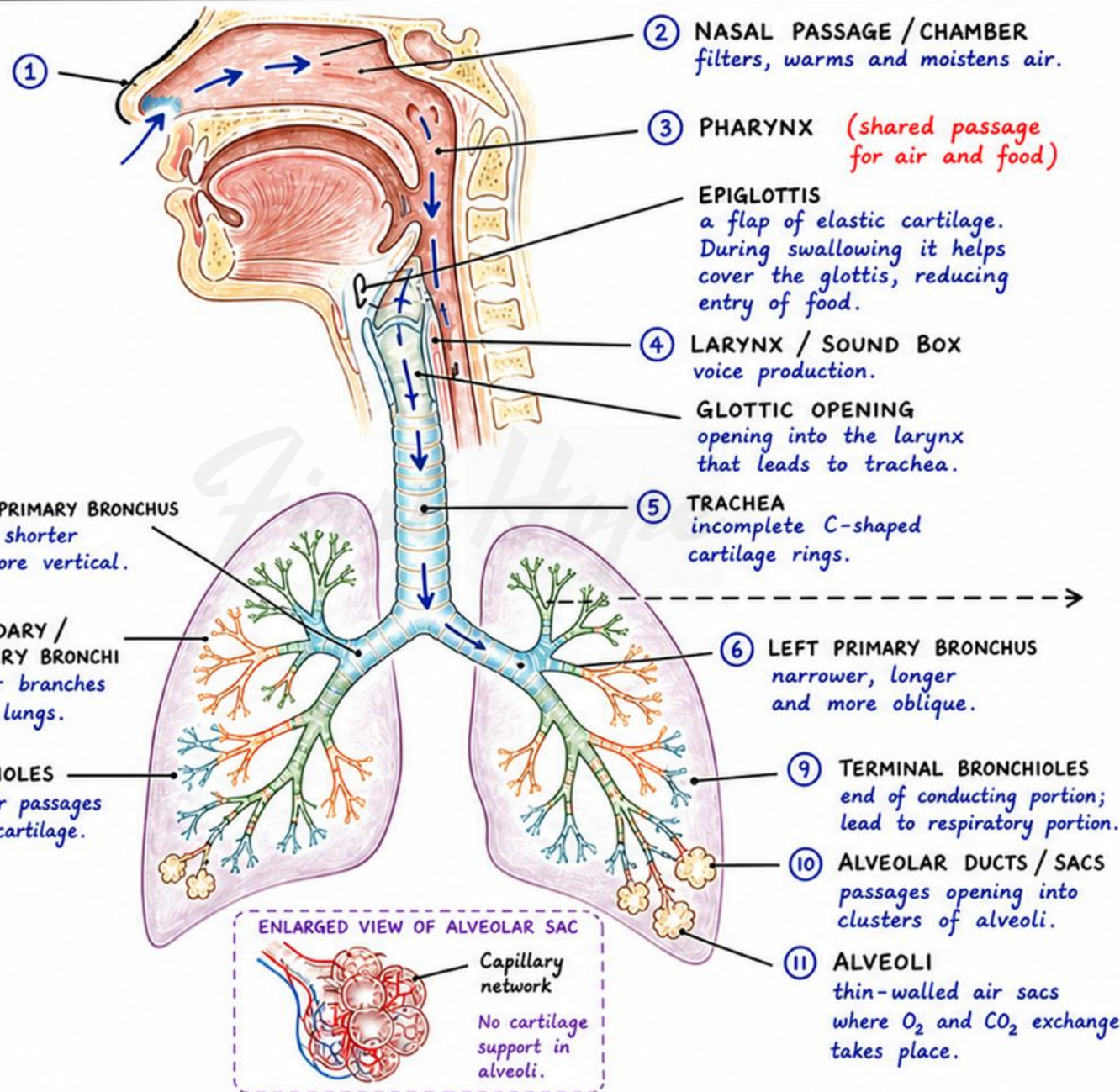
HUMAN RESPIRATORY PASSAGE

Path of inspired air

- ① **EXTERNAL NOSTRILS**
openings to the outside.
- ② **NASAL PASSAGE / CHAMBER**
filters, warms and moistens air.
- ③ **PHARYNX**
shared passage for air and food.
- ④ **LARYNX / SOUND BOX**
voice production.
Contains the glottic opening.
- ⑤ **TRACHEA**
windpipe; conducts air to the bronchi.
- ⑥ **RIGHT & LEFT PRIMARY BRONCHI**
one to each lung.
- ⑦ **SECONDARY / TERTIARY BRONCHI**
further branches within lungs.
- ⑧ **BRONCHIOLES**
small air passages without cartilage.
- ⑨ **TERMINAL BRONCHIOLES**
end of conducting portion.
- ⑩ **ALVEOLAR DUCTS / SACS**
lead to clusters of alveoli.
- ⑪ **ALVEOLI**
sites of gaseous exchange.

IMPORTANT NOTE

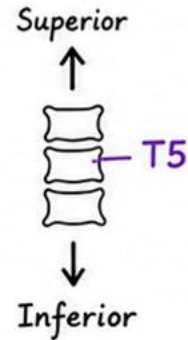
Trachea and larger bronchi have incomplete cartilage rings (C-shaped) for support. Cartilage support is absent from terminal exchange surfaces and alveoli.



LEGEND

- Path of inspired air
- Conducting portion (1 - 9)
- Respiratory portion (10 - 11)

TRACHEAL BIFURCATION
occurs near vertebral level T5.



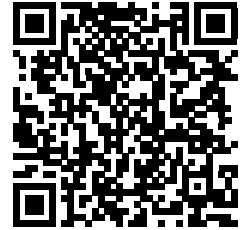


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