FREE NOTES · NCERT + NEET LEVEL

Breathing & Exchange of Gases

Respiratory organs, human respiratory system, mechanism of breathing, respiratory volumes and capacities, exchange and transport of gases, regulation of respiration and disorders.

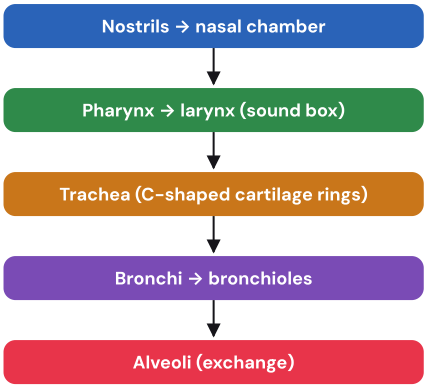
01 Respiratory organs
02 Human respiratory system
03 Mechanism of breathing
04 Respiratory volumes and capacities
05 Exchange and transport of gases
06 Regulation and disorders
07 Extra + tricks
08 Important Q&A
09 Common mistakes
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11 Quick revision

01 Respiratory organs

- Simple diffusion over body surface: sponges, coelenterates, flatworms. Moist cuticle: earthworm. **Tracheal tubes**: insects. **Gills**: most aquatic arthropods, molluscs, fishes (branchial). **Lungs**: terrestrial (pulmonary). Amphibians (frog) also use moist skin (cutaneous).

02 Human respiratory system

- Larynx = cartilaginous sound box; **epiglottis** (elastic cartilage flap) prevents food entering larynx.
- Trachea divides at 5th thoracic vertebra into right and left bronchi; trachea to initial bronchioles supported by incomplete cartilaginous rings.
- **Alveoli**: thin, irregular-walled, vascularised bag-like; exchange site. Lungs covered by double-layered **pleura** with pleural fluid (reduces friction).
- Conducting part (nostrils to terminal bronchioles: filter, warm, humidify air) and exchange part (alveoli and their ducts).
- Thoracic chamber: vertebral column dorsally, sternum ventrally, ribs laterally, dome-shaped **diaphragm** below; air-tight.



Path of air

03 Mechanism of breathing

Step	Inspiration (active)	Expiration (normally passive)
Diaphragm	Contracts, flattens	Relaxes, dome shape
External intercostal muscles	Contract: ribs and sternum lift up	Relax
Thoracic volume	Increases (dorso-ventral + antero-posterior)	Decreases
Intra-pulmonary pressure	Below atmospheric ⇒ air rushes in	Above atmospheric ⇒ air goes out

Abdominal muscles help increase the strength of breathing. Healthy human: 12–16 breaths per minute; measured by **spirometer**.

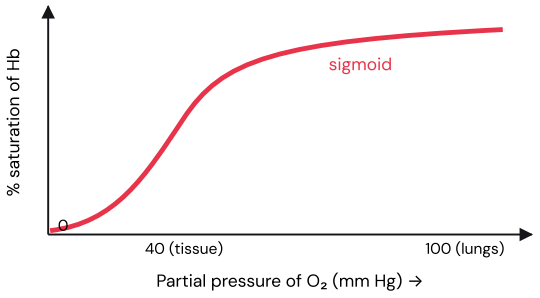
04 Respiratory volumes and capacities

Term	Meaning	Value
Tidal volume (TV)	Air in/out in normal breath	~500 mL (6000–8000 mL/min)
IRV	Extra air inspired forcibly	2500–3000 mL
ERV	Extra air expired forcibly	1000–1100 mL
Residual volume (RV)	Air left after forcible expiration	1100–1200 mL
Inspiratory capacity	TV + IRV	
Expiratory capacity	TV + ERV	
FRC	ERV + RV	
Vital capacity (VC)	ERV + TV + IRV (max after forced inspiration)	
Total lung capacity	VC + RV	

05 Exchange and transport of gases

mm Hg	Air	Alveoli	Deoxy blood	Oxy blood	Tissues
pO_2	159	104	40	95	40
pCO_2	0.3	40	45	40	45

- CO_2 solubility is 20–25 times that of O_2. Diffusion membrane: alveolar squamous epithelium + basement membrane + capillary endothelium (<1 mm total).
- O_2: ~97% by RBC as oxyhaemoglobin, 3% in plasma. Each Hb carries up to 4 O_2. Every 100 mL oxygenated blood gives ~5 mL O_2 to tissues.
- CO_2: 20–25% as carbamino-haemoglobin, ~70% as bicarbonate (carbonic anhydrase), ~7% dissolved. 100 mL deoxygenated blood gives ~4 mL CO_2 to alveoli.
- Low pO_2, high pCO_2, high H^+, high temperature (tissues) favour O_2 release: curve shifts right.



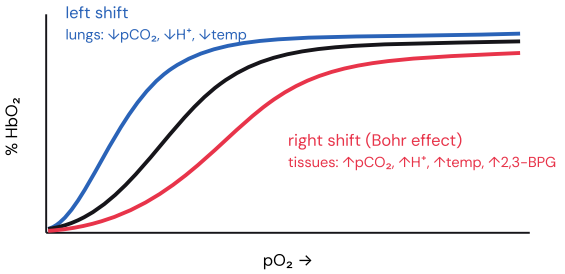
Oxygen dissociation curve

06 Regulation and disorders

- **Respiratory rhythm centre** in medulla; **pneumotaxic centre** in pons moderates it (shortens inspiration, raises rate). Chemosensitive area next to rhythm centre responds to CO_2 and H^+. Receptors in aortic arch and carotid artery. O_2 role is insignificant.
- **Asthma**: inflammation of bronchi/bronchioles, wheezing. **Emphysema**: alveolar walls damaged, less surface area; cigarette smoking a major cause. **Occupational disorders**: dust in grinding/stone-breaking ⇒ fibrosis (silicosis, asbestosis); protective masks needed.

07 Extra + tricks

- **Bohr effect**: high pCO_2 / H^+ lowers Hb's affinity for O_2 ⇒ O_2 released in tissues (right shift).
- **Haldane effect**: oxygenation of Hb in lungs releases CO_2 (and H^+).
- **Chloride shift** (Hamburger phenomenon): HCO_3^- leaves RBC to plasma; Cl^- enters RBC to keep electrical neutrality.
- Respiratory organs: skin (earthworm, frog), tracheae (insects), book lungs (scorpion, spider), book gills (*Limulus*), gills (fish, crustaceans), ctenidia (molluscs), lungs (reptiles, birds, mammals).
- Trick for capacities: every **capacity** = sum of two or more **volumes**.



Shifts of the O_2 dissociation curve

08 Important Q&A

Q1. Why is expiration normally passive?

It occurs by relaxation of diaphragm and intercostal muscles, which reduces thoracic volume; no active muscle contraction is needed in quiet breathing.

Q2. Calculate vital capacity if TV 500, IRV 2500, ERV 1000 mL.

VC = 500 + 2500 + 1000 = 4000 mL.

Q3. In which form is most CO_2 transported?

As bicarbonate (~70%), formed by carbonic anhydrase in RBC.

09 Common mistakes

- Including residual volume in vital capacity.
- Saying O_2 level mainly controls breathing (CO_2 and H^+ do).
- Writing pO_2 of alveoli as 159 (that is air; alveoli 104).
- Thinking trachea rings are complete circles (C-shaped).

10 Practice (NEET style)

1. Centre moderating respiratory rhythm?
2. Approx. tidal volume?
3. Enzyme forming bicarbonate?
4. Disease with damaged alveolar walls?
5. pO_2 in tissues?

ANSWERS

1) Pneumotaxic (pons) · 2) 500 mL · 3) Carbonic anhydrase · 4) Emphysema · 5) 40 mm Hg

11 Quick revision: 5 minutes before the exam

BREATHING

- Inspiration: diaphragm contracts
- Pressure below atmospheric

VOLUMES

- TV 500, IRV 2500–3000
- ERV 1000–1100, RV 1100–1200
- VC = TV+IRV+ERV

TRANSPORT

- O_2 97% as HbO_2
- CO_2 70% bicarbonate
- Curve sigmoid

CONTROL/DISORDERS

- Medulla rhythm, pons pneumotaxic
- Asthma, emphysema

Have a doubt? Ask the AI Doubt Solver at padhaiadda.netlify.app, or take the mock test on this chapter.