

# Breathing and Exchange of Gases — NEET MCQs with Solutions

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**Q1. Respiration in fishes primarily occurs through:**

- (A) Lungs
- (B) Skin
- (C) Tracheae
- (D) Gills

**Q2. External nostrils in humans open into the:**

- (A) Pharynx
- (B) Larynx
- (C) Nasal chamber
- (D) Trachea

**Q3. The double-layered membrane surrounding each lung is called the pleura. The fluid between its two layers primarily functions to:**

- (A) Supply  $O_2$  to lung tissue
- (B) Prevent pleural infection
- (C) Reduce friction during breathing movements
- (D) Maintain lung temperature

**Q4. The ciliated epithelium lining the nasal chamber primarily helps in:**

- (A) Warming inspired air
- (B) Lubricating the nasal mucosa
- (C) Trapping and removing dust particles via mucociliary action
- (D) Producing surfactant for nasal passages

**Q5. Which structure marks the beginning of the respiratory zone in the human respiratory tract?**

- (A) Terminal bronchioles
- (B) Respiratory bronchioles
- (C) Alveolar sacs
- (D) Tracheal bifurcation

**Q6. In the bronchial tree, primary bronchi divide to form secondary bronchi, which further divide to form:**

- (A) Bronchioles directly
- (B) Alveolar ducts
- (C) Tertiary bronchi
- (D) Terminal bronchioles

**Q7. During inspiration, the ribs move in which direction?**

- (A) Downward and inward
- (B) Upward and outward
- (C) Downward and outward
- (D) Inward and backward

**Q8. The movement of air into and out of lungs is specifically termed:**

- (A) External respiration
- (B) Pulmonary ventilation
- (C) Cellular respiration
- (D) Internal respiration

**Q9. During forced inspiration, which accessory muscles are recruited in addition to the diaphragm and external intercostals?**

- (A) Internal intercostals and abdominal muscles
- (B) Smooth muscle of bronchioles
- (C) Alveolar muscles contracting to expand sacs
- (D) Sternocleidomastoid and scalene muscles

**Q10. Forced expiration involves contraction of:**

- (A) Diaphragm and external intercostals
- (B) Internal intercostal muscles and abdominal muscles
- (C) External intercostal muscles only
- (D) Diaphragm and external intercostals together

**Q11. The partial pressure of carbon dioxide in deoxygenated blood reaching the lungs is approximately:**

- (A) 40 mm Hg
- (B) 95 mm Hg
- (C) 104 mm Hg
- (D) 45 mm Hg

**Q12. At the pulmonary capillaries, carbon dioxide diffuses from:**

- (A) Alveolar air into blood
- (B) Tissues directly into alveoli
- (C) Blood into tissues
- (D) Blood into alveolar air

**Q13. CO<sub>2</sub> diffuses across the respiratory membrane approximately 20-25 times faster than O<sub>2</sub> despite a smaller partial pressure gradient. The primary reason is:**

- (A) CO<sub>2</sub> molecules are smaller than O<sub>2</sub> molecules
- (B) CO<sub>2</sub> is actively transported across alveolar epithelium
- (C) CO<sub>2</sub> has higher molecular weight, slowing diffusion less
- (D) CO<sub>2</sub> is about 20-25 times more soluble in the aqueous layers of the respiratory membrane than O<sub>2</sub>

**Q14. Approximately what percentage of carbon dioxide is transported as bicarbonate ions in plasma?**

- (A) 7%
- (B) 23%
- (C) 70%
- (D) 97%

**Q15. During the chloride shift, as bicarbonate ions move out of the RBC into plasma, which ion moves inward to maintain electrochemical neutrality?**

- (A) Sodium (Na<sup>+</sup>)
- (B) Chloride (Cl<sup>-</sup>)
- (C) Potassium (K<sup>+</sup>)
- (D) Hydrogen (H<sup>+</sup>)

**Q16. Which of the following best explains why the oxygen-haemoglobin dissociation curve is sigmoid rather than hyperbolic?**

- (A) Hb is saturated at very low PO<sub>2</sub> values
- (B) Cooperative binding causes each successive O<sub>2</sub> to bind with increasing affinity up to full saturation
- (C) Hb binds O<sub>2</sub> and CO<sub>2</sub> simultaneously at all PO<sub>2</sub> values
- (D) Hb affinity for O<sub>2</sub> decreases with each successive binding

**Q17. The Bohr effect refers to:**

- (A) Increased  $O_2$  affinity of Hb at elevated  $CO_2$
- (B) Reduced affinity of Hb for  $O_2$  at higher  $PCO_2$  and lower pH
- (C) Increased  $CO_2$  transport by deoxygenated blood
- (D) Exchange of bicarbonate and chloride ions across RBC membrane

**Q18. The inspiratory centre sends motor impulses primarily to which muscles to initiate inhalation?**

- (A) Internal intercostal muscles and abdominal muscles
- (B) Smooth muscles of bronchioles
- (C) External intercostal muscles only
- (D) Diaphragm and external intercostal muscles

**Q19. Which structure integrates signals from both central and peripheral chemoreceptors to adjust breathing rhythm?**

- (A) Cerebral cortex
- (B) Hypothalamus
- (C) Medulla oblongata
- (D) Cerebellum

**Q20. Hyperventilation lowers arterial  $PCO_2$ . Which of the following correctly predicts the immediate consequence on respiratory drive?**

- (A) Respiratory rate increases further due to reflex hypoxia
- (B) Blood pH falls, stimulating chemoreceptors more strongly
- (C) Respiratory drive decreases as  $H^+$  concentration in CSF falls
- (D) Peripheral chemoreceptors compensate by increasing  $O_2$  sensitivity

**Q21. Pneumonia primarily affects alveoli. Which of the following correctly identifies the site of infection?**

- (A) Trachea and larynx
- (B) Bronchi and pleural cavity
- (C) Alveoli and surrounding lung parenchyma
- (D) Diaphragm and chest wall

**Q22. The bacterium responsible for the most common form of bacterial pneumonia is:**

- (A) Streptococcus pneumoniae
- (B) Mycobacterium tuberculosis
- (C) Staphylococcus aureus
- (D) Klebsiella pneumoniae

**Q23. Asthma characteristically makes expiration more difficult than inspiration. Which mechanism explains this?**

- (A) Inspiratory muscles are paralysed during an attack
- (B) During expiration, airway pressure compresses already-narrowed bronchioles, worsening obstruction
- (C) Diaphragm contracts continuously, preventing full exhalation
- (D) Alveolar walls collapse inward during expiration

**Q24. Which disorder is caused by long-term inhalation of dust particles leading to pulmonary fibrosis and reduced diffusion capacity?**

- (A) Asthma
- (B) Bronchitis
- (C) Pneumoconiosis
- (D) Emphysema

## **Answer key and explanations**

**Q1. Answer: (D) Gills**

Fishes use gills to extract dissolved  $O_2$  from water. Gills have gill lamellae with rich capillary supply for efficient counter-current exchange. Lungs and trachea are terrestrial adaptations.

**Q2. Answer: (C) Nasal chamber**

External nostrils lead directly into the nasal chambers, which are lined with mucus and cilia for filtering, warming, and humidifying air. The nasal chamber then opens into the nasopharynx.

**Q3. Answer: (C) Reduce friction during breathing movements**

Pleural fluid lubricates the two pleural layers (visceral and parietal), reducing friction during respiratory movements. The absence or accumulation of this fluid causes pleuritis or pleural effusion respectively.

**Q4. Answer: (C) Trapping and removing dust particles via mucociliary action**

Cilia beat rhythmically to move the mucus layer (with trapped dust and microbes) toward the pharynx for removal — a mechanism called mucociliary clearance. Warming is done by vascularised mucosa, not cilia directly.

**Q5. Answer: (B) Respiratory bronchioles**

The respiratory zone begins at respiratory bronchioles, where alveolar outgrowths first appear enabling gas exchange. Terminal bronchioles are the last purely conducting structures — a distinction frequently tested in NEET.

**Q6. Answer: (C) Tertiary bronchi**

Primary bronchi → secondary (lobar) bronchi → tertiary (segmental) bronchi → bronchioles. Each tertiary bronchus supplies one bronchopulmonary segment. Bronchioles are formed after tertiary bronchi, not directly from secondary bronchi.

**Q7. Answer: (B) Upward and outward**

External intercostal contraction pulls ribs upward and outward, increasing both the anteroposterior and lateral diameters of the thorax. Downward and inward rib movement occurs during expiration via internal intercostals.

**Q8. Answer: (B) Pulmonary ventilation**

Pulmonary ventilation refers specifically to the mechanical breathing movements (inspiration + expiration). External respiration is gas exchange at alveoli; internal respiration is gas exchange at tissues; cellular respiration is ATP production.

**Q9. Answer: (D) Sternocleidomastoid and scalene muscles**

During forced inspiration, sternocleidomastoid elevates the sternum and scalene muscles elevate the upper ribs — both further increase thoracic volume. Internal intercostals and abdominals are expiratory muscles, not inspiratory accessory muscles.

**Q10. Answer: (B) Internal intercostal muscles and abdominal muscles**

Forced expiration is active: internal intercostals pull ribs downward and inward; abdominal muscles compress abdominal viscera, pushing diaphragm up — both reduce thoracic volume forcefully. External intercostals are inspiratory muscles.

**Q11. Answer: (D) 45 mm Hg**

Venous (deoxygenated) blood entering the pulmonary capillaries carries  $PCO_2$  of ~45 mm Hg. Option A (40 mm Hg) is alveolar  $PCO_2$  — the gradient drives  $CO_2$  out of blood into alveoli.

**Q12. Answer: (D) Blood into alveolar air**

Pulmonary capillary blood carries  $PCO_2$  ~45 mm Hg vs alveolar  $PCO_2$  ~40 mm Hg.  $CO_2$  therefore diffuses from blood → alveoli. Option A reverses the correct direction.

**Q13. Answer: (D)  $CO_2$  is about 20-25 times more soluble in the aqueous layers of the respiratory membrane than  $O_2$** 

Diffusion rate is proportional to solubility of the gas.  $CO_2$ 's ~20-25× higher solubility in biological fluids compensates for its smaller pressure gradient (~5 mm Hg vs ~64 mm Hg for  $O_2$ ), resulting in faster net diffusion. Options A and C are factually incorrect.

**Q14. Answer: (C) 70%**

~70% of  $\text{CO}_2$  is transported as  $\text{HCO}_3^-$ .  $\text{CO}_2$  enters RBCs, is hydrated to  $\text{H}_2\text{CO}_3$  by carbonic anhydrase, then dissociates to  $\text{H}^+ + \text{HCO}_3^-$ ;  $\text{HCO}_3^-$  moves into plasma. Option D (97%) is  $\text{O}_2$ -Hb transport percentage — the classic cross-topic trap.

**Q15. Answer: (B) Chloride ( $\text{Cl}^-$ )**

As  $\text{HCO}_3^-$  exits the RBC,  $\text{Cl}^-$  enters in exchange (antiport) to maintain electrochemical neutrality — this is the Hamburger shift or chloride shift. Option D ( $\text{H}^+$ ) is incorrect;  $\text{H}^+$  is buffered inside the RBC by deoxyhaemoglobin.

**Q16. Answer: (B) Cooperative binding causes each successive  $\text{O}_2$  to bind with increasing affinity up to full saturation**

Cooperative binding: binding of first  $\text{O}_2$  to one subunit induces conformational change increasing affinity of remaining subunits. Option D describes negative cooperativity (which would give a hyperbolic curve, not sigmoid). Option A is false — Hb is not saturated at low  $\text{PO}_2$ .

**Q17. Answer: (B) Reduced affinity of Hb for  $\text{O}_2$  at higher  $\text{PCO}_2$  and lower pH**

The Bohr effect: elevated  $\text{CO}_2$  and  $\text{H}^+$  (lower pH) reduce Hb- $\text{O}_2$  affinity, promoting  $\text{O}_2$  unloading at tissues. Option A reverses the relationship. Option D describes the chloride shift — a separate mechanism.

**Q18. Answer: (D) Diaphragm and external intercostal muscles**

The inspiratory centre activates the diaphragm (primary muscle of inspiration) and external intercostal muscles, causing them to contract and expand the thoracic cavity. Internal intercostals are expiratory muscles. Bronchiolar smooth muscle is not directly controlled by the inspiratory centre.

**Q19. Answer: (C) Medulla oblongata**

The respiratory rhythm centre in the medulla oblongata integrates inputs from central chemoreceptors (local  $\text{H}^+/\text{CO}_2$  sensing) and signals relayed from peripheral chemoreceptors (carotid/aortic bodies) to modulate the rate and depth of breathing. The cerebellum coordinates movement but does not regulate respiration.

**Q20. Answer: (C) Respiratory drive decreases as  $\text{H}^+$  concentration in CSF falls**

Hyperventilation washes out  $\text{CO}_2$ , reducing arterial  $\text{PCO}_2$  (hypocapnia). This lowers  $\text{H}^+$  in CSF, reducing stimulation of central chemoreceptors and depressing respiratory drive — a classic negative feedback mechanism. This is why forced hyperventilation can cause breath-hold extension (dangerous in swimmers).

**Q21. Answer: (C) Alveoli and surrounding lung parenchyma**

Pneumonia is an infection of the lung parenchyma, specifically the alveoli, where pathogens (bacterial, viral, or fungal) cause inflammatory exudate to accumulate. This consolidates lung tissue and impairs gas exchange. The trachea and bronchi may be transiently involved but are not the primary site.

**Q22. Answer: (A) Streptococcus pneumoniae**

Streptococcus pneumoniae (pneumococcus) is the most common cause of community-acquired bacterial pneumonia as per NCERT context. Mycobacterium tuberculosis causes TB, not typical pneumonia. Staphylococcus and Klebsiella are less common and typically hospital-acquired.

**Q23. Answer: (B) During expiration, airway pressure compresses already-narrowed bronchioles, worsening obstruction**

During asthma, narrowed bronchioles are further compressed by the positive pleural pressure generated during active expiration, worsening obstruction and causing the characteristic wheeze. During inspiration, negative pleural pressure slightly opens airways, making inhalation comparatively easier.

**Q24. Answer: (C) Pneumoconiosis**

Pneumoconiosis (including silicosis, asbestosis, and coal worker's pneumoconiosis) results from chronic inhalation of mineral or organic dust. The particles trigger fibrotic scarring of lung tissue, thickening the diffusion pathway and reducing gas exchange capacity. Unlike emphysema, alveolar walls are replaced by scar tissue rather than destroyed.

## Numbers and facts to remember

| Topic                     | Key fact                                                                                                                                                                                                            |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Respiratory organs        | Body surface (sponges, coelenterates, flatworms); moist cuticle (earthworm); tracheal tubes (insects); gills (most aquatic arthropods, molluscs); lungs (terrestrial animals); amphibians also breathe through skin |
| Airway                    | Nostrils → nasal chamber → pharynx → larynx → trachea → primary, secondary, tertiary bronchi → bronchioles → alveoli; incomplete cartilaginous rings support trachea and bronchi                                    |
| Breathing rate            | 12-16 breaths per minute in a healthy adult                                                                                                                                                                         |
| Tidal volume              | About 500 mL (6000-8000 mL per minute)                                                                                                                                                                              |
| IRV / ERV / RV            | 2500-3000 mL / 1000-1100 mL / 1100-1200 mL                                                                                                                                                                          |
| Capacities                | Vital capacity = ERV + TV + IRV; total lung capacity = VC + RV; FRC = ERV + RV                                                                                                                                      |
| Partial pressures (mm Hg) | Alveoli: O <sub>2</sub> 104, CO <sub>2</sub> 40; deoxygenated blood: O <sub>2</sub> 40, CO <sub>2</sub> 45; oxygenated blood: O <sub>2</sub> 95, CO <sub>2</sub> 40; tissues: O <sub>2</sub> 40, CO <sub>2</sub> 45 |
| Solubility                | CO <sub>2</sub> is 20-25 times more soluble than O <sub>2</sub>                                                                                                                                                     |
| O <sub>2</sub> transport  | About 97% by RBCs as oxyhaemoglobin; about 3% dissolved in plasma                                                                                                                                                   |
| CO <sub>2</sub> transport | 20-25% as carbamino-haemoglobin; about 70% as bicarbonate; about 7% dissolved in plasma                                                                                                                             |
| Delivery                  | 100 mL oxygenated blood delivers about 5 mL O <sub>2</sub> to tissues; 100 mL deoxygenated blood delivers about 4 mL CO <sub>2</sub> to alveoli                                                                     |
| Regulation                | Respiratory rhythm centre in medulla; pneumotaxic centre in pons; chemosensitive area responds to CO <sub>2</sub> and H <sup>+</sup>                                                                                |
| Disorders                 | Asthma (inflamed bronchi and bronchioles); emphysema (damaged alveolar walls, mainly from smoking); occupational disorders cause lung fibrosis                                                                      |