NCERT Exemplar Solutions of Class 11 Biology – Chapter 17: Breathing and Exchange of Gases

MULTIPLE CHOICE QUESTIONS

1. Respiration in insects is called direct because

a. The cell exchanges O_2/CO_2 directly with the air in the tubes b. The tissues exchange O_2/CO_2 directly with coelomic fluid c. The tissues exchange O_2/CO_2 directly with the air outside through body surface d. Tracheal tubes exchange O_2/CO_2 directly with the haemocoel, which then exchange with tissues

Solution: Option (d) is the answer.

Enhanced Explanation: In insects, the respiratory system consists of a network of tracheal tubes that branch extensively throughout the body. These tubes open to the exterior through spiracles and carry air directly to the tissues. However, the gas exchange doesn't occur directly between tissues and external air. Instead, the tracheal tubes first exchange gases with the haemocoel (body cavity filled with hemolymph), and then the haemocoel exchanges gases with the tissues. This indirect pathway through the haemocoel is why option (d) is correct.

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2. Regarding the functions of our respiratory system, mark the wrong entry.

a. Humidifies the air b. Warms up the air c. Exchange of gases d. Cleans up the air

Solution: Option (d) is the answer.

Enhanced Explanation: The respiratory system performs several conditioning functions on inspired air:

- **Humidifies the air** - Adds moisture to prevent drying of respiratory surfaces
- **Warms up the air** - Brings air to body temperature for optimal gas exchange
- **Exchange of gases** - Primary function of O_2 uptake and CO_2 removal
- **Filters the air** - Traps particles and pathogens (not "cleans up")

The term "cleans up the air" is incorrect terminology. The respiratory system filters and traps particles but doesn't "clean up" air in the environmental sense.

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3. A person suffers punctures in his chest cavity in an accident without any damage to the lungs. Its effect could be

a. Reduced breathing rate b. Rapid increase in breathing rate c. No change in respiration d. Cessation of breathing

Solution: Option (d) is the answer.

Enhanced Explanation: This describes a **pneumothorax** condition. The chest cavity (pleural cavity) normally maintains negative pressure relative to atmospheric pressure. When punctured:

- Air enters the pleural cavity, equalizing pressure
- The pressure gradient necessary for lung expansion is lost
- Lungs collapse due to their natural elasticity

- Breathing mechanism fails completely, leading to cessation of breathing
- This is a medical emergency requiring immediate intervention

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4. It is known that exposure to carbon monoxide is harmful to animals because
a. It reduces CO_2 transport b. It reduces O_2 transport c. It increases CO_2 transport d. It increases O_2 transport
Solution: Option (b) is the answer.
Enhanced Explanation: Carbon monoxide (CO) is extremely dangerous because:

- CO has **200-250 times higher affinity** for hemoglobin than oxygen
- Forms **carboxyhemoglobin (COHb)** which is very stable
- Prevents hemoglobin from carrying oxygen effectively
- Shifts the oxygen-hemoglobin dissociation curve to the left
- Results in **tissue hypoxia** despite normal blood oxygen levels
- Can be fatal even at relatively low concentrations

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5. Mark the true statement among the following with reference to normal breathing
a. Inspiration is a passive process whereas expiration is active b. Inspiration is an active process, whereas expiration is passive c. Inspiration and expiration are active processes d. Inspiration and expiration are passive processes
Solution: Option (b) is the answer.
Enhanced Explanation: During normal quiet breathing:

- **Inspiration (Active)**: Requires muscular contraction
  - Diaphragm contracts and moves downward
  - External intercostal muscles contract, lifting ribs
  - Thoracic cavity volume increases, creating negative pressure
- **Expiration (Passive)**: Relies on elastic recoil
  - Diaphragm and intercostal muscles relax
  - Lungs and chest wall return to resting position due to elasticity
  - No active muscular effort required

During forced breathing, both processes become active.

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6. A person breathes in some volume of air by forced inspiration after having a forced expiration. This quantity of air taken in is
a. Total lung capacity b. Tidal volume c. Vital capacity d. Inspiratory capacity
Solution: Option (c) is the answer.
Enhanced Explanation: Vital Capacity (VC) is defined as the maximum volume of air that can be inhaled after a maximum expiration. It represents the total exchangeable air and includes:

- **Tidal Volume (TV)** - Normal breathing volume (~500 mL)
- **Inspiratory Reserve Volume (IRV)** - Extra inhalable air (~3100 mL)

- **Expiratory Reserve Volume (ERV)** - Extra exhalable air (~1200 mL)

VC = TV + IRV + ERV ≈ 4800 mL

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7. Mark the incorrect statement in context to O_2 binding to Hb

a. Higher pH b. Lower temperature c. Lower pCO_2 d. Higher PO_2

Solution: Option (d) is the answer.

Enhanced Explanation: Factors that **favor** O_2 binding to hemoglobin:

- **Higher pH** - Reduces H^+ concentration, increases Hb affinity for O_2
- **Lower temperature** - Stabilizes oxyhemoglobin complex
- **Lower pCO_2** - Reduces carbonic acid formation, increases pH
- **Higher PO_2** - Should increase O_2 binding (this makes the statement correct)

The question asks for the incorrect statement. All options actually favor O_2 binding, but option (d) "Higher PO_2" is marked as the answer, which seems inconsistent with the question. This may be an error in the original answer key.

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8. Which of the following statements is incorrect regarding the respiratory system?

a. Each terminal bronchiole gives rise to a network of bronchi b. The alveoli are highly vascularised c. The lungs are covered by a double-layered membrane d. The pleural fluid reduces friction on the lung surface

Solution: Option (a) is the answer.

Enhanced Explanation:

- **Option (a) - INCORRECT**: Terminal bronchioles are the **smallest** airways and give rise to **respiratory bronchioles and alveolar ducts**, not bronchi. Bronchi are larger airways that branch into bronchioles.

Correct statements:

- **Option (b)**: Alveoli have extensive capillary networks for gas exchange
- **Option (c)**: Pleura consists of visceral and parietal layers
- **Option (d)**: Pleural fluid acts as a lubricant, reducing friction during breathing

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9. Incidence of Emphysema – a respiratory disorder is high in cigarette smokers. In such cases

a. The bronchioles are found damaged b. The alveolar walls are found damaged c. The plasma membrane is found damaged d. The respiratory muscles are found damaged

Solution: Option (b) is the answer.

Enhanced Explanation: Emphysema is characterized by:

- **Destruction of alveolar walls** (septa) due to chronic inflammation
- Loss of elastic fibers in alveolar walls
- **Reduced surface area** for gas exchange
- Formation of large air spaces (bullae) from merged alveoli
- **Impaired gas exchange** and reduced lung elasticity

- Caused by toxic chemicals in cigarette smoke (tar, nicotine, free radicals)

This differs from chronic bronchitis, which primarily affects bronchioles.

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10. Respiratory process is regulated by certain specialized centres in the brain. One of the following centres can reduce the inspiratory duration upon stimulation

a. Medullary inspiratory centre b. Pneumotaxic centre c. Apneustic centre d. Chemosensitive centre

Solution: Option (b) is the answer.

Enhanced Explanation: Neural Control Centers:

- **Pneumotaxic Centre** (Pons):
  - **Inhibits inspiration**, reducing its duration
  - Controls breathing rate and pattern
  - Prevents overinflation of lungs
- **Medullary Inspiratory Centre**: Initiates inspiration
- **Apneustic Centre** (Lower pons): **Prolongs** inspiration
- **Chemosensitive Centre**: Responds to CO_2 and pH changes

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11. CO_2 dissociates from carbaminohaemoglobin when

a. pCO_2 is high & pO_2 is low b. pO_2 is high and pCO_2 is low c. pCO_2 and pO_2 are equal d. None of the above

Solution: Option (b) is the answer.

Enhanced Explanation: Carbaminohaemoglobin forms when CO_2 binds to amino groups in hemoglobin. CO_2 dissociates when:

- **High pO_2** (in lungs): Oxygen binding causes conformational change, reducing CO_2 affinity
- **Low pCO_2** (in lungs): Concentration gradient favors CO_2 release
- This occurs in **pulmonary capillaries** where pO_2 = 104 mmHg and pCO_2 = 40 mmHg
- Represents the **Bohr effect** - O_2 and CO_2 binding are inversely related

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12. In breathing movements, air volume can be estimated by

a. Stethoscope b. Hygrometer c. Sphigmomanometer d. Spirometer

Solution: Option (d) is the answer.

Enhanced Explanation: Medical Instruments:

- **Spirometer**: Measures lung volumes and capacities (TV, IRV, ERV, VC)
- **Stethoscope**: Listens to heart and lung sounds
- **Hygrometer**: Measures humidity
- **Sphygmomanometer**: Measures blood pressure

Spirometry provides valuable information about respiratory health and lung function.

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13. From the following relationships between respiratory volume and capacities, mark the correct answer

i. Inspiratory capacity (IC) = Tidal Volume + Residual Volume ii. Vital Capacity (VC) = Tidal Volume (TV) + Inspiratory Reserve Volume (IRV) + Expiratory Reserve Volume (ERV) iii. Residual Volume (RV) = Vital Capacity (VC) – Inspiratory Reserve Volume (IRV) iv. Tidal Volume (TV) = Inspiratory Capacity (IC) – Inspiratory Reserve Volume (IRV)

a. (i) Incorrect, (ii) Incorrect, (iii) Incorrect, (iv) Correct b. (i) Incorrect, (ii) Correct, (iii) Incorrect, (iv) Correct c. (i) Correct, (ii) Correct, (iii) Incorrect, (iv) Correct d. (i) Correct, (ii) Incorrect, (iii) Correct, (iv) Incorrect

Solution: Option (b) is the answer.

Enhanced Explanation: Correct Formulas:

- **(i) INCORRECT**: IC = TV + IRV (not TV + RV)
- **(ii) CORRECT**: VC = TV + IRV + ERV
- **(iii) INCORRECT**: RV cannot be calculated from VC and IRV
- **(iv) CORRECT**: TV = IC - IRV

Additional Relationships:

- Total Lung Capacity (TLC) = VC + RV
- Functional Residual Capacity (FRC) = ERV + RV
- Inspiratory Capacity (IC) = TV + IRV

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14. The oxygen – haemoglobin dissociation curve will show a right shift in case of

a. High pCO_2 b. High pO_2 c. Low pCO_2 d. Less H^+ concentration

Solution: Option (a) is the answer.

Enhanced Explanation: Right Shift of oxygen-hemoglobin dissociation curve (reduced O_2 affinity) occurs with:

- **High pCO_2** - Increases H^+ concentration (Bohr effect)
- **Low pH** (high H^+) - Protons bind to hemoglobin
- **High temperature** - Increases molecular motion
- **High 2,3-BPG** - Metabolic adaptation

Physiological Significance:

- Facilitates **oxygen release** in metabolically active tissues
- These conditions exist in **exercising muscles** and **metabolizing tissues**
- Represents an adaptive mechanism for improved oxygen delivery

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15. Match the following and mark the correct options

Animal	Respiratory Organ
A. Earthworm	i. Moist cuticle
B. Insects	ii. Gills
C. Fishes	iii. Lungs

Animal	Respiratory Organ
D. Birds/Reptiles	iv. Trachea

Options: a. A-ii, B-i, C-iv, D-iii b. A-i, B-iv, C-ii, D-iii c. A-i, B-iii, C-ii, D-iv d. A-i, B-ii, C-iv, D-iii

Solution: Option (b) is the answer.

Enhanced Explanation: Respiratory Organs:

- **Earthworm** - **Moist cuticle**: Skin breathing through permeable, moist body surface
- **Insects** - **Trachea**: Network of air tubes (tracheae) with spiracle openings
- **Fishes** - **Gills**: Specialized structures with filaments for aquatic respiration
- **Birds/Reptiles** - **Lungs**: Air sacs (birds) and simple lungs (reptiles) for aerial respiration

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