

Breathing and Exchange of Gases — Assignment 2

Class 11 Biology · Higher-difficulty challenge set + integrated problems · Answer key included · Narayan Gurukul Academy

Instructions: (1) Attempt all questions; start with the topic-wise challenge set, then attempt the integrated (multi-topic) problems.
(2) Give all answers with correct SI units. $g = 10 \text{ m/s}^2$ unless stated.
(3) A final answer key is provided at the end — try the full set before checking it.

Part A — Topic-wise challenge questions

Human Respiratory System — Structure

1. List the parts of the human respiratory system in order.
2. State two features of alveoli that make them efficient for gas exchange.
3. Describe the structure of the human respiratory system.

Mechanism of Breathing — Inspiration and Expiration

1. Distinguish between inspiration and expiration.
2. Explain the role of the diaphragm in breathing.
3. Describe the mechanism of breathing.

Respiratory Volumes and Capacities

1. Distinguish between tidal volume and vital capacity.
2. Write the formula for vital capacity.
3. Describe the respiratory volumes and capacities.

Exchange of Gases — Partial Pressures

1. State the pressure gradient that drives oxygen uptake.
2. Explain how CO_2 is exchanged at the tissues.
3. Explain the exchange of gases with reference to partial pressures.

Transport of Oxygen and Carbon Dioxide

1. State two forms in which CO_2 is transported.
2. What is the oxyhaemoglobin dissociation curve?
3. Describe the transport of oxygen in the blood.

Regulation of Breathing and Disorders

1. How is breathing regulated by CO_2 ?
2. Distinguish between asthma and emphysema.
3. Explain the regulation of breathing.

Part B — Integrated problems (multi-topic)

1. Describe the structure of the human respiratory system, naming the parts from nose to alveoli.
2. Explain the mechanism of inspiration and expiration with the role of the diaphragm and ribs.
3. Define tidal volume, vital capacity and residual volume, and give the relation for vital capacity.
4. Explain the exchange of O₂ and CO₂ between alveoli, blood and tissues using partial pressures.
5. Describe the transport of oxygen and carbon dioxide in the blood.
6. Explain how breathing is regulated and describe two respiratory disorders.

Answer Key

Human Respiratory System — Structure

Order: nostrils → nasal cavity → pharynx → larynx → trachea → bronchi → bronchioles → alveoli. Alveoli are thin-walled (single layer), richly supplied with capillaries and have a large surface area. The respiratory system consists of the conducting part (nose to bronchioles) and the exchange part (alveoli), with the lungs enclosed in the pleura and the diaphragm below.

Mechanism of Breathing — Inspiration and Expiration

Inspiration: the diaphragm contracts and flattens and the ribs move up and out, increasing thoracic volume and lowering pressure, so air enters. Expiration: the diaphragm relaxes and domes up and the ribs move down and in, decreasing volume and forcing air out. Inspiration is active; normal expiration is passive. Pressure changes: inspiration lowers intrapulmonary pressure below atmospheric, expiration raises it above atmospheric.

Respiratory Volumes and Capacities

Tidal volume is the air moved in a normal breath (~500 mL); vital capacity is the maximum air expired after maximum inspiration; residual volume is the air left after forced expiration. Vital capacity = TV + IRV + ERV. Spirometry measures these volumes.

Exchange of Gases — Partial Pressures

Oxygen diffuses from the alveoli (higher pO₂) into the blood (lower pO₂). CO₂ diffuses from the tissues (higher pCO₂) into the blood and then into the alveoli. Gases move by simple diffusion down partial-pressure gradients: O₂ from alveolar air (pO₂ ~104 mm Hg) into deoxygenated blood, and CO₂ from tissue (pCO₂ high) into blood and out through the alveoli.

Transport of Oxygen and Carbon Dioxide

About 97% of O₂ is carried as oxyhaemoglobin and 3% dissolved in plasma. CO₂ is carried as bicarbonate (~70%), carbamino-haemoglobin (~23%) and dissolved in plasma (~7%). The oxyhaemoglobin dissociation curve is a sigmoid curve showing that haemoglobin saturation with O₂ varies with pO₂. CO₂ transport: carbonic anhydrase in RBCs converts CO₂ to bicarbonate; some CO₂ binds haemoglobin as carbamino-haemoglobin.

Regulation of Breathing and Disorders

Breathing is regulated by the respiratory centre in the medulla oblongata, chiefly in response to CO₂ (and H⁺) levels. Asthma is difficulty in breathing due to inflammation of bronchi/bronchioles; emphysema is damage to alveolar walls reducing surface area. The medulla's respiratory centre sets the rhythm; chemosensitive areas detect rising CO₂/H⁺ and increase breathing rate.

Integrated problems

1: Nostrils → nasal cavity → pharynx → larynx → trachea → bronchi → bronchioles → alveoli. 2: Inspiration — diaphragm contracts, ribs up/out, volume ↑, pressure ↓, air in; expiration — reverse. 3: $TV \approx 500 \text{ mL}$; $VC = TV + IRV + ERV$; RV = air left after forced expiration. 4: O_2 diffuses down its partial-pressure gradient into the blood; CO_2 diffuses down its gradient into the blood and out. 5: O_2 as oxyhaemoglobin (97%); CO_2 as bicarbonate (~70%), carbamino-haemoglobin (~23%), dissolved (~7%). 6: Medulla oblongata, regulated by CO_2/H^+ ; asthma (bronchial inflammation) and emphysema (alveolar damage).