SUMMING-UP

1 The role of oxygen in metabolism

- The nutrients derived from diet are oxidised in order to produce energy.
- Each cell must receive oxygen (O_2) to carry out cellular respiration and then must remove the carbon dioxide (CO_2) produced in the process.
- This gas exchange is called **respiration**, which consists of three phases:
  - entry of O_2 into the body of the organism;
  - its transport to each cell in the body through the blood;
  - transfer of O_2 and transport of CO_2 outside of the body.
- The oxygen we breathe constitutes 21% of the atmosphere. The diffusion of oxygen from the air to the blood depends on its partial pressure, which decreases with decreasing pressure and therefore with increasing altitude.

2 Respiratory exchanges in animals

- In animals, the respiratory exchange takes place by simple diffusion through a surface of the body that must be constantly moist.
- In order for the amount of oxygen to be sufficient, this surface must be sufficiently large.
- In simple animals, the body surface of the animal is sufficient to ensure the oxygen requirement.
- In more complex animals, however, there are special **respiratory organs**:
  - gills;
  - tracheae;
  - lungs.

3 The human respiratory system

- Human beings have a highly specialised respiratory tract, formed in the following order:
  - nose and nasal cavity;
  - pharynx, shared with the digestive system;
  - larynx, containing the vocal cords, the organ of speech;
  - trachea and bronchi;
  - lungs, consisting of a large number of pulmonary alveoli or dead ends, on the surface of which the respiratory exchange takes place.
- The alveoli are made of a thin wall of muscle and connective tissue that allows the diffusion of oxygen from the air into the blood and carbon dioxide in the blood to the air contained in the alveoli.

4 Pulmonary ventilation

- Ventilation is the mechanical process that allows air to travel along the respitory tract and enter the inside of the lungs. During **inspiration** (or **inhalation**) the diaphragm lowers and the rib cage expands, this decreases the pressure inside, making the air enter. During **expiration** (or **exhalation**) the opposite occurs.
- The volume of air exchanged in breathing at rest is called the **tidal volume** and amounts to about 500 mL. It can increase up to 5 L in situations of stress, but in no event shall the lungs empty completely.
- Coughing and sneezing are involuntary defence reflexes of the respiratory system.

5 The transport of respiratory gases in the blood

- The greater part of the oxygen carried in the blood binds to haemoglobin and is carried inside red blood cells.
- Haemoglobin is a protein made up of 4 polypeptide chains, each of which is bound to a heme group that contains an iron atom. This atom represents the point at which oxygen binds through a reversible bond.
- The binding affinity between oxygen and haemoglobin depends on the oxygen concentration. The blood leaves the lungs with a percentage saturation of haemoglobin of 100% and gradually releases oxygen to tissues throughout the body.

6 Gas exchange in plants

- Plants absorb carbon dioxide from the air (or water in the case of aquatic plants) and use it for **photosynthesis**.
- Oxygen, a waste product of photosynthesis, is used in part by the plant to recover energy from sugars (via **cellular respiration**) and is in part released into the atmosphere.
- Gas exchange in plants occurs mainly in the opposite direction to that in which it occurs in animals.
- Gas exchange occurs at the level of the leaves. The gases enter and leave through the **stomata**, openings on the surface of the leaves that normally open during the day and close at night.
- The stomata are surrounded by two cells that function as a valve, regulating the opening and closing of the stoma itself: the **guard cells**.