The Respiratory System

حامعة المعقل الاهلية/كلية طب الاسنان
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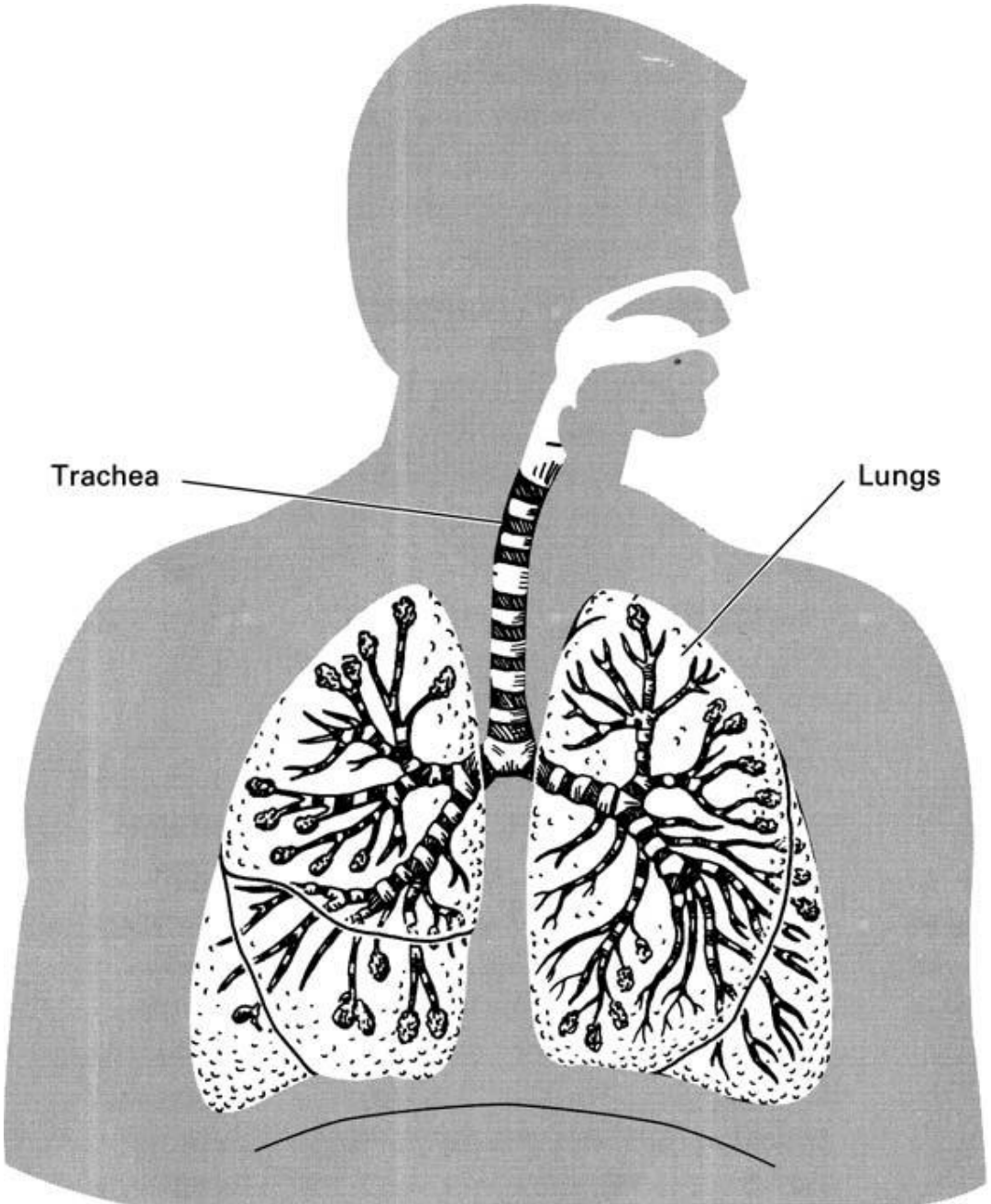
- Human require energy to function. This energy is provided by food, which is oxidized by the body.
- On the average, 0.207 liter of oxygen at 760 torr are required for every Cal of energy released by the oxidation of food in the body. At rest, an average 70-kg adult requires about 70 Cal of energy per hour, which implies a consumption of 14.5 liter of O2 per hour, which is about 10^{20} oxygen molecules per second

- The oxygen is obtained through the lungs.
- The lungs can be thought of as an elastic bag suspended in the chest cavity (see Fig. 9.7). When the diaphragm descends, the volume of the lungs increases, causing a reduction in gas pressure inside the lungs. As a result, air enters the lungs through the trachea. The trachea branches into smaller and smaller tubes, which finally terminate at tiny cavities called alveoli. It is here that gas is exchanged by diffusion between the blood and the air in the lungs.

- The lungs of an adult contain about 300 million alveoli with diameters ranging between 0.1 and 0.3 mm. The total alveolar area of the lungs is about 100 m^2, which is about 50 times larger than the total surface area of the skin. The barrier between the alveolar air and the blood in the capillaries is very thin, only about 4×10^{-5}cm. Therefore, the gas exchange of oxygen into the blood and CO2 out of the blood is very fast.


Trachea
Lungs

- The lungs are not fully emptied and filled with each breath. In fact, the full volume of the lungs is about 6 liter, and at rest only about 1 2 liter is exchanged during each breath.
- The oxygen requirement, of course, rises with increased physical activity, which results in both faster and deeper breathing.

Surfactants and Breathing

- The discussion in the previous section neglected an important aspect of breathing, the size of the alveoli. As was stated, the diameters of the alveoli range from about 0.1 to 0.3 mm (radius R from 0.05 to 0.15 mm). The inner wall of the alveoli is coated with a thin layer of water that protects the tissue. The surface tension of this water layer tends to minimize the surface thereby shrinking the alveolar cavity.

- When the diaphragm descends, the incoming air has to enter the alveoli and expand them to their full size. Because the alveoli are embedded in a moist medium, expanding the alveoli is analogous to creating a bubble inside a liquid to create gas bubble of radius R in a liquid with surface tension T, the pressure of the gas injected into the liquid must be greater than the pressure of the surrounding liquid by P .P required to expand a 0.05 diameter alveolus to its full volume is 2.9 atmospheres. This is the minimum pressure required to open a 0.05 diameter alveolus that has its walls coated with plain water. Clearly the incoming air at one atmosphere cannot open the small alveoli and can barely begin to expand the larger ones.

- Breathing is made possible by surfactants that cover the alveolar water layer and greatly reduce its surface tension. These surfactant molecules are a complex mixture of lipids and proteins produced by special cells in the alveoli and they can reduce surface tension by as much as a factor of 70 (to about 1 dyn/cm).

Diffusion and Contact Lenses

- Most parts of the human body receive the required oxygen from the circulating blood. However, the cornea, which is the transparent surface layer of the eye, does not contain blood vessels (this allows it to be transparent). The cells in the cornea receive oxygen by diffusion from the surface layer of tear fluid, which contains oxygen. This fact allows us to understand why most contact lenses should not be worn during sleep. The contact lens is fitted so that blinking rocks the lens slightly. This rocking motion brings fresh oxygen-rich tear fluid under the lens. Of course, when people sleep they do not blink; therefore, the corneas under their contact lenses are deprived of oxygen. This may result in a loss of corneal transparency.