

700 million alveoli doing the exchange, a double pump doing the delivery



Respiration, the energy conversion

- **respiration**: biochemical, orderly oxidation of organic compounds to liberate chemical energy as ATP
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 38 \text{ ATP}$
- **respiratory surface**: where gases exchange with the environment
- an efficient one is large in area, thin, highly vascular and permeable, and moist



breathing exchanges air with the atmosphere; external respiration, gases at the alveoli; internal, gases at the tissues; cellular respiration oxidizes food to ATP in the cell

Gaseous exchange in plants *

- land plants: continuous air spaces through stem, leaf, root
- O_2 diffuses in via stomata, CO_2 /water vapour diffuse out
- aerated soil: O_2 dissolves in the moisture film around root tissue, then diffuses in
- woody plants exchange gases through **lenticels**, pores in the otherwise impervious bark

Respiratory surfaces across animals

- protists, sponges, coelenterates (aquatic): plasma membrane
- flatworms, annelids, frog (aquatic/semiaquatic): moist body surface
- insects (terrestrial): tracheal tubes + spiracles
- spiders, scorpions (terrestrial): book lungs
- Limulus (aquatic): book gills; fish (aquatic): internal gills
- reptiles, birds, mammals (terrestrial): lungs
- one process, diffusion, across all of them: the same three rules of area, thinness, moisture

Human respiratory tract: upper

- nasal chamber, 3 regions: vestibule (hair-filtered), respiratory (warms/moistens air), olfactory (smell)
- pharynx: nasopharynx $\rightarrow$ oropharynx (shared with food) $\rightarrow$ laryngopharynx; carries the tonsils
- **larynx** (voice box): true vocal cords produce sound; opens via the glottis
- leaf-shaped **epiglottis** guards it, blocking food from entering the trachea

Trachea and bronchi

- **trachea**: 10-12 cm, held open by 16-20 C-shaped cartilage rings
- lining: ciliated pseudostratified, with mucous glands
- right/left primary bronchi $\rightarrow$ secondary, tertiary bronchi $\rightarrow$ terminal bronchioles $\rightarrow$ alveoli

