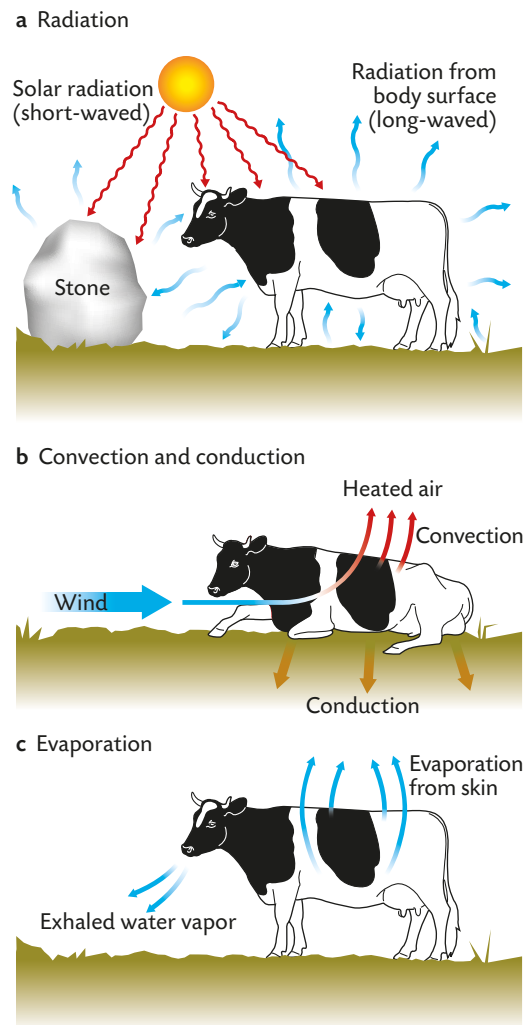


**Figure 18.7** Mechanisms of heat exchange.

**a Radiation.** When the body is warmer than the environment, there is a net loss of heat to the environment in the form of infrared radiation.

**b Convection and conduction.** Heat is transferred by conduction directly from the body surface to objects that are in contact with the animal. Air warmed by heat conduction from the skin surface rises and is replaced by colder air, thus enabling dissipation of more heat (free convection). Wind also transports heated air away from the body surface (forced convection).

**c Evaporation.** Liquid water is transformed to water vapor by evaporation. This process requires energy. When water evaporates from the body surfaces, the energy is taken from the body in the form of heat. Heat is lost by evaporation from the respiratory tract, by evaporation of water that diffuses across the epidermis, and by evaporation of sweat.



?

**27** List the four processes for heat exchange.

**28** Compare the influence of skin color on absorption of visible light and infrared radiation, respectively.

**29** Define the term radiation balance.

**30** What determines the radiation balance of a body?

## Conduction

Heat conduction is heat exchange between objects or substances that are in physical contact with one another. During heat conduction, heat energy is transferred directly between atoms, ions, or molecules when these collide. The thermal motion of the particles, and hence their kinetic energy, increases with increasing temperature. When two objects with different temperatures are held against each other, the warmer object loses some of its heat energy while the colder object gains the same amount of energy (Fig. 18.7b). Air and other gas mixtures have poor thermal conductivity, and are consequently good insulators, whereas metals have high thermal conductivity relative to blood and water (Tab. 18.3).

The amount of heat exchanged by conduction between two objects increases proportionally

with the contact area, the temperature difference between the objects, and the thermal conductivity of the materials involved. The conditions that determine the degree of heat conduction can thus be compared with those that determine the extent of diffusion of a given substance between regions with different concentrations of the substance (Fick's law, p. 12).

The term thermal conductivity signifies how easily heat is transferred between the molecules and ions of the material. In humans, heat conduction is normally of minor importance for heat exchange between the body and its surroundings, because air is a poor conductor of heat. However, when the body is submerged in water at a temperature below the core temperature, heat loss by conduction is greatly enhanced, because the thermal conductivity of water is 25 times that of air (Tab. 18.3). Domestic animals lose heat by conduction to the ground or the floor, and to walls and other structures

Conduction is heat transfer between objects in direct contact with each other

Heat is lost by conduction when the body is in contact with a cooler surface

Water conducts heat 25 times better than does air