

## Preface

The effects of cold in the form of frost-bite or gangrene of the feet have been 'recorded in armies from early historic times. Xenophon makes various references to the effect of cold in producing these conditions during his perilous march through Armenia. Larrey's description in 1812 of the effects of cold in Napoleon's Russian campaign shows that it was then a familiar condition. In the medical history of the Crimean War of 1854-6 it is recorded that cases of frost-bite and gangrene occurred when the temperature was above freezing point, and especially when there were rain, a cold north-east wind and frost at night. Other factors in this campaign which helped to bring about the disease were lack of opportunities for changing the clothes, tight boots, fatigue, and defective nutrition. Diseases such as scurvy or " fever," were factors in the production of trench foot. Owing to the peculiar conditions of trench warfare, opportunity of movement such as would assist the circulation of the blood was much restricted, and men in the trenches were compelled to remain under cover in the least exposed positions, most frequently at the bottom of a trench half filled with snow or with mud and water up to their knees. Similar cases of frostbite were described by Davys and Powell Connor among the members of the British Mission to Tibet in 1903; in the Russojapanese War in 1904-5, by Macpherson, and again, in the Balkans in 1912, by Max Page.



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## CHAPTER 1

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### MECHANISMS OF HEAT TRANSFER

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A characteristic property of warm-blooded animals is the ability to raise body temperatures greater than ambient temperature ( $T_{amb}$ ). However, this property is not limited to vertebrates. The human body obeys the laws of thermodynamics, as heat is transferred from a higher to a lower temperature.

In humans and probably most animals, hyperthermia is not always painful and may even induce euphoria. It is this lack of a pain warning that is the major facilitator of heat illnesses. As a result, an athlete or soldier may choose to continue performing severe exercise in the heat, even as the risk of heat injury increases.

It is convenient to classify the more familiar heat disorders such as heat syncope, heat exhaustion (including that induced by exertion, and water or salt depletion), heat cramps, and classic and exertional heatstroke (EHS) into separate, well-defined categories. Even so, the symptoms often overlap.

Environmental variables that have the largest impact on heat exchange are temperature; humidity; radiation from the air, water, or land; and air or water motion. To maintain stable body temperature, organisms rely on four avenues of heat exchange: conduction, convection, radiation, and evaporation.

Dry heat exchange is achieved by conduction, convection, and radiation. The effectiveness of these mechanisms depends on differences between the skin and environmental temperatures. That is, dry heat loss occurs when skin temperature exceeds that of the environment, and dry heat