

## Pneumothorax

The intrapleural pressure is negative. A foreign object penetrating the rib cage and the parietal pleura, or a broken rib that ruptures the pleura, creates a channel that opens the intrapleural space to the atmosphere. Air is then sucked into the intrapleural space, thereby eliminating the transpulmonary pressure gradient and disrupting the fluid bond holding the lungs to the thoracic wall. Elastic forces in the lung tissue then pull the lungs towards the hilum. Air in the intrapleural space is termed pneumothorax. Pneumothorax may also occur spontaneously by rupture of a weakened section of the lung and the visceral pleura, allowing air to flow into the intrapleural space from the lung tissue. Pneumothorax leads to expansion of the thoracic cavity

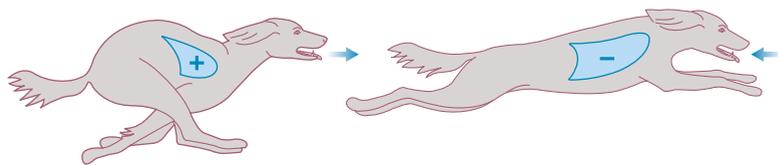
and collapse of the lung, preventing normal ventilation. Treatment of pneumothorax involves sealing the channel and removing as much air as possible from the intrapleural space. The surrounding tissue will then absorb the remaining air, restoring the fluid bond between the pleural sheets. In rare cases, tissue adjacent to the hole in the pleura may function as a valve, allowing air to flow into the intrapleural space during inhalation, but closing the hole during exhalation. The result may be formation of excess pressure in the intrapleural space and compression of the healthy lung on the opposite side. This is a life-threatening condition, and may require surgery in order to close the hole and remove the air from the intrapleural space.

ribs in a caudal and inward direction, and contractions of the muscles in the abdominal wall accelerate the forward shift of the diaphragm by elevating the pressure in the abdominal cavity. This results in faster deflation of the lungs, which is a prerequisite for increased respiratory frequency. In dogs, expiration also has an active component at rest.

The mechanism of ventilation in horses differs somewhat from that described above. In a resting horse, there is an active phase and a passive phase in both inspiration and expiration. Expiration starts as a passive recoil, but contraction of abdominal muscles contributes towards the end. Potential energy stored during this active phase of expiration is released as passive recoil that initiates the succeeding inspiration, before contraction of the inspiratory muscles commences.

In a resting horse, both inspiration and expiration are composed of an active and a passive phase

The breathing of galloping animals is synchronized with the stride cycle



**Figure 12.11** Dorsoventral bends in the body of a galloping dog alternately compress and expand the lungs, thereby assisting both expiration and inspiration, which are strictly phase-locked to the stride cycle. Plus and minus symbols indicate positive and negative pressures exerted on the lungs by the locomotory movements. Modified from Kardong, 1995.

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- 21** How is the volume of the thoracic cavity reduced during expiration at rest in most mammals?
- 22** Use Boyle's law to explain the flow of air during expiration.
- 23** Which muscles are active during forced expiration?
- 24** Compare the mechanisms of expiration and inspiration in a resting horse and in most other mammals at rest.

## Locomotion and ventilation

During locomotion, ventilation is influenced by contraction of numerous muscles in addition to those already mentioned. The breathing of galloping animals is synchronized with the stride cycle in a 1:1 ratio (Fig. 12.11), whereas no strict synchronization occurs during trotting or walking. However, the locomotory muscles may affect ventilation even at these gaits, although the interaction is less obvious than at gallop.

## Ventilation in diving mammals

In mammals specialized for diving (pinnipeds and cetaceans), breathing takes place at the water surface. During a dive, such animals display voluntary apnea (p. 524) ranging in duration from a few minutes to, in certain species, more than one hour. The walls of the conducting airways of