

RESPIRATION

Among vertebrates, the respiratory system of birds is at the peak of evolution. This special breathing system allows for high-energy flights even at altitudes of up to several thousand metres.

It also plays an important role in maintaining the bird's body temperature.

Birds have relatively small lungs, but with the nine air sacs attached, the total surface area of the respiratory system can be several times that of a mammal.

Birds' lungs do not inflate and deflate, but maintain a constant volume and are unidirectional. Respiratory movements are produced by the pectoralis and intercostal muscles, with no diaphragm.

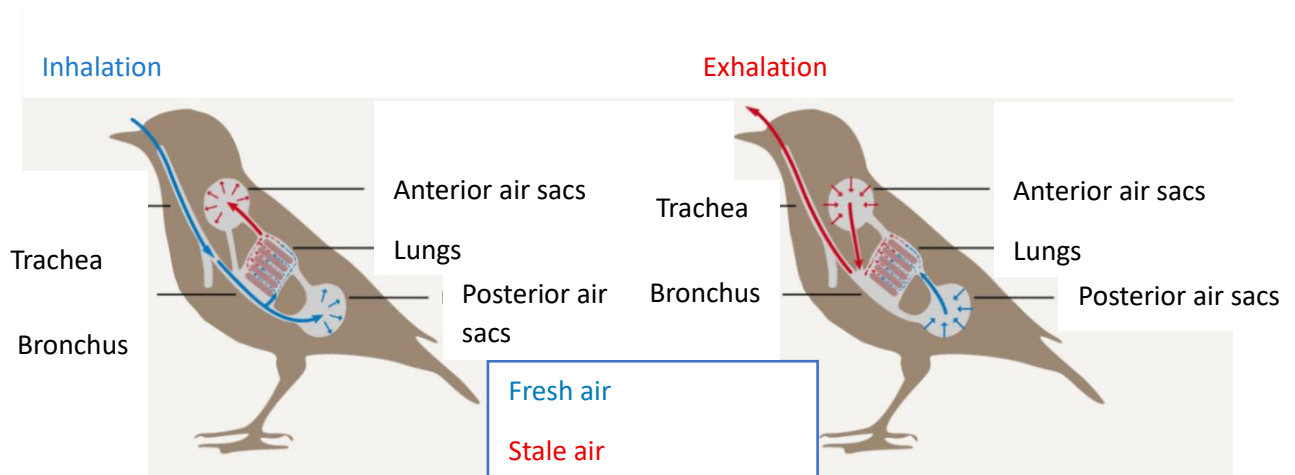
In terms of gas flow, the lungs, which are halfway between the air sacs, are continuously ventilated with fresh air in one direction during both inhalation and exhalation. This continuous, unidirectional airflow means that birds' lungs are better ventilated than those of mammals.

The double breathing

When inhaling, fresh air flows directly into the posterior air sacs and through the lungs to the anterior air sacs. On exhalation, fresh air is expelled into the lungs from the posterior air sacs. This ensures a continuous exchange of gas during inhalation and exhalation.

The efficiency of the birds' breathing is further enhanced by a unique mechanism: the flow of blood and air in opposite directions within the tertiary bronchi. As a result, oxygen flows more efficiently into the bloodstream, while carbon dioxide is removed with the same efficiency.

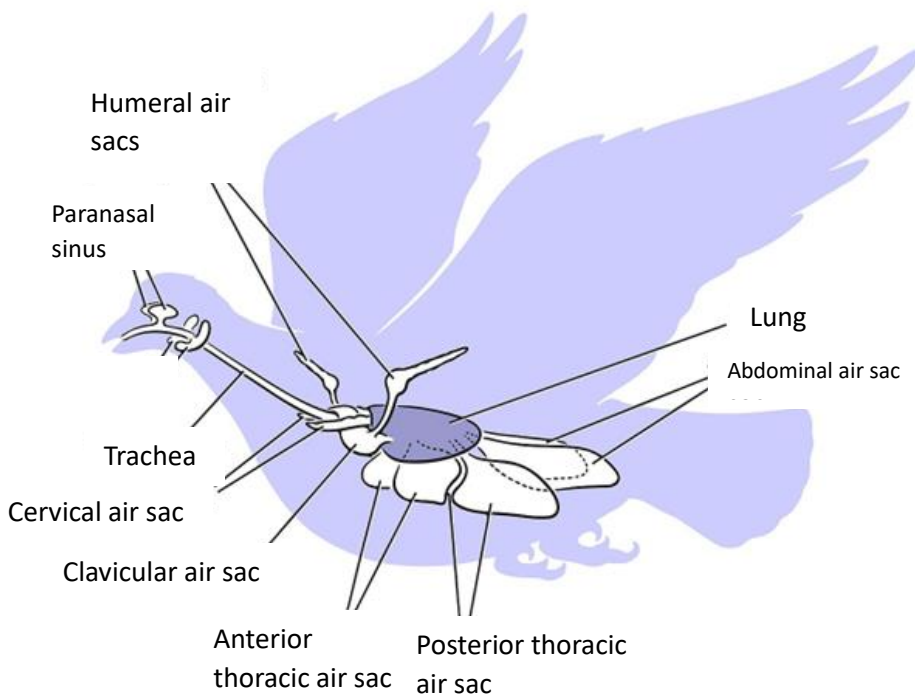
Parabronchus (tertiary bronchi), where the respiratory capillaries originate, on the surface of which gas exchange takes place.



Source: <https://asknature.org/strategy/respiratory-system-facilitates-efficient-gas-exchange/>

Bats are the only mammal to prove that flight is not impossible without bird respiration, but their flight duration and altitude are more limited.

Air sacs



Source: <https://silvotherapy.co.uk/articles/how-birds-breathe>

Central to the respiratory system of birds are the air sacs, which are thin-walled structures with a small blood supply. They play a crucial role in maintaining a continuous flow of air through the lungs. They are not involved in gas exchange but serve as a reservoir of air, facilitating a continuous, unidirectional flow of oxygen-rich air through the respiratory

system. The different air sacs alternately contract and expand, causing air movement. There are two-two cervical, anterior thoracic, posterior thoracic and abdominal sacs in the respiratory system.