

# Bird Physiology

Module 4 · Online Birding Enthusiast Course · curriculum by Joe Grosel (1966–2021)

Physiology is biology in action. This module covers the physics of flight, the engineering of bird song, how birds maintain temperature in the heat and cold, and how they survive without drinking for days at a time.

## 4.1 Four forces of flight

Weight (down), Lift (up), Thrust (forward), Drag (back). In steady flight: Lift = Weight, Thrust = Drag. Birds adjust wing shape and angle of attack to control all four.

## 4.2 Aerofoil principle

The wing's curved upper surface forces air to travel further — creating lower pressure above and higher pressure below — generating lift (Bernoulli effect). The whole wing is shaped like an aerofoil cross-section.

## 4.3 Flight styles

Flapping (most), soaring (vultures, eagles — use thermals), gliding (kites), hovering (hummingbirds, kingfishers, kestrels), dynamic soaring (albatross), undulating (woodpeckers, finches).

## 4.4 Wing-loading

Body weight ÷ wing area. Low wing-loading = soarer (vulture, eagle). High wing-loading = fast direct flier (swift, duck). This single ratio explains most flight differences between species.

## 4.5 The syrinx

Birds have NO larynx. The syrinx sits at the trachea–bronchi junction. Its TWO sets of membranes can vibrate independently, allowing some species (eg. wood-thrushes, robin-chats) to sing two simultaneous notes.

## 4.6 Thermoregulation

Feathers insulate. Birds pant and gular-flutter to lose heat. Counter-current heat exchange in legs reduces heat loss in cold water (ducks, gulls).

## 4.7 Water balance

Many arid species can survive without drinking — they extract water from food and produce metabolic water during respiration. Doves visit waterholes once a day; sandgrouse males carry water in their belly feathers to chicks.

## Key Terms

|      |                                                  |
|------|--------------------------------------------------|
| Lift | Upward force generated by airflow over the wing. |
|------|--------------------------------------------------|

|      |                                     |
|------|-------------------------------------|
| Drag | Resistance opposing forward motion. |
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|------------------------|---------------------------------------------------|
| <b>Wing-loading</b>    | Weight divided by wing area (kg/m <sup>2</sup> ). |
| <b>Syrinx</b>          | Bird vocal organ at the base of the trachea.      |
| <b>Aerofoil</b>        | Wing cross-section that produces lift.            |
| <b>Metabolic water</b> | Water produced as a by-product of respiration.    |