Flight – how do bats fly?

There are over 1,300 species of bat in the world, yet if you saw any one for the first time you would immediately recognise it as a bat by its hand-wings. A bat's wing is built of the same bones as our hand and arm, but the bat's hand bones are much longer. Imagine your fingers growing and growing to nearly the length of your body – that's how big your wings would be if you were a bat!

The serotine has broad wings enabling it to manoeuvre and fly close to vegetation to take prey. Its flight is relatively slow.

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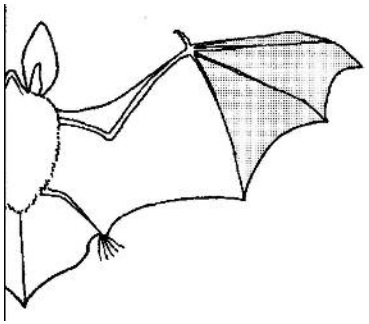
A bat's wing is a double layer of skin, or membrane, that is supported by the arm, very long fingers, the legs and tail. The membrane is criss-crossed with tiny blood vessels which carry oxygen and nutrient to the flight muscles. It looks very fragile, but elastic fibres make it less likely to puncture even than a thick rubber glove, and tiny holes heal very quickly. It is very flexible so the bat can position its wings into different shapes, enabling it to perform amazing acrobatics as it weaves and dives in the air.

How does a bat fly?

To fly, the bat must have **lift** to support it in the air, and **thrust** to move it forward. It is mainly the wing membrane between the sides of the body and the bat's fifth finger (shown clear in the diagram) which give the bat support and lift. Without this, gravity would make the bat fall down.



The hand-wing, the membranes between the fingers, shaded in the diagram, are the most important for thrust, to move the bat forwards. The muscles that power the wings (taking the place of an engine in a plane) are the ones you use to flap your arms. For their size they are many times stronger than yours.

By moving their thumbs, feet and wrists, bats can alter the curvature of their wings and so alter the lift. They will change this according to whether they are flying steadily or manoeuvring to catch their prey.

Wing shape

Whether a bird, bat or an aircraft, the shape of the wings tells you something about the way it flies. In a bat, these differences have a lot to do with where they feed, how they feed and what they eat. Long narrow wings are designed for faster flight, and use less energy over long distances. Short broad wings are designed for slower flight, give more manoeuvrability but use more energy, so make short flights. Some broad-winged bats are able to hover as they take insects from leaves or (in the tropics) nectar from flowers.

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The wing of this brown long-eared bat is fairly short but broad. It is so manoeuvrable that the bat can fly in and out between the branches of the trees, and even hover before picking a moth from a leaf. This shape of wing enables them to carry quite heavy prey like large moths to a feeding perch, where they hang up to eat them.

By contrast, the noctule is a streamlined bat, with long narrow wings built for speed. It regularly flies long distances to feed so needs to travel fast and use as little energy as possible getting there. It usually flies in open spaces, making steep dives to catch its insect prey.

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Flight – energy demands

Although flight gives bats many advantages over terrestrial animals, and is very efficient, it has one big disadvantage – it is very energy-expensive; flying uses twice as much energy per second as a person running.

However, in order to supply as much energy to its muscles when flying as a mammal on the ground, bats have some very special physiological adaptations.

The flight muscles need a constant supply of oxygen: this is carried in the blood pumped around the body by the heart. This is known as the **cardio vascular system**, and has been adapted in bats in order to power the flight muscles, which rely on a constant supply of oxygen to prevent fatigue.

The heart must work very hard to keep up that oxygen supply to the flying bat, so a bats' heart is as much as two or three times the size of a terrestrial mammal of the same size. Although the heart rate of a resting bat is similar to that of terrestrial mammals of the same size, in flight this may increase two to six-fold.

Those bats studied have more red blood cells than other mammals, so can carry more oxygen, and the lung can extract more oxygen from the air than any other mammal.

A small bat such as a pipistrelle typically has a heart rate of 200-450 beats per minute at rest, rising to 800 – 1,000 in flight.

So rather than a different system to achieve flight, typical mammalian physiology is fine-tuned to enable bats to fly.

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Greater horseshoe bats usually catch their prey in their wing then transfer it to their mouth.

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This Nathusius's pipistrelle bat, ringed in Latvia in September 2015, was trapped at Rye, East Sussex, six weeks later. A direct line between those two places measures 1,458km. though the bat probably covered a far greater distance whilst foraging.

Fuel shortage

However efficient an engine may be, it still needs fuel to keep going. Bats in Britain and in all temperate regions, where winters are cold, suffer a fuel shortage as there are few insects about when temperatures drop. So the success of bats in temperate regions is due to another amazing adaptation – their ability to reduce their body temperature and save energy when insect availability is low. Dropping their temperature to a low level is known as going into torpor; they may even do this in summer if food is short.

Read more about this in '***Bats through the year***'.