LESSON 2.1

Flying mammals

Overview

Students are introduced to the term **Adaptation** and look at how micro-bats have adapted over time to develop specialised features that help them survive. Students focus on one adaptation – flying. Bats are the only mammal to truly fly and students identify the differences between gliding and flying by looking at different species. Students look further into the structure of a bat's wing and determine the similarities and differences between humans and bats.

Background information

Adaptations identify features or characteristics that animals develop to help them survive. In the world of bats these adaptations include flying, echolocation, hibernation, being nocturnal, size, the way some species reproduce and the specialised food they eat.

Although bats can fly like a bird, they do not have feathers, build nests or lay eggs. Bats are mammals. The name given to bats is the animal order "Chiroptera", which is Greek for "Hand-wing". A bat's wing consists of bones that are very similar to the bones in a human arm and hand. Long arm bones, with extra-long extended finger bones, are covered with a double layer of thin skin called a membrane. The membrane is so thin that you can see light through it. It is made up of fine blood vessels, elastic fibres and muscle fibres.

The membrane stretches over the arm bones and extended finger bones to the sides of the body and leg. In some bats, this membrane may also extend between the legs and include the tail. The small, clawed thumbs (often used for climbing or moving across surfaces) are left free. The second and third fingers, along with the membrane in between, give the wing a stiff leading edge similar to an airplane's, while the third finger forms the wing tip.

A bat's wings act like webbed hands. The bat can move its wings like we move our fingers enabling it to change its wings' shape rapidly to dart, flip and turn quickly. Although birds use their tails to brake and steer, bats use their wings by folding one wing for a second and using one independently of the other. Many bats have also mastered hovering flight, similar to hummingbirds and helicopters, and this enables them to remain stationery in flight while other bats are able to achieve brief periods of gliding flight.

The surface area of a micro-bat's wing in ratio to its body size is small; therefore they need to increase the number of wing strokes to keep up speed and loft when flying. They raise and lower their wings from 11-18 times per second. Some micro-bats have been recorded at flying 50 kilometres per hour. These small, fast moving wings enable micro-bats to change direction quickly and sometimes even hover in flight while hunting.

Resources

Bat Wing Basics poster or PDF file
Stockings or socks - at least 12
Large tub/s filled with water
Scales - large and small
Craft materials - tape, glue, scissors
Gloves
Black fabric (e.g. poplin)
Crepe paper
Pipe cleaners
Sticks or bamboo garden stakes
Long cardboard rolls
Cardboard sheets

Flying mammals

Activity descriptions

Activity 1: Differences and similarities

Using the *Background information* about bat wings and flight, talk to the students about the difference between flying and gliding, what they think the bat wing looks like, how they fly etc... Using the 'Bat Wing Basics' poster, look at the differences and similarities between bats, birds and humans.

Students use the poster as a guide to complete the activity sheet by:

- Colouring the same bones the same colour to identify the similarities
- Recording their observations of what is similar and what is different
- Tracing their own outstretched-hand and, if they were a bat, marking where the membrane would go.

Students put a sock or stocking over their hands to create a webbed effect. When they wave their hand in the air like they were flying, do they notice anything? Repeat the exercise but without the sock/stocking – is there a difference? Next, students put their webbed hand in a trough of water and move it rapidly from side to side (like they were flying). Repeat this action but without the sock/stocking. Ask students:

- Did you notice how much easier it was to move your hand through the water without the sock or stocking?
- Imagine that the sock extended from your fingers to your ankles. How hard/easy do you think it would it be to move around?
- Imagine flapping your hand through the water 11 times per second. How much food would you need to eat to keep your energy levels up to do that all night long?

EXTENSION ACTIVITY: Wing to weight ratio – take a look at the fact sheet on the wing to weight ratio. How big a wing span do bats need to keep their bodies flying? This information may come in handy with Activity 2.

As a class - weigh different classroom items and using the Average Ratio, determine the optimal wingspan for flight. Items can include fruit, chairs, pencil boxes, etc.

Time requirement: 30-60 mins (approx)

Activity 2: Design Batman's new wings

After investigating the structure of a bat's wing, how it compares to humans and how big a wing span is needed to lift the weight of different bats, students design their own set of bat wings.

Students are given the scenario that they are to construct Batman's new wings that he needs to fly around Gotham City. First, students need to draw their wing design on paper and think about and record what materials they could use. Make this a class competition to see which designs will go through to the next phase. Wing design will be judged on ability to keep Batman in flight/glide (wingspan), ease for Batman to use and the availability of materials to make a prototype.

Next, choose up to three different designs that will go to the 'prototype' phase. In groups/ teams, students make their bat wings in the classroom using available materials (students can bring materials from home if they wish). The original designer will be the 'project manager' and tasks are assigned to other team members, such as:

- 'materials officer' – in charge of sourcing the to use materials
- 'tools operator' – in charge of getting the tools and operating them (e.g. scissors, tape)

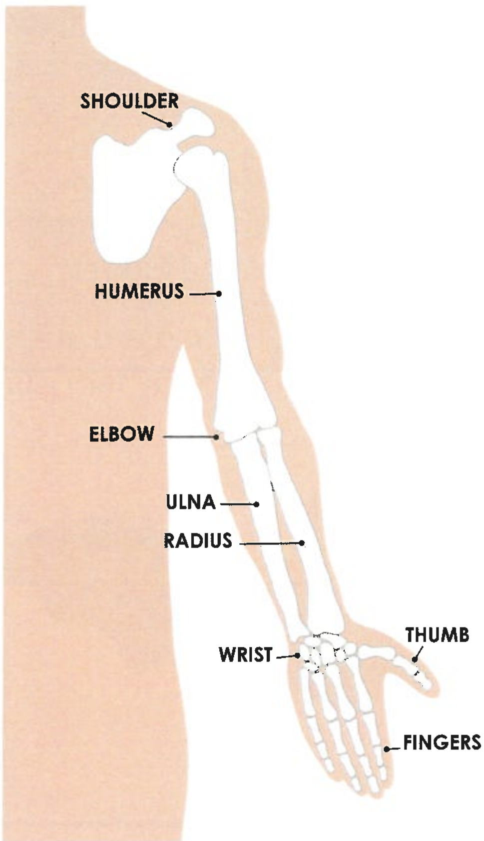
- 'graphic designer' – in charge of creating a design on the wings
- 'model' – the person who will wear and model the wings at the end

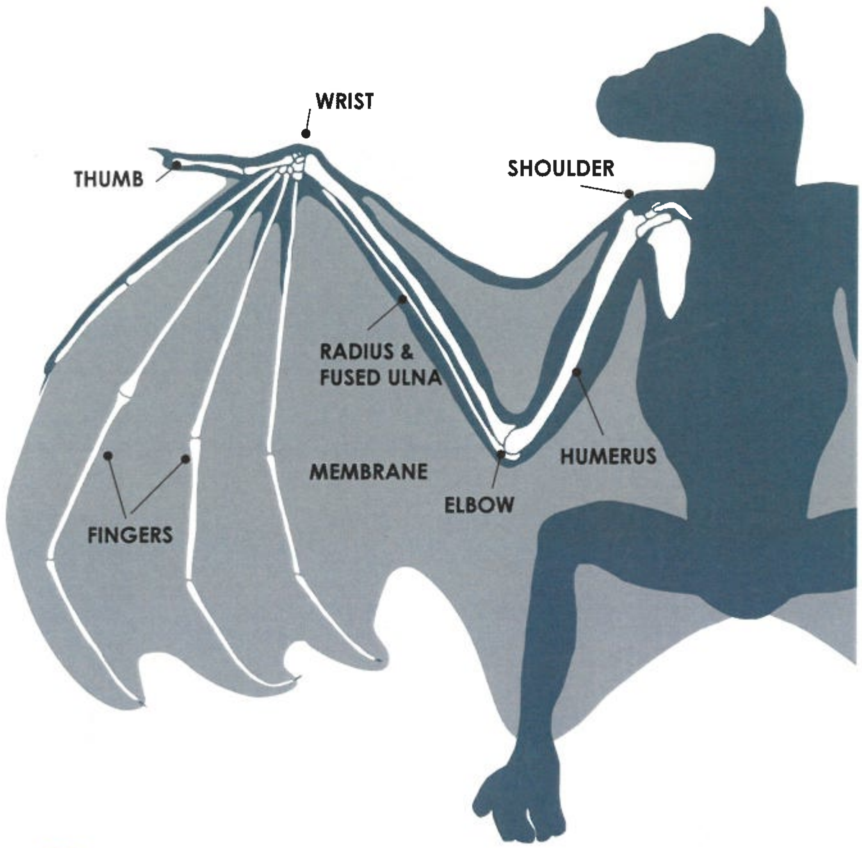
Have teams parade their Batman wings at an assembly or in front of another class. This is a good opportunity for students to talk about the design and materials chosen in front of an audience that aren't their peers. Students need to present on: their design and how it applies to the adaptation of bats, the materials used and the overall look. With a show of hands, other students must indicate which design they like the most.

Time requirement: 2-4 hours (approx)

ACTIVITY 2.1A

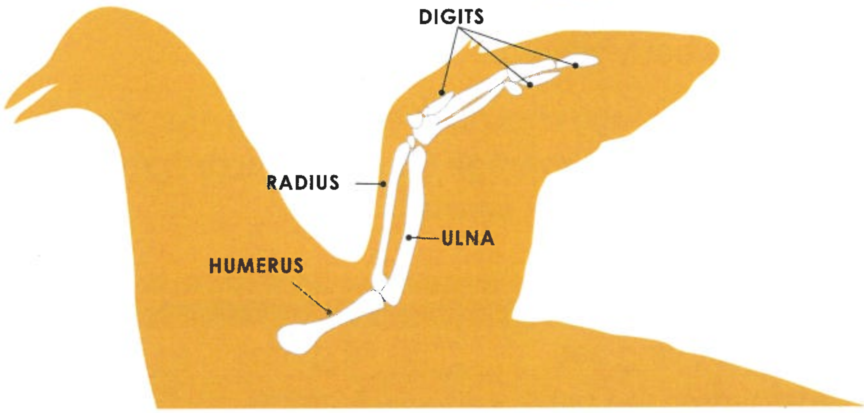
Differences and similarities





Colour the same bones the same colour.

Look closely at the bat and the bird wing structures. Record your observations of the differences and similarities in the table.



DIFFERENCES	SIMILARITIES

ACTIVITY 2.1B

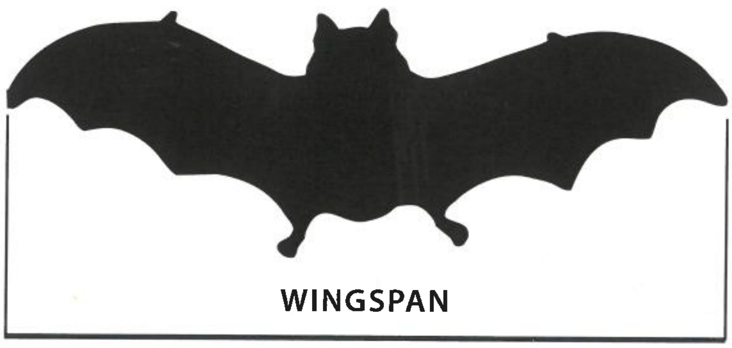
Wingspan for flight

BATTY FACT: Bats need to have wings big enough to keep their body weight in continual flight. The size of their wings can vary depending on the species and the habitat in which they live.

BATTY FACT: Bats hang by their feet with their head down because it is energy efficient. To reduce as much weight as possible for flight, the bones and muscles of the legs are very light weight compared with those of a non-flying mammal. The biggest bones and muscles are those used for flying.

Bats and their body to wingspan ratio

A ratio compares two values. In this example we are comparing weight (measured in grams) to wingspan (measured in millimetres).



In the table below we have chosen six different micro-bats and recorded their average weight and wingspan. The ratio is calculated by dividing the wingspan by body weight.

In the example of the chocolate wattled bat - for every gram of weight, the wingspan is 30 mm across. **The average for all six micro-bats is 1:33** - for every gram of weight, a bat's wingspan is 33 mm across.

Bat Species	Body Weight	Wingspan	Ratio
Eastern bentwing bat	14 grams	341 mm	1:24
Little broad-nosed bat	6 grams	234 mm	1:39
Golden tipped bat	7 grams	250 mm	1:36
Gould's long-eared bat	8 grams	276 mm	1:34
Large-footed myotis	8 grams	281 mm	1:35
Chocolate wattled bat	9 grams	271 mm	1:30
		Average	**1:33**

Translate that into human size - a person who weighs 65 kilograms would have a wingspan that is 2,145 metres or 2.145 kilometres.

ACTIVITY 2.1C

Design Batman's new wings

Batman needs some new wings to help him fight crime in Gotham City. He has asked you to develop a lightweight design that will help him fly or glide between buildings, just like a bat.

He wants the wings to mimic that of a real bat's wing structure, as it is unique to flying mammals - just like Batman.

Draw your design of Batman's new wings below. Label the length of each wing and what material you might use to make them. If your design is good enough, Batman will ask that you take it to the next stage - making a wing prototype.