Key Stage 5 Worksheet

Earth LIVE Lessons: Glowing Puffin Bills & More

What is it about?

In this video, Jamie Dunning, a PhD researcher at Imperial College London who studies birds (including the house sparrow), talks about the use of colour by birds and the different ways colours are produced in bird's bodies and how they are seen by other birds.

Watch the video here:
www.youtube.com/watch?v=muYZ-7h26EM&feature=youtu.be

Open the file in your web browser to click on the links.

Colour and light

When we see a colour what we are seeing is generated by the absorption and reflection of **different wavelengths of visible light.** You can read more about wavelengths of light **here.**

Visible light exists in a spectrum from longer wavelength 'red-light' to shorter wavelength 'violet light' – so when we see 'red' we are seeing longer wavelengths of light and when we see 'purple' colours we are seeing shorter wavelengths of light.

Ultraviolet light has even shorter wavelengths and cannot be perceived by humans with the naked eye. Sunlight contains UV wavelengths, but we only 'see' the visible white light. The shorter UV wavelengths in sunlight have the **potential to damage our skin.**

Like us, birds are able to see in colour, but they can see a wider range of colours than us, because their eyes can see shorter wavelengths of light as well as the 'visible spectrum'. Some species are able to perceive ultraviolet, or near-ultraviolet, wavelengths of light.

Colour and light continued...

Image: Cynthia Tedore via ScienceAlert.com. On the left is how we would see leaves, as a big, green mess. On the right is how scientists discovered some birds can see leaves when they can also detect a difference in how UV light bounces around the tops and underside of the leaves. It makes the leaves much easier to see in detail. You can read more about this study **here.**

Birds use colour for finding food and as part of attracting a mate (sexual selection). It has been suggested that some fruits have developed their colours in order to attract birds, and male birds use colourful feathers to indicate their health and fitness in order to attract females.

Colourful feathers

Most of the colour in birds' feathers comes from compounds called carotenoids and melanins. You can read more about these animal pigments **here.**

Birds get carotenoids from the food they eat. They tend to create colours such as yellow, beige and brown. Melanins are made in the bird's body and are used to generate darker colours such as black.

Blue feathers are created structurally, rather than using pigments. Green feathers are particularly special as they take a lot of energy to produce including structuring the feather to make it blueish and then adding in carotenoids to make green.

Did you know...

Most people know that the dinosaurs went extinct 66 million years ago when an asteroid hit the Earth. But not all the dinosaur groups were wiped out. One group, the avian dinosaurs, survived and evolved into modern-day birds. All birds, from chicken's to eagles, are, in fact, dinosaurs and, just like modern-day birds, many dinosaurs had coloured feathers.

In his dinosaur books, Professor Ben Garrod explores how palaeontologists found out that dinosaurs had coloured feathers too. Melanosomes are small structures that are used to give colour to hair and feathers. Scientists looked at fossilized dinosaur feathers under a scanning electron microscope. When scientists explored the range of feather patterns the fossilised melanosomes indicated they found out that some dinosaurs, especially the Therapod dinosaurs, had really elaborate feather patterns and colours including striped tails, ginger feathers, and orange cheek feathers!

You can read more about this **here.**

Special puffin bills...

Puffins have colourful bills, which are not believed to be sexually selected because both male and female birds have them. Jamie's and his research team wanted to find out more about the bright colours in a puffin's bill and so they one, carefully, under ultraviolet light to observe the appearance of the bill. The team observed something called fluorescence – the bill absorbed the short wave ultraviolet radiation and re-emitted it as longer wave radiation, in the green and yellow part of the visible light spectrum. What this is better knowns as is 'glow in the dark'!

Researchers don't yet know why puffins have 'glow in the dark' bills. Ongoing research is investigating how the bill colours might be seen by puffins, and what function they might have. They might help to produce greater contrast between different parts of the bill, or to draw attention to particular areas or they might just be a side effect of a particular structure to the keratin the bill is made from.

Find out more!

- Find out about the structure of birds' eyes in species that are able to perceive ultraviolet light **here.**
- Carotenoids are lipophilic ('fat liking') molecules used by birds to produce coloured feathers. Read more about their chemical structure and their other functional roles in the animal kingdom, including in humans **here.**
- Explore the electromagnetic spectrum, including the wavelengths of ultraviolet light absorbed by the ozone layer **here.**
- Discover more about how fluorescence works **here.**
- Investigate the role sexual selection plays in determining the colours of male birds **here.**
- Explore some of the other physical and behavioural adaptations of male birds that have arisen through sexual selection **here.**
- Explore the use of fluorescence in different organisms, and consider how fluorescence might be used by puffins **here.**
- You may wish to take your exploration of fluorescence further to consider how Green Fluorescent Protein (GFP) is used as a marker in genetic modification (this is linked to the A2 Biology syllabus around DNA). You can read more about this **here.**
- Investigate the role sexual selection plays in determining the colours of male birds **here.**
- Explore some of the other physical and behavioural adaptations of male birds that have arisen through sexual selection, **here**.

Questions

Interactive: Click on box to start typing

How does birds' perception of colour differ from humans'?

Birds can perceive a wider range of wavelengths than humans. They can see shorter wavelengths, allowing them to perceive ultraviolet or near-ultraviolet light.

How do birds use colour to provide a selective advantage?

Birds can use muted colours like brown to camouflage them from predators, and male birds can use bright colours to help them to display their fitness to attract a mate.

What is the difference between natural selection and sexual selection?

Natural selection acts on all members of a species, selecting for the individuals best adapted to survive and reproduce. Sexual selection acts on the males of a species, and is based on female choice. Characteristics that are favoured by females, for example bright colours demonstrating health and fitness, are selected for.

Why are brown birds very common but green birds are relatively rare?

Green feathers take a lot of energy to create. The feather needs to have a special structure to create a blueish colour, as well as carotenoids to add a yellowish colour, mixing to form green. Brown is easily created by melanin, which birds can make inside their feathers.

How are different colours formed in birds' feathers?

Colour is formed in feathers by their structure or by the pigments (coloured compounds) they contain, or a mixture of the two (e.g. green). Carotenoid pigments come from the bird's diet, and melanin pigments are made inside their bodies.

What observation suggests that puffins' brightly coloured bills have not arisen through sexual selection?

The bills of males and females are the same.

Spicy fact!

An interesting example of a plant whose seeds are dispersed by birds is the chilli pepper. The "heat" of a chilli is produced by a chemical that birds are not affected by, they can eat as many chilli seeds as they lick and don't feel any spiciness. Mammals, however, experience a heat-like painful sensation when they eat chilli pepper fruit and seeds. The chilli has evolved to deter mammals from eating its fruits, because the seeds would be destroyed as they passed through the mammalian digestion. Chilli seeds emerge intact when birds eat them, and are dispersed.

Try an exercise!

Research the role of sexual selection in determining energetically expensive morphological (e.g. elaborate tails and crests) and behavioural traits in male birds. These traits reduce the bird's chances of survival by making them more conspicuous, but increase their chances of securing a mate. Use your research to produce a summary of commonly-observed characters in birds that have arisen through sexual selection.

For teachers and home schoolers

Links to Science in the National curriculum for Wales (KS5)

www.wjec.co.uk/media/gcgjtvqj/wjec-gce-biology-spec-from-2015.pdf

AS Biology: Basic Biochemistry and Cell Organisation - Chemical elements are joined together to form biological compounds [(f) the structure, properties and functions of lipids as illustrated by triglycerides and phospholipids] – carotenoids as a lipophilic group of molecules, providing pigmentation to birds' feathers.

A2 Biology: Variation and Inheritance – Variation and evolution [(c) the effect of inter- and intra-specific competition on breeding success and survival; (k) Darwin's theory of evolution that existing species have arisen through modification of ancestral species by natural selection] – the phenomenon of sexual selection and how this can generate characteristics, such as bright green feathers in birds, which are energetically expensive and confer no survival advantage, through their advertisement of a male's health and fitness and the role of female choice.

A2 Biology: Biodiversity and Physiology of Body Systems - All organisms are related through their evolutionary history [(n) the different types of adaptations of organisms to their environment including anatomical, physiological and behavioural adaptations] – the use of colour as part of the suite of adaptations of birds, and of plants whose fruits are consumed by birds in order to effectively disperse the seeds.

www.wjec.co.uk/media/gxbjl243/wjec-gce-physics-spec-from-2015-english.pdf

AS Physics: Electricity and Light [(f) the fact that the visible spectrum runs approximately from 700 nm (red end) to 400 nm (violet end) and the orders of magnitude of the wavelengths of the other named regions of the electromagnetic spectrum] – ultraviolet light and the visible spectrum of light, and the perception of these by birds.

Swansea University Science for Schools Scheme
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EARTH LIVE LESSONS
UNDEB EWROPEAIDD EUROPEAN UNION
Llywodraeth Cymru Welsh Government
Cronfa Gymdeithasol Ewrop European Social Fund
(S4) Funded by the European Social Fund and the Welsh Government.