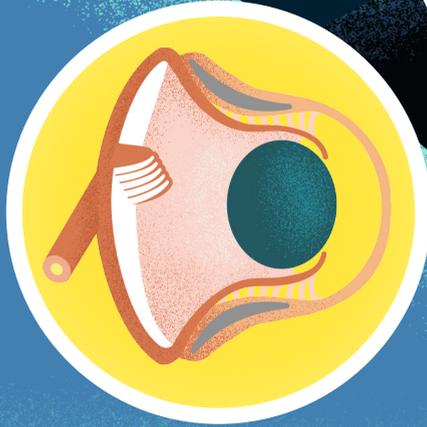


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How Do Animals See?

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Carp



DISTORTED IMAGE

Image that passes through the fish lens is relatively wide, so the **brain perceives it as distorted**. The fact that it is located **outside the centre of the eye** also contributes to this. The distance between the lens and the retina is therefore

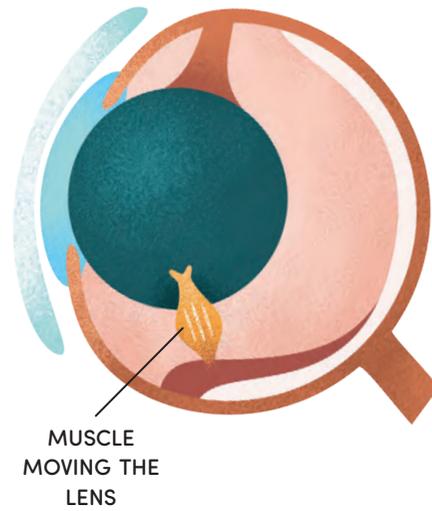
different for different parts of the seen image. This has its advantages as well. Fish have a sense of what is happening **in front of them and on the sides**. This can be vital for them in their search for food, even in case of impending danger.





Carp

Just like yours, fish eyes are made up of the **cornea, the iris, the pupil, the lens and the retina**. So how are they different? Firstly, fish have a **rounded and transparent cornea**. This is especially important in the aquatic environment. Unlike air, **water has a similar density to the cornea**, which is why there is not as much refraction of light in a fish eye as in that of terrestrial vertebrates.



MUSCLE MOVING THE LENS



Perhaps the most interesting thing about a fish eye is its **lens**. It is **spherical**, firm, and therefore fish cannot focus by changing its shape. Fish, amphibians and snakes focus

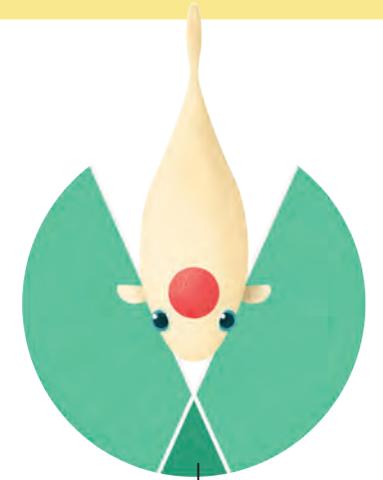
differently: they **change the position of the lens thus changing the distance between the lens and the retina**. Did you know that a type of photography lens is named after the fish lens? This so-called "**fish-eye**" has a wide-angle lens and a can achieve large barrel distortion.

WIDE-ANGLE LENS



NEAR AND FAR VISION

When a fish looks **forward** it is **short-sighted**. This means that it can see the image in front of itself clearly and sharply, but it cannot focus the image at a greater distance. The vision to its **sides**, however, is monocular and **far-sighted**. So, they can clearly see what is going on at a greater distance, but cannot see the small prey at their back.



BINOCULAR VISION



Another difference in the fish's eye is that fish **lack eyelids** and the **tear gland** which keeps eyes moistened, washes out impurities and thus **protects the eye from infection**. Fish living in an aquatic environment are not in danger of dry eye though. You might be wondering, how do fish sleep when they do not have eyelids they can close? **Fish do not sleep like we do**. They just rest in a quiet place with their eyes open.

The **iris** in your eye functions like a window that **adjusts the size of the pupil**, and therefore the amount of light that enters the eye. In **fish**, however, the **iris is inflexible, immobile** and the pupil is fixed in size. That's why fish take longer to get used to more light.



IMMOBILE IRIS



Cat



SPATIAL VISION

Cat's eyes face forward, just like yours. Thanks to this, cats have perfect spatial vision. This allows them to **estimate the distance very accurately**. The properties of the eye enabling high-quality spatial vision, in contrast, reduce the extent of the visual field, which is

a little narrower than the field of humans. This is, however, compensated for by greater **head mobility**. Cat's eyes also catch even the slightest movement of the grass caused by the presence of a prey and clearly distinguishes it from the movement caused by the wind.





Cat

Another interesting adaptation of cat eyes is the ability to actively **control the amount of light that reaches the eyes**. When a cat is lying **in the sun**, its pupils are retracted into the shape of a **narrow slit**. When the cat is active **at dusk**, in contrast, its pupils occupy almost the **entire surface of the iris**. In addition, the pupil has the shape of a vertical slit, thanks to which the cat's vision has a higher resolution in the horizontal direction. And that's not all! **The cat pupil has a 50% larger diameter than the human one.**



CAT'S PUPIL

NIGHT HUNTER



Every mouse would definitely agree that a cat is a dangerous night hunter. Not only does the developed **tapetum lucidum** help the cat do this, but also the high-quality spatial vision allowed by the **curved cornea** and the **large number of rods**. With such equipment, the cat does just fine with only starlight

even on the darkest night. Do cats see colours? They can see some, their eye has **some cones** as well. There really are not many of them though and cats see only **shades of blue and yellow** during the day.



Like many other vertebrate species, cats have developed a **third eyelid** called the **nictitating membrane**. The cat, however, **cannot control it**. The nictitating membrane slides across the eye, for example, when there is an imminent danger.

A THIRD LID

TAPETUM LUCIDUM

The eye of a cat is very similar to the human one. Its structure differs, however, in terms of the presence of special cells located behind the retina. These cells form a special **reflective layer** in the cat's eye, scientifically called tapetum lucidum. You can see it at night when the **eyes of cats are green**. Light consequently passes through the eye twice and the cat can see better and much clearer at dusk.



Tapetum lucidum basically works like a mirror. This, however, results in one **negative effect**, namely the **scattering of the light**, which decreases the resolution of the resulting visual perception. Similarly, **image sharpness** is low due to the low number of cones in the eye. Objects at a distance of more than six metres appear blurry to cats and therefore they always **hunt their prey up close**.

BLURRED VISION



Have you ever wondered how animals perceive the world around us? Whether they can see the same colours as we do, whether the vision of a fish is blurry underwater like ours? Or whether dogs like to watch TV, or cats really can see in the dark? If you have ever asked yourself these questions and it bothers you that you cannot ask the animals themselves, don't worry, because the book you are holding in your hands has the answers to all of these questions and much more.

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