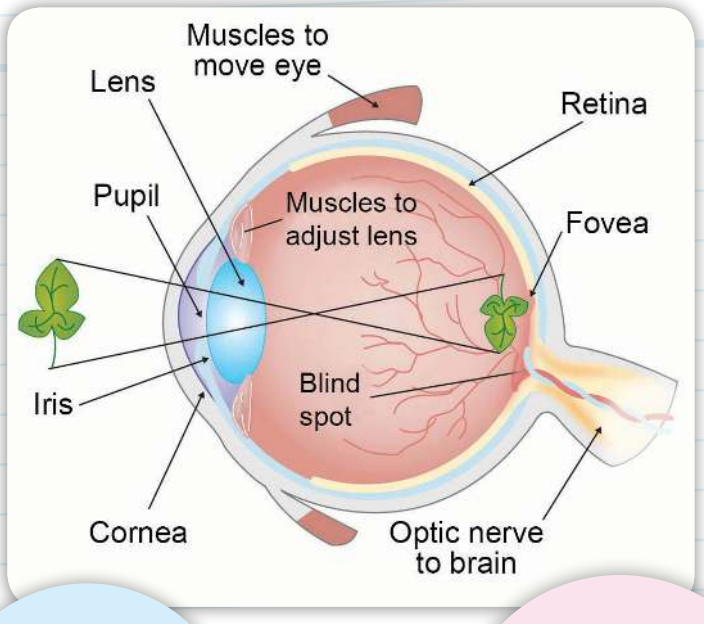
TEACHER RESOURCE

SCIENCE CONTENT/ CURRICULUM LINK
NATURE OF SCIENCE / PHYSICAL WORLD

STARDOME OBSERVATORY & PLANETARIUM
FACTS, RESOURCES AND ACTIVITIES ON...

NIGHT EYES
DARK ADAPTATION



The fact that our knowledge of the Universe evolved at all before telescopes were invented is a great testimony to just how much astronomy can be done with the unaided eye. Understanding a little about how our eyes work means we can better utilise them for night sky observing whether we have a telescope or not.

Behind the front surface of the eye, known as the cornea, lies the iris, which is the coloured bit we are all familiar with. At its middle is a dark hole called the pupil which is where light enters the eye. It is the job of the iris to allow less light in when it is bright and more when it is dark. Moving from a bright room into a dark place means the eye must adapt in a process called dark adaptation. The iris will open up, or dilate, which is the first step in the process, taking a few seconds.

Behind the iris and pupil lies the lens which focuses the light through a liquid called the vitreous gel to the retina at the back of the eye. The retina is covered with millions of light-sensitive detectors called rods and cones. These also need to adjust to the dark 'chemically' in the second phase of dark adaptation. This takes at least half an hour.

Dark adaptation is not the only thing that we need to think about when observing. If we look directly at an object most of the light hits a part of the retina called the macula where the cones are more concentrated. There are about 6 million of them, they're fantastic at detecting colour, but not as light-sensitive as the rods.

If some light is needed 'red is best'. Red is lower energy and our eyes are less sensitive to it.

In the dark our cones don't work well but our rods are at their best.

It can take up to an hour for our eyes to be at their best for astronomy, but we can lose it in an instant if someone flashes a bright light.

Surrounding the macula are about 120 million rods - these are much more light-sensitive but pretty hopeless at detecting colour.

This is why, in dark environments, we see shades of grey instead of colours.

This is not a problem for viewing planets which are bright in telescopes so that we can see their colours. But if you're looking at dim objects like nebulae or distant star clusters we use a technique called 'averted vision'. By looking slightly to the side of a dim object more of the light falls on our rods, and like magic, it pops into view in greater detail.

Check out these other resources...

ucalgary.ca/pip369/mod3/brightness/darkadaptation

The following contains numerous other activities relating our eyes
faculty.washington.edu/chudler/chvision.html

What animals and other creatures see better (or worse) in the dark than humans? Why do you think this is?

Why do we see dim objects in the dark better if we don't look directly at them?

DISCUSSION POINTS

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ACTIVITY

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AVERTED VISION

YOU WILL NEED:

- Either a room that can be made very dark (preferably windowless) OR a night time environment. The latter could be at a school camp or the activity could easily be done by students at home.
- A dark surface and/or a light surface and bottle tops similar in shade to the surfaces.

WHAT TO DO:

1. Set up a dark lid and/or a light lid on similar coloured surface/s then darken the room.
2. Wait a few minutes.
3. Test the averted vision technique by first staring directly at a lid then looking slightly away.

Students should notice the lid spring into view more clearly as they avert their vision.

IRIS OBSERVATIONS

- Sit in front of a mirror in a bright room for at least a minute with one eye covered and tightly closed.
- With your open eye stare at the reflection of your covered closed eye in the mirror.
- When you're ready uncover and open your closed eye and watch that pupil rapidly contract.

Students will see how quickly the eye loses its dark adaptation.

EXTRA FUN

- Have the students in the dark for 5 minutes and before turning on the lights ask the students to close one eye and cover it tightly with one hand.
- Turn on the lights for a minute (students must keep one eye closed and covered so that only one eye adapts to the light).
- Turn off the lights again and then ask the students to open both eyes**.

****Don't tell them beforehand – they should experience a very strange sensation arising from the asymmetric dark adaptation of their two eyes – discuss why this might be.**

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ACTIVITY

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LOW LIGHT LEVELS

TEST YOUR COLOUR SENSITIVITY!

YOU WILL NEED:

- Either a room that can be made very dark (preferably windowless) OR a night time environment. The latter could be at a school camp or the activity could be adapted for students to do at home.
- Bottle tops of various colours – they should feel the same, but not look the same. We used milk bottle tops obtained from cafes.
- Colour square template on the following page

WHAT TO DO:

1. In a bright room, ask students to shuffle the caps around then turn off the lights so the room is very, very dim. Immediately ask them to separate the caps into their various colours. Turn on the lights and look at the results... there should be many mistakes. Count the number of errors.
2. Shuffle the caps again and turn off the lights and talk/discuss about dark adaptation or about the animals that can see in the dark. Plan to discuss for 5-7 minutes – this should be enough time for some adaptation. Once again get the students to sort the caps in the dark, turn on the lights, and count the number of errors. There should be fewer errors this time.

EXTRA FUN

- Distribute the colour square templates and, in a bright room, ask the students to identify which colour square (red or blue) appears the brightest.
- Repeat this immediately after the lights have been turned off and at intervals over the next few minutes. The brightness of the colours should appear reversed in the dark.
- Discuss the results.

Our eyes are essentially identical in design!

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