BIOLOGY

Process and analyse information from secondary sources to compare and describe the nature of photoreceptor cells in mammals, insects and simple light receptors

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COMMUNICATION

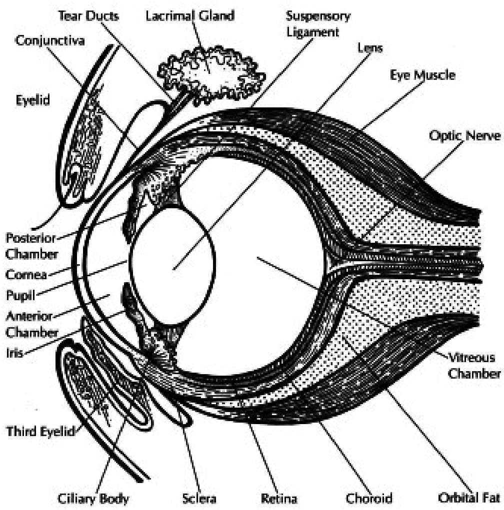
MAMMAL # 1: HORSE

The horse possesses the largest eye in the mammalian world, its structure and nature of photoreceptor cells, directly related to its behaviour.

The structure of its eye:

The horse has eyes more spaced apart then humans, allowing them to see 215 degrees, compared to humans, who only have a 180 degrees peripheral vision. Their monocular vision is crucial, allowing them to see predators on the horizon, whilst grazing.

[1]The nature of a horse's photoreceptors:



1. Horses have more rods to cones, in an approximate, (20:1) ratio.
2. They contain 2 types of cones in their eyes, one short and one of middle wavelength, allowing different intensities of light to be detected.
3. They have a lower sense of colour detection due to the less number of cones, which can distinguish between different intensities of light and colour. They have dichromatic vision, seeing two of the three basic wavelengths from the visible light spectrum. Horses can distinguish between only green and blue and their sight is based on different shades of grey.
4. Their retina contains a tapetum lucidum, a reflective panel, with rods and cones that gather all available light, hence allowing superior night vision.
5. [2]Their detection of colour vision diminishes with decreasing light and are less able to adjust to sudden changes of light.

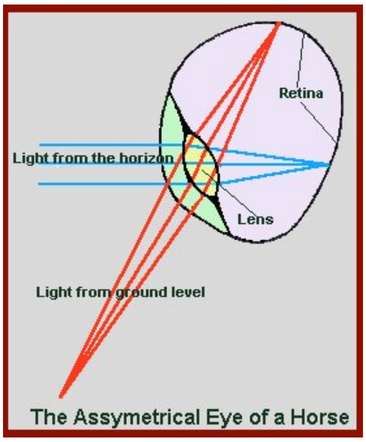


Figure 2: monocular vision of the horse

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[1] Figure 1: http://eyeonthehorse.blogspot.com/
[2] http://horses.suite101.com/article.cfm/horse_vision

MAMMAL # 2 CAT

The nature of a cat's photoreceptor cells:

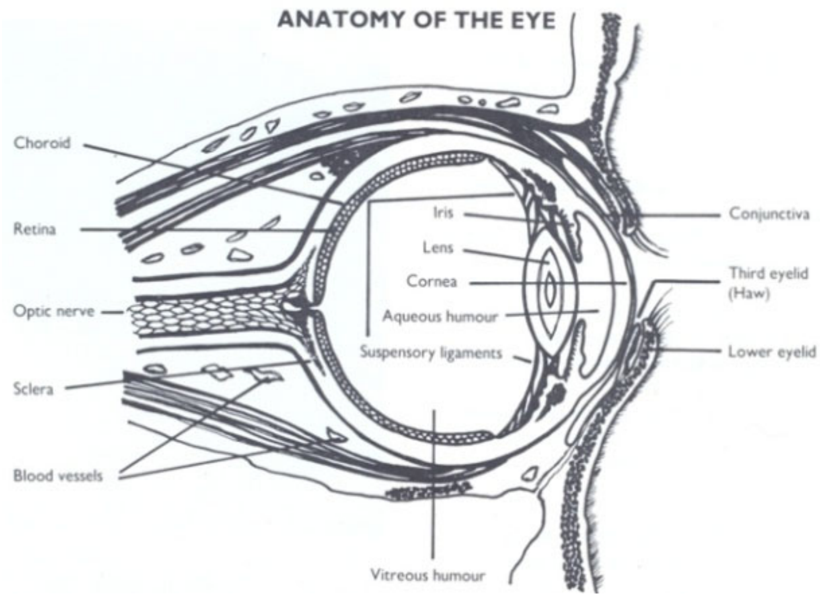
1. Cat's eyes can function in one sixth of the light needed for human to see.

2. Cats contain a greater concentration of rods, specialised for low light conditions hence, aiding night time vision.

3. Their limited amount of cones in the retina make their ability to see colours less enhanced however colour is still possible.

4. Greater concentration of receptor cells along a broader, horizontal band, giving cats more sensitivity to movement along the horizontal axis, hence being able to detect prey at greater distances.

5. Cats also have a tapetum lucidum, acting like a mirror, reflecting light back onto the light sensor cells in retina. This allows the cat to make more use of the existing light.



[3]

The structure of its eye:

The pupil of a cat's eye is controlled by two **extra** cilliary muscles, often resulting in an elliptical pupil.

[3] http://www.kittyshow.com/cat_color_vision.html

COMPARISON OF MAMMALIAN PHOTORECEPTORS:

Similarities	Differences
1. Both the horse and cat contain a tapedum lucidum behind their retina.	1. The horse's ability to see colour is less enhanced than the cats ability to see colour.
2. Both have a greater concentration of rods, than cones, allowing greater night vision.	
Similarities	**Differences**
2. Both the horse and cat contain a tapedum lucidum behind their retina.	3. The horse's ability to see colour is less enhanced than the cats ability to see colour.
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Characteristic #	Horse #	Cat #
Presence of rods and cones:	Yes.	Yes.
Concentration of rods and cones:	Presence of rods greater than cones in a 20:1 ratio.	Greater concentration of rods to aid night time vision.
Ability to see colour:	Less enhanced. Horses have dichromatic vision and can only distinguish between greens and blues. Their colour is based on shades of grey.	Cats aren't colour blind however the limited concentration of cones, cause lack of colour perception.
Presence of extra light absorption mechanisms:	Yes- tapetum lucidum, aids night vision.	Yes- tapetum lucidum.
how these benefit the mammal:	The Horses' night vision assists them whilst grazing, early dawn, where light is often dimmed.	Cats have superior night vision, benefitting their behavioural patterns, especially at night.

INSECT 1 –HONEY BEE/ 'APIS MELLIFERA'

The nature of a Honey Bee's photoreceptor cells:

1. Amongst the Bee's compound eyes, each contains approximately 6000 lenses that cover openings of miniscule tubes, each containing 8 light photoreceptors. These photoreceptors, composed of rods and cones, detect UV light and send these to the brain.

2. In each of the Honey Bees' ommatidium, there are four visual cells that respond to light intensity in between wavelengths of 300- 650nm.

a. Of these four distinct visual cells, two respond to blue light and 2 respond to UV light. This is beneficial as Honey Bees are able to differentiate between species of flowers, and secure nectar from one species at a time.

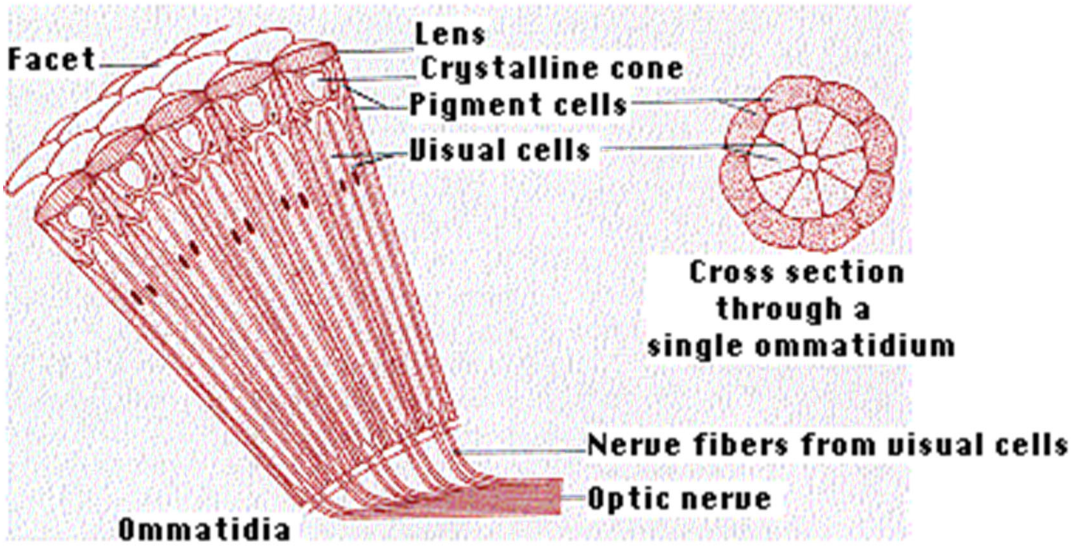


Figure 1: a Bee's ommatidia

The structure of its eye:

The Bee has compound eyes- made up of hundreds of simple eyes called ommatidia. They produce a mosaic like image and their compound eyes are useful in movement perception.

b. The bees have a fairly broad colour range and can differentiate between six major colours- yellow, blue-green, blue, violent, Ultra Violet, and 'bee's purple' (a combination of yellow and UV). Bees however cannot see red.

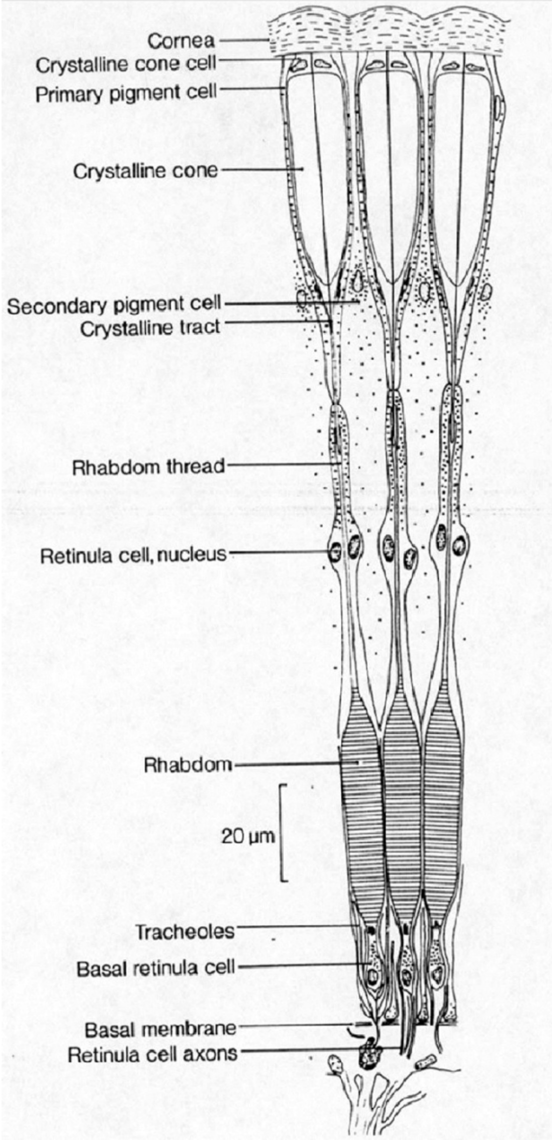
3. [4]Bees are able to see polarized light and their photoreceptors are sensitive to the refracted light from the waxy surface of plants.

[4] http://www.howstuffworks.com/question675.html

INSECT 2 – MOTHS

Nature of a Moth's photoreceptors:

1. Moths are positively phototactic, attracted to light.
2. Their rods are sensitive to Ultra Violet light.
3. White light attracts moths more than yellow light, as their cones are more sensitive to white light.
4. Their eyes contain nanostructures which create an effective medium where the refractive index gradually increases as light travels from air through to the insect's optical nerve.



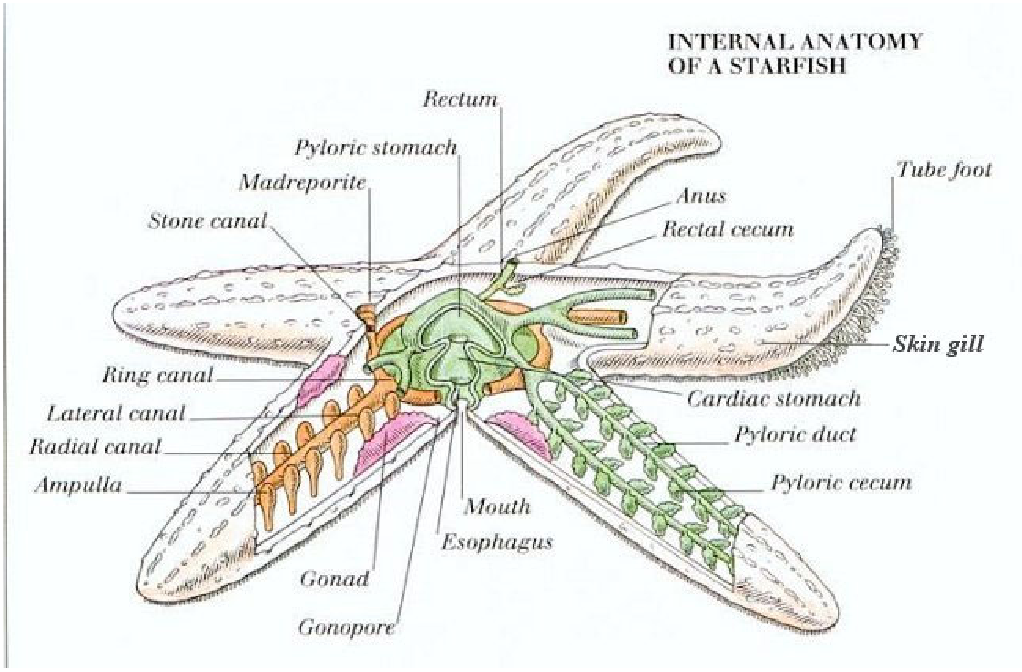
COMPARSION OF INSECT PHOTORECEPTORS:

Characteristic #	Honey bee #	Moth #
Structure of the eye:	Compound eye composed of single eyes called Ommatidias.	Nanostructure.
Colour perception:	Broad colour range that can differentiate between six major colours. Most attracted to UV and bees purple- a mixture of yellow and UV.	Attracted to white light more than yellow light.
Light sensitivity:	Can detect within a wavelength of 300-650nm and can also detect UV light.	Sensitive to UV light.
Mechanisms to refract light:	Light is refracted through the lenses in each ommatidia.	Light is refracted through the nanostructures in the eye.

INVEREBRATE: STARFISH

Nature of the Starfish's photoreceptors:

[5]Each of the starfish's arms are covered with light sensitive cells, called eyespots. Nerves run from the pigment spots to the starfish's central nerve ring. Their eyespots contain a red pigment that is sensitive to light. Varying amounts and intensities of lights that hit these eyespots cause movement. These give out signals that affect the starfish's behaviour, enabling it to avoid intense light and adapt to differing light preferences. The starfish's 'eyespots' are not sophisticated enough, like humans to develop proper images however are useful in adapting to various environments.



[5] Image of starfish anatomy: http://physicsworld.com/cws/article/news/37711

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