HSC Biology

Communication

Focus 4:

- *The light signal reaching the retina is transformed into an electrical impulse.*

Identify photoreceptor cells as those containing light sensitive pigments and Explain that these cells convert light images into electrochemical signals that the brain can interpret.

- Photoreceptors are found in the retina.
  - They contain light sensitive pigments.
    - Rhodopsin (in rods).
    - Opsin (in cones).
      - 3 iodopsin's (red, green, blue).
  - Convert light into electrochemical impulses that are interpreted by the brain.
    - Electrochemical impulse created by flow of Na^+ & K^+ across selective channels in membrane of a neuron.
      - Action potential created.

Describe the differences in distribution, structure and function of the photoreceptor cells in the human eye.

- Retina is a thin sheet of cells containing photoreceptor cells.
  - Light sensitive cells that are activated to produce an action potential.
  - Modified neurones, not distributed evenly around the retina.
  - Retina also contains the bipolar cell layer, ganglion cell layer & horizontal & amacrine cells (associated nerve cells).

- Photoreceptor layer receives light, convert light into electrochemical signals and transmits impulse to bipolar cells.
  - Bipolar cell layer receives impulses from photoreceptor layer and pass them onto the ganglion cell layer.
  - Neurones in ganglion cell layer receive impulse, distal end carries signal to optic nerve.
  - Horizontal cells occur at junction between photoreceptor cells & bipolar cells.
  - Amacrine cells occur between bipolar cells & ganglion cells, ‘summarise’ info.

- 2 types of photoreceptor cells found at in the very last layer of the retina.
  - Rods.
    - Activated in low light conditions.
    - Only sensitive to blue-green end of spectrum.
  - Cones.
    - Activated in plentiful light, produce visible spectrum.

- Rods:
  - 125million in human eye.
  - Long, rod shaped cells.
  - Sensitive to low levels of light.
  - Can’t discriminate between different wavelengths of light. Discriminate between shades of light & dark.
  - Low visual acuity (image formed lacks detail).
    - Due to many rods converging to 1 ganglion cell.
    - Linked in groups to single neurones.
  - Located around periphery of retina, none in fovea.
  - Best suited to night vision.
  - Most rods exposed when pupil dilated.
  - Sensitive to movement.

- Cones:
  - 6.5million in human eye.
  - Conical shaped cells.
  - Contain pigments (opsin) which are sensitive to high amounts of light.
    - 3 different forms sensitive to blue, green, red.
  - Extensive nerve connections.
    - Highly detailed image formed.
  - More concentrated to back of retina.
    - Most dense in fovea.
  - Most suited to day vision.
    - Most light, pupils contracted.
  - Require high amounts of light to be activated.
    - Can't detect colours in poor light.

- Level of visual activity depends on concentration of cone cells per area.
  - More cone cells = more impulses initiated = more detailed image.

Photoreceptor Cells In Humans				
Photoreceptor cell	**Distribution**	**Pigment**	**Function**	**Wavelength sensitive to**
Rods	Periphery of retina	Rhodopsin	- Discriminate between shades of dark & light. - Detection of movement.	Blue-green
Cones	Mostly in fovea	Iodopsin (blue, green, red)	- Discriminate between wavelengths of light to create colour vision.	380nm - 780nm (visible spectrum)

Outline the role of rhodopsin in rods.

- Rhodopsin:
  - Consists of;
    - A protein molecule (***opsin***).
    - A light absorbing part (***retinal***) which is a derivative of vitamin A.
      - Retinal exists as in either activated or deactivated form.

- The role of rhodopsin:
  - Main function is to absorb light.
  - Light striking rhodopsin causes a change from resting state to excited state.
    - Retinal part of rhodopsin activated.
  - Rhodopsin splits into opsin & free retinal (bleached).
    - Temporary.
  - Change in electrical charges of membrane of the rod.
    - The beginning of an electrical impulse and moves along receptor.
  - Release of neurotransmitter carries impulse from photoreceptor layer to bipolar layer which is carried to the ganglion layer etc...

- Rhodopsin is 'bleached' or broken down in presence of light.
  - Regenerated & reused.
    - Enzymes used to rejoin opsin & retinal.
    - Vitamin A must be present in this process.

Identify that there are three types of cones, each containing a separate pigment sensitive to either blue, green or red light.

- Cones contain 3 different photosensitive pigments.
  - Blue.
  - Green.
  - Red.

- Trichromatic theory of vision suggests each type of pigment is sensitive to different wavelengths of light.
  - Sensitivity of pigments broad enough to cover full spectrum of visible light.
  - Pigments very similar to those in rods but require more light to be activated.

- Each pigment located in different cones.
  - Perception of colours from different inputs of cone types.
  - Colour picture built on number of impulses from each cone cell.

Explain that colour blindness in humans results from the lack of one or more of the colour sensitive pigments in the cones.

- Colour blindness caused by absence of or dysfunction of one or more types of cone cells.
  - Causes wrong impulse to be sent, resulting in incorrect picture forming.
  - Most common form is red-green colour blindness.

Process and Analyse information from secondary sources to Compare and Describe the nature of photoreceptor cells in mammals, insects and in simple light receptors in one other animal.

	Animal	Distribution of photoreceptors	Ability to perceive colour
Mammal	Humans	- Located in eye. - Rods & cones. - 3 types of cones. - Located towards centre of retina. - Rods towards periphery.	- Trichromatic vision.
	Dog	- Located in eye. - 2 types of cones.	- Red/green colour blind.
Invertebrate	Bee	- Compound eye. - 100s of optical units called ommatidia.	- 3 colour vision. - Can see U.V. light. - Can't see red.
	Flatworm	- Cup eyes.	- Directional info only. - No colour.

Process and Analyse information from secondary sources to Describe and Analyse the use of colour for communication in animals and relate this to the occurrence of colour vision in animals.

The Nature of Photoreceptors In Animals				
	Animal	**Acuity**	**Colour**	**Detection of Movement**
Pigment cup	Planarian	Very little detail	No	Very low sensitivity
Compound eye	Insect	High detail in close range	Yes	Highly sensitive to movement
Mammalian eye	Human	Moderate to high	Yes	Yes

- Humans:
  - Ability to see colour assists in differentiation between objects.
  - Communicates situations.
    - *eg.* Red = danger.
  - Signs on roads distinguished by colour.

- Other animals:
  - Colour used for:
    - Attracting mates.
    - Warning signs (red = poisonous).
    - Visual displays.
    - Marking territory.
    - Colour also used for camouflage.

  eg. Bower bird collects bright or blue things to attract females.

- Insects (*eg.* Bees) use colour vision to detect flowers.
  - Use U.V. vision to find nectar in flower.

- Birds use colour vision to attract / find mates.
  - Believed to have tetrachromatic vision (4 types of cones).

- Most mammals possess dichromatic vision (2 types of cones).