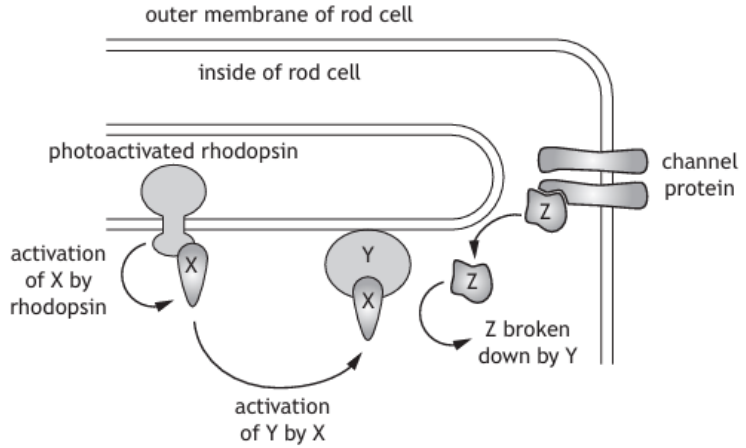
1 The diagram shows events in the response to light in the rod cells of animals.



When a photon of light hits a molecule of rhodopsin it activates molecule X, which disassociates from rhodopsin and activates another molecule, Y. Activated Y breaks down molecule Z, which in turn affects the function of a channel protein.

Which row in the table identifies molecules X, Y and Z?

	Molecule X	Molecule Y	Molecule Z
A	cGMP	transducin	PDE
B	transducin	PDE	cGMP
C	PDE	transducin	cGMP
D	transducin	cGMP	PDE

2 Which line in the table below correctly describes features of cone cells in humans?

	Function in low light intensity	*Contain different forms of opsin*
A	no	yes
B	yes	yes
C	no	no
D	yes	no

3 The statements describe the sequence of events that follows the absorption of a photon of light by rhodopsin in the rod cell of a mammal.

1. Cyclic GMP is hydrolysed
2. Ion channels in the membrane of the rod cell close
3. The G-protein transducin is activated
4. The enzyme phosphodiesterase is activated

The order in which these events occur is

A 1, 3, 4, 2
B 3, 4, 1, 2
C 4, 3, 2, 1
D 3, 1, 2, 4.

4 In animal rod cells rhodopsin absorbs a photon of light initiating the following cell events.

1 nerve impulse is generated
2 sufficient product formation is triggered
3 activation of hundreds of G-protein molecules
4 activation of hundreds of molecules of an enzyme

The correct order of events is

A 4, 2, 1, 3
B 3, 4, 2, 1
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5 Which row in the table below describes features of rod cells in humans?

	function in low light intensity	*contain different forms of opsin*
A	no	yes
B	yes	yes
C	no	no
D	yes	no

1. Rod cells contain the protein complex rhodopsin. When struck by a photon of light, rhodopsin becomes photoexcited.

Describe how photoexcited rhodopsin results in amplification of this signal to enable vision in low light intensities. **2**

2. As retinitis pigmentosa progresses, cone cells are also lost.

Predict what effect this would have on an individual's vision. **1**

3. The most common cause of night blindness in developing countries is vitamin A deficiency (VAD). VAD results from a lack of dietary vitamin A but is also made worse by infections, which reduce both intake and absorption of vitamin A.

(i) The main circulating form of vitamin A in the blood is retinol, which is required to produce retinal.

Suggest how VAD may lead to night blindness. **1**

4. Vitamin A is also required for certain white blood cells to proliferate correctly.

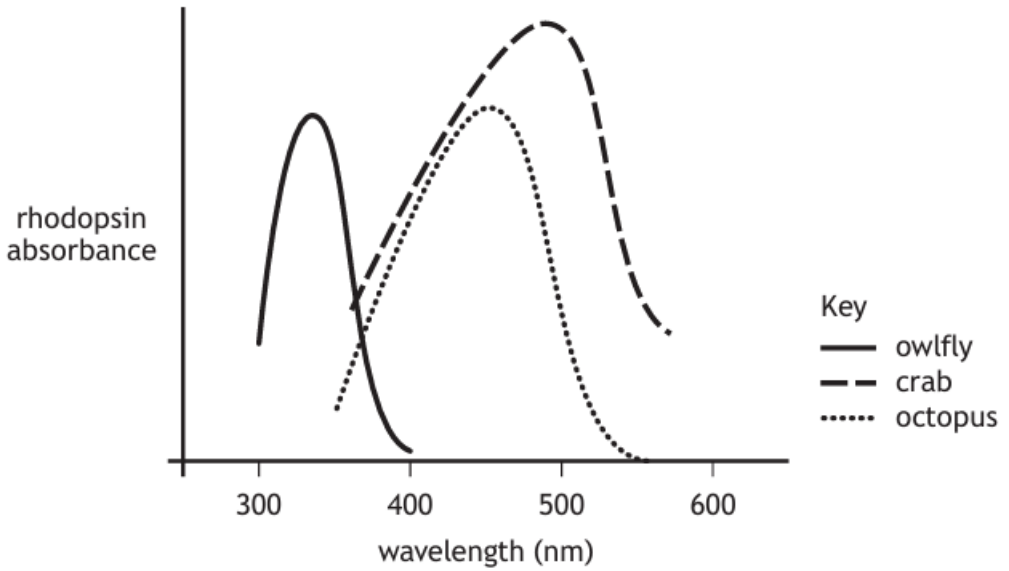
Explain how this would contribute to progressive worsening of VAD in affected individuals. **2**

5. Name the light sensitive molecule in animals that combines with the protein opsin to form photoreceptors of the eye. **1**

6. Rod cells contain rhodopsin.

Explain why these cells can function in low light intensity. **1**

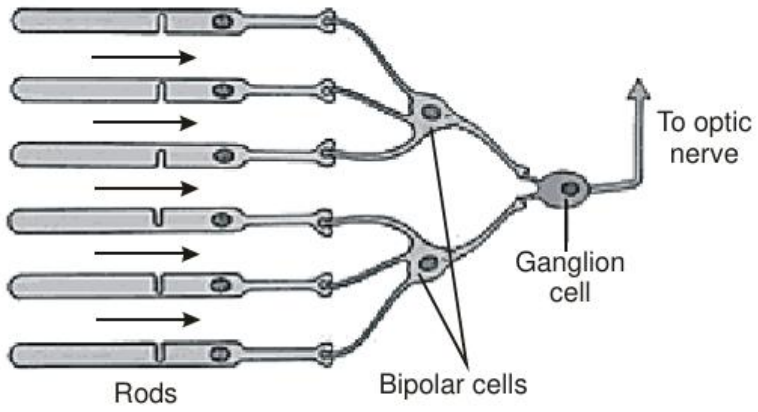
Figure 1



7. Owlflies have rhodopsin that is sensitive to light of 345 nm (UV).

Suggest how the photoreceptor proteins of owlflies differ from those of crabs. **1**

8 The diagram below represents the arrangement of rods in the retina.



(a) Name the light-sensitive molecule in rods.

_____ **1**

(b) Give the characteristic of rod vision which is favoured by the high rod to ganglion ratio.

_____ **1**

9 Rod cells are more sensitive than cone cells at low light intensities.

State how this sensitivity is achieved. **1**

_____

_____

10 Most birds have four types of cone cells.

Name the additional wavelength range to which these organisms are sensitive. **1**

_____

11 a) Name the light-absorbing component of rhodopsin. **1**

_____

b) Describe the mechanism by which the absorption of a photon by rhodopsin leads to the generation of a nerve impulse. **3**

_____

_____

_____

_____

_____

_____

12 (a) Give one feature of the photoreceptor system in rods that allows these cells to function in low light intensity. **1**

_____

_____

(b) In cone cells, the light sensitive molecule retinal combines with a membrane protein to form photoreceptor proteins.

Name this membrane protein. **1**

_____

13) Rod cells and cone cells are photoreceptors in vertebrate eyes. Membranes in these cells contain rhodopsin, a protein molecule that has a light-absorbing component. Rhodopsin generates a nerve impulse when light is absorbed.

(a) Name the light absorbing component in rhodopsin.

_____ **1**

(b) Photoexcited rhodopsin activates hundreds of G-proteins and each of these activates an enzyme called phosphodiesterase (PDE).

(i) Name the G-proteins activated.

_____ **1**

(ii) Describe how the action of phosphodiesterase (PDE) triggers a nerve impulse.

_____

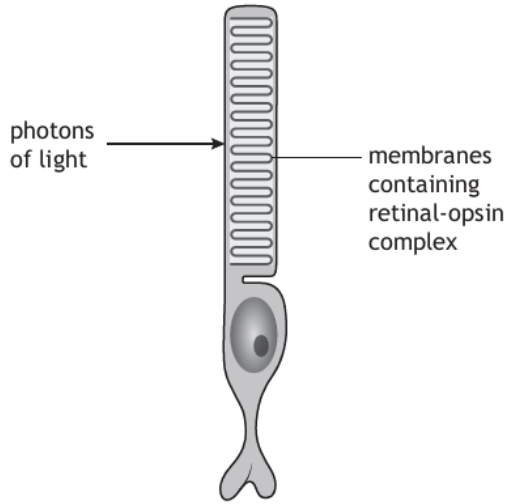
_____

_____ **2**

(c) Cone cells are sensitive to different wavelengths of light. Name the component of rhodopsin that varies in cone cells.

_____ **1**

14) Rod cells and cone cells are photoreceptors in the retinas of vertebrate eyes which are sensitive to photons of light. The diagram below shows a rod cell containing membranes rich in a retinal-opsin complex.



(a) Name the retinal-opsin complex found in vertebrate rod cells. **1**

_____

(b) The retinal opsin complex activates hundreds of G-protein molecules and so provides amplification in the system.

(i) Describe the role of activated G-protein molecules. **1**

_____

_____

(ii) State why amplification is an advantage to vertebrates. **1**

_____

_____

(c) Describe how the photoreceptor proteins of cone cells differ from those of rod cells. **1**

_____

_____

(d) Explain why the variety of photoreceptor proteins in cone cells provides an advantage to vertebrates. **1**

_____

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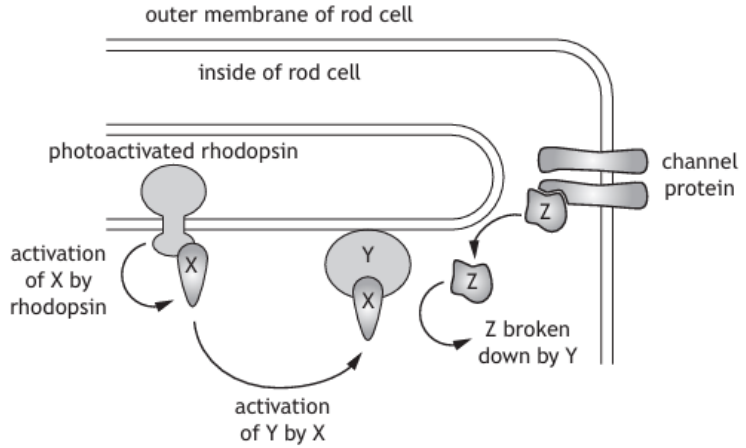

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1. Rod cells contain the protein complex rhodopsin. When struck by a photon of light, rhodopsin becomes photoexcited.

Describe how photoexcited rhodopsin results in amplification of this signal to enable vision in low light intensities. **2**

A single photoexcited rhodopsin activates hundreds of transducin

Each activated transducin activates one PDE molecule

Each active PDE molecule breaks down thousands of cGMP molecules per second.

2. As retinitis pigmentosa progresses, cone cells are also lost.

Predict what effect this would have on an individual's vision. **1**

Loss of colour vision.

3. The most common cause of night blindness in developing countries is vitamin A deficiency (VAD). VAD results from a lack of dietary vitamin A but is also made worse by infections, which reduce both intake and absorption of vitamin A.

(i) The main circulating form of vitamin A in the blood is retinol, which is required to produce retinal.

Suggest how VAD may lead to night blindness. **1**

Without retinal it can't combine with opsin to form rod photoreceptors.

4. Vitamin A is also required for certain white blood cells to proliferate correctly.

Explain how this would contribute to progressive worsening of VAD in affected individuals. **2**

Less WBC's results in more infections

Infections reduce intake/absorption of vitamin A.

5. Name the light sensitive molecule in animals that combines with the protein opsin to form photoreceptors of the eye. **1**

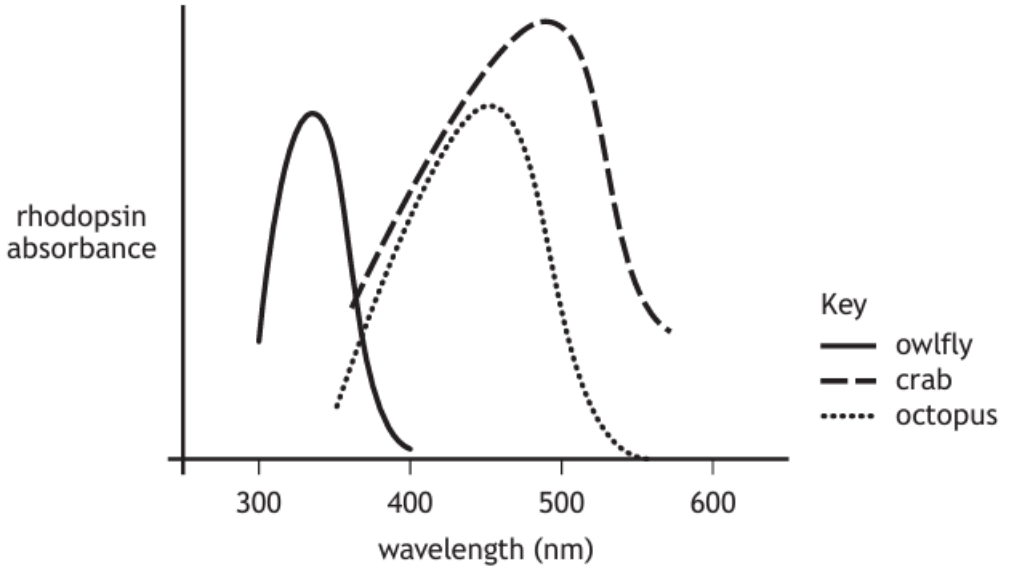
retinal

6. Rod cells contain rhodopsin.

Explain why these cells can function in low light intensity. **1**

Higher amplification of pathway

Figure 1



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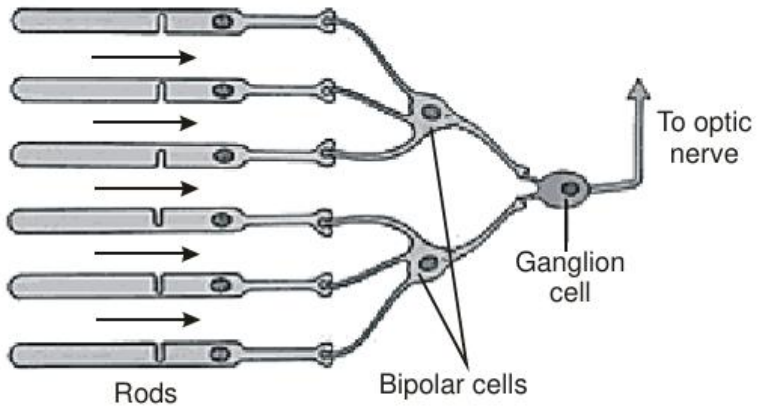
Suggest how the photoreceptor proteins of owlflies differ from those of crabs. **1**

Different forms of opsin.

8 The diagram below represents the arrangement of rods in the retina.



(a) Name the light-sensitive molecule in rods.

Retinal

1

(b) Give the characteristic of rod vision which is favoured by the high rod to ganglion ratio.

See in dim light/higher degree of amplification

1

9 Rod cells are more sensitive than cone cells at low light intensities.

State how this sensitivity is achieved. 1

Higher degree of amplification.

10 Most birds have four types of cone cells.

Name the additional wavelength range to which these organisms are sensitive. 1

UV light

11 a) Name the light-absorbing component of rhodopsin. 1

retinal

b) Describe the mechanism by which the absorption of a photon by rhodopsin leads to the generation of a nerve impulse. 3

Rhoposin changes conformation to become photoexcited rhopsin

1 photoexcited rhodopsin activates 100's of transducin

One transducin activates one PDE.

100's of PDE breakdown 1000's of cyclic GMP

Ion channel closes

12 (a) Give one feature of the photoreceptor system in rods that allows these cells to function in low light intensity. 1

Higher degree of amplification

(b) In cone cells, the light sensitive molecule retinal combines with a membrane protein to form photoreceptor proteins.

Name this membrane protein. 1

Opsin

13) Rod cells and cone cells are photoreceptors in vertebrate eyes. Membranes in these cells contain rhodopsin, a protein molecule that has a light-absorbing component. Rhodopsin generates a nerve impulse when light is absorbed.

(a) Name the light absorbing component in rhodopsin.

Retinal

1

(b) Photoexcited rhodopsin activates hundreds of G-proteins and each of these activates an enzyme called phosphodiesterase (PDE).

(i) Name the G-proteins activated.

transducin

1

(ii) Describe how the action of phosphodiesterase (PDE) triggers a nerve impulse.

Hydrolyses thousands of cyclic GMP per second/
Closes ion channel in rod cell membrane

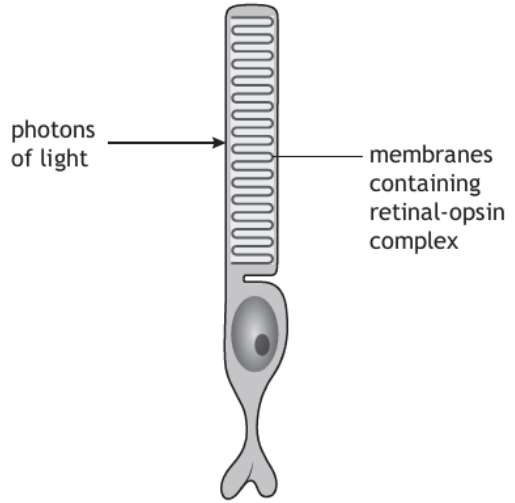
2

(c) Cone cells are sensitive to different wavelengths of light. Name the component of rhodopsin that varies in cone cells.

opsin

1

14) Rod cells and cone cells are photoreceptors in the retinas of vertebrate eyes which are sensitive to photons of light. The diagram below shows a rod cell containing membranes rich in a retinal-opsin complex.



(a) Name the retinal-opsin complex found in vertebrate rod cells. 1

rhodopsin

(b) The retinal opsin complex activates hundreds of G-protein molecules and so provides amplification in the system.

(i) Describe the role of activated G-protein molecules. 1

Activate PDE

(ii) State why amplification is an advantage to vertebrates. 1

Can see at low light intensities

(c) Describe how the photoreceptor proteins of cone cells differ from those of rod cells. 1

Have different forms of opsin

(d) Explain why the variety of photoreceptor proteins in cone cells provides an advantage to vertebrates. 1

Colour detection