

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

5.2.2 MONITORING VISUAL FUNCTION

SCORE

/63

PERCENTAGE

%

STEMUP

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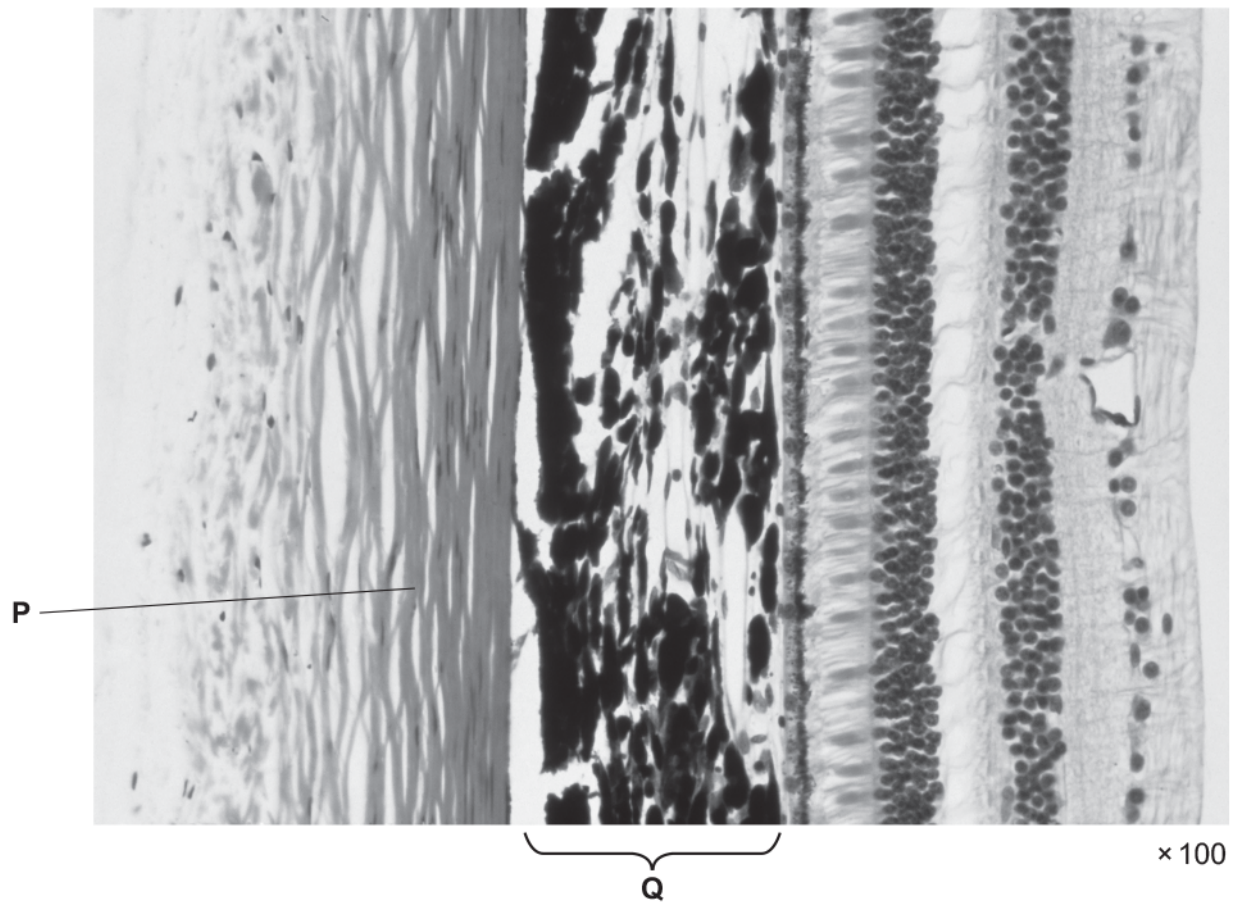
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1(a) The photomicrograph below shows a section through the wall of a mammalian eye.



(i) Outline the structure and function of the outer layer, labelled P, in the photomicrograph.

[2]

(ii) The layer labelled **Q** contains highly pigmented cells.

Name layer **Q** and state the importance of this layer to the functioning of the eye.

Name -----

Importance -----

----- [2]

(b) Bardet-Biedl syndrome (BBS) is a human genetic disorder. One of the main symptoms is child-onset loss of vision.

Abnormalities of cilia are known to be related to a wide range of disease symptoms including those commonly seen in BBS patients. It is now accepted that mutated *BBS* genes affect microtubules and the normal functioning of cilia.

In the early childhood of individuals with BBS, deterioration of cone cells in the retina occurs, leading to poor visual acuity and colour blindness.

(i) Using your knowledge of the internal structure of photoreceptor cells, suggest why mutated *BBS* genes lead to deterioration of cone cells and poor visual acuity.

----- [2]

(ii) Explain how cone cells enable humans to distinguish colour.

[3]

(iii) Obesity, syndactyly, diabetes and kidney failure are other symptoms associated with BBS.

Suggest why BBS is described as a syndrome.

[1]

(iv) State the mechanism that prevents syndactyly occurring in healthy individuals.

[1]

2(a) Fig. 3.1 is a scanning electron micrograph of receptor cells in the retina of the human eye.

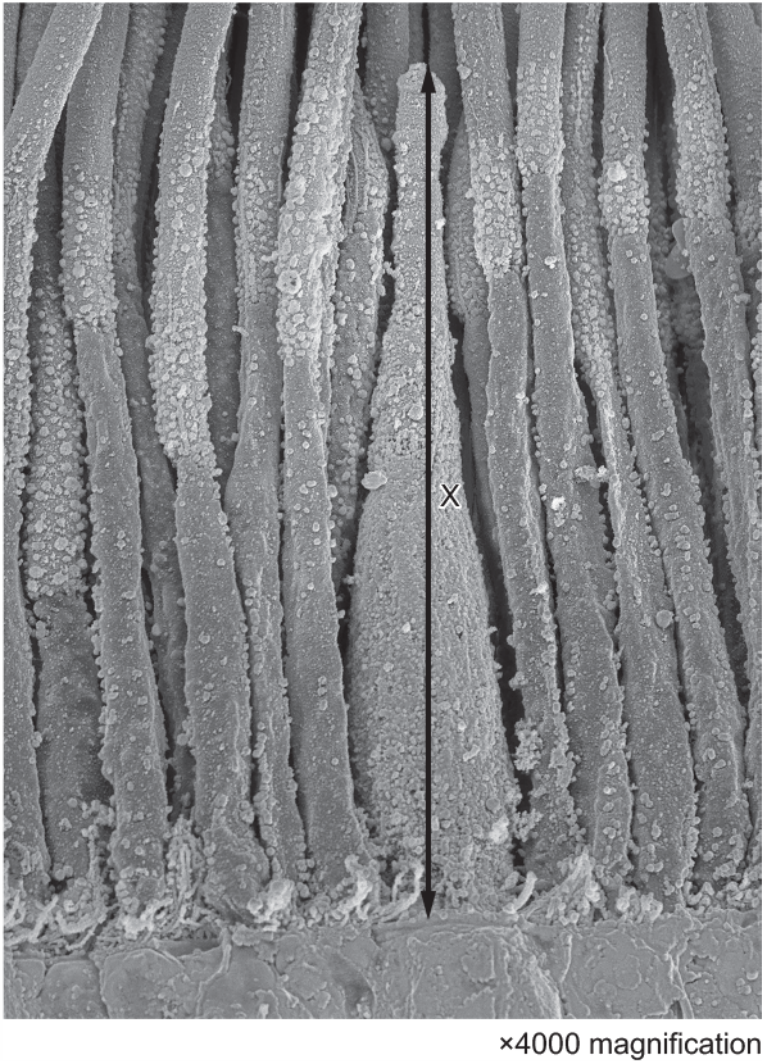


Fig. 3.1

(i) Calculate the actual height of the cone cell using line X.

Give your answer to 3 significant figures.

height of cone cell = ... μm [2]

(ii) Name the photosensitive pigment found in cone cells.

[1]

(iii) Give **two disadvantages** of the technique used to prepare the image in Fig. 3.1.

[2]

(b) Fig. 3.2 is a light micrograph of a section through a mammalian eye.

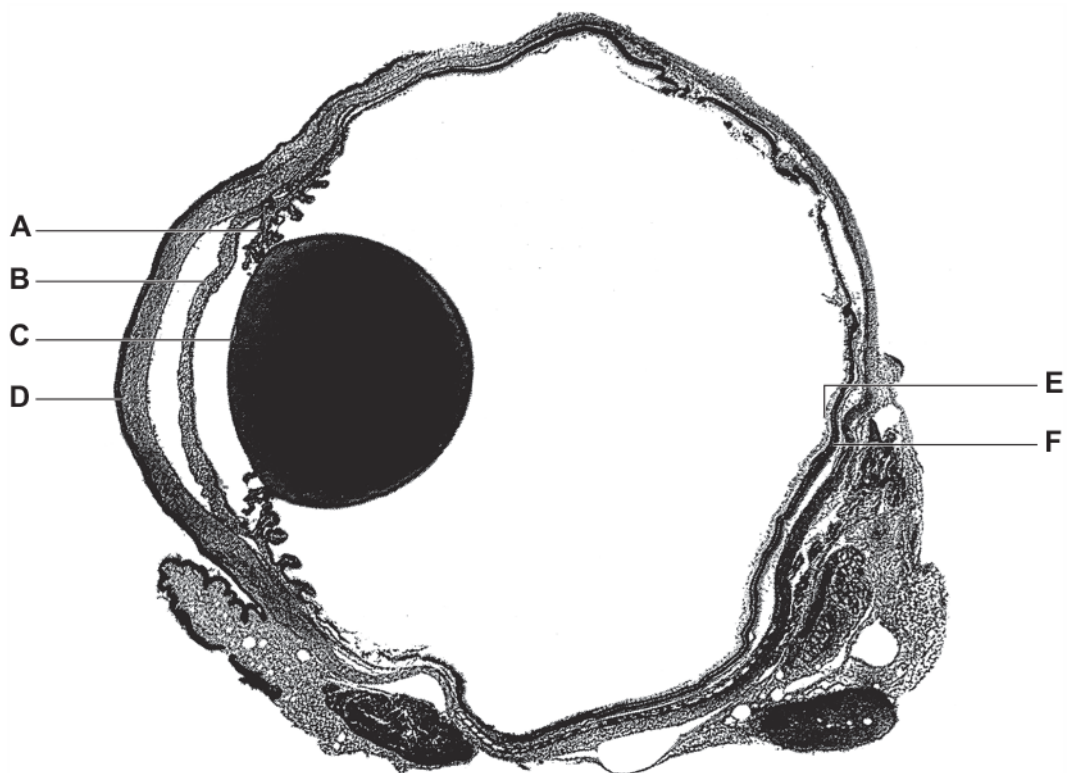


Fig. 3.2

Complete the table below about the structures labelled A to F in Fig. 3.2.

Label	Name	Function
A	ciliary muscle	
B		Controls amount of light entering the eye
C		Focuses light rays
D	cornea	
E	retina	
F		Pigmented layer to prevent internal reflection

[3]

(c) A student is performing a dissection of a sheep’s eye and wishes to extract the lens. The eye is covered in fatty tissue.

Describe how the items of equipment are to be used in the dissection and the actions that should be taken to ensure safe working in a dissection procedure.

[3]

3 One factor that contributes to damage to the retina is macular oedema, which is swelling in the eye.

Use your knowledge of tissue fluid formation to explain how hypertension could increase the incidence of oedema.

[3]

4(a) Fig. 5 shows a vertical section through the human eye.

The regions labelled C, D and E are affected by degenerative diseases of the eye associated with ageing.

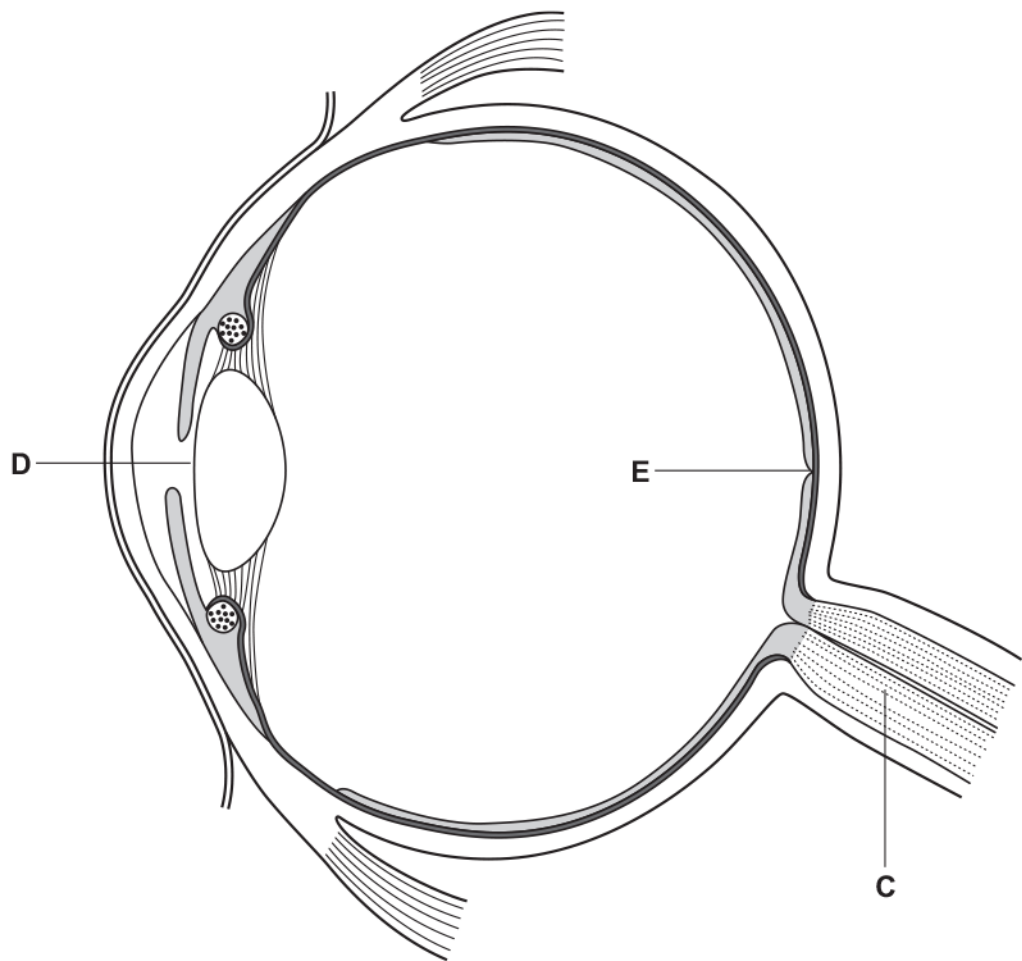


Fig. 5

(i) For regions C and D in Fig. 5, name the degenerative disease and explain why vision would be affected.

Region C

name of disease

explanation

.....

Region D

name of disease

explanation

[4]

- (ii) Ranibizumab is a monoclonal antibody-based drug that inhibits the growth of new blood vessels.

Suggest how ranibizumab would be effective in treating a degenerative disease that affects the region labelled E in Fig. 5.

[2]

- (b) The retina in the eye contains light-sensitive photoreceptor cells.
- (i) Explain why photoreceptor cells in the retina are described as transducers.

[1]

- (ii) Rod cells undergo various changes when they are stimulated by light.

Complete the following table by writing 'Rest' or 'Light' in the space provided to indicate whether the description refers to a rod cell at rest or when stimulated by light.

The first row has been completed for you.

Process in rod cell	Rest or Light
Rhodopsin is broken down to form opsin and <i>trans</i> -retinal	Light
Rod cell membrane is hyperpolarised	
Neurotransmitter is released by exocytosis from the rod cell into the synaptic cleft	
Sodium ion channels open	

[2]

- 5 Which of the options, A to D, is a molecule that requires vitamin C for its synthesis?

- A collagen
- B deoxyribonucleic acid
- C haemoglobin
- D rhodopsin

Your answer

[1]

6 The statements below relate to photoreceptor cells in the retina.

Which of the following statements is / are correct?

1 The inner segment of a photoreceptor cell contains many mitochondria.

2 Rod cells are absent in the fovea.

3 A cone cell contains three photosensitive pigments, each sensitive to a different wavelength of light.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer

[1]

7 For each region of the retina **A** to **C** in Fig. 31.2:

- describe how damage would affect vision, if at all, in bright light **and** dim light
- explain why vision would or would not be affected in terms of photoreceptor cells.

Write your answers in the table below.

Region **C** has been completed for you.

Region	Effect of damage on vision	Explanation
A	----- ----- -----	----- ----- -----
B	----- ----- -----	----- ----- -----
C	no effect on vision in dim light or bright light	region C does not contain photoreceptor cells

[4]

8(a) Age-related macular degeneration (AMD) is one of the leading causes of irreversible sight loss in developed countries such as the United Kingdom.

AMD results in changes in the retina leading to the loss of visual acuity.

(i) State what is meant by visual acuity and describe briefly how visual acuity is assessed.

[4]

(ii) Explain why damage to the macula leads to loss of visual acuity.

[2]

(b) One form of AMD, known as **neovascular** AMD or wet AMD, is caused by the growth of blood vessels into the macula.

- A growth factor is normally released by cells in response to low oxygen concentrations.
- The growth factor stimulates the growth of blood vessels.
- Blood vessels may leak causing very rapid loss of vision.

(i) Suggest **one** factor, other than ageing, which may increase the risk of developing wet AMD.

Explain your suggestion.

[2]

(ii) The growth of blood vessels is stimulated by a growth factor called **VEGF**.

VEGF binds to receptors on the cell surface membrane of endothelial cells.

One treatment available for wet AMD involves blocking the action of **VEGF** using a modified antibody.

Suggest how the modified antibody prevents the action of **VEGF**.

[2]

(c) Fig. 4.3 shows the results from one clinical trial of the modified antibody treatment.

At 3-monthly intervals, each patient’s visual acuity was measured and compared to their visual acuity at the beginning of the trial. A positive value indicates an improvement and a negative value indicates a decline.

- (i) State what may be concluded about the effectiveness of the modified antibody treatment based on the results of this clinical trial.

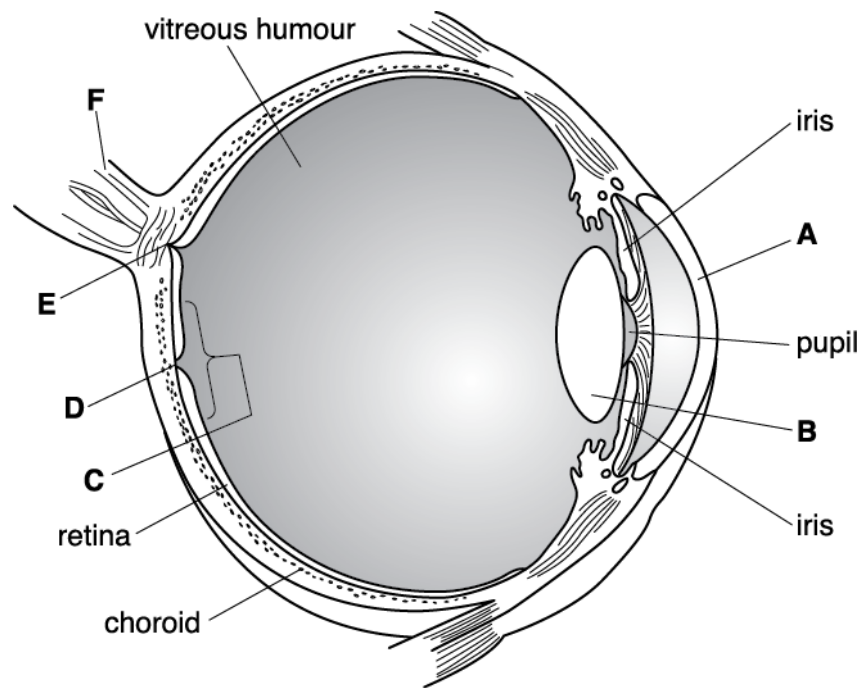
[2]

- (ii) Suggest **one** further piece of information that would be required in order for your conclusion to be valid.

[1]

9 Partial sight or blindness can occur as a result of damage to several different parts of the eye.

The following figure shows a diagram of the eye.



Complete the table by inserting the appropriate letter or letters from the diagram.

Description	Letter(s)
The region that is damaged if glaucoma is not treated	
The region where a cataract can form	
The region of the retina where only cones are found	
The region of the retina where both rods and cones are found	
The region of the retina where no rods or cones are found	

[5]

- 10 Ocular melanoma is the most common form of cancer to affect the eye. More than 400 new cases are diagnosed each year in the UK.

Fig. 7.1 shows the structure of a human eye.

Ocular melanoma can develop in the choroid, ciliary body or at **A** in Fig. 7.1. Diagnosis is usually made earlier for melanomas that have developed at **A**.

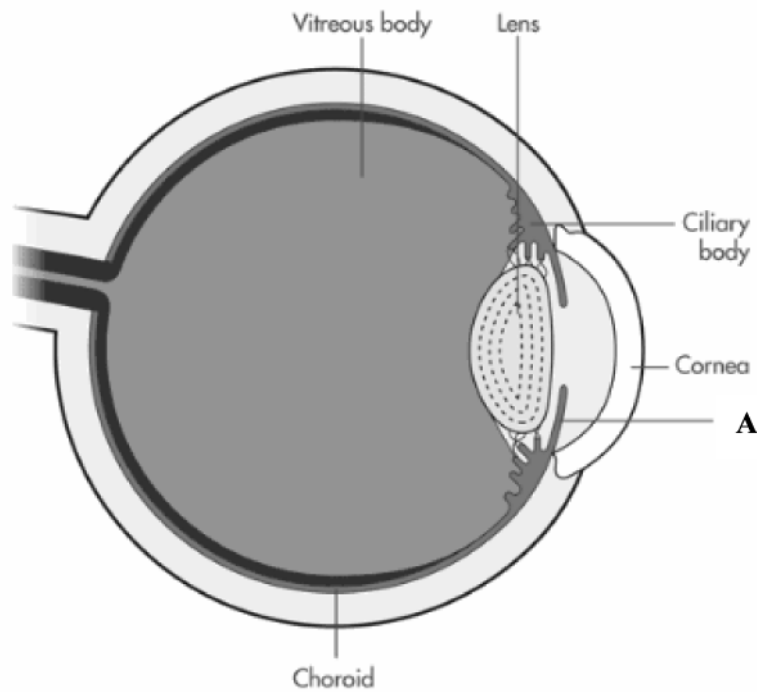


Fig. 7.1

- (i) Name the part of the eye labelled **A** in Fig. 7.1.

----- [1]

- (ii) Suggest why melanomas at **A** are diagnosed earlier than other ocular melanomas.

----- [1]

- (iii) Cells in the choroid and **A** in Fig. 7.1 produce a pigment called melanin.

Suggest and explain **two** functions of melanin.

1

2

[2]

11 The statements below describe the response to light by a rod cell in the retina.

Which of the following statements is / are correct?

Statement 1: The plasma membrane becomes hyperpolarised.

Statement 2: Rhodopsin is broken down.

Statement 3: Glutamate is released from a rod cell, causing depolarisation of a connecting bipolar cell.

- A 1, 2 and 3 are correct
- B Only 1 and 2 are correct
- C Only 2 and 3 are correct
- D Only 1 is correct

Your answer

☐

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	contains collagen fibres ✓ protection / maintains shape , of the eye ✓ enables muscle / ligament attachment ✓	2 max(AO1.1)(AO2.1)	
		ii	choroid ✓ prevents internal reflection ✓	2(AO1.1)	
	b	i	cilia connect inner and outer segments of (cone) cell ✓ (mutated BBS genes cause) production of non-functional proteins in , cilia / microtubules ✓ less / no , transport of proteins between segments ✓	2 max(AO2.1)	
		ii	different (cone) cells have different type of iodopsin ✓ (so iodopsin) absorbs either red or green or blue light ✓ (so) cone cells differ in sensitivity to different wavelengths of light ✓ trichromatic vision ✓	3 max(AO1.1)	ALLOW description
		iii	widespread effects in the body ✓ affects , several organs / systems, in the body ✓	1 max(AO2.5)	
		iv	apoptosis ✓	1(AO1.1)	ALLOW description
			Total	11	
2	a	i	Line measured as 112mm = 28.0 (µm) and 114mm = 28.5 (µm) 28.0 to 28.5 (µm) ✓✓	2 AO 2.8	Only allow values within the range (using image size 112 to 114) ALLOW one mark as ECF for incorrect measurement provided there is evidence of rearranging formula AND showing working AND answer given to 3 sf i.e. = $\frac{\text{incorrect measured value}}{4000}$ = ECF value to 3sf
		ii	iodopsin ✓	1 AO1.1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																					
		iii	<i>MARK FIRST TWO RESPONSES</i> procedure is more technical / requires more advanced practical skills / AW ✓ further detail of skill required e.g. complex staining process needed to prepare specimens ✓ artefacts may occur ✓	2 max AO 2.7	IGNORE Specimens must be placed in a vacuum and so must be dehydrated / dead as image 3.1 is a <u>section</u> of tissue IGNORE reference to black and white images as this is not related to the preparation of the image IGNORE references to cost																					
	b		✓✓✓ <table><tr><th>Label</th><th>Name</th><th>Function</th></tr><tr><td>A</td><td><i>ciliary muscle</i></td><td>alter shape of lens</td></tr><tr><td>B</td><td>iris</td><td><i>Control amount of light entering the eye</i></td></tr><tr><td>C</td><td>lens</td><td><i>Focuses light rays</i></td></tr><tr><td>D</td><td><i>cornea</i></td><td><u>Refracts</u> light (to retina)</td></tr><tr><td>E</td><td><i>retina</i></td><td>Contains photoreceptors / converts light energy to action potentials</td></tr><tr><td>F</td><td>choroid</td><td><i>Pigmented layer to prevent internal reflection</i></td></tr></table>	Label	Name	Function	A	<i>ciliary muscle</i>	alter shape of lens	B	iris	<i>Control amount of light entering the eye</i>	C	lens	<i>Focuses light rays</i>	D	<i>cornea</i>	<u>Refracts</u> light (to retina)	E	<i>retina</i>	Contains photoreceptors / converts light energy to action potentials	F	choroid	<i>Pigmented layer to prevent internal reflection</i>	3 AO 1.1	ALL six rows correct 3 marks Four or five rows correct 2 marks Two or three rows correct 1 mark One row correct 0 marks
Label	Name	Function																								
A	<i>ciliary muscle</i>	alter shape of lens																								
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Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		<i>Only allow 2 marks maximum from any one area to ensure candidates address both parts of the question</i> <i>Equipment</i> use scissors, to cut away fatty tissue ✓ use scalpel, to remove, (rectus) muscles / fine sections of fat / make an incision in sclera ✓ use blunt seeker, to separate lens ✓ <i>Safe working</i> (prevent) contamination from tissue or fluid, by wearing gloves / using mat / disinfecting instruments / washing hands / use of biological waste bin ✓ (prevent) injury from scalpel / scissors, by cutting away from body ✓ (prevent) allergic reaction, by assessing before starting dissection ✓	3 max AO 1.1	Marks for equipment must give name of equipment AND use for each mark Marks for safe working points must be linked to <u>preventative</u> action
			Total	11	
3			any three from: increased blood pressure leads to increased , <u>hydrostatic</u> pressure / HP ✓ in capillaries in the eye ✓ HP is even greater than oncotic pressure (than normal) ✓ so more tissue fluid is formed (than normal) ✓	3 AO 2.5	ALLOW reverse argument ALLOW answer based on less return of tissue fluid
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4	a	i	C = glaucoma ✓ (increased pressure) damages optic nerve ✓ D = cataract ✓ lens (protein) becomes opaque ✓	4 AO1.1	ALLOW cloudy for 'opaque' <u>Examiner's Comments</u> Most candidates recognised region D and correctly identified cataracts, with varied spelling, and most connected this correctly with an opaque lens although most stated 'cloudy'. Only a few candidates named a disease associated with region C. Common errors were Alzheimer's, Parkinson's disease and macula degeneration.
		ii	preventing / reversing , growth of (new) blood vessels into the, retina / macula / fovea ✓ (so) reduces / prevents, damage to, retina / macula / fovea ✓	2 AO2.1	ALLOW scarring for 'damage' <u>Examiner's Comments</u> Well answered with a lot of candidates correctly identifying region E and connecting it with preventing macula degeneration. Candidates that did not achieve a mark could not name region E.
	b	i	convert <u>light</u> energy to <u>chemical</u> energy ✓	1 AO1.1	ALLOW electromagnetic energy for light energy <u>Examiner's Comments</u> Only a few candidates correctly answered this part question. Common errors were conversion of light energy to electrical energy. Some candidates discussed transducers in the sense of transmission, of an action potential for example.

Mark Scheme

Question			Answer/Indicative content		Marks	Guidance											
		ii	<table><tr><td>Process in rod cell</td><td>Rest or Light</td><td rowspan="5">✓ ✓</td></tr><tr><td>Rhodopsin is broken down to form opsin and <i>trans</i>-retinal</td><td>Light</td></tr><tr><td>Rod cell membrane is hyperpolarised</td><td>Light</td></tr><tr><td>Neurotransmitter is released by exocytosis from the rod cell into the synaptic cleft</td><td>Rest</td></tr><tr><td>Sodium ion channels open</td><td>Rest</td></tr></table>	Process in rod cell	Rest or Light	✓ ✓	Rhodopsin is broken down to form opsin and <i>trans</i> -retinal	Light	Rod cell membrane is hyperpolarised	Light	Neurotransmitter is released by exocytosis from the rod cell into the synaptic cleft	Rest	Sodium ion channels open	Rest	2 AO1.1	3 correct = 2 marks 2 correct = 1 mark 1 or 0 correct = 0 marks <u>Examiner's Comments</u> All candidates attempted this answer. Many candidates achieved full marks and all variations were seen. Some candidates wrote 'dark' instead of 'rest'. Candidates should check their answers to make sure they have used the correct terminology. Some answers were correct for normal neurotransmitters so candidates hadn't appreciated that rods and cones are associated with an inhibitory neurotransmitter.	
Process in rod cell	Rest or Light	✓ ✓															
Rhodopsin is broken down to form opsin and <i>trans</i> -retinal	Light																
Rod cell membrane is hyperpolarised	Light																
Neurotransmitter is released by exocytosis from the rod cell into the synaptic cleft	Rest																
Sodium ion channels open	Rest																
			Total	0													
5			A	1													
			Total	1													
6			B ✓	1	<u>Examiner's Comments</u> Candidates did not perform well on this question. The most common incorrect answer was option A suggesting that candidates had not read the options carefully. Statement 3 incorrectly stated that each cone cell contains three photosensitive pigments, not that there are three types of cone cells.												
			Total	1													
7			<table><tr><td>Region</td><td>Effect of damage</td><td>Explanation</td></tr><tr><td>A</td><td>affects vision in bright and dim light ✓</td><td>rod cells and cone cells present ✓</td></tr><tr><td>B</td><td>affects vision in only bright light ✓</td><td>only cone cells present ✓</td></tr><tr><td>C</td><td><i>no effect on vision in dim light or bright light</i></td><td><i>does not contain photoreceptor cells</i></td></tr></table>	Region	Effect of damage	Explanation	A	affects vision in bright and dim light ✓	rod cells and cone cells present ✓	B	affects vision in only bright light ✓	only cone cells present ✓	C	<i>no effect on vision in dim light or bright light</i>	<i>does not contain photoreceptor cells</i>	4	
Region	Effect of damage	Explanation															
A	affects vision in bright and dim light ✓	rod cells and cone cells present ✓															
B	affects vision in only bright light ✓	only cone cells present ✓															
C	<i>no effect on vision in dim light or bright light</i>	<i>does not contain photoreceptor cells</i>															
			Total	4													

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a	i	<i>visual acuity</i> how clearly / AW, objects can be seen ; plus up to 3 marks from the following use a Snellen chart / AW ; patient sits at a fixed distance and reads letters ; the smaller the letter read the greater the visual acuity ; AVP;	4	ACCEPT 'how clearly you can see' 'how much detail you can see' IGNORE references to focussing or accuracy ACCEPT a description of a chart CREDIT reference to 6m or 20 feet for distance e.g. one eye at a time, ref to 20/20 or 6/6 as 'very good' Examiner's Comments Part (a)(i) was accessible to most candidates although several could not recall the name of the Snellen Chart and some did confuse the visual acuity test with tests for colour blindness or the pupil response test. In (a)(ii) it is clear that the role of cone cells in visual acuity is not widely understood with relative few candidates referring to single cone cells being connected to single ganglion cells (in the fovea). The role of the macula as the region where high concentrations of cone cells are found (with the fovea being composed only of cone cells) was not understood with some candidates writing about the macula focussing the lens.
		ii	idea that (more) cone cells lost (which are responsible for visual acuity) ; macula / fovea, contains largest number of cone cells / region of concentrated cone cells ; <i>idea that</i> a single individual cone cell links to one ganglion cell ;	2	ACCEPT no cone cells outside macula / only rod cells outside macula

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	<i>Factor</i> smoking / obesity / high altitude / sickle cell anaemia / (familial) hypercholesterolaemia / high blood pressure ; <i>Explanation</i> increases risk of, atherosclerosis / AW, (for smoking / obesity / hypercholesterolaemia / high blood pressure) OR carbon monoxide (in tobacco smoke) reduces oxygen transported by haemoglobin (smoking) OR lung damage reduces, gas exchange / uptake of oxygen (smoking) OR less haemoglobin saturation (in lungs) (high altitude) OR fewer red blood cells to transport oxygen (sickle cell anaemia);	2	One mark for named factor and one for correctly linked explanation. IGNORE ref to Diabetes ACCEPT 'high blood cholesterol' or 'high LDL' for hypercholesterolaemia CREDIT alternative biologically correct explanations for a named factor (one mark for factor and one for explanation). ACCEPT idea of less oxygen transported by red blood cells Examiner's Comments In part (d) many candidates could suggest a risk factor with high blood pressure appearing quite commonly. Again, a failure to read carefully the stem of the question meant that the cause of wet AMD (the <i>growth</i> of blood vessels) was then not addressed and weaker candidates suggested that high blood pressure meant the blood vessels leaked rather than explain why high blood pressure meant blood vessels would grow in the first place. Some very imaginative answers were seen in the form of high altitude or sickle cell anaemia as factors which increased the risk. In part (ii) some good explanations were seen although some weaker candidates assumed the antibody would engulf the VEGF. Part (d) was done well but in (e) the question required candidates to suggest what further information was needed for a

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					valid statement - rather than simply identify a variable that was controlled. So answers such as 'age' required more development....the age might well be known but if the age of the two groups was not the same then the statement would not be valid.
		ii	variable / complementary, region / AW, binds to VEGF ; VEGF no longer, fits / is complementary to, membrane receptor ; OR antibody , binds to / AW, receptor for VEGF ; (antibody) blocks receptor / prevents binding of VEGF ;	2	ACCEPT idea that antibody has same shape as the VEGF receptor (as this implies it is complementary) ALLOW ref to binding site for variable region. IGNORE references to the active site
	c	i	(treatment) improves visual acuity, (within 3 months) I AW ; (treatment) prevents decline of visual acuity I improvement is maintained I AW ;		CREDIT idea that visual acuity declines with placebo
		ii	size of samples ; same test of visual acuity ; ref to double blind trial I randomised design ; AVP;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks e.g. gender balance (between groups) e.g. not having any other treatment e.g. age profile similar (in both groups) e.g. ethnicity profile similar e.g. size of doses / how often treatment was given

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance												
			Total	13													
9			<table><tr><td>Description</td><td>Letter</td></tr><tr><td><i>The region damaged by untreated glaucoma</i></td><td>F</td></tr><tr><td><i>The region where a cataract can form</i></td><td>B</td></tr><tr><td><i>The region where only cones are found</i></td><td>D</td></tr><tr><td><i>The region of the retina where both rods and cones are found</i></td><td>C</td></tr><tr><td><i>The region of the retina where no rods or cones are found</i></td><td>E</td></tr></table>	Description	Letter	<i>The region damaged by untreated glaucoma</i>	F	<i>The region where a cataract can form</i>	B	<i>The region where only cones are found</i>	D	<i>The region of the retina where both rods and cones are found</i>	C	<i>The region of the retina where no rods or cones are found</i>	E	5	Examiner's Comments This was answered well with many candidates achieving full marks. Candidates had been told in the question that the allele was sex linked and given the symbols to choose from.
Description	Letter																
<i>The region damaged by untreated glaucoma</i>	F																
<i>The region where a cataract can form</i>	B																
<i>The region where only cones are found</i>	D																
<i>The region of the retina where both rods and cones are found</i>	C																
<i>The region of the retina where no rods or cones are found</i>	E																
			Total	5													
10		i	iris	1													
		ii	visible externally / AW	1													
		iii	Any 2 from: (choroid), absorbs light, (giving) clearer image / AW (iris), absorbs light, (allowing) amount of light entering the eyeball to be controlled / AW protection from, UV / dangerous, radiation	2	ALLOW choroid reduces light reflection (within eyeball)												
			Total	4													
11			B	1													
			Total	1													