

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

3.1.1 THE DEVELOPING CELL: CELL DIVISION AND CELL DIFFERENTIATION

SCORE

/76

PERCENTAGE

%

STEMUP

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- 1 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.

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

Suggest why BBS is described as a syndrome.

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

Drosophila simulans and *Drosophila mauritiana* are two closely related species of fruit fly.

The *OdsH* gene in *Drosophila* is described as a speciation gene. It causes epigenetic changes to the DNA that regulates the condensation of chromosomes.

- (i) Name the stage of the cell cycle in which condensation of chromosomes occurs.

-----[1]

- (ii) The *OdsH* gene causes male sterility in *D. simulans* – *D. mauritiana* hybrids.

Based on the information provided, suggest how the *OdsH* gene has caused *D. simulans* and *D. mauritiana* to become and remain separate species.

-----[3]

3 The following shows part of a sequence of events that can take place inside cells:

- the cell shrinks and the nucleus condenses
- enzymes breakdown the cytoskeleton
- the nucleus breaks down.

Which of the processes, **A** to **D**, is being described in this sequence of events?

- A** mitosis
- B** cytokinesis
- C** apoptosis
- D** meiosis

Your answer

[1]

4(a) Fig. 36.1 is a light micrograph showing a group of cells prepared from an onion root tip.

Five cells are labelled P to T.

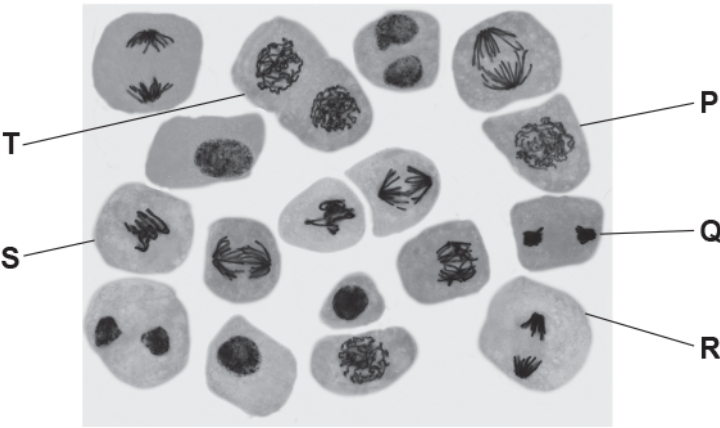


Fig. 36.1

(i) Identify the stages of mitosis shown in cells labelled P to S. Write your answers in the table below.

Cell	Stage of mitosis
P	
Q	
R	
S	

(ii) Cytokinesis in plant cells includes a step absent from cytokinesis in animal cells.

State how that step allows two cells to be formed from cell T.

- (b) Apoptosis is a major mechanism of cell death that occurs as part of an organism's growth and development. Several features of apoptosis are shared between animals and plants.

Fig. 36.2 shows a plant cell in apoptosis.

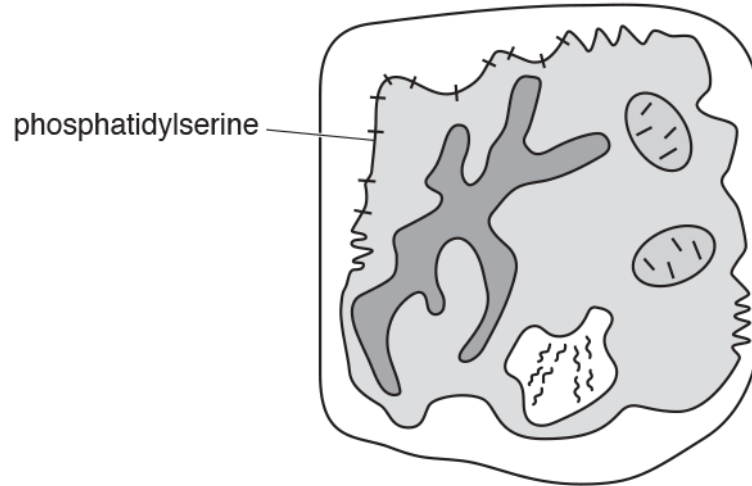


Fig. 36.2

Describe **three** features of apoptosis that can be observed in the plant cell in Fig. 36.2.

1. _____

2. _____

3. _____

5 Which of the options, **A** to **D**, is the potency of adult bone marrow stem cells?

- A multipotent
- B pluripotent
- C totipotent
- D unipotent

Your answer

[1]

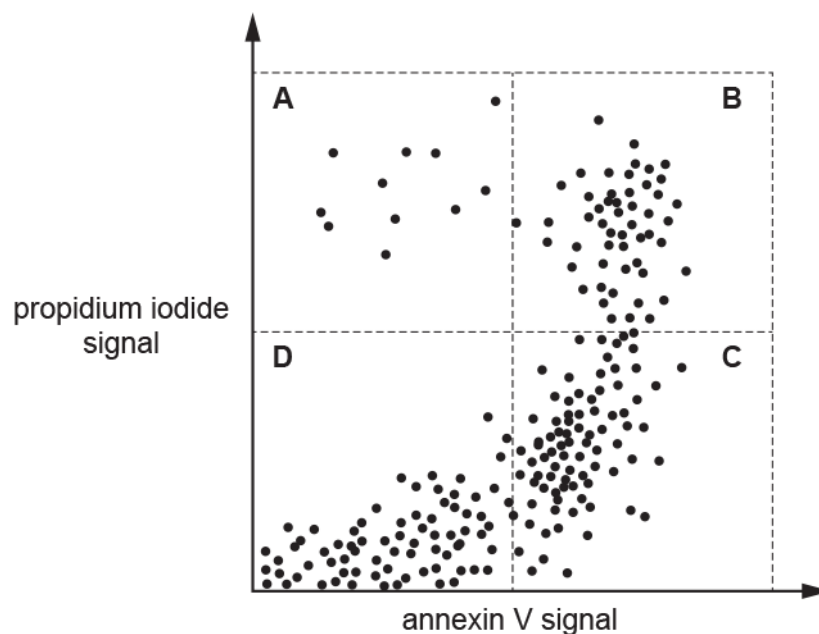
6 Cells undergoing apoptosis can be distinguished from living cells by staining with two reagents:

- annexin V, which binds to phosphatidylserine
- propidium iodide, which binds to DNA.

After staining, a flow cytometer is used to measure the fluorescent signal from each cell.

Neither reagent can diffuse across biological membranes.

The graph below shows the result of a flow cytometry experiment in a population of cells using annexin V and propidium iodide. Four regions are labelled A to D.



Which of the regions from the graph, A to D, identifies cells in late apoptosis?

Your answer

[1]

- 7 A section of plant tissue was examined to determine the percentage of cells in each stage of the cell cycle. There were 115 cells in total. Some of the results are shown in the table below.

Stage of cell cycle	Number of cells
anaphase	4
cytokinesis	2
G ₁ phase	41
G ₂ phase	17
prophase	3
metaphase	3
S phase	36
telophase	9

Which of the options, A to D, is the percentage of cells in nuclear division?

- A 2
- B 17
- C 18
- D 82

Your answer

[1]

(i) Name the process by which cells are destroyed in programmed cell death.

-----[1]

(ii) Suggest **one** tissue type in a mature plant which is **formed** by programmed cell death.

-----[1]

9 Here are three statements about the *BRCA1* gene:

1 Women with mutations in *BRCA1* are at increased risk of breast cancer.

2 *BRCA1* mutations can be inherited by males.

3 *BRCA1* is a proto-oncogene.

Which of the statements is/are correct?

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]

10(a) (See insert for H42202, June 2018)

This question is based on the Advance Notice article **SPINAL CORD INJURIES: HOW COULD STEM CELLS HELP?**, which is an insert.

The spinal cord contains both motor and sensory neurones.

- (i) State one similarity and one difference between the structure of motor and sensory neurones.

similarity -----

difference -----

[2]

- (ii) Explain why a spinal cord injury (SCI) causes both paralysis **and** loss of feeling below the site of the injury.

[2]

- (iii) Describe the role of the myelin sheath in the propagation of nerve impulses.

-----[2]

- (iv) The Advance Notice discusses oligodendrocytes, which are cells found only in the central nervous system (CNS).

State the name of the cells that perform a function equivalent to oligodendrocytes in the peripheral nervous system.

-----[1]

- (b) Treatment of injuries to the spinal cord, including with stem cell therapy, requires surgeons to determine the exact location and extent of the injury.

- (i) State the name of an imaging technique that could be used for this purpose.

-----[1]

- (ii) Describe how the technique you have given in (i) can be used to help surgeons to assess the location and extent of injury.

-----[3]

- (c) The Advance Notice article describes several types of stem cell.

Stem cells can be classified as totipotent, pluripotent, and multipotent.

Suggest which of these types of stem cell have been used in the clinical trials described in the Advance Notice. Give reasons for your choice.

[3]

- (d) * Using information from the Advance Notice, evaluate the risks, benefits and ethical issues related to the use of stem cells in the treatment of spinal cord injury (SCI).

In your answer, you should demonstrate an understanding of the current and future potential of stem cell therapy.

[6]

Oogenesis occurs in the ovaries of female mammals, resulting in the production of gametes.

- (i) Name the type of nuclear division that results in the production of **secondary** oocytes from **primary** oocytes during oogenesis.

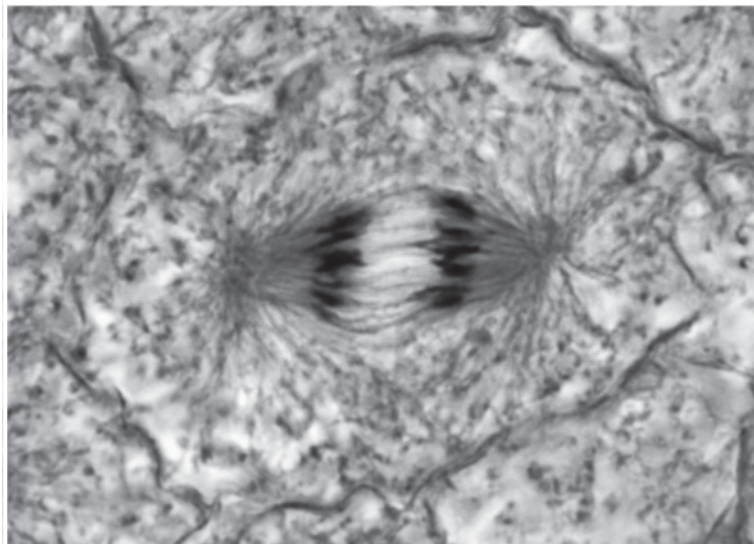
-----[1]

- (ii) Complete the table below to indicate the stage and type of nuclear division in which the events being described occur.

Event	Type of nuclear division	Stage in nuclear division
Chromosomes line up on the equator; there is no association between homologous chromosomes.		
Homologous chromosomes form bivalents.		
Homologous chromosomes separate and are pulled to opposite poles.		
Crossing over occurs.		

[4]

12 The micrograph below shows a cell in mitosis.



Which of the options, **A** to **D**, identifies the stage of mitosis shown in the micrograph?

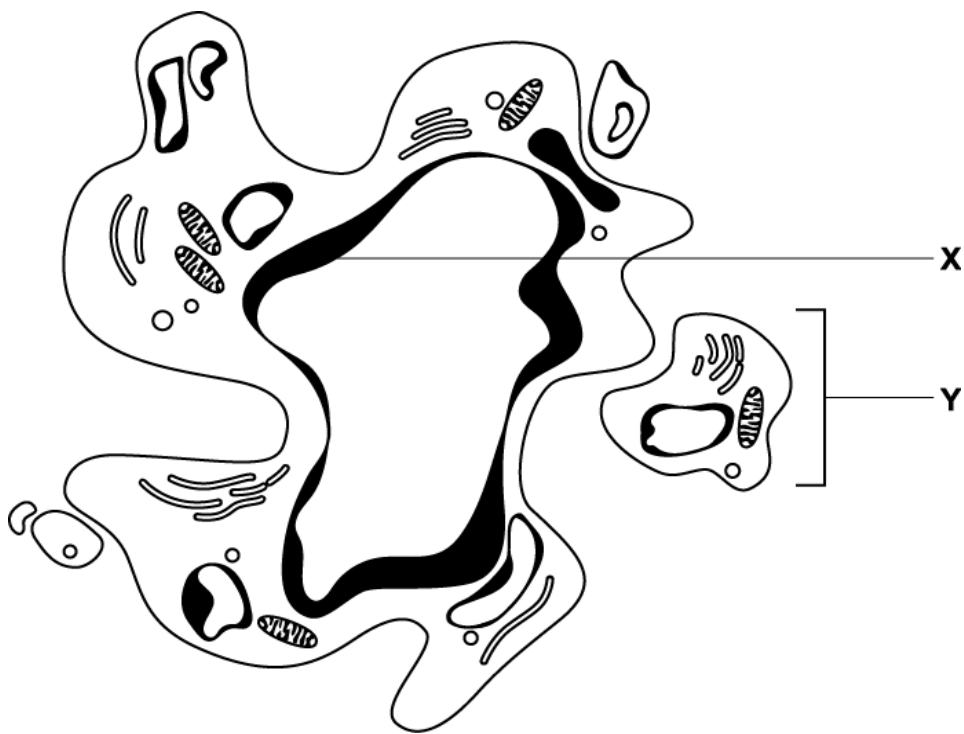
- A** anaphase
- B** metaphase
- C** prophase
- D** telophase

Your answer

[1]

13 The diagram below shows a cell in a late stage of apoptosis.

Two features are labelled **X** and **Y**.



Which of the following statements is/are correct?

- 1 X is a complex of DNA and protein.
- 2 Phosphatidylserine is present on the surface of Y.
- 3 The contents of Y are digested in a lysosome.

- 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]

14(a) Many researchers are involved in investigating the potential use of stem cells to treat a variety of human conditions.

Stem cells can be produced from a variety of sources. One possible source is known as somatic cell nuclear transfer (SCNT).

In SCNT:

- the nucleus is removed from a donor's oocyte
- a nucleus from the patient's somatic cell is introduced into the oocyte
- the resultant cell is allowed to divide to produce several cells
- some of these cells will be used to produce cultures of stem cells.

Insert a tick (✓) against the term that best describes the production of stem cells using SCNT.

Term	Insert a tick (✓)
Genetic engineering	
Therapeutic cloning	
Reproductive cloning	
ICSI	
IVF	

[1]

(b) Stem cells have the potential to be used to treat patients with conditions such as Parkinson’s disease or Type 1 diabetes.

(i) Suggest the **type** of stem cell which is produced using SCNT.

[1]

(ii) State **two** properties of the stem cells produced by SCNT that would make them potentially suitable for treating conditions such as Parkinson’s disease or Type 1 diabetes.

1 -----

2 -----

[2]

- Antibiotics will be used to treat the horse, but the vet must first find out which species of bacterium is causing the pneumonia.
- A sample of fluid containing the bacteria is taken from the horse and sent to a laboratory for analysis in a small lidded bottle.

You should name any equipment needed and justify your choice of equipment.

[9]

- (b) The vet discovers that two different species of bacteria are present which may be causing the pneumonia.

Once suitably prepared and stained using the Gram staining technique, a sample of the bacteria are observed using the high power lens of a light microscope.

In one of the bacterial species, the cells are seen to be stained red / pink.

- (i) Why must a high power lens be used to view the bacteria?

----- [1]

- (ii) What does the red / pink colour of the stained bacteria suggest about the structure of the cells?

----- [1]

- (c) Fig. 2.1 is a photomicrograph of the bacterium, *Klebsiella pneumoniae*, the probable cause of the pneumonia.

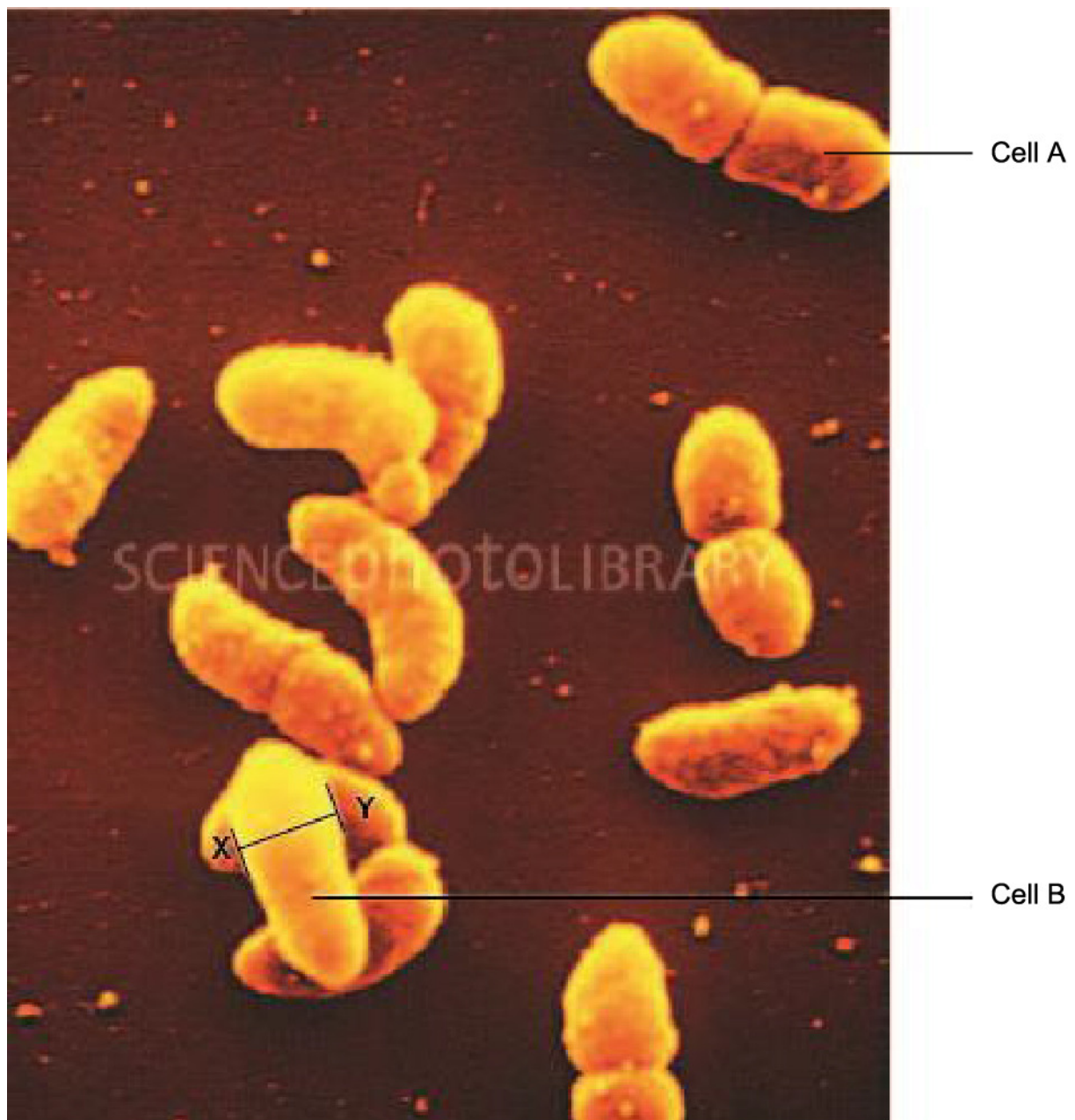


Fig. 2.1

- (i) The cell labelled A, in Fig. 2.1, is undergoing cell division by a process called binary fission.

Suggest why these bacterial cells do not divide by mitosis.

[1]

- (ii) The cell labelled B, in Fig. 2.1, has a width of $5\text{ }\mu\text{m}$ measured between X and Y.

Calculate the magnification of the photomicrograph.
Show your working. Give your answer to **three** significant figures.

Answer X [2]

Fig. 2.2 shows the results of a test carried out using the *Klebsiella pneumoniae* bacteria cultured from the horse. The bacterial culture was spread on an agar plate and discs containing antibiotics A to D were placed on the agar as shown. The plate was then incubated overnight.

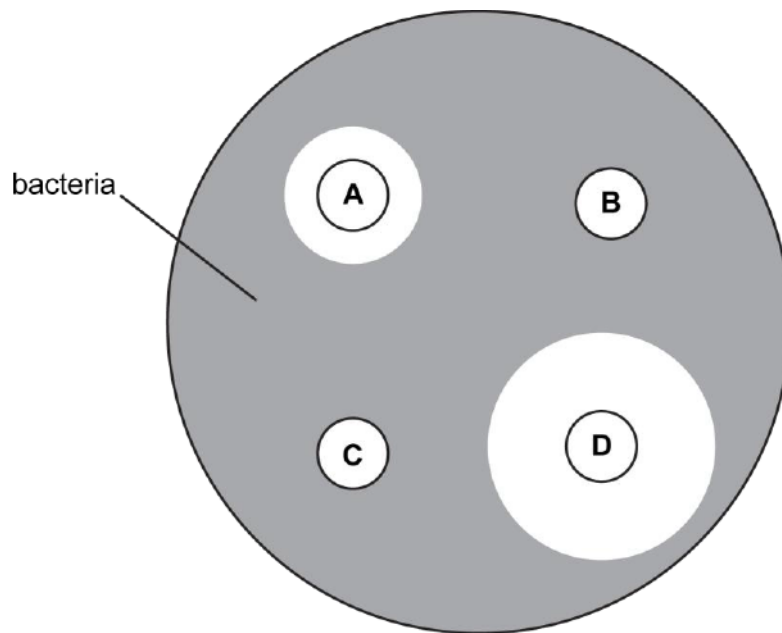


Fig. 2.2

Table 2.1 shows information about the 4 antibiotics used in the test.

Antibiotic	Mode of Action	Notes
A	Inhibits the synthesis of protein by bacteria, leading to cell death	Family of over 20 antibiotics
B	Inhibits bacterial cell wall synthesis	Most widely used antibiotics
C	Inhibits bacterial cell wall synthesis	Resistance evolves rapidly
D	Interferes with bacterial DNA replication and transcription	Common 'drug of last resort' used with resistant strains

Table 2.1

(d) The vet chooses to use antibiotic A. Using Fig 2.2 and Table 2.1, justify this decision.

[2]

16 The Abert's squirrel, *Sciurus aberti*, and the Kaibab squirrel, *Sciurus aberti kaibabensis*, are two biological species that live in the mountainous Grand Canyon region of North America.

(i) What is meant by the term biological species?

[2]

(ii) Complete Table 32.1 below to show the full biological classification of *S. aberti*.

Domain	-----
Kingdom	Animalia
-----	Chordata
Class	Mammalia
Order	Rodentia
Family	Sciuridae
Genus	<i>Sciurus</i>
Species	<i>S. aberti</i>

Table 32.1

[2]

17 In human fertilisation, a spermatozoon penetrates an ovum and forms a diploid cell known as a zygote.

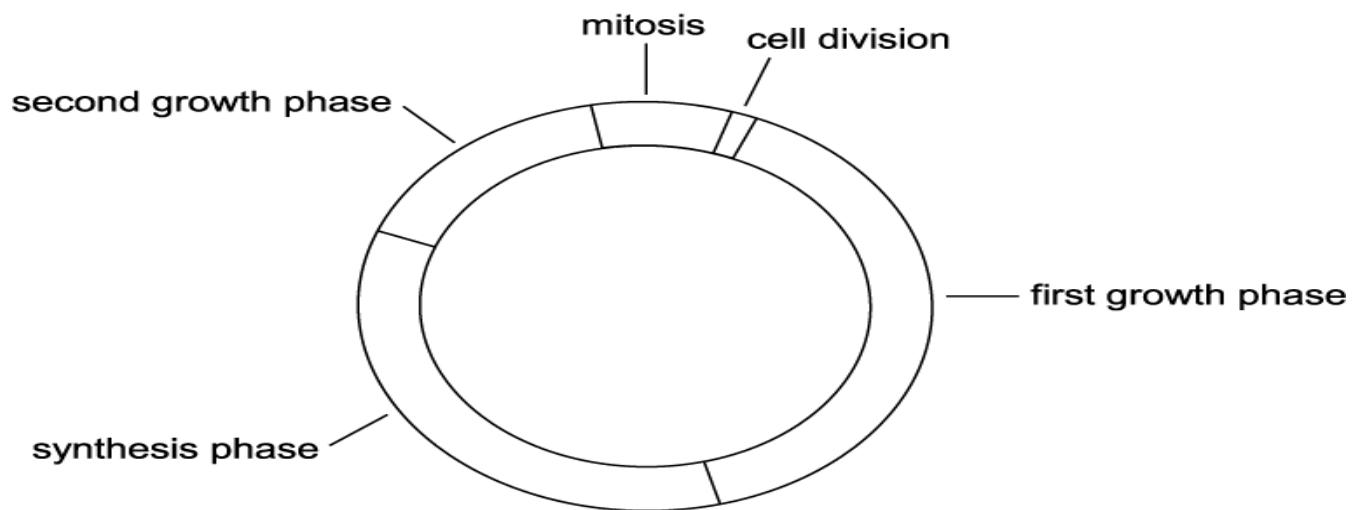
Which of the options, **A** to **D**, correctly describes the zygote?

- A multipotent
- B pluripotent
- C totipotent
- D unipotent

Your answer

[1]

18 The diagram below represents the cell cycle in eukaryotes.



Which of the options, **A** to **D**, is the phase in which spontaneous mutations are most likely to arise?

- A mitosis
- B first growth phase
- C synthesis phase
- D second growth phase

Your answer

[1]

- 19 Some cells with damaged DNA undergo the process of apoptosis. Towards the end of the process, macrophages bind to a molecule on the cell.

What is the type of molecule to which macrophages bind?

- A Glycoprotein
- B Phospholipid
- C Glycolipid
- D Cholesterol

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1		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	7	
2		i	prophase ✓	1	ALLOW mitosis
		ii	(reference to) reproductive isolation ✓ epigenetic changes alter gene expression ✓ stops , meiosis / gamete formation ✓ (because) hybrids are <u>infertile</u> ✓ (so) species would diverge / remain separate ✓	max 3(AO3.2)(AO3.2)(AO3.2)(AO3.2)	
			Total	4	
3			C	1 AO1.2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	1	
4	a	i	P: prophase Q: telophase R: anaphase S: metaphase ✓✓	2 AO2.5	all correct = 2 marks any 2 correct = 1 mark
		ii	(lay down of) cell plate ✓	1 AO1.1	ALLOW cell wall formed
	b		cell / cytoplasm, shrinkage ✓ nuclear, condensation / fragmentation ✓ phosphatidylserine on <u>outer</u> leaflet / surface, of, <u>cell surface / plasma</u> membrane ✓ <u>cell surface / plasma</u> membrane forms blebs ✓	max 3 AO2.1	ALLOW translocation of phosphatidylserine
			Total	6	
5			A	1 AO1.1	
			Total	1	
6			B	1 AO2.8	<u>Examiner's Comments</u> This proved to be the most challenging question of the multiple choice items. Both DNA and phosphatidylserine are normally found within cells and because neither reagent can normally diffuse across the membrane they would not be stained and picked up in flow cytometry. In late apoptosis the cell fragments, so that annexin can access phosphatidylserine and propidium iodide will be able to stain the DNA. Thus, there would be high signals from both reagents as demonstrated by section B. Most candidates either opted for A or C.2
			Total	1	
7			B	1 AO2.8	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8		i	apoptosis ✓	1 (AO 1.2)	
		ii	xylem ✓	1 (AO 2.1)	IGNORE vascular tissue
			Total	0	
9			B	1	<u>Examiner's Comments</u> Almost all candidates opted for either A or B. However, <i>BRCA1</i> is a tumor suppressor gene.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10	a	i	<i>Similarity (presence of)</i> axon / cell bodies / dendrites / synaptic knobs / myelin (sheath) / Schwann cells / nodes of Ranvier ✓ <i>difference</i> cell body at end of motor neurone AND cell body in middle of sensory neurone OR sensory neurone has a dendron / sensory neurone has short axon AND motor neurone has long axon ✓	2	IGNORE ref to function or direction of impulse. ALLOW suitably labelled diagrams DO NOT ALLOW both have long axons <u>Examiner's Comments</u> Similarities were well answered with a good spread of answers. Candidates who did not gain the difference mark had difficulty explaining the position of the cell body. Many candidates described the direction of the impulse and so did not appreciate the key word 'structure' in the question.  Few candidates attempted diagrams to answer this but appropriately labelled diagrams would be an excellent way of illustrating both differences and similarities and avoid the difficulties some candidates encountered when trying to describe the position of the cell body for the two types of neurones. Candidates should not be restricted to text just because lines are provided.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	both sensory and motor neurones are damaged ✓ impulse cannot, reach muscles / pass through motor neurone ✓ prevents impulse transmission, through sensory neurone / from receptors ✓	2 max	IGNORE signals/messages/information for 'impulses' ALLOW from stimulus for 'from receptors'. <u>Examiner's Comments</u> This was well answered with many candidates appreciating the relevance of the two consequences of damage to the two types of neurone. More candidates recognised the significance of the (damaged) motor neurone to paralysis than the (damaged) sensory neurone to loss of feeling.
		iii	insulates (the axon) / prevents passage of ions ✓ saltatory conduction ✓ (this) increases / speeds up , (rate of) transmission of impulses ✓	2 max	IGNORE signals/messages/information for 'impulses' ALLOW action potential jumps from node to node for 'saltatory conduction'. <u>Examiner's Comments</u> Most candidates recognised myelin as an insulator and could either state saltatory conduction or describe it.  Myelin was often referred to as protecting the axon which suggests an analogy with adipose tissue in various parts of the body. This is not correct and myelin should be described purely in terms of its role in increasing the axon's membrane resistance and decreasing the membrane capacitance. Relating the role of myelin to symptoms of multiple sclerosis often helps to emphasise the importance of its function in a contextual sense. Succinct

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					descriptions can be found at: https://www.sciencedirect.com/topics/neuroscience/myelin (1aii & 1aiii)  Too many candidates use terms like signals, messages and information to describe an action potential. When describing the propagation of an action potential, avoid using signalling or messaging as transitive verbs referring to the direction of impulse, e.g. avoid 'an impulse signals to the CNS'. This will help to remove these words in any context (verb or noun). Concentrate on using words e.g. transmitted, propagated. This should help candidates to disconnect the use of signals and messages when describing any aspect of nerve transmission. Key Misconception 
		iv	Schwann cells	1	<u>Examiner's Comments</u> Generally, well answered although many candidates stated glial cells. There were a few NR for this question part.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	MRI / fMRI (functional MRI) / CT ✓	1	ALLOW lower case letters <u>Examiner's Comments</u> Most candidates described MRI and recalled the use of a magnetic field and radio-waves to produce an image. Those who described a CT scan successfully recalled the use of X-rays and producing a 3D image.  Candidates described the resultant images as showing damaged areas, as if the whole image would focus only on areas of injury. It should be demonstrated that images would show damaged areas compared to surrounding healthy tissue. Many images can be found that illustrate small areas of damage compared to surrounding tissue. Videos can also be shown that can be in any context e.g. herniated disc, as it serves to illustrate the relevance and limitations of these techniques. https://www.bing.com/videos/search?q=herniated+disc+mri&view=detail&mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&FORM=VIRE

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	1 (both) show difference, between healthy and damaged areas ✓ <i>MRI / fMRI</i> M2 uses magnet(s) / magnetic field ✓ M3 detects, increase in water (content) / swelling / inflammation / (changes in) blood flow ✓ M4 (can be used to) detect areas of demyelination ✓ OR <i>CT</i> C2 uses X-rays (and computer) ✓ C3 builds up 3-D image (of the spinal cord) ✓ C4 shows areas with, poor blood supply / bleeding / blood clot ✓	3 max	IGNORE ref to tumours or other conditions not related to SCI IGNORE ref to technique other than <i>1bi</i> answer ALLOW 3DMRI gives a 3D image <u>Examiner's Comments</u> Most candidates described MRI and recalled the use of a magnetic field and radio-waves to produce an image. Those who described a CT scan successfully recalled the use of X-rays and producing a 3D image.  Candidates described the resultant images as showing damaged areas, as if the whole image would focus only on areas of injury. It should be demonstrated that images would show damaged areas compared to surrounding healthy tissue. Many images can be found that illustrate small areas of damage compared to surrounding tissue. Videos can also be shown that can be in any context e.g. herniated disc, as it serves to illustrate the relevance and limitations of these techniques. https://www.bing.com/videos/search?q=herniated+disc+mri&view=detail&mid=26378AD9C02AB6505D1B26378AD9C02AB6505D1B&FORM=VIRE

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		1 neural stem cells / human brain tissue stem cells / MSCs, are <u>multipotent</u> ✓ 2 (as) derived from adult (stem cells) / able to differentiate into a limited range of cell types ✓ 3 embryonic stem cells are <u>pluripotent</u> ✓ 4 (as) they can differentiate into any type of cell ✓	3 max	ALLOW ref to trial names (e.g. Balgrist / Neuralstem) for 'neural stem cells/MSCs' ALLOW pluripotent in the context of iPSCs ALLOW ref to Asterias trial for 'embryonic stem cells' ALLOW embryonic stem cells are <u>toti</u> potent as <u>early</u> embryo used <u>Examiner's Comments</u> Well answered with most candidates clearly extracting relevant information from the Advance Notice article. Marks were lost for confusing pluripotent with totipotent stem cells.  As both pluripotent and totipotent stem cells derive from embryos and can differentiate into any type of cell, candidates confuse the terms and focus on totipotent stem cells. It should be emphasised that the medical use of stem cells use pluripotent stem cells that are also called embryonic stem cells or ESC's.
	d		<i>Summary of instructions to markers:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> award the higher mark where the Communication Statement has		

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	been met. ◦ award the lower mark where aspects of the Communication Statement have been missed. • The science content determines the level. • The Communication Statement determines the mark within a level. Level 3 (5–6 marks) An evaluation of the risks and benefits and the ethical issue of using stem cells. There is clear reference to the future potential of stem cell therapy. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. There are clear links to the information in the article. All the information presented is relevant and forms a continuous narrative.</i> Level 2 (3–4 marks) An evaluation of the benefits and risk or risks and benefit of using stem cells including any ethical issue surrounding this use. There is reference to the future potential of stem cell therapy. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. There is a link to the information in the article The information presented is mostly relevant.</i> Level 1 (1–2 marks) An evaluation of the risk or benefit and any ethical issue related to the use of stem cells. However, there is no reference to future potential. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of	6	Indicative scientific points may include Risks Risk of rejection Risk of infection with many injections or collection of MSCs Risk of further injury with many injections Need for immunosuppression Unknown long-term effect May not work Risk of teratogenesis / oncogenesis (with iPSCs) Too much emphasis on data with small sample size Benefits Reduces symptoms of SCI/ treats SCI Replace damaged cells Patients could walk/move, again Prevents further damage due to SCI Still under research/ not known Lack of other treatments Gives hope to patients No rejection if from own bone marrow Data used to help future sufferers Ethical Destroying embryos Use of iPSCs Use of human brain tissue Gives false hope Future potential Stem cell therapies will be approved Use of iPSCs Data gathered can be used in future <u>Examiner's Comments</u>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			credit.		Well answered with most candidates covering all aspects of ethical risks, benefits and potential future benefit. Many candidates had learned about the use and potential of induced pluripotent stem cells (iPSCs). Some candidates used up too much space (and time) discussing ethical issues in terms of playing god, embryos can't give consent, etc. without mentioning the obvious fact that producing embryonic stem cells usually means destroying an embryo. Candidates often lost marks for failing to appreciate the future potential of stem cell therapy. Exemplar 1 The benefits of using stem cells in the treatment of spinal cord injuries are that they may be able to treat the spinal cord injury, restoring function and feeling to affected areas, by restoring neurons, replace lost myelin, and protect the cord from spreading the damage after injury. Then the financial, social, for physical and psychological burdens on the patients with the injury will be reduced and hopefully removed. These financial, social and psychological burdens also affect the patients' family, thereby making stem cells a great idea for the patient's spinal cord injury. You are also helping their family and support. When the risks associated with stem cell use are that the stem cells may induce tumours in the patients, the tumours are known as teratomas. Another risk is with the use of stem cells on the patient the patient may have to take low levels of immunosuppression, medicines which may leave them vulnerable to opportunistic infections, etc. tuberculosis. The ethical issues associated with the use of stem cells for spinal cord injuries are that if the stem cells used are from human embryos some people believe this is wrong, as you are destroying a potential human life, while others believe the embryo is simply a ball of undifferentiated cells lacking human qualities. Also some people worry that using stem cells in medicine may lead to the cloning of humans or that people may receive human enhancement. Also stem cells in the future can be used to test drugs which could help treat diseases such as spinal cord injuries in vitro rather than in the patient. Good use of all available space on page. Clearly moves through ethical benefits, risks and potential for future benefit. There was good discussion of each, with no focus on any particular component and always related to SCI.
			Total	20	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																				
11		i	<u>Meiosis</u> ✓	1	IGNORE ref to I or II. Examiner's Comments The vast majority of candidates achieved the mark for (a)(i).																				
		ii	<table><tr><th>Event</th><th>Type of nuclear division</th><th>Stage in nuclear division</th><th></th></tr><tr><td>Chromosomes line up on the equator; there is no association between homologous chromosomes.</td><td>mitosis</td><td>(early / late) metaphase</td><td>✓</td></tr><tr><td>Homologous chromosomes form bivalents.</td><td>meiosis</td><td>prophase I</td><td>✓</td></tr><tr><td>Homologous chromosomes separate and are pulled to opposite poles.</td><td>meiosis</td><td>anaphase I</td><td>✓</td></tr><tr><td>Crossing over occurs.</td><td>meiosis</td><td>prophase I</td><td>✓</td></tr></table>	Event	Type of nuclear division	Stage in nuclear division		Chromosomes line up on the equator; there is no association between homologous chromosomes.	mitosis	(early / late) metaphase	✓	Homologous chromosomes form bivalents.	meiosis	prophase I	✓	Homologous chromosomes separate and are pulled to opposite poles.	meiosis	anaphase I	✓	Crossing over occurs.	meiosis	prophase I	✓	4	1 mark per row – needs correct type and stage Examiner's Comments In (a)(ii) although most candidates scored, many failed to state the correct stage of nuclear division for meiosis by omitting I or II.
Event	Type of nuclear division	Stage in nuclear division																							
Chromosomes line up on the equator; there is no association between homologous chromosomes.	mitosis	(early / late) metaphase	✓																						
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Crossing over occurs.	meiosis	prophase I	✓																						
			Total	5																					
12			A ✓	1	Examiner's Comments This question was straightforward recall and the majority of candidates chose the correct response.																				
			Total	1																					
13			A ✓	1																					
			Total	1																					

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance												
14	a		<table><thead><tr><th>Term</th><th>Insert a tick</th></tr></thead><tbody><tr><td>Genetic engineering</td><td></td></tr><tr><td>Therapeutic cloning</td><td>✓</td></tr><tr><td>Reproductive cloning</td><td></td></tr><tr><td>ICSI</td><td></td></tr><tr><td>IVF</td><td></td></tr></tbody></table>	Term	Insert a tick	Genetic engineering		Therapeutic cloning	✓	Reproductive cloning		ICSI		IVF		1	Examiner's Comments This question addressed AO1 and AO2 objectives. DO NOT CREDIT if more than one box has been ticked DO NOT CREDIT hybrid ticks Examiner's Comments While most candidates could identify therapeutic cloning, responses were seen that covered each of the options given with some candidates ticking more than one box. Part (b) was accessible although some candidates did make the same point twice regarding the ability to differentiate into a variety of different cells.
Term	Insert a tick																
Genetic engineering																	
Therapeutic cloning	✓																
Reproductive cloning																	
ICSI																	
IVF																	
	b	i	embryonic / pluripotent ;	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 ALLOW totipotent / multipotent IGNORE omnipotent												
		ii	mark in any order can (continue to) divide ; pluripotent OR able to differentiate into / AW, (several) different types of, cells / tissues ; <i>idea that</i> have same antigens as patient / will not be rejected (by patient's immune system);	2	Mark the first answer on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks IGNORE 'totipotent'												
			Total	4													

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
15	a	<i>* Please refer to the marking instruction point 10 for guidance on how to mark this question.</i> <i>In summary:</i> Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the Communication Statement (shown in <i>italics</i>): • award the higher mark where the Communication Statement has been met. • award the middle mark where aspects of the Communication Statement have been missed • award the lower mark where the Communication Statement has not been met. • <i>The science content determines the level.</i> • <i>The Communication Statement determines the mark within a level.</i> Level 3 (7–9 marks) Details of apparatus and a method to produce bacterial colonies are provided. A thorough risk assessment is written which includes most of the high risk hazards and suitable control methods. The importance of aseptic technique is evident and most examples are given. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a</i>	9	Indicative scientific points may include: Equipment correctly identified with a reason • container / named container (e.g. Petri dish, flask, bottle, flat) because sterile / easily sterilised / lidded • culture medium because provides food / nutrients / water IGNORE moist • incubator because gives controlled optimum temperature • inoculating loop because allows for, accurate transfer / transfer of a small number / one colony, of bacteria • spreader because enables bacteria to be dispersed across / through medium • nutrient agar plates / broth because supplies the nutrients for bacterial growth ALLOW references to different nutrient agars Aseptic technique • flaming of flask / bottle neck • flaming of inoculation loop / spreader • keeping lids on culture dishes / flasks (when not in use) • keeping Petri dishes upside down • work next to Bunsen flame to carry away contaminating bacteria in convection current / rising hot air OR to stop bacteria in air from falling onto / contaminating plates Method • detail of removal of fluid from bottle and transfer to nutrient plate / broth • detail of streak plating after initial culture • incubation of sample / kept at constant optimum temperature • detail of selecting bacteria with differing colony morphology to separate bacterial species

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			<i>continuous narrative.</i> Level 2 (4–6 marks) The apparatus and a method to produce bacterial colonies are provided although some details may be missing. There is an outline risk assessment including some control measures. Aseptic technique is evident and some examples are given. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1–3 marks) The apparatus and an outline method are suggested which will allow for bacterial culture. A risk assessment is present but incomplete. Information about aseptic technique is limited. <i>There is a logical structure to the answer. The explanation, though basic, is clear.</i> 0 marks No response or no response worthy of credit.		Hazards identified with an appropriate control measure • (zoonotic) bacteria (on surfaces / from fluid touched by hands – wear gloves • (zoonotic) bacteria (on surfaces / from fluid transferred to clothes – wear a lab coat / remove lab coat before exiting lab • flammable liquids / ethanol used (e.g. in irrigating during Gram staining / flaming) – ensure bottles / flasks kept away from ignition sources / Bunsen burner / flame • 100% ethanol used risks intoxication – use at arm's length / use in a well-ventilated space
	b	i	bacteria very small / too small to be seen with low power lens	1	ALLOW because the bacteria are only 5 µm wide / shape of individual bacterium cannot be seen with LP IGNORE bacteria are small / bacteria can't be seen with a low power, lens / microscope
		ii	cells have thin(ner) (peptidoglycan) cell walls	1	
	c	i	Bacteria do not have a nucleus / nuclear membrane	1	ALLOW bacteria only have a single / one chromosome (plus plasmids)
		ii	× 3000 (1) (1)	2	ALLOW one mark for correct working [15 mm × 1000] / 5 µm

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	d		D is largest clear zone (diameter) indicates more bacteria killed is not selected because this antibiotic is used as a last resort / with resistant strains (so) A is selected as next largest clear zone (diameter) / next largest number of bacteria killed, and inhibits protein synthesis / prevents bacteria, dividing / reproducing, without risk of selecting antibiotic resistant strains	2	Candidates may describe A being tried and, if found not to work, vet has another antibiotic to choose. ALLOW if correct ref is also given to mode of action (second mark point only)
			Total	16	
16		i	group of organisms that interbreed (to produce fertile offspring) (1) similarity of genetic / physiological / behavioural attributes (1)	2	
		ii	Domain Eukarya / Eukaryota (1) Phylum (1)	2	DO NOT ALLOW eukaryote(s) ALLOW lowercase initial letters
			Total	4	
17			C	1	
			Total	1	
18			C	1	
			Total	1	
19			B	1	
			Total	1	