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Anglo - Chinese School
(Independent)



FINAL EXAMINATION 2022

YEAR FOUR INTEGRATED PROGRAMME / SBGE / ACS

BIOLOGY

Paper 1 Multiple Choice

3 October 2022

1 hour

Additional materials: Multiple Choice Answer Sheet
Soft eraser
Soft pencil

INSTRUCTIONS TO CANDIDATES

Write in **soft pencil**.

Write and shade your index number on the Multiple Choice Answer Sheet in the spaces provided.

Do not open this examination paper until instructed to do so.

There are **forty** questions on this question paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C, and D**.

Choose the **one** you consider correct and record your answer in **soft pencil** on the Multiple Choice Answer Sheet provided.

Read the instructions on the Multiple Choice Answer Sheet very carefully.

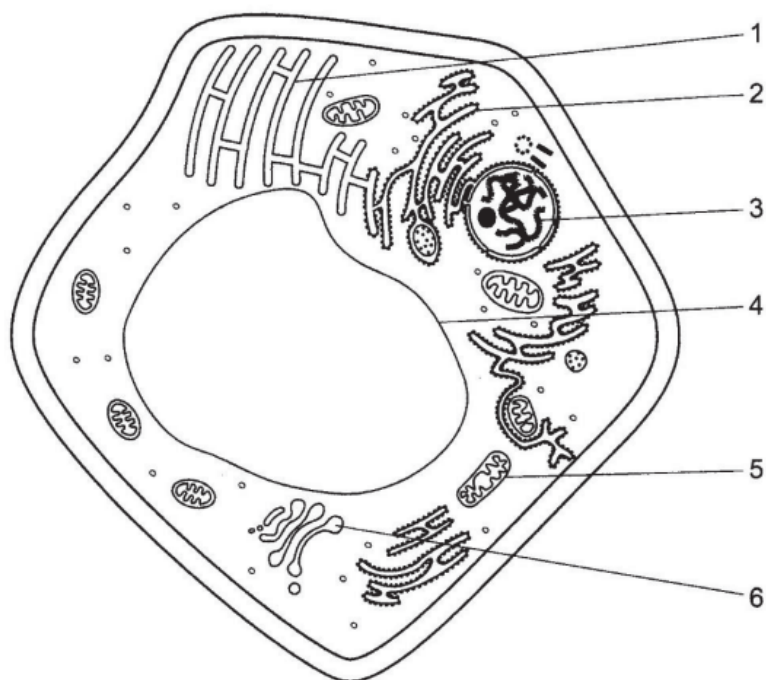
Each correct answer will score one mark. No marks will be deducted for a wrong answer.

Any rough working should be done in the question booklet.

Electronic calculators may be used.

This paper consists of **21** printed pages.

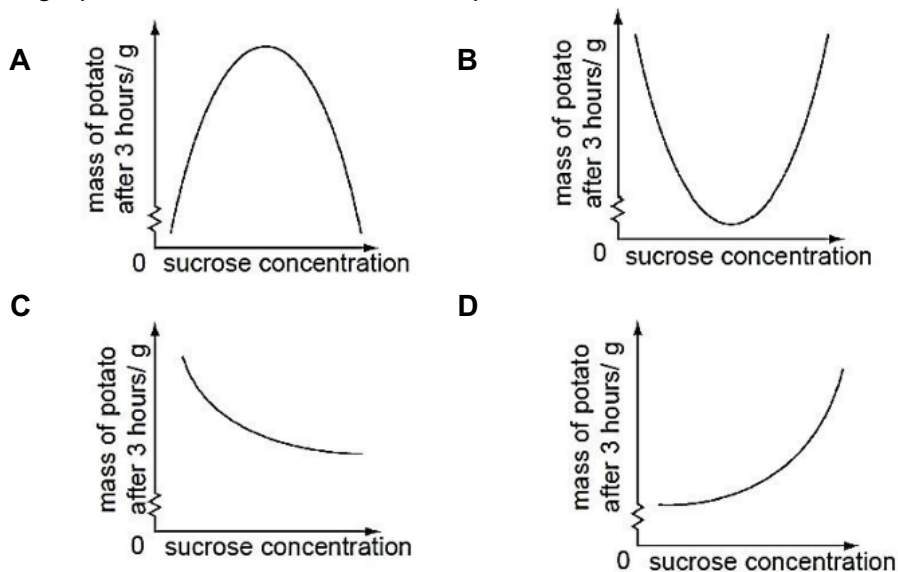
- 1 The diagram below shows the structure of a plant cell as seen using an electron microscope.



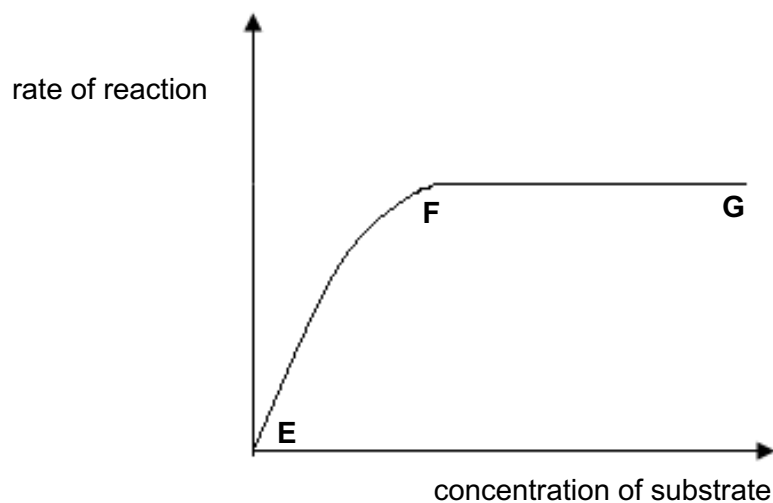
Which structures are involved in the process of enzyme synthesis within this cell?

- A** 1, 2, 4, 5 and 6
B 1, 3 and 6
C 2, 3, 5 and 6
D 3, 4 and 5
- 2 Identical pieces of potato are placed in sucrose solutions of different concentrations. After three hours, the mass of each potato piece is measured.

Which graph shows the results of this experiment?



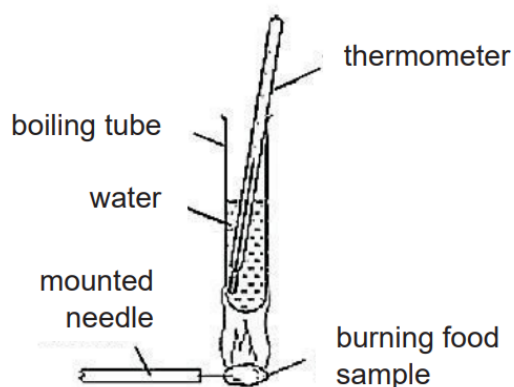
- 3 The graph shows the effect of increasing substrate concentration on the rate of enzymatic reaction.



What can be reasonably deduced from the shape of the curve?

- A** From E to F, the enzyme concentration is limiting the rate of reaction.
- B** From E to G, substrate concentration is limiting the rate of reaction.
- C** From F to G, the enzyme concentration is limiting the rate of reaction.
- D** From F to G, the substrate concentration is limiting the rate of reaction.

- 4 Four equal masses of different foods were burned as shown.

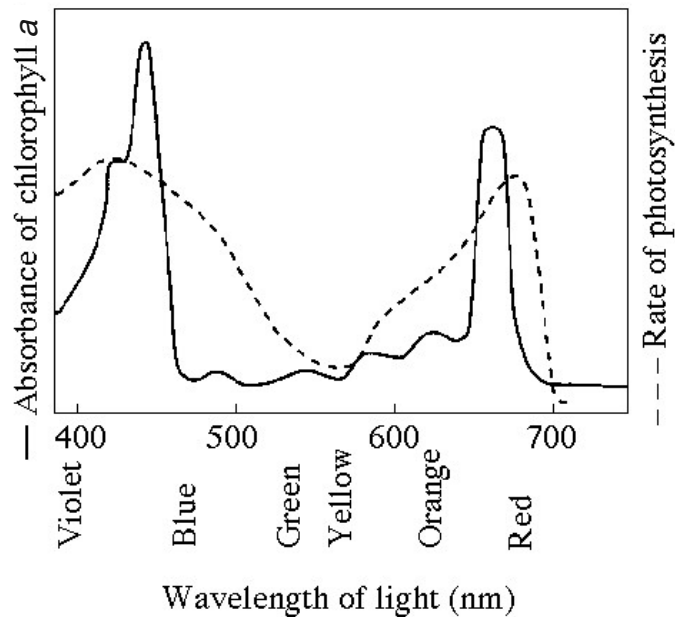


The temperature of the water was measured before and after each food sample was burned. The results are shown in the table.

Which food sample is likely to contain the most fats?

	water temperature at the start/°C	water temperature at the end/°C
A	16	37
B	17	95
C	18	87
D	19	22

- 5 The graph below shows the absorption spectrum for chlorophyll and the action spectrum for photosynthesis.



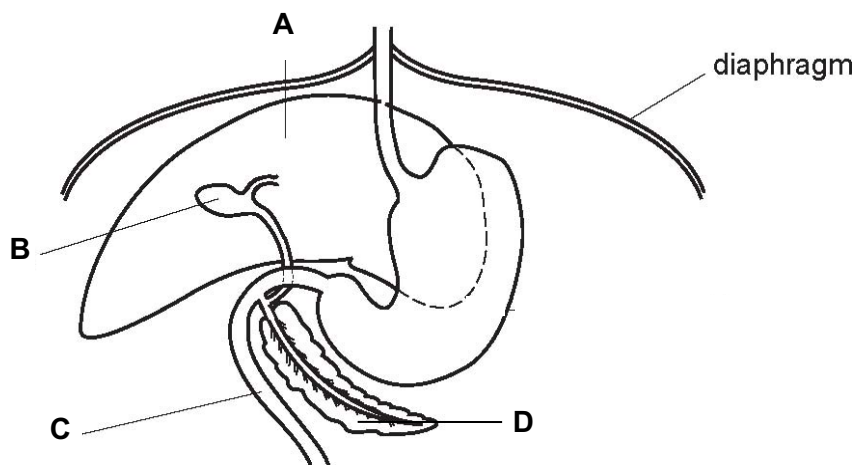
Which wavelength of light is most effective for photosynthesis to take place?

- A 420 nm
 - B 475 nm
 - C 575 nm
 - D 625 nm
- 6 An experiment was conducted on a young plant, using an aphid stylet (mouth part) to measure the rate of translocation. The same plant was then placed in a bell jar together with a chemical which absorbs oxygen. It was observed that the rate of translocation decreased and eventually stopped.

Which of the following best explains the above observation?

- A Companion cells no longer produced sufficient energy.
- B Mitochondria in the xylem vessels ceased to function.
- C Photosynthesis could not occur in the plant placed in the bell jar.
- D Translocation occurred only by diffusion.

- 7 The diagram below shows part of the digestive system and associated organs of Man.



In which structure does emulsification of fats take place?

- 8 A human heart, when cut along plane XY as in shown in **Fig 8.1**, produces the cut surface as shown in **Fig 8.2**. Blood filled regions are indicated by R and S respectively.

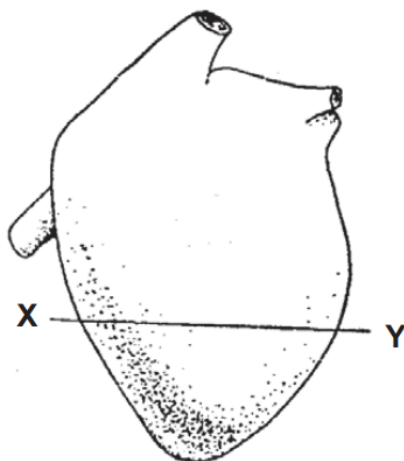


Fig 8.1

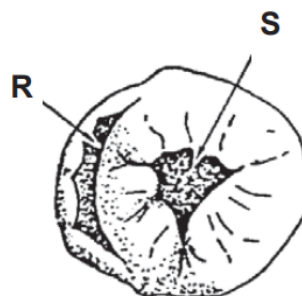
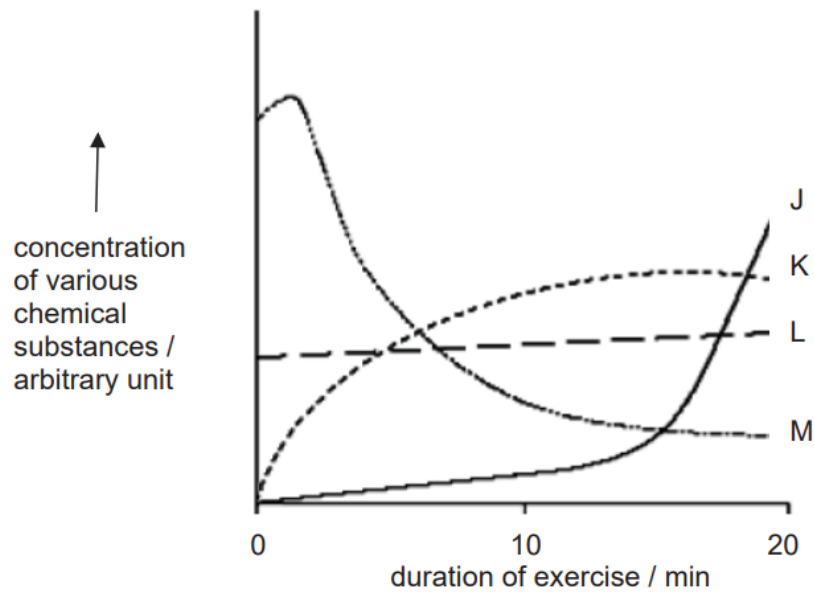


Fig 8.2

Which of the following is not true?

- A** Blood would flow from S into the aorta.
- B** Blood in R would leave the heart via the pulmonary vein.
- C** Blood in S came immediately from the left atrium.
- D** Blood in S would have a higher concentration of oxyhaemoglobin than the blood in R.

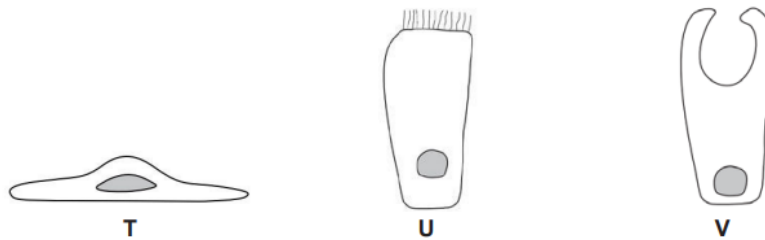
- 9 The graph shows changes in the concentrations of various chemical substances in the thigh muscles of a person running vigorously on a treadmill.



Which of the following is true?

- A Line J represents glycogen.
- B Line K represents carbon dioxide.
- C Line L represents oxygen.
- D Line M represents lactic acid.

- 10 The diagram shows three types of cells.



Which cells are found in alveoli and in bronchi?

	alveoli	bronchi
A	T	U and V
B	T and U	V
C	U and V	T
D	V	T and U

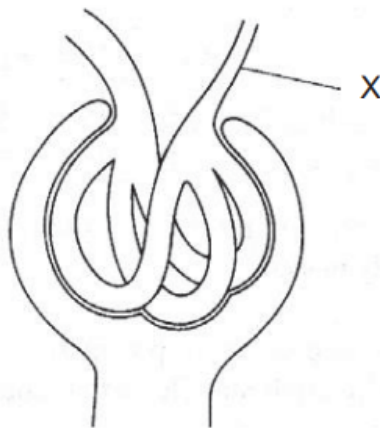
11 Some effects of smoking are listed.

- 1 paralyses cilia
- 2 increases heart rate
- 3 increases mucus production
- 4 is addictive
- 5 reduces the amount of oxygen in the blood
- 6 emphysema

Which effects are caused by nicotine?

- A** 1, 2 and 5
B 1 and 3
C 2 and 4
D 3, 4 and 6

12 The diagram shows a part of a mammalian nephron.



What happens if the diameter of the blood vessel is enlarged at **X**?

- A** More glucose will appear in the urine.
B More sodium will appear in the urine.
C Water reabsorption will be decreased.
D The rate of urine production will be reduced.

- 13 The table shows a medical report of a patient after some diagnostic tests. He had been given cakes for breakfast eight hours before the tests.

diagnostic test	glycogen content in liver	protein in urine	sugar in urine	urea in urine
result	normal amount	present	present	present

Which diagnosis about the patient's body is correct?

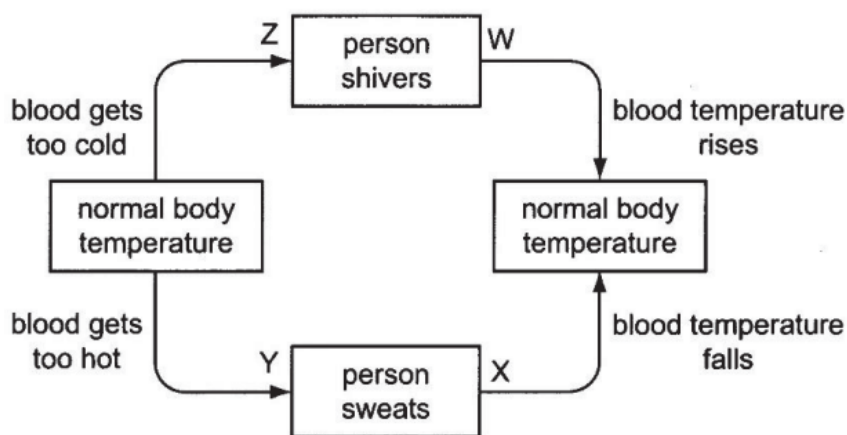
Key:

+ = healthy

- = malfunctioning

	pancreas	bowman's capsule in kidney	convoluted tubules in kidney
A	-	+	+
B	-	+	-
C	+	-	-
D	+	-	+

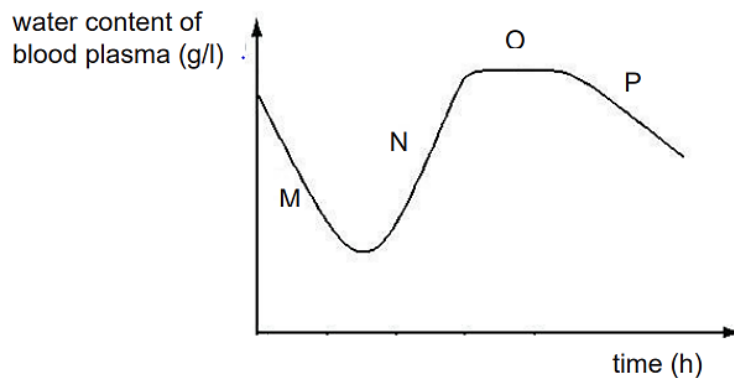
- 14 The diagram shows an example of homeostasis in a person.



Which two letters represent negative feedback changes?

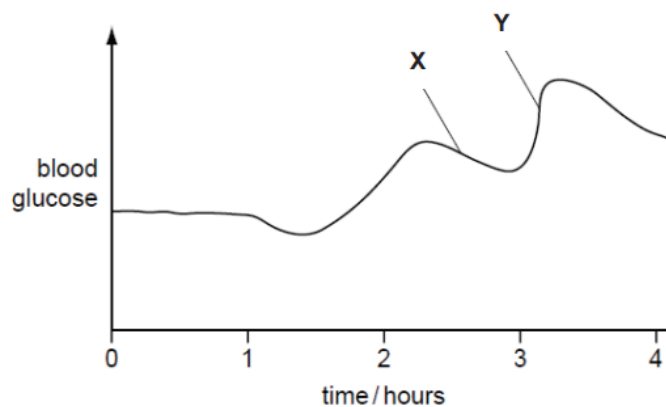
- A W and X
- B W and Y
- C X and Z
- D Y and Z

- 15 The graph shows the effect of antidiuretic hormone (ADH) on the regulation of water content in blood plasma.



Which part(s) of the graph reflect(s) the effect of increased ADH secretion?

- A M only
 B N only
 C M and P
 D N and O
- 16 The graph shows changes in a person's blood glucose concentration over four hours.



What might cause the changes at X and Y?

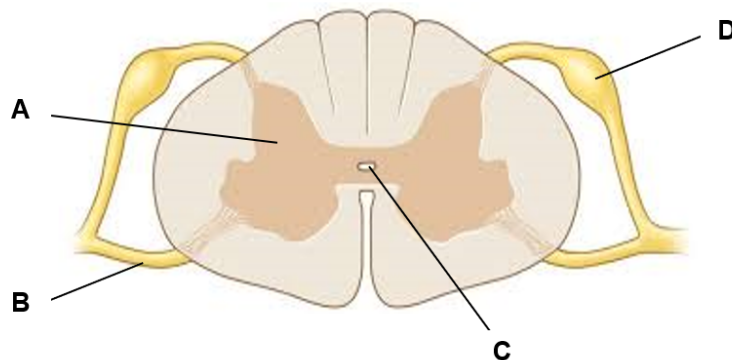
	X	Y
A	decreased insulin	decreased adrenaline
B	decreased insulin	increased adrenaline
C	increased adrenaline	increased insulin
D	increased insulin	increased adrenaline

- 17 Adrenaline not only functions as a hormone in our body but can also be administered as a drug in life-saving situations. Under which condition(s) would the administration of adrenaline be useful?

- 1 low blood glucose concentration
- 2 low heart rate
- 3 low water potential of blood

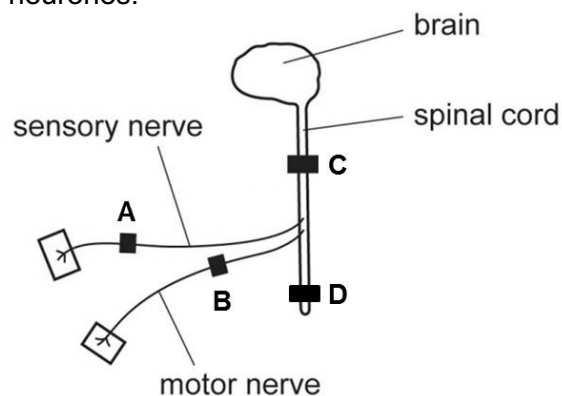
- A** 3 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

- 18 The diagram shows a transverse section of the spinal cord of a human.



Which labelled region, **A**, **B**, **C** or **D** contains the cell bodies of the sensory neurones?

- 19 The diagram below represents the central nervous system. **A**, **B**, **C** or **D**, show possible sites where a local anaesthetic block can be applied. The block prevents nerve impulses from travelling along neurones.

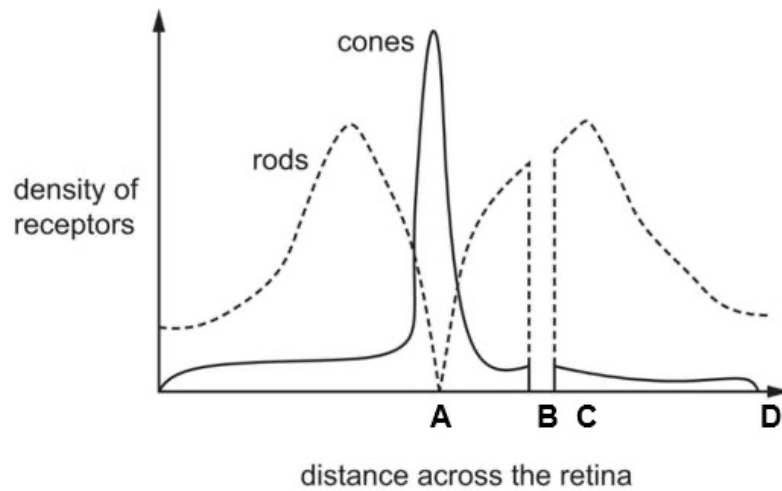


After the anaesthetic was administered to a man, he can feel a pinprick on his leg but cannot move it.

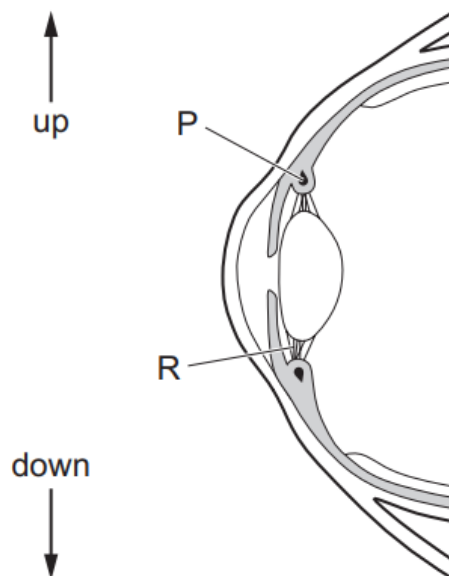
At which site, **A**, **B**, **C** or **D**, was the anaesthetic block applied?

- 20 The diagram shows the density of rods and cones across a horizontal section of the retina.

What is the position of the optic nerve?



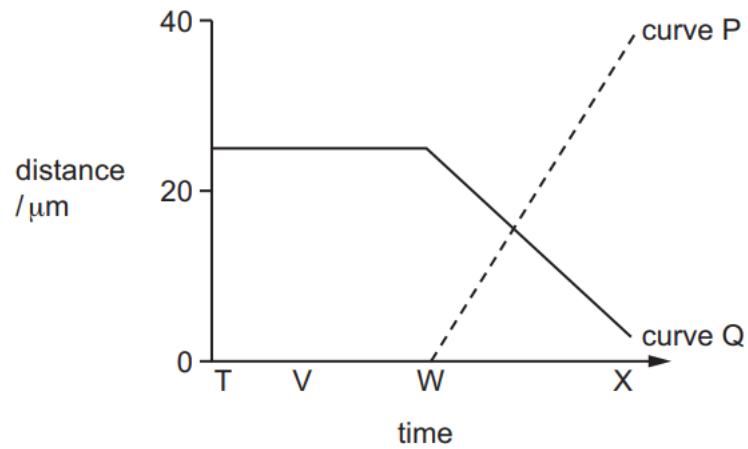
- 21 The diagram shows a section through the eye.



When the person looks down and focuses on their mobile phone, what is the state of the structures P and R?

	P	R
A	contracted	slacken
B	contracted	taut
C	relaxed	slacken
D	relaxed	taut

- 22 The graph shows how the distance between sister chromatids (curve P) and the distance between chromatids and centrioles (curve Q) changes during part of mitosis.

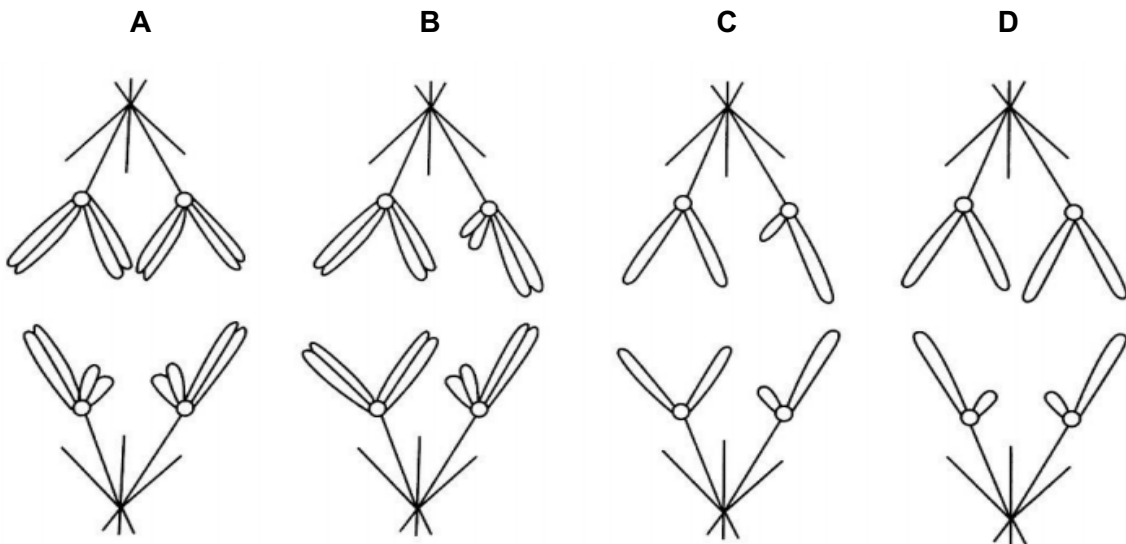


Which statements could be correct?

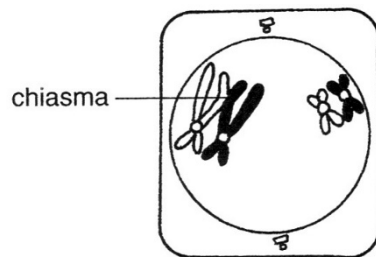
- 1 T to V represents interphase.
- 2 T to W represents metaphase.
- 3 W to X represents anaphase.

- A** 1 and 3 **B** 2 and 3 **C** 1 only **D** 2 only

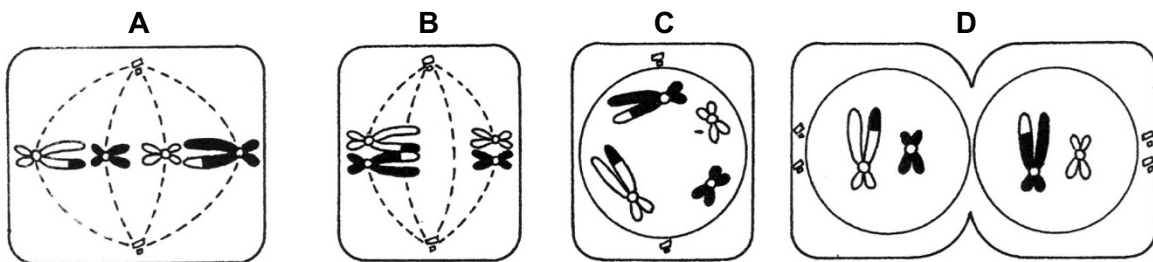
- 23 Which diagram shows anaphase I in a nucleus containing **two** pairs of homologous chromosomes?



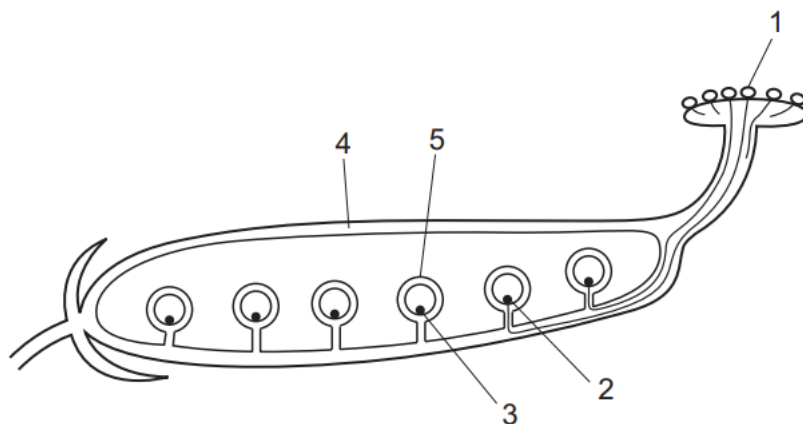
- 24 The diagram shows a cell undergoing meiosis.



Which of the following shows the next stage in the process?



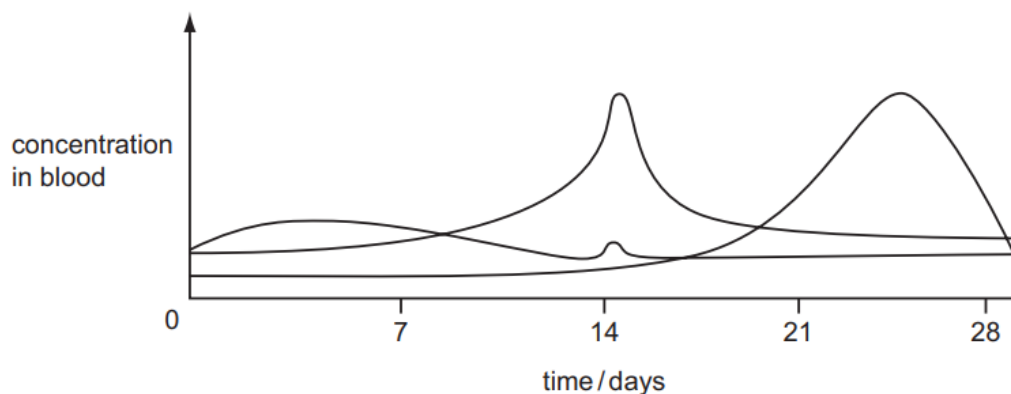
- 25 The diagram shows part of a flower after it has been pollinated.



Which labelled structures are diploid and which are haploid?

	diploid	haploid
A	1	4
B	2	1
C	3	2
D	4	5

- 26 During sexual reproduction in plants, what will give rise to the greatest variation in the offspring?
- A All of the flowers on the same plant have male and female reproductive organs.
- B The anthers and stigmas on the same plant mature at the same time of year.
- C There are separate male and female flowers on the same plant.
- D There are separate male and female plants.
- 27 The graph shows the concentration in the blood of three of the four hormones FSH, LH, oestrogen and progesterone during a menstrual cycle.



Which hormone is not shown?

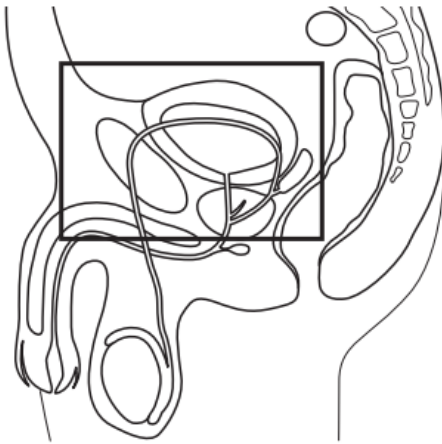
- A FSH
- B LH
- C oestrogen
- D progesterone
- 28 A woman's menstrual flow started on the 23rd of March.

Week	March						
	Sun	Mon	Tue	Wed	Thur	Fri	Sat
A	-	-	-	1	2	3	4
B	5	6	7	8	9	10	11
C	12	13	14	15	16	17	18
D	19	20	21	22	23	24	25
	26	27	28	29	30	31	

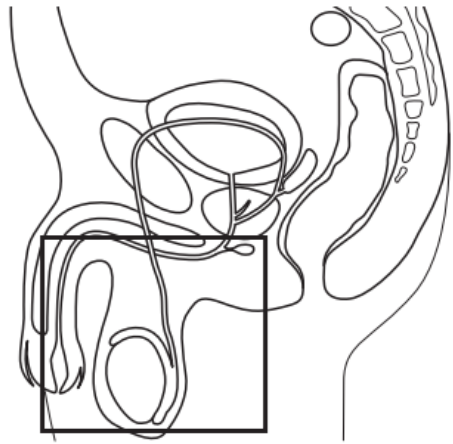
In which week did ovulation most likely occur?

- 29 The diagrams below are of a vertical section through the lower abdomen of a human male. A box has been drawn in each diagram.

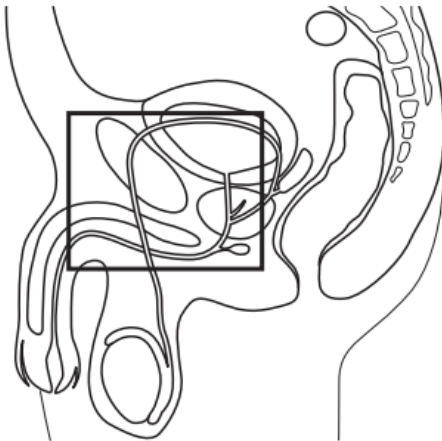
1



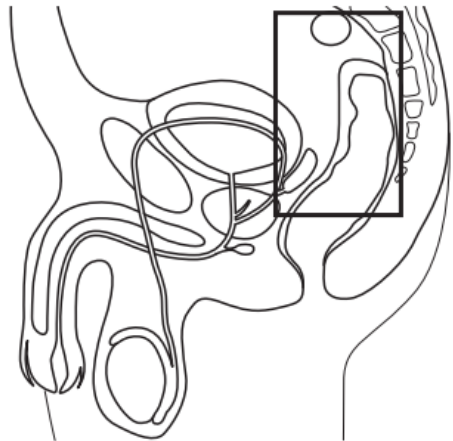
2



3



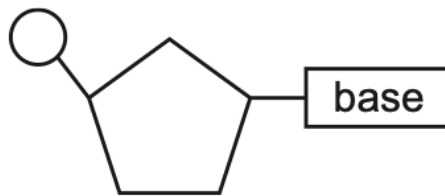
4



In which boxes does all, or a part of, the Cowper's gland appear?

- A** 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 and 4

- 30 The diagram represents a nucleotide containing adenine.



Which statements about this nucleotide are correct?

- 1 The carbohydrate is a 5 carbon sugar.
- 2 The base contains nitrogen.
- 3 Base pairing occurs with uracil.
- 4 Adenine is a pyrimidine.

- A** 1, 2, 3 and 4 **B** 1,2 and 3 only **C** 1 and 2 only **D** 3 and 4 only

- 31 Scientists grew bacteria in a medium containing heavy nitrogen, ^{15}N , as the only source of nitrogen. After many generations, both strands of all of the bacterial DNA molecules contained heavy nitrogen.

These bacteria were then moved from the heavy nitrogen medium into a medium with only light nitrogen, ^{14}N . The bacteria divided once to form the first generation and once more to form the second generation.

A sample of bacteria was collected from the second generation and the DNA was analysed to find:

- the percentage of DNA strands that contained only light nitrogen
- the percentage of DNA molecules that contained light nitrogen and heavy nitrogen.

Which of the following shows the results of this analysis?

	percentage of DNA strands that contained only light nitrogen	percentage of DNA molecules that contained light nitrogen and heavy nitrogen
A	50	25
B	50	50
C	75	25
D	75	50

- 32** The table shows the tRNA anticodons for four amino acids.

amino acid	tRNA anticodon
asparagine	UUA, UUG
glutamic acid	CUU, CUC
proline	GGA, GGG, GGU, GGC
threonine	UGA, UGG, UGU, UGC

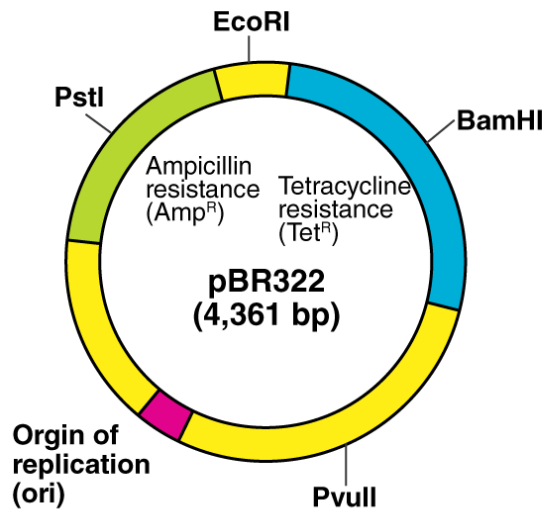
A cell makes a polypeptide containing the amino acid sequence shown.

asparagine – threonine – proline – glutamic acid

Which sequence of bases on the transcribed strand of a DNA molecule could code for this part of the polypeptide?

- A** AATACCCCTGAA
B AATACCCCTCAA
C TTACTTGGATGG
D TTATGGGGACTT
- 33** Which statement about the process of genetic engineering is not correct?
- A** Animals with suitable organs for transplant can be developed in the laboratory.
B Gene therapy can be used to prevent infectious bacterial diseases.
C It can be used to make important medical products such as insulin and human growth hormone.
D Plants can be made to resist pests and disease, and to produce bigger fruit with more flavour.

- 34 The pBR322 vector is used to clone a eukaryotic gene, which has been digested by the restriction enzyme BamHI.



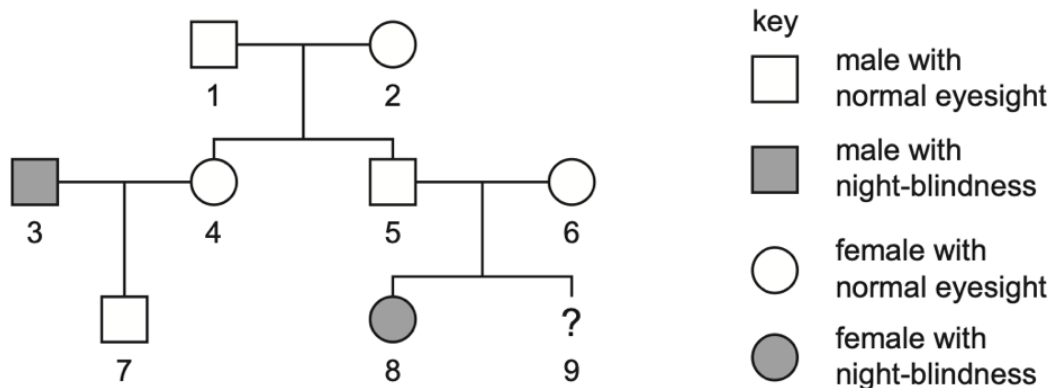
Following transformation, bacterial cells were grown in four different media, as shown below:

- 1 nutrient broth plus ampicillin
- 2 nutrient broth plus tetracycline
- 3 nutrient broth plus ampicillin and tetracycline
- 4 nutrient broth without antibiotics

Which of the following media would bacterial cells that contain the recombinant plasmids grow in?

- A** 4 only **B** 1 and 2 only **C** 2 and 3 only **D** 1 and 4 only

- 35 The diagram shows a family tree in which hereditary night-blindness occurs.



What is the chance that the unborn child, 9, will be a male with night-blindness?

- A** 1 in 2 **B** 1 in 4 **C** 1 in 8 **D** 3 in 4

- 36 The inheritance of the ABO blood groups in humans is controlled by three alleles (I^A , I^B and I^O), only two of which can be present in one individual.

What are the possible blood groups of children born to a homozygous group A woman and a heterozygous group B man?

- A** AB and B only
B AB and A only
C A, B and AB only
D A, B, AB and O

- 37 Which two statements about continuous variation are correct?

- 1 The heights of adult humans will partly depend on the quality of their diets when young.
- 2 The faster period of growth in humans is in the embryo.
- 3 A group of adult males had heights ranging from 155 cm to 220 cm.
- 4 Humans have stopped growing by the time they are 22 years old.
- 5 Humans grow taller during babyhood and childhood.

- A** 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 5

- 38** During the division of a nucleus by meiosis, changes can happen that produce a gamete with an abnormal number of genes or chromosomes.

Which change might produce a gamete that can result in a child having Down's Syndrome?

- A** a gamete with one extra chromosome
 - B** a gamete that lacks one gene
 - C** a gamete that lacks one chromosome
 - D** a gamete with one extra gene
- 39** Which statements about natural selection are correct?
- 1 It can cause gene mutations to occur.
 - 2 It can lead to the extinction of an existing species.
 - 3 It occurs when farmers choose their best animals for breeding the next generation.
- A** 1 only
 - B** 2 only
 - C** 3 only
 - D** 1, 2 and 3
- 40** Which statement is correct?
- A** Evolution is natural selection.
 - B** Evolution results in natural selection.
 - C** Natural selection and evolution are independent of each other.
 - D** Natural selection results in evolution.

End of paper

Answers

Paper 1

1	C	11	C	21	A	31	D
2	C	12	D	22	B	32	D
3	C	13	C	23	B	33	A
4	B	14	A	24	B	34	D
5	A	15	B	25	B	35	C
6	A	16	D	26	D	36	B
7	C	17	B	27	C	37	B
8	B	18	D	28	B	38	A
9	B	19	B	29	C	39	B
10	A	20	B	30	B	40	D

Paper 2

Section A		
1a	A = Guard cell; B = Epidermal cell; C = Phloem cell/Sieve tube cell/Xylem vessel D = Palisade cell	[2]
1b	To keep the leaf floating on water/ provide buoyancy for the leaf	[1]
1c	Air chambers are present in the palisade cells; Stomata are located on the upper epidermis; REJECT: on upper/lower surface Chloroplasts are present in the lower epidermis; Cuticle is absent on the lower epidermis	[2]
		Total 5
2a	The healthy child has longer villi /more protrusion while patient has shorter/fewer villi; The healthy child's villi are separated while patient are not separated; The healthy child's villi have larger surface area as compared to the patient's villi	[1]
2b	Microvilli provide a larger surface area to volume ratio for food to be absorbed faster; REJECT: presence of villi as question stated other features. Each villus is supplied with a network of blood capillaries to maintain a <u>steep diffusion gradient</u> for rapid diffusion of food substances; The villi are thin walled / one cell thick walls of villi provide a short diffusion distance for digested food to pass through the walls quickly; The small intestine is long to allow more time for digested food to be absorbed; Mitochondria are found in the cells of the epithelium to help in the absorption via active transport	[2]
2c	Enzymes are specific in action / Each protein must be digested by one specific enzyme; Each enzyme has an <u>active site</u> . The shape of the active site is complementary to shape of substrate / only allows a particular substrate to fit in;	[2]
		Total 5
3ai	0.3-0.4 minutes/18-24s	[1]
3aii	<u>Aerobic</u> respiration	[1]

NAME OF
STUDENT

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INDEX
NUMBER

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Anglo - Chinese School
(Independent)



FINAL EXAMINATION 2022
YEAR FOUR INTEGRATED PROGRAMME / SBGE / ACS

BIOLOGY

Paper 2 Structured Questions

3 October 2022

1 hour 45 minutes

No Additional Materials required.

INSTRUCTIONS TO CANDIDATES

Write your index number on the Question Paper in the spaces provided above.

Write in dark blue or black pen. You may use a soft pencil for any diagrams or graphs.

Do not open this examination paper until instructed to do so.

Section A

Answer **all** questions in this section in the spaces provided on the Question Paper.

Section B

Answer **three** questions in this section in the spaces provided on the Question Paper.

At the end of the examination, submit the Question Paper.

Electronic calculators may be used.

The number of marks is given in brackets [] at the end of each question or part question.

Name of Parent / Guardian: _____

Signature & Date: _____

FOR EXAMINER'S USE		
Section A		/ 50
Section B		/ 10
		/ 10
		/ 10
Total		/ 80

This paper consists of **20** printed pages

Section A

Answer **all** questions. Write your answers in the boxes provided.

- 1 **Fig. 1.1** shows a green water plant and **Fig. 1.2** shows a section through one of its leaves.

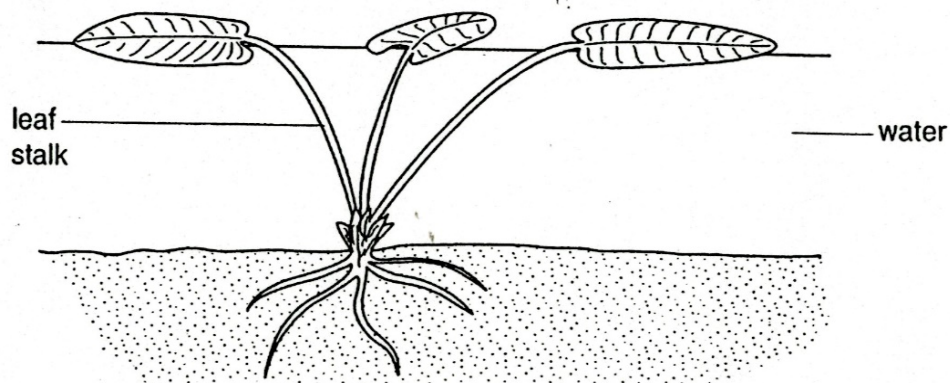


Fig. 1.1

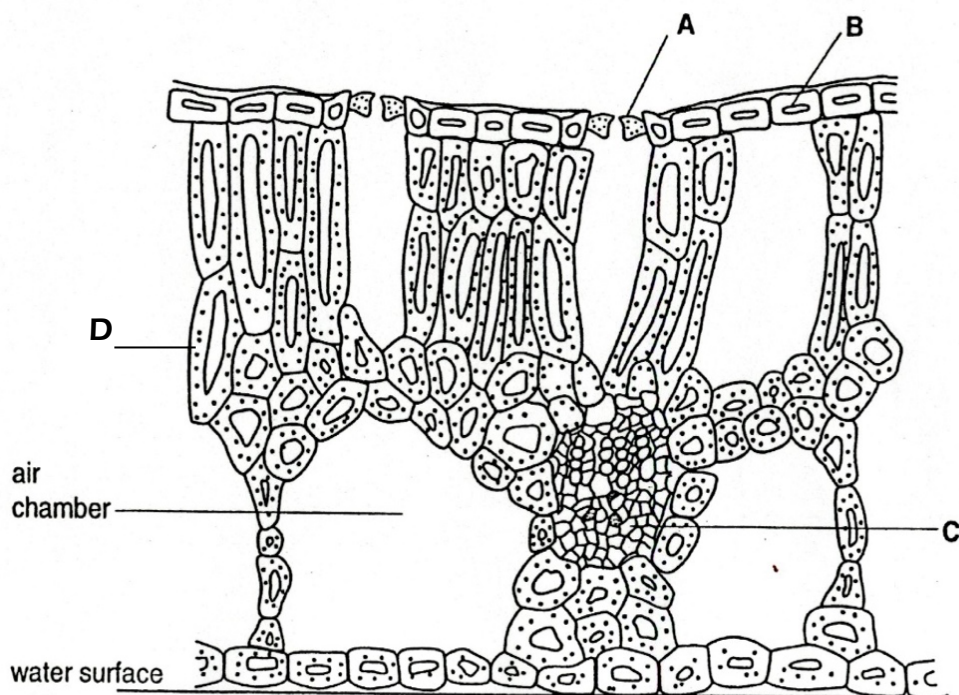


Fig. 1.2

- (a) Identify the types of cells found at **A**, **B**, **C** and **D** in **Fig. 1.2**.

[2]

A:	_____
B:	_____
C:	_____
D:	_____

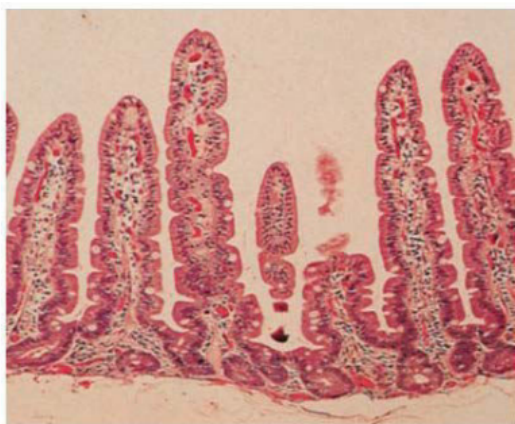
For
Examiners'
use only.
Do not write
in this
margin.

- (b) Suggest a function of the air chambers in **Fig. 1.2** related to maintaining the position of the leaf. [1]

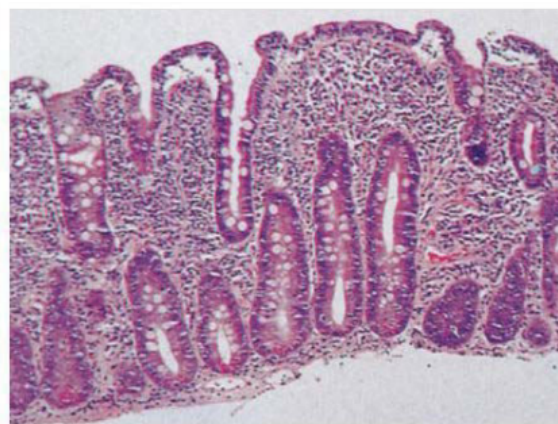
- (c) State two ways in which the structure of this leaf differs from that of a typical plant growing on land. [2]

[Total: 5]

- 2 A surgeon carried out a biopsy on a child who was not gaining the weight expected for his age. A small sample of tissue was removed from inside the child's small intestine. **Fig. 2** shows the appearance of the villi in a normal healthy child and that of the child patient's small intestine of the same age. Both diagrams are to the same scale.



healthy child



child patient

Fig. 2

- (a) With reference to **Fig. 2**, state one difference between the villi of the healthy child and that of the child patient. [1]

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- (b) Describe and explain two other features of a healthy small intestine that help to maximise the absorption of digested food. [2]

- (c) The child was diagnosed as suffering from coeliac disease. This is a condition in which an individual lacks a particular enzyme needed to digest gluten. Gluten is a protein found in wheat. A dietician was asked to advise the family on a suitable diet for the child. The child's parents found it hard to understand why the child could digest proteins present in meat but was unable to digest gluten.

How might the dietician have explained to them, using his knowledge of enzymes? [2]

[Total: 5]

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- 3 **Fig. 3** shows the effect of exercise on the concentration of oxygen in the blood and the concentration of lactic acid in the muscles of a healthy person over a 5-minute period.

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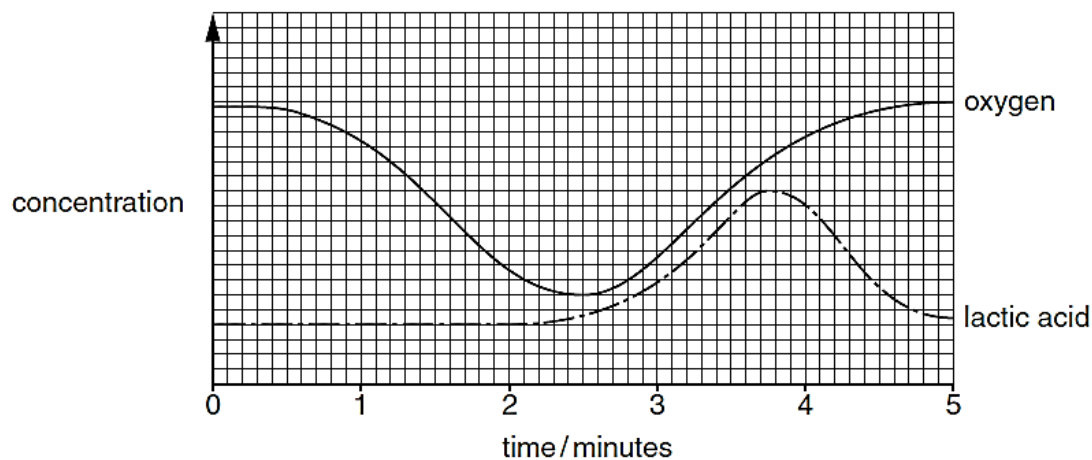


Fig. 3

- (a) With reference to **Fig. 3**,

(i) state the time at which the person started to exercise.

[1]

(ii) name the process that causes the change in oxygen concentration during the first 2 minutes.

[1]

- (b) Suggest and explain how each of the two curves on **Fig. 3** might be different if the person suffered from emphysema. [3]

[Total: 5]

- 4 **Table 4** shows the average body length and rate of heat production in four animals.

Table 4		
animal	average body length /cm	rate of heat production / kJ kg ⁻¹ h ⁻¹
rat	10	17.0
rabbit	30	13.0
dog	70	7.2
human	150	3.3

- (a) Describe the relationship between the average body length and the rate of heat production. [1]

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- (b) Seth who had an average body mass of 70 kg stayed in a hot desert environment for 2 hours. The average percentage of body mass he lost per hour was 1%.

Calculate the total average body mass lost, **in kg**, over the 2-hour period. Show your calculations clearly in the space provided below. [2]

- (c) Most of the body mass lost was in the form of water. Explain how this loss of mass helped Seth survive in the hot conditions. [2]

[Total: 5]

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- 5 **Fig. 5** shows the appearance of an eye before and after a reflex action which occurs in response to an increase in light intensity.

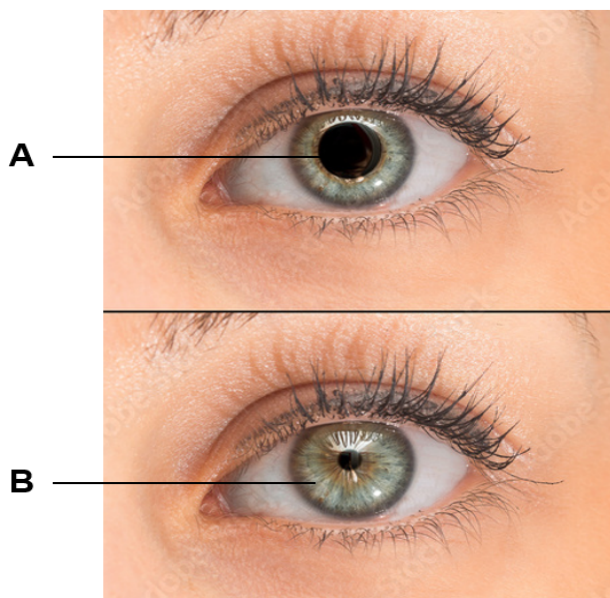


Fig. 5

- (a) Identify structures **A** and **B** in **Fig. 5**. [2]

A:	_____
B:	_____

- (b) Describe how structures **A** and **B** change when there is an increase in light intensity. [3]

[Total: 5]

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- 6 **Fig. 6** shows the tissues of the mother and fetus in the placenta of humans.

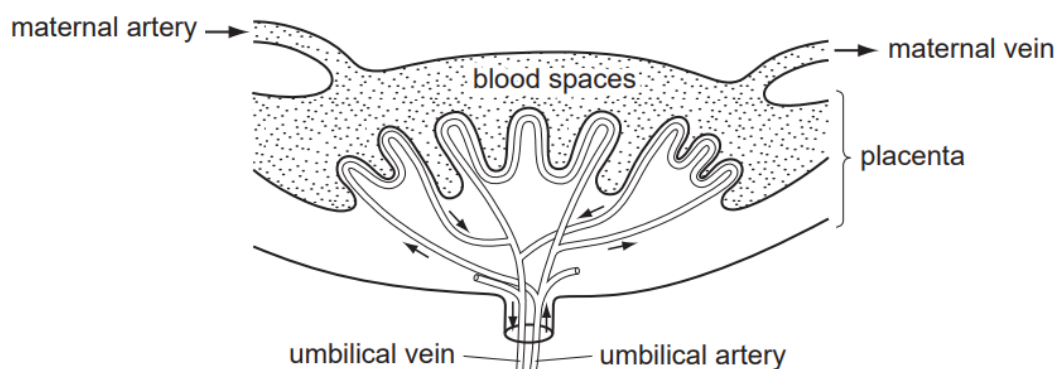


Fig. 6

- (a) Suggest one reason why the maternal and fetal blood systems are kept separate. [1]

- (b) The placenta is often described as “a small intestine and a kidney”.

Explain how the placenta functions like a

- (i) small intestine. [2]

- (ii) kidney. [2]

[Total: 5]

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7 **Fig. 7** shows the stages involved in protein synthesis.

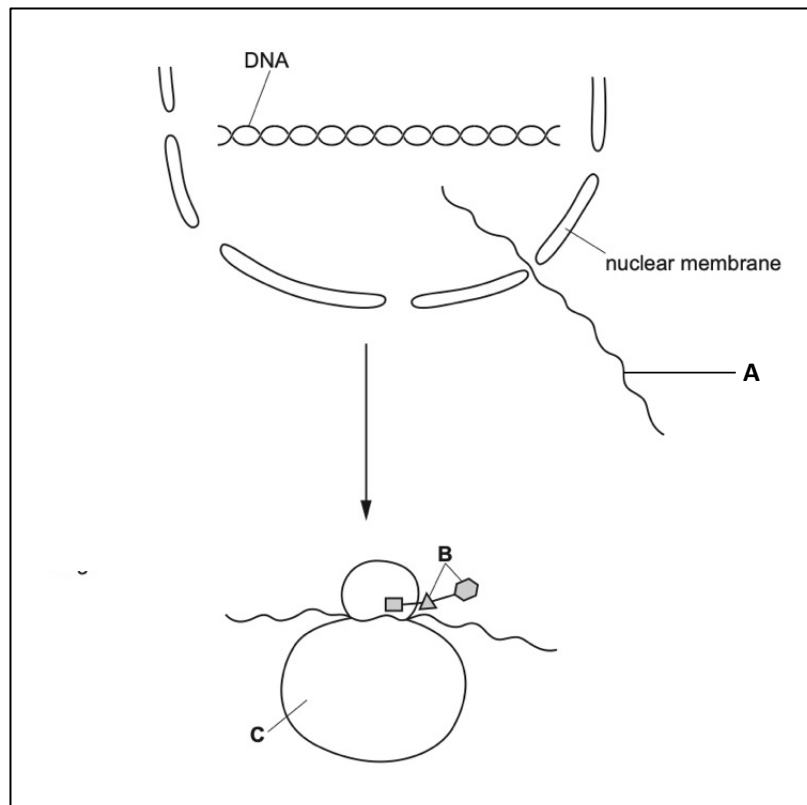


Fig. 7

(a) State the name of the parts represented by the letters **B** and **C** in **Fig. 7**.

[2]

B:

C:

(b) Outline how structure **A** in **Fig. 7** is formed.

[4]

[Total: 6]

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8(a) Distinguish between *phenotype* and *genotype*.

[2]

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- (b)** Coat colour in cats is determined by a sex-linked gene with two alleles, black and ginger. When black cats are mated with ginger cats, the female offspring are always tortoiseshell, their coats showing a mottling of small black and ginger patches, while the male offspring always have the same coat colour as their mothers.

Using X^B and X^G to represent the X chromosome carrying the black colour allele and ginger colour allele respectively, construct a genetic diagram in the space below to explain these results. [6]

- (c) Genes are also important in the clotting of blood. Blood will clot normally if a person possesses at least one dominant allele (**B**). This gene is carried only on the X chromosome.

Suggest why more males than females are likely to suffer from a disease in which blood does **not** clot normally. [2]

[Total: 10]

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9 Fig. 9 shows a giraffe and an okapi.

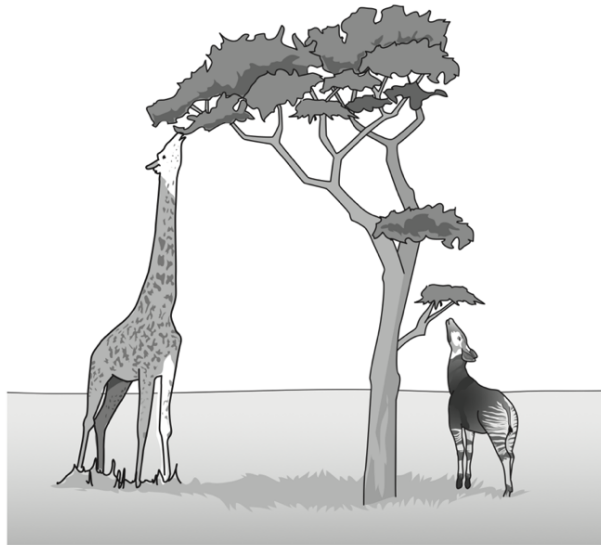


Fig. 9

The long neck is an adaptive feature for giraffes. It helps them feed on leaves that other animals like the okapi cannot reach. Giraffes developed long necks by the process of natural selection.

The statements in the table below are about how natural selection occurred in giraffes.

statement number	statement
1	more offspring than the environment can support.
2	giraffes have necks of different length.
3	the giraffes with longer necks can survive to reproduce.
4	there is a selection pressure on the giraffe population.
5	the surviving giraffes pass on their alleles for long necks to their offspring.

Arrange the statement number in a sequence to explain how natural selection occurred in giraffes. One has been done for you. [4]

	2			
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[Total: 4]

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Section B

Answer **three** questions. Write your answers in the boxes provided.

- 10 (a)** Explain how coronary heart disease is caused by a fatty diet and smoking. [5]
- (b)** Describe the role of kidneys as osmo-regulators, after a person has completed running a marathon. [5]
- 11 (a)** Describe the chemical nature of synaptic transmission. [5]
- (b)** Distinguish between *mitosis* and *meiosis*. [5]
- 12 (a)** Describe the structure and function of DNA. [5]
- (b)** Outline the process of DNA replication on the leading strand. [5]
- 13 (a)** Describe how bacteria can be used to produce human insulin. [5]
- (b)** Describe the mutation that gives rise to sickle cell anaemia. Name one factor which may increase the rate of mutations. [5]

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End of paper

Answers

Paper 1

1	C	11	C	21	A	31	D
2	C	12	D	22	B	32	D
3	C	13	C	23	B	33	A
4	B	14	A	24	B	34	D
5	A	15	B	25	B	35	C
6	A	16	D	26	D	36	B
7	C	17	B	27	C	37	B
8	B	18	D	28	B	38	A
9	B	19	B	29	C	39	B
10	A	20	B	30	B	40	D

Paper 2

Section A		
1a	A = Guard cell; B = Epidermal cell; C = Phloem cell/Sieve tube cell/Xylem vessel D = Palisade cell	[2]
1b	To keep the leaf floating on water/ provide buoyancy for the leaf	[1]
1c	Air chambers are present in the palisade cells; Stomata are located on the upper epidermis; REJECT: on upper/lower surface Chloroplasts are present in the lower epidermis; Cuticle is absent on the lower epidermis	[2]
		Total 5
2a	The healthy child has longer villi /more protrusion while patient has shorter/fewer villi; The healthy child's villi are separated while patient are not separated; The healthy child's villi have larger surface area as compared to the patient's villi	[1]
2b	Microvilli provide a larger surface area to volume ratio for food to be absorbed faster; REJECT: presence of villi as question stated other features. Each villus is supplied with a network of blood capillaries to maintain a <u>steep diffusion gradient</u> for rapid diffusion of food substances; The villi are thin walled / one cell thick walls of villi provide a short diffusion distance for digested food to pass through the walls quickly; The small intestine is long to allow more time for digested food to be absorbed; Mitochondria are found in the cells of the epithelium to help in the absorption via active transport	[2]
2c	Enzymes are specific in action / Each protein must be digested by one specific enzyme; Each enzyme has an <u>active site</u> . The shape of the active site is complementary to shape of substrate / only allows a particular substrate to fit in;	[2]
		Total 5
3ai	0.3-0.4 minutes/18-24s	[1]
3aii	<u>Aerobic</u> respiration	[1]

3b	Oxygen curve not as high at start/finish and oxygen curve drops more quickly; Alveoli damaged and less surface area for oxygen absorption; More lactic acid build-up/lactic acid curve rises higher/takes longer to return normal; Shorter period of aerobic/longer period of anaerobic respiration	[3]
	Total 5	
4a	As the average body length increases, the rate of heat production decreases.	[1]
4b	Body mass lost during 1st hour = $1\% \times 70\text{ kg} = 0.700\text{kg}$ Body mass lost during 2nd hour = $1\% \times 69.3\text{ kg} = 0.693\text{kg}$ Total body mass lost = $0.700 + 0.693 = 1.393\text{kg}$	[2]
4c	Water was lost through sweat which evaporated and removed <u>latent heat of vaporisation</u> ; Thus he was able to cool/lower his body temperature and survive in hot conditions	[2]
	Total 5	
5a	A: pupil B: iris/ iris muscles	[2]
5b	<i>Max. 3</i> - Increased light intensity stimulates the photoreceptors which generate nerve impulses that are transmitted - along sensory neurone to relay neurone to motor neurone to the effector/ iris muscles - Iris circular muscles contract while radial muscles relax - pupil constricts	[3]
	Total: 5	
6a	<i>Any 1 of the below</i> - may be of different blood groups, possibly causing agglutination - blood pressure of mother may be higher than fetus, may cause damage to fetal blood vessels - prevent direct transfer of drugs/ toxins/ pathogens	[1]
6bi	<i>small intestine:</i> - allows transfer/ absorption/ diffusion of nutrients e.g. glucose/ amino acids/ vitamins/ mineral ions/ oxygen - from mother into fetus	[2]
6bii	<i>kidney:</i> allows transfer of urea and other excretory waste products from fetus/ to mother	[2]
	Total: 5	
7a	B: amino acids C: ribosome	[2]
7b	RNA polymerase attaches to promoter RNA polymerase uses DNA template to synthesize mRNA Based on complementary base-pairing Adds RNA nucleotides Enzymes reach a particular sequence and detaches from DNA template	[4]
	Total: 6	

8a	Phenotype is the observable/expressed feature/characteristic Genotype is the combination of alleles at a gene loci/genetic make up				[2]									
8b					[6]									
	Parental Phenotype	Female Black Cat		Male Ginger Cat										
	Parental Genotype	$X^B X^B$		$X^G Y$										
	Gametes	X^B X^B		X^G Y										
		<table><tr><td></td><td> X^G </td><td> Y </td></tr><tr><td> X^B </td><td>$X^G X^B$</td><td>$X^B Y$</td></tr><tr><td> X^B </td><td>$X^G X^B$</td><td>$X^B Y$</td></tr></table>					X^G	Y	X^B	$X^G X^B$	$X^B Y$	X^B	$X^G X^B$	$X^B Y$
		X^G	Y											
	X^B	$X^G X^B$	$X^B Y$											
	X^B	$X^G X^B$	$X^B Y$											
	Offspring Genotype	$X^G X^B : X^B Y$												
	Offspring Genotype Ratio	1:1												
Offspring Phenotype	Female Tortoiseshell: Male Black													
Offspring Phenotype Ratio	1:1													
*Credit given if parents are: Female Ginger Cat X Male Ginger Cat														
Correct Parent Phenotype and Genotype [1] Punnett square/Genetic Cross [1] Offspring Genotype [1] and Ratio [1] Offspring Phenotype [1] and Ratio [1]														
8c	Female needs to be homozygous recessive/two recessive alleles for disease to manifest. Males will manifest disease when with one recessive allele for disease to manifest. REJECT: "Female has higher probability of inheriting X^B dominant allele than males" without reference to parental genotype.				[2]									
					Total: 10									
9	<table><tr><td>1</td><td>2</td><td>4</td><td>3</td><td>5</td></tr></table> 1 mark for each correct answer				1	2	4	3	5	[4]				
1	2	4	3	5										
					Total: 4									
Section B														
10a	Fatty substances such as cholesterol and polyunsaturated fats may be deposited on the inner surface of the coronary arteries. This narrows the lumen of the arteries and increases blood pressure and leading to arteriosclerosis. Nicotine increases blood pressure, and the risk of blood clotting in coronary arteries. Carbon monoxide increases the risk of fatty deposits on the inner surfaces of the arteries.				[5]									

10b	The water potential of the blood needs to be kept constant. After a marathon, blood plasma is too concentrated / low in water potential, cells will shrink. Increase in anti-diuretic hormone (ADH) secreted by pituitary gland in the brain. ADH increases the water permeability of the collecting duct. Kidney tubules will reabsorb more water from the urine. Water potential rises and <u>negative feedback</u> is sent to the receptor to ensure water potential of the blood be returned to normal level.	[5]
11 (a)	<i>Max. 5</i> • Nerve impulses are transmitted across the synapse in the form of neurotransmitters (e.g. acetylcholine) • Exocytosis of secretory vesicles containing neurotransmitters (acetylcholine) • and diffusion of the neurotransmitters across the synapse/ synaptic cleft to dendron/ post-synaptic neurone/ membrane. • Receptors at the dendron cell membrane bind with neurotransmitters (e.g. acetylcholine) • This triggers a new nerve impulse at the dendron. • Excess neurotransmitters are broken down by enzymes (e.g. cholinesterase breaks down acetylcholine) • or reabsorption into presynaptic cell membrane (back into synaptic vesicles)	[5]

11b	Any 5 of the below	[5]																	
	<table><tr><th>Mitosis</th><th>Meiosis</th></tr><tr><td>Involves one nuclear division</td><td>Involves two nuclear divisions</td></tr><tr><td>Two daughter cells are formed</td><td>Four daughter cells are formed</td></tr><tr><td>Daughter cells have the same number of chromosomes as parent cells (diploid)</td><td>Daughter cells have half the number of chromosomes as parent cells (haploid)</td></tr><tr><td>Crossing over does not occur (as homologous chromosomes do not pair up in prophase)</td><td>Crossing over may occur (when homologous chromosomes pair up during prophase I)</td></tr><tr><td>Daughter cells are genetically identical</td><td>Daughter cells are genetically different</td></tr><tr><td>Occurs in plant or animal or bacterial cells</td><td>Occurs in reproductive organs/ gonads/testes/ovaries/anthers</td></tr><tr><td>For asexual reproduction;</td><td rowspan="2">To produce gametes/sex cells/sperm and ova/for sexual reproduction</td></tr><tr><td>For growth of organism and repair of tissues</td></tr></table>		Mitosis	Meiosis	Involves one nuclear division	Involves two nuclear divisions	Two daughter cells are formed	Four daughter cells are formed	Daughter cells have the same number of chromosomes as parent cells (diploid)	Daughter cells have half the number of chromosomes as parent cells (haploid)	Crossing over does not occur (as homologous chromosomes do not pair up in prophase)	Crossing over may occur (when homologous chromosomes pair up during prophase I)	Daughter cells are genetically identical	Daughter cells are genetically different	Occurs in plant or animal or bacterial cells	Occurs in reproductive organs/ gonads/testes/ovaries/anthers	For asexual reproduction;	To produce gametes/sex cells/sperm and ova/for sexual reproduction	For growth of organism and repair of tissues
	Mitosis		Meiosis																
	Involves one nuclear division		Involves two nuclear divisions																
	Two daughter cells are formed		Four daughter cells are formed																
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	For asexual reproduction;		To produce gametes/sex cells/sperm and ova/for sexual reproduction																
For growth of organism and repair of tissues																			
12a	Max 5: • A molecule that carries genetic information. • DNA is made of nucleotides; Each nucleotide is made of a base (one of 4 types – Adenine, Cytosine, Thymine and Guanine); • deoxyribose sugar and a phosphate group • Nucleotides in DNA backbone/DNA strand held together by phosphodiester bonds • Anti-parallel strands / Double stranded DNA • held by complementary base pairing between complementary bases by hydrogen bonds	[5]																	
12b	Max 5: • Helicase separates double strand DNA into single strands • Single strand binding proteins prevents single stranded DNA to anneal back into double stranded DNA. • RNA primase makes a short RNA primer • DNA polymerase polymerizes free deoxyribonucleotides into a newly synthesized DNA strand • by complementary base pairing • Synthesis of new strand in a 5' to 3' direction • DNA polymerase also replaces RNA primer with DNA. • Ligase joins DNA fragments together	[5]																	
13a	Max 5: • Isolate insulin gene using a restriction enzyme. • The bacterium plasmid is cut with the same restriction enzyme • to produce complementary sticky ends to insulin gene. REJECT: same sticky ends • The plasmid is mixed with the DNA fragment containing the insulin gene and DNA ligase is added to join the insulin gene to the plasmid.	[5]																	

	E. coli bacteria is allowed to take up the plasmids by applying temporary heat or electric shock to <u>open up the pores</u> in the cell surface membrane of the bacterium for the plasmid to enter. - Bacteria can be isolated and grown for mass production.	
13b	<i>Max 4</i> - Missense mutation / substitution mutation / point mutation - beta chain of haemoglobin - GAG to GTG on mRNA - resulting in replacement of glutamic acid by valine, REJECT: glutamine or wrong spelling - produces hemoglobin S instead of hemoglobin A which clump together / hemoglobin clumps together <i>Max 1</i> - ultraviolet rays - radiation - chemicals – formaldehyde, tar REJECT: Mutagen	[5]