ANSWERS

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

Geylang Methodist School (Secondary)
Preliminary Examination 2020

Candidate Name	**ANSWERS SCHEME**		
Class		Index Number	

BIOLOGY
Paper 2

6093/02
Sec 4 Express

Additional materials: Nil

1 hour 45 minutes

Setter: Miss Ng Sio Ying

26 Aug 2020

READ THESE INSTRUCTIONS FIRST
Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper. Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
write your answers in the spaces provided on the Question Paper.

Section B
Answer **all** questions.
write your answers in the spaces provided on the Question Paper.
Write an **E** (for Either) or an **O** (for Or) next to the number 12 in the grid below to indicate which question you have answered.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.

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

For Examiner's Use		
Section A		**50**
Section B		
8		**11**
9		**9**
10		**10**
Total		**80**

Section A

Answer **all** questions in the spaces provided.

1 In an investigation, the volume of samples of 20 dried raisins was measured. Each sample was then placed in water or sugar solution of different concentrations.

Fig. 1.1 shows the volume of each sample of raisins after 12 hours.

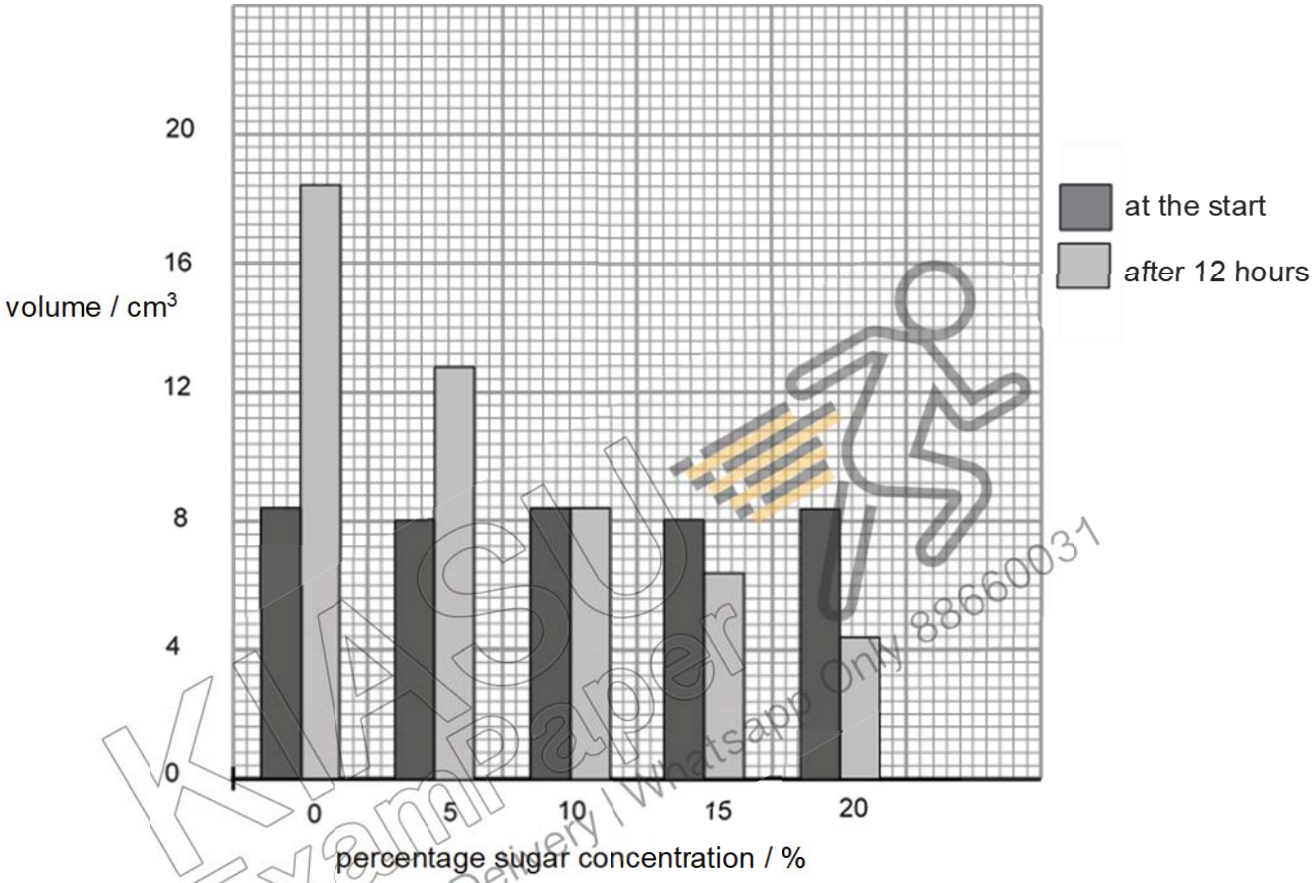


Fig. 1.1

(a) Explain why samples of 20 raisins were used rather than a sample of one raisin.

To increase the accuracy of the investigation by taking the average results of 20 raisins.	1

[1]

(b) Explain why there is an increase in the volume of the sample of raisins in 5% sugar solution.

The water potential of the 5% sucrose solution outside the raisin is higher than that of the raisin contents;	1
Water molecules move into the raisins by osmosis down the water potential gradient through the partially permeable membrane causing the raisin to swell and increase in volume;	1

[2]

(b) Calculate the percentage increase in the volume of the sample of raisins in 5% sugar solution.
(Show your working)

(12.8 – 8) cm^3 / 8 x 100	1
= 60%	1

[2]

(c) Suggest the concentration of the cell sap in the raisin.

Explain your answer.

The concentration of the raisin is 10% sugar solution	1
From the results/ bar chart, it can be seen that there is no net change in volume at 10% sucrose solution / The concentration inside and outside the raisin must be the same / No net movement of water molecules / water potential is the same / no concentration gradient;	1

[2]

[Total: 7]

2 It is reputed that almost 65% of the world's population has lactose intolerance. Consuming cow's milk, which has 5% lactose, will result in diarrhoea, bloating and vomiting.

Cow's milk can be treated with enzyme lactase to hydrolyse lactose. The end result is lactose-free milk. Fig. 2.1 shows how the simplified version of this treatment is carried out. Beads are coated with lactase and placed in a funnel-like apparatus. Cow's milk flows over the beads and the lactose is hydrolysed.

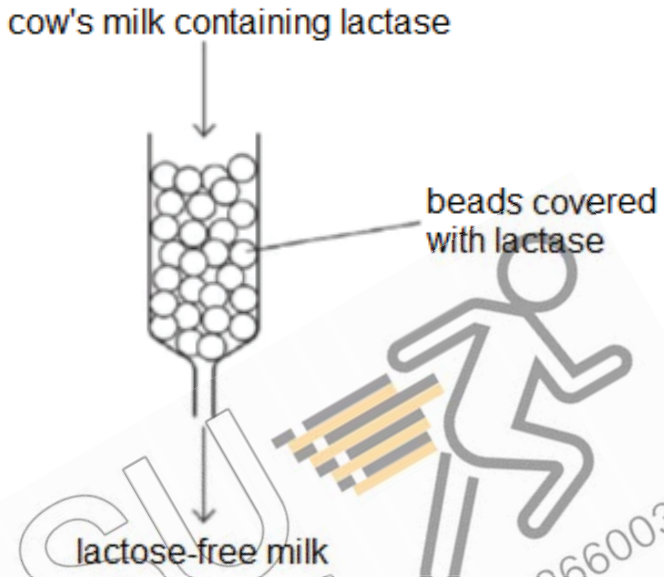


Fig. 2.1

(a) Using beads coated in lactase is a more efficient use of lactase than adding lactase directly to the cow's milk.

Suggest **two** reasons why this is so.

• **Lactase beads can be reused as they are not washed away** • **There is no need to add more lactase as they are not washed away** • **No need to remove lactase from milk after hydrolysis/efficient reuse of enzymes;** • **Avoid contamination of product;** • **Enzymes are spread out/larger surface area to volume ratio/easier contact with substrate for faster reaction;** • **Longer time for reaction because beads will slow down milk flow;**	**Any 2**

[2]

(b) Suggest why the lactose-free milk made after hydrolysis with lactase tastes sweeter than the cow's milk containing lactose.

Lactose is hydrolysed/broken down/ digested to galactose and glucose	1
Monosaccharide molecules are sweeter in taste;	1

[2]

(c) An equipment error during the production of lactose-free milk resulted in boiling water being poured over the beads covered with lactase.

Predict how the milk produced due to this equipment error would differ from the expected product and provide a reason for your answer.

The milk produced will contain lactose / will not be lactose-free	**1**
Lactase has denatured due to high temperatures	**1**

[2]

[Total: 6]

3 Read this passage taken from a website.

Diabetes Mellitus and Glucose Tolerance Test

The name "diabetes mellitus" means "sweet urine." It stems from ancient times, when physicians would taste a patient's urine as a part of diagnosis.

A Glucose Tolerance Test is a diagnostic test for diabetes. After fasting overnight, you are given a concentrated sugar solution (50 to 100 grams of glucose) to drink, and your blood is sampled periodically over the next several hours to test its glucose levels.

Normally, blood glucose does not rise very much and returns to normal within two to three hours. In a diabetic, the blood glucose is usually higher after fasting, rises more after the glucose solution and takes from four to six hours to come down.

Craig Freudenrich, Ph.D. "How Diabetes Works" 22 June 2001. HowStuffWorks.com. <https://health.howstuffworks.com/diseases-conditions/diabetes/diabetes.htm> 11 July 2020

Fig. 3.1

Use the information from the passage in Fig. 3.1 to help you answer these questions.

(a) Explain what causes the blood glucose to return to normal levels within two to three hours of the Glucose Tolerance Test for a normal (non-diabetic) person.

islets of Langerhans cells in the pancreas produces insulin in response to the increase in blood glucose concentration;	1
insulin increases the permeability of cell membranes to glucose;	1
Thus, increases the rate of glucose uptake by cells;	1
insulin increases oxidation of glucose during tissue respiration;	1
insulin stimulates liver and muscles cells to convert glucose to glycogen to be stored in the liver and muscles; **all these actions reduce the blood glucose concentration to return to normal**	1

[5]

(b) Explain the two ways in which a person suffering from diabetes would respond differently to the Glucose Tolerance Test than a normal person.

His pancreas is not able to produce insulin to stimulate the conversion of excess glucose to glycogen / His cells are not responsive to the insulin produced	1
glucose remains in the blood until it is removed through the urine	1

[2]

(c) Diabetics can control their blood glucose levels artificially by injecting insulin. Insulin is a protein.

Suggest why insulin has to be injected rather than taken orally.

Insulin is a protein and would be digested by protease in the alimentary canal before it can be absorbed.	1

[1]

[Total: 8]

4 Fig. 4.1 is a photomicrograph of a cross-section through the leaf of *N. oleander*.

Nerium oleander is a xerophytic plant. Xerophytic plants have adaptations to survive in an environment with little water, such as a desert or snow-covered region.

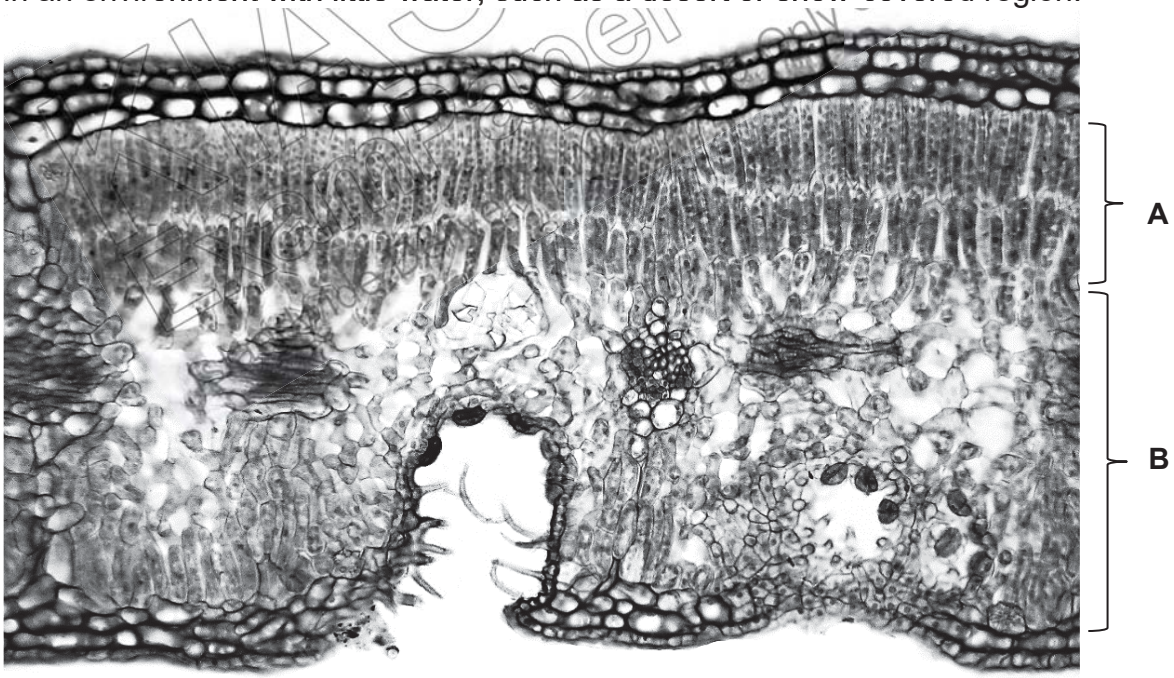


Fig. 4.1

(a) Identify the tissues labelled **A** and **B**.

A palisade mesophyll

B spongy mesophyll [2]

(b) The leaf shown in Fig. 4.1 has a number of adaptations to reduce water loss by transpiration. Two of the adaptations are:

- a multilayered epidermis
- stomata only found in depressions, known as stomatal crypts, on the lower surface of the leaf.

Explain how the two adaptations will help to reduce water loss in *N. oleander.*

multilayered epidermis

Thick layer of epidermis increases diffusion distance hence slows down water loss by evaporation from the surface	1

[1]

stomatal crypts

The leaf has sunken stomata/ stomata that lie in the grooves of the leaf on the lower surface of the leaf OR has hairs that trap water vapour diffusing out of the stomata.	1
This increases the humidity around the stomata and so reduces the rate of transpiration.	1

[2]

[Total: 5]

5 Table 5.1 shows the results of a survey on fifty females to investigate the impact of smoking on the live birth weight of babies.

All participants were habitual smokers who continued smoking during pregnancy.

Table 5.1

average number of cigarettes smoked each day	average live birth weight of the baby / kg
0	2.78
2	2.60
4	2.45
6	2.33
8	2.20
10	2.12

(a) Describe and explain the results shown in Table 5.1.

[describe the trend] **As the number of cigarettes smoked increases from 0 to 10 sticks, the average live birth weights of a baby decrease from 2.78 to 2.12 kg.** ***(no marks if no reference is made to values in table)***	1
[content of cigarette smoke] cigarette smoke contains nicotine.	EITHER explanation 1 – 2 m
[effects of cigarette smoke] nicotine constricts blood vessels including the umbilical blood vessels, hence less oxygenated blood are transported to the developing fetus leading to reduced average live birth weights	
[content of cigarette smoke] cigarette smoke contains carbon monoxide	OR explanation 2 – 2 m
[effects of cigarette smoke] carbon monoxide binds irreversibly to the mother's haemoglobin which result is less oxygenated blood being transported and less oxygenated blood transported to the developing fetus leading to reduced average live birth weights	

[3]

(b) Name the hormone that is high in concentration throughout pregnancy.

State its source and outline its role in maintaining pregnancy.

[name of hormone] Progesterone	1
[source] Corpus luteum releases progesterone (accept: ovary)	1
[function] to maintain the thickness of the uterine lining	1
[during pregnancy] when the placenta develops, more progesterone is released causing further thickening of uterine lining to ensure sufficient nutrient exchange between mother and fetus	1

[4]

[Total: 7]

6 **(a)** Fig. 6.1 shows the total mass of DNA in a haploid nucleus of an organism's egg cell and the total mass of DNA in a body cell developed from this egg cell after fertilisation and cell division.

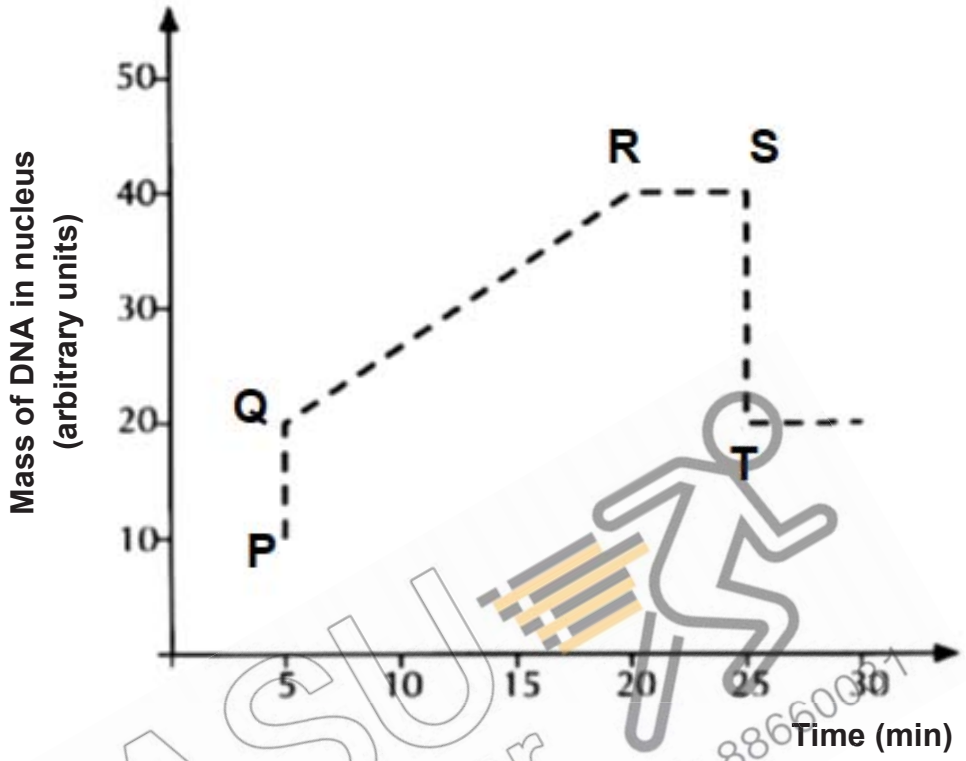


Fig. 6.1

With reference to Fig. 6.1,

(i) explain what is happening from **Q** to **R**.

DNA replication during interphase	1

[1]

(ii) given that the mass of DNA in a chromosome of this organism is 1 arbitrary unit, state the diploid number of this organism.

20	1

[1]

(b) Fig. 6.2 is a photomicrograph of a cut section of the root tip of a broad bean plant. The cell labelled **D** is in interphase.

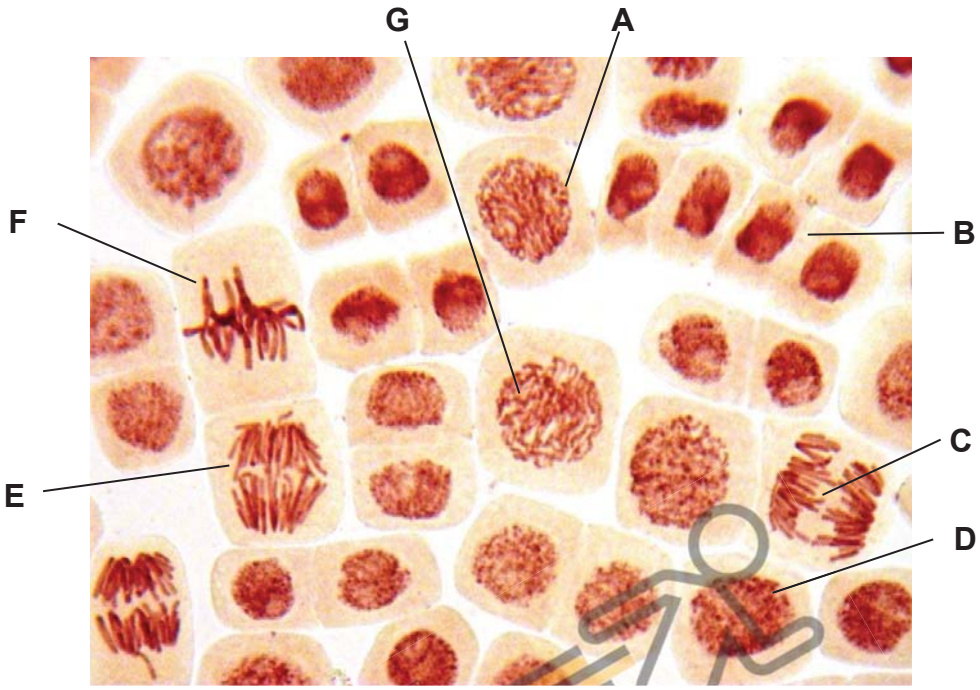


Fig. 6.2

(i) Complete the table below by:

- naming the stages of mitosis in the correct sequence following interphase.
- Identifying one example from the cells labelled **A** to **G** that is in the stage of mitosis that you have named.

stage of mitosis	label from photomicrograph
Prophase	**A or G**
Metaphase	**F**
Anaphase	**C or E**
Telophase	**B**

1 row 1 mark [4]

(ii) Describe how stage **F** is different from a similar stage in meiosis I.

Metaphase 1 in meiosis 1 involves the lining of homologous chromosomes at the equatorial plane but	1
metaphase in mitosis involves lining of chromosomes/sister chromatids only.	1

[2]

[Total: 8]

7 Fig. 7.1 shows flowers from the same species of a plant at different stages, **D** and **E**, in their development.

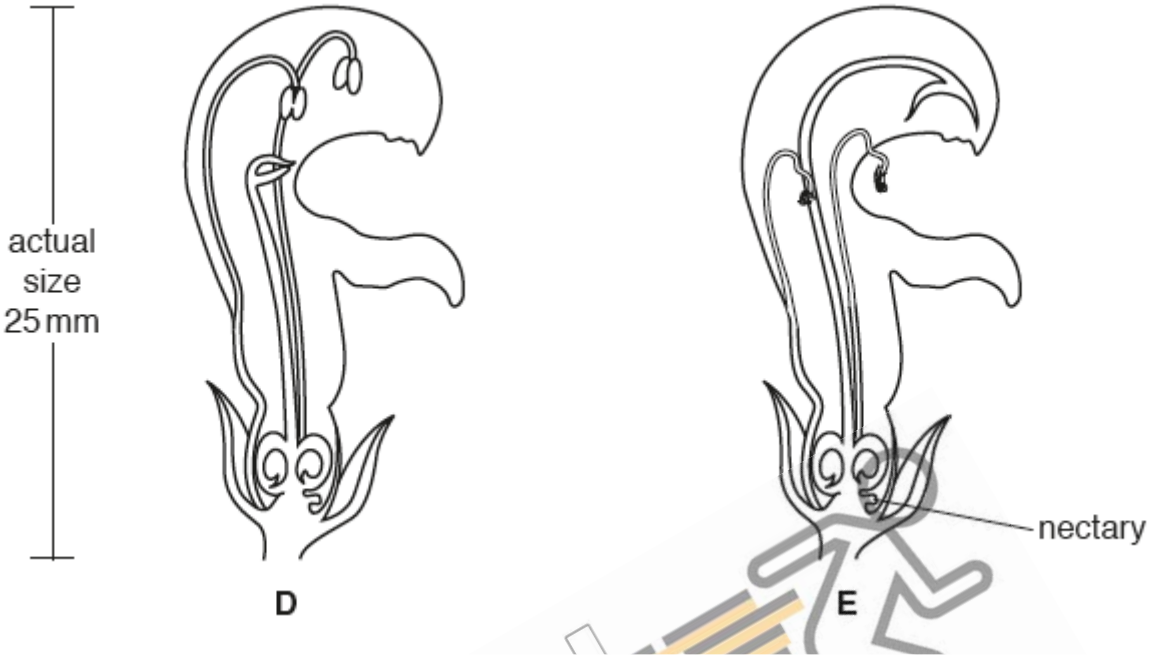


Fig. 7.1

(a) The flowers are cross-pollinated by an insect.

Explain why the insect must visit flower **D** before visiting flower **E**.

The **anthers on flower D are mature** and can produce/release pollen while **the stigma is closed** and cannot receive pollen	1
The **anthers on flower E are withered** hence no longer produce pollen while the **stigma is mature/open.**	1
Insect must visit flower **D to pick up pollen** and then **transfer to stigma of flower E.**	1

[3]

(b) Suggest how flowers of this species are adapted to be pollinated by an insect such as a bee.

- **Large colourful petals to attract insects/for insects to land on;** - **Nectaries/sweet smell to attract insects;** - **Nectar guides to guide insects to the nectaries;** - **Pollen has rough edges/sticky to stick to insects' hairy body;** - **Compact/not feathery stigma;** - **Stigma/stamen does not protrude out of flower/non-pendulous;**	Any 3

[3]

(c) In some species, some plants have only male flowers while the rest have only female flowers.

Explain the advantages of this to the species.

Ensures **cross pollination** as 2 parents are involved	1
Offspring can inherit beneficial qualities from both parents	1
Greater genetic variation in offspring hence more adaptive to changing environmental conditions	1

[3]

[Total: 7]

Section B

Answer all **three** questions in this section in the spaces provided.
The last question is in the form of an Either / Or and only one of the alternatives should be attempted.

8 Table 8.1 shows the information about some of the characteristics of 20 students in a class.

Table 8.1

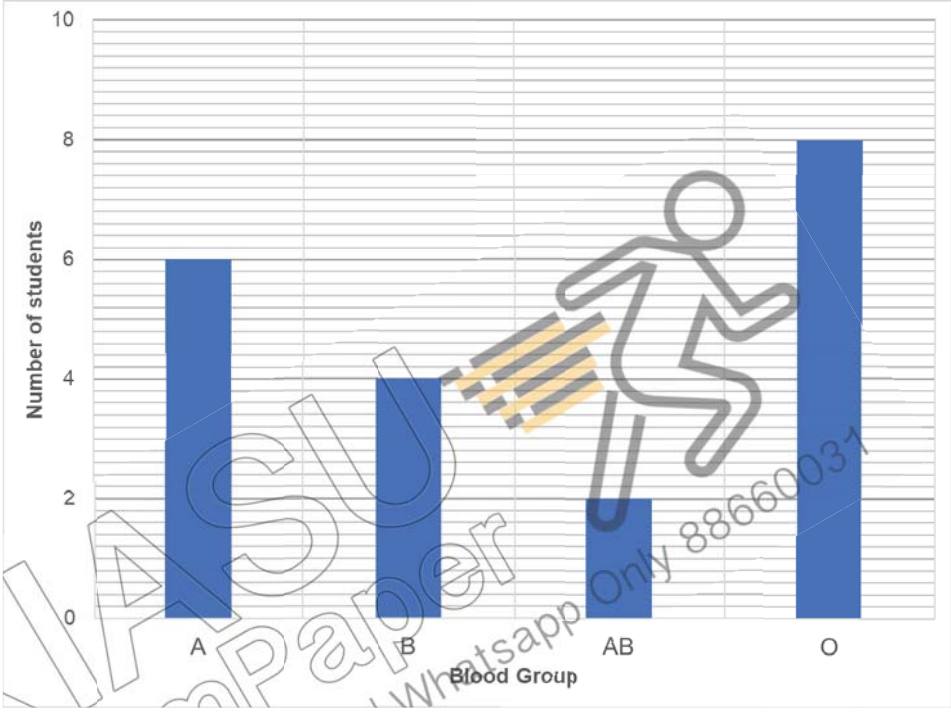
student	height / cm	blood group	ability to roll tongue
1	136	O	roller
2	165	A	roller
3	159	A	non-roller
4	139	O	roller
5	174	O	non-roller
6	167	AB	non-roller
7	165	O	roller
8	164	A	roller
9	161	B	non-roller
10	169	O	roller
11	179	O	roller
12	170	A	non-roller
13	163	B	roller
14	166	B	roller
15	164	A	roller
16	165	B	roller
17	162	O	roller
18	170	AB	roller
19	168	A	roller
20	168	O	non-roller

(a) **(i)** State and explain the type of variation shown by blood group.

Discontinuous variation. Blood group occurs in **discrete/ distinct/ clear cut** groups.	1

[1]

(ii) On the grid below, plot a bar chart to show the distribution of students with different blood groups. [3]



Scale	1
Discrete grouping (equal gaps between bars, bars of equal width, drawn with clear lines)	1
Axes labeled	1

(b) Both parents of student 1 have blood group A.

Use a genetic diagram to explain how two parents with blood group A are able to have a child with blood group O.

Phenotype of parents	**Father Blood group A**	**Mother Blood group A**	**1**
Genotype of parents	**I^AI^O**	**I^AI^O**	
Gametes	**I^A I^O**	**I^A I^O**	**1**
Genotypes of offspring (accept Punnett square or arrows)	I^A / I^O × I^A / I^O: $I^A I^A$, $I^A I^O$, $I^A I^O$, $I^O I^O$		**1**
Genotype of offspring	**$I^A I^A$**	**$I^A I^O$**	**$I^O I^O$**
Phenotype of offspring	**Blood group A**	**Blood group A**	**Blood group O**	**1**

[4]

(c) The ability to roll tongue is determined by a pair of alleles.

Students 19 and 20 are sisters. Both their parents are tongue rollers.

Deduce, with reasons, whether the allele for tongue rolling is dominant or recessive.

ability to roll tongue is a dominant trait	**1**
both parents are heterozygous for the trait	**1**
each contribute one recessive allele to student 20 who is a non roller	**1**

Reverse is true

ability to roll tongue is a dominant trait	**1**
it cannot be recessive as both parents being tongue rollers, they will be homozygous recessive	**1**
they will not be able to produce child 20 who is a non-tongue roller as they do not have the dominant allele to pass down.	**1**

[3]

[Total: 11]

9 **(a)** Describe the structure of DNA.

DNA is a **double helix** made up of two anti-parallel strands.	1
Each strand consists of repeating units of **nucleotides**. Each nucleotide comprises of a **deoxyribose sugar, a phosphate group and a nitrogenous base.**	1
There are four types of nitrogenous bases, **adenine, guanine, thymine and cytosine.**	1
Adenine binds to thymine while **guanine binds to cytosine**, also known as complementary base pairing.	1
Hydrogen bonds hold the two strands of polynucleotides together to form a DNA molecule.	1

[5]

(b) Genetic engineering can also be used to produce crop plants for consumption by humans.

Discuss the potential advantages and dangers of using genetic engineering to produce crop plants for this purpose.

Potential advantages: • **increase yield of genetically modified crop grown / able to grow quickly** • **Able to grow in harsh environment conditions, grow in new areas** • **able to transfer beneficial genes / characteristics between species.** • **Can be resistant to diseases or pests.**	Any 2
Potential dangers • **risk of diseases spread to other species** • **Expensive / costly to implement genetic engineering** • **Possible health risks to people / organisms when consuming genetically modified crops / possible food allergies**	Any 2

[4]

[Total: 9]

10 A small toddler went barefooted into the grass field and stepped on a sharp object.

A series of reactions as shown below occurred:

Reaction 1: Leg muscles contract to draw back foot upon stepping on sharp object.

Reaction 2: Pain is felt on the foot with blood flowing out from the wound.

Reaction 3: The toddler starts to cry.

(a) Explain briefly why reaction 1 is an involuntary reaction.

Response is immediate/ without requiring conscious thought;	1
impulses travel through reflex arc involving the spinal cord only and bypassing the brain;	1

[2]

(b) Describe and explain the action of the body's clotting mechanism on the large wound formed in reaction 2.

Damaged cells and platelets release thrombokinase;	1
Thrombokinase activates prothrombin to thrombin with the help of calcium ions;	1
Thrombin converts soluble fibrinogen into insoluble fibrin threads;	1
Mesh-like structure formed which traps blood cells to prevent the further loss of blood;	1

[4]

(c) Describe the route taken by the nerve impulse in reaction 3.

Pain receptors in skin stimulated and electrical impulse generated	1
Sensory neurone transmit impulses to relay neurone in spinal cord;	1
Relay neurones transmit impulses within the spinal cord up to the brain;	1
Brain interprets impulses as pain / initiates crying response – as a result of awareness of pain;	1

[4]

[Total: 10]

End of Paper