Oxford Cambridge and RSA

A Level Biology B (Advancing Biology)

H422/01 Fundamentals of biology

Thursday 7 June 2018 – Morning

Time allowed: 2 hours 15 minutes

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **110**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*****).
- This document consists of **32** pages.

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SECTION A

You should spend a maximum of 40 minutes on this section.

Write your answer to each question in the box provided.

Answer **all** the questions.

1 Which of the rows, **A** to **D**, from the table below indicates the type of bond present (✓) or absent (✘) in the secondary structure of a protein?

	Disulfide	Hydrogen	Hydrophobic	Ionic	Peptide
A	✘	✓	✘	✘	✓
B	✘	✓	✘	✓	✓
C	✓	✓	✘	✘	✓
D	✓	✘	✓	✓	✓

Your answer ☐

[1]

2 A student is purifying DNA from a bacterial culture.

Which of the molecules, **A** to **D**, is required for the precipitation of DNA during the purification process?

A ethanol

B glucose

C lysozyme

D water

Your answer ☐

[1]

3 Which of the statements, **A** to **D**, is true of single nucleotide polymorphisms (SNPs)?

A All SNPs have four possible variations.

B Genetic recombination can generate a SNP.

C SNPs can influence banding patterns on a DNA fingerprint.

D SNPs occur in exons only.

Your answer ☐

[1]

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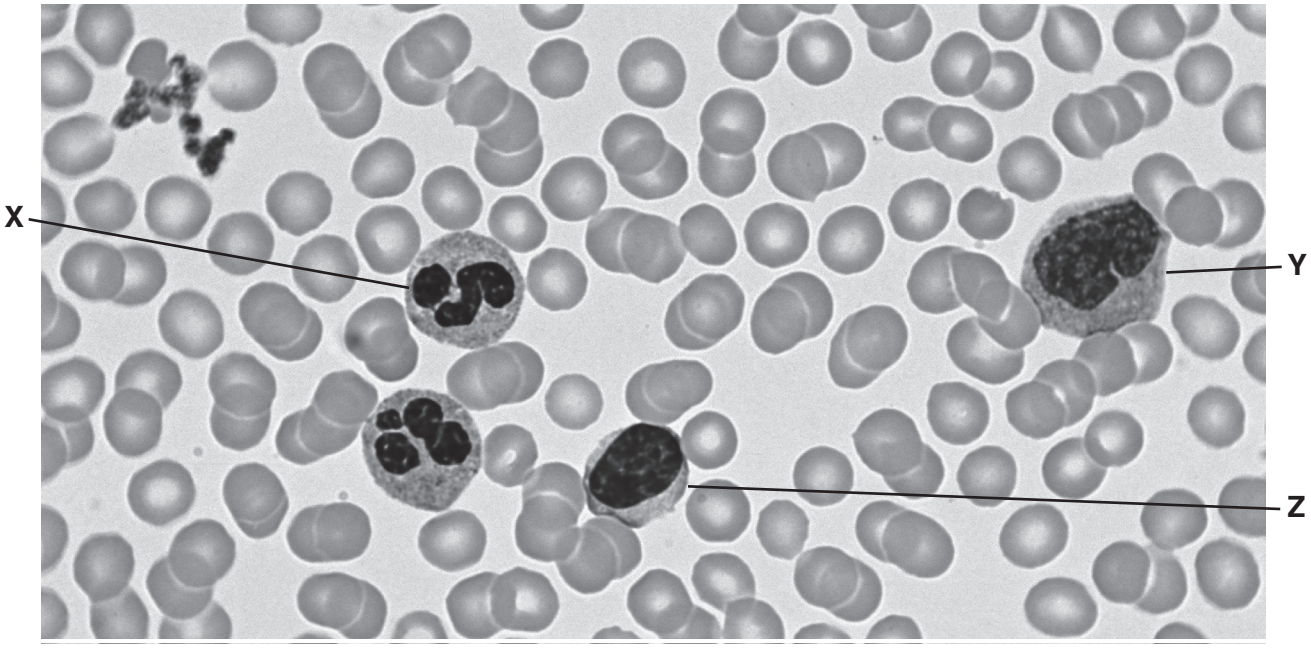
The image below is a photomicrograph of a human blood smear. Three cells are labelled **X**, **Y** and **Z**.

Questions **4** and **5** refer to this image.



4 The diameter of cell **X** in the image is 15.5 mm and its actual diameter is 12.4 μm.

Which of the options, **A** to **D**, is the magnification of the image?

A ×125

B ×800

C ×1250

D ×8000

Your answer ☐

[1]

5 Which of the rows, **A** to **D**, in the table below correctly identifies cells **X**, **Y** and **Z**?

	Monocyte	**Neutrophil**	**Lymphocyte**
A	X	Y	Z
B	Z	X	Y
C	Y	X	Z
D	Y	Z	X

Your answer ☐

[1]

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6 Meiosis II pauses in the secondary oocyte and is only completed if fertilisation occurs.

Which of the options, **A** to **D**, is a description of the **last** meiotic stage prior to fertilisation?

A Homologous chromosomes align to the equator of the oocyte.

B Homologous chromosomes migrate to opposite poles of the oocyte.

C Single chromosomes align to the equator of the oocyte.

D Sister chromatids migrate to opposite poles of the oocyte.

Your answer ☐

[1]

7 Which of the options, **A** to **D**, is an action of luteinising hormone (LH) in males?

A inhibition of follicle-stimulating hormone (FSH) release

B initiation of spermatogenesis

C sensitisation of testicular cells to testosterone

D stimulation of testosterone release

Your answer ☐

[1]

8 Antidiuretic hormone (ADH) is required for osmoregulation.

Which of the options, **A** to **D**, is a region of the nephron that is responsive to ADH?

A Bowman's capsule

B collecting duct

C loop of Henle

D proximal convoluted tubule

Your answer ☐

[1]

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9 Which of the options, **A** to **D**, is the heart chamber in which electrical activity is initiated?

A left atrium

B left ventricle

C right atrium

D right ventricle

Your answer ☐

[1]

10 A doctor takes a blood pressure measurement from a patient using a manual sphygmomanometer. The result is $\frac{160}{100}$ mm Hg.

Here are three statements about the doctor's examination:

1 The patient has hypertension that requires medical treatment.

2 The greatest pressure exerted on the patient's arterial walls during the cardiac cycle is 260 mm Hg.

3 At cuff pressures below 100 mm Hg, blood flow can be heard using a stethoscope.

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]

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11 Which of the options, **A** to **D**, is the long-term effect of aerobic training on VO_2 max and excess post-exercise oxygen consumption (EPOC)?

A decreased VO_2 max and decreased EPOC

B decreased VO_2 max and increased EPOC

C increased VO_2 max and decreased EPOC

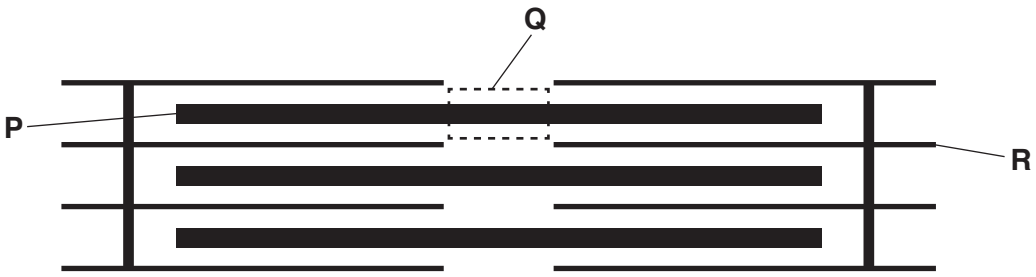
D increased VO_2 max and increased EPOC

Your answer ☐

[1]

12 The diagram below represents the ultrastructure of a single sarcomere in skeletal muscle.

Three features of the sarcomere are labelled **P**, **Q** and **R**.



Here are three statements about the diagram:

1 During muscle contraction, **R** slides along **P**.

2 **P** is responsive to calcium ions.

3 **Q** is responsive to ATP molecules.

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]

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13 Excitatory and inhibitory postsynaptic potentials have similarities and differences.

Which of the options, **A** to **D**, is a feature of an excitatory, but not inhibitory, postsynaptic potential?

A all-or-nothing response

B depolarising

C graded in response

D hyperpolarising

Your answer ☐

[1]

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

A collagen

B deoxyribonucleic acid

C haemoglobin

D rhodopsin

Your answer ☐

[1]

15 Which of the options, **A** to **D**, is true of type 2 diabetes?

A caused by autoimmunity

B present from birth

C rapid onset

D slow onset

Your answer ☐

[1]

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16 Glaucoma is an eye condition caused by increased pressure within the eye.

Which of the options, **A** to **D**, is a correct explanation for the increased pressure?

A decreased production of aqueous humour

B increased production of vitreous humour

C poor drainage of aqueous humour

D poor drainage of vitreous humour

Your answer ☐

[1]

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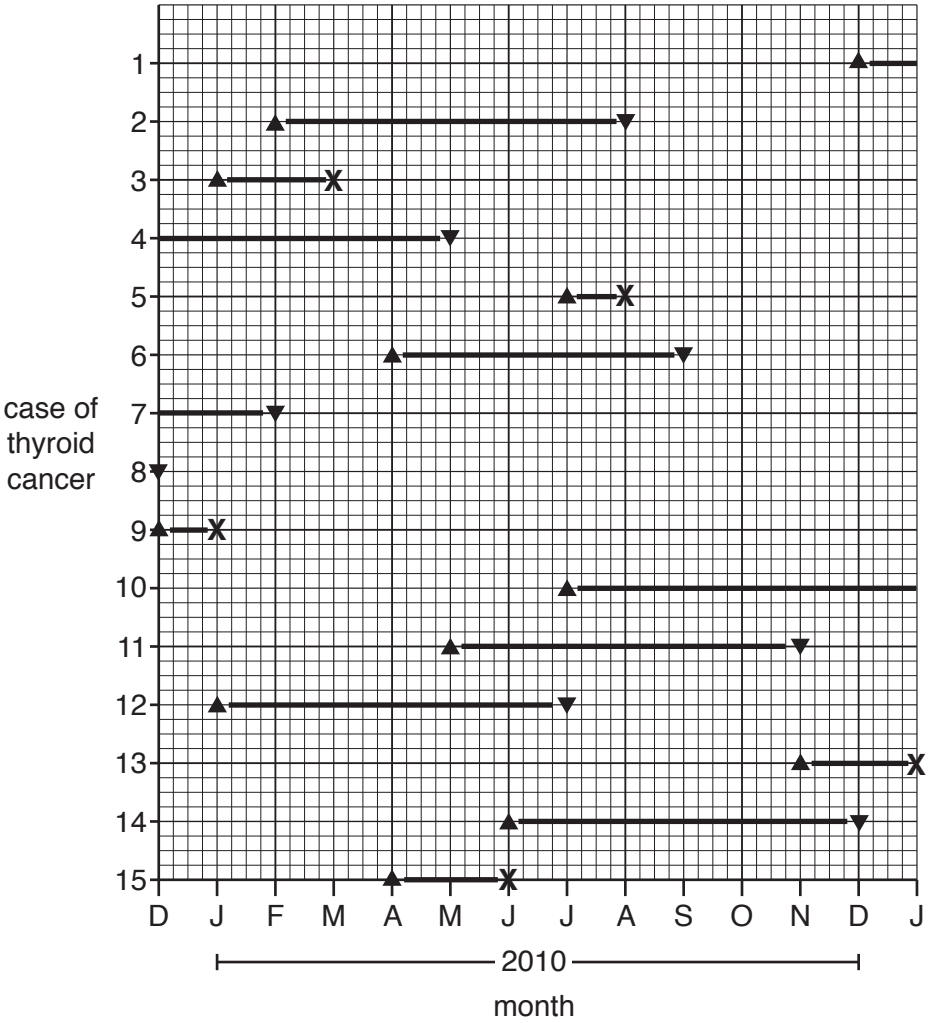
17 15 cases of thyroid cancer were recorded in Iceland between December 2009 and January 2011.

The graph below shows, for each case, the month of diagnosis (▲) and month of recovery (▼) or death (**X**) from the disease.



Iceland has a population of 330 000 people.

Which of the options, **A** to **D**, was the incidence rate (per 100 000) of thyroid cancer in 2010?

A 2.1

B 2.7

C 3.3

D 4.2

Your answer ☐

[1]

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18 Scientists are producing a vaccine against a disease-causing bacterium.

The table below shows the locations and mutation rates of four proteins, **A** to **D**, in the bacterium.

	Protein location	**Mutation rate (per amino acid)**
A	cell membrane	2.1×10^{-4}
B	cell wall	4.3×10^{-4}
C	pilus	7.7×10^{-4}
D	ribosome	1.8×10^{-4}

Which of the proteins, **A** to **D**, is most suitable as the basis of a vaccine against this bacterium?

Your answer ☐

[1]

19 Which of the options, **A** to **D**, describes the type of gene mutation that causes Huntington's disease?

A change of nucleotide that affects the protein

B change of nucleotide that does not affect the protein

C deletion of nucleotides

D insertion of nucleotides

Your answer ☐

[1]

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20 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]

21 Which of the statements, **A** to **D**, is true of epigenetics?

A Guanine is the most commonly methylated DNA base.

B Identical twins show identical epigenetics.

C Proteins cannot undergo epigenetic modification.

D Some epigenetic changes can be reversed.

Your answer ☐

[1]

22 The polymerase chain reaction (PCR) involves a repeating sequence of temperature changes.

Which of the options, **A** to **D**, occurs at a temperature of 72 °C?

A annealing of primers

B detachment of primers

C polymerisation of free nucleotides

D separation of DNA strands

Your answer ☐

[1]

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23 Here are three statements about the evolution of language:

1 Sequencing the genome of extinct human ancestors helps to indicate the origins of language.

2 The evolution of language will have been influenced by reproductive (mating) preferences.

3 The 'gossip' hypothesis relies on trust between animals for the acceptance of unfamiliar sounds.

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]

24 The genetic diversity of monkey populations in a forest ecosystem was studied. The data for one population are shown in the table below.

Total genes studied	Genes with one allele	Genes with two alleles	Genes with more than two alleles
49	33	5	11

Which of the options, **A** to **D**, is the proportion of polymorphic genes in the monkey population?

A 0.11

B 0.33

C 0.67

D 0.78

Your answer ☐

[1]

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25 Wind speed influences the rate of transpiration in a plant.

Which of the options, **A** to **D**, would **increase** in windy conditions?

A kinetic energy of water molecules in leaf airspaces

B probability that stomata are open

C relative humidity of the atmosphere

D water potential gradient between airspaces in the leaf and the atmosphere

Your answer ☐

[1]

26 Which of the options, **A** to **D**, would promote flowering in a short-day plant?

A longer exposure to cold temperatures

B longer exposure to darkness

C shorter exposure to cold temperatures

D shorter exposure to darkness

Your answer ☐

[1]

27 A study was conducted to compare the effectiveness of two fertilisers, TomatoXL® and TomatoGro®, on the growth of tomato plants.

Twenty plants of similar height were divided randomly into two groups of ten. Each day, one group was fed with TomatoXL® and the other group with TomatoGro®.

After one month, the height of each tomato plant was measured and the results were analysed.

Which of the options, **A** to **D**, would be the appropriate statistical method to determine which fertiliser was the more effective?

A Chi squared test

B paired Student's t-test

C Spearman's rank correlation coefficient

D unpaired Student's t-test

Your answer ☐

[1]

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28 Which of the molecules, **A** to **D**, is the source of electrons in photosynthesis?

A ATP

B CO_2

C H_2O

D NADPH

Your answer ☐

[1]

29 DCPIP is a molecule that is used to measure the rate of the Hill reaction in isolated chloroplasts.

Which of the options, **A** to **D**, correctly describes DCPIP during the Hill reaction?

A it becomes oxidised

B it loses electrons

C it mimics NADP

D it turns from colourless to blue

Your answer ☐

[1]

30 Proton pumps establish electrochemical gradients, which are required for ATP production.

Which of the options, **A** to **D**, are regions of a plant cell **into** which protons are pumped?

A chloroplast stroma and mitochondrial intermembrane space

B chloroplast stroma and mitochondrial matrix

C thylakoid space and mitochondrial intermembrane space

D thylakoid space and mitochondrial matrix

Your answer ☐

[1]

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PLEASE DO NOT WRITE ON THIS PAGE

Turn over for the next question

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SECTION B

Answer **all** the questions.

31 A Robertsonian translocation is a type of chromosomal translocation in which the long arms of two chromosomes fuse together.

Fig. 31.1 shows this event occurring between chromosomes 14 and 21.

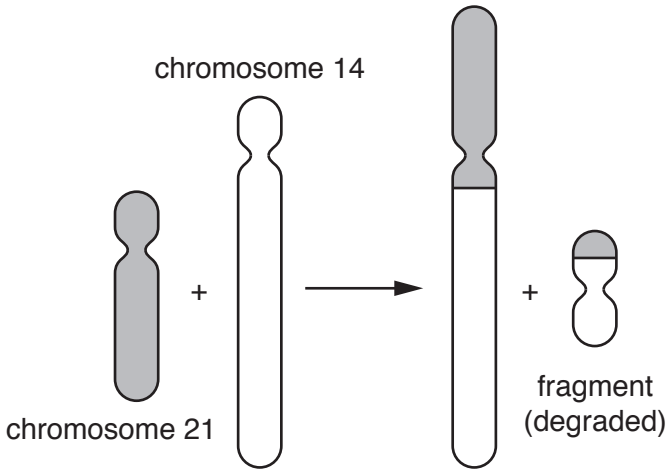

Fig. 31.1

An individual who inherits the translocated chromosome in Fig. 31.1 will either have Down's syndrome or be a carrier of the disorder.

A couple have a child. The mother is a carrier and the father is genetically normal. The genetic material with respect to chromosomes 14 and 21 in the somatic cells of the parents are shown in Fig. 31.2.

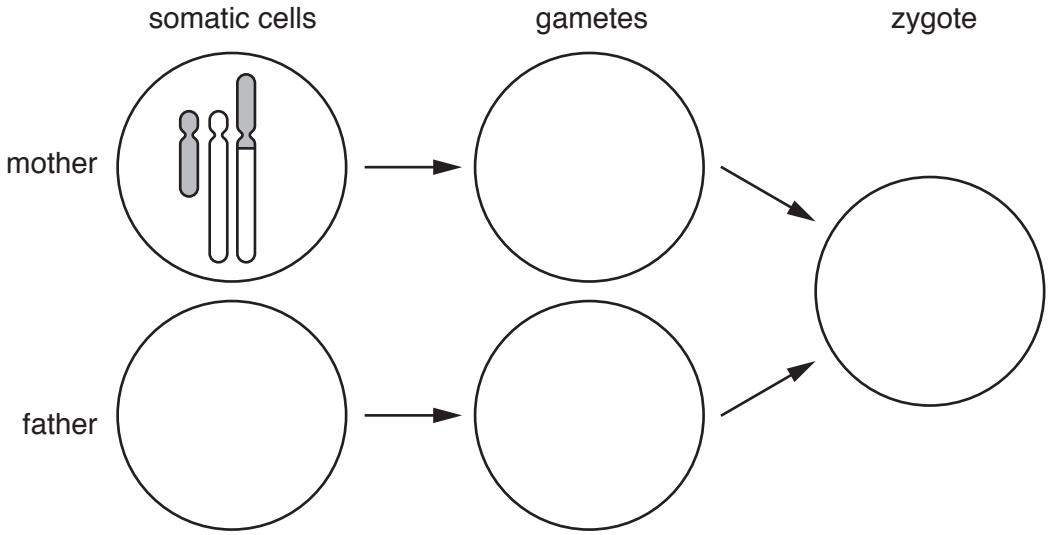

Fig. 31.2

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(a) **(i)** With reference to Fig. 31.2, suggest why the mother does **not** have Down's syndrome.

.....

..... **[1]**

(ii) The child is born with Down's syndrome.

Complete the diagram in Fig. 31.2 to show the genetic material with respect to chromosomes 14 and 21 in:

- the somatic cell of the father
- the gametes of the mother and father
- the zygote of the child.

[Answer on Fig. 31.2] **[4]**

(b) Down's syndrome is more commonly caused by a genetic event that is distinct from that shown in Fig. 31.1.

State the name of this event **and** outline how it arises.

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..... **[3]**

(c) A sample of cells can be collected from a fetus to test for genetic disorders such as cystic fibrosis.

(i) Chorionic villus sampling (CVS) and amniocentesis are two methods of obtaining fetal cells.

State the **source** of fetal cells that are obtained through these methods.

CVS .....

Amniocentesis .....
[1]

(ii) The sample of fetal cells can be used to produce a karyotype for genetic analysis.

Explain why karyotyping can **not** be used to detect cystic fibrosis.

.....

..... **[1]**

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32 Homeostatic mechanisms require hormones, such as thyroxine, to maintain a stable internal environment.

(a) Iodine is required to produce thyroxine.

Explain why a deficiency in iodine could cause weight gain.

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..... **[1]**

(b) The release of thyroxine is regulated by negative feedback and involves two other hormones, as shown in Fig. 32.

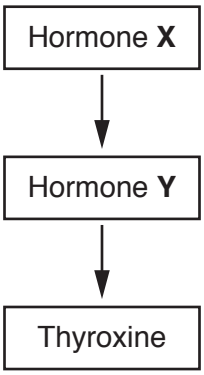

Fig. 32

(i) Identify hormones **X** and **Y**.

X .....

Y .....
[2]

(ii) Describe the **general** features of a negative feedback mechanism.

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..... **[3]**

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(c) Core body temperature is maintained between 36.5 °C and 37.5 °C.

Describe **and** explain **two** physiological mechanisms that would be initiated following a decrease in core body temperature.

1 .....

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2 .....

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[2]

(d) Doctors often take temperature measurements from the skin surface, inside the ear or inside the mouth.

Suggest why the ear provides a more accurate measurement of body temperature than the skin surface.

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..... **[2]**

Question 33 begins on page 20

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33 **(a)** Complete the paragraph below about ecosystems using the most appropriate terms.

Natural change in the community of an ecosystem over time is known as succession. In this process, biodiversity increases until a …… community is reached. Human activities such as agriculture and forestry can prevent formation of this type of community, instead forming a ……. This process is known as …… succession.

[3]

(b) Pioneer species are the first to colonise an ecosystem.

How do pioneer species promote future biodiversity?

.....

..... **[1]**

(c) Fig. 33 shows a region of coastal land, stretching from tide to woodland.

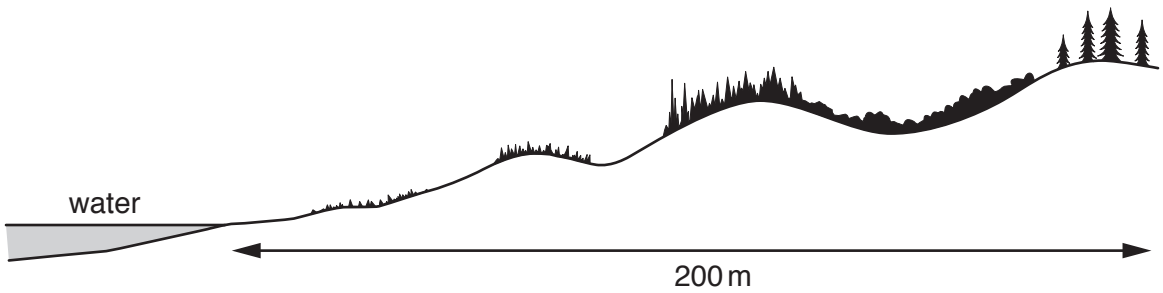

Fig. 33

Outline a sampling method that could be used to investigate succession in this region.

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..... **[3]**

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(d) **(i)** Beef cattle that are produced for their meat are fed maize. In a cow, 13 100 MJ of stored biomass energy are produced from 83 000 MJ of maize.

Calculate the efficiency of this energy transfer in the cow.

Answer = ... % **[2]**

(ii) In snail farming, snails are fed lettuce leaves.

The efficiency of energy transfer from the lettuce leaves to stored biomass energy in snails is **greater** than that from maize to stored biomass energy in cattle. Suggest why.

.....

..... **[1]**

(e)* Cattle are ruminant animals. The stomach of a ruminant animal contains specialised chambers.

Explain how the ruminant stomach digests food to produce important molecules.

Your answer should refer to **named** chambers of the stomach.

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..... **[6]**

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34 Aerobic respiration involves a series of reactions.

(a) The table below gives three types of reaction involved in aerobic respiration.

Complete the table by inserting, for each type of reaction:

- **one** metabolic pathway in which the reaction occurs
- the precise location of the metabolic pathway in the cell.

For example, dehydrogenation is a reaction of the Krebs cycle, which occurs in the mitochondrial matrix. The first row has been done for you.

Type of reaction	Metabolic pathway	Precise location in cell
Dehydrogenation	Krebs cycle	mitochondrial matrix
Oxidative decarboxylation	....	....
Substrate level phosphorylation	....	....

[2]

(b) (i) The unbalanced equation for the aerobic respiration of a substrate is shown below.

$$C_{16}H_{32}O_2 + \text{.....}\ O_2 \rightarrow \text{.....}\ CO_2 + \text{.....}\ H_2O$$

Balance the equation above by writing the correct numbers in the blank spaces. **[1]**

(ii) Calculate the respiratory quotient (RQ) of this respiratory substrate. Give your answer to **two** significant figures.

RQ = ... **[2]**

(iii) Suggest **one** reason for an RQ greater than 1 in an organism respiring aerobically.

.....

..... **[1]**

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(c)* A respirometer is used to investigate the rate of respiration.

Fig. 34 shows the setup of a respirometer with two chambers.

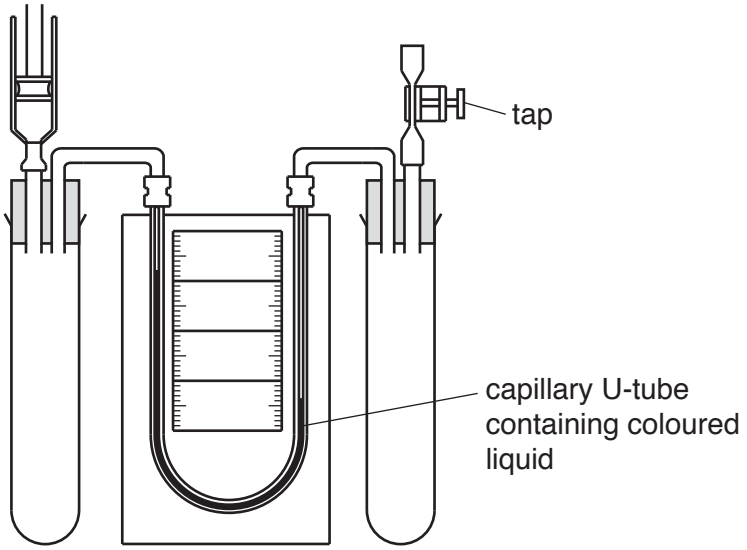

Fig. 34

Discuss how the respirometer in Fig. 34 can be used to calculate the RQ of germinating peas.

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..... **[6]**

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35 This question is about the development of medicines.

(a) **(i)** What are the features of a chronic disease?

.....

..... **[1]**

(ii) Over half of commonly-used drugs are similar or identical to chemicals found in plants.

Name **one** such drug and state its medical use.

Drug .....

Medical use .....
[1]

(b) Drugs must be evaluated for safety and effectiveness in clinical trials before they are licensed for the treatment of specific diseases.

A clinical trial was conducted to investigate the effect of a drug on blood glucose levels in patients with type 2 diabetes. Blood glucose levels can be monitored by measuring glycosylated (or glycated) haemoglobin (HbA_{1C}).

- Sixty patients with untreated type 2 diabetes were recruited.
- HbA_{1C} levels were measured before the trial began.
- The patients were divided into two groups.
- One group received daily drug treatment and the other group received a daily placebo.
- After three months, HbA_{1C} levels were measured and changes from pre-trial measurements were calculated.

Fig. 35 shows the results of the trial. The boxes show the mean change in HbA_{1C} levels after three months and the error bars represent standard deviations.

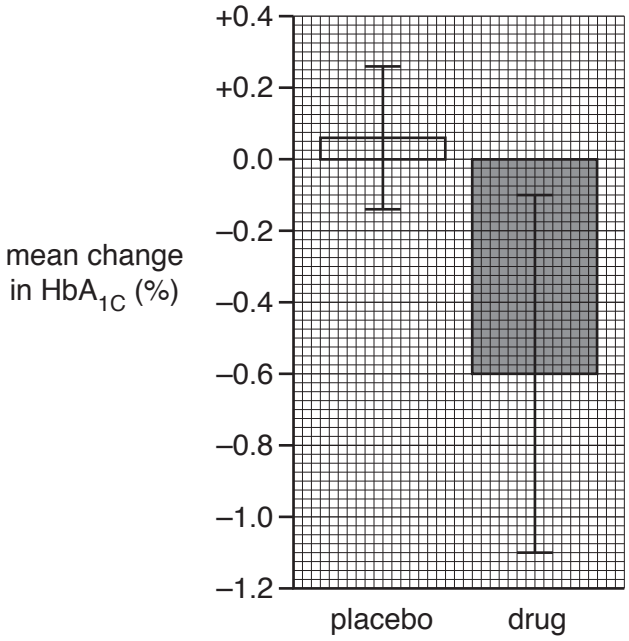

Fig. 35

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(i) State the **phase** of the clinical trial in which the data in Fig. 35 were obtained.

..... **[1]**

(ii) Describe what a placebo is **and** explain why it was used.

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..... **[2]**

(iii) Compare the results shown in Fig. 35 for the group receiving the placebo with the group receiving the drug.

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.....

..... **[3]**

(iv) Suggest **two** reasons why this trial does **not** support the use of the drug in the treatment of type 2 diabetes.

1 .....

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2 .....

.....

[2]

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36 Water is a polar molecule. Molecules of water are attracted to each other.

Fig. 36.1 shows the structure of a water molecule.

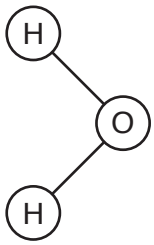

Fig. 36.1

(a) Draw a **second** water molecule on Fig. 36.1, in the position it might take up beside the first water molecule.

Your drawing should show:

- the bond(s) between the two molecules
- the name of each bond
- the charges on each atom.

[Answer on Fig. 36.1] **[3]**

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(b) Water is required for many metabolic reactions, such as the hydrolysis of starch.

The enzyme that catalyses this reaction, amylase, is commonly used in the food industry. It is produced in large-scale bacterial cultures.

A group of students investigated the amylase activity of five bacterial species.

The bacterial species were treated using the following method:
1. Prepare three nutrient agar plates containing 1% potato starch.
2. Soak five paper discs with cultures of five bacterial species, **A** to **E**.
3. Allow excess liquid to drain from the paper discs and then place onto an agar plate.
4. Repeat steps 1–3 for the other two agar plates.
5. Incubate the agar plates at 25 °C for 3 days.
6. After 3 days, flood the agar plates with reagent **X**.
7. Measure the diameter of any clear zones around the paper discs using a ruler.

Fig. 36.2 shows an agar plate at the end of the investigation.

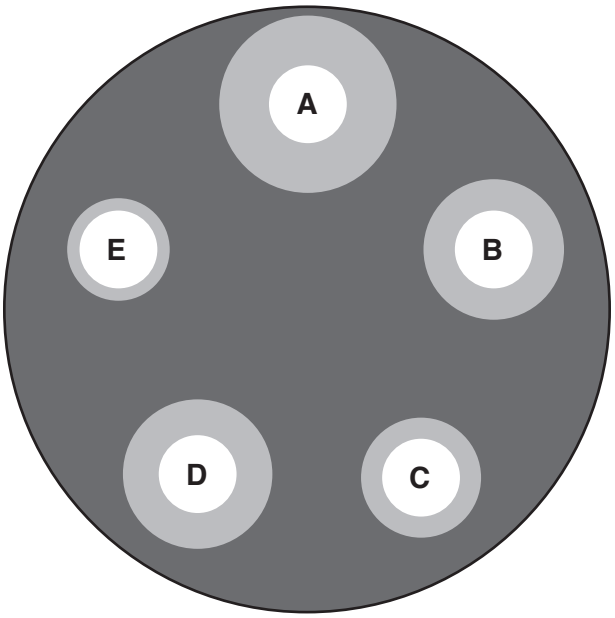

Fig. 36.2

(i) State the **precise** name of the chemical bond in starch that is hydrolysed by amylase.

..... **[1]**

(ii) Reagent **X** was used to indicate the presence or absence of starch in the agar plates.

State the name of this reagent **and** its colour in the presence of starch.

Name .....

Colour .....
[1]

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(iii) The table below shows the results of the investigation.

Bacterial species	Diameter of clear zone (mm)				
	Plate 1	Plate 2	Plate 3	Mean	Standard deviation
A	23	22	22	22.3	0.6
B	17	20	19	18.7	1.5
C	15	15	14	14.7	0.6
D	19	18	20	19.0	1.0
E	9	12	12	11.0	

Calculate the standard deviation for the data for bacterial species **E**.

$$s = \sqrt{\frac{\Sigma(x - \overline{x})^2}{n - 1}}$$

Standard deviation = ... **[2]**

(iv) The investigation did not include any control experiment.

Suggest **one** control experiment that could have been included in this investigation **and** explain its importance.

.....

.....

.....

..... **[2]**

(v) Suggest **one** other way in which the method could be changed to improve the validity of the conclusions.

.....

..... **[1]**

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37 The process of gas exchange involves several specialised cell types.

Fig. 37.1 shows a human bronchiole and surrounding alveoli under a light microscope. Two cell types are labelled **R** and **S**.

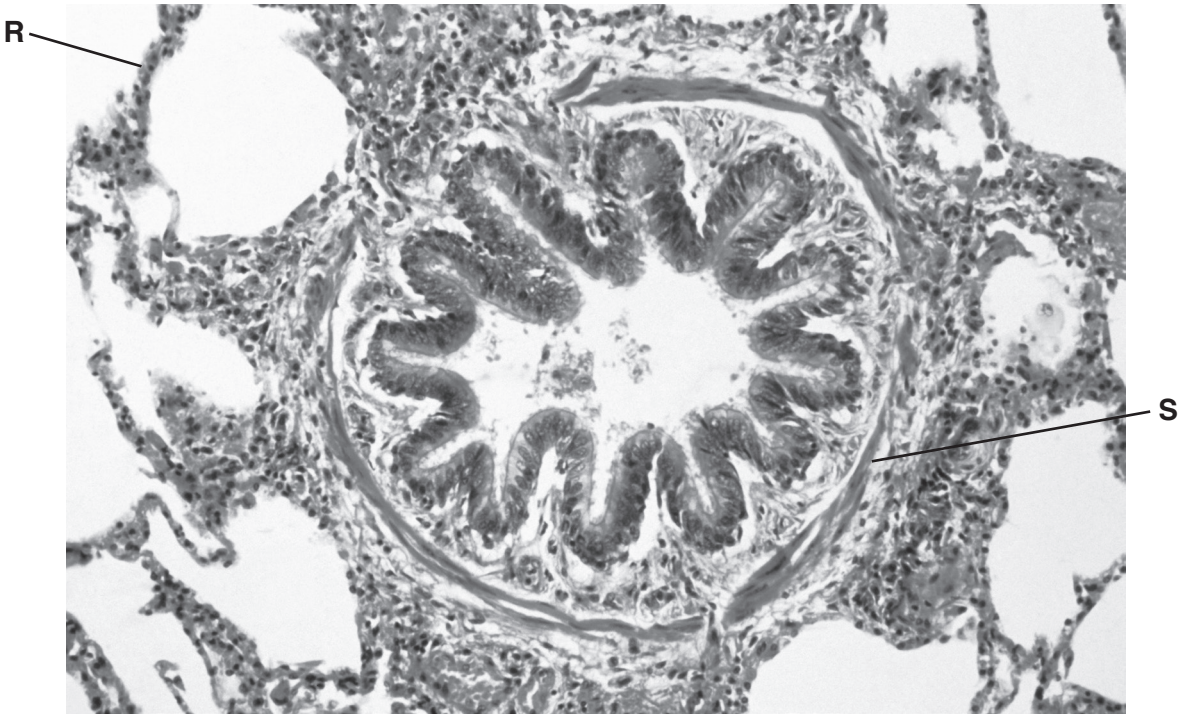

Fig. 37.1

(a) Complete the table below by inserting, for each cell type:

- the **precise** name
- **one** role in gas exchange.

Cell type	Name	Role
R	....	....
S	....	....

[4]

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(b) A health campaign was launched to help people to give up cigarette smoking.

Fig. 37.2 is a graph that featured in the campaign.

Lung function is represented as a percentage of FEV_1 at the age of 25 years.

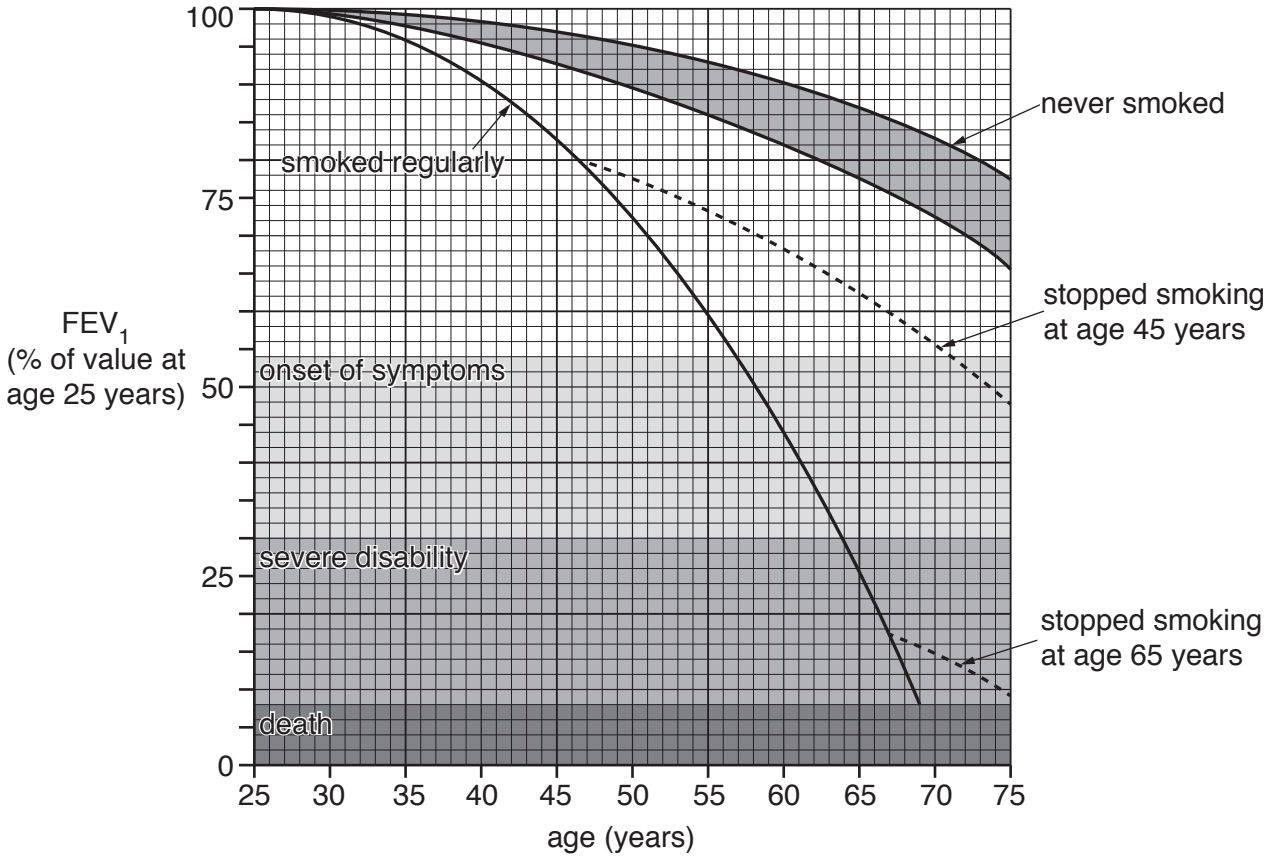

Fig. 37.2

(i) The health campaign claimed that giving up cigarette smoking improves quality of life and prevents smoking-related death.

Evaluate this claim using the data from the graph in Fig. 37.2.

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..... **[3]**

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(ii) During the campaign, doctors warned that the graph in Fig. 37.2 could not accurately predict the lung function of **individual** cigarette smokers over time.

Suggest **two** reasons why.

1 .....

.....

2 .....

.....

[2]

(c) Cigarette smoking increases an individual's risk of a heart attack.

A heart attack can lead to respiratory arrest.

Describe how expired air resuscitation is performed to manage an adult in respiratory arrest.

.....

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..... **[3]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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