Cambridge Pre-U

Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

* 4 6 6 9 1 2 4 8 1 4 *

BIOLOGY (PRINCIPAL) **9790/01**

Paper 1 Structured **May/June 2018**

2 hours 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
21	
22	
23	
24	
25	
26	
Total	

This syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **29** printed pages and **3** blank pages.

CAMBRIDGE
International Examinations

Section A

Answer **all** the questions.

You are advised to spend no more than 30 minutes on this section.

1 The dental formula of a mammal shows the number of each type of tooth in one side of the jaw. In a dental formula:

- the number above the line for each tooth type shows how many teeth of that type there are in one side of the upper jaw
- the number below the line for each tooth type shows how many teeth of that type there are in one side of the lower jaw.

The dental formulae of two mammals, **X** and **Y**, of very similar head and body size, are shown in Fig. 1.1.

X

$$i\,\frac{3}{3}\quad c\,\frac{1}{1}\quad pm\,\frac{4}{4}\quad m\,\frac{2}{3}$$

Y

$$i\,\frac{0}{3}\quad c\,\frac{0}{1}\quad pm\,\frac{3}{3}\quad m\,\frac{3}{3}$$

key
i = incisor c = canine pm = premolar m = molar

Fig. 1.1

Based on the dental formulae in Fig. 1.1, a student made the following statements about the dentition of the two mammals.

1 A canine tooth from **X** is likely to be sharper than a canine tooth from **Y**.

2 **X** has a total of eight more teeth in the whole of the upper jaw and two more teeth in the whole of the lower jaw than **Y**.

3 **X** has a diastema but **Y** does not have a diastema.

4 The molars of **X** are likely to be flatter and broader than the molars of **Y**.

Which statements are correct?

A 1 and 2 only

B 1 and 4 only

C 2, 3 and 4 only

D 1, 2, 3 and 4

answer ....[1]

2 Which steps occurring during photosynthesis require ATP?

1 carboxylation of RuBP to form an unstable molecule before forming GP

2 reduction of GP to triose phosphate

3 reduction of NADP in non-cyclic photophosphorylation

4 regeneration of RuBP from triose phosphate

A 1 and 3 only

B 2 and 4 only

C 3 and 4 only

D 1, 2 and 4 only

answer ....[1]

3 Which row in Table 3.1 correctly describes the main movement of sodium ions (Na^+) and glucose during selective reabsorption in the proximal convoluted tubule (PCT) of the kidney?

Table 3.1

	movement from lumen of PCT into epithelial cell	movement from epithelial cell of PCT into tissue fluid
A	Na^+ and glucose enter the cell through the same membrane protein down their concentration gradients.	Na^+ and glucose are actively transported out of the cell by the same membrane protein.
B	Na^+ and glucose are actively transported into the cell using different membrane proteins.	Na^+ leave the cell by facilitated diffusion and co-transport glucose through the same membrane proteins.
C	Na^+ enter the cell by active transport and co-transport glucose through the same membrane proteins.	Na^+ and glucose leave the cell by facilitated diffusion, each through different membrane proteins.
D	Na^+ enter the cell by facilitated diffusion and co-transport glucose through the same membrane proteins.	Na^+ are actively transported out of the cell, and glucose leaves the cell by facilitated diffusion using a different membrane protein.

answer ....[1]

4 Which statement outlines the species-area concept?

A Habitat fragmentation increases the risk of population extinction.

B The larger the area of a region, the greater the competition between the species.

C The larger the area of a region, the greater the number of different species.

D The population of a species in an area increases with the size of the area.

answer ....[1]

5 Membranes are important features of many eukaryotic cell structures.

How many of these statements are correct?

1 Cell structures bound by a double membrane include mitochondria, nuclei and chloroplasts.

2 Cell structures bound by a single membrane include Golgi apparatus, centrioles and ribosomes.

3 Cell structures bound by a single membrane include lysosomes, nucleoli and rough endoplasmic reticulum.

4 Cell structures bound by a single membrane include proteasomes, smooth endoplasmic reticulum and cilia.

A none

B one

C two

D three

answer ....[1]

6 Transfusion of donor red blood cells to a recipient can result in an agglutination reaction, which can lead to adverse effects in the recipient. Options **A**, **B**, **C** and **D** each describe two different red blood cell transfusions.

Which option will result in agglutination reactions for **both** of the described transfusions?

A A person with blood group A:
- donates blood to a person with blood group AB
- receives blood from a person with blood group O.

B A person with blood group AB:
- donates blood to a person with blood group O
- receives blood from a person with blood group A.

C A person with blood group B:
- donates blood to a person with blood group O
- receives blood from a person with blood group AB.

D A person with blood group O:
- donates blood to a person with blood group B
- receives blood from a person with blood group B.

answer ....[1]

7 Fig. 7.1 shows the effect of pH on the activity of an enzyme.

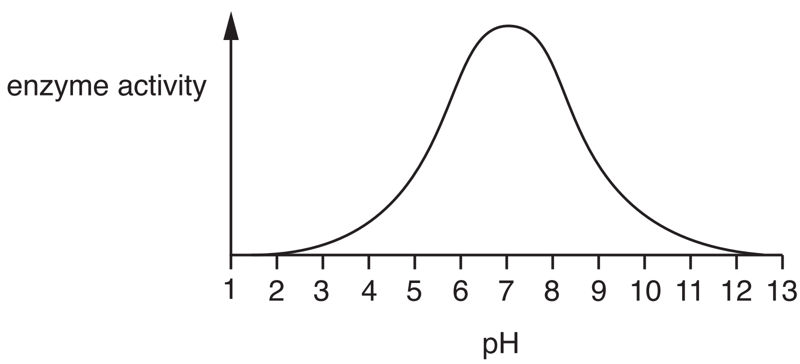

Fig. 7.1

Which statement could explain the change in enzyme activity when pH is decreased from pH 7 to pH 6?

A Disulfide bridges between amino acid side chains break and the enzyme loses its tertiary structure.

B The enzyme becomes less soluble as changes in charge occur.

C The enzyme is fully denatured as ionic bonds between amino acid side chains break.

D The mode of action of the enzyme changes from an induced-fit to a lock-and-key mechanism.

answer ....[1]

Questions 8, 9 and 10

A study was carried out into behavioural development in two bird species, the great tit and the blue tit. Eggs of each species were removed from their nests and placed into the nests of breeding birds of the other species. The newly hatched nestlings were reared by their foster parents.

During their first year of life, the fostered birds were observed for their ability to form pair-bonds with birds of the opposite sex. Some fostered birds bonded with their own species and some pair-bonded with the species of their foster parent, while others were unable to pair-bond.

The same observations were carried out on birds of both species that were allowed to remain in their own nests.

The results of the study are shown in Fig. 8.1. The numbers in brackets are the total number of nestlings in each group.

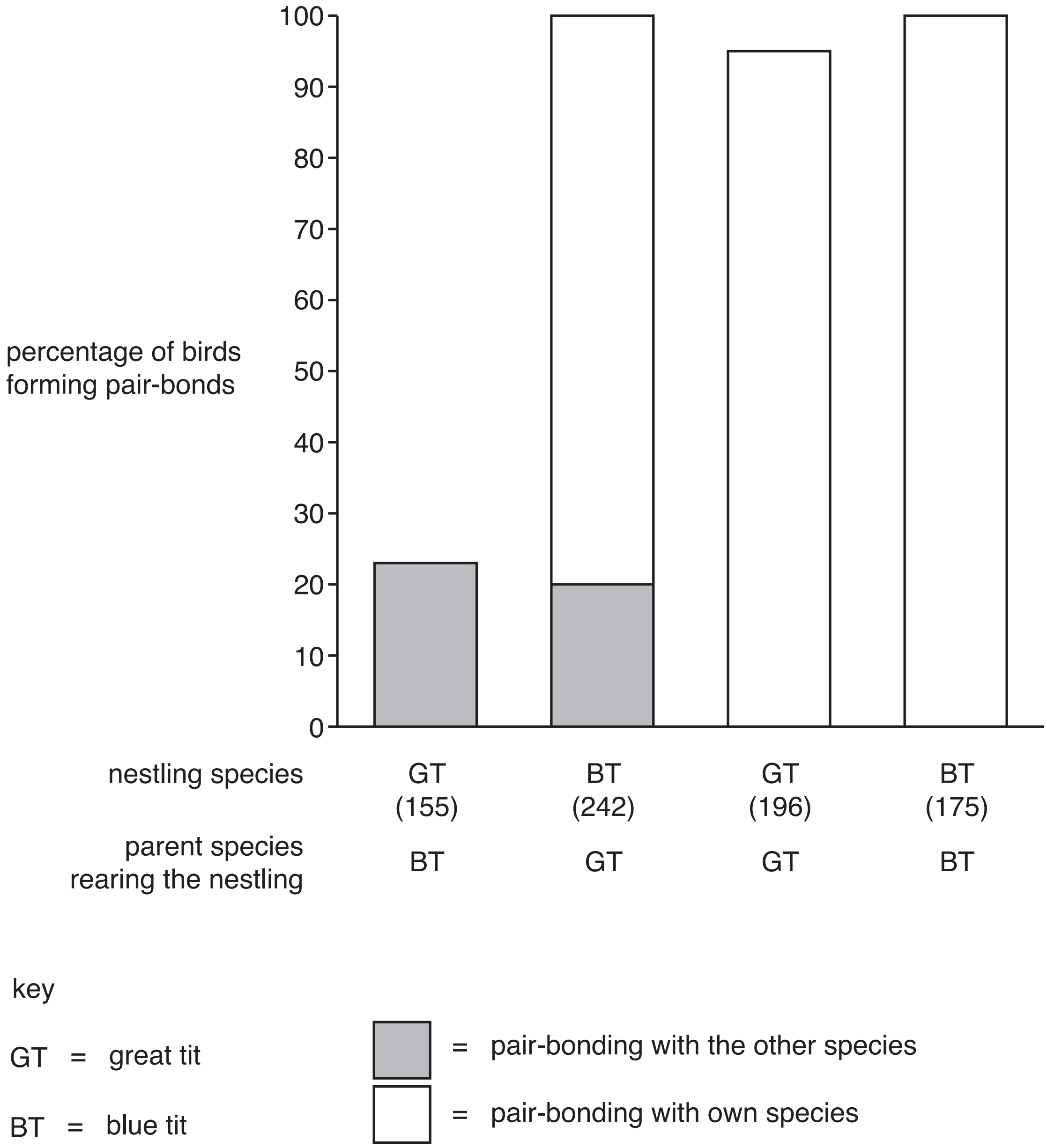

Fig. 8.1

8 Which type of behaviour is being studied in this investigation?

A classical conditioning

B habituation

C imprinting

D operant conditioning

answer ....[1]

9 Which statement or statements concerning the results of the investigation are correct?

1 There are interspecific differences in the type of behaviour shown.

2 There are intraspecific differences in the type of behaviour shown.

3 The developmental behaviour of the birds was affected to the same extent in both species.

A 1 only

B 1 and 2 only

C 2 and 3 only

D 3 only

answer ....[1]

10 With reference to the investigation, which are acceptable statements concerning pair-bonding?

1 Few of the fostered great tits formed pair-bonds.

2 Most of the fostered blue tits formed pair-bonds with their own species.

3 No fostered great tits formed pair-bonds with their own species.

4 100% of the non-fostered great tits formed pair-bonds with their own species.

A 1 and 2 only

B 3 and 4 only

C 1, 2 and 3 only

D 2, 3 and 4 only

answer ....[1]

11 Table 11.1 shows the concentrations of certain ions in sea water and in the cells of the marine alga *Halicystis ovalis*.

Table 11.1

ion	concentration in sea water / $mmol\,dm^{-3}$	concentration in cell / $mmol\,dm^{-3}$
Na^{+}	488	257
K^{+}	12	337
Cl^{-}	523	543
Ca^{2+}	12	2
Mg^{2+}	34	trace

Which statement about the cells of *H. ovalis* is supported by the data?

A Energy is required to move potassium ions into the cells.

B *H. ovalis* cells use chloride ions in greater quantities than sodium ions.

C Positively charged ions move into the cell more readily than negatively charged ions.

D Sodium ions move out of the cell down their concentration gradient.

answer ....[1]

12 The statements refer to photorespiration in C3 crops growing in greenhouses.

Which statements are correct?

1 Increasing light intensity in the greenhouse will increase photorespiration as there is an increase in oxygen production from non-cyclic photophosphorylation.

2 If the temperature in the greenhouse increases, photorespiration is favoured over photosynthesis, which results in the production of a greater quantity of ATP.

3 Keeping the temperature of the greenhouse below 30 °C will prevent photorespiration from occurring, as oxygen cannot bind to the active site of rubisco.

4 Photorespiration can be decreased by increasing the concentration of carbon dioxide in the atmosphere in the greenhouse.

A 1 and 4 only

B 2 and 3 only

C 2 and 4 only

D 1, 2 and 3 only

answer ....[1]

13 Soay sheep, a primitive breed of domesticated sheep, live wild on the small and remote Scottish island of Hirta.

Studies have shown that the mean size of an adult Soay sheep has been decreasing over the past thirty years.

Which statements could explain the decrease in mean size of adult Soay sheep on Hirta?

1 Stabilising selection is occurring, with the largest and smallest sheep being selected against.

2 Small lambs are less likely to survive their first winter than large lambs.

3 Climate change has led to milder winters, so smaller lambs are surviving to adulthood.

4 Food has become scarcer and smaller sheep need less food than larger sheep.

A 1 only

B 1 and 3 only

C 2 and 4 only

D 3 and 4 only

answer ....[1]

14 Which statement supports the theory that eukaryotic cells originated by endosymbiosis?

A Bacterial ribosomes and eukaryotic ribosomes are both composed of two subunits, each of which consists of proteins complexed with rRNA.

B Some disease-causing bacteria are intracellular pathogens that can use the host cell metabolism before causing the death of the host cell.

C Some types of bacterial plasmid can be inserted into eukaryotic cells and successfully integrate into the host genome.

D When a cell takes in a bacterium by phagocytosis, the bacterium is surrounded by a membrane to form a vesicle.

answer ....[1]

15 *Agrobacterium tumefaciens*, which causes crown gall disease, is well known for its use in biotechnology.

Which is a correct statement about *A. tumefaciens* and its **use** in biotechnology?

A *A. tumefaciens* is able to attach to plant cells in tissue culture and insert a modified T-DNA region from a recombinant Ti plasmid.

B *A. tumefaciens* is the source of the thermostable enzyme *Taq* polymerase, used in PCR.

C The recombinant Ti plasmid of *A. tumefaciens* contains the tumour-inducing genes that cause crown gall disease.

D The Ti plasmid of *A. tumefaciens* can be removed and replaced with plasmids from other bacteria that carry desired genes.

answer ....[1]

16 What are requirements in the dye-terminator method of sequencing a fragment of DNA?

1 promoter for attachment of polymerase enzyme

2 fluorescently tagged deoxyribonucleoside triphosphates (dNTPs) for polynucleotide synthesis

3 fluorescently tagged dideoxyribonucleoside triphosphates (ddNTPs) to stop chain extension

4 DNA primers to begin DNA synthesis

A 2 only

B 1 and 2 only

C 3 and 4 only

D 2, 3 and 4 only

answer ....[1]

Questions 17, 18, 19 and 20

The drawings in Fig. 17.1 were made to the same scale from electron micrographs of blood taken from a mammal. Not all of the internal structures are shown.

Study the drawings in Fig. 17.1 and identify which cell, **P**, **Q**, **R**, **S** or **T**, correctly matches the description in each of questions **17**, **18**, **19** and **20**.

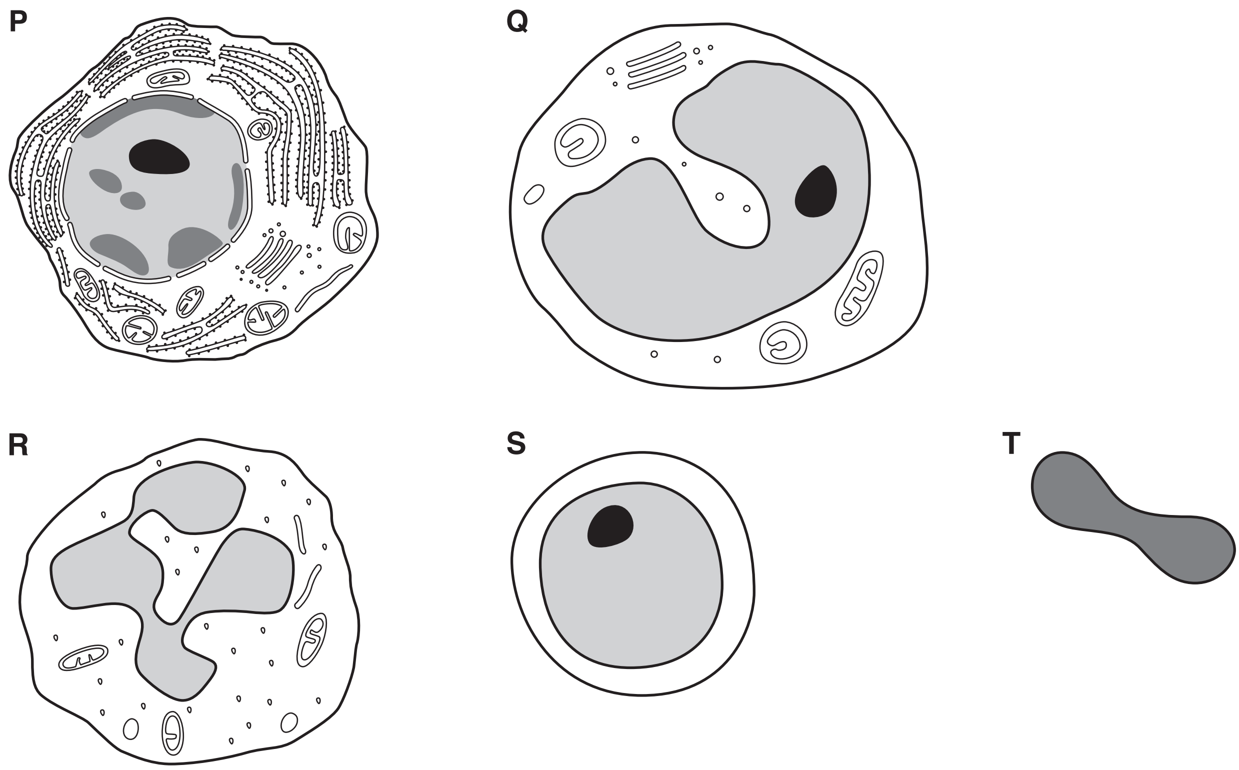

Fig. 17.1

17 A cell that synthesises and secretes immunoglobulins.

answer ....[1]

18 A cell that differentiates into a macrophage.

answer ....[1]

19 A cell that contains carbonic anhydrase.

answer ....[1]

20 A cell that can become a memory cell.

answer ....[1]

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Section B

Answer **all** the questions.

You are advised to spend no more than 2 hours on this section.

21 Gibberellins are a group of biological molecules that have an important role in the control and coordination of plant development and growth.

(a) In the absence of gibberellins, the expression of genes involved in plant growth can be restricted by the action of proteins that can prevent mRNA synthesis.

State the term that is given to these proteins.

....[1]

(b) Fig. 21.1 shows the results of an investigation into the effect of gibberellins on the elongation of the stem of germinating seedlings of the common lettuce, *Lactuca sativa*.

- Six different gibberellins, **A** to **F**, were used.
- For each of **A** to **F**:
  - three different concentrations of gibberellin were prepared: 0.30×10^{-3} mmol dm^{-3}, 3.0×10^{-3} mmol dm^{-3} and 30×10^{-3} mmol dm^{-3}.
  - each concentration of gibberellin was applied to 30 germinating seedlings and the mean stem elongation calculated after three days of growth.
- A gibberellin concentration of 0.0 mmol dm^{-3} resulted in a mean stem elongation of 3.2 mm.

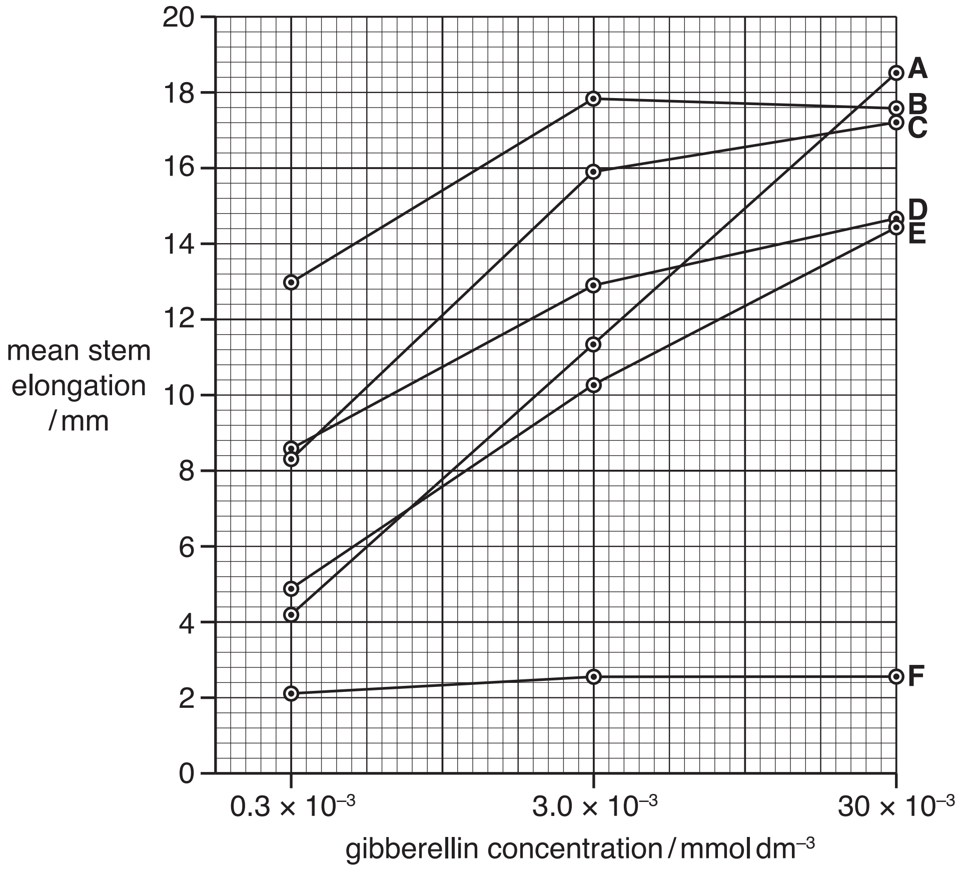

Fig. 21.1

(i) With reference to Fig. 21.1, describe the results of the investigation.

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(ii) Suggest why a gibberellin concentration of 0.0 $mmol\,dm^{-3}$ results in a mean stem elongation of 3.2 mm, rather than 0.0 mm.

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....[1]

(c) Seeds of *L. sativa* contain endosperm tissue.

State how the endosperm of a seed is formed.

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....[2]

[Total: 8]

22 The many different breeds of the chicken, *Gallus gallus*, exhibit a wide variation in characteristics such as body mass, feather texture, feather colour, feather pattern, feather distribution and comb shape. A comb is a natural, featherless outgrowth from the bird's head, usually red in colour.

G. gallus is a member of the Phasianidae family, which includes pheasants and partridges. Some species of this family that occur in the wild are similar in appearance to some breeds of *G. gallus*.

(a) Outline ways that could confirm that a suspected breed of chicken, with very little external morphological similarity to the common breeds of chicken, was *G. gallus*.

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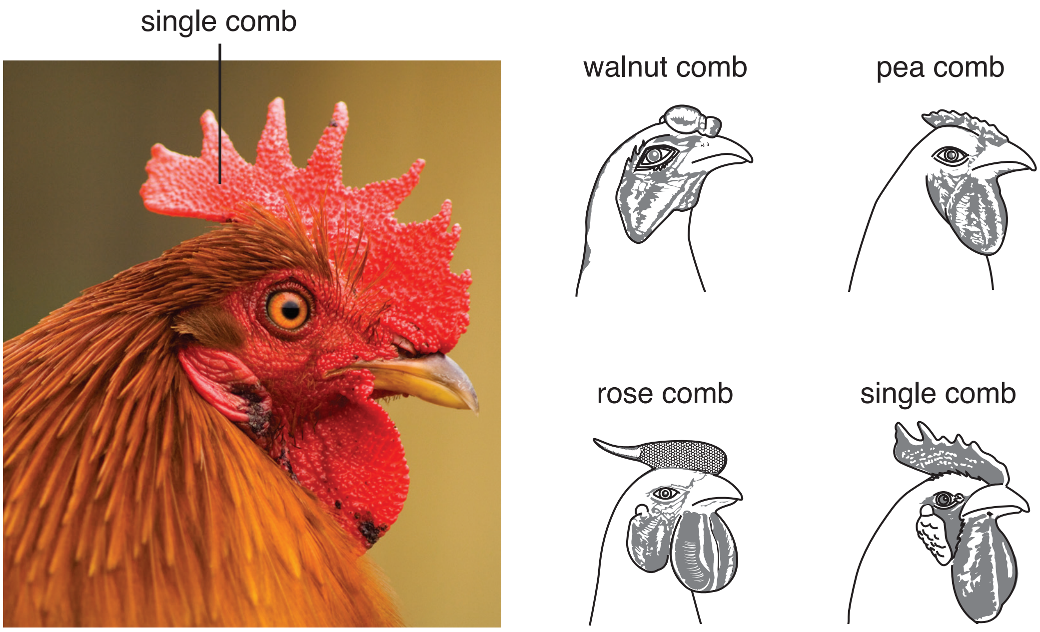
(b) Fig. 22.1(a) is a photograph of a chicken with a single comb. Fig. 22.1(b) shows four different comb shapes, including the single comb.



(a) **(b)**

Fig. 22.1

The shapes of the combs in Fig. 22.1(b) are caused by the interaction between two genes (gene 1 and gene 2) that have loci on different chromosomes. Each gene has a dominant allele and a recessive allele.

A cross was carried out between a chicken with a pea comb and a chicken with a rose comb. All the offspring had walnut combs.

(i) Use the symbols **P**, **p** for gene 1, and **R**, **r** for gene 2, to complete Table 22.1 to show the genotypes of the parents.

Take care to distinguish between **P** and **p** in your answers.

Table 22.1

	gene 1	gene 2	phenotype	genotype
parent 1	homozygous dominant	homozygous recessive	pea comb	
parent 2	homozygous recessive	homozygous dominant	rose comb	

[1]

(ii) The offspring were crossed with each other. Each chicken in the resulting generation had one of four different comb shapes, in the ratio of:

9 walnut comb : 3 rose comb : 3 pea comb : 1 single comb.

State the phenotype of each of the following genotypes.

PpRR ....

PPRr ....

ppRr ....

pprr ....

[2]

(c) Read this passage.

> Although chickens have homeostatic mechanisms to maintain an approximately constant body temperature of between 39.8 °C and 43.6 °C, investigations have shown that this is affected to some extent by extremes of external temperature.
>
> Some poultry owners remove part or all of the combs of their chickens if the chickens are to be kept for extended periods of time in below-freezing external temperatures.
>
> In hot areas, possession of a comb is an advantageous adaptation.

Comment on the statements in the passage.

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Fig. 22.2 shows a Transylvanian naked neck chicken. This breed of chicken has a large insertion mutation known as *Naked neck* mutation, or *Na*, on chromosome 3.

Fig. 22.2

Homozygous (*Na Na*) chickens and heterozygous (*Na na*) chickens show a reduction in feather mass relative to body mass, compared to normally feathered chickens (*na na*).

(d) Suggest what is meant by a *large insertion* mutation.

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.... [1]

(e) The *Na* mutation affects the expression of a gene, *BMP12*, located nearby on the same chromosome. *BMP12* codes for a signalling protein that has a role in inhibiting feather development in the neck.

The results of an investigation that measured the quantity of neck feathers possessed by naked neck chickens compared to normally feathered chickens are shown in Table 22.2.

Table 22.2

genotype	percentage reduction in neck feather mass compared to *na na* chickens
na na	0
Na na	15–20
Na Na	30–40

Suggest explanations for the results shown in Table 22.2.

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[Total: 15]

23 **(a)** Fig. 23.1 is an incomplete diagram summarising the endocrine role of the human placenta during pregnancy.

(i) Complete Fig. 23.1, using **only** terms taken from the list below.

Each term may be used once, more than once, or not at all.

ADH	**protein**	**insulin**	**hPL (human placental lactogen)**
LH	**stimulate**	**glucose**	**CG (chorionic gonadotrophin)**
adrenaline	**progesterone**	**steroid**	**FSH**
glucagon	**oestrogen**	**inhibit**	**contraction**

placenta

.... suppresses the contraction of the myometrium to allow pregnancy to reach full term.

.... maintains the thickness and function of the endometrium and helps to .... the immune response.

Towards the end of pregnancy, the .... hormone oestrogen acts as an antagonist to the hormone suppressing contraction of the myometrium.

Progesterone and oestrogen inhibit secretion of the pituitary gonadotrophins, such as ....

To allow fetal growth and development, maternal blood glucose concentration is raised by the protein hormone .... , which decreases the sensitivity of maternal target cells to the hormone ....

.... , important in the early stages of pregnancy, maintains the corpus luteum to ensure the continued production of progesterone.

Fig. 23.1

[7]

(ii) Steroid placental hormones enter their target cells, but peptide and protein placental hormones bind to receptors on the surfaces of their target cells.

Explain why peptide and protein hormones are unable to pass through the cell surface membrane, whereas steroid hormones are able to pass through.

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....[2]

(b) Cholecystokinin (CCK) is a peptide hormone synthesised by endocrine cells of the mucosa of the duodenum. The presence of partially digested proteins and lipids stimulates CCK secretion.

Increased concentration of CCK in the blood leads to the release of pancreatic enzymes and stimulates contraction of the gall bladder and its associated duct.

(i) Complete Table 23.1 with:

- the names of **three** pancreatic enzymes that are released from the human pancreas
- the products formed as a result of the activity of each enzyme.

Table 23.1

name of enzyme	products formed

[3]

(ii) Explain why the action of CCK on the gall bladder and its duct benefits digestion.

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[Total: 14]

24 Fig. 24.1 shows some of the organic molecules formed in the mesophyll cell from triose phosphate, a product of the Calvin cycle.

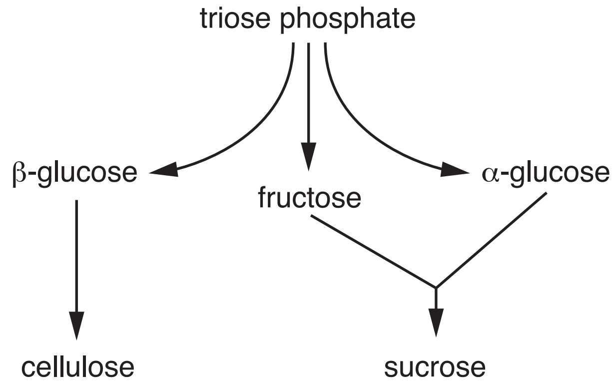

Fig. 24.1

Following photosynthesis in a leaf mesophyll cell, organic molecules such as sucrose and β-glucose are formed, as shown in Fig. 24.1. Sucrose is transferred into phloem sieve tubes for translocation.

(a) β-glucose is used in the synthesis of cellulose molecules for cell wall formation.

(i) Draw the ring structure of β-glucose.

[2]

(ii) Describe the structure of a cellulose molecule **and** explain how its structure makes it suitable as a component of plant cell walls.

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(b) Sucrose is transferred from a leaf mesophyll cell into a phloem sieve tube element via a companion cell.

Describe and explain the mechanisms that move sucrose into a companion cell and then from the companion cell into a sieve tube element.

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(c) Describe the passage of water from the xylem of the leaf to the mesophyll cells **and** explain the properties of water that allow this movement within the leaf.

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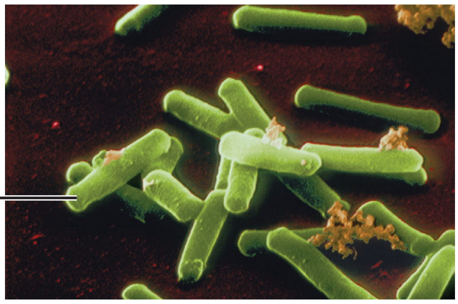
[Total: 16]

25 Tetanus is a disease caused by the bacterium *Clostridium tetani*. Fig. 25.1 is a scanning electron micrograph of *C. tetani*.

C. tetani cell



×3300

Fig. 25.1

(a) Calculate the actual length of the labelled *C. tetani* cell in Fig. 25.1.

Show your working and give your answer to the nearest whole micrometre (µm).

answer .... µm
[2]

(b) *C. tetani* can be classified using the three domain classification system or the five kingdom classification system.

(i) Name the kingdom in the five kingdom classification system in which *C. tetani* is classified.

....[1]

(ii) Explain why classification systems are used to categorise organisms.

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....[4]

(c) *C. tetani* reproduces asexually by binary fission.

Describe, using **annotated diagrams**, the sequence of events that occurs in the growth and asexual reproduction by binary fission of a single bacterial cell. Fig. 25.2 is the first diagram in the sequence. It has been drawn and labelled, but not annotated.

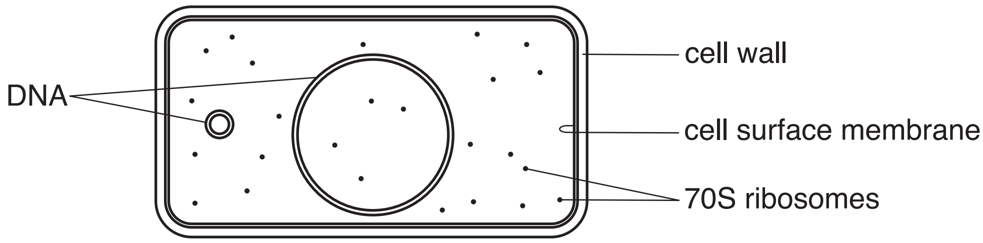

Fig. 25.2

[5]

(d) State **three** ways in which mitosis and cell division in **plant** cells differ from asexual reproduction in *C. tetani*.

1 ....

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2 ....

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3 ....

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[3]

(e) Tetanus is a very serious disease and can be fatal. Symptoms of the disease are caused by a toxin produced by *C. tetani*.

There are different ways to gain immunity to the disease.

State precisely the type of immunity described in each of the situations **A** to **C**.

A A very young baby has immunity even though the baby has not been vaccinated.

....

B A student has immunity after receiving an initial vaccine and two booster doses of tetanus toxin, modified so that it does not cause disease.

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C A person, who has not been vaccinated and who has just been infected by the pathogen, gains immediate immunity by being given an injection containing antibodies specific to the tetanus toxin.

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[3]

[Total: 18]

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26 Myocytes (muscle cells) of skeletal (striated) muscle can carry out respiration in aerobic or anaerobic conditions.

(a) Fig. 26.1 is a diagram of one complete sarcomere of striated muscle during muscle relaxation.

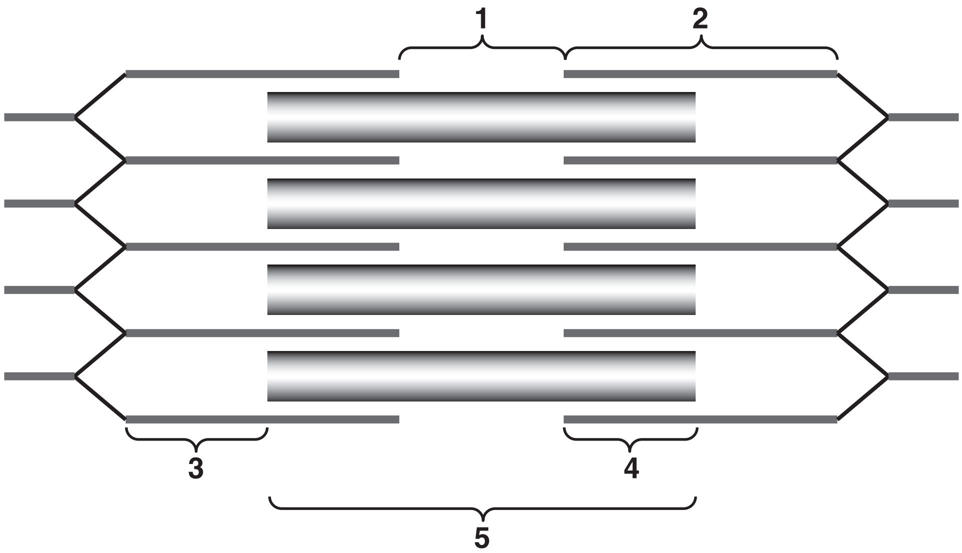

Fig. 26.1

Complete Table 26.1 to summarise the changes that will occur in the sarcomere when the muscle contracts.

For each row of Table 26.1, place a tick (✓) in the correct box. Leave the other boxes blank.

Table 26.1

region of sarcomere		change occurring during muscle contraction		
		increases	decreases	stays the same
1	width of band showing myosin filaments only			
2	actin filament length			
3	width of band showing actin filaments only			
4	width of band where actin and myosin filaments overlap			
5	myosin filament length			

[3]

(b) Outline respiration in skeletal muscle myocytes in anaerobic conditions **and** explain why less energy is released per molecule of glucose compared to respiration in aerobic conditions.

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.... [4]

(c) Myocytes of cardiac muscle soon die when the muscle is deprived of oxygen.

Explain why less oxygen reaches cardiac muscle when a person has coronary heart disease.

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.... [2]

[Total: 9]

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