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A Level Biology A

H420/02 Biological diversity

Tuesday 20 June 2017 – 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 **100**.
- 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 20 minutes on this section.

Write your answer for each question in the box provided.

Answer **all** the questions.

1 Membranes are found within and surrounding cells.

Which of the statements, **A** to **D**, is **not** a role of membranes in cells?

A acts as a barrier between areas

B cell signalling

C provides support for cell

D site of chemical reactions

Your answer ☐ **[1]**

2 Which of the statements, **A** to **D**, about amylopectin is correct?

A it contains 1-4 and 1-6 glycosidic bonds between α-glucose monomers

B it is an unbranched chain of α-glucose monomers

C it contains α 1-4 and β 1-6 glycosidic bonds

D it is made up of β-glucose monomers and is uncoiled

Your answer ☐ **[1]**

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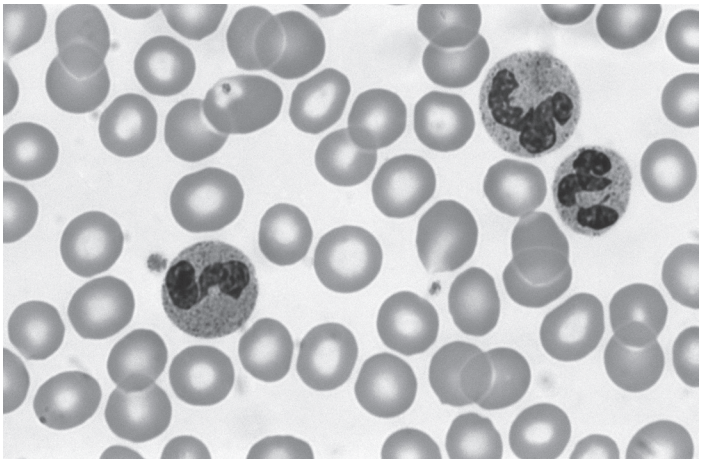
3 The photograph below shows a blood smear.



Which row correctly lists the cells that are visible in the smear?

	erythrocytes	lymphocytes	monocytes	neutrophils
A	✓	×	✓	✓
B	✓	×	×	✓
C	✓	✓	✓	×
D	×	✓	✓	✓

Your answer ☐ **[1]**

4 The haploid chromosome number in the koala, *Phascolarctos cinereus*, is 8.

Independent assortment of chromosomes in meiosis contributes to genetic variation in the gametes of the koala.

How many genetically different versions of koala gamete would it be possible for one individual to produce if independent assortment were the only source of genetic variation?

A 64

B 128

C 256

D 512

Your answer ☐ **[1]**

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5 Which of the following processes occur during DNA replication?

1 breakage and (re)formation of phosphodiester bonds
2 breakage and (re)formation of hydrogen bonds
3 alignment of free nucleotides with their complementary bases

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

6 Which of the statements, **A** to **D**, best defines the term *species evenness*?

A the number of species in an area

B the relative abundance of each species in an area

C the relative number of individuals of a species in an area

D the spread of species over an area

Your answer ☐ **[1]**

7 The first stage of primary succession is the pioneer community.

Which of the following statements about a pioneer community are correct?

1 species produce large numbers of wind-carried seeds or spores
2 biomass is low
3 many species are lichens and mosses

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

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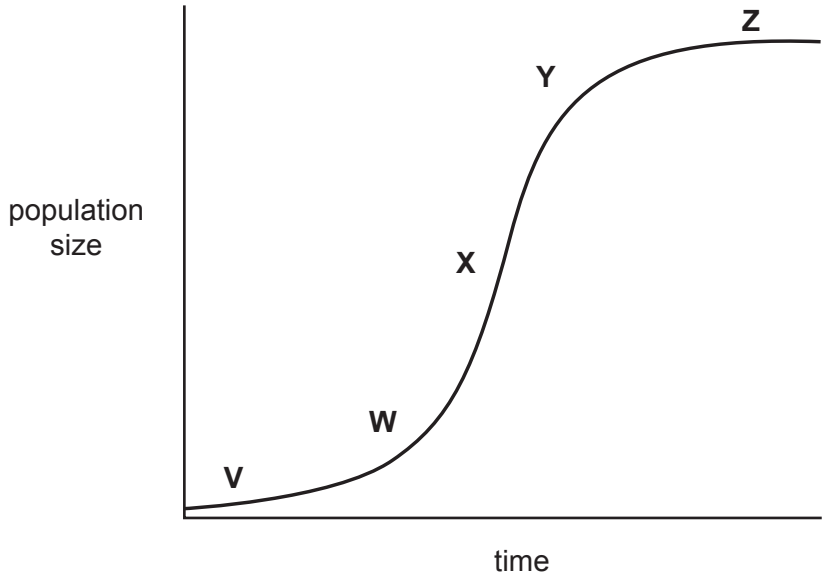
8 The graph shows a typical population growth curve.



Which row correctly describes what is happening at each of stages **V** to **Z**?

	V	**W**	**X**	**Y**	**Z**
A	reproduction rate is higher than death rate	as time doubles population doubles	population size is proportional to time	population growth is slowing	reproduction rate is similar to death rate
B	reproduction rate is higher than death rate	as time doubles population more than doubles	reproduction rate is much higher than death rate	population growth is slowing	reproduction rate is similar to death rate
C	reproduction rate is higher than death rate	as time doubles population doubles	population size is proportional to time	population growth is decreasing	reproduction rate is similar to death rate
D	reproduction rate is higher than death rate	population is increasing rapidly	reproduction rate is much higher than death rate	population is decreasing	reproduction rate is similar to death rate

Your answer ☐ **[1]**

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9 Cut pieces of agar jelly can be used to investigate the factors affecting diffusion rates in cells.

Four pieces of agar jelly containing universal indicator were soaked in the same concentration of hydrochloric acid for one minute.

The cubes were then removed and blotted dry.

Which of the following pieces of agar jelly would be the first to turn entirely red?

A a cube with edges 4 cm each

B a cuboid with edges 2 cm, 4 cm and 6 cm

C a cuboid with edges 3 cm, 3 cm and 5 cm

D a sphere with diameter 4 cm

Your answer ☐ **[1]**

10 Which of the options, **A** to **D**, is a primary defence against pathogens?

A antibody production

B inflammation

C phagocytosis

D T-killer cells

Your answer ☐ **[1]**

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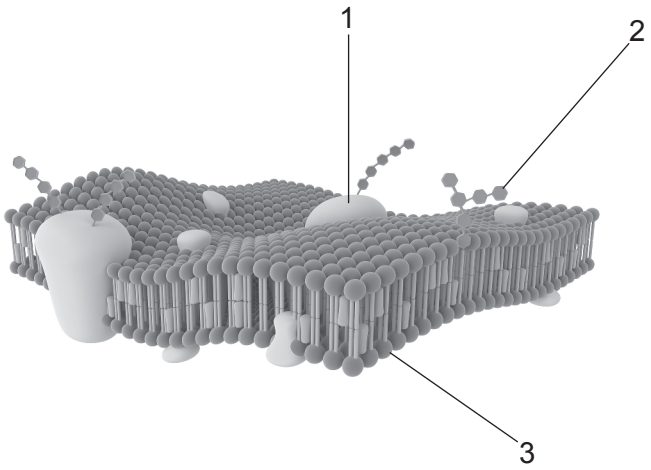
11 The diagram below shows part of a plasma membrane.



Which of the label lines points to a structure that could contain a sulfur atom?

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

12 Which of the following statements about gene therapy is **not** correct?

A changes resulting from gene therapy cannot be passed on to offspring

B germ-line gene therapy affects the whole organism

C gene therapy is a form of genetic engineering

D somatic cell gene therapy can only affect a limited number of cells

Your answer ☐ **[1]**

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13 Below are three processes that occur within living organisms.

1 apoptosis
2 mitosis
3 meiosis

Which of these processes is important in determining the body plan of an organism?

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

14 Three methods of pathogen transmission between animals or plants are listed below.

1 direct contact
2 vectors
3 droplets

Which of the methods of pathogen transmission does **not** apply to plants?

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

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15 The image below shows a European badger, *Meles meles*, which is a member of the family Mustelidae.

The American badger belongs to a different genus within the same family.

Which of the options, **A** to **D**, is the correct binomial name for the American badger?

A *Meles leucurus*

B *mellivora capensis*

C *mustelidus Everetti*

D *Taxidea taxus*

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 The Madidi National Park, in the South American rainforest, is home to a wide variety of species. The largest predator in the area is the jaguar. These large cats are well camouflaged and hunt mostly at night. A single individual can cover a very large area.

(a) In 2007 the Wildlife Conservation Society (WCS) attempted to estimate the population of jaguars in the Madidi National Park.

- Digital camera traps were placed in areas that jaguars were likely to visit.
- If an infrared beam was broken by an animal, the camera was activated.
- The camera then took a photograph of the animal.

(i) Suggest why it was **not** appropriate to estimate the number of jaguars using the capture-recapture technique.

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

(ii) Most studies estimate the population density of jaguars in the South American rainforest to be 5 individuals per 100 km^2.

In the 2007 study:

- 100 camera traps were set up covering an area of 271 km^2.
- 28 images of 9 different jaguars were recorded.

How well do these results support a population estimate of 5 individuals per 100 km^2?

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..... **[4]**

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(iii) Other evidence used to estimate the jaguar population includes footprints and reports of sightings by local humans.

Suggest one disadvantage of each of these methods for estimating the size of the jaguar population.

human sightings .....

.....

footprints .....

.....

[2]

(b) The Madidi National Park is also home to approximately 260 000 humans who support themselves by means of cattle-farming, and the production of timber and brazil nuts (a large nut harvested from a local native tree).

Conservationists have been working with:

- local people to promote sustainable use of these resources; and
- government agencies to maintain the quality of the national park.

Explain why the Madidi National Park is an example of conservation rather than preservation.

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

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17 The sweet pea plant has been used to study inheritance since the nineteenth century. The seeds of the sweet pea can vary in colour and shape.

The gene that controls colour has two alleles:
- **Y** is dominant and produces yellow seeds.
- **y** is recessive and produces green seeds.

The gene that controls shape has two alleles:
- **R** is dominant and produces round seeds.
- **r** is recessive and produces wrinkled seeds.

(a) In the nineteenth century, Gregor Mendel crossed a pea plant that was heterozygous for both seed colour and shape with a pea plant that had green and wrinkled seeds.

(i) List the gametes that would be produced by a sweet pea plant that was heterozygous for both seed colour and shape.

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

(ii) List the genotypes of the offspring that were produced from Mendel's cross and state the corresponding phenotypes.

genotypes.....

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phenotypes.....

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[2]

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(b) When Mendel crossed two pea plants that were heterozygous for both seed colour and shape, the ratio of phenotypes in the offspring was:

- 9 yellow round
- 3 green round
- 3 yellow wrinkled
- 1 green wrinkled.

Some students tried to recreate this investigation using a modern variety of plant that showed the same phenotypic variation in seed colour and shape.

The students crossed two of the modern plants that were heterozygous for both seed colour and shape. The results of this cross were:

- 58 yellow and round
- 31 green and round
- 21 yellow and wrinkled
- 2 green and wrinkled

The students used the chi-squared test to compare their data to the expected 9 : 3 : 3 : 1 ratio.

(i) Use the chi-squared formula $\chi^2 = \sum \frac{(O-E)^2}{E}$ to calculate the χ^2 value for these data.

You may use the table below for working out.

χ^2 = ... **[3]**

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Table 17 shows a χ^2 probability table.

Degrees of freedom	Probability (*p*)					
	0.95	**0.90**	**0.10**	**0.05**	**0.025**	**0.01**
1	0.00	0.02	2.71	3.84	5.02	6.64
2	0.10	0.21	4.61	5.99	7.38	9.21
3	0.35	0.58	6.25	7.82	9.35	11.34
4	0.71	1.06	7.78	9.49	11.14	13.28
5	1.15	1.61	9.24	11.07	12.83	15.09
6	1.64	2.20	10.64	12.59	14.45	16.81
7	2.17	2.83	12.02	14.07	16.01	18.48

Table 17

(ii) After analysing the results, the students stated that the inheritance of the seed colour and shape in their investigation was different from that in Mendel's investigation.

Using Table 17, discuss whether the results of the investigation and the chi-squared test support the students' statement.

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

(iii) A ratio that is different from the expected 9 : 3 : 3 : 1, in a cross such as this, can be the result of epistasis.

Suggest and explain one reason, **other** than epistasis, why the phenotype ratio might not be 9 : 3 : 3 : 1.

Suggestion .....

Explanation .....

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

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(c) The yellow colour in peas is the result of an enzyme that breaks down chlorophyll, which is green.

- The **Y** allele codes for the production of an enzyme that breaks down chlorophyll.
- The **y** allele is the result of a mutation in the **Y** allele.
- The **y** allele codes for an inactive form of this enzyme.

(i)* Outline how the **Y** allele codes for the production of this enzyme **and** explain why the **y** allele codes for an enzyme with a different primary structure.

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(ii) With reference to the proteins coded for by the seed colour gene, explain why the **y** allele is recessive.

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

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18 The potato plant, *Solanum tuberosum*, is a staple food plant in many parts of the world.

Potatoes are susceptible to infection by a pathogen called *Phytophthora infestans*, which causes a disease known as potato late blight. The most visible sign of the disease is a brown discolouration of the leaves.

Some varieties of potato are resistant to infection by *P. infestans.*

(a) State **two** ways in which an individual *S. tuberosum* plant could respond to infection by *P. infestans.*

1.....

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2.....

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[2]

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(b) The resistance of different varieties of *S. tuberosum* to infection by *P. infestans* was investigated.

- Three different clones, A, B and C, of *S. tuberosum* were used.
- The clones were grown in adjacent fields over the same time period.
- The percentage of leaf area affected by the disease was estimated at regular intervals.

The results are shown in Fig. 18.

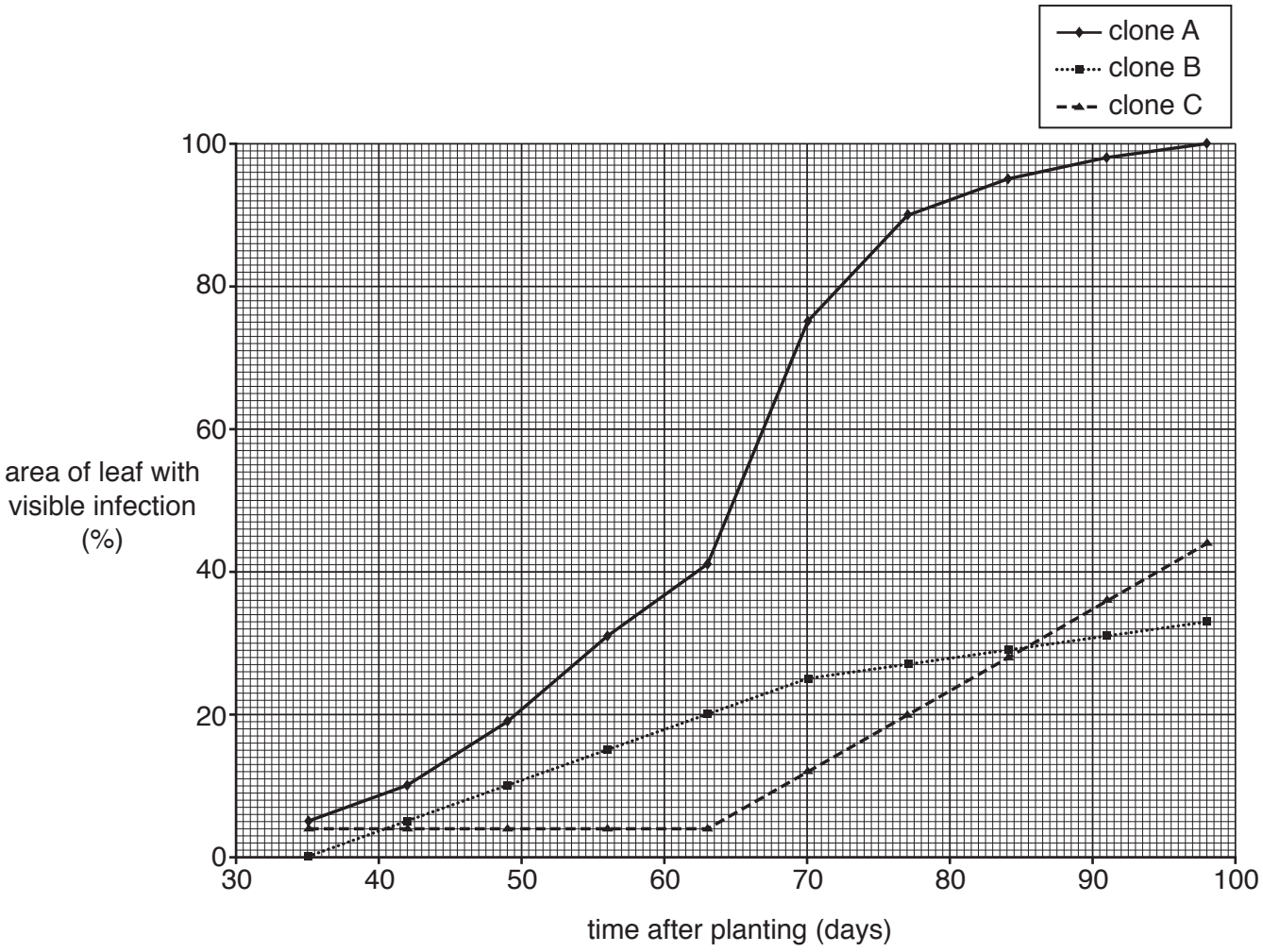

Fig. 18

(i) Suggest why it is important to use clones in an investigation such as this.

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

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(ii) State how a clone of potatoes could be produced for this investigation and explain why it is important to carry out this procedure under aseptic conditions.

procedure .....

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asepsis is important because .....

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

(iii) The extent of infection is estimated by comparing the area under the curve from the graph. The area under the curve for clone **B** is 1250. (Units can be ignored in this instance.)

Using Fig. 18, calculate the approximate area under the curve, between day 35 and day 98, for clone **C**.

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

(iv) Calculate the area under the curve for clone **C** as a proportion of the area under the curve for clone **B**.

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

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(v) **Using Fig. 18**, suggest why the area under the curve is used as a measure of infection rather than the area of leaf that is visibly affected on a given day.

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

(vi) The clones were planted in adjacent fields in order to control variables such as temperature, wind speed and rainfall.

Suggest two other abiotic variables that this precaution was intended to control.

1 .....

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2 .....

.....

[2]

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19 Two species of chimpanzees, the chimpanzee and the bonobo, are the closest living relatives of humans.

Fig. 19.1 is a diagram representing the current classification of chimpanzees and humans within the Family Hominidae.

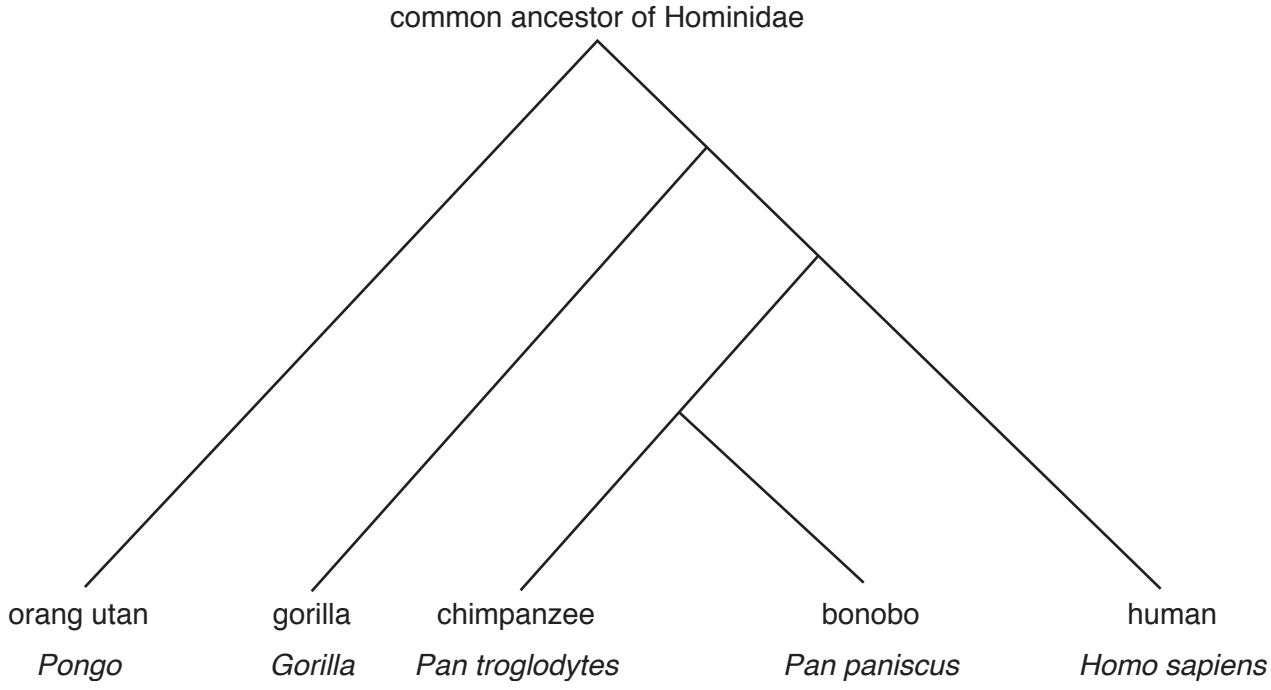

Fig. 19.1

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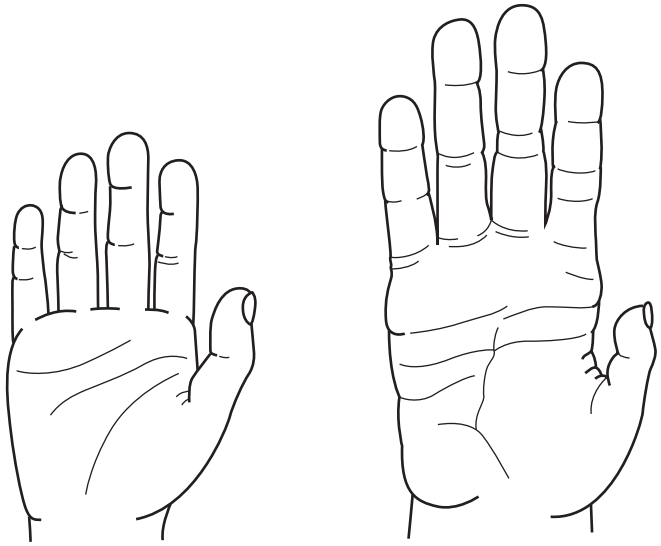
(a) Humans and chimpanzees are currently classified within the same family.

Chimpanzees were once classified separately from humans in the Family Pongidae along with gorillas and orang utans.

Fig. 19.2 shows a human hand and a chimpanzee hand.



H. sapiens *P. troglodytes*

Fig. 19.2

Describe **two** differences between the two images that could have been used to classify humans and chimpanzees in separate families.

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

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(b) Differences between the nucleotide base sequences can be used to estimate the length of time since two species diverged from one another.

The greater the number of differences, the greater the length of time that has elapsed since the two organisms were part of the same species.

Fig. 19.3 shows the line of best fit for the differences in DNA between pairs of primate species plotted against the number of years since the two species diverged from a common ancestor.

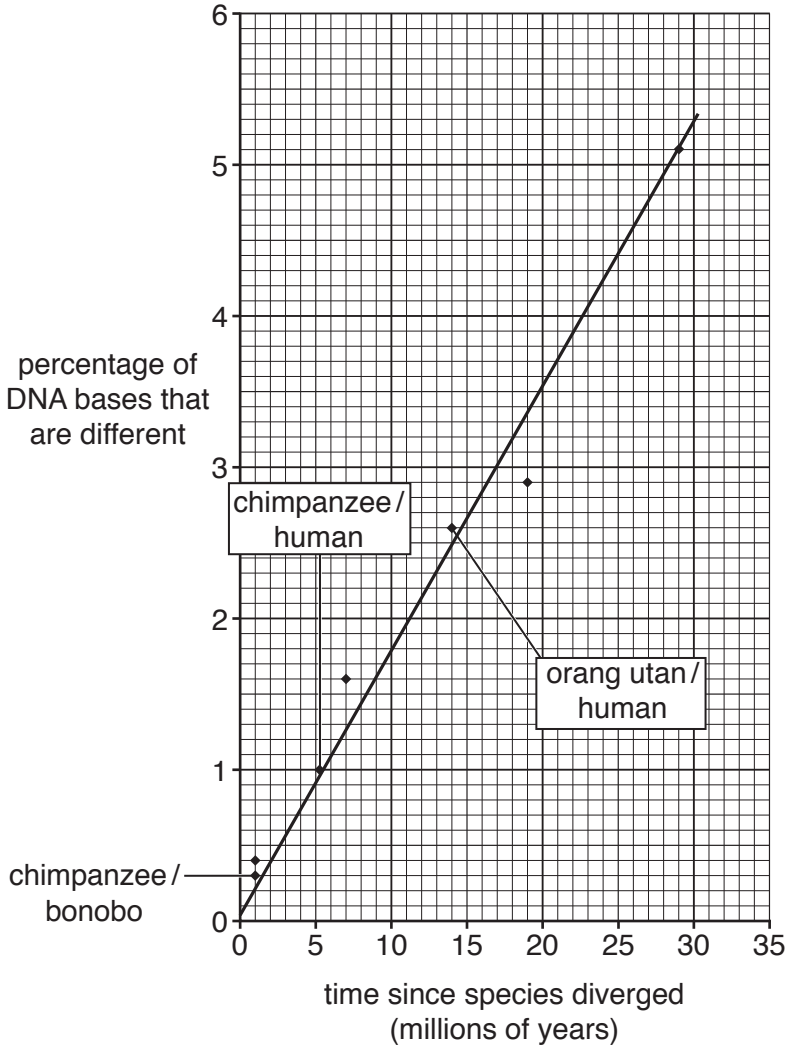

Fig. 19.3

(i) Calculate the rate of DNA change using the data in Fig. 19.3.

Give your answer to **three** significant figures.

Answer .....% per million years **[2]**

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(ii) The mutation rate in mammals can vary by as much as 20% between species.

Use Fig. 19.3 to calculate the time since the phylogeny of humans diverged from chimpanzees, and the range over which this estimate may vary.

time since divergence = ...

range = ...

[2]

(iii)* Some scientists have suggested that humans and chimpanzees should be reclassified as belonging to the same **genus**.

Evaluate their suggestion using evidence from **Figs. 19.1 to 19.3 and** your own knowledge of the scientific basis for the classification of organisms.

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

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(iv) One type of gene is known as a homeobox gene.

The base sequences of homeobox genes in humans and chimpanzees are almost identical.

What conclusions about the evolutionary relationship between humans and chimpanzees can be drawn from this piece of evidence?

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

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20 Fig. 20 shows the disaccharide lactose, which is found in milk.

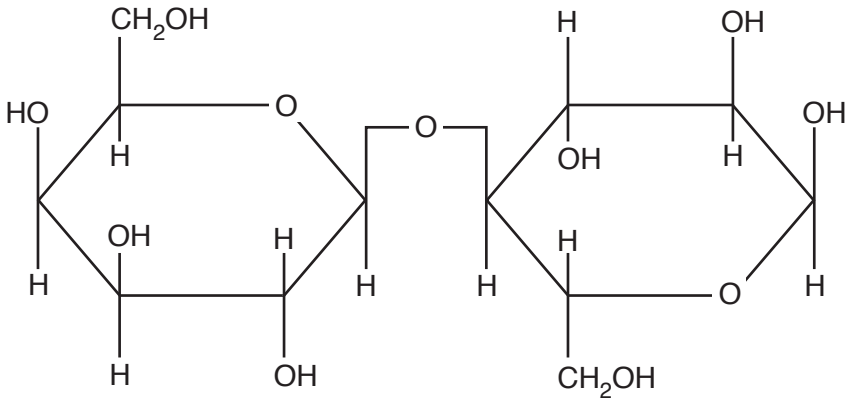

Fig. 20

(a) Another disaccharide is maltose. Maltose and lactose both contain the same number of atoms of each element, C, H and O.

(i) State two **other** structural similarities between lactose and maltose.

1 .....

.....

2 .....

.....

[2]

(ii) Complete the table below to identify differences between the structures of lactose and maltose. The first one has been completed for you.

Lactose	Maltose
one glucose monomer and one galactose monomer	both monomers are glucose

[3]

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(b) One of the monomers of lactose is galactose.

The bacterium *E. coli* usually uses glucose as a respiratory substrate.

Under certain circumstances, *E. coli* is able to use galactose as a respiratory substrate by breaking down lactose into glucose and galactose and then using both glucose and galactose as respiratory substrates.

(i) Explain how the structure of galactose allows it to be used as a respiratory substrate.

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

(ii) *E. coli* usually grows in conditions where the extracellular concentration of lactose is low. In such conditions lactose does not easily cross the bacterial cell surface membrane.

Suggest and explain why lactose is unable to cross membranes.

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

(iii) In order for lactose to enter the cytoplasm of *E. coli* a protein is required.

The *E. coli* living in the digestive system of young mammals are more likely to contain this protein than *E. coli* living in the digestive system of old mammals.

Suggest an explanation for this observation.

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

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(c) Lactose is a reducing sugar.

Benedict's reagent can be used to detect the presence of lactose in a solution.

A colorimeter can be used to measure the concentration of lactose.

The colorimeter first needs to be calibrated.

Describe how a method that uses Benedict's reagent and a colorimeter could be calibrated to measure the concentration of lactose in an unknown sample.

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..... **[4]**

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21 Fig. 21 shows some of the steps involved in producing a genetically modified bacterium.

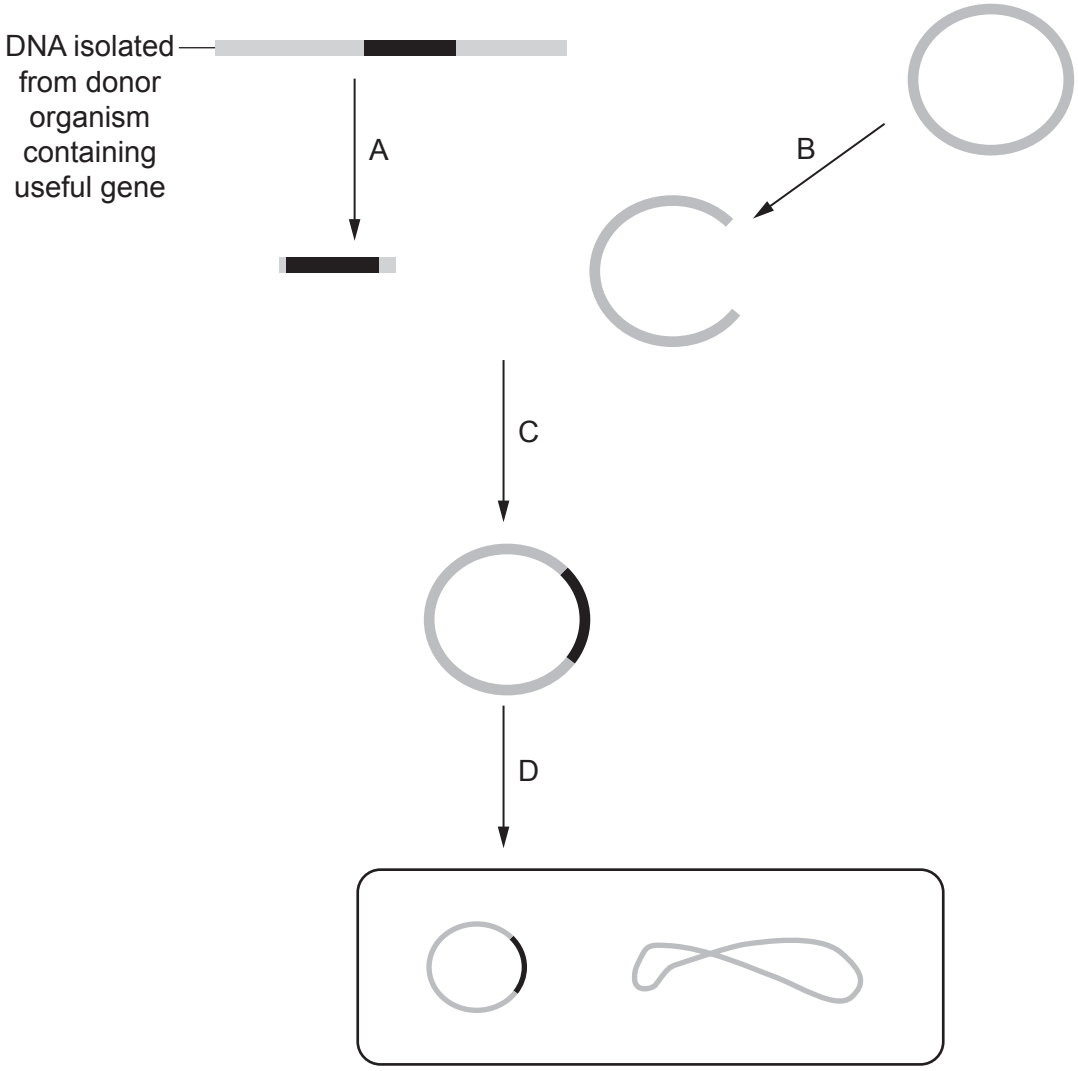

Fig. 21

(a) The following passage describes steps A and B. Complete the passage using the most appropriate terms.

A gene is cut from the DNA of the donor organism using a ....

The ..... enzyme is used to cut open a small piece of bacterial DNA so that the base sequences at the end of each piece of DNA are ..... .

[3]

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(b) Describe the **events** that are taking place at the step labelled C.

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

(c) Step D results in a transformed bacterium.

Many individual bacteria are not transformed successfully during this procedure.

Explain how scientists can determine the success of step D in this procedure.

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

(d) Bacteria can be genetically modified to produce human insulin.

The process is similar to that shown in **Fig. 21** with some differences.

First, instead of isolating DNA that contains the insulin gene, mRNA that codes for insulin is extracted from human pancreas cells.

What needs to be done with the mRNA in order for the rest of the genetic modification to be completed?

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

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(e) Some people are concerned about genetic modification.

State one valid concern that people have about the genetic modification of **bacteria**.

.....

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

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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