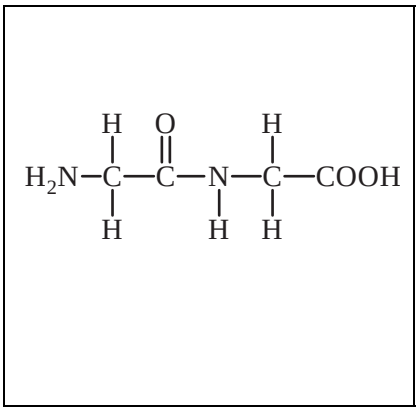
Practice exam questions

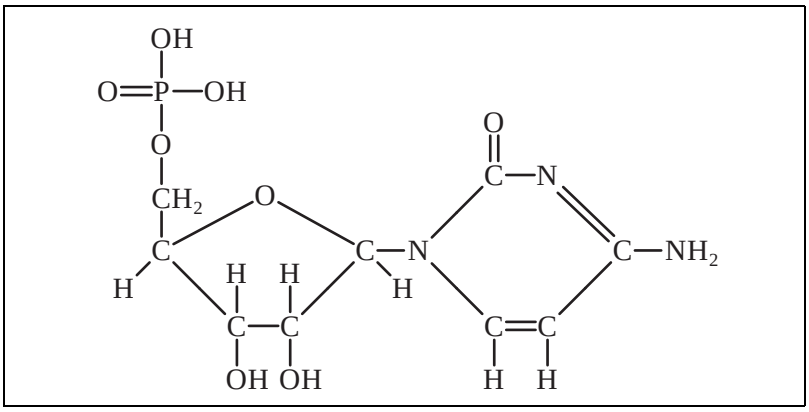
MULTIPLE-CHOICE QUESTIONS

The diagrams below illustrate the chemical structure of some biomolecules. Use them to answer Questions 1 and 2.

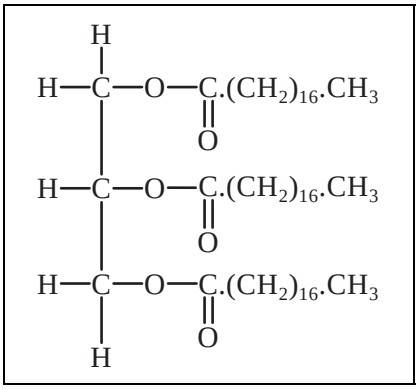
W



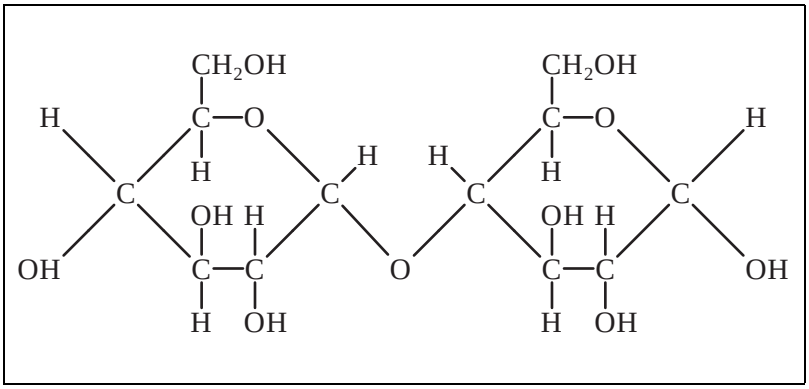
X



Y



Z



Question 1

Which molecule(s) make up the chemical structure of proteins?

A. *W* only
B. *X* only
C. *W* and *X*
D. All of them

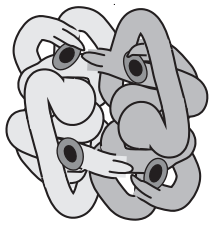
Question 2

Which molecule(s) was/were formed by condensation reactions?

A. *W*, *X* and *Z*
B. All of them
C. *X* only
D. *Z* only

Use the following information to answer Question 3.

The figure below shows a single molecule of haemoglobin, an oxygen-transporting protein found in red blood cells. The molecule consists of four polypeptide chains.



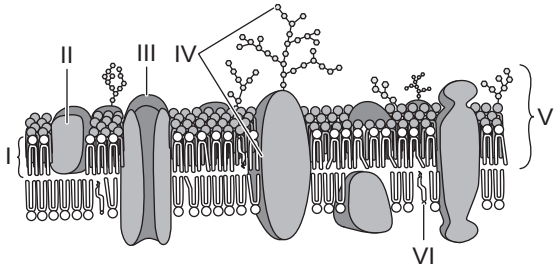
Question 3

Which term best describes the three-dimensional structure of haemoglobin?

A. primary
B. secondary
C. tertiary
D. quaternary

Use the following information to answer Question 4.

The diagram below represents the structure of the plasma (cell) membrane.



Question 4

Which structure(s) represent glycoproteins?

A. I and VI
B. II, III and IV
C. IV and V
D. IV only

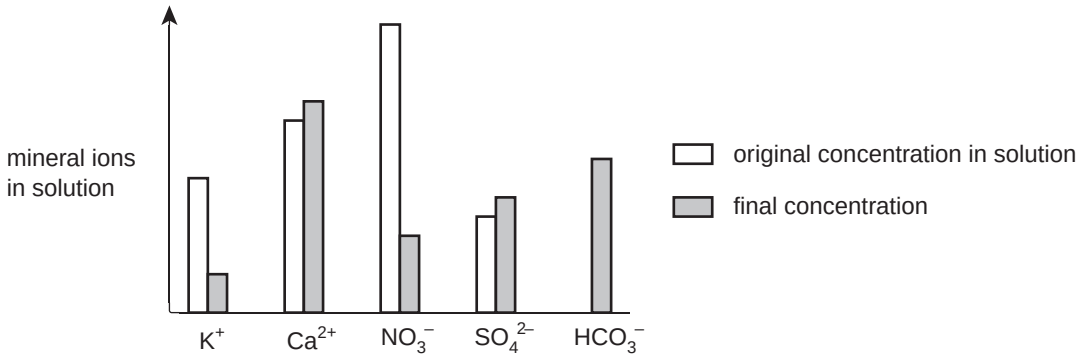
Question 5

Simple diffusion in plants is sufficient to account for

A. absorption of water by root hairs.
B. transport of potassium ions through protein channels in the cell membrane.
C. the secretion of cellulose to form the cell wall.
D. exchange of oxygen and carbon dioxide within the leaves.

Use the following information to answer Question 6.

Tomato plants can be grown in sterile culture solutions using a technique called hydroponics. The graph below shows the changes in the concentrations of certain mineral ions in a culture solution in which tomato plants have been grown for 24 hours.



Question 6

Which of the following ions appear to have been taken up from the solution by active transport into the roots?

A. K^+ and HCO_3^-

B. Ca^{2+} and SO_4^{2-}

C. K^+ and NO_3^-

D. HCO_3^- only

Question 7

Which one of the following is a correct summary of the main events in photosynthesis?

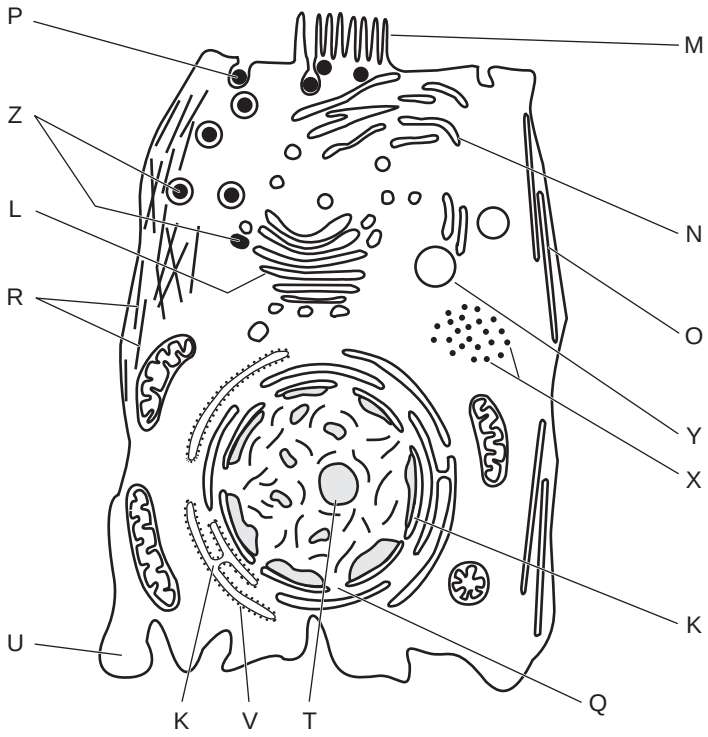
A. Light is required to join carbon dioxide to hydrogen (which was split from water using ATP) in carbohydrate production.

B. Oxygen reacts with a carbohydrate to produce water and carbon dioxide in the presence of light.

C. Light splits carbon dioxide, producing oxygen gas, and the resulting carbon then combines with oxygen and hydrogen obtained from water to produce carbohydrate.

D. Carbon dioxide combines with hydrogen split from water by light to produce carbohydrate using ATP.

For Questions 8 and 9, study this view of an animal cell as seen using an electron microscope.



Question 8

What is the polysaccharide found at X?

A. ATP
B. glucose
C. glycogen
D. starch

Question 9

In this cell, lipase and amylase molecules are produced by protein synthesis and secreted in large quantities. Which sequence of letters best describes the route taken by a radioactively-labelled amino acid as it is incorporated into an enzyme molecule prior to secretion?

A. T → Q → U → Y → Z → P
B. U → V → L → N → Z → P
C. T → Q → V → M → O → R
D. U → V → K → L → Z → P

Question 10

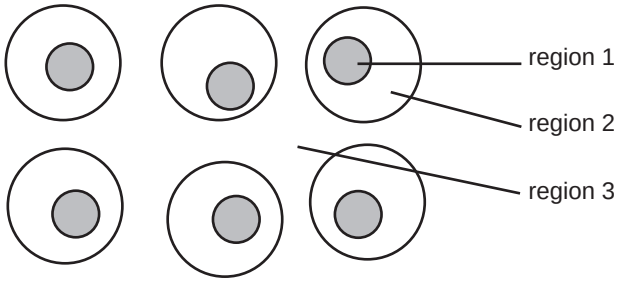
Adenosine triphosphate, ATP, provides energy within the cell. When ATP is used, the reaction may be summarised as

$$ATP \rightarrow ADP + P_i + \text{energy}$$

Which of these statements concerning this reaction is **correct**?

A. The reaction is endergonic.
B. ATP contains a base, a sugar and two phosphate groups.
C. The reaction is catabolic.
D. This reaction takes places mainly in the mitochondria.

Questions 11 and 12 refer to the following diagram of human body cells as seen using a light microscope.



Question 11

Which area from the diagram represents the extra-cellular environment?

A. Region 1
B. Region 2
C. Region 3
D. Regions 1, 2 and 3

Question 12

Which of the areas from the diagram would you expect to be approximately 37 °C?

A. Region 1
B. Region 2
C. Region 3
D. Regions 1, 2 and 3

Question 13

Hormones are responsible for keeping factors such as blood glucose within a narrow range. Which of the following factors is an action a hormone could reasonably be expected to take?

A. A reaction with a membrane receptor that will lead to a cellular change.
B. Be released from exocrine tissue.
C. Circulate in the bloodstream directly to the target tissue.
D. A more rapid response than the action of nerves.

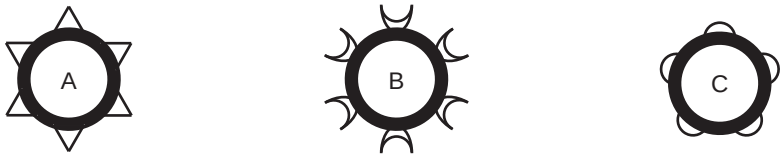
Question 14

Which of the following cells of the immune system are primarily involved with the production of chemicals that destroy virus-infected cells?

A. mast cells
B. natural killer cells
C. dendritic cells
D. macrophages

Use the following information to answer Question 15.

The diagram below depicts three strains of virus (A, B and C) with different types of antigens exposed. Each antigen is unique to each strain of virus.



Question 15

If a person becomes infected with strain C, which of the antibodies depicted below would the body synthesise to eradicate that strain?

A.


B.


C.


D.


Question 16

In horses, sooty dark bay coat colour (**E**) is dominant to light bay **(e)**. Assuming no mutation, it would be reasonable to infer that

A. a light bay horse must have at least one light bay parent.

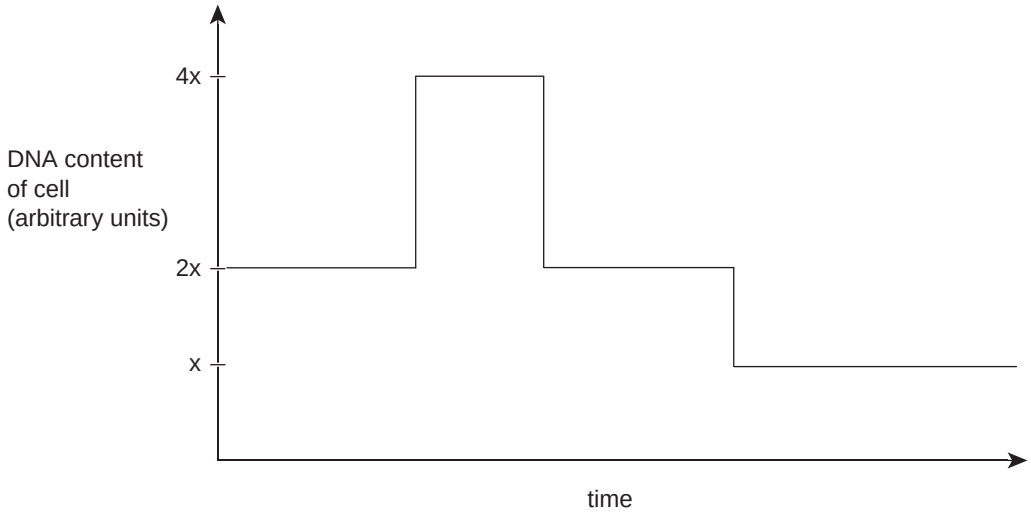
B. all the offspring of a sooty dark bay stallion will be sooty dark bay.

C. a sooty dark bay horse must have a least one sooty dark bay parent.

D. the offspring of a sooty dark bay stallion and a light bay mare will be a medium bay colour.

Question 17 refers to the following information.

The graph below shows the changes in the level of DNA over time in a cell undergoing nuclear division.



Question 17

Which of the following correctly describes the process of nuclear division shown in the graph?

A. Nuclear division leading to the formation of a skin cell.

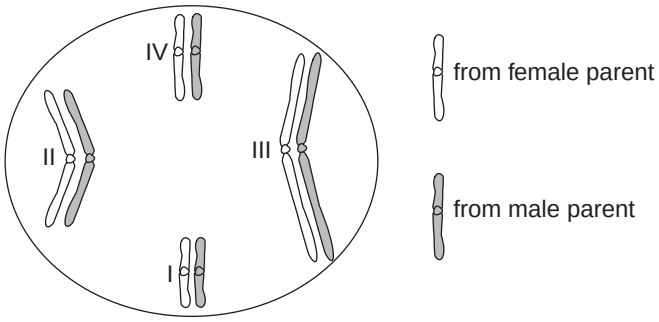
B. Nuclear division leading to the growth of a zygote.

C. Nuclear division leading to the formation of bacteria.

D. Nuclear division leading to the formation of a sperm cell.

Question 18

The diagram below shows a sperm mother cell of a male fruit fly *Drosophila melanogaster*. The chromosomes derived from each parent are shaded differently.



What is the probability of a sperm receiving all four paternal chromosomes when this sperm mother cell undergoes meiosis?

A. 1 in 16

B. 1 in 8

C. 1 in 4

D. 1 in 2

HL - Question 19

Two genes, located on different autosomes, control bulb colour in onions. One gene, C, determines whether or not the bulb is coloured. The presence of colour is dominant over white. The second gene determines the colour of the bulb and has two alleles (**R** for red and **r** for yellow).

What would be the expected phenotypic ratio for offspring from the cross **CcRr** $\times$ **ccrr**?

A. 2 red : 1 yellow : 2 white
B. 1 red : 1 yellow : 2 white
C. 3 red : 3 yellow : 2 white
D. 2 red : 1 yellow : 1 white

Questions 20 and 21 refer to the following information.

The colour of a cat's coat is X-linked. The allele $\mathbf{X^g}$ produces ginger fur and the allele $\mathbf{X^b}$ produces black fur. Females with the genotype $\mathbf{X^gX^b}$ have tortoiseshell fur (a mixture of black and ginger). A ginger female and a black male produced a litter consisting of two tortoiseshell females, a ginger male and a tortoiseshell male.

Question 20

The genotype of the tortoiseshell male was

A. $\mathbf{X^gY^b}$
B. $\mathbf{X^gY}$
C. $\mathbf{X^bY}$
D. $\mathbf{X^gX^bY}$

Question 21

The most likely cause of the genotype produced in **Question 20** was

A. non-disjunction of the sex chromosomes in the male parent.
B. non-disjunction of the sex chromosomes in the female parent.
C. a mutation of the Y chromosome in the male parent.
D. a translocation involving the sex chromosomes in the female parent.

Question 22

A population of Australian fur seals breeds regularly on an isolated beach on an island off the coast of Western Australia. Of this population, 9% of seals have silver fur, which is a recessive trait. This is a much higher frequency of the silver phenotype than is encountered among populations of seals breeding on the Australian mainland.

The biological phenomenon that best explains the features of the population of fur seals on the island is

A. a genetic bottleneck.
B. the founder effect.
C. geographical isolation.
D. allopatric speciation.

Question 8 refers to the following information.

In foxes, a gene controlling coat colour has the following alleles:

- $\mathbf{W}^{+}$ = silver
- $\mathbf{W}^{P}$ = platinum
- **W** = white-faced silver

The combinations **WW**, $\mathbf{W^PW^P}$ and $\mathbf{W^PW}$ are all lethal, i.e. in each case the embryo dies at an early stage of development.

Question 23

You could reasonably expect that

A. all adult foxes will have at least one $\mathbf{W}^{+}$ allele.

B. adult foxes would have one of two possible genotypes.

C. half the adult foxes will have one $\mathbf{W}^{P}$ allele.

D. heterozygous adults will have only one possible genotype.

~~**Question 24**~~

~~The sequence of bases in mitochondrial DNA (mtDNA) has been used to study relatedness between families of humans and test hypotheses concerning the evolution of humans, hominids and other mammals.~~

~~Which of the following statements concerning mtDNA is correct?~~

~~**A.** mtDNA mutates so rapidly that it cannot be used to study evolutionary relationships between animals.~~

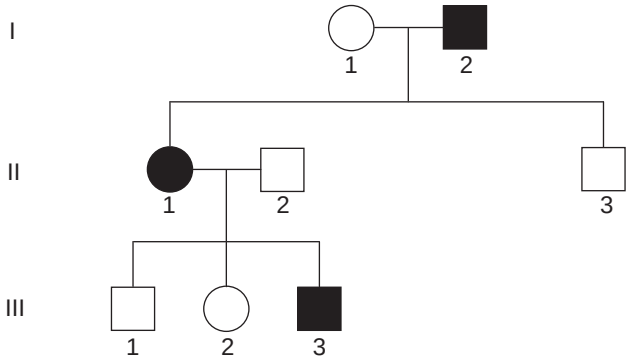
~~**B.** mtDNA is single-stranded.~~

~~**C.** mtDNA is a circular molecule similar to the DNA of a bacterial chromosome.~~

~~**D.** mtDNA is inherited through the paternal line.~~

Question 25

A genetic counsellor was investigating the pattern of inheritance of a genetic trait in a family. She drew up the following pedigree, where shaded individuals have the trait.



The genetic counsellor could conclude with certainty that the mode of inheritance for this trait is

A. X-linked dominant.

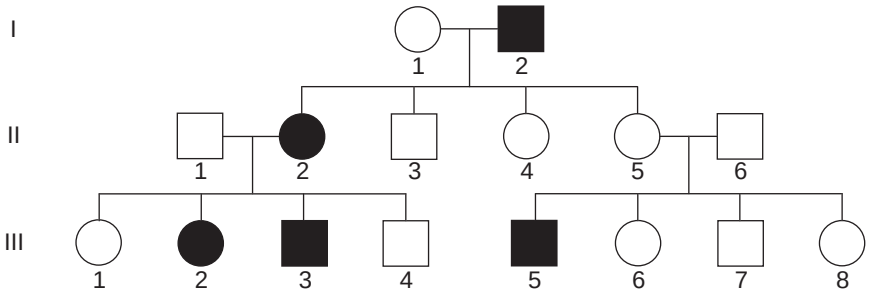
B. autosomal recessive.

C. autosomal dominant.

D. not X-linked recessive.

Question 26

Syndactyly is a rare genetic condition, inherited as an autosomal dominant trait, where webbing develops between the fingers and toes. Unusually, however, a person who has the defective allele responsible for syndactyly, (**N**), does not always show the trait. The diagram below shows the pedigree of a family with syndactyly.



There was no history of syndactyly in the ancestors of individuals I-1, II-1 and II-6. Assuming that there are no new mutations, it is reasonable to conclude that

A. individual II–5 has the genotype **nn**.

B. individuals II–4 and II–5 may have the same genotype.

C. individual II–1 has the genotype **Nn**.

D. individuals III–2 and III–5 may have different genotypes.

Question 27

Which of the following enzymes would be needed for DNA replication?

A. restriction enzymes

B. RNA polymerase

C. reverse transcriptase

D. DNA polymerase

Question 28

Refer to the following template section of single-stranded DNA.

G A C T G A C T G A C T

Which of the following responses relates to this strand?

A. The mRNA strand that is complementary is CUGACUGACUGA.

B. The DNA strand that is complementary is TCAGTCAGTCAG.

C. It contains 24 units of phosphate.

D. The first anticodon would be GUC.

HL - Question 29

A eukaryote gene usually provides much more genetic information than is needed to code for a protein. From a gene's transcription to its final translation, which of the following events occur and lead to a decrease in the amount of genetic information that is translated?

A. Introns removed from the translated DNA.

B. Exons removed from the transcribed pre-mRNA.

C. Introns removed from the transcribed pre-mRNA.

D. Exons removed from the translated mRNA.

Questions 30 and 31 refer to the following information.

Gene therapy is like molecular surgery. Single gene genetic disorders (such as cystic fibrosis and thalassaemia) are potential candidates for gene therapy. Hopefully gene therapy will one day cure these and other diseases. The concept of gene therapy is to insert a previously cloned normal form of the gene into the tissue needed to express that particular gene. There are two main forms of gene therapy.

1) **Somatic cell gene therapy**

The correct form of the gene is inserted into the body cells that need them and so are only expressed by them.

2) **Germ line gene therapy**

The correct gene is inserted into a gamete. If this gamete is fused with another gamete to form a zygote, each somatic cell descended from it will carry the correct gene.

Question 30

Based on all the information above and your knowledge of biotechnology, which of the following statements **could** be a consequence of gene therapy?

A. In each case, the faulty form of the gene is removed.
B. The correct gene, when inserted, could disrupt other genes.
C. Only one copy of the correct gene could be inserted into target cells.
D. The procedure for somatic cell gene therapy would never need to be repeated.

Question 31

Biotechnology experts are inclined to support somatic cell gene therapy and reject germ line gene therapy. Which of the following statements would be the best biological argument as to why this would be the case?

A. Germ line gene therapy should be rejected because it could lead to a reduction in genetic variation in the future.
B. Somatic cell gene therapy should be accepted because it could lead to a reduction in genetic variation in the future.
C. Germ line gene therapy should be rejected because it could lead to an increase in genetic variation in the future.
D. Germ line gene therapy should be rejected because it is unethical to experiment with gametes under any circumstances.

Question 32

Which of the following would lead to increased genetic variation?

A. An increase in environmental mutagens.
B. An extreme environmental change.
C. Reduced crossover between homologous chromosomes.
D. Fewer than normal numbers of offspring produced each generation.

Question 33

Natural selection acts on

A. phenotypes.
B. genotypes.
C. alleles.
D. environmental factors.

Question 34

Breeders have developed a variety of dog called the Chinese hairless crested dog.
Which methods were most likely used to produce this variety?

A. DNA hybridisation
B. artificial selection
C. cloning
D. random breeding

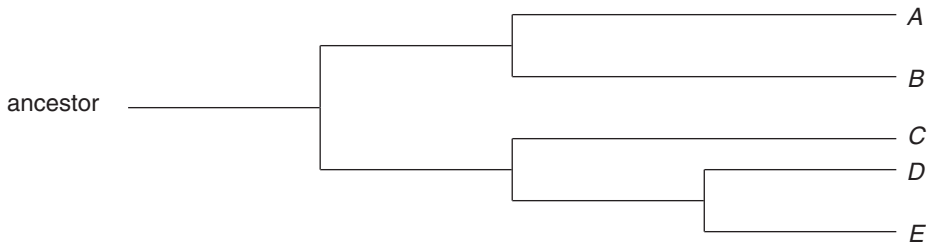
Question 35

There are many different types of animals with backbones and they live in a large variety of environments. However, they have a great many similarities in the bone structure of the vertebrae that make up the backbone. This observation provides evidence for

A. convergent evolution.
B. divergent evolution.
C. extinction.
D. structural analogies.

Question 36

The following diagram represents an evolutionary tree illustrating the relationships between five organisms (*A, B*, *C*, *D* and *E*). These are developed from evidence generated from many different areas.



Which of the following statements is consistent with this evolutionary tree?

A. Organisms *A* and *B* are the most closely related organisms.
B. Organisms *C* and *B* are the most closely related organisms.
C. Organisms *D* and *E* are the most closely related organisms.
D. The length of the horizontal lines in the evolutionary tree represent how long ago the organisms were found.

Question 37

Cytochrome *c* is a protein that serves a very important role during cellular respiration. Cytochrome *c* is found in the mitochondria of every eukaryote. The amino acid sequences of many of these have been determined, and comparing them shows that they are related. The table below shows a comparison of the first 20 amino acids of the cytochrome *c* molecule in four organisms compared to that in humans.

Note: The "–" symbol illustrates the amino acid at that point in the polypeptide chain is the same as that found in the human.

Amino acid number in the polypeptide chain	Human	Pig	Chicken	Wheat	Yeast
1	Gly	–	–	–	–
2	Asp	–	–	Asn	Ser
3	Val	–	Ile	Pro	Ala
4	Glu	–	–	Asp	Lys
5	Lys	–	–	Ala	–
6	Gly	–	–	–	–
7	Lys	–	–	Ala	Ala
8	Lys	–	–	–	Thr
9	Ile	–	–	–	Leu
10	Phe	–	–	–	–
11	Ile	Val	Val	Lys	Lys
12	Met	Gln	Gln	Thr	Thr
13	Lys	–	–	–	Arg
14	Cys	–	–	–	–
15	Ser	Ala	–	Ala	Glu
16	Gln	–	–	–	Leu
17	Cys	–	–	–	–
18	His	–	–	–	–
19	Thr	–	–	–	–
20	Val	–	–	–	–

Which of the following statements is consistent with the data from the table?

A. The pig and chicken each have three amino acid differences compared to the human cytochrome *c* and so would have the same differences in the DNA coding for this protein.

B. Yeast has 11 amino acid differences and would have a more distant common ancestor to humans than the other organisms in the table.

C. The amino acid similarities that all organisms show would only arise as a result of the DNA sequences in those sections being the same.

D. Organisms of decreasing similarity with the human would be in the following order: pig (most similar), chicken, wheat and yeast (least similar).

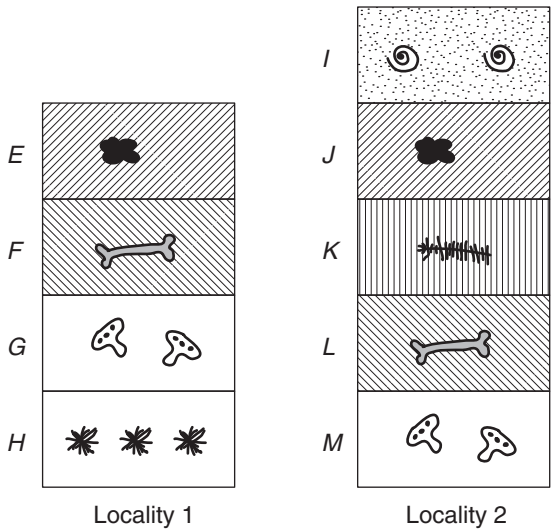
Question 38

When the Isthmus of Panama closed about 3 million years ago, creating a land bridge between North and South America, marine creatures on either side of Central America were separated. Scientists have studied this geological event and its effects on populations of snapping shrimp. They found that shrimps on one side of the isthmus appeared almost identical to those on the other side. Shrimps from opposite sides were also genetically similar. But when they put males and females from different sides of the isthmus together, they snapped aggressively instead of courting. There were no successful matings. The biological process which best explains this is

A. sexual selection.
B. reproductive isolation.
C. genetic drift.
D. natural selection.

Question 39

The following diagrams represent the strata layers found in two different locations (1 and 2). Each layer is symbolised with a letter (*E* to *M*). A variety of fossils were found in each layer and can be used as a guide to determine the relative age of each layer and each fossil.



What is the correct letter sequence that represents the layers in both locations from oldest to youngest?

A. *H, G, F, J, K*
B. *M, H, G, F, E*
C. *I, J, K, L, M*
D. *H, G, K, J, I*

Question 40

Which of the following organisms or parts of organisms are most likely to be fossilised?

A. Single-celled organisms such as amoeba.
B. Soft parts such as muscle.
C. Organic material such as DNA.
D. Hard bony parts such as teeth.

SHORT ANSWER QUESTIONS

Question 41

Antibiotics work by interfering with some essential operations in bacterial cells. Penicillin and cephalosporin both inhibit the synthesis of the bonds that strengthen bacterial cell walls. These walls consist of long, linear polymers called peptidoglycans.

Peptidoglycan molecules are cross-linked by peptide chains. Antibiotics inhibit the synthesis of the peptide links, resulting in a weak cell wall through which the bacterium explodes. Because they work during the synthesis of the cell wall, these antibiotics are active against bacteria only when they are growing.

Chloramphenicol and streptomycin interfere with protein synthesis by binding to the ribosomes. Streptomycin, for example, distorts the ribosome and thus causes an error in reading the genetic code so that the wrong amino acid is inserted into the growing peptide chain. This effect, however, is likely to be less rapid than the irreversible halt to protein synthesis that occurs within minutes of adding the antibiotic rifampicin to a bacterial culture.

The above text is adapted from "Antibiotics Explained: A post-16 study resource" by J. Cherfas published by The Biotechnology and Biological Sciences Research Council (1995). Used with permission.

a. Define the following terms.

i. polymer

_____

_____

_____

1 mark

ii. peptide chain.

_____

_____

_____

1 mark

b. Explain how a 'weak cell wall' can cause a bacterium to 'explode'.

_____

_____

_____

_____

2 marks

c. Rifampicin acts by preventing transcription.

i. Which nucleic acid would be prevented from forming?

_____

1 mark

ii. Describe how preventing transcription would cause an 'irreversible halt to protein synthesis' in a bacterium.

_____

_____

_____

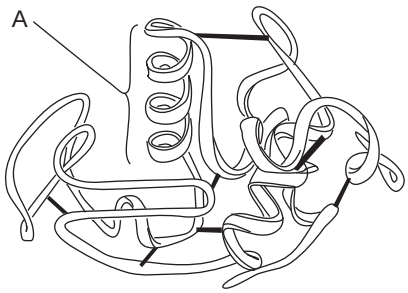
_____

2 marks
Total 7 marks

Question 42

Lipase is an enzyme that catalyses the hydrolysis of triglycerides. It is a soluble globular protein. The function of an enzyme depends upon the precise nature of its tertiary structure.

The diagram below represents the structure of an enzyme. The black strips represent the disulfide bonds that help to stabilise its tertiary structure.



a. **i.** Region A in the above diagram is a secondary structure. What is this secondary structure called?

_____

1 mark

ii. Explain why the function of an enzyme depends upon the precise nature of its tertiary structure.

_____

_____

_____

_____

2 marks

iii. Describe the effect of breaking the disulfide bonds on lipase function.

_____

_____

_____

_____

2 marks
Total 5 marks

Question 43

Some results of research recently conducted suggest a link between marijuana use and a reduction in memory and reduction in neuron size. The active ingredient in marijuana is THC and when in the bloodstream the THC moves to the brain and binds with receptors on the cell surface of neurons.

The interaction between the THC and 'cannabinoid' receptor (CB-receptor) has an inhibitory effect on neuron function.

a. **i.** What is a function of a neuron?

_____

1 mark

ii. What is the specific stimulus of the inhibitory effect displayed in this case?

_____

1 mark

One of the impacts of this combination of the THC and CB-receptor is inhibition of nerve impulse-dependent calcium channels which, when stimulated, promote exocytosis from the pre-synaptic membrane of the neuron.

b. Use this information to describe the effect of THC on a functioning synapse.

_____

_____

_____

2 marks

Another aspect of research revealed that when THC bound with the CB-receptor, it also inhibited a biochemical pathway that normally led to the accumulation of proteins in the cytoplasm of the neurons. This is thought to lead to reduced cell size as well as cell death.

c. Give a biological explanation as to why reduced protein synthesis may lead to cell death.

_____

_____

_____

2 marks

Total 6 marks

Question 44

Apple farmers often use artificial environments to ensure their apples are available to consumers all year round. One such method is to accelerate fruit ripening by exposing large quantities of apples to a specific set of conditions.

An experiment was carried out to test the effect of varying the levels of a plant hormone ethylene on apple ripening when exposed to different temperatures. Testing was conducted in aluminium containers that had 100 equally sized unripe apples placed in them. The internal environment of the aluminium containers could be altered by adding or removing factors in the air by an inlet and outlet valve.

The apples were considered ripe when two apples could be consecutively removed and deemed ripe by tasting them for sweetness as well as looking at their colour. Results of such an experiment are outlined in the table below.

Ethylene concentration (ppm)	Temperature (°C)	Time taken for apples to ripen (hours)
0	20	200
1	20	150
2	20	100
50	20	75
150	20	30
500	20	30
500	5	100

a. **i.** List one strength in the experimental design.

_____

1 mark

ii. List one weakness in the experimental design.

_____

1 mark

iii. Use the experimental results to describe the optimal conditions you would recommend to apple farmers for fast fruit ripening.

_____

_____

_____

2 marks
Total 4 marks

Question 45

There have been major concerns about the avian influenza virus (bird flu) infecting humans and possibly causing a worldwide pandemic. The bird flu is one of many different subtypes of type A influenza viruses. These subtypes differ because of changes in certain antigenic proteins on the surface of the influenza A virus. The proteins are symbolized with the letters H (hemagglutinin) and N (neuroaminidase).

H1N1, H1N2 and H1N3 are the strains of the influenza A virus currently affecting the human population. However, they are usually only suffered for a week and the victims generally survive. On the other hand, the bird flu is the variant form H5N1 and humans have rarely been exposed to this strain. When contracted by humans, this form of the flu is generally very severe. The symptoms can range from high temperatures to brain swelling and death.

The H5N1 strain is usually contracted from infected birds and it is rare for humans to pass this strain of flu onto other humans.

a. ~~Draw a labelled diagram of a typical virus.~~

2 marks

b. The viral DNA in the H1N3 and H5N1 strains is different. Explain why this leads to different antigenic proteins on their surfaces.

_____

_____

_____

1 mark

c. The table below illustrates the number of confirmed cases from the World Health Organisation of humans who have contracted the bird flu in the recent past.

Year of onset	Total cases reported	Number of deaths
2003	3	3
2004	46	32
2005	89	36

What has happened to the percentage of mortality over the last three years?

_____

1 mark

d. Research is currently being conducted at a frenzied pace in an effort to develop a vaccine for the bird flu so that a possible pandemic may be thwarted.

i. What does a vaccine contain?

_____

_____

1 mark

ii. If, after being vaccinated, a person was infected with the bird flu, how would you expect this person's immune system to respond?

_____

_____

_____

_____

_____

3 marks
Total 8 marks

Question 46

There are several factors that are taken into account when determining the compatibility of a potential organ donor. These are outlined below in order of importance:

- **ABO Blood types.** Blood types of the donor and recipient should be the same. There are four blood types: A, B, AB and O.
- **Rhesus factor.** This can either be negative or positive which should match with the recipient and the donor.
- **Tissue matching.** The cells of the recipient and the donor should be as similar as possible with respect to a group of six antigens (called HLA proteins) located on the surface of all body cells.

a. Define the term antigen in the context of this question.

_____

1 mark

A certain individual who is blood type B positive is in need of a kidney transplant and luckily two potential donors are available at the same time. Their compatibility, with respect to the factors above, follows:

- Person 1: Blood type B negative and five of the antigens are a perfect match.
- Person 2: Blood type B positive and three of the antigens are a perfect match.

b. Based on the information provided, explain which person (1 or 2) would be the best donor.

_____

_____

1 mark

c. Using the information provided as well as your understanding of the immune system, explain why the risk of rejection of the transplanted organ still exists even if all the factors outlined above are a perfect match.

_____

_____

_____

2 marks

d. Describe a measure that could be taken which could reduce the risk of rejection of the transplanted organ.

_____

_____

1 mark

Total 5 marks

HL - Question 47

The plant genus *Brassica* contains a number of species useful to humans, including common vegetable and fodder plants such as cabbage, broccoli, swede and canola.

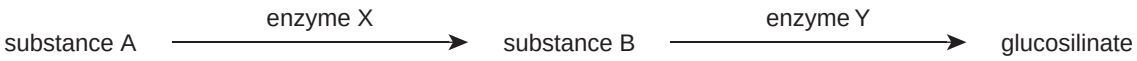
For cabbage (*Brassica oleracea*), selective breeding programmes have been aimed at improving the tightness of the leaf-heads and reducing the levels of glucosilinate in the leaves. Leaf-head tightness is controlled by a single gene, T, and the desirable 'tight-headedness' is a recessive trait (t).

Glucosilinate is present in all *Brassica* species. It provides resistance to insect pests and produces the 'hot' flavour in mustard seeds. Glucosilinate production is a dominant phenotype controlled by two genes, B and G.

Gene B controls the production of enzyme X while gene G controls the production of enzyme Y. The ability to produce enzyme X (B) is dominant to the inability to produce the enzyme (b). Similarly, the ability to produce enzyme Y (G) is dominant to the inability to produce this enzyme (g). The T, B and G genes show independent assortment.

The two enzymes interact to synthesise glucosilinate in the metabolic pathway shown below.

Substance B is desirable in cabbages, since it produces the distinctive flavour of cabbage and also provides some degree of pest resistance.



a. **i.** A breeder crossed a pure-breeding, glucosilinate-producing cabbage with a cabbage unable to produce either of the two enzymes. Write the genotype of the offspring (F_1) of this cross.

_____

ii. Write the genotype of a cabbage plant that will only produce substance B.

_____

1 + 1 = 2 marks

b. In order to produce tight-headed, substance B-producing cabbages, the breeder crossed a pure-breeding, loose-headed plant that produces only substance B with a plant that is tight-headed but cannot produce substance B. He finds that none of the offspring plants have the desired tight-headed characteristics, although they all produce substance B.

In view of this, what further cross would you recommend to the breeder? Explain your suggestion by setting out this cross clearly to show the proportion of the offspring that you would expect to have the desired characteristics (i.e. tight-headed, producing substance B).

3 marks

c. Some useful *Brassica* crops have evolved as the result of hybridisation between species. Hybridisation between the turnip *Brassica rapa* (2n = 20) and the black mustard *Brassica nigra* (2n = 16) initially produced a sterile hybrid (2n = 18). However, spontaneous chromosome doubling in the sterile hybrid has given rise to a new species, the brown mustard *Brassica juncea* (4n = 36).

i. What term is used to describe the chromosomal make-up of a hybrid species such as *Brassica juncea*?

_____

ii. Explain why brown mustard plants are able to produce fertile seeds if the original hybrid was sterile.

_____

_____

_____

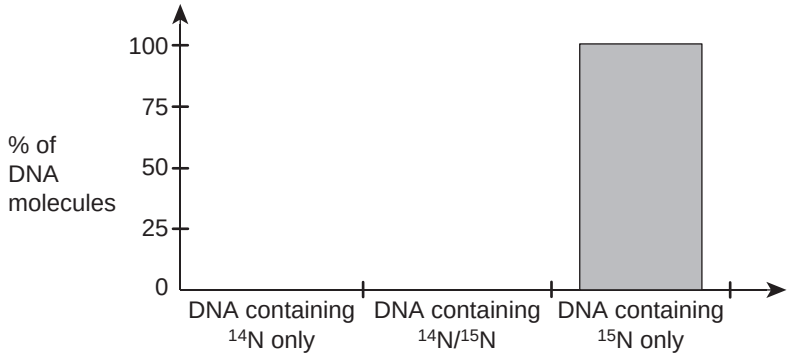
_____

1 + 2 = 3 marks
Total 8 marks

Question 48

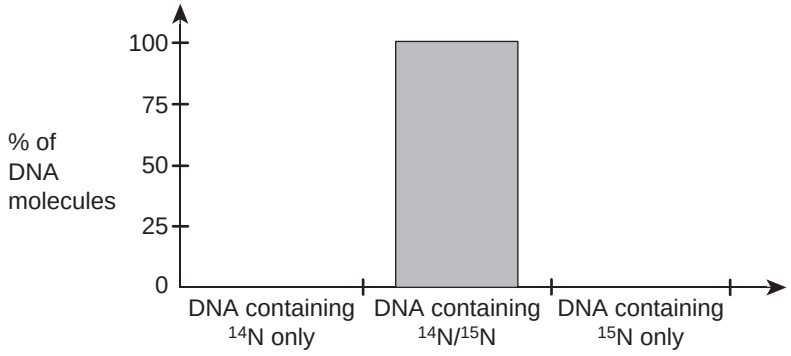
During research into the mechanism of DNA replication, bacteria were grown for many generations on a medium containing only the 'heavy' isotope of nitrogen, ^{15}N. This resulted in all the DNA molecules containing only ^{15}N. This is shown below.

Graph 1



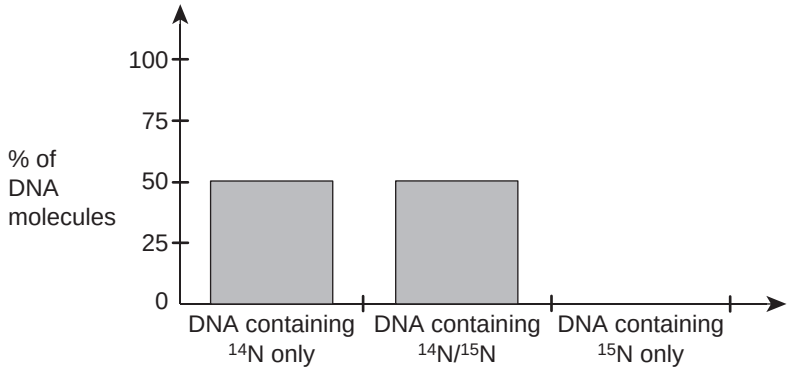
The bacteria were then grown in a medium containing only 'light' nitrogen, ^{14}N. After the time required for the bacteria to replicate once, the DNA was analysed. The results are shown below.

Graph 2



The bacteria continued to grow in the 'light' nitrogen (^{14}N) medium until they had replicated once more. At this point the DNA molecules were again analysed. The results are shown below.

Graph 3



a. In exactly which part of the DNA molecule is nitrogen found?

_____

1 mark

b. Explain how the data in Graphs 2 or 3 supports the semi-conservative hypothesis of DNA replication.

_____

_____

_____

_____

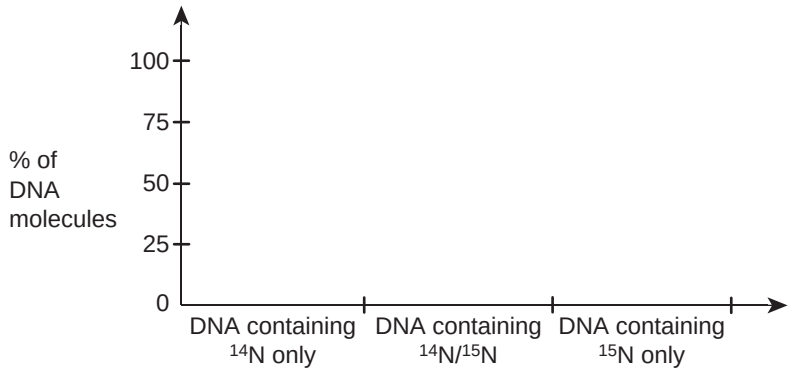
_____

_____

3 marks

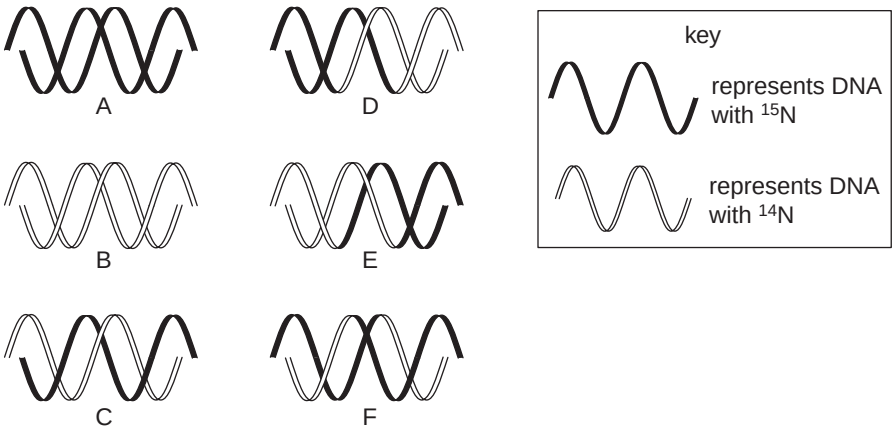
c. The bacteria then continued to grow in the 'light' (^{14}N) medium for a third generation. The DNA molecules were then collected and analysed a final time. Complete the bar chart below to show the expected composition of these DNA molecules.

Graph 4



1 mark

d. The diagram below shows simple DNA molecules, indicating the nitrogen content of each. With reference to the diagram, select the letter(s) which best represent(s) the bacterial DNA shown in Graphs 1, 2 and 3.



	Letter(s)
Graph 1	
Graph 2	
Graph 3	

2 marks
Total 7 marks

Question 49

The use of forensic DNA testing is increasing in popularity. It has a wide variety of uses including

- determining the guilt of criminal offenders
- determining the true father of children in paternity cases.

The method used for forensic DNA testing for each of the above examples is similar. The method involves

- DNA extraction
- amplification of DNA
- targeting sections of DNA
- separation of targeted sections of DNA for easy analysis.

a. Outline the method known as PCR that is used to amplify DNA.

_____

_____

_____

_____

_____

2 marks

b. DNA probes can be used to target particular sections of DNA of the individuals being tested. The DNA probe is compatible to a particular section of single-stranded DNA. One such DNA probe is described below.

3' G A T T A C A 5'

The sequence below is part of a single strand of DNA extracted from an individual who is being tested in a forensic DNA testing case.

3' A C A T T A G T G T A A T C G A T T A C A C T A A T G T A A 5'

i. Show clearly on the single strand of DNA above where the DNA probe would bind (anneal).

ii. Explain your answer to part **(i)**.

_____

_____

1 + 1 = 2 marks

c. In a paternity case involving forensic testing, a DNA probe similar to the one outlined above was added to DNA extracted from a mother, her two children and two males (one is the father). The DNA probes are designed to target specific sections of DNA known as Restriction Fragment Length

Polymorphisms (RFLPs). This particular DNA probe targets one section of DNA that shows large variation in size and the variants can be distinguished after gel electrophoresis.

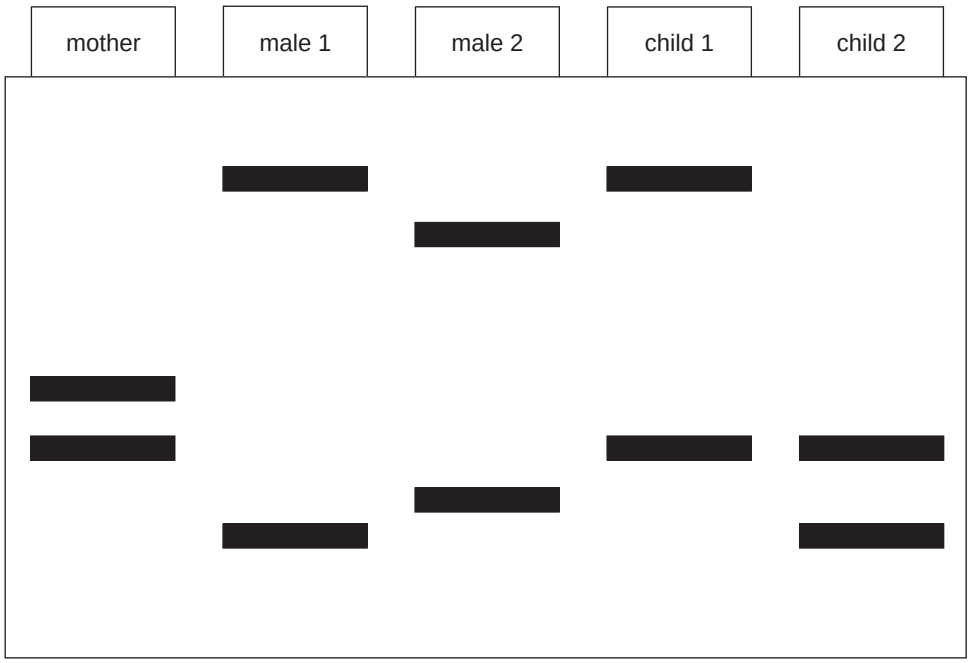
What is a property of DNA that enables gel electrophoresis to separate the DNA into different sizes?

_____

_____

1 mark

d. A stained gel for the paternity in question is shown below.



Use evidence from the gel pattern above to show whether male 1 or male 2 is the father of the children.

_____

_____

_____

_____

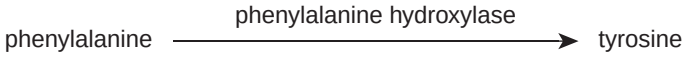
2 marks

Total 7 marks

Question 50

Phenylketonuria (PKU) is an autosomal recessive disorder affecting 1 in 10 000 humans. If this condition is detected early in life it can be treated with diet modification to reduce the symptoms of the disorder.

The intracellular biochemical reaction of the conversion of phenylalanine to tyrosine is shown below.



In sufferers of PKU, the enzyme phenylalanine hydroxylase (PAH) no longer functions due to a mutation in the gene coding for its synthesis. This leads to a build-up of phenylalanine which subsequently leads to the genetic disorder PKU.

a. Where within a cell would PAH be synthesised?

_____

1 mark

b. Describe the steps involved in the transcription of the PAH gene.

_____

_____

_____

2 marks

c. There are many different kinds of mutations that lead to variations in PAH. Each variation will lead to the symptoms of PKU. Generally, the greater the degree of difference between the normal PAH and the version formed from the mutated gene, the more severe the symptoms.

The following DNA base sequence is from a template strand within the normal PAH gene.

3' T T G A T G C A C 5'

Using the DNA strand above and the table of mRNA codons on the next page, show how a single base substitution could lead to a different version of PAH.

2 marks

second base

first base	U	C	A	G	third base
U	UUU phe UUC phe UUA leu UUG leu	UCU ser UCC ser UCA ser UCG ser	UAU tyr UAC tyr UAA stop UAG stop	UGU cys UGC cys UGA stop UGG trp	U C A G
C	CUU leu CUC leu CUA leu CUG leu	CCU pro CCC pro CCA pro CCG pro	CAU his CAC his CAA gln CAG gln	CGU arg CGC arg CGA arg CGG arg	U C A G
A	AUU ile AUC ile AUA ile AUG met	ACU thr ACC thr ACA thr ACG thr	AAU asn AAC asn AAA lys AAG lys	AGU ser AGC ser AGA arg AGG arg	U C A G
G	GUU val GUC val GUA val GUG val	GCU ala GCC ala GCA ala GCG ala	GAU asp GAC asp GAA glu GAG glu	GGU gly GGC gly GGA gly GGG gly	U C A G

d. Other mutations that can cause a change in the normal form of PAH include

- single base substitution
- a single base deletion that codes for a stop signal.

Using the nine base sequence from the normal PAH gene as a starting point, give a DNA sequence that would illustrate a single base deletion coding for a stop signal.

_____

1 mark

e. If the DNA base sequence from part **c.** was near the start of the template strand from the PAH gene, which type of mutation would be more likely to lead to more severe symptoms of PKU? Choose either a single base substitution or a single base deletion that codes for a stop signal. Explain your answer.

_____

_____

_____

_____

2 marks
Total 8 marks

Solutions to Practice exam questions

MULTIPLE-CHOICE QUESTIONS

Question 1 A

Molecule *W* is a dipeptide, consisting of two amino acid residues connected by a peptide bond. Of the major biomolecules, only proteins and nucleic acids consist of subunits containing nitrogen (N), but molecule *X* is a nucleotide.

Question 2 B

All four classes of biomacromolecules – carbohydrates, lipids, proteins and nucleic acids – are formed by the condensation of subunits.

Question 3 D

The haemoglobin molecule consists of four polypeptide chains, each enclosing a haem group. Protein molecules consisting of more than one polypeptide chain are said to show quaternary structure.

Question 4 D

I = phospholipid; II and III = proteins; V = glycolipid; VI = cholesterol.

Question 5 D

A = osmosis; **B** = facilitated diffusion/active transport; **C** = exocytosis. Non-polar gas molecules such as oxygen and carbon dioxide are small enough to diffuse through membranes without metabolic assistance.

Question 6 C

The final concentrations of these ions are much lower than the original concentrations, showing that the plants have taken up these ions in large quantities. All the other ions have increased in concentration in the solution.

Question 7 D

Photosynthesis involves the capture of light energy by chlorophyll. This energy is used to make ATP (a source of chemical energy) and to split water molecules (a source of hydrogen). In the Calvin cycle, the energy from the ATP is used to combine the hydrogen with carbon dioxide to manufacture carbohydrates.

Question 8 C

The pancreas is an animal organ. Animal cells store carbohydrate in the form of glycogen. Starch is only stored in plant cells. ATP is the ready-use 'energy currency' of the cell and cannot be stored, and in any case, ATP is not a polysaccharide.

Question 9 D

Amino acids are transferred from the cytosol (U) to the ribosomes (V) where they are joined together via peptide bonds to make 'raw' protein molecules. These proteins are transported through the endoplasmic reticulum (K) to the Golgi apparatus (L). Here, the proteins are modified into the form in which they will be secreted (inactive enzymes) and packaged into membrane-bound vesicles (Z). The vesicles bud off from the Golgi apparatus and migrate to the cell surface membrane (P). They fuse with it and release the enzymes they contain outside the cell by exocytosis.

Question 10 C

ADP and ATP are both based on a **single** nucleotide molecule called adenosine, and contain two and three phosphate groups respectively. The reaction is catabolic because the chemical bond between two of the phosphate groups in ATP has been broken to release energy. ATP is formed in mitochondria during aerobic respiration, so **D** is incorrect.

Question 11 C

The extracellular environment is the area on the outside of cells (region 3). The intracellular environment is the area on the inside of cells, both the cytoplasm (region 2) and the nucleus (region 1). The boundary between these environments is the plasma membrane.

Question 12 D

As human body cells are homeostatic for temperature as well as water content you would expect stability both inside and outside of cells. All regions should have those stable conditions with only slight fluctuations.

Question 13 A

A hormone binds to either membrane surface or intracellular receptors. This leads to some kind of cellular change. In this case, hormones are released into the bloodstream but do not move directly to target cells. This process is slow and as the secretion is internal, it is regarded as endocrine not exocrine.

Question 14 B

Mast cells are involved with allergic responses by producing histamines. Dendritic cells are there for antigen recognition. Macrophages engulf and destroy cellular material. Natural Killer cells detect the interleukins released by virus-infected cells and destroy the virus-infected cells.

Question 15 B

Antibodies have two antibody/antigen reaction sites. Both of them must be the same - so **B** is the only possible answer.

Question 16 C

Light bay horses do not have to have light parents as both parents could be sooty dark bay (**Ee**).
The offspring of a sooty dark bay stallion need not be sooty dark bay if the offspring is heterozygous (**Ee**). A medium bay colour would result from a situation of incomplete dominance or co-dominance.

Question 17 D

The graph depicts meiosis, since the final products are haploid (n). Options **A** and **B** require mitosis. Bacteria, having no nucleus, do not undergo nuclear division.

Question 18 A

Only one chromosome from each homologous pair will enter a gamete as a result of independent segregation. Each homologue has an equal (1/2) chance of doing so. So the likelihood of only the paternal chromosomes from each of the four homologous pairs entering the same sperm cell is
$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \mathbf{\frac{1}{16}}$.

Question 19 B

The expected results of the cross will be

	cr
CR	**CcRr** – red
Cr	**Ccrr** – yellow
cR	**ccRr** – white
cr	**ccrr** – white

Note: If the genotype is ***cc****, the genotype in respect of gene R is immaterial, as no colour can form.*

Question 20 D

In mammals, 'sex-linked' generally means 'X-linked' and the chromosome does not carry an allele of the gene in question. Tortoiseshell fur requires both $\mathbf{X^b}$ and $\mathbf{X^g}$ alleles to be present. In a male cat, this is only possible if the animal inherits two X chromosomes (i.e. the feline equivalent of Klinefelter's syndrome).

Question 21 A

Mutation of the Y chromosome is unlikely to be the cause, since the Y chromosome lacks a locus for the fur colour gene. The female parent has the genotype $\mathbf{X^gX^g}$. If translocation between these X chromosomes duplicated the $\mathbf{X^g}$ allele on one of them ($\mathbf{X^{gg}}$), this would presumably produce male offspring that were ginger. Likewise, non-disjunction of the X chromosomes in the female cat would mean the male kitten would inherit the genotype $\mathbf{X^gX^gY}$ and have ginger fur.

Question 22 B

No new species has formed. A genetic bottleneck would produce abnormally low genetic diversity rather than favour a particular phenotype. While islands may be geographically remote, they do not necessarily 'geographically isolate' populations of marine animals from gene flow. The higher frequency of silver seals is most likely due to an unusually high frequency of silver seals in the original breeding population that colonised the island.

Question 23 A

All surviving foxes must have one of the three non-lethal genotypes $\mathbf{W^+W^+}$, $\mathbf{W^+W}$ or $\mathbf{W^+W^P}$. Two of these are heterozygous and all three contain the $\mathbf{W^+}$ allele. Nothing is said in the question about the frequencies of the alleles.

Question 24 C

mtDNA is a circular molecule of double-stranded DNA, not associated with histone proteins, similar in size to a bacterial chromosome. It is usually inherited through the female line, because the ovum provides the original mitochondria of the embryo. mtDNA mutates faster than chromosomal DNA and is used as a 'molecular clock' for studying trends in human evolution over the last 200 000 years.

Question 25 D

The trait cannot be X-linked recessive because this would mean all males in generation III would be affected. Person III-1 is unaffected. All other modes of inheritance can be justified from this (very limited) data.

Question 26 B

Since there is no history of syndactyly in his family, person II–1 must have the genotype **nn**. Person II–5 must have the genotype **Nn** in order for person III–5 to inherit the **N** allele. Persons III–2 and III–5 must both have the genotype **Nn**. Since both of these individuals originate from the cross **Nn** × **nn**, neither can have the genotype **NN**.

Question 27 D

DNA polymerase enables the correct nucleotide to be put into position on a single strand of DNA. Restriction enzymes cut DNA. Reverse transcriptase transcribes RNA strands into cDNA.

Question 28 A

RNA is different to DNA in that Uracil replaces Thymine. All other base pairing combinations are the same. This makes option **B** incorrect. Option **C** is incorrect because there are only 12 nucleotides represented on the single strand of DNA. The first three nucleotides GAC will transcribe to CUG and this codon will be complementary to the anticodon GAC **not** GUC.

Question 29 C

When a gene is originally transcribed, the pre-mRNA contains segments that are cleaved out prior to translation. These sections that are cleaved out are referred to as introns. This leaves option **A** and option **C** as the only possible answers. Option **A** is incorrect as the DNA is not translated.

Question 30 B

The information suggests that the gene is inserted into the target cells. There is no reference to the faulty gene being removed. When the gene is inserted, the process is a little hit and miss. This means more than one copy could be inserted per cell and other genes could be disrupted as the DNA integrates into the genome of the target cell. Somatic cells often need replacing and if this type of cell is the target then the procedure would need to be repeated.

Question 31 A

If this procedure became commonplace then the generations of modified gametes would be more similar than the previous, unmodified generations of gametes. This means the variety in successive generations would be lessened. This means option **A** is correct and, by default, option **B** and option **C** are incorrect. Option **D** is incorrect as there are many situations where utilising gametes is not only legal but regarded as ethical. For example, in-vitro fertilisation (IVF) is a way that gametes can be used that is regarded as ethical.

Question 32 A

More mutagens would lead to more mutations which leads to more genetic variation. However this doesn't mean these variants will be more suited to survival. Extreme changes in environment are more likely to lead to death of many individuals, reducing variation amongst the population. Fewer crossovers will lead to fewer allele combinations and less genetic variation. Fewer offspring will not directly influence the genetic variation.

Question 33 A

Natural selection acts on organisms with the most suited characteristics. In genetics, characteristics are called phenotypes. The phenotype is an expressed trait that is present due to the interaction between the environment and the genes inherited. The genes inherited often have a variety of alleles. Sometimes different genotypes have the same phenotype. The environment is the driving force for natural selection, not the other way round.

Question 34 B

DNA hybridisation is generally used to determine genetic similarity between groups of organisms. Cloning may one day be 'in vogue' for dog breeders; it is certainly not commonplace. Random breeding will have a lower success rate of generating pure-bred dogs as they are the result of selective breeding where the breeder selects the dogs to breed so that desired traits will be kept.

Question 35 B

If organisms possess structures that have similarities in their design yet may be found in organisms that live in a wide variety of environments, then these are tell-tale signs of a common ancestral past. Hence the answer is divergent evolution.

Question 36 C

The horizontal lines provide evidence on how long ago the organisms diverged from each other. The ones that branch more recently are more closely related.

Question 37 B

The more differences in the amino sequences there are, the more distantly related the species are. This is the rule of thumb for such information. DNA codes for proteins and so the more differences there are in a protein sequence, the more different the corresponding DNA sequences will be. The DNA and amino acid differences serve as an evolutionary clock. Option **A** is incorrect as we are dealing with different DNA sections. Option **C** is incorrect as a result of silent mutations due to the degenerative nature of the DNA code. Option **D** is incorrect as you cannot determine whether the pig or the chicken is closer to the human when both the pig and the chicken have three differences.

Question 38 B

Since there were no matings there is no evidence of sexual selection. There is no evidence that the shrimp populations were very small, which is necessary for genetic drift to be significant. There is no evidence to support option **D**, because there is no information in the question concerning selection pressures and the shrimps have not evolved any obvious new adaptations. The refusal of shrimps from geographically isolated populations to interbreed is an example of reproductive isolation.

Question 39 D

Stratigraphic correlation is a useful way to determine the relative ages of fossils. When taking both areas into account, the layers from oldest to youngest are: *H, GM, FL, K, EJ, I*. Location 1 has the oldest layer as there is a layer below *G* which is also found as layer *M* in location 2.

Question 40 D

Most parts of organisms are destroyed in the fossilisation process as it is unlikely they will be in a situation conducive to this process. Hence single-celled organisms are very unlikely to be fossilised as are soft tissue parts. Organic material is usually replaced by minerals in the fossilisation process.

SHORT ANSWER QUESTIONS

Question 41

a. **i.** A very large molecule comprising a chain of many similar or identical subunits (monomers) which have bonded together. 1 mark

ii. A chain of amino acid subunits bonded together by peptide bonds. 1 mark

b. The bacterium takes up water by osmosis and increases in volume (1). The swelling is not limited by the cell wall so the cell membrane ruptures (1). 2 marks

c. **i.** Messenger ribonucleic acid (mRNA). 1 mark

ii. mRNA is produced by transcription and is the form in which the genetic code is carried from the nucleus to the ribosome (1). Without it, amino acids cannot be assembled into proteins by the ribosome (1). 2 marks

Total 7 marks

Question 42

a. **i.** α–helix or alpha helix. 1 mark

ii. The tertiary structure determines the three-dimensional shape (conformation) of the protein molecule (1) and so determines the (three-dimensional) shape of the active site or the specificity of the enzyme (1). 2 marks

iii. It will after the three-dimensional shape of the active site preventing it from binding with the triglyceride (1), thus preventing lipase from functioning (1). 2 marks

Total 5 marks

Question 43

a. **i.** To receive messages (from other neurons or some type of receptor) and transfer them to other neurons (or effectors). 1 mark

ii. THC triggers the response and so is the stimulus. 1 mark

b. Neurotransmitters are released by exocytosis (1) which diffuse across the synapse to the neurotransmitter receptors on the post-synaptic membrane OR dendrite OR effector cell (1). 2 marks

c. Proteins have specific functions within the cell (enzyme, membrane protein etc.) (1) and if these are not synthesised properly it may disrupt metabolism (enzymes) or movement (1). 2 marks

Total 6 marks

Question 44

a. **i.** A variety of ethylene concentrations were used OR many apples used per test. 1 mark

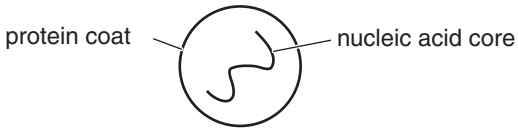
ii. Tasting only involved two apples OR tasting was open to opinion. 1 mark

iii. 150 ppm ethylene (1) at 20 degrees Celsius (1) (not 500 ppm ethylene as 150 provides the same result and so would be cheaper). 2 marks

Total 4 marks

Question 45

a. Protein coat with a nucleic acid core.



2 marks

b. Different nucleic acid codes for different amino acid sequences and hence proteins. This means the protein coats will be different (1). 1 mark

c. The percentage of mortality has decreased. 1 mark

d. **i.** A vaccine retains the antigen but through various methods, the nucleic acid core is removed OR changed. 1 mark

ii. Memory cells recognise antigens on the virus (1) and clone into plasma cells (1) that produce large quantities of antibodies (1). This leads to the eradication of the virus. 3 marks

Total 8 marks

Question 46

a. Components (protein) on transplanted cells or the blood within transplanted tissue that would be recognised by the recipients immune system as foreign. 1 mark

b. Person 2, as their blood type is the same and this is more important according to the information. 1 mark

c. There are only eight factors used to determine compatibility, so other antigens may exist in the transplanted tissue that were not accounted for when determining compatibility (1) thus there is a risk of rejection as the immune system will be stimulated to act against the other antigens (1).

2 marks

d. Since rejection involves an immune response against the transplanted organ, a measure to be taken would be to suppress the immune system by taking some kind of medication (1) that stops the immune system working OR give the person immunosuppressant medication. A substance found on the surface of red blood cells and other transplanted tissues that is capable of causing a human to produce antibodies. 1 mark

Total 5 marks

Question 47

a. **i.** **BbGg** 1 mark

ii. **BBgg** OR **Bbgg** 1 mark

b. Two solutions are possible from the breeder's stock of plants.

Solution 1:

Cross TtBb × TtBb (both parents loose-headed and produce substance B).

	TB	tB	Tb	tb
TB	TTBB	TtBB	TTBb	TtBb
tB	TtBB	<u>ttBB</u>	TtBb	<u>ttBb</u>
Tb	TTBb	TtBb	TTbb	Ttbb
tb	TtBb	<u>ttBb</u>	Ttbb	ttbb

Of the offspring, $\frac{3}{16}$ will have the desired characteristics (genotypes underlined).

3 marks
1 mark for correct cross
1 mark for correct Punnett grid
1 mark for highlighting ttBB and ttBb genotypes as $\frac{3}{16}$ of the offspring

Solution 2:

Cross TtBb (loose-headed, produces substance B) × ttbb (tight-headed, cannot produce substance B)

	TB	Tb	tB	tb
tb	TtBb	Ttbb	<u>ttBb</u>	ttbb

Of the offspring, $\frac{1}{4}$ will have the desired characteristics (genotype underlined).

3 marks
1 mark for correct cross
1 mark for correct Punnett grid
1 mark for highlighting ttBb as $\frac{1}{4}$ of the offspring

c. **i.** polyploid OR tetraploid

1 mark

ii. In the sterile hybrid, the 10 chromosomes inherited from *Brassica rapa* could not form homologous pairs with the eight chromosomes inherited from *Brassica nigra* so gametes could not form. In the fertile polyploid hybrid *B. juncea* the chromosomes are able to form homologous pairs in meiosis. (Chromosomes will segregate normally into gametes which have n = 18).

2 marks
1 mark for identifying why original hybrid was sterile
1 mark for identifying why brown mustard plants are fertile
Total 8 marks

Question 48

a. In the (nitrogenous) bases OR in adenine, thymine, guanine and cytosine.

1 mark

b. Each of the two strands of the original ^{15}N-DNA acts as a template strand in DNA replication. However, because only ^{14}N is available in the medium, new complementary strands are made of ^{14}N nucleotides. As such, all the first generation DNA will be 'hybrid' (^{14}N/^{15}N-DNA) with one ^{15}N parent strand being conserved in each new DNA molecule.

3 marks
1 mark for identifying that ^{15}N-DNA forms a template strand in DNA replication
1 mark for identifying complementary strands as ^{14}N
1 mark for identifying the first generation as a hybrid

c. The bar chart should show 25% of molecules are ^{14}N/^{15}N-DNA and 75% of molecules are ^{14}N-DNA.

1 mark

d. Graph 1 = molecule *A* only; Graph 2 = molecule *C* only; Graph 3 = molecules *B* and *C*.

2 marks
2 marks if all three correct
1 mark if only one error
otherwise 0 marks
Total 7 marks

Question 49

a. DNA is heated to about 70°C. This breaks the hydrogen bonds between nucleotides so that single-stranded DNA is produced (1). The single-stranded DNA is cooled – and with heat-tolerant enzymes and free nucleotides – new double-stranded DNA molecules are formed along each single strand. The process is repeated through cycles (1).

2 marks
1 mark for denaturing reaction
1 mark for polymerase reaction

b. **i.**

3' A C A T T A G T G T A A T C G A T T A C A C T A A T G T A A 5'
5' A C A T T A G 3'

1 mark

ii. The DNA probe will anneal backwards to the single strand because DNA is anti-parallel and the sequence is complementary to the GATTACA DNA probe.

1 mark

c. As DNA is an acid it is negatively charged in solution. This is the reason why it moves through the gel away from the negative electrode.

1 mark

d. Male 1 is the father as his band pattern has bands in common with both children whereas male 2 does not.

2 marks
1 mark for correct answer
1 mark for explanation
Total 7 marks

Question 50

a. ribosomes

1 mark

b. Enzymes such as RNA polymerase break the hydrogen bonds between complementary nucleotides. Single-stranded RNA (where U replaces T) nucleotides are placed on the template strand so that the mRNA is formed in the 5'–3' direction.
(RNA polymerase is the catalyst for this process).

2 marks
1 mark for breaking H bonds
1 mark for mRNA synthesis

c.

Normal DNA

DNA template	T T G A T G C A C
mRNA	A A C U A C G U G
amino acid	asn tyr val

Mutated DNA

one change	T T **T** A T G C A C
mRNA	A A **A** U A C G U G
amino acid	**lys** tyr val

Note: There are other changes that would give a correct answer but they could only be the first or second nucleotide.

2 marks
1 mark for identifying the pre-mutational amino acid sequence
1 mark for showing post-mutation amino acid sequence

d.

stop signal	T T G A T C A C
peptide	asn stop

Note: This nucleotide is the only one that could be deleted to code for a stop signal.

1 mark

e. The stop signal is more likely to cause more disruption. The single base change is likely to change one amino acid. However, the stop interrupted the protein's formation near the start of the polypeptide and so no more amino acids would be placed onto the growing amino acid chains.

*Note: The other mutation types may **or** may not code for a stop.*

2 marks
1 mark for correct answer
1 mark for explanation
Total 8 marks