H

JURONG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS
Higher 1

CANDIDATE NAME

CLASS

BIOLOGY

8875/01

Paper 1 Multiple Choice

15 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and class on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **20** printed pages and **2** blank pages.

[Turn over

1 An actively growing cell is supplied with radioactive amino acids.

Which cell component would first show an increase in radioactivity?

A Golgi body

B mitochondrion

C nucleus

D rough endoplasmic reticulum

2 When mucus is secreted from a goblet cell in the trachea, these events take place.

1 addition of carbohydrate to protein

2 fusion of the vesicle with the plasma membrane

3 secretion of a glycoprotein

4 separation of a vesicle from the Golgi body

What is the sequence in which these events take place?

A 1 → 4 → 2 → 3

B 1 → 4 → 3 → 2

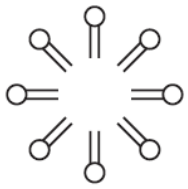
C 4 → 1 → 2 → 3

D 4 → 1 → 3 → 2

3 When a small quantity of phospholipid is added to a test tube of water and then shaken vigorously, an emulsion is formed by small droplets called liposomes.

Which diagram shows the arrangement of phospholipid molecules in a cross-section of a liposome? **ANSWER: C**

A



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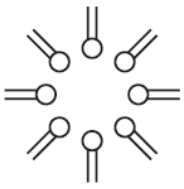

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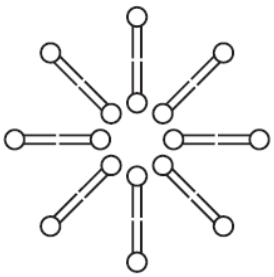

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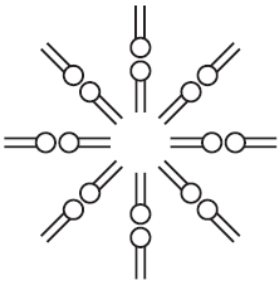
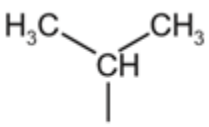
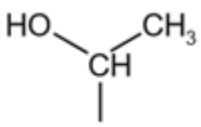


4 Threonylvaline is a dipeptide formed from the two amino acids, valine and threonine. A peptide bond forms between the amine group of valine and carboxyl group of threonine.

The side-chains (R groups) of the two amino acids are shown.



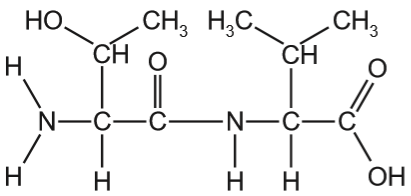
valine



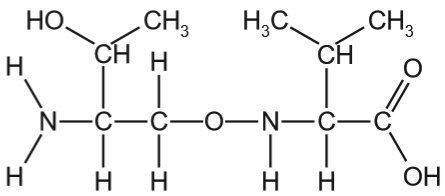
threonine

Which molecular structure is threonylvaline? **ANSWER: A**

A



B



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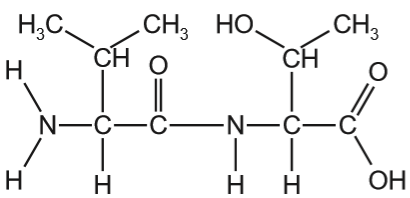

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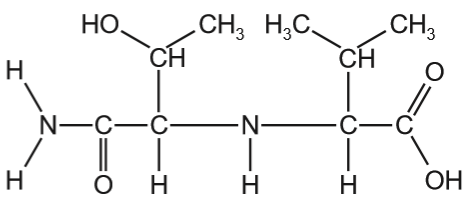


5 Which set of statements correctly describes haemoglobin?

	1	2	3	4
A	four polypeptide chains, each containing a haem group	iron ions can associate with oxygen forming oxyhaemoglobin	in each chain, hydrophobic R groups of amino acids point towards the centre of the molecule	at 50% saturation, two oxygen molecules are transported by the molecule
B	polypeptide chains interact to produce a globular chain	each chain contains a haem group of amino acids surrounding an iron ion	consists of two identical alpha chains and two identical beta chains	each chain can transport an oxygen molecule
C	polypeptide chains interact to produce an almost spherical molecule	an iron ion is present within each haem group	quaternary structure has two alpha chains and two beta chains	each molecule can transport a total of four oxygen atoms
D	polypeptide chains produce a loose helical shape, which folds to form a spherical molecule	iron ions in the molecule can bind reversibly with oxygen	in each chain, hydrophobic R groups of amino acids surround the iron ion	each molecule can transport a total of eight oxygen atoms

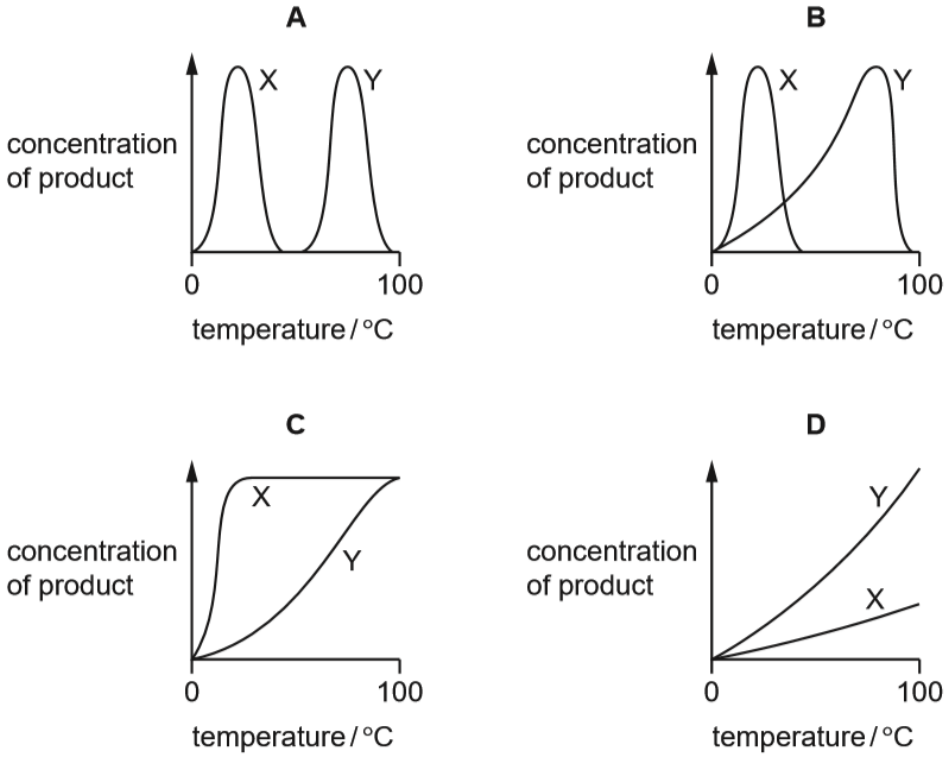
6 Two enzymes, X and Y, were used in an experiment.

Enzyme X was from bacteria that live in rivers and lakes at temperatures from 5°C to 20°C.

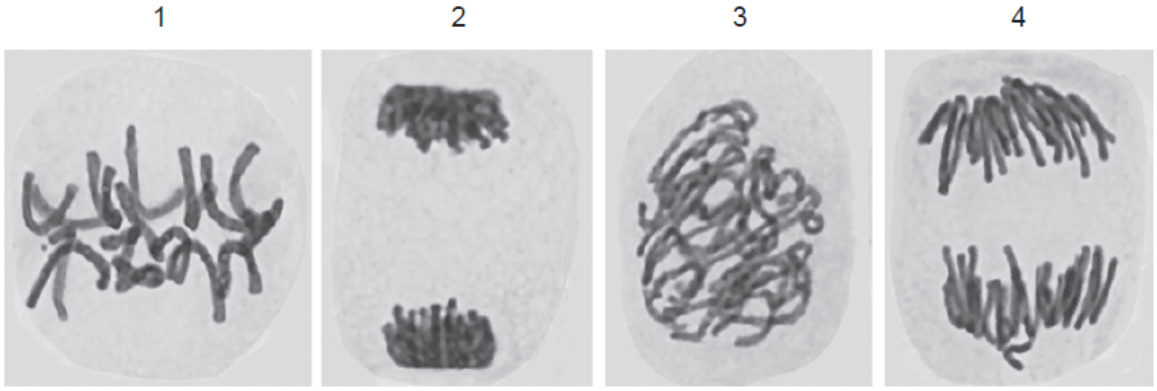
Enzyme Y was from bacteria that live in hot water springs at temperatures from 40°C to 85°C.

The experiment measured the concentration of product produced by each enzyme at temperatures between 0°C and 100°C after 5 minutes.

Which graph shows the results? **ANSWER: B**



7 The photomicrographs show cells in various stages of the cell cycle.



Which cells contain twice as many DNA molecules as a cell from the same organism after cytokinesis?

A 1, 2, 3 and 4

B 1, 2 and 4 only

C 1 and 3 only

D 2 and 4 only

8 Yeast cells without a *cdc25* gene cannot divide. This gene is active throughout the cell cycle, steadily building up the concentration of a protein, p80cdc25. This protein activates a kinase which regulates other proteins involved in cell division, but does not seem to affect other cell processes. When the p80cdc25 protein reaches a critical concentration, mitosis starts.

Which changes will be seen if p80cdc25 is produced at a faster rate than usual?

1 faster cell cycle

2 slower cell cycle

3 smaller cells

4 larger cells

A 1 and 3

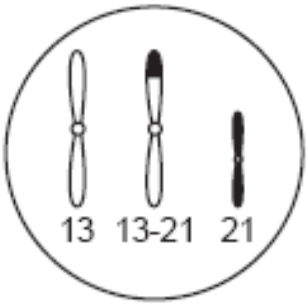
B 1 and 4

C 2 and 3

D 2 and 4

9 Down's syndrome can be caused by a trisomy of chromosome 21, but can also result from the translocation of chromosome 21 into chromosome 13, forming a single chromosome 13-21.

The diagram shows chromosomes 13 and 21 in the nucleus of a diploid (2n) testis cell from a phenotypically normal male carrier of a 13-21 translocation. This cell has a chromosome number of 45.



Which is not a likely outcome of fertilisation of normal oocytes by sperm from this male?

	chromosomes in sperm	embryo
A	13 and 21	2n = 46 normal phenotype
B	13-21	2n = 45 normal phenotype
C	13-21 and 21	2n = 46 Down's syndrome
D	13-21 and 21	2n = 47 Down's syndrome

10 Which row represents the correct features of the nitrogenous base guanine?

	has a single ring structure	is a purine	joins its complementary base by three hydrogen bonds
A	✗	✓	✓
B	✓	✗	✓
C	✓	✓	✓
D	✗	✗	✓

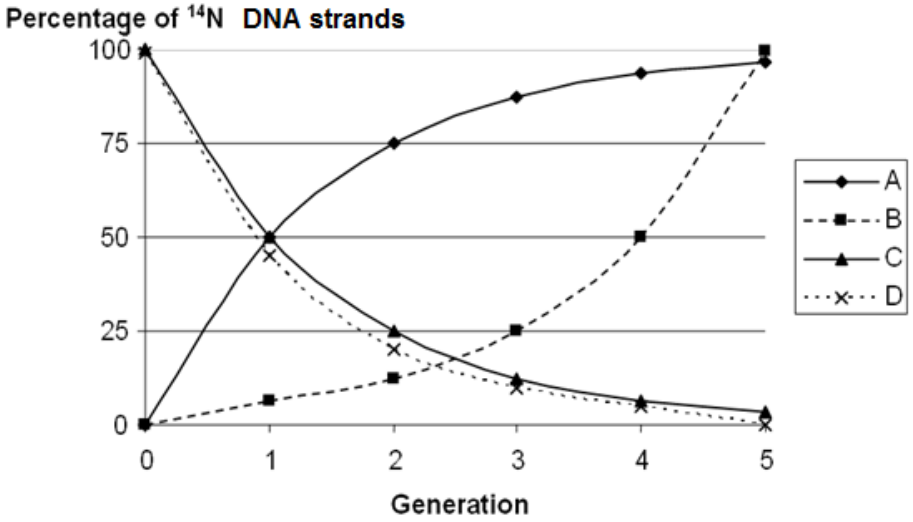
key

✓= true

✗ = false

11 Bacteria were cultured in a medium containing heavy nitrogen (^{15}N) until all DNA was labelled. These bacteria were then grown in a medium containing only normal nitrogen (^{14}N) for 5 generations. The percentage of ^{14}N DNA strands in each generation was estimated.

Which curve provides evidence that DNA replication is semi-conservative? **ANSWER: A**



12 An unidentified single-stranded molecule was described as having the following features:

- complementary base pairing along some of its length
- an area that can attach to a ribosome
- a site to which a specific amino acid attaches

What is the unidentified molecule?

A ribosomal RNA

B messenger RNA

C RNA polymerase

D transfer RNA

13 In order to synthesise a polypeptide, the DNA triplet code of the template (non-coding) strand of the DNA is transcribed to mRNA.

What correctly describes this process?

A mRNA is made from free bases complementary to those of the template strand of DNA.

B mRNA is made from free bases identical to those of the template strand of DNA.

C mRNA is made from free RNA nucleotides complementary to those of the template strand of DNA.

D mRNA is made from free RNA nucleotides identical to those of the template strand of DNA.

14 Some antibacterial drugs can affect the synthesis of proteins.

antimicrobial drug	rifampicin	streptomycin	tetracycline
mode of action	binds to RNA polymerase	genetic code misread during translation	prevents binding of tRNA to ribosome

Which is the correct set of immediate effects of these drugs?

antimicrobial drug	rifampicin	streptomycin	tetracycline
A	defective protein synthesised	mRNA does not bind to ribosome	amino acids not added to growing chain
B	mRNA not synthesised	defective protein synthesised	amino acids not added to growing chain
C	mRNA not synthesised	mRNA does not bind to ribosome	transcription prevented
D	transcription prevented	defective protein synthesised	mRNA does not bind to ribosome

15 The table shows the DNA triplet codes for some amino acids from the strand complementary to mRNA.

amino acid	DNA triplet codes
glycine	CCA, CCG, CCT, CCC
leucine	AAT, AAC, GAA, GAG, GAT, GAC
lysine	TTT, TTC
methionine	TAC
proline	GGA, GGG, GGT, GGC
threonine	TGA, TGG, TGT, TGC

The sequence of DNA triplets from the strand complementary to mRNA for part of a gene is shown.

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

Which mutated DNA sequence of this part of a gene would result in the same amino acid sequence as the original gene sequence?

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

B … T A C T T C G A T G G C C C T G A G G G C T A C T G T …

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

D … T A C T T T A A T G G C C C T G A G G G C T T C T G T …

16 The feather colour of a certain breed of chicken is controlled by codominant alleles. A cross between a homozygous black-feathered chicken and a homozygous white-feathered chicken produces all speckled chickens.

What phenotypic ratios would be expected from a cross between two speckled chickens?

A all speckled

B 1 black feathers : 1 white feathers

C speckled, black feathers and white feathers in equal numbers

D 1 black feathers : 2 speckled feathers : 1 white feathers

17 The presence of freckles is a characteristic controlled by a dominant gene. Two parents who are heterozygous for the characteristic have three children, all of whom have freckles.

Which statement is true if they have a fourth child?

A There is a 100% chance that their next child will have freckles.

B There is a 75% chance that their next child will have freckles.

C There is a 50% chance that their next child will have freckles.

D The next child will have no freckles as the ratio is 3 with freckles to 1 without freckles.

18 Isolated chloroplasts, suspended in buffer solution, are often used to study the light dependent stage of photosynthesis.

During this stage, electrons (e^-) are transferred by carriers and provide energy so that a proton (H^+) gradient can be formed. Protons diffuse through membrane proteins that are linked to synthase enzymes.

Three compounds that can be added to isolated chloroplasts are:

1 DCMU, which inactivates a carrier that accepts electrons from photosystem II

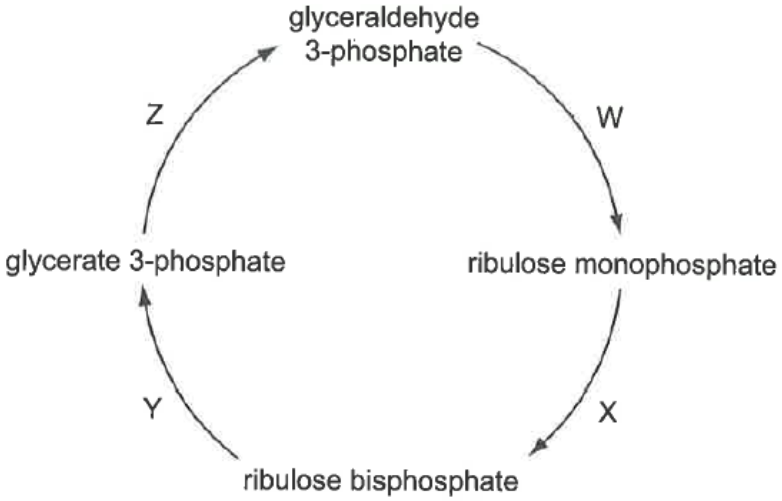
2 DCPIP, which can act as a final electron acceptor

3 ammonium hydroxide solution, which absorbs protons

Which compounds, when added separately to isolated chloroplasts, would allow the light dependent stage of photosynthesis to occur and which would inhibit it?

	allow	inhibit
A	1	2 and 3
B	1 and 3	2
C	2	1 and 3
D	2 and 3	1

19 The diagram shows the main stages in the Calvin cycle.

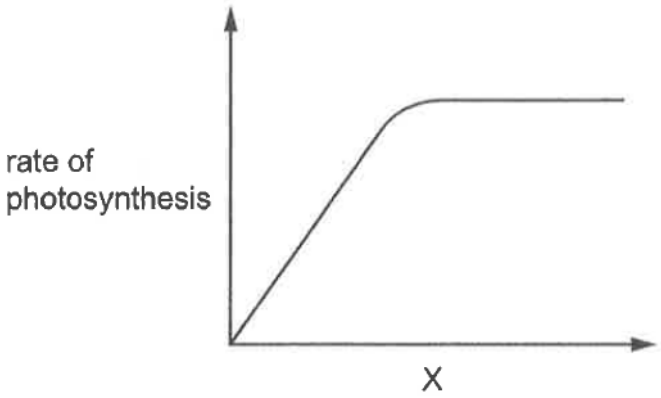


At which stages are ATP and reduced NADP used and carbon dioxide taken up?

	ATP used	reduced NADP used	carbon dioxide taken up
A	W and Z	X	Y
B	X	W and Y	Z
C	Y	X and Z	W
D	X and Z	Z	Y

20 The rate of photosynthesis in pondweed was measured when one variable was changed and all others were standardised.

The graph shows the rate of photosynthesis at different values of a variable, X.



Which variables could be represented by X?

1 carbon dioxide availability

2 light intensity

3 oxygen availability

4 temperature

5 leaf area exposed to direct light

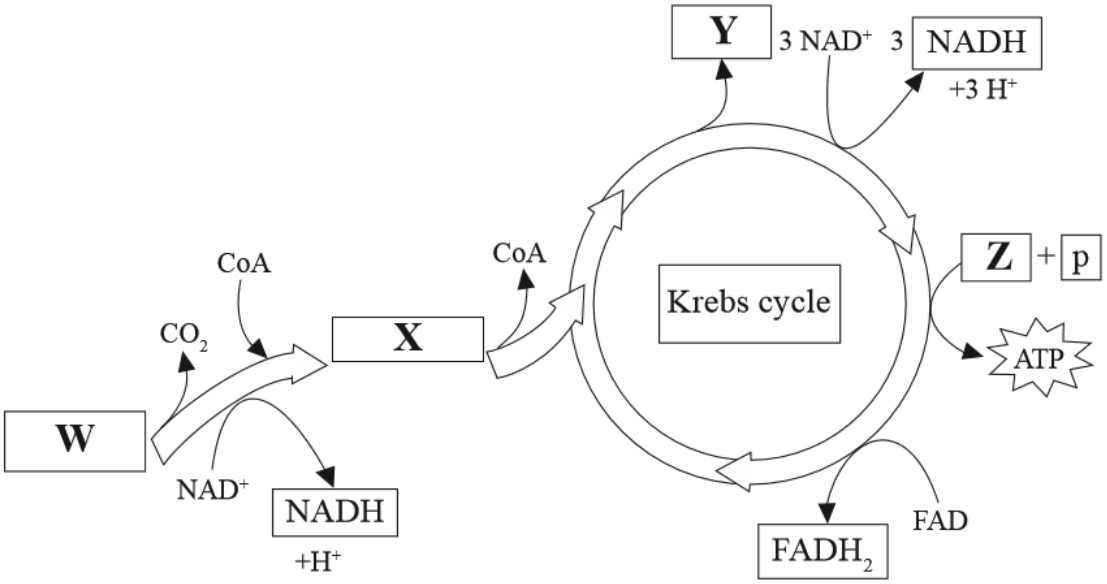
A 1, 2 and 5

B 1 and 2 only

C 2, 4 and 5

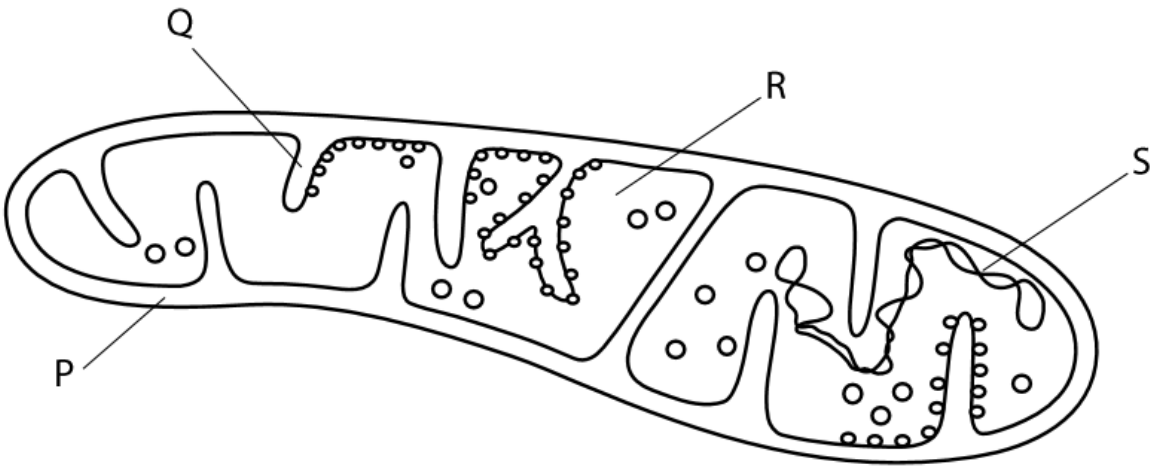
D 3 and 4

21 The diagram below shows the link reaction and stages of the Krebs cycle. Which molecules are represented by the letters W, X, Y and Z?



	W	X	Y	Z
A	acetyl CoA	carbon dioxide	ADP	pyruvate
B	pyruvate	acetyl CoA	carbon dioxide	ADP
C	ADP	carbon dioxide	acetyl CoA	pyruvate
D	acetyl CoA	pyruvate	carbon dioxide	ADP

22 Aerobic respiration is a series of reactions that occur in the cytoplasm and mitochondria of animal and plant cells. The diagram shows a mitochondrion.

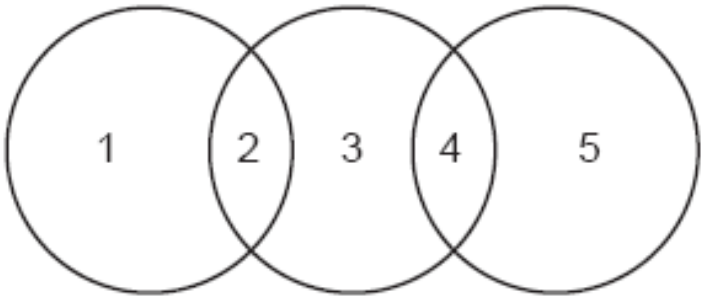


Which row shows where each process takes place in a mitochondrion?

	diffusion of hydrogen ions	production of reduced NAD
A	P	Q
B	Q	R
C	R	S
D	S	P

23 The diagram shows the relationship between different polysaccharides and the glycosidic bonds formed between the monomers.

Which row is correct?



	1	2	3	4	5
A	amylopectin	α-1,6	cellulose	β-1,4	glycogen
B	amylose	α-1,4	glycogen	β-1,4	amylopectin
C	cellulose	β-1,4	amylose	α-1,4	glycogen
D	glycogen	α-1,6	amylopectin	α-1,4	amylose

24 Which roles of the cell surface membrane are a result of the properties of the phospholipids?

1 to allow cytokinesis to occur in mitotic cell division

2 to allow entry and exit of oxygen and carbon dioxide

3 to allow the phagocytosis of a bacterium into a cell

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

25 Which statements are acceptable parts of Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.

2 In competition for survival, the more aggressive animals are more likely to survive.

3 Species perfectly adapted to a stable environment will continue to evolve.

4 Variation between individuals of a species is essential for evolutionary change.

A 1, 2 and 4

B 2 and 3

C 3 and 4

D 4 only

26 Myxomatosis is a viral disease of rabbits. It spreads rapidly and most rabbits die within 14 days of being infected. Myxomatosis has been deliberately used to reduce the number of rabbits in countries where they are a significant crop pest.

The initial release of the virus caused populations of rabbits to fall by 90%. Resistance to myxomatosis increased in the 70 years following initial release, so at the present time up to 50% of infected rabbits are able to survive.

Which statement could explain the increasing frequency of resistance to myxomatosis in the years following release?

A During disease outbreaks there is greater food availability for the remaining rabbits, increasing the probability that infected rabbits will survive and breed.

B In populations with high incidences of myxomatosis, mutations leading to resistance are more likely to occur.

C Rabbits with genotypes that increase resistance to the disease are more likely to survive disease outbreaks and pass on their genes to the next generation.

D Since rabbits breed very rapidly, in between outbreaks of the disease the frequency of alleles for resistance to myxomatosis quickly increases.

27 Some comparisons of mRNA with DNA from a eukaryote are listed.

1 A body cell has two copies of DNA coding for a particular protein but it can have thousands of copies of mRNA coding for the same protein.

2 Each DNA molecule in human cells codes for hundreds of proteins, but each mRNA molecule codes for the translation of only one protein.

3 mRNA contains the base uracil, but DNA has thymine instead.

4 mRNA is single-stranded but DNA is double-stranded.

5 Unlike DNA, mRNA has no introns.

Which are reasons why mRNA is the preferred starting point for genetically engineering bacteria to produce human proteins?

A 1, 2 and 3

B 1, 2 and 5

C 2, 3 and 4

D 3, 4 and 5

28 Which uses of the information from the human genome project are generally considered to be unethical?

1 an insurance company only giving cheap rates to people with genetic predispositions to fewer diseases

2 genetic archaeologists identifying the earliest forms of genes to show evolutionary relationships

3 cytologists developing tests for only some defective genes

4 doctors only giving specific drugs to block the actions of faulty genes to carriers of those genes

5 genetic councillors giving specific lifestyle information only to people genetically predisposed to risks

6 parents choosing embryos for implantation only after ante-natal tests for acceptable genes

A 1 and 3

B 1 and 6

C 2 and 5

D 3 and 4

29 A gene for an insecticidal toxin was introduced into crop plants via genetic engineering. The toxin causes death to only a specific type of insect.

What is not likely to be affected by this genetic engineering?

A ratio of population size between different insect species within the region

B growth of other crop plants within the region

C use of insecticides in the area of crop growth

D the number of insects resistant to the toxin

30 Blood transfusion laboratories around the world are hoping to produce large numbers of red blood cells (RBCs) from unused human embryos produced during *in vitro* fertilisation procedures.

Embryonic stem cells are removed from an embryo and cultured in a growth medium that stimulates their differentiation into RBCs.

Which statement correctly describes this differentiation?

A Multipotent stem cells differentiate into pluripotent blood stem cells and then into RBCs.

B Pluripotent stem cells differentiate into multipotent blood stem cells and then into RBCs.

C Totipotent stem cells differentiate into multipotent blood stem cells and then into RBCs.

D Totipotent stem cells differentiate into pluripotent blood stem cells and then into RBCs.

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JURONG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS
Higher 1

CANDIDATE NAME

CLASS

BIOLOGY 8875/02

Paper 2 Structured Questions **25 August 2017**

Additional Materials: Answer Paper **2 hours**

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
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.

Section A
Answer **all** the questions.

Section B
Answer **one** question.
Circle the question number of the question attempted.

The use of an approved scientific calculator is expected, where appropriate.
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	
1	
2	
3	
4	
Section B	
5 / 6	
Total	

This document consists of **15** printed pages.

[Turn over

Section A

Answer **all** the questions in this section.

1 White blood cells such as dendritic cells synthesise intracellular enzymes.

Fig. 1.1 is a summary diagram of events that occur in a dendritic cell.

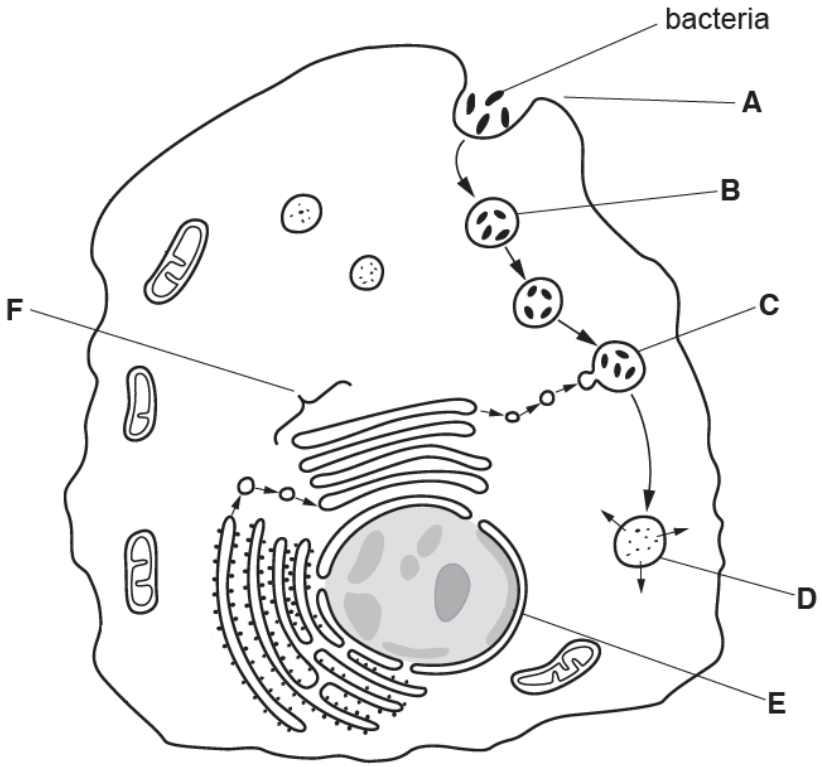


Fig. 1.1

(a) (i) Name the process at A. [1]

1. **phagocytosis / endocytosis;;**
R pinocytosis I engulfing

(ii) Name structures B, E and F. [3]

B: phagocytic / endocytic vacuole / phagosome;;
A vesicle
R incorrectly qualified vacuole or vesicle (e.g. large / secretory / Golgi / excretory)
(Ignore) food / pathogenic

E: (outer) nuclear envelope;;

F: Golgi body;;

(b) Describe what happens to the bacteria between C and D. [2]

1. **the bacteria are destroyed / digested / broken down / hydrolysed;;**
2. **(by lysosomes containing) hydrolytic enzymes, e.g. carbohydrase, lysozymes, proteases, nucleases, lipases *(any one)*;;**
3. **catalysed the breakage of glycosidic bond, peptide, ester, phosphodiester bond, ester bond in peptidoglycan, polysaccharide(s), polypeptides, nucleic acids, lipids;; *(bond broken must match substrate) (any one)***

(Ignore) fusion of lysosomes with phagosome and diffusion of products of digestion

(c) The gene coding for transcription factor in dendritic cells is known as *Batf3*. The transcription factor is essential for the development of dendritic cells.

(i) Explain what is meant by a *gene*. [1]

1. **a specific sequence of nucleotides in the DNA which codes for a polypeptide;;**

A protein for polypeptide / information to produce a polypeptide /codes for sequence of amino acids / primary structure (of a, polypeptide / protein)
R genetic code for a polypeptide

(ii) There are a number of known mutations for *Batf3*.

Outline how a mutation in *Batf3* can lead to the formation of an altered polypeptide where one amino acid is replaced by a different amino acid. [3]

1. **Results in changes in the sequence of DNA nucleotides in the gene;;**
2. **This includes base-pair substitution / replacement of one nucleotide base pair with another base pair in a gene;;**
3. **result in a change in the <u>codon</u> in the <u>mRNA</u>;;**
4. **new amino acid coded for may have different property due to different R groups and result in a change in polypeptide sequence /primary structure;;**

[Total: 10]

2 Fig. 2.1 shows some stages in mammalian respiration.

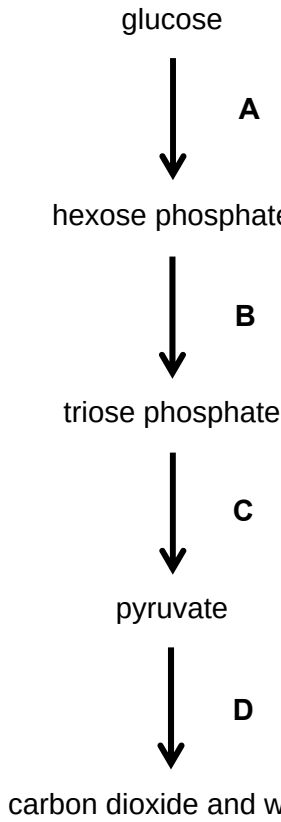


Fig. 2.1

(a) Name the processes taking place during Stage D and state precisely where they occur. [3]

1. **Link reaction – mitochondrial matrix;;**
2. **Krebs cycle – mitochondrial matrix;;**
3. **Oxidative phosphorylation – inner mitochondrial membrane;;**

(b) Intermediates produced at the end of Stages B and C are important in the conversion of carbohydrates to lipids such as triglycerides. Some of the triose phosphate can be converted into glycerol-3-phosphate, while pyruvate can undergo further reactions to form intermediates required for the synthesis of fatty acids.

Describe the formation of triglycerides. [3]

1. **A triglyceride is formed by condensation reactions between <u>1 glycerol and 3 fatty acids</u>;;**
2. **Each of <u>glycerol's hydroxyl/–OH groups</u> condenses with the <u>carboxyl/ –COOH group of a fatty acid</u>;;**
3. **In each <u>condensation reaction</u>, one <u>water molecule is removed</u>, resulting in the formation of an <u>ester bond/linkage</u>;;**

(c) The first reaction in Stage A is catalysed by the enzyme hexokinase. It has been observed that hexokinase is bound to the outer mitochondrial membrane in muscle cells which undergo high rates of glycolysis.

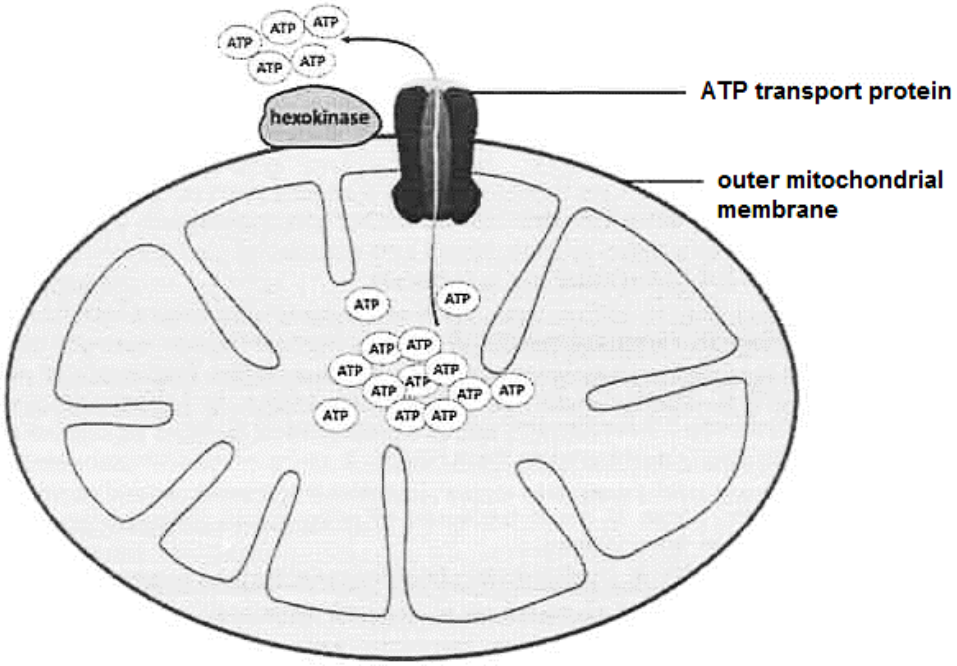


Fig. 2.2

With reference to the role of mitochondria and Fig. 2.2, suggest how the association of hexokinase with mitochondria can lead to high rates of glycolysis. [2]

1. **Mitochondria are the site of aerobic respiration to synthesise ATP;;**
2. **Due to the <u>close proximity</u> of hexokinase to the mitochondria *(mark for idea)*, <u>ATP produced</u> by the mitochondria <u>can easily be used</u> by hexokinase <u>to phosphorylate glucose</u>;; increasing the rate of glycolysis.**

(d) Fig. 2.3 shows an electron micrograph of a mitochondrion.

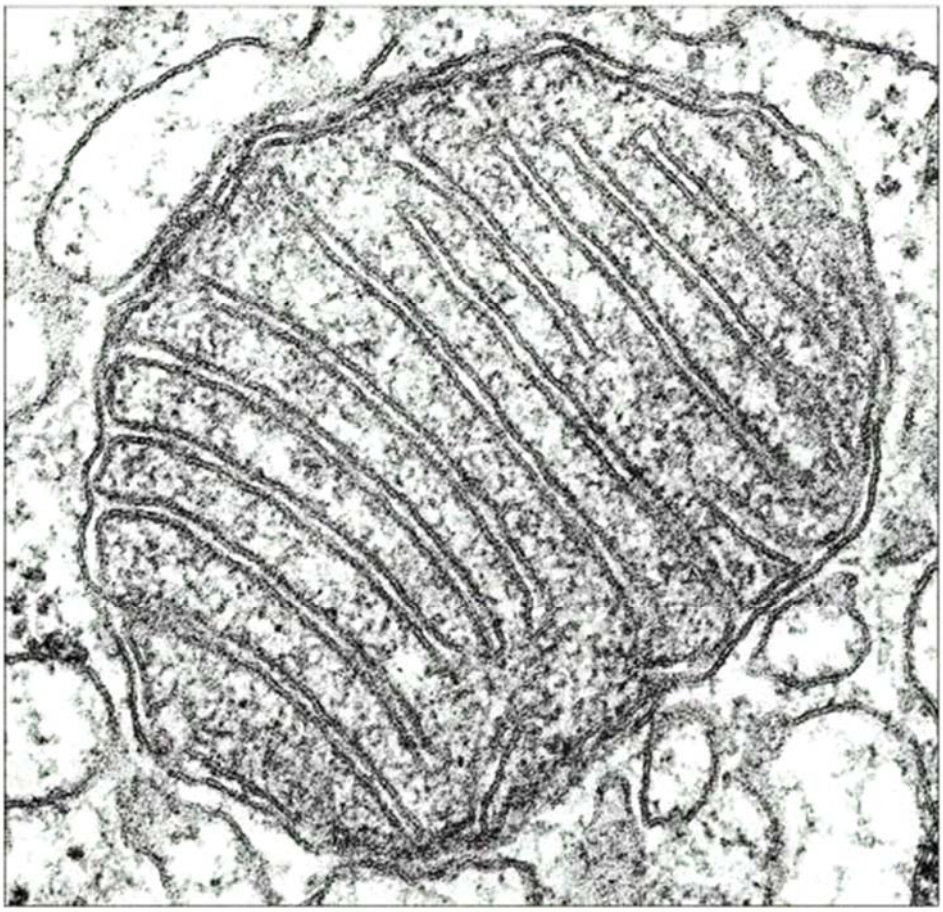


Fig. 2.3

With reference to features visible in Fig. 2.3, outline how the structure of the mitochondrion is adapted for its function. [1]

1. **The inner mitochondrial membrane is <u>highly folded</u>, providing <u>a large surface area</u> where stalked particles, enzymes and electron carriers of the electron transport chain (ETC) *(any 1 e.g.)* needed for <u>aerobic respiration</u> can be located;;**
2. **The mitochondrion is enclosed by <u>double membranes</u> separated by (an extremely narrow fluid-filled space) intermembrane <u>space</u>, allowing for <u>compartmentalisation</u> within the mitochondrion / specialised metabolic pathways to take place in different areas;;**

(e) Phosphatidylcholine (a phospholipid) is present in membranes such as those of the mitochondrion. The molecular structures of tristearin (a triglyceride) and phosphatidylcholine are shown in Fig. 2.4.

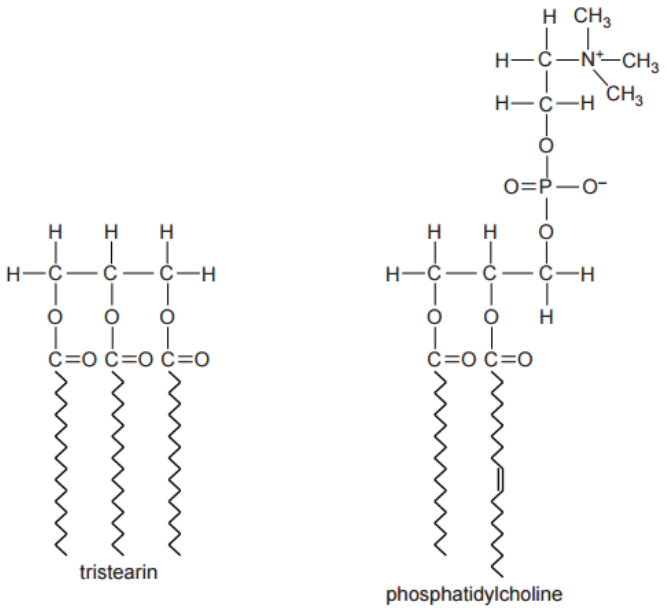


Fig. 2.4

State two structural differences between tristearin and phosphatidylcholine, other than in numbers of the different types of atoms. [2]

structural feature	triglyceride	phospholipid
phosphate (group) / contains phosphorus	×	✓
nitrogen	×	✓
charged / polar	×	✓
(number of) fatty acids	3	2
number of ester bonds	3	2
number of phosphate ester bonds	0	1
award one mark for any of the following comparisons		
number of double bonds (in hydrocarbon chain)	0	1
number of saturated fatty acids / ORA	3	1
presence of double bonds	×	✓
presence of unsaturated fatty acids	×	✓

These are alternatives – award one mark only

[Total: 11]

3 A type of pheasant occurs in a range of colours, especially when bred in captivity. It may, for example, have green or purple plumage as seen in Fig. 3.1.

Fig. 3.1

Sometimes when a green male is crossed with a green female all the offspring, male and female, are green. However, sometimes a green male crossed with a green female results in offspring in which the majority of the offspring are green, but in which some of the females are purple, as shown in Table 3.1.

Table 3.1

phenotype	number of offspring
green male	7
green female	3
purple female	4

Plumage colour in pheasants is sex-linked.

In birds, the sex chromosomes are referred to as W and Z, rather than Y and X as in mammals. The W chromosome has no genes that affect plumage colour. The heterogametic sex is the female, **not** the male. Thus the male has two Z chromosomes (ZZ) and the female has one W and one Z chromosome (WZ).

(a) Use a genetic diagram to explain the results in Table 3.1. [3]

Parental phenotypes:	**green male**	**x**	**green female**		
Parental genotypes:	**Z^GZ^g**	**x**	**WZ^G**		**;;**
Gametes	**Z^G**	**Z^g**	**W**	**Z^G**	**;;**

Punnett Square

	Z^G	Z^g
W	**WZ^G**	**WZ^g**
Z^G	**Z^GZ^G**	**Z^GZ^g**

Offspring genotype :	**Z^GZ^G Z^GZ^g**	**:**	**WZ^G**	**:**	**WZ^g**	**;**
Offspring phenotype :	**green male**	**:**	**green female**	**:**	**purple female**	**;**
Offspring phenotypic ratio:	**2**	**:**	**1**	**:**	**1**	

(b) Using the same symbols as in **(a)**, indicate the genotypes of the parents which could give rise to purple male offspring. [1]

1. $Z^GZ^g \times WZ^g$;;
OR
2. $Z^gZ^g \times WZ^g$;;

(c) Using the information provided, state which allele for plumage colour is dominant and explain your answer. [2]

1. *dominant allele –*
allele coding for green feather (**carried on the Z chromosome);;**

2. *explanation –*
Heterozygote male appeared green, thus showing the gene product of the allele coding for green feather masked the effect of the gene product expressed by the allele coding for purple feather;;

(d) Describe how you would determine the unknown genotype of a green male. [2]

1. Carry out a test cross by breeding with a purple female;;
2. If all the offspring have green plumage then the male must be homozygous dominant;;
OR
3. If some of the offspring have purple plumage then the male must be heterozygous;;

[Total: 8]

4 Human growth hormone (hGH) is a peptide hormone that is important for human development. Recombinant hGH can be synthesised via genetic engineering with the use of plasmids.

(a) (i) State the type of organism that contains plasmids. [1]

1. **Bacterium/prokaryotes;;**

(ii) Describe one feature of plasmids that make them suitable to be used for genetic engineering. [2]

1. **contain an <u>origin of replication</u>;;**
2. **so that the vector and the inserted gene of interest can <u>replicate independently of the bacteria chromosome</u> to produce <u>multiple copies</u> within the host cell;;**
   OR
3. **contain <u>genetic/selectable markers</u>;;**
4. **e.g. antibiotic resistant genes that confer resistance of the host cell to antibiotics / lacZ gene coding for β-galactosidase which <u>enable selection</u>;;**
   OR
5. **possess <u>restriction sites</u>;;**
6. **which can be recognised, bound and cut by restriction enzymes for insertion of gene of interest;;**

The polymerase chain reaction (PCR) can be used to amplify the gene coding for hGH before genetic engineering is carried out.

(b) Describe what occurs during the first two stages in PCR.

(i) Stage 1 [2]

1. **Denaturation by heating to 95ºC;; (A) 90-100ºC**
2. **Hydrogen bonds between (complementary bases of) double-stranded DNA break, separating the double-stranded DNA into single-stranded DNA;;**

(ii) Stage 2 [2]

1. **Annealing of DNA primers by cooling to 65ºC;; (A) 30-65ºC**
2. **Primers base pair via complementary base pairing with (complementary sequences at the) <u>3' end</u> of the <u>single-stranded DNA</u>;;**

(c) Outline how a recombinant plasmid can be produced for genetic engineering after the gene coding for hGH was isolated from human cells and amplified using PCR. [3]

1. **<u>Same restriction enzyme</u> was used to recognise, bind and cut the gene coding for hGH and plasmid;;**
2. **to produce restriction fragments with <u>complementary sticky ends</u> that would <u>anneal/complementary base pair via hydrogen bond formation</u>;;**
3. **<u>DNA ligase</u> would then <u>seal the nicks</u> between fragments by formation of <u>phosphodiester bonds between adjacent nucleotides</u>, forming a <u>recombinant plasmid</u>;;**

(d) With the advancement in technology, plasmid-free bacteria cells have been constructed for the production of hGH with the gene coding for hGH inserted directly into the host chromosome instead of using plasmid.

Suggest how this new method is an improvement over the previous method. [1]

1. **No need for antibiotic selection / lower costs as no antibiotics needed/no need to remove the antibiotics used for selection;;**
2. **Less metabolic burden on host strain;;**
3. **Genes are more stable;;**

[Total: 11]

Section B

Answer **one** question.

Write your answers on the separate answer paper provided.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

4 Early ancestors of today's horses were browsers. Their teeth were adapted for eating woody shrubs and trees. In the early Miocene (23 million years ago), the first groups adapted for grazing emerged. Modern horses are grazers, with teeth adapted for grinding tougher, grassy materials.

The foot structure evolved from four separate toes to three, then to only one that touched the ground with two smaller side toes higher than the ground. In more modern horses, the two side bones are fused together. Modern horses are of much greater size than their ancestors.

(a) Describe the causes of variation in horses. [6]

Causes of variation

1. **Gene mutations and chromosomal aberrations;;**

OR

2. **Gene mutations + one example e.g. base pair substitution / insertion / deletion;;**
3. **Chromosomal aberrations + one example e.g. duplication / translocation;;**
4. **Independent assortment and segregation of chromosomes in meiosis;;**

OR

5. **Independent assortment and segregation of homologous chromosomes during metaphase I and anaphase I, respectively;;**
6. **Independent assortment and segregation of chromatids during metaphase II and anaphase II, respectively;;**
7. **Crossing over between non-sister chromatids of homologous chromosomes during prophase I in meiosis I;;**
8. **Give new combination of alleles;;**
9. **Random fusion of gametes during sexual reproduction;;**

(b) Explain how natural selection could lead to evolution of modern horses with distinct phenotypic differences. [6]

1. **Spontaneous mutation results in genetic variation in horses within a population;;**
2. **There were phenotypic variation / difference in characteristics in the populations in each habitat e.g. teeth / foot structure;;**
3. **The horses were exposed to different environments in each habitat and were subjected to different selection pressures;;**
4. **Examples of phenotypic variation e.g. teeth / foot structure OR different selection pressures e.g. type of foot and ground type / habitat;;**
5. **Since there was variation within the populations, individuals who are better adapted to the environment / with favourable characteristics will be at a selective advantage;;**
6. **These individuals will survive to maturity, reproduce and pass down their favourable alleles to their offspring;;**
7. **With each succeeding generation, the proportion of individuals having the favourable characteristics increases while the proportion of individuals lacking the characteristics decreases;;**
8. **Over time / successive generations, there is a change in allele frequency in the populations, leading to evolution and thus distinct phenotypic differences between the populations of horses;;**
9. **Diverse forms of horses have thus arisen by descent with modifications from ancestral species by accumulation of modifications as the population of horses adapt to the new environment;;**

(c) Explain, with examples, what is meant by anatomical and molecular homologies in horses. [8]

1. **Diverse forms of horses have thus arisen by descent with modifications from ancestral species by accumulation of modifications as the population of horses adapt to the new environment;;**
   OR
2. **Homologies show "descent with modification + Comparisons of homologies between species show how an ancestral homology in a population may have been modified in descendent species through natural selection and changes in allele frequency;;**
3. **Homology is similarity in characteristics resulting from common ancestry;;**
4. **and developed as a result of natural selection and changes in allele frequency;;**
5. **Homologies suggest common ancestry + Similarity in anatomical / molecular homology between species suggests that they are descended from a common ancestor which had a basic form of the structure / homologous genes;;**
6. **Species with common ancestors should display underlying similarities even in features that no longer match in function;;**
7. **Species with a higher level of similarity diverged from a common ancestor more recently (than species with a lower level of similarity) and thus are more closely related;;**

8. **Organisms with anatomical homologies have physical structures that are derived from a common ancestor;;**
9. **E.g. teeth, foot structure in horses, with different forms in different species;;**
10. **Organisms with molecular homology have similar DNA nucleotide / amino acid sequences of homologous genes that are derived from a common ancestor;;**
11. **Examples of homologous genes in different horses are the haemoglobin genes and the cytochrome oxidase genes which are derived from a common ancestor;;**

Pt 8-11 are required.

12. **Homologies provide the basis of comparison + Comparison of molecular homologies between species by comparing homologous DNA nucleotides/amino acid sequence OR Comparison of homologous traits/structures/teeth/foot structure between species (as they are derived from a common ancestor) shows the modification process from a basic ancestral form;;**

[Total: 20]

5 Invertase, a major enzyme present in plant tissues such as the developing roots of carrots, catalyses the hydrolysis of sucrose (a non-reducing sugar) to fructose and glucose (reducing sugars).

A scientist carried out an investigation into the effect of pH on the activity of invertase in carrots, by recording the time taken for the reducing sugars to change the colour of pink potassium manganite (VII) solution to a colourless end point. From the results obtained, the scientist concluded that the optimum pH of invertase was pH 5.0.

After additional analyses, the scientist also found that the invertase is:

- made up of several subunits
- synthesised with a signal peptide required for entry into the rough endoplasmic reticulum and thus into the secretory pathway
- glycosylated and bound to the cell wall

(a) Describe how invertase can be synthesised from mRNA. [8]

<u>Amino acid activation</u> [max 1m]

1. **A specific amino acid is joined to the 3' end of a tRNA, forming an amino acyl-tRNA, reaction catalysed by a specific aminoacyl-tRNA synthetase;;**
2. **The amino acid that the tRNA attaches to is determined by the specific anticodon of the tRNA (which is complementary to the mRNA codon);;**

<u>Initiation</u>

3. **A small ribosomal subunit recognises and binds to the 5' end of the mRNA and travels along the mRNA until it reaches the first AUG codon that serves as the start codon;;**
4. **An initiator tRNA carrying the amino acid methionine (Met), with anticodon UAC, binds to the start codon AUG on the mRNA (via complementary base pairing);;**
5. **The union of mRNA, initiator tRNA and a small ribosomal subunit is followed by the attachment of large ribosomal subunit, completing a translation initiation complex;;**
6. **Initiation factors and GTP are required to bring all these components together;;**
7. **At the completion of the initiation process, the initiator tRNA fits into the P site of the large ribosomal subunit and the vacant A site is ready for the next aminoacyl tRNA;;**

Elongation

8. **The anticodon of the next incoming aminoacyl-tRNA, carrying its specific amino acid, undergoes complementary base pairing and forms hydrogen bonds with the mRNA codon in the A site of the ribosome;;**
9. **A peptide bond is formed between the amino end of the amino acid in the A site and the carboxyl end of the growing chain in the P site, catalysed by peptidyl transferase;;**
10. **After the peptide bond has been formed, the ribosome translocates one codon downstream along the mRNA in a 5' to 3' direction;;**
11. **This moves the tRNA, carrying the growing polypeptide in the A site, to the P site and the tRNA in the P site now moves to the E site and leaves the ribosome and A site is free to receive the next aminoacyl-tRNA;;**

Termination

12. **Elongation continues until a stop codon, UAA, UAG or UGA reaches the A site of the ribosome;;**
13. **A protein release factor recognises and binds to the stop codon on the mRNA, causes the addition of a water molecule to the polypeptide chain;;**
14. **This reaction hydrolyses the completed polypeptide from the tRNA that is in the P site, freeing the polypeptide from the ribosome;;**
15. **remainder of translational complex then comes apart / are disassembled;;**

(pt 3-15: must have at least 1 pt from each stage of translation for full credit)

Extra points

16. **(Each) polypeptide chain/subunit may undergo folding into a specific shape due to formation of hydrophobic interactions, disulfide bonds, ionic bonds and hydrogen bonds between (R groups of) amino acids;;**
17. **and aggregate with other polypeptide chains/subunits to form a functional protein, invertase;;**

(b) Outline structural features and roles of the rough endoplasmic reticulum. [4]

Structure of rER

1. **consists of a network of sheets (called cisternae);;**
2. **ribosomes are present / bound / attached to the membrane of the rough ER;;**

Roles of rER

3. **Site of protein/invertase synthesis – (the polypeptides of) invertase are synthesised by ribosomes attached to the rough ER;;**

4. **Biochemical/Chemical modification – the polypeptides/invertase is transported through the pore in the ER membrane into the ER lumen, where carbohydrate chains are added to them – glycosylation;;**

5. **Intracellular transport – the rough ER forms part of the intracellular transport system which transports the synthesised/modified (polypeptides of) invertase to other compartments within the cell by transport vesicles budding off from the ER membrane;;**

(c) Describe the investigation carried out by the scientist to examine the effect of pH on the activity of invertase in carrots. [8]

Variables

1. **The independent variable of the experiment would be pH;;**
2. **The dependent variable would be the rate of reaction, measured by the time taken for the reducing sugars to change the colour of pink potassium manganite (VII) solution to a colourless end point;;**

Variables to be kept constant [max 2m]

3. **Volume and concentration of invertase**
   ***Carrot discs/cubes of identical sizes were cut from a single carrot and 5 discs/slices were added to a boiling tube*;;**
   OR
   ***Invertase is obtained by blending a single carrot to obtain a homogenous liquid carrot solution to ensure that the concentration of invertase is constant throughout the solution. 5 cm^3 of invertase solution was placed in the boiling tube*;;**

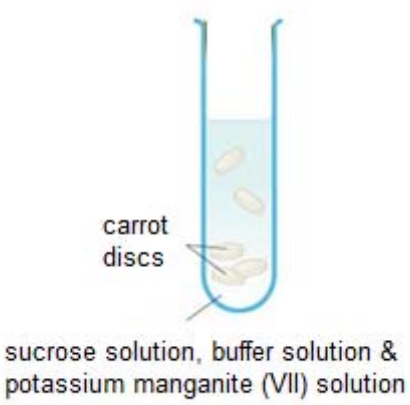
4. **Volume and concentration of sucrose solution**
   ***Equal volumes of sucrose solution (of a fixed concentration) to be placed in the boiling tube, e.g. 5 cm^3 of (10.0%) sucrose solution was placed in the boiling tube*;;**

5. **Temperature – enzyme activity is affected by temperature**
   Temperature of experiment must be kept constant at 35^oC by placing boiling tubes in a thermostatically controlled water bath;;
   OR
   ***The experiment was carried out at room temperature of 26^oC, which is assumed to remain constant throughout the experiment*;;**

(pt 3-5: award 1m for stating 2 variables to keep constant; 1m for describing how variables are to be kept constant)

Procedure

6. **Set up the apparatus as shown (fully labelled diagram);;**



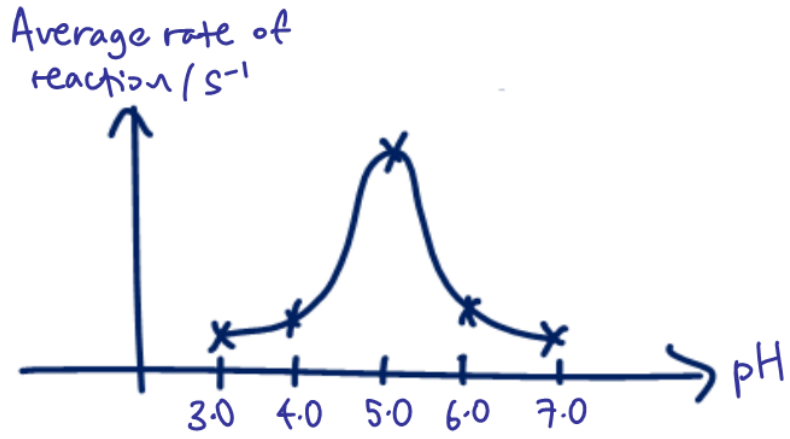
OR

7. **Add 5 carrot discs/cubes containing invertase / Add (5 cm^3 of) invertase solution to the boiling tube containing (5 cm^3 of) sucrose solution, (5 cm^3 of) potassium manganite (VII) solution and (5 cm^3 of) pH 3.0 buffer solution;;**
8. **The buffer solution helps to keep the pH constant at pH 3.0;;**
9. **Using a stopwatch, start timing and measure the time taken for the reducing sugars to change the colour of pink potassium manganite (VII) solution to a colourless end point;;**
10. **Repeat twice to get a total of 3 readings;;**
11. **Repeat steps 6 to 10 using different buffers at pH 4.0, pH 5.0, pH 6.0 and pH 7.0;;**
12. **Calculate the average rate of reaction (1 / average time taken for the reducing sugars to change the colour of pink potassium manganite (VII) solution to a colourless end point) and record these data in a table;;**
13. **Table of results**

pH	Time taken for the reducing sugars to change the colour of pink potassium manganite (VII) solution to a colourless end point / s				Average rate of reaction / s^{-1}
	Reading 1	Reading 2	Reading 3	Average Reading	
3.0					
4.0					
5.0					
6.0					
7.0					

Graph

14. **Plot a graph of average rate of reaction against pH using the data in the table;;**



Safety issues

15. **As the buffers used are corrosive, wear gloves / protective goggles when handling the buffer solutions to prevent contact with skin / eyes;;**
16. **As the scalpel is sharp / glassware is fragile, handle them carefully / place them away from the main work area after use;;**

[Total: 20]

H

JURONG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS
Higher 1

CANDIDATE NAME

CLASS

BIOLOGY 8875/02

Paper 2 Structured Questions **25 August 2017**

Additional Materials: Answer Paper **2 hours**

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
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.

Section A
Answer **all** the questions.

Section B
Answer **one** question.
Circle the question number of the question attempted.

The use of an approved scientific calculator is expected, where appropriate.
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	
1	
2	
3	
4	
Section B	
5 / 6	
Total	

This document consists of **15** printed pages and **3** blank pages.

[Turn over

Section A

Answer **all** the questions in this section.

1 White blood cells such as dendritic cells synthesise intracellular enzymes.

Fig. 1.1 is a summary diagram of events that occur in a dendritic cell.

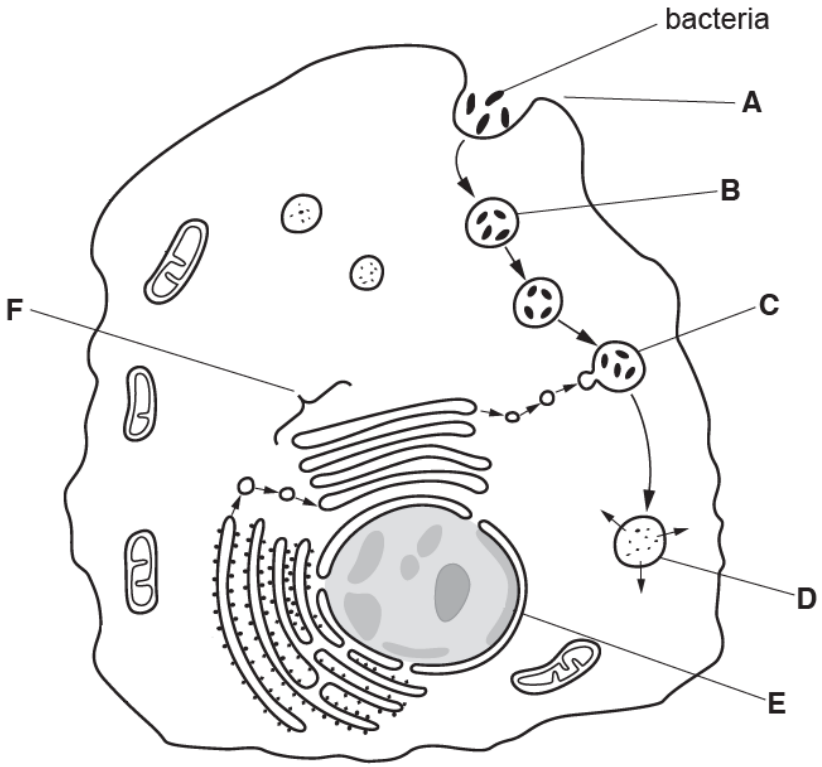


Fig. 1.1

(a) (i) Name the process at A. [1]

_____

(ii) Name structures B, E and F. [3]

B _____

E _____

F _____

(b) Describe what happens to the bacteria between C and D. [2]

(c) The gene coding for transcription factor in dendritic cells is known as *Batf3*. The transcription factor is essential for the development of dendritic cells.

(i) Explain what is meant by a *gene*. [1]

(ii) There are a number of known mutations for *Batf3*.

Outline how a mutation in *Batf3* can lead to the formation of an altered polypeptide where one amino acid is replaced by a different amino acid. [3]

[Total: 10]

2 Fig. 2.1 shows some stages in mammalian respiration.

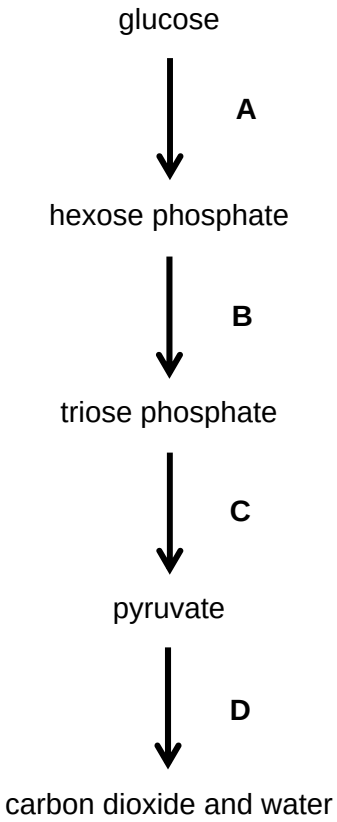


Fig. 2.1

(a) Name the processes taking place during Stage D and state precisely where they occur. [3]

(b) Intermediates produced at the end of Stages B and C are important in the conversion of carbohydrates to lipids such as triglycerides. Some of the triose phosphate can be converted into glycerol-3-phosphate, while pyruvate can undergo further reactions to form intermediates required for the synthesis of fatty acids.

Describe the formation of triglycerides. [3]

(c) The first reaction in Stage A is catalysed by the enzyme hexokinase. It has been observed that hexokinase is bound to the outer mitochondrial membrane in muscle cells which undergo high rates of glycolysis.

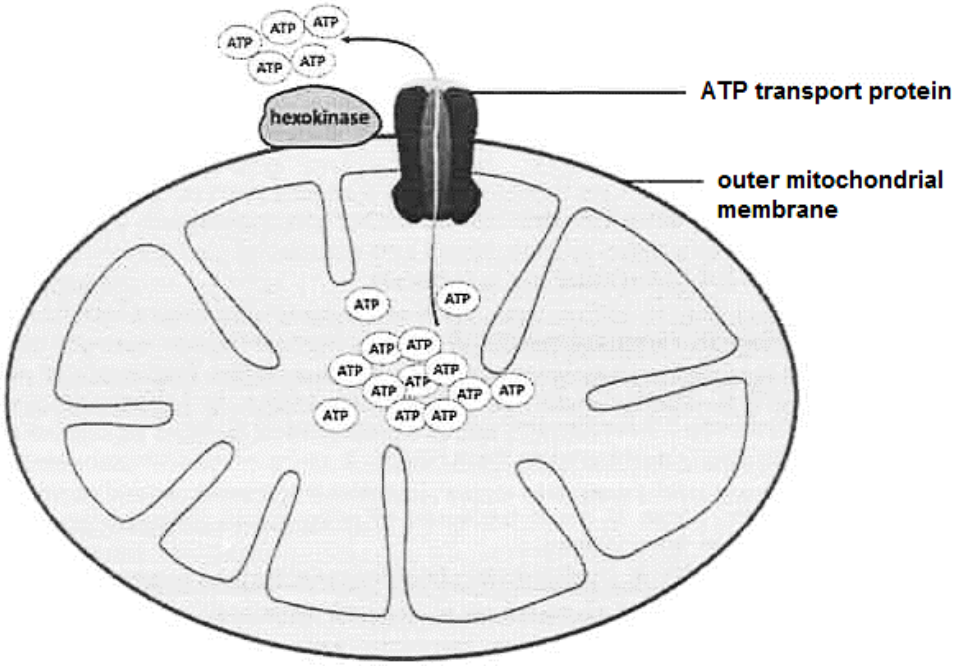


Fig. 2.2

With reference to the role of mitochondria and Fig. 2.2, suggest how the association of hexokinase with mitochondria can lead to high rates of glycolysis. [2]

(d) Fig. 2.3 shows an electron micrograph of a mitochondrion.

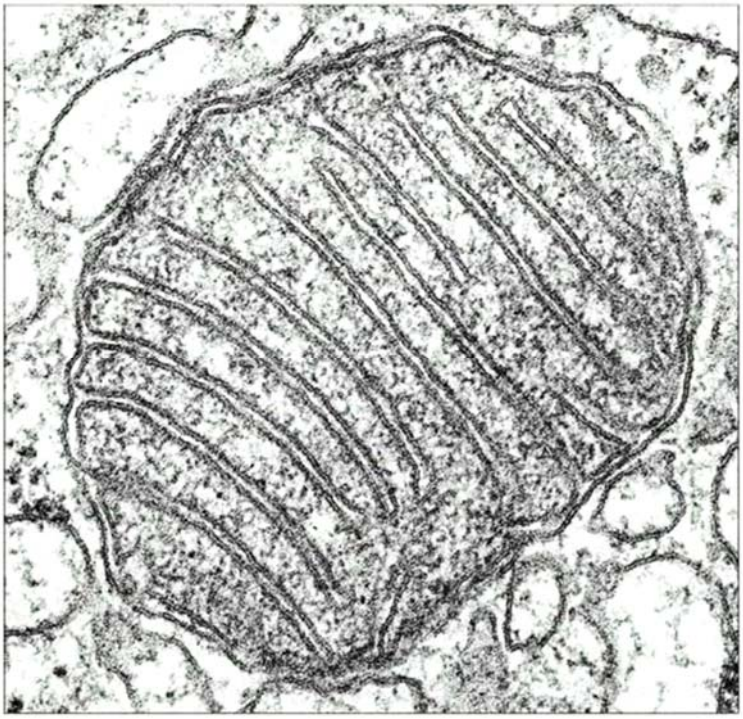


Fig. 2.3

With reference to features visible in Fig. 2.3, outline how the structure of the mitochondrion is adapted for its function. [1]

(e) Phosphatidylcholine (a phospholipid) is present in membranes such as those of the mitochondrion. The molecular structures of tristearin (a triglyceride) and phosphatidylcholine are shown in Fig. 2.4.

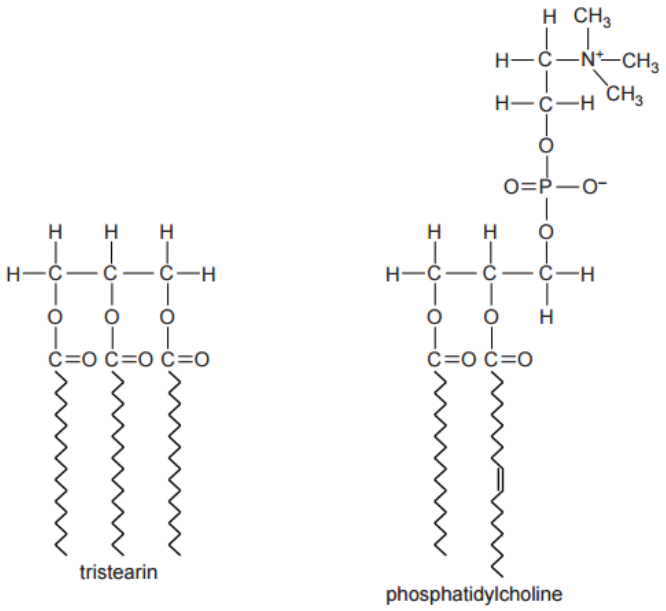


Fig. 2.4

State two structural differences between tristearin and phosphatidylcholine, other than in numbers of the different types of atoms. [2]

[Total: 11]

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3 A type of pheasant occurs in a range of colours, especially when bred in captivity. It may, for example, have green or purple plumage as seen in Fig. 3.1.

Fig. 3.1

Sometimes when a green male is crossed with a green female all the offspring, male and female, are green. However, sometimes a green male crossed with a green female results in offspring in which the majority of the offspring are green, but in which some of the females are purple, as shown in Table 3.1.

Table 3.1

phenotype	**number of offspring**
green male	7
green female	3
purple female	4

Plumage colour in pheasants is sex-linked.

In birds, the sex chromosomes are referred to as W and Z, rather than Y and X as in mammals. The W chromosome has no genes that affect plumage colour. The heterogametic sex is the female, **not** the male. Thus the male has two Z chromosomes (ZZ) and the female has one W and one Z chromosome (WZ).

(a) Use a genetic diagram to explain the results in Table 3.1. [3]

(b) Using the same symbols as in **(a)**, indicate the genotypes of the parents which could give rise to purple male offspring. [1]

(c) Using the information provided, state which allele for plumage colour is dominant and explain your answer. [2]

(d) Describe how you would determine the unknown genotype of a green male. [2]

[Total: 8]

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4 Human growth hormone (hGH) is a peptide hormone that is important for human development. Recombinant hGH can be synthesised via genetic engineering with the use of plasmids.

(a) (i) State the type of organism that contains plasmids. [1]

(ii) Describe one feature of plasmids that make them suitable to be used for genetic engineering. [2]

The polymerase chain reaction (PCR) can be used to amplify the gene coding for hGH before genetic engineering is carried out.

(b) Describe what occurs during the first two stages in PCR.

(i) Stage 1 [2]

(ii) Stage 2 [2]

(c) Outline how a recombinant plasmid can be produced for genetic engineering after the gene coding for hGH was isolated from human cells and amplified using PCR. [3]

(d) With the advancement in technology, plasmid-free bacteria cells have been constructed for the production of hGH with the gene coding for hGH inserted directly into the host chromosome instead of using plasmid.

Suggest how this new method is an improvement over the previous method. [1]

[Total: 11]

Section B

Answer **one** question.

Write your answers on the separate answer paper provided.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

4 Early ancestors of today's horses were browsers. Their teeth were adapted for eating woody shrubs and trees. In the early Miocene (23 million years ago), the first groups adapted for grazing emerged. Modern horses are grazers, with teeth adapted for grinding tougher, grassy materials.

The foot structure evolved from four separate toes to three, then to only one that touched the ground with two smaller side toes higher than the ground. In more modern horses, the two side bones are fused together. Modern horses are of much greater size than their ancestors.

(a) Describe the causes of variation in horses. [6]

(b) Explain how natural selection could lead to evolution of modern horses with distinct phenotypic differences. [6]

(c) Explain, with examples, what is meant by anatomical and molecular homologies in horses. [8]

[Total: 20]

5 Invertase, a major enzyme present in plant tissues such as the developing roots of carrots, catalyses the hydrolysis of sucrose (a non-reducing sugar) to fructose and glucose (reducing sugars).

A scientist carried out an investigation into the effect of pH on the activity of invertase in carrots, by recording the time taken for the reducing sugars to change the colour of pink potassium manganite (VII) solution to a colourless end point. From the results obtained, the scientist concluded that the optimum pH of invertase was pH 5.0.

After additional analyses, the scientist also found that the invertase is:

- made up of several subunits
- synthesised with a signal peptide required for entry into the rough endoplasmic reticulum and thus into the secretory pathway
- glycosylated and bound to the cell wall

(a) Describe how invertase can be synthesised from mRNA. [8]

(b) Outline structural features and roles of the rough endoplasmic reticulum. [4]

(c) Describe the investigation carried out by the scientist to examine the effect of pH on the activity of invertase in carrots. [8]

[Total: 20]

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