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**YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2016**

BIOLOGY

8875/01

HIGHER 1

29 Aug 2016

Mon 0800 hr – 0900 hr

Paper 1 Multiple Choice

1 hour

**Additional material:
Multiple Choice Answer Sheet**



READ THESE INSTRUCTIONS FIRST

Write in soft pencil (type B or HB is recommended).

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, full NRIC number and CTG on the Multiple Choice Answer Sheet and question paper in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

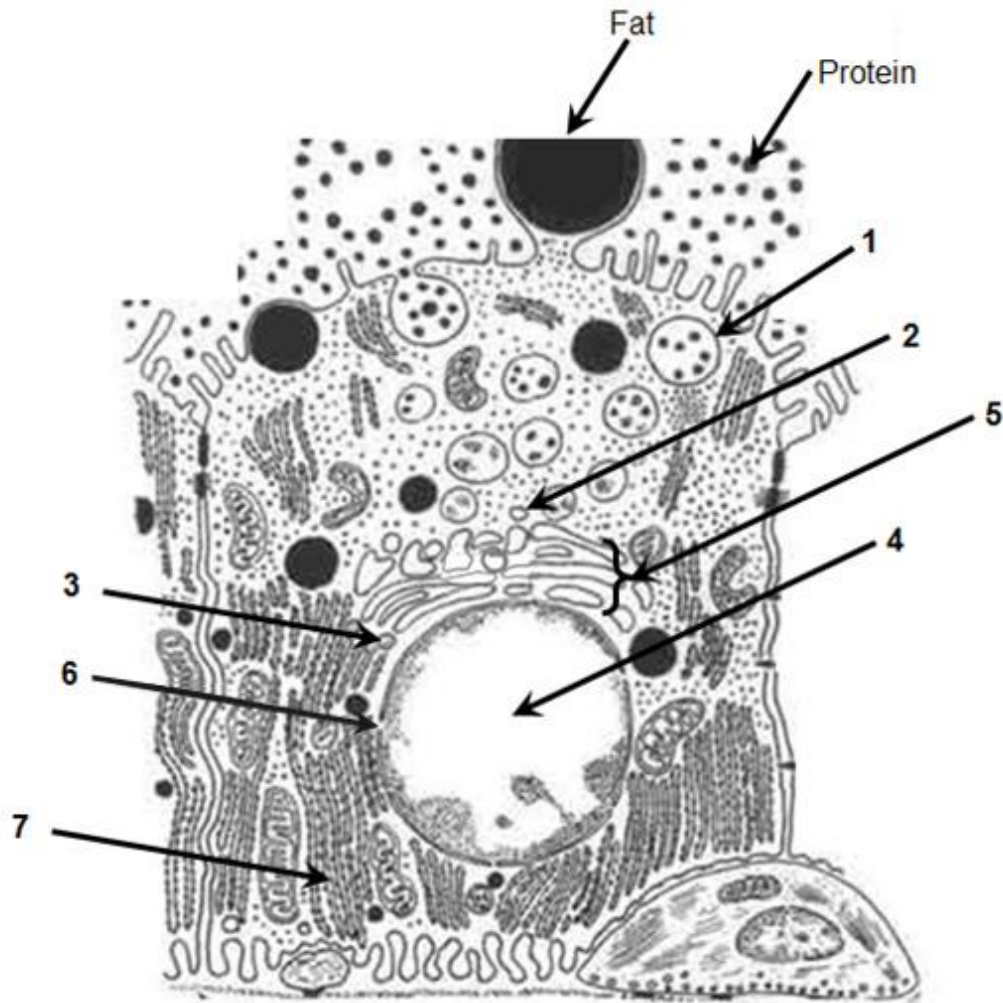
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Mark Sheet.

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.

Calculators may be used.

This question paper consists of **17** printed pages and 1 blank page.

- 1 The diagram below shows a lactating mammary secretory cell. In this cell, milk proteins, such as casein, are transcribed and translated, and eventually secreted into the lumen of the mammary gland.



Which of the following shows the most likely sequence of locations involved in this process?

	start	→					finish
A	6	3	4	7	2	5	1
B	6	4	3	7	5	2	1
C	4	6	7	3	5	2	1
D	4	3	7	6	2	5	1

- 2 The table gives a description of four membranous structures in a cell.

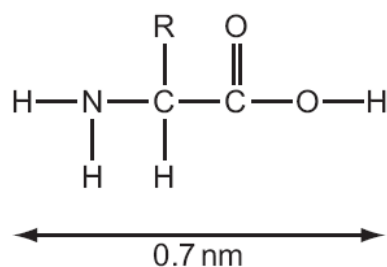
Which structure is correctly matched to its function?

	Structure	Function
A	an extensive network of tubes and sacs; each tube and sac bounded by a single membrane	Lipid synthesis
B	a spherical sac bounded by a single membrane	Protein synthesis
C	a sac bounded by two membranes, the inner highly folded	Packaging of proteins
D	a stack of elongated, curved sacs; each sac bounded by a single membrane	Photosynthesis

- 3 The diameters of some atoms when they form bonds are given in the table.

Atom	Single bond / nm	Double bond / nm
H	0.060	-
O	0.132	0.110
N	0.140	0.120
C	0.154	0.134

The approximate length of the amino acid shown below was estimated using the figures in the table.



What would be the approximate length of a dipeptide formed using this amino acid?

- A** 0.8 nm **B** 1.2 nm **C** 1.5 nm **D** 1.9 nm

- 4 The enzyme phosphofructokinase is involved in phosphorylation of hexose phosphate sugars during glycolysis. It is involved in control of the rate of glycolysis and as a result, respiration, by end-product inhibition.

Which of the following describes this enzyme?

	Shape of binding site(s)	Substrate	Product
A	no allosteric site, active site complementary to ATP and hexose	hexose	hexose phosphate
B	allosteric site complementary to glucose, active site complementary to hexose phosphate	hexose phosphate	hexose phosphate
C	allosteric site complementary to ATP, active site complementary to ATP and hexose phosphate	hexose phosphate	hexose biphosphate
D	no allosteric site, active site complementary to hexose biphosphate	hexose biphosphate	two triose phosphate

- 5 A cell in the G1 phase has two homologous pairs of chromosomes. It then undergoes a mitotic division, followed by meiosis. At the end of meiosis II, what is the total number of chromosomes and gene loci found in all the daughter cells formed?
- A** 8 chromosomes and 4 times as many gene loci as the original parent cell
- B** 8 chromosomes and 8 times as many gene loci as the original parent cell
- C** 16 chromosomes and 4 times as many gene loci as the original parent cell
- D** 16 chromosomes and 8 times as many gene loci as the original parent cell
- 6 For organisms undergoing sexual reproduction, a reduction division occurs before fertilisation.

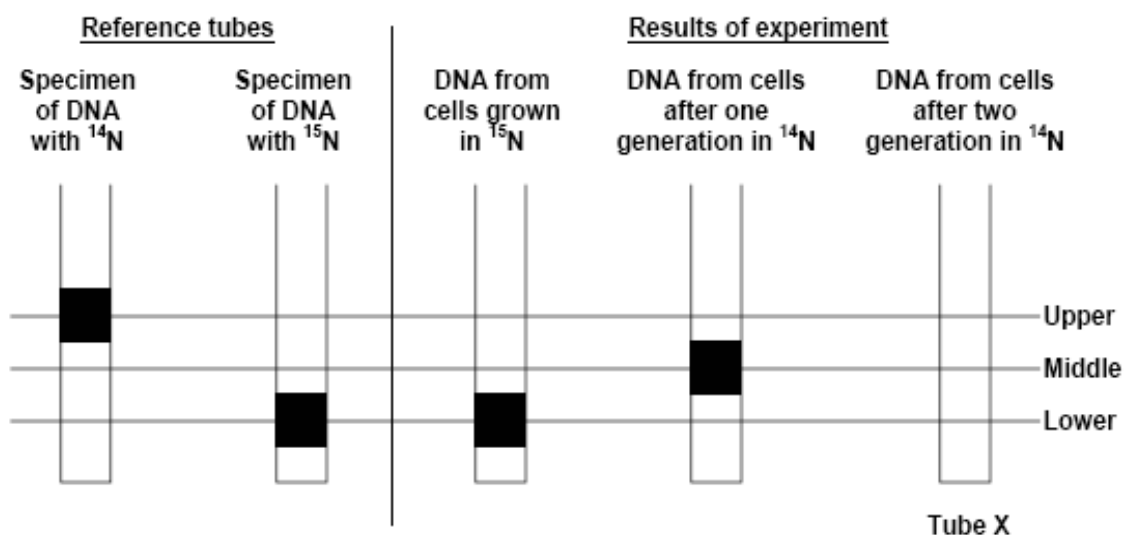
Which of the following statement(s) explain why this is necessary?

- 1 increase genetic variation
- 2 prevent doubling of the chromosome number
- 3 reduce the chances of mutation

- A** 1 only **B** 2 only **C** 1 and 2 only **D** 1, 2 and 3

- 7 One complete turn of the double helix of DNA contains 10 base pairs and is 3.4nm long. What is the approximate number of amino acids in an enzyme coded by a 132 nm length of DNA?
- A 38
- B 129
- C 150
- D 388
- 8 Cells of the bacterium *E. coli* were grown for many generations in a medium containing only the heavy isotope of nitrogen, ^{15}N . The cells were then transferred to a medium containing only ^{14}N and allowed to grow. Samples of the bacteria were removed from the culture after one generation and after two generations. The DNA from each sample was extracted and centrifuged.

The figure below shows two reference tubes and the results of this experiment.



What are the positions and relative proportions of the bands in Tube X?

	Upper	Middle	Lower
A	50%	50%	0%
B	0%	50%	50%
C	50%	0%	50%
D	25%	50%	25%

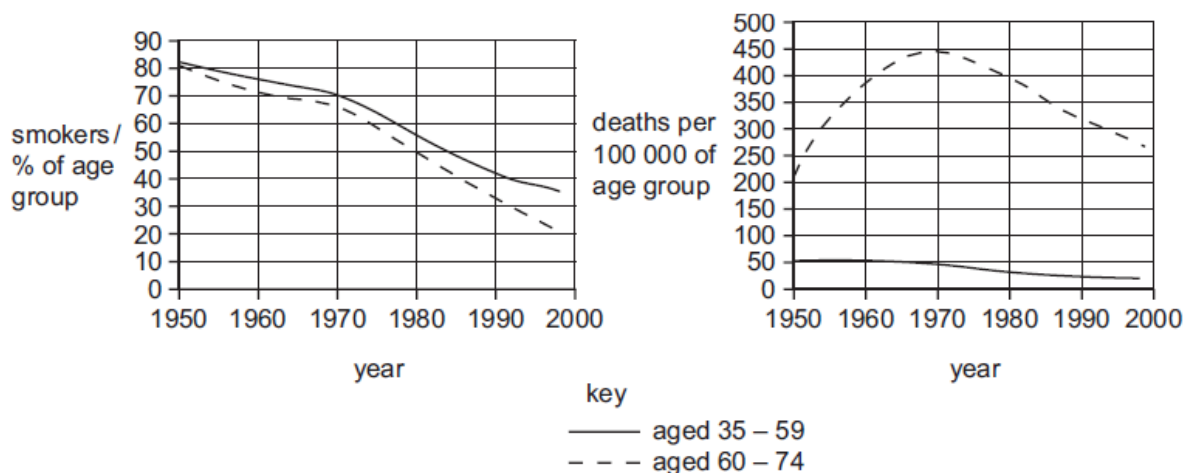
- 9 A student obtained a sample of DNA and mRNA was transcribed from the DNA. The samples were subsequently purified. He then separated the two strands of the DNA sample.

The base compositions of each DNA strand and that of the mRNA were analysed. The results of the analysis are shown in the table below.

	A	G	C	T	U
DNA strand 1	19.1	26.0	31.0	23.9	0.0
DNA strand 2	24.2	30.8	25.7	19.3	0.0
DNA strand 3	20.5	25.2	29.8	24.5	0.0
mRNA	19.0	25.9	30.8	0.0	24.3

Which strand of the DNA is the template strand?

- A Strand 1
- B Strand 2
- C Strand 3
- D None of the above
- 10 Some studies suggest that smoking increases the risk of developing lung cancer. The two graphs show the percentage of smokers and the deaths from lung cancer in men of two age groups between 1950 and 1998.



Which statement is **not** supported by the data in the graphs?

- A Deaths from lung cancer in men 35-59 decreased by 50% over the period of the study.
- B Deaths from lung cancer in men 60-74 increased up to 1970.
- C The data for men 60-74 between 1950 to 1970 suggests that lung cancer takes up to 20 years to develop.
- D The number of men aged 35-59 who were smokers decreased by approximately 70% over the period of the study.

- 11** Some people are genetically predisposed to suffer from particular diseases. The table shows some diseases and their cause.

	disease	cause
1	Alzheimer's syndrome	myeloid protein plaques in the brain
2	brittle bone disease	abnormal collagen
3	Down's syndrome	extra chromosome 21
4	sickle cell anaemia	abnormal haemoglobin
5	Turner's syndrome	absence of a second sex chromosome
6	Cri-du-chat syndrome	missing part of chromosome 5

Which diseases are caused by chromosome aberration and gene mutation respectively?

	chromosome aberration	gene mutation
A	2 and 4	3 and 5
B	2 and 5	1 and 3
C	3 and 5	4 and 6
D	3 and 6	2 and 4

- 12** A test cross is carried out on a parent organism of unknown genotype. Half of the offspring have the same phenotype as the parent.

What can be concluded from this result?

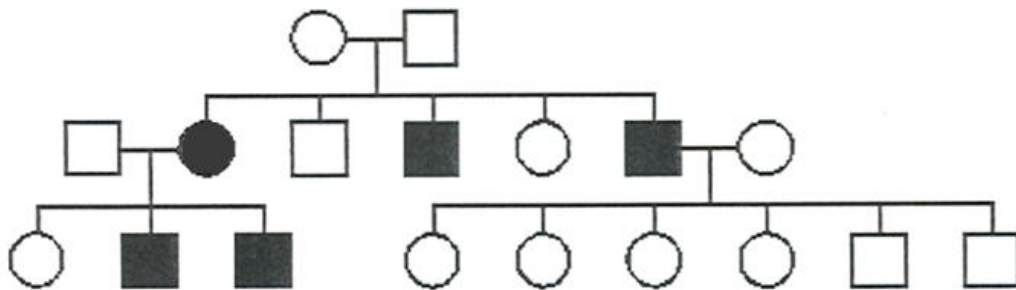
- A** The parent is heterozygous for the trait.
- B** The parent is homozygous dominant for the trait.
- C** The parent is homozygous recessive for the trait.
- D** The trait being inherited is polygenic.

- 13 The table shows the results of a series of crosses in a species of small mammal.

coat colour phenotype		
male parent	female parent	offspring
dark grey	light grey	dark grey, light grey, albino
light grey	albino	light grey, white with black patches
dark grey	white with black patches	dark grey, light grey
light grey	dark grey	dark grey, light grey, white with black patches

What explains the inheritance of the range of phenotypes shown by these crosses?

- A one gene with multiple alleles
 B one gene with a pair of co-dominant alleles
 C sex linkage of the allele for grey coat colour
 D two genes, each with a dominant and recessive allele
- 14 The following pedigree depicts the inheritance of a rare hereditary disease affecting muscles.



What is the mode of inheritance of this disease?

- A autosomal dominant
 B autosomal recessive
 C X-linked dominant
 D X-linked recessive

- 15** In cats, the genes controlling coat-colour are co-dominant and carried on the X chromosome. When a black female was mated with a ginger male, the resulting litter consisted of black male and tortoise-shell female kittens, which is the F_1 generation. In the F_2 generation, the black male and the tortoise-shell female from F_1 generation were crossed.

What phenotypic ratio would be expected in the F_2 generation?

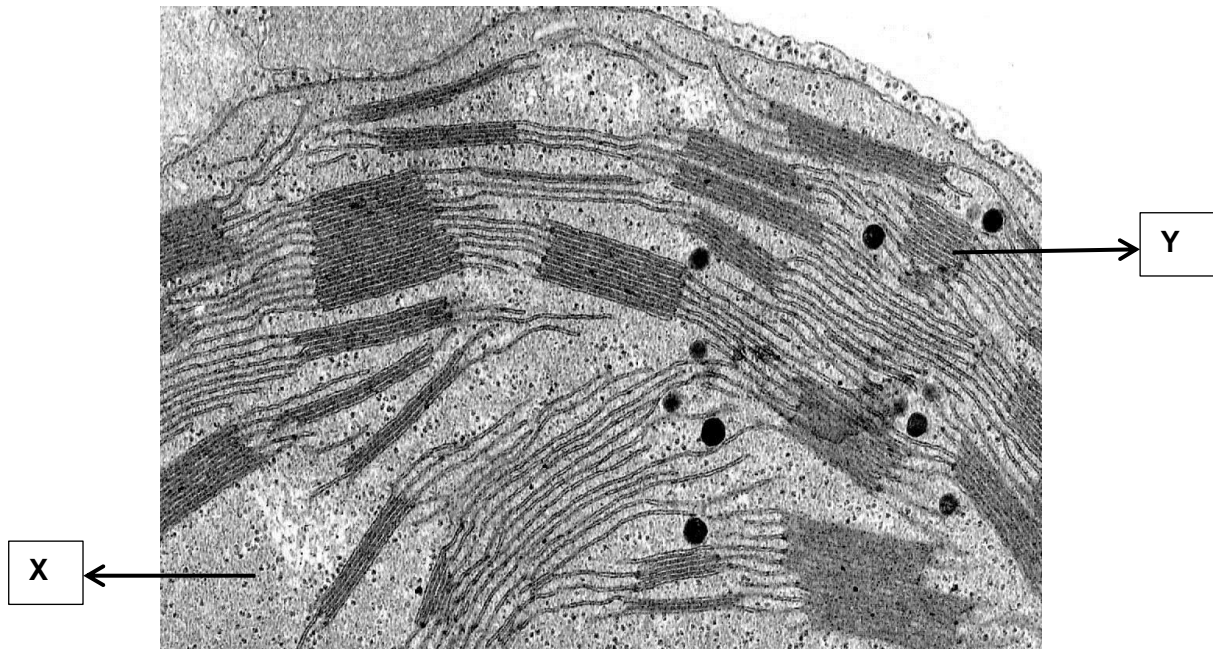
What is the expected phenotypic ratio in the F_2 generation?

- A** 1 black male : 1 ginger male : 1 tortoise-shell female : 1 black female
- B** 1 black male : 1 ginger male : 2 tortoise-shell females
- C** 2 black males : 1 tortoise-shell female : 1 ginger female
- D** 2 black males : 1 tortoise-shell female : 1 black female
- 16** The following statements describe aspects of genetics.
- 1 The phenotype is affected by both alleles at the same locus of a heterozygous individual.
 - 2 The combined effects of alleles at two or more gene loci equal the sum of their individual effects.
 - 3 Many different alleles present in a gene pool can occupy the same gene locus.
 - 4 The phenotype is only shown when both copies of the alleles are identical.

Which of the following correctly describes the statements?

	Codominant alleles	Recessive alleles	Multiple alleles	Additive genes
A	1	4	2	3
B	1	4	3	2
C	2	1	4	3
D	3	1	4	2

- 17 The electron micrograph shows a chloroplast of a plant cell with structures **X** and **Y** labelled.



Which of the following statements is correct?

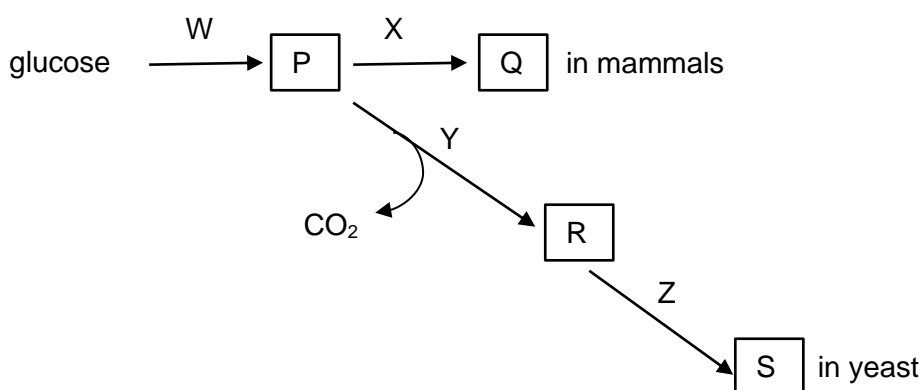
- A There is production of NADH and ATP within structure Y.
- B There are photosynthetic pigments present in structure X which harness chemical energy.
- C Structure Y is the location in which triose phosphate is produced.
- D Structure Y contains proteins involved in the phosphorylation of ADP.

- 18** 2,4-dinitrophenol (DNP) is a chemical and was used for weight loss. However, prolonged overdose of DNP leads to toxicity including the potential for hyperthermia and death. DNP targets the inner mitochondrial membrane to uncouple oxidative phosphorylation from electron transport. It allows protons to cross the inner mitochondrial membrane and thus dissipates the proton gradient. It also increases tissue metabolism.

Which of the following is true of a cell treated with 2,4-dinitrophenol?

	Ability to use oxygen	Ability to produce carbon dioxide	ATP yield
A	No	Yes	Increases
B	Yes	No	Decreases
C	Yes	Yes	Decreases
D	Yes	No	Increases

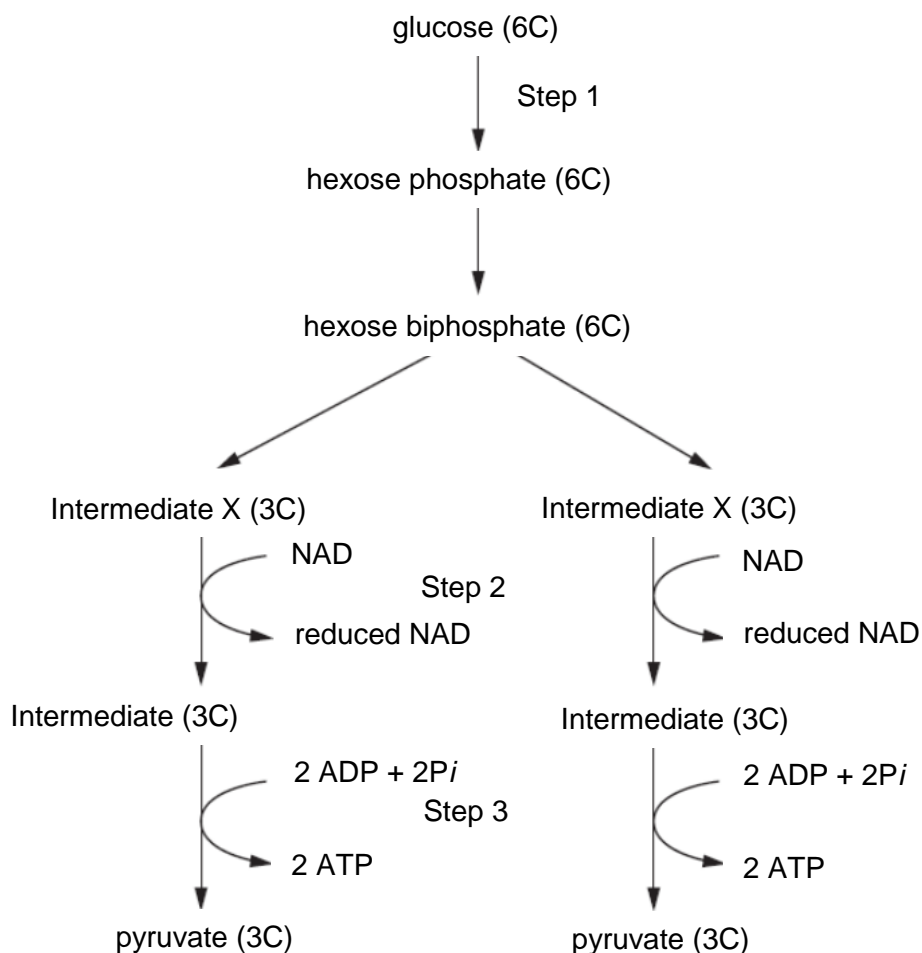
- 19** The diagram shows a summary of the processes of anaerobic respiration.



Which compounds are represented by the letters P, Q and R and which processes result in the formation of ATP?

	P	Q	R	Formation of ATP
A	ethanal	ethanol	pyruvate	W, X, Y and Z
B	ethanal	lactate	ethanol	Y and Z
C	pyruvate	lactate	ethanal	W
D	pyruvate	lactate	ethanol	X and Z

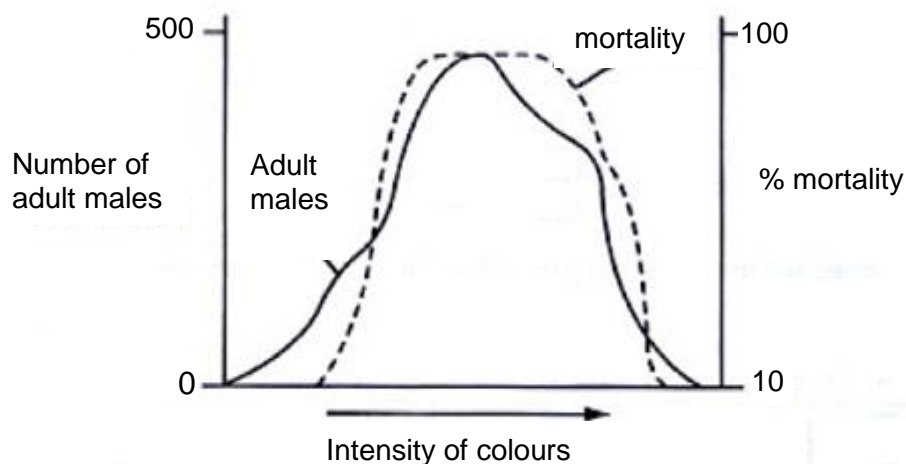
- 20 During glycolysis, glucose is converted by a series of steps into two molecules of pyruvate.



Which of the following correctly labels intermediate X, steps 1 – 3 and the location where step 3 occurs?

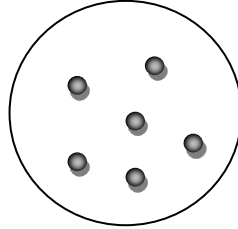
	Location	Intermediate X	Step 1	Step 2	Step 3
A	Cytosol	Glyceraldehyde-3-phosphate	Reduction	Oxidation	Oxidative phosphorylation
B	Cytosol	Triose phosphate	Phosphorylation	Reduction	Substrate level phosphorylation
C	Mitochondrial matrix	Glycerate-3-phosphate	Reduction	Reduction	Substrate level phosphorylation
D	Cytosol	Triose phosphate	Phosphorylation	Oxidation	Oxidative phosphorylation

- 21** As adults, certain species of whales possess baleen instead of teeth. Baleen is used to filter the whales' diet of planktonic animals from seawater. As embryos, baleen whales possess teeth, which are later replaced by baleen. The teeth of embryonic baleen whales are evidence that
- A** all whales are descendants of terrestrial mammals.
 - B** among ancient whales, baleen evolved before teeth.
 - C** baleen whales are descendants of toothed whales.
 - D** baleen embryos pass through a stage where they resemble adult toothed whales.
- 22** Which of the following increases the number of different alleles in a population?
- A** crossing over
 - B** gene mutation
 - C** random fusion of gametes
 - D** random assortment of chromosomes in meiosis
- 23** The graph below shows data on a population of a species of moth which shows considerable variation in colour intensity. Which conclusion can be made from this graph?



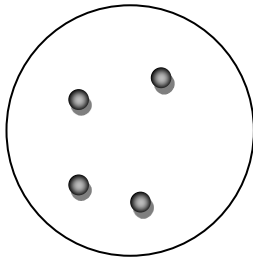
- A** Colour variation is environmentally induced.
- B** Colour variation is genetically determined.
- C** Extreme forms are favoured by natural selection.
- D** The species shows discontinuous variation with respect to colour.

- 24** The insulin gene and a plasmid with ampicillin and tetracycline resistance genes were cut using the same restriction enzyme, *EcoRI*. The cut plasmid and insulin gene was mixed together and DNA ligase was allowed to react. Subsequently the mixture was heat shocked at 42°C with *E. coli*. The mixture was then plated on nutrient agar to obtain a master plate with colonies shown below.

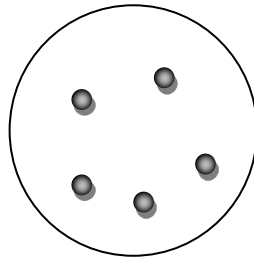


Master plate (nutrient agar)

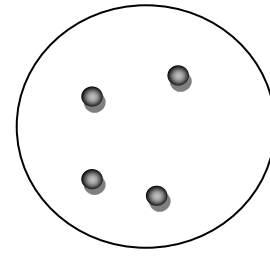
Three replica plates containing different antibiotics were obtained from the master plate. The diagram below shows the results of the replica plates.



Nutrient agar with
ampicillin



Nutrient agar with
tetracycline



Nutrient agar with
tetracycline and
ampicillin

Which of the following can be concluded from the results obtained?

- A** The ampicillin resistance gene is inactivated by insertion of the insulin gene.
- B** The tetracycline resistance gene is inactivated by insertion of the insulin gene.
- C** The tetracycline resistance gene does not act as a selectable marker.
- D** The ampicillin resistance gene does not act as a selectable marker.

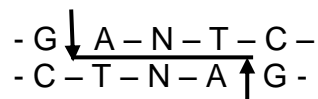
- 25** When human insulin was originally produced from bacteria, the recombinant DNA was synthesised using processed mRNA molecules from the cytoplasm of pancreatic β cells.

The following enzymes were used in this process:

- 1 DNA ligase
- 2 DNA polymerase
- 3 restriction endonuclease
- 4 reverse transcriptase

Which sequence is correct?

- A** 2 \rightarrow 4 \rightarrow 1 \rightarrow 3
- B** 3 \rightarrow 4 \rightarrow 2 \rightarrow 3
- C** 4 \rightarrow 2 \rightarrow 1 \rightarrow 3
- D** 4 \rightarrow 2 \rightarrow 3 \rightarrow 1
- 26** The restriction enzyme *HinfI* cuts DNA at its target site, as shown in the diagram by arrows and a line. In the target site, N/N can be any complementary base pair.



How many DNA fragments will be found after exposing the following short length of linear DNA to *HinfI*?

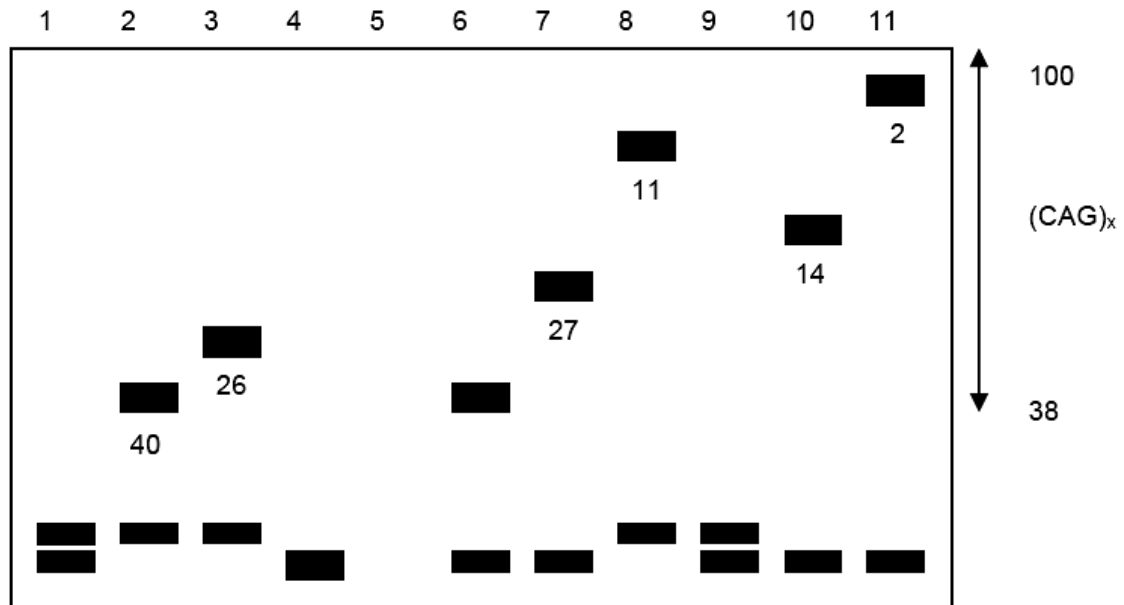
A - C - G - A - T - T - C - A - G - A - T - T - T - C - G - A - A - T - C - G - A
T - G - C - T - A - A - G - T - C - T - A - A - A - G - C - T - T - A - G - C - T

- A** 1
- B** 2
- C** 3
- D** 6

- 27** The data below shows the results of electrophoresis of PCR fragments amplified using primers for the site that has been shown to be altered in Huntington's disease.

The inherited mutation in the Huntington's disease gene abnormally repeats the nucleotide sequence CAG from 36 up to more than 120 times. The male parent, shown as individual 2, had the onset of Huntington's disease when he was 40 years old.

Six of his children (individuals 3, 5, 7, 8, 10, 11) suffer from Huntington's disease, and the age at which the symptoms first began is shown by the number below the band from the PCR fragment.



What is the likely outcome for the normal individuals 4, 6, and 9?

- A** Individuals 4 and 9 do not have the trait, and will not get Huntington's disease, but individual 6 is likely to start the disease when he reaches his father's age of 40.
- B** Individuals 4, 6, and 9 have not inherited the defect causing Huntington's disease.
- C** Individuals 4, 6, and 9 will still develop Huntington's disease at some point in their lives, since the disease is inherited as a dominant trait.
- D** Two of the three will develop the disease, since it is inherited as a dominant trait, but the data does not allow you to predict which two.

28 Which of the following statements are true about adult stem cells?

- 1 They can undergo self-renewal.
- 2 They can be totipotent, pluripotent or multipotent.
- 3 They can differentiate into almost any cell type.
- 4 They can give rise to specialised cells.

- A** 1 and 2
- B** 1 and 4
- C** 2 and 3
- D** 3 and 4

29 Some crop plants have been genetically modified to give resistance against specific insects.

Which feature is least likely to be affected by this development?

- A** crop damage caused by the specific insects
- B** initial presence of the specific insects in the area of crop growth
- C** population size of the specific insects
- D** use of insecticides in the area of crop growth

30 Developing fish eggs can be treated to produce a diploid egg. In salmon, such eggs have been fused with haploid salmon sperm to give infertile triploid salmon.

Reproductive organ tissue from diploid trout was transplanted into newly hatched triploid salmon. This tissue matured as the fish grew and the salmon successfully produced viable trout sperm or eggs which resulted in young trout.

Which fish could be seen as genetically modified?

- A** salmon providing eggs for treatment
- B** trout providing reproductive organ tissue
- C** young triploid salmon
- D** young trout

MCQ answers

1	C	11	B	21	C
2	A	12	A	22	B
3	B	13	A	23	C
4	C	14	B	24	A
5	C	15	A	25	D
6	B	16	B	26	B
7	B	17	D	27	A
8	A	18	C	28	B
9	B	19	C	29	B
10	D	20	D	30	C