VICTORIA JUNIOR COLLEGE

JC 2 PRELIMINARY EXAMINATION 2017

NAME : _____

CT CLASS : _____

H2 BIOLOGY **9744/1**

Paper 1 Multiple Choice **1 hour**

Additional material: Multiple choice answer sheet

READ THESE INSTRUCTIONS FIRST

Write your name, exam number on the answer sheet provided.
Do not use any staples, paper clips, highlighters, glue or correction fluid.

There are **30** questions in 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 paper.

The use of an approved scientific calculator is expected, where appropriate.

1 Which of the following is a false statement regarding centrioles and ribosomes?

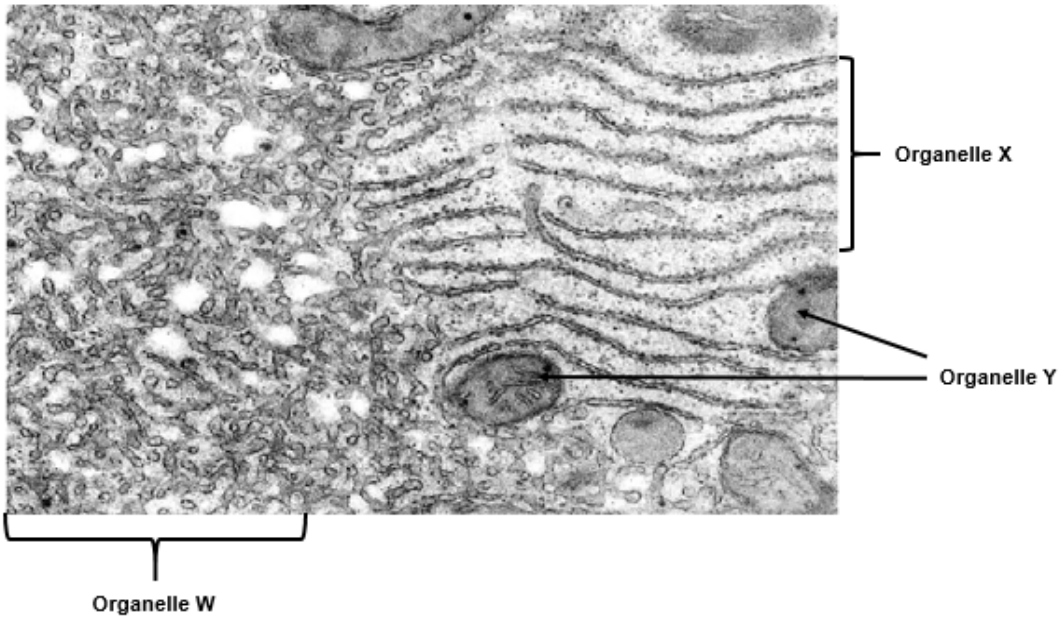
A Both are non-membrane bound organelles.

B Only centrioles are present in a cell undergoing mitosis.

C Both are present in dividing and non-dividing animal cells.

D Under high temperature, both will be denatured as they have a proteinaceous component.

2 Fig 2 shows three cell organelles W, X and Y.



Which of the following statements about these organelles is true?

A Only organelle Y contains RNA.

B Only organelle W contains carbohydrates and phospholipids.

C Organelle X has 80S ribosomes whereas organelle Y has 70S ribosomes.

D Organelles X and Y have double membrane whereas organelle W has a single membrane.

3 Which set of factors shown below will produce the **least** fluid cell surface membrane?

A	● High proportion of cholesterol ● High temperature
B	● Low proportion of phospholipids with saturated fatty acids ● High temperature
C	● Low proportion of phospholipids with unsaturated fatty acids ● Low temperature
D	● High proportion of phospholipids with unsaturated fatty acid ● Low temperature

4 Fig 4 shows a repeating unit found in a biomolecule.

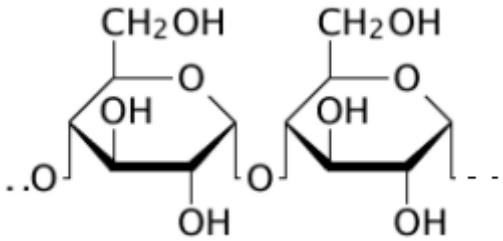


Fig 4

In which of the following biomolecules, would one expect to find the above repeating unit?

X Absent
√ Present

	Cellulose	**Glycogen**	**Amylose**	**Collagen**
A	X	X	√	X
B	√	X	√	X
C	√	X	X	√
D	X	√	√	X

5 Fig 5 below is an electron micrograph of a stained fiber of deoxyhemoglobin S (HbS).

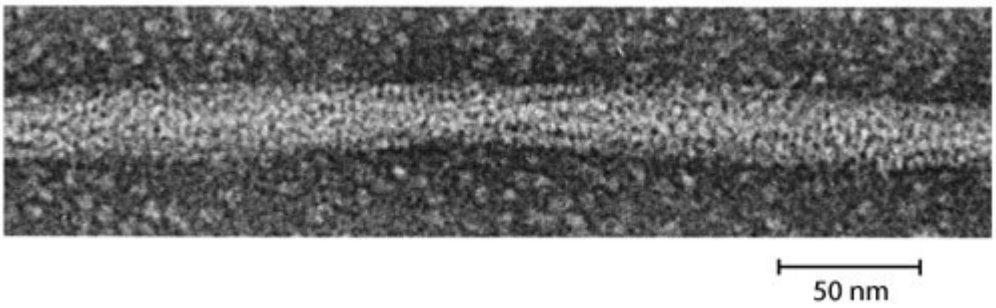


Fig 5

[From G. Rykes, R.H. Crepeau, and S.J. Edelstein. *Nature* 272(1978):509.]
Source: http://www.nslc.wustl.edu/sicklecell/part2/molecular.html

Which of the following statements is true?

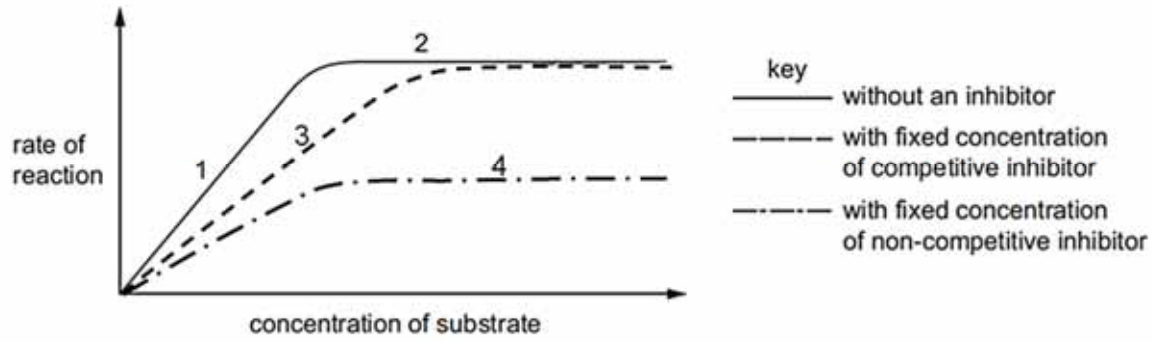
A Mutation in the red blood cell results in the production of HbS which precipitates out as long rigid fibers under low oxygen concentration.

B The long HbS molecule is insoluble due to its large molecular size and this results in the sickling of red blood cells.

C The aggregration of HbS molecules, under low oxygen concentration, causes the fiber to be precipitated out of solution, resulting in the sickling of red blood cells.

D Under low oxygen concentration, HbS molecules form a triplex helix structure, causing the cell membrane of the red blood cells to be more rigid and hence they sickled.

6 The graph shows the effect of increasing the concentration of substrate on the rate of enzyme catalysed reaction.



What is limiting the rate of the enzyme-catalysed reaction at 1, 2, 3 and 4 on the graph?

	1	**2**	**3**	**4**
A	enzyme concentration	substrate concentration	competitive inhibitor	non-competitive inhibitor
B	enzyme concentration	substrate concentration	non-competitive inhibitor	competitive inhibitor
C	substrate concentration	enzyme concentration	competitive inhibitor	non-competitive inhibitor
D	substrate concentration	enzyme concentration	non-competitive inhibitor	competitive inhibitor

7 Many people are opposed to the use of embryonic stem cells on ethical grounds. Researchers have come up with a way of developing embryonic stem cells from a patient's cells. The cultured embryonic cells can then be used to treat the patient. Fig 7 shows the process.

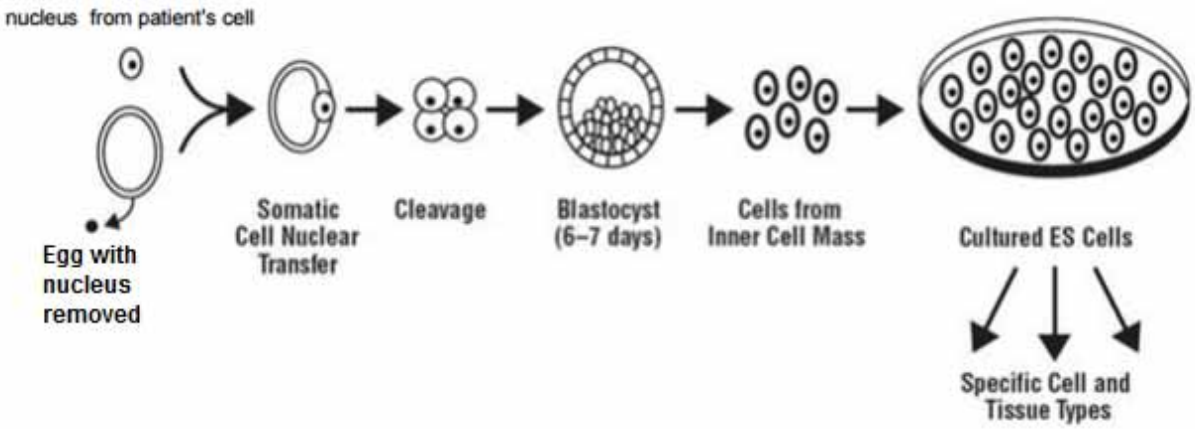


Fig 7

http://media.www.dailyvanguard.com/media/storage/paper941/news/2004/02/26/News/Is.Cloning.Ethical-2612583.shtml

Which of the following options is true?

1 The patient will not show any immune response when the specific cell types developed from the embryonic stem cells are introduced into the patient.

2 No embryo is destroyed in the process of harvesting the embryonic stem cells.

3 The cultured embryonic stem cells can be used for reproductive cloning.

4 The moral concern of the embryo being an individual is not an issue as the embryonic cells come from the patient.

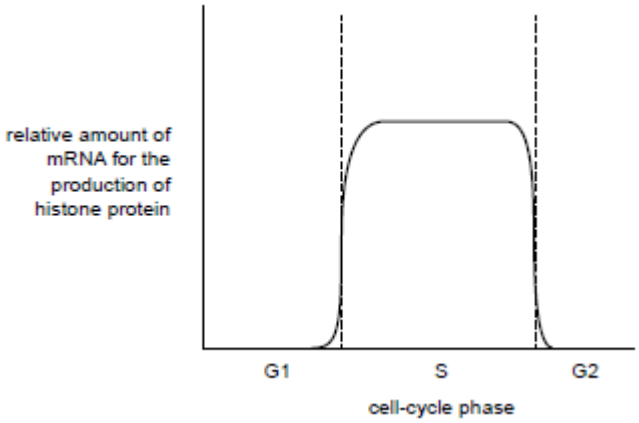
A 1 only

B 1 and 4 only

C 2 and 3 only

D 1, 2, 3 and 4

8 The graph below shows the relative amount of mRNA for the production of histone protein at different times throughout a cell cycle.



Using your knowledge of the cell cycle and the information in the graph, it is correct to state that

A DNA replication occurs most actively in the G1 phase.

B histone genes are highly active throughout the cell cycle.

C histone protein synthesis occurs simultaneously with DNA synthesis.

D histone protein is not present in the cell during the G1 and G2 phases.

9 The following are descriptions of different regions of chromosomes.

1 Non-coding sequences are only located within the genes.

2 The ends of the chromosomes can be lengthened using a RNA template.

3 Sequences found in the middle of the chromosomes are always integral to the positioning of spindle fibres.

4 Each chromosome comprise of tight packing of several DNA molecules around histone proteins and scaffold proteins.

Which of the statements above apply only to a eukaryotic chromosome?

A 2 only

B 1 and 3 only

C 3 and 4 only

D All of the above

10 The sequence below depicts the template strand of a hypothetical gene. The exons are in bold type.

3′ **TAC AAA** CCG GCC **TTT GCC AAA** CCC AAC CTA **AAT ATG AAA ATT** 5′

An allele for this gene codes for a polypeptide with only five amino acids. This is caused by a mutation in one of the exons.

Which of the following describes the change(s) that results in the formation of the shorter polypeptide?

A Deletion of one adenine

B Addition of two cytosine

C Substitution of thymine with adenine

D Addition of cytosine and removal of adenine

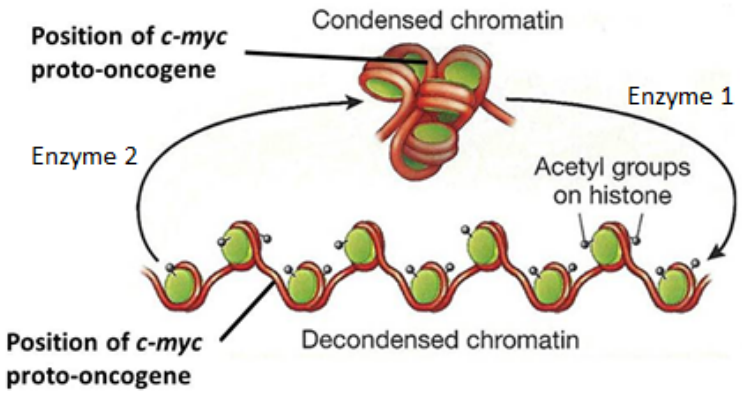
11 The following events occur during transcription.

P. Bonds break between complementary bases.
Q. Bonds form between complementary bases.
R. Phosphodiester bonds form.
S. Free nucleotides pair with complementary nucleotides.

Which options correctly depicts the frequency of the events occurring in the nucleus?

	Occurs once	**Occurs twice**
A	P, R, S	Q
B	Q, R, S	P
C	R, S	P, Q
D	P, S	Q, R

12 The *c-myc* proto-oncogene on chromosome 8 codes for the c-myc protein, a transcription factor that promotes cell proliferation. In cells that are induced to differentiate, the gene is expressed at a very low level. The figure below shows the involvement of two enzymes in regulating the expression of this gene.



Which one of the following statement is true?

A A hyperactive enzyme 2 can lead to tumor formation.

B Enzyme 1 is only functional in both stem cells and cancerous cells.

C Enzyme 2 can be recruited by methylation of *c-myc* gene.

D Both enzymes 1 and 2 carry out chemical modification on the DNA molecule.

13 Which of the following mechanism can reduce the amount of polypeptides produced from a given mRNA molecule?

A Addition of ubiquitin to the mRNA

B Increasing the region of DNA methylation

C Preventing activators from binding to enhancers

D Inhibiting the activity level of poly(A) polymerase

14 Fig. 13.1 represents the changes in the quantity of DNA in two types of cell divisions that occur in different types of cells of an organism. Fig. 13.2 shows the entire set of homologous chromosomes in a diploid sex cell of this organism before it undergoes the type of nuclear division that leads to **P**.

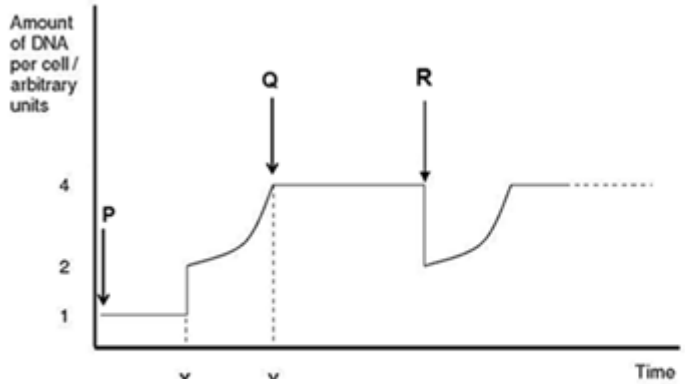


Fig. 13.1

Fig 13.2

Identify the correct combination of outcomes within a cell in this organism at **P**, **Q** and **R**.

	At **P**	At **Q**	At **R**
A		Diploid set of homologous chromosomes, each with identical sister chromatids.	Diploid set of homologous chromosomes, each a single DNA molecule.
B		Diploid set of homologous chromosomes, each with identical sister chromatids.	Haploid set of chromosomes, each a single DNA molecule.
C		Diploid set of homologous chromosomes, each a single DNA molecule.	Haploid set of chromosomes, each a single DNA molecule.
D		Tetraploid sets of homologous chromosomes, each a single DNA molecule.	Diploid set of homologous chromosomes, each a single DNA molecule.

15 Which of the following statements are true of HIV and influenza virus?

1	Genetic material with the same sense
2	Uncoating occurs after fusion of envelope with host membrane
3	Viral particles contain specific enzymes that are not found in the host cells
4	Replication of viral genetic material takes place in the nucleus immediately upon infection
5	Changes in the genome are due to the lack of proofreading mechanism only

A 1 and 4 only
B 2 and 3 only
C 1, 4 and 5 only
D 2, 3 and 5 only

16 In mice, hair colour pigment is expressed by the B/b locus. The dominant allele B codes for black colour hair while the recessive allele b codes for brown colour.

Banding of hair colour is caused by the A/a locus. The dominant agouti allele A causes banding on hairs such that the coat appears paler in colour. Black hair appears grey and brown hair appears beige. The recessive allele a does not cause banding so that the coat is a continuous colour.

What are the likely genotypes of the two parents if the offspring phenotypic ratio of black: grey: beige: brown offspring is 3:3:1:1?

A AaBb and AaBb
B AaBb and aaBb
C AaBb and Aabb
D AABb and aaBB

17 A farmer is interested in selling white squash as a novel vegetable bred two white squashes together and obtained all white squashes in the F1 generation. He then performed a self-cross of one of these F1 offspring and found that the F2 offspring can be grouped into three different colours of squash as shown below.

White squash	234
Yellow squash	58
Green squash	18

Which of the following is the best explanation for the inheritance of fruit colour in squash?

A Fruit colour is controlled by one gene with multiple alleles.

B Fruit colour is controlled by one gene that showed incomplete dominance.

C Fruit colour is controlled by two genes that showed independent assortment.

D Fruit colour is controlled by two epistatic genes that did not assort independently.

18 In a common genetic condition afflicts children, the mutant allele differs from the wild-type allele by a single nucleotide substitution. This substitution eliminates a *NheI* restriction site so that the mutant allele is not cut by the restriction enzyme, *NheI*. A pedigree of a family exhibiting this condition is shown in Fig. 17.1.

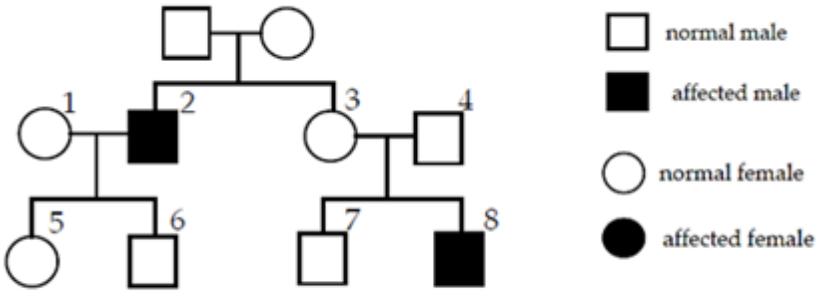


Fig 17.1

The DNA from four individuals in the pedigree were isolated and subjected to polymerase chain (PCR) reaction. This technique amplifies a 1000 bp portion of their DNA that includes the *NheI* site that is affected by the mutation. The PCR products are then digested with *NheI* and analysed. The DNA fragments from the digest are run on an agarose gel and the results are shown in Fig. 17.2.

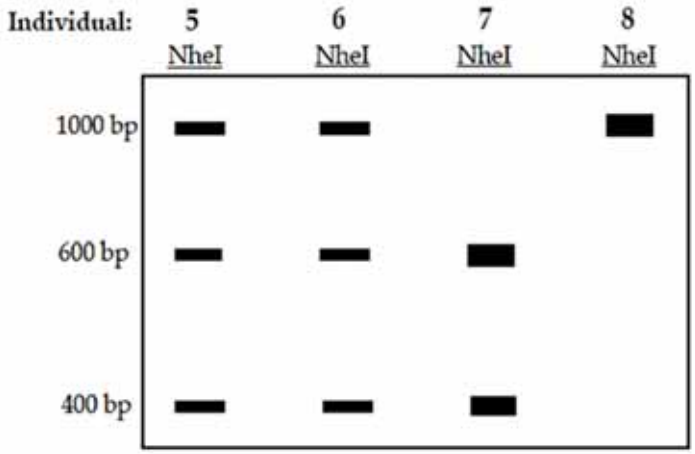


Fig. 17.2

Based on the data in Fig. 17.1 and Fig. 17.2, identify the correct mode of inheritance and the probability of Individuals 3 and 4 having a daughter who will be affected.

	Mode of inheritance of disease	**Probability**
A	autosomal dominant	0.125
B	autosomal recessive	0.25
C	X-linked dominant	0
D	X-linked recessive	0.5

19 Tyrosinase is an enzyme that catalyses the conversion of the amino acid tyrosine into the black pigment melanin. It is responsible for the black fur colour of some rabbits.

group of rabbits kept at 30 °C resulted in 90% of the rabbits with light fur colour. A second group of rabbits kept at 10 °C resulted in 90% of the rabbits with black fur colour.

Which hypothesis is supported by these results?

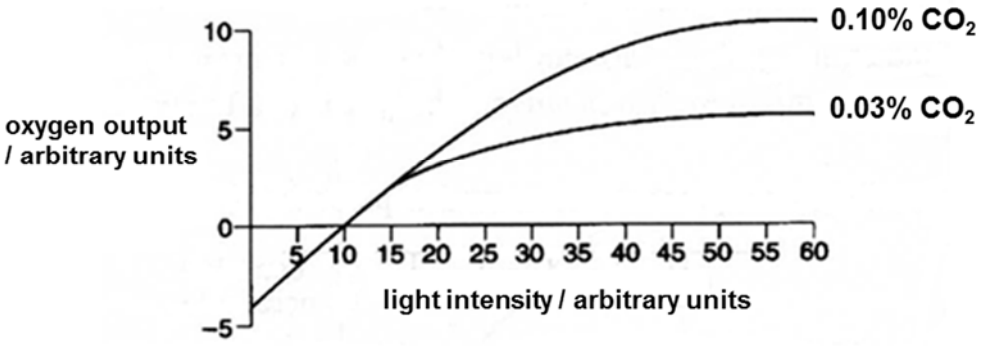
A An inhibitor is present in rabbit skin cells that can bind strongly to tyrosinase when the external temperature is 30 °C.

B At 10 °C external temperature there are fewer tyrosinase-tyrosine complexes formed and less melanin is produced.

C Tyrosinase is an enzyme that is coded for by a gene that is switched off when the external temperature is 10 °C.

D Tyrosinase is a temperature-sensitive molecule that is only activated when the external temperature is 30 °C.

20 The graph shows the oxygen output of a green plant at different light intensities in two separate setups with different concentrations of carbon dioxide in the surrounding air.



What can be deduced from the graph above?

I At 10 arbitrary units of light intensity, the rate of photosynthesis is equivalent to the rate of respiration.

2 Concentration of carbon dioxide limits the rate of photosynthesis when light intensity exceeds 15 arbitrary units.

3 Enzymes catalysing carbon fixation are saturated at high light intensities (above 30 arbitrary units) in both experiments.

4 Oxygen output can be used to quantify the rate of photosynthesis due to their role as final acceptor of protons and electrons.

A 1 only

B 1 and 2 only

C 3 and 4 only

D 2, 3 and 4 only

21 Which of the following statements show a difference between cyclic and non-cyclic photophosphorylation?

A Cyclic photophosphorylation involves PSI and PSII only whereas non-cyclic photophosphorylation involves PSI, PSII and NADP.

B Light energy is required to boost electrons in cyclic photophosphorylation whereas for non-cyclic photophosphorylation, the energy comes from photolysis of water.

C Only non-cyclic photophosphorylation produces protons which is required for the generation of the proton gradient for ATP synthesis.

D Oxygen is produced in non-cyclic photophosphorylation only.

22 Two respirometers (one shown in Fig 22) were set up to investigate the rate of respiration in spiders. To one setup, the spiders were fed a diet containing a drug before the experiment. For this setup, the drop of fluid remained stationary after a short distance from the starting position. Distance moved is shorter than the control setup.

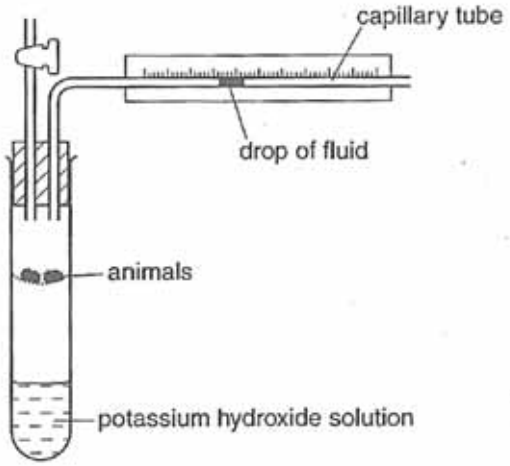


Fig 22

What could be a possible explanation for this observation?

A The oxygen content in the boiling tube was depleted.

B A mutation occurred that causes the ATP synthase to become hyperactive.

C A drug was introduced that act as an ion channel on the mitochondrial membrane.

D Inhibitor of the electron carriers in the electron transport chain was added to the animal's diet.

23 ARHI has been identified as a tumor-suppressor gene and is of significant importance in modulating cell growth and apoptosis. It was proposed that in cancerous cells, ARHI gene expression was decreased. Expression of ARHI is proposed to be related to acetylated STAT3.

To study how the expression of ARHI is affected by acetylation of STAT3, cultures of normal ovarian epithelial cells and ovarian cancer cells were analysed. The results are shown in Fig 23.1 and 23.2 below.

Fig 23.1 shows the extent of methylation in normal and cancer ovarian cultures. For Fig 23.2, amount of protein present is indicated by the density and thickness of the band.

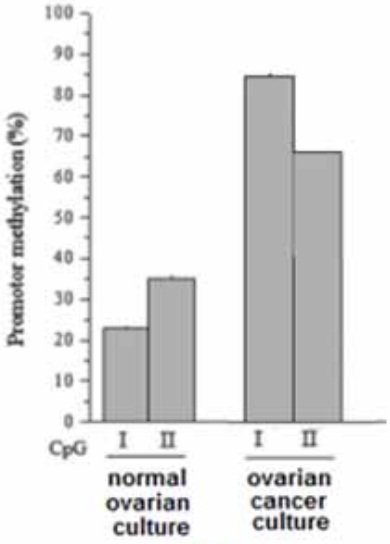


Fig 23.1

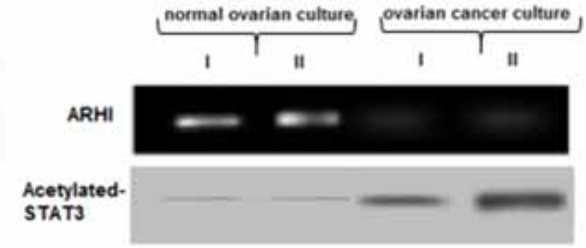


Fig 23.2

From the information given, which of the following is true?

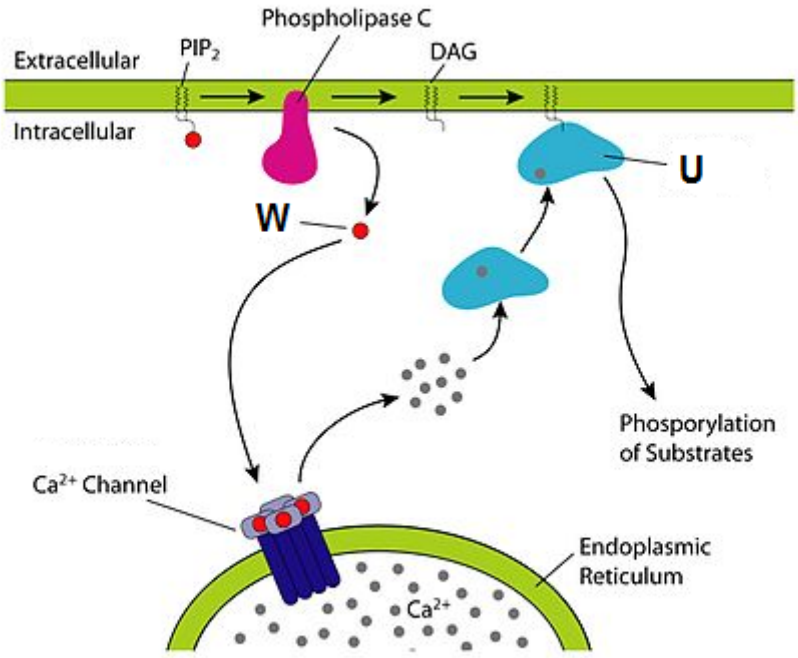
A Normal ovarian cells show lower methylation of the ARHI promoter which increases the accessibility of the ARHI gene, resulting in the synthesis of acetylated STAT3 which promotes apoptosis.

B Acetylation of STAT3 results in increased accessibility of ARHI gene, resulting in ARHI being expressed in normal ovarian cells.

C Elevated acetylated STAT3 in ovarian cancer cells results in hypermethylation of the AHRI promoter, decreasing its expression.

D Lower methylation of the ARHI gene in normal ovarian cells results in ARHI being expressed as the gene is loosely coiled around the acetylated STAT3.

24 The figure below shows a signaling pathway involving calcium ions.



Which of following is true about molecules W and U?

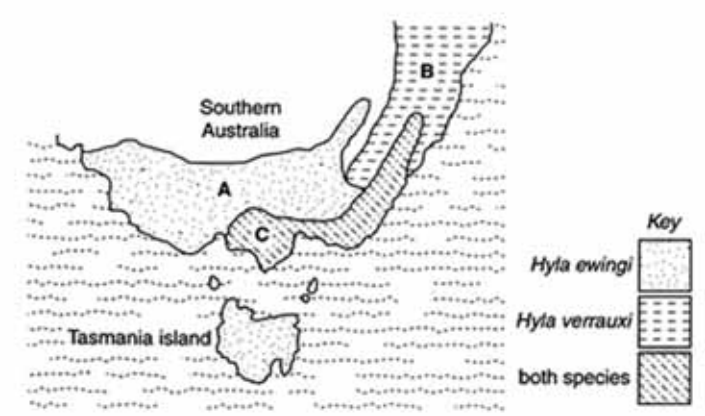
A Both molecules W and U are made up of amino acids.

B Only molecule W is expected to be produced in large number.

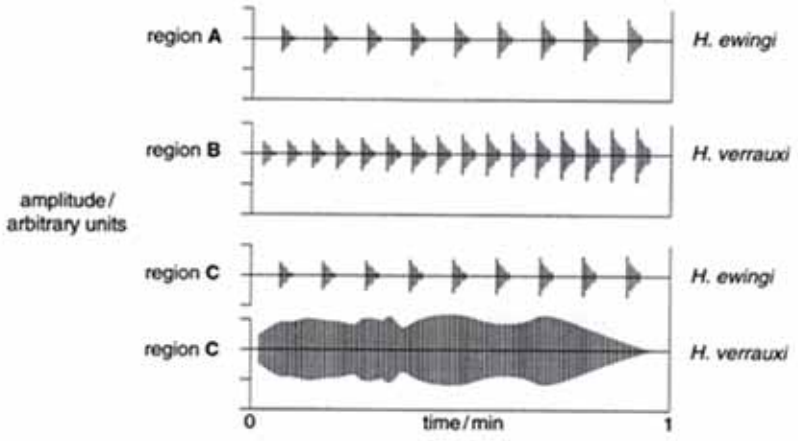
C Increased production of both W and U occurs in response to the binding of ligand.

D Removal of molecule W from the cell will result in the inability of ligand to bind to the receptor.

25 *Hyla ewingi* and *Hyla verrauxi* are two closely related species of tree frogs from southern Australia.



DNA sequence comparisons show a high level of homology and interbreeding can occur to produce viable offspring. Mate selection is based on females responding to the frequency of mating calls emitted by male frogs. The following data shows the pulse frequency and amplitude in the mating calls of *H. ewingi* and *H. verrauxi* from the regions **A**, **B** and **C**.



The distinct mating call observed in region C involves events shown below:

I Sexual selection by females of *Hyla verrauxi* selects for males with a continuous calls over males that emit a discontinuous call.

II Female *Hyla verrauxi* tree frogs preferred mates that emit calls of higher amplitude.

III Males of both species in region C compete for mates.

IV Variations in amplitude occur in male mating calls present in population of *Hyla* frogs.

V The genes that code for continuous high amplitude calls are passed down to future generations and become established in the population of *H. verrauxi.*

What is the correct sequence of events that leads to the distinct profile of male mating call of *H verrauxi* in region C?

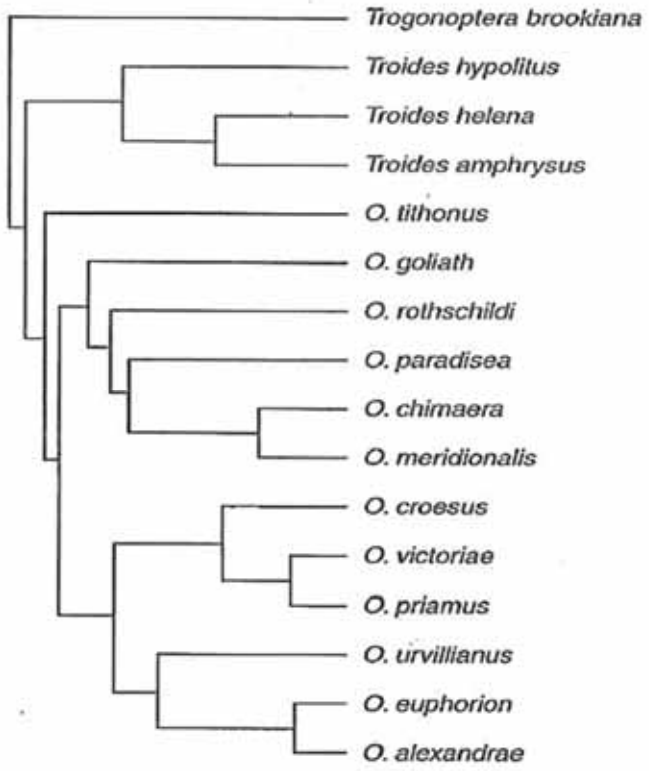
A III → I → IV → II → V

B I → II → IV → III → V

C IV → I → V → III → II

D II → IV → V → I → III

26 The figure is a phylogenetic tree of three genera of butterflies *(Orniithoptera*, *Trogonoptera* and *Troides)* that was constructed based on the comparison of the nucleotide sequences of the gene *ND5* that is located in the mitochondrial genome.



Based on the phylogenetic tree, what conclusions can be drawn regarding the relationships of these three genera?

1 The three genera *Orniithoptera*, *Trogonoptera* and *Troides* form a monophyphyletic clade.

2 *O. victoriae* shares fewer identical nucleotides in the ND5 gene with *O. alexandrae* than with *O. goliath.*

3 *Troides hypolitus* shares both ancestral and shared derived traits with *Troides helena* and *Troides amphyrysus.*

4 *Trogonoptera brookiana* diverged from the common ancestor much earlier than *O. alexandrae* so it is now extinct.

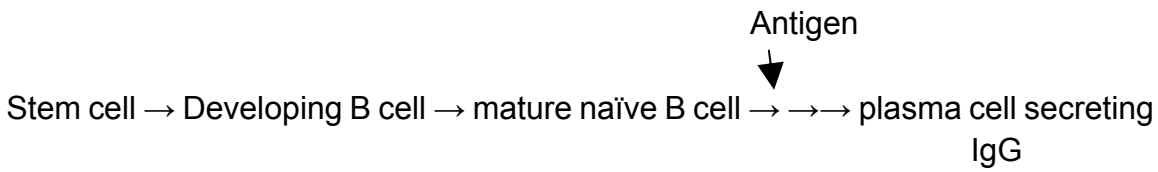
A 1 only

B 1 and 3 only

C 2 and 4 only

D 2, 3 and 4 only

27 The flow chart below shows the development of a B cell.



Which of the following statements below are true of the different cells above?

I	In a developing B cell, somatic hypermutation produces different mature naïve B cells with different BCR (B cell receptor).
II	The mature, naïve B cell will be expressing both IgM and IgD on its cell surface membrane.
III	From one stem cell, it is possible to obtain many different mature naïve B cells each specific for a different antigen.
IV	The plasma cell will contain all the genes present in the stem cell.

A I and II only

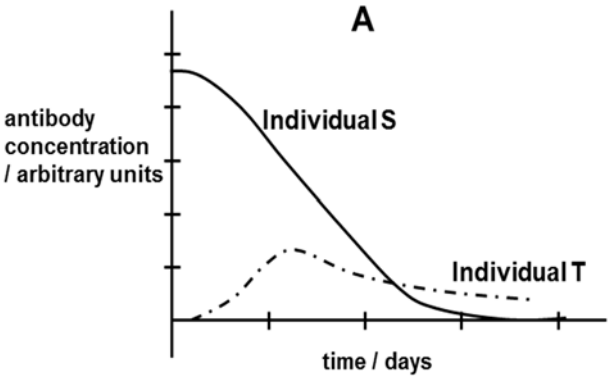
B I and III only

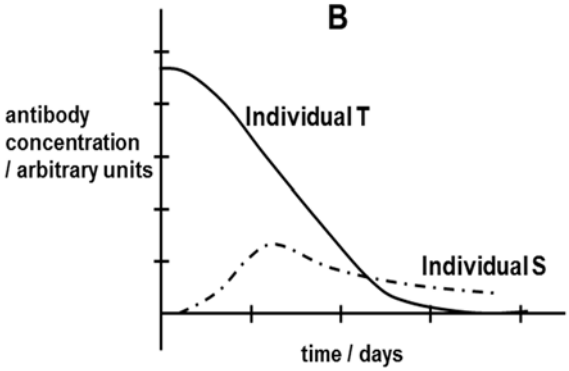
C II and III only

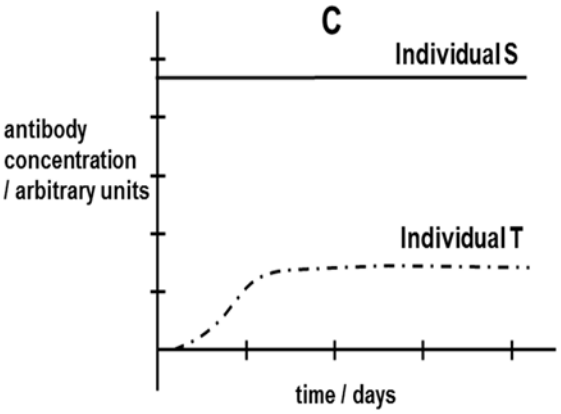
D III and IV only

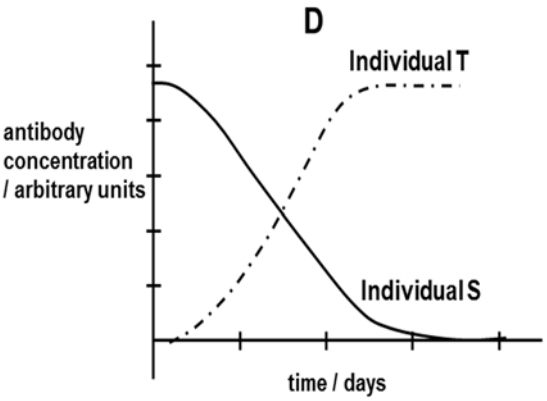
28 Two individuals took part in a study to investigate the effectiveness of two different types of immunisation. Individual S received an injection of antibodies against tetanus and Individual T received a tetanus vaccination.

Which of the options below shows correctly the changes to the antibody concentration in the blood of S and T?

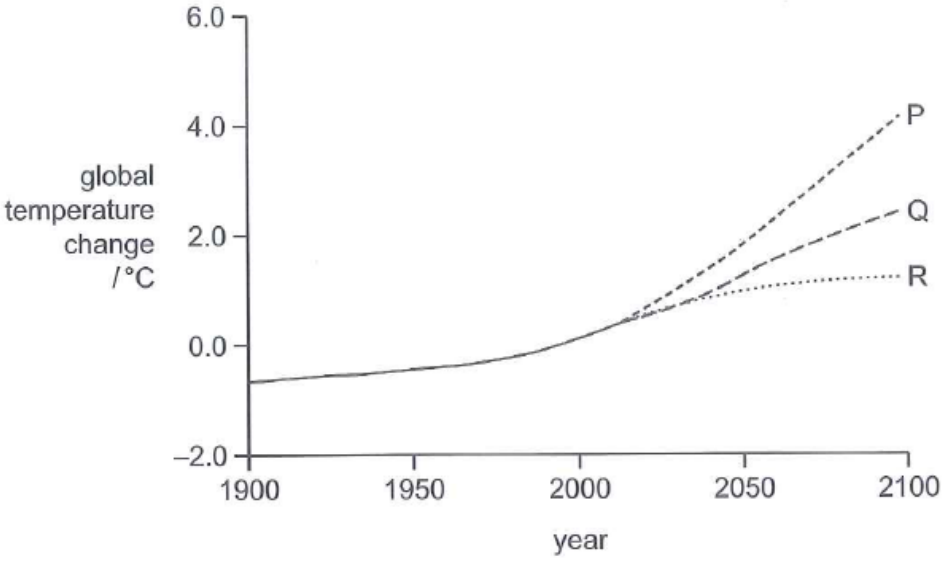








29 The graph shows the predicted change in global temperatures using three different models, P, Q and R. Model Q assumes that no new factors act to influence the rate of climate change.



The predictions based on models P and R can be explained using some of the following statements.

1 An increased global temperature and reduced rainfall will lead to an increase in forest fires.

2 Permanently frozen soil and sediment in the Arctic will begin to thaw as global temperatures increase.

3 Rising sea temperatures will cause increased growth of photosynthetic algae.

4 Rising sea temperatures will reduce the solubility of greenhouse gases in the oceans.

Which of these statements support predictions of P and R?

	Statements that support prediction **P**	Statements that support prediction **R**
A	1, 2 and 4	3
B	1 and 3	2 and 4
C	2	1, 3 and 4
D	3 and 4	1 and 2

30 Rice crops in Japan are damaged by the green rice leafhopper *(Nephotettix cincticeps),* a pest that reduces crop yield.

In a study of the effect of climate change on crop damage by the green rice leafhopper, it was found that an increase in winter temperatures caused an increase in crop damage, while an increase in summer temperatures caused a decrease in crop damage.

Which of the following are possible explanations for these findings?

1 Increased temperatures in the summer cause a rise in metabolic rate that results in the pests reproducing more rapidly.

2 Increased temperatures in the summer raise the metabolic rate above the range that the pests can tolerate.

3 Increased temperatures in the winter disrupt the pests' life cycle and result in fewer being able to reproduce.

4 Increased temperatures in the winter allow more pests to survive and results in an increase in the pest population.

A 1 and 3 only

B 1 and 4 only

C 2 and 3 only

D 2 and 4 only