VICTORIA JUNIOR COLLEGE

JC 2 PRELIMINARY EXAMINATION 2017

NAME : _____

CT CLASS : _____

H1 BIOLOGY **8875/1**

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.

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

A Both are non-membrane bound organelles.

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

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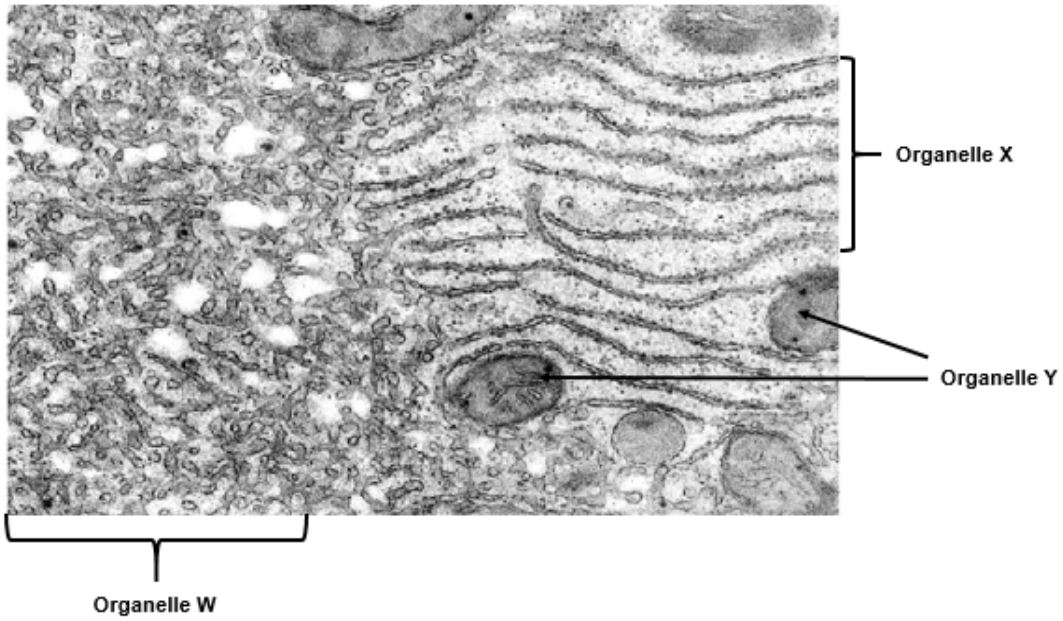

Which of the following statements about these organelles is true?

A Only organelle Y contains RNA.

B Only organelle W contains carbohydrates and phospholipids.

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D Organelles X and Y have double membranes 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
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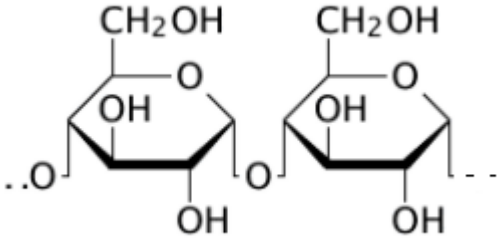

Fig 4

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).

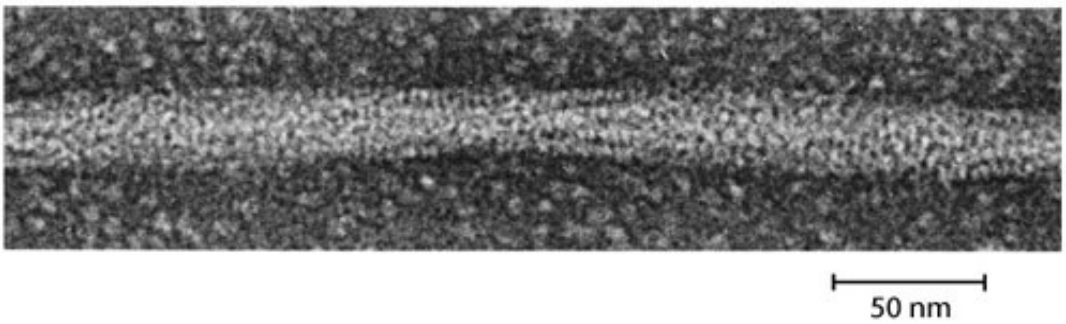

Fig 5

[From G. Rykes, R.H. Crepeau, and S.J. Edelstein. *Nature* 272(1978):509.]
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Which of the following statements is true?

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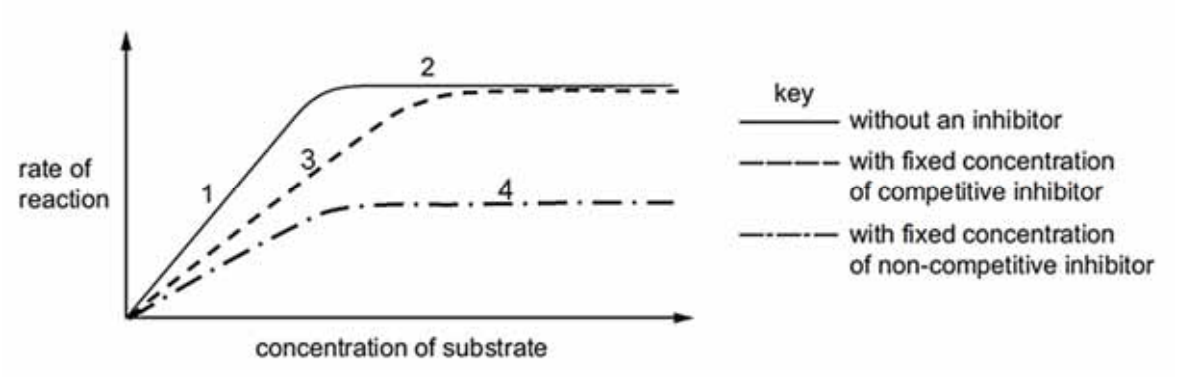

What is limiting the rate of the enzyme-catalysed reaction at 1, 2, 3 and 4 on the graph?

	1	2	3	4
A	enzyme concentration	substrate concentration	competitive inhibitor	non-competitive inhibitor
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A Crossing over of sister chromatids during prophase I and random orientation of homologous chromosomes in metaphase II

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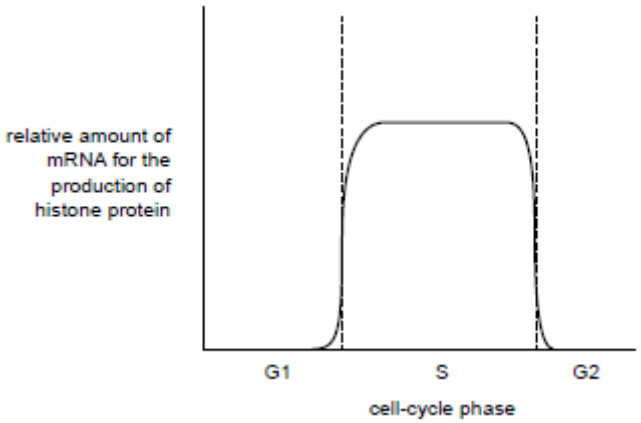


Using your knowledge of the cell cycle and the information in the graph, it is correct to state that

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 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 cytosines

C Substitution of thymine with adenine

D Addition of cytosine and removal of adenine

10 The mechanism of action of four drugs that inhibit DNA replication is stated below:

- Drug 1 inhibits the action of DNA ligase.
- Drug 2 resembles the shape of a DNA nucleotide.
- Drug 3 attaches irreversibly to the DNA molecule.
- Drug 4 binds irreversibly to the active site of DNA polymerase.

Which option correctly matches the drug(s) to the effect on DNA replication?

	Daughter strands of varying lengths are synthesized.	Only fragments are synthesized at the end of replication process.	Phosphodiester bonds cannot be formed.	Template strand becomes inaccessible by the enzyme.
A	4	3	2	1
B	2	4	3	1
C	2	1	4	3
D	3	2	1	4

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 following statements are descriptions of polynucleotides found in eukaryotes.

1. Has catalytic properties
2. Can associate closely with specific proteins
3. Has variable length
4. Has fixed length and can fold into specific shape
5. Can be subjected to degradation by cytoplasmic enzymes

Which row matches the description to its function?

	Stores coded information	Provides a site for amino acid to bind	Forms a ribosome	Serves as a template for translation
A	4	5	1, 3	2
B	3, 5	1	2	4
C	2	4	1	3, 5
D	1, 5	2	4	3

13 The following two examples illustrate the inheritance of a sex-linked gene on the X-chromosome. In the parental generation (*P*), the homogametic sex is homozygous for colour in both examples.

Cat	**Magpie Moth**
black dominant to yellow	normal colour dominant to pale colour
P Black male x yellow female	*P* Pale colour male x normal female
F 1 yellow male to 1 black female	*F* 1 normal male to 1 pale female

In these crosses, the heterogametic sex is…

A male in the cat, female in the moth
B female in the cat, male in the moth
C male in both the cat and moth
D female in both the cat and moth

14 After pollinating plant 1, which had rough stems and yellow flowers, with plant 2, which had rough stems and white flowers, 80 seeds were obtained. When sown, these seeds grew into plants showing the four combinations of characteristics as follows:

26 with rough stems and yellow flowers.
12 with smooth stems and yellow flowers.
33 with rough stems and white flowers.
9 with smooth stems and white flowers.

Assuming that yellow is the dominant flower colour, which one of the following options is confirmed by these results?

	plant 1 is heterozygous for	**plant 2 is heterozygous for**
A	stem surface and flower colour	flower colour only
B	stem surface and flower colour	stem surface only
C	flower colour only	flower colour and stem surface
D	stem surface only	flower colour and stem surface

15 Flamingos are birds that live by lakes. The feather colour of flamingos may vary from white to pink to red. To investigate the inheritance of feather colour, a scientist performed the following crosses and recorded the feather colour of all the offspring when one year old. The diet of the offspring was also recorded.

Cross	**Feather colour of parents**	**Feather colour of all one-year-old offspring**	**Diet of offspring**
1	white × white	white	aquatic plants
2	red × white	white	aquatic plants
3	white × white	pink	algae and crustaceans
4	red × white	pink	algae and crustaceans

Based on this information, a correct conclusion would be that…

A both the parents in cross 1 must be homozygous for white feather colour.

B white feather colour is recessive to red feather colour

C the feather colour of flamingos is influenced by their environment.

D two parents, both with pink feather colour, would produce pink offspring

16 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.

A 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.

17 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.

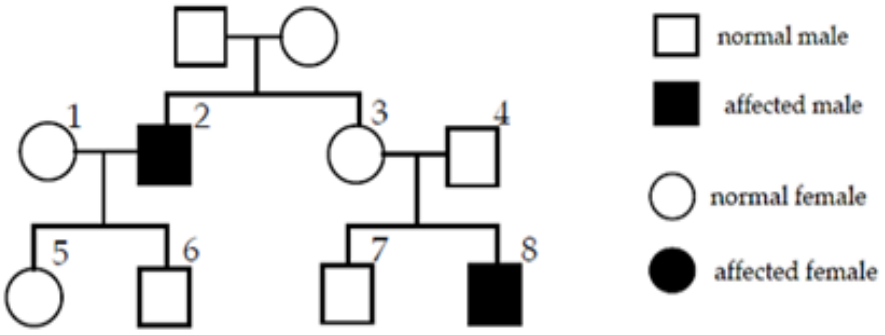


Fig 17.1

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.

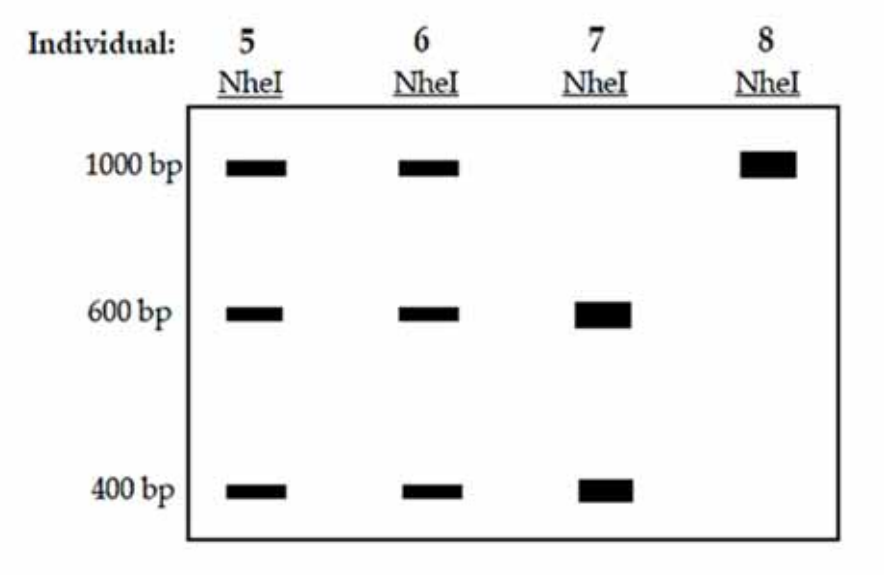
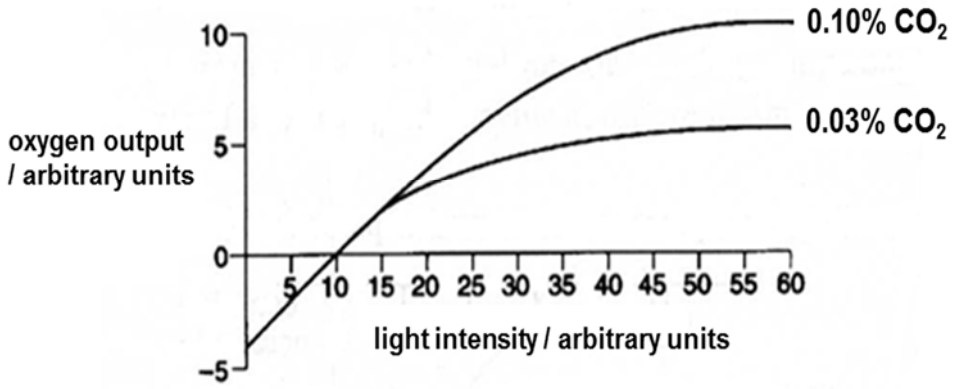


Fig. 17.2

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 of 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

18 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

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

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

B Light is required to boost electrons 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.

20 Metformin is widely used to reduce high blood sugar levels caused by diabetes.

It exerts its activity through increasing glucose uptake and utilisation by cells. Metformin has also been shown to affect mitochondrial respiration in the following ways:

- Decreases the activity of the enzyme (pyruvate dehydrogenase) that converts pyruvate to acetyl CoA
- Inhibit one of the electron carriers in the electron transport chain

Which of the following are possible observations of cells that have been treated with metformin?

1. An increase in oxygen uptake by the cells.
2. A decrease in the pH of the cytoplasm
3. An increase in the breakdown of glucose.
4. A decrease in the carbon dioxide release.

A 1 and 4 only

B 2 and 3 only

C 3 and 4 only

D 2, 3 and 4 only

21 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.

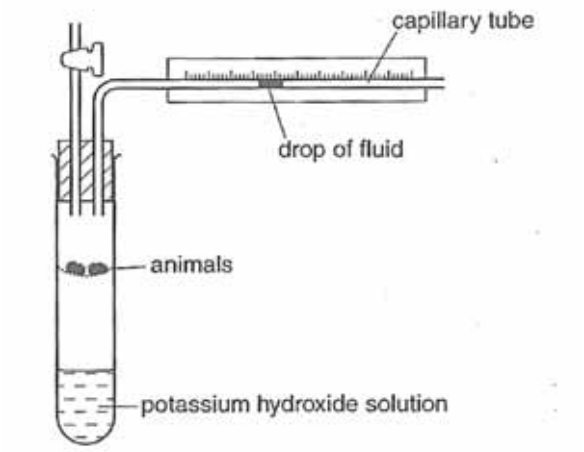


Fig 22

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.

22 Which feature does **not** support Darwin's theory of natural selection?

A adaptations to the environment, e.g. increased density of fur in bears in cold climates

B homologous molecular structures, e.g. ATP in diverse organisms

C similar anatomy, e.g. same number of neck vertebrae among mammals

D similar structures for specific functions, e.g. fin of whale and shark

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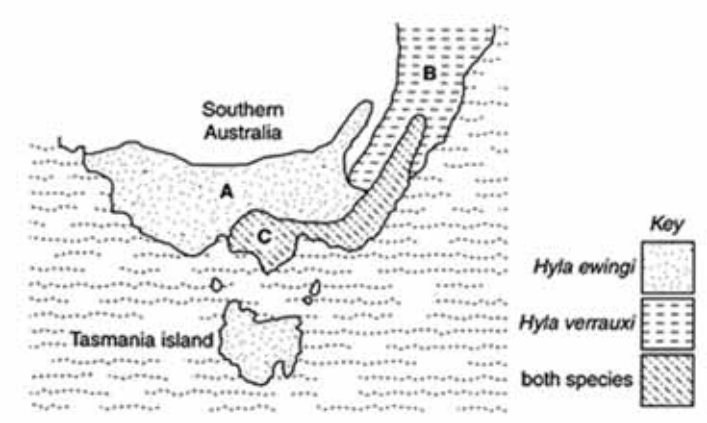
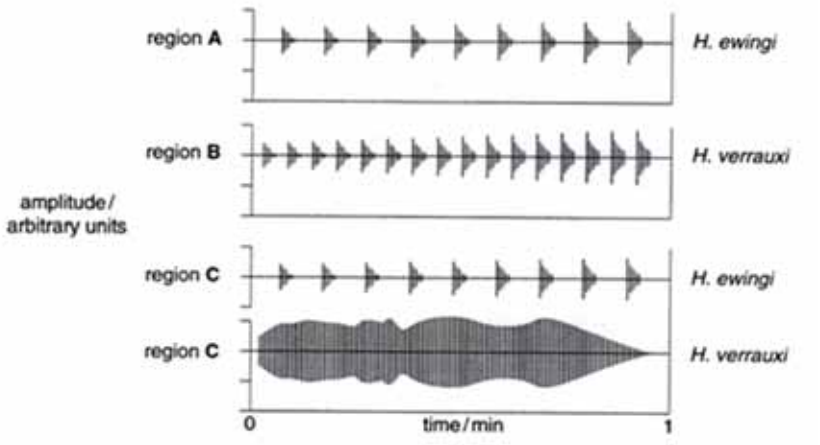
23 *Hyla ewingi* and *Hyla verrauxi* are two closely related species of tree frogs from southern Australia.



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?

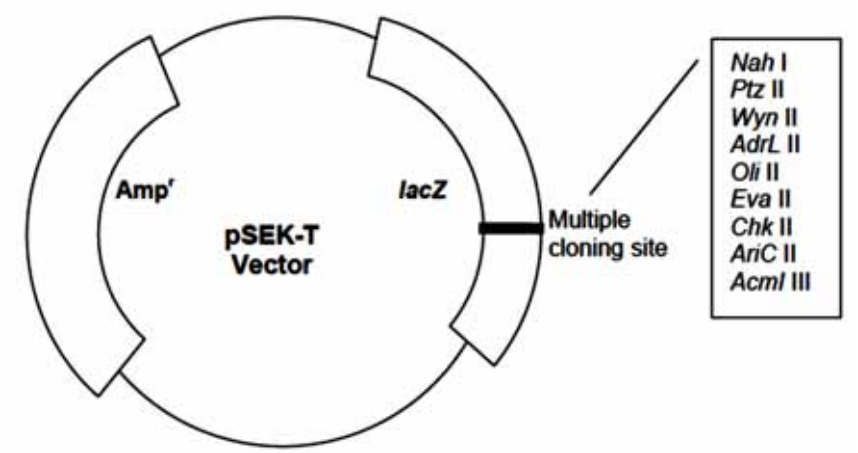
A III → I → IV → II → V

B I → II → IV → III → V

C IV → I → V → III → II

D II → IV → V → I → III

24 As part of the procedure to produce recombinant proteins in *E. coli*, you are asked to insert the gene encoding for the D-ONG protein into the pSEK-T vector. The restriction sites and selectable markers on the vector are shown below.



If the gene for D-ONG protein were to be inserted into the multiple cloning site, what should be added to the agar plate in order to screen for recombinant clones and how would the recombinant clones appear?

	Chemicals to be added		**Colour of colonies**
A	Ampicillin	X-gal	Blue
B	β-galactosidase	X-gal	Blue
C	Ampicillin	X-gal	White
D	β-galactosidase	Lactose	White

25 Which of the following does **not** occur during the polymerase chain reaction?

A Synthesis of a complementary primer

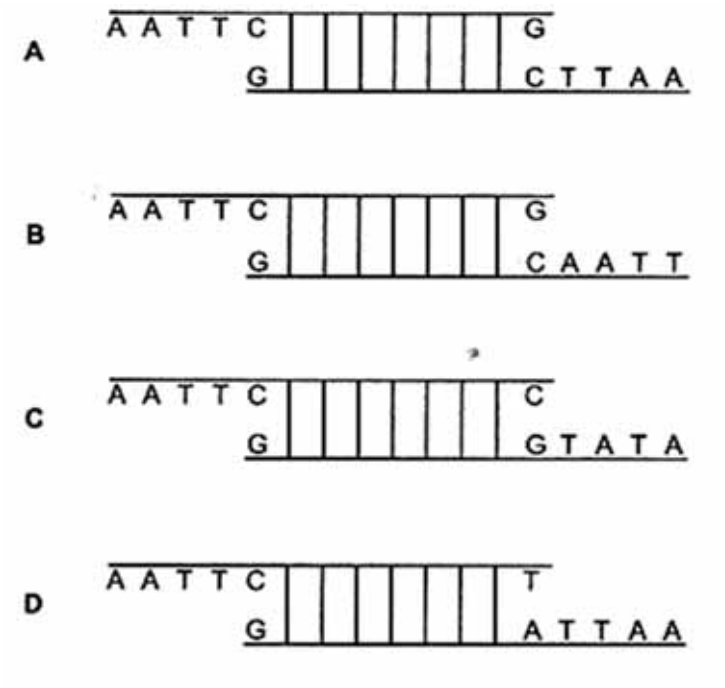
B Separation of parental DNA strands

C Formation of strong covalent bonds

D Involvement of inorganic enzyme co-factors

26 In genetic engineering, a restriction enzyme is used to cut plasmid DNA at a specific target site. The enzyme recognises a sequence of six bases and forms sticky ends.

Which diagram of such a cut section of DNA is correct? A



27 One type of GM tilapia that is close to commercial consideration is a hybrid of two tilapia species, with transgene consisting of a tilapia growth hormone cDNA spliced to a viral promoter. Consumers and critics have expressed some concerns about the production of GM tilapia.

I excessive production of growth hormone in the tilapia

II GM fish gaining a mating advantage over wild tilapia should they escape

III production of foreign protein in tilapia

IV undesirable effects of transgene

Which of their concerns is / are not valid?

A I and II

B II and III

C III only

D IV only

28 Which combination of properties is true about embryonic stem cells and hematopoietic stem cells?

	embryonic stem cells	**hematopoietic stem cells**
A	able to form all cell types in the body excluding extra-embryonic tissues	able to form some cell types in the body
B	can self-renew but not differentiate	can self-renew and differentiate
C	cannot perform a specialized function	can perform a specialized function
D	totipotent	multipotent

29 Which of the following is an outcome of the Human Genome Project that has ethical implications?

A Screening of the genetic make-up of newborn infants for susceptibility to certain key diseases.

B Creation of customised medicines that are potentially more expensive to produce than traditional drugs.

C Consideration of a suspect's genetic pre-disposition to violent behaviour in criminal trials

D The free availability and accessibility of the complete sequence of the human genome on the Internet.

30 Which of the following is **not** a possible concern of cultivating *Bt* corn?

A Toxic effects of *Bt* on non-target insects e.g. monarch butterfly larvae could have predictable ecological consequences.

B Transfer of selection marker to bacteria that reside in the human gut thereby conferring upon the bacteria antibiotic resistance

C Spread of the *Bt* gene from cultivated corn to wild relative which would then lead to the loss of biodiversity

D Transfer of *Bt* gene to the pests thereby increasing their resistance to the *Bt* toxin

-End of paper-

VICTORIA JUNIOR COLLEGE

JC 2 PRELIMINARY EXAMINATION 2017

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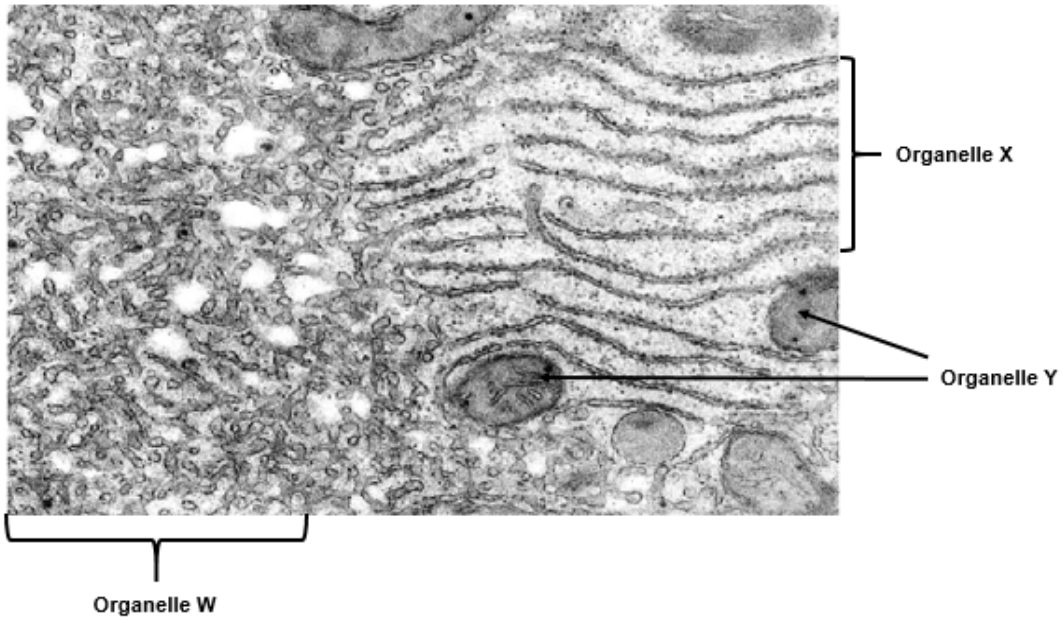

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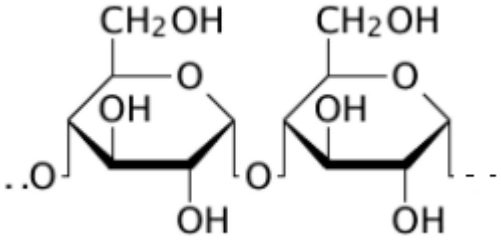

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B	√	X	√	X
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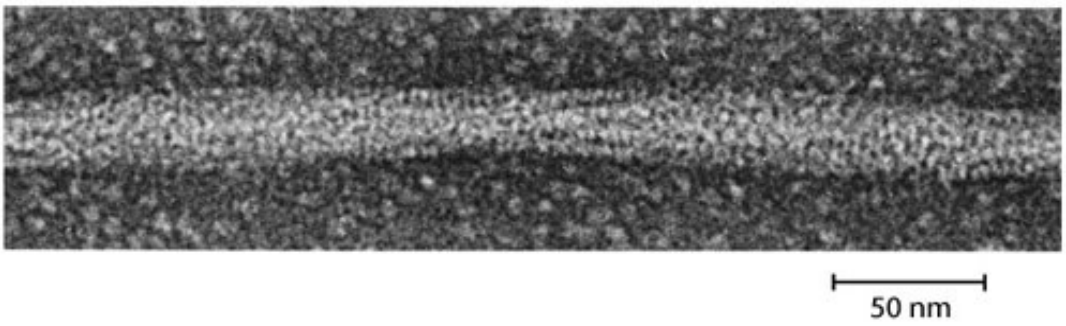

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Source: http://www.nslc.wustl.edu/sicklecell/part2/molecular.html

Which of the following statements is true?

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

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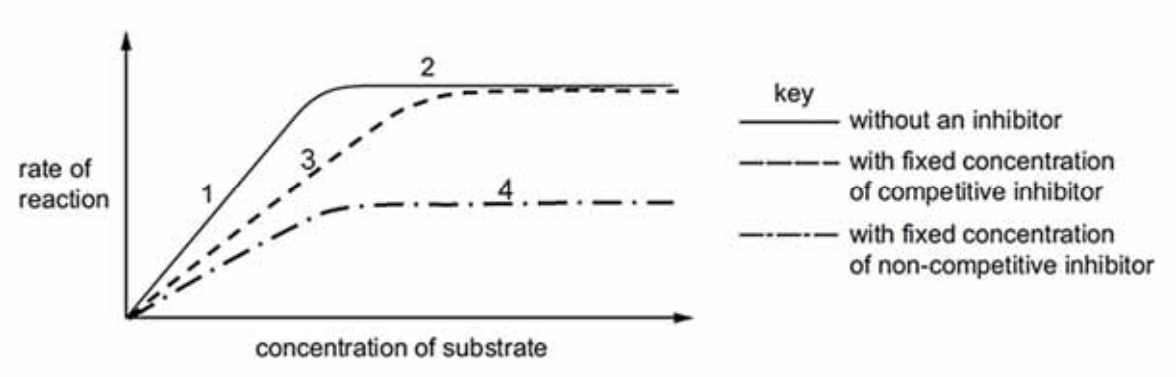

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B Crossing over in prophase I and random orientation of homologous chromosomes in metaphase I

C Pairing of maternal and paternal chromosomes during prophase I and crossing over in metaphase I

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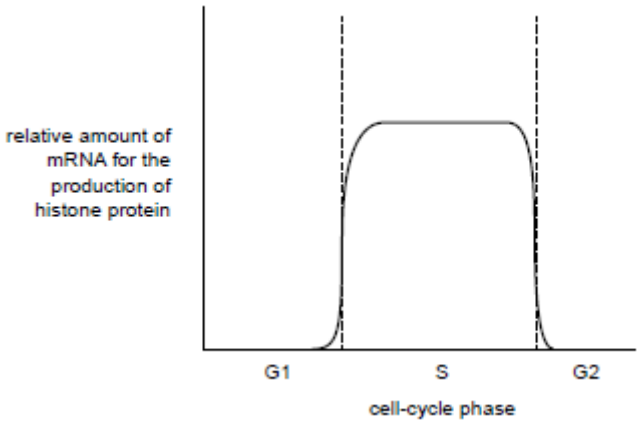
8 The graph below shows the relative amount of mRNA for the production of histone protein at different times throughout a cell cycle.



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 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 cytosines

C Substitution of thymine with adenine

D Addition of cytosine and removal of adenine

10 The mechanism of action of four drugs that inhibit DNA replication is stated below:

- Drug 1 inhibits the action of DNA ligase.
- Drug 2 resembles the shape of a DNA nucleotide.
- Drug 3 attaches irreversibly to the DNA molecule.
- Drug 4 binds irreversibly to the active site of DNA polymerase.

Which option correctly matches the drug(s) to the effect on DNA replication?

	Daughter strands of varying lengths are synthesized.	Only fragments are synthesized at the end of replication process.	Phosphodiester bonds cannot be formed.	Template strand becomes inaccessible by the enzyme.
A	4	3	2	1
B	2	4	3	1
C	2	1	4	3
D	3	2	1	4

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 following statements are descriptions of polynucleotides found in eukaryotes.

1. Has catalytic properties
2. Can associate closely with specific proteins
3. Has variable length
4. Has fixed length and can fold into specific shape
5. Can be subjected to degradation by cytoplasmic enzymes

Which row matches the description to its function?

	Stores coded information	Provides a site for amino acid to bind	Forms a ribosome	Serves as a template for translation
A	4	5	1, 3	2
B	3, 5	1	2	4
C	2	4	1	3, 5
D	1, 5	2	4	3

13 The following two examples illustrate the inheritance of a sex-linked gene on the X-chromosome. In the parental generation (*P*), the homogametic sex is homozygous for colour in both examples.

Cat	**Magpie Moth**
black dominant to yellow	normal colour dominant to pale colour
P Black male x yellow female	*P* Pale colour male x normal female
F 1 yellow male to 1 black female	*F* 1 normal male to 1 pale female

In these crosses, the heterogametic sex is…

A male in the cat, female in the moth
B female in the cat, male in the moth
C male in both the cat and moth
D female in both the cat and moth

14 After pollinating plant 1, which had rough stems and yellow flowers, with plant 2, which had rough stems and white flowers, 80 seeds were obtained. When sown, these seeds grew into plants showing the four combinations of characteristics as follows:

26 with rough stems and yellow flowers.
12 with smooth stems and yellow flowers.
33 with rough stems and white flowers.
9 with smooth stems and white flowers.

Assuming that yellow is the dominant flower colour, which one of the following options is confirmed by these results?

	plant 1 is heterozygous for	**plant 2 is heterozygous for**
A	stem surface and flower colour	flower colour only
B	stem surface and flower colour	stem surface only
C	flower colour only	flower colour and stem surface
D	stem surface only	flower colour and stem surface

15 Flamingos are birds that live by lakes. The feather colour of flamingos may vary from white to pink to red. To investigate the inheritance of feather colour, a scientist performed the following crosses and recorded the feather colour of all the offspring when one year old. The diet of the offspring was also recorded.

Cross	**Feather colour of parents**	**Feather colour of all one-year-old offspring**	**Diet of offspring**
1	white × white	white	aquatic plants
2	red × white	white	aquatic plants
3	white × white	pink	algae and crustaceans
4	red × white	pink	algae and crustaceans

Based on this information, a correct conclusion would be that…

A both the parents in cross 1 must be homozygous for white feather colour.

B white feather colour is recessive to red feather colour

C the feather colour of flamingos is influenced by their environment.

D two parents, both with pink feather colour, would produce pink offspring

16 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.

A 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.

17 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.

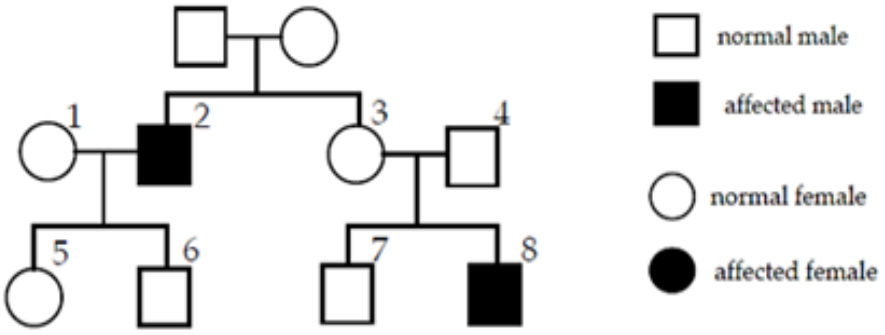


Fig 17.1

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.

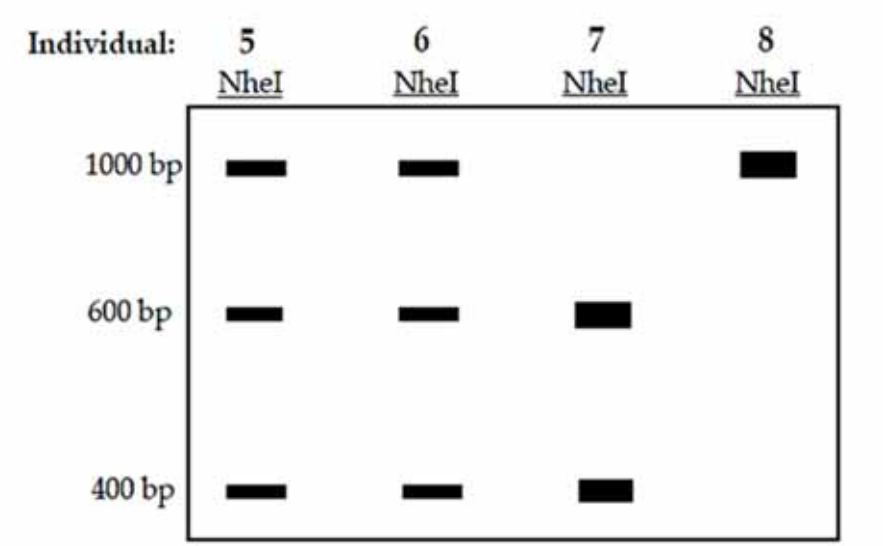
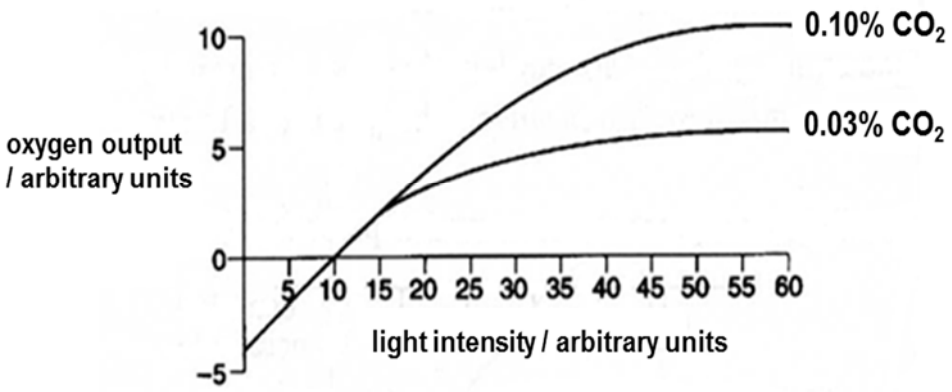


Fig. 17.2

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 of 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

18 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

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

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

B Light is required to boost electrons 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.

20 Metformin is widely used to reduce high blood sugar levels caused by diabetes.

It exerts its activity through increasing glucose uptake and utilisation by cells. Metformin has also been shown to affect mitochondrial respiration in the following ways:

- Decreases the activity of the enzyme (pyruvate dehydrogenase) that converts pyruvate to acetyl CoA
- Inhibit one of the electron carriers in the electron transport chain

Which of the following are possible observations of cells that have been treated with metformin?

1. An increase in oxygen uptake by the cells.
2. A decrease in the pH of the cytoplasm
3. An increase in the breakdown of glucose.
4. A decrease in the carbon dioxide release.

A 1 and 4 only

B 2 and 3 only

C 3 and 4 only

D 2, 3 and 4 only

21 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.

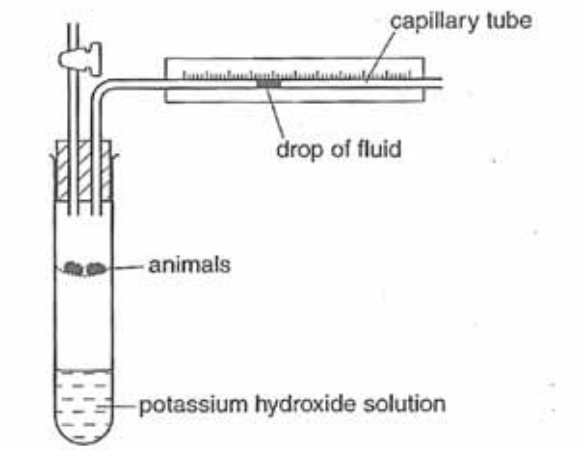


Fig 22

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.

22 Which feature does **not** support Darwin's theory of natural selection?

A adaptations to the environment, e.g. increased density of fur in bears in cold climates

B homologous molecular structures, e.g. ATP in diverse organisms

C similar anatomy, e.g. same number of neck vertebrae among mammals

D similar structures for specific functions, e.g. fin of whale and shark

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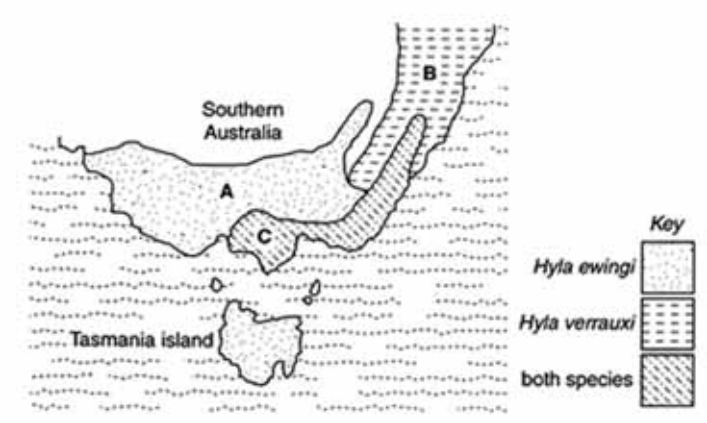
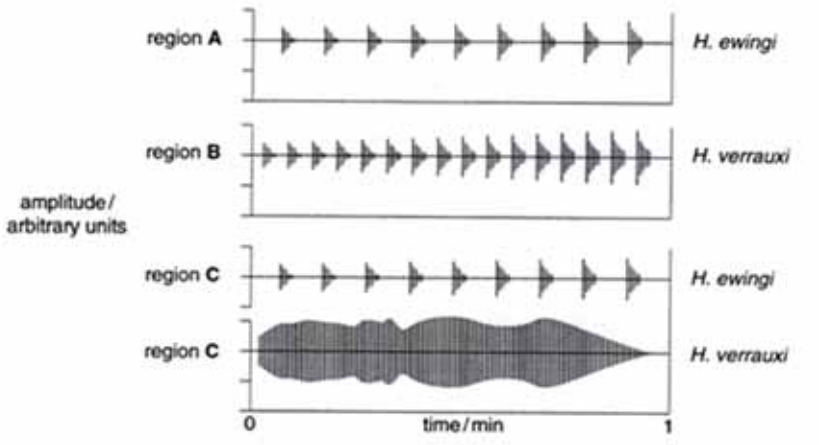
23 *Hyla ewingi* and *Hyla verrauxi* are two closely related species of tree frogs from southern Australia.



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?

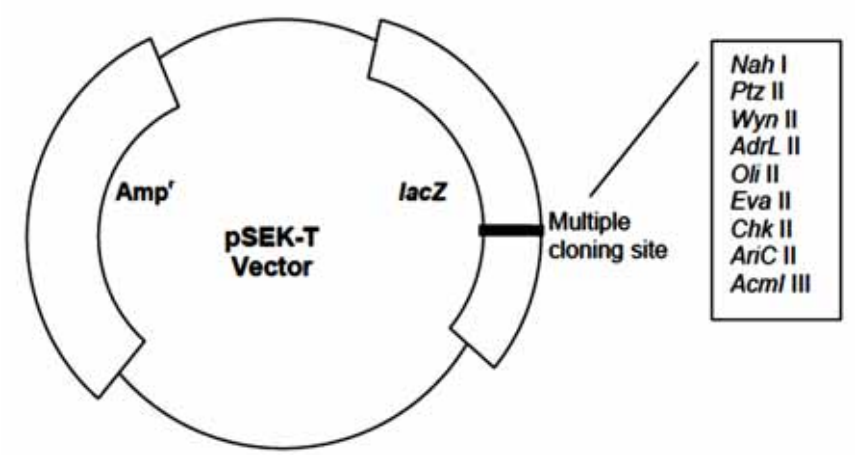
A III → I → IV → II → V

B I → II → IV → III → V

C IV → I → V → III → II

D II → IV → V → I → III

24 As part of the procedure to produce recombinant proteins in *E. coli*, you are asked to insert the gene encoding for the D-ONG protein into the pSEK-T vector. The restriction sites and selectable markers on the vector are shown below.



If the gene for D-ONG protein were to be inserted into the multiple cloning site, what should be added to the agar plate in order to screen for recombinant clones and how would the recombinant clones appear?

	Chemicals to be added		**Colour of colonies**
A	Ampicillin	X-gal	Blue
B	β-galactosidase	X-gal	Blue
C	Ampicillin	X-gal	White
D	β-galactosidase	Lactose	White

25 Which of the following does **not** occur during the polymerase chain reaction?

A Synthesis of a complementary primer

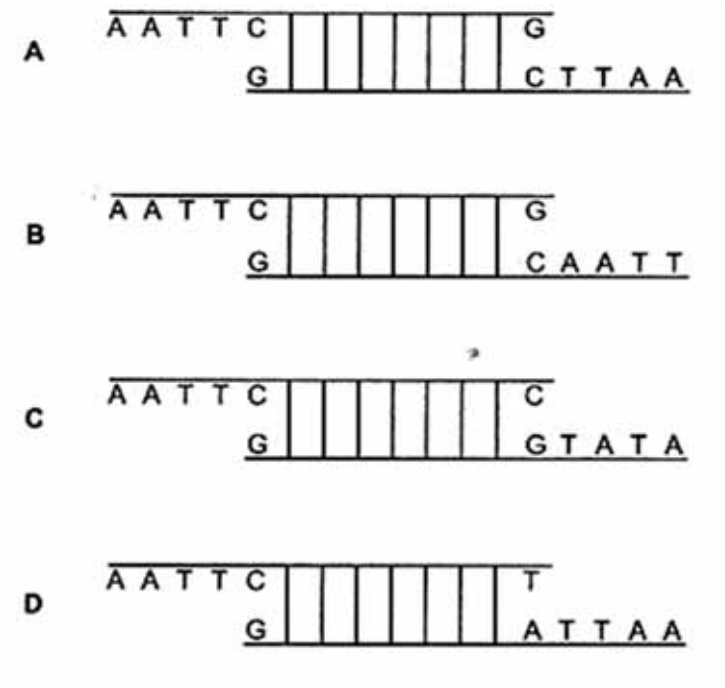
B Separation of parental DNA strands

C Formation of strong covalent bonds

D Involvement of inorganic enzyme co-factors

26 In genetic engineering, a restriction enzyme is used to cut plasmid DNA at a specific target site. The enzyme recognises a sequence of six bases and forms sticky ends.

Which diagram of such a cut section of DNA is correct? A



27 One type of GM tilapia that is close to commercial consideration is a hybrid of two tilapia species, with transgene consisting of a tilapia growth hormone cDNA spliced to a viral promoter. Consumers and critics have expressed some concerns about the production of GM tilapia.

I excessive production of growth hormone in the tilapia

II GM fish gaining a mating advantage over wild tilapia should they escape

III production of foreign protein in tilapia

IV undesirable effects of transgene

Which of their concerns is / are not valid?

A I and II

B II and III

C III only

D IV only

28 Which combination of properties is true about embryonic stem cells and hematopoietic stem cells?

	embryonic stem cells	**hematopoietic stem cells**
A	able to form all cell types in the body excluding extra-embryonic tissues	able to form some cell types in the body
B	can self-renew but not differentiate	can self-renew and differentiate
C	cannot perform a specialized function	can perform a specialized function
D	totipotent	multipotent

29 Which of the following is an outcome of the Human Genome Project that has ethical implications?

A Screening of the genetic make-up of newborn infants for susceptibility to certain key diseases.

B Creation of customised medicines that are potentially more expensive to produce than traditional drugs.

C Consideration of a suspect's genetic pre-disposition to violent behaviour in criminal trials

D The free availability and accessibility of the complete sequence of the human genome on the Internet.

30 Which of the following is **not** a possible concern of cultivating *Bt* corn?

A Toxic effects of *Bt* on non-target insects e.g. monarch butterfly larvae could have predictable ecological consequences.

B Transfer of selection marker to bacteria that reside in the human gut thereby conferring upon the bacteria antibiotic resistance

C Spread of the *Bt* gene from cultivated corn to wild relative which would then lead to the loss of biodiversity

D Transfer of *Bt* gene to the pests thereby increasing their resistance to the *Bt* toxin

-End of paper-

VICTORIA JUNIOR COLLEGE

JC 2 PRELIMINARY EXAMINATION 2017

NAME : _____

CT CLASS : _____

H1 BIOLOGY **8875/2**

Paper 2 **2 hours**

READ THESE INSTRUCTIONS FIRST
Write your Name and CT class on all the work you hand in.
Write in dark blue or blue pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use any staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **one** question.
Write your answers on separate answer paper provided.

At the end of the examinations,
1. hand in section A and the one question you attempted from section B separately;
2. fasten all your work securely;
3. enter the number of the section B question you have answered in the grid opposite.

The intended number of marks is given in brackets [ ] at the end of each question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
Section B	
Total	

Section A

1 Fig.1 shows an electron micrograph of an organelle. There are two distinct group of vesicles (Boxes B and C) associated with this organelle.

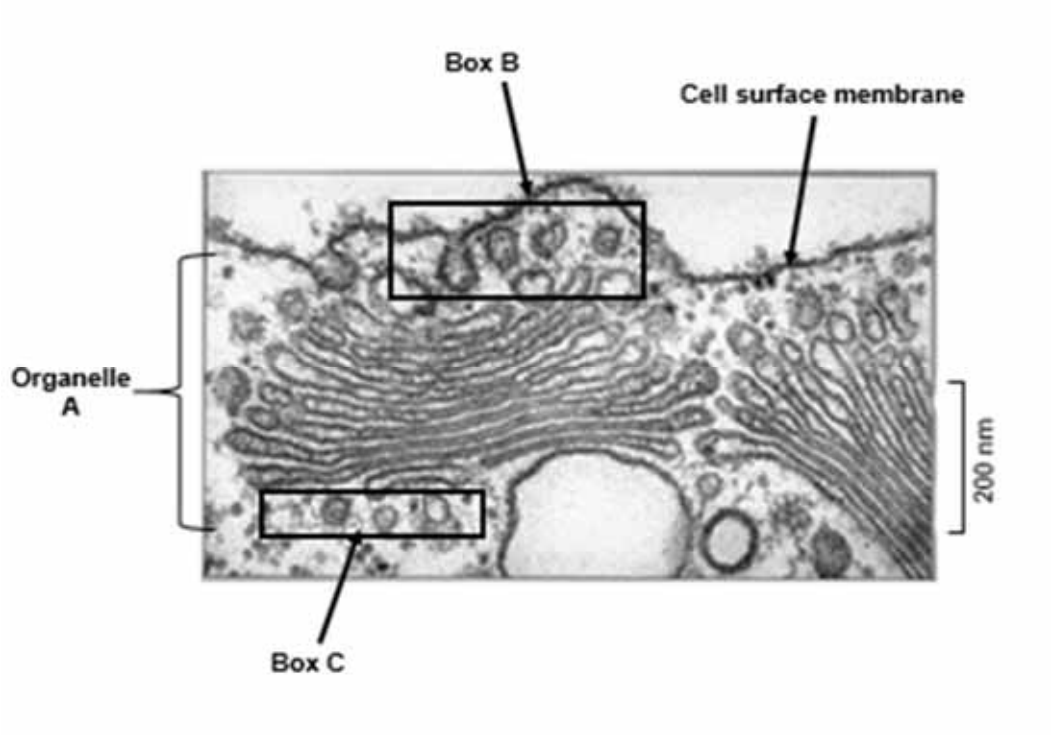


Fig. 1

(a) (i) Identify organelle A.

…….…….. [1]

(ii) Describe the differences in the role of the vesicles in Boxes B and C.

…….....

…….....

…….....

…….....

…….....

…….....

…….....

…….. [4]

In Angelman syndrome, a severe and rare neurodevelopmental disorder, it has been reported that the lack of ubiquitin protein ligase E3A (*UBE3A*) expression leads to a disruption of structure and function of Organelle A. Ubiquitin protein ligases are enzymes that attach a small molecule called ubiquitin to certain proteins. Such proteins are then degraded by the cells.

(b) Suggest how the lack of E3A expression can lead to a disruption in the structure and function of Organelle A.

……

……

……

…… [2]

The diameter of a prokaryotic cell is usually between 1-10 μm, whereas a typical eukaryotic cell is between 10-100 μm. The size of a cell is often restricted by its ability to metabolise nutrients to produce energy. A possible reason for the small size of the prokaryotes is the lack of membrane-bound organelles.

(c) Explain the importance of membrane-bound organelles in allowing the increase in size of eukaryotic cells.

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……

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……

……

…… [3]

[Total: 10]

2 Fig 2 below shows a magnified view of the eukaryotic chromosome.

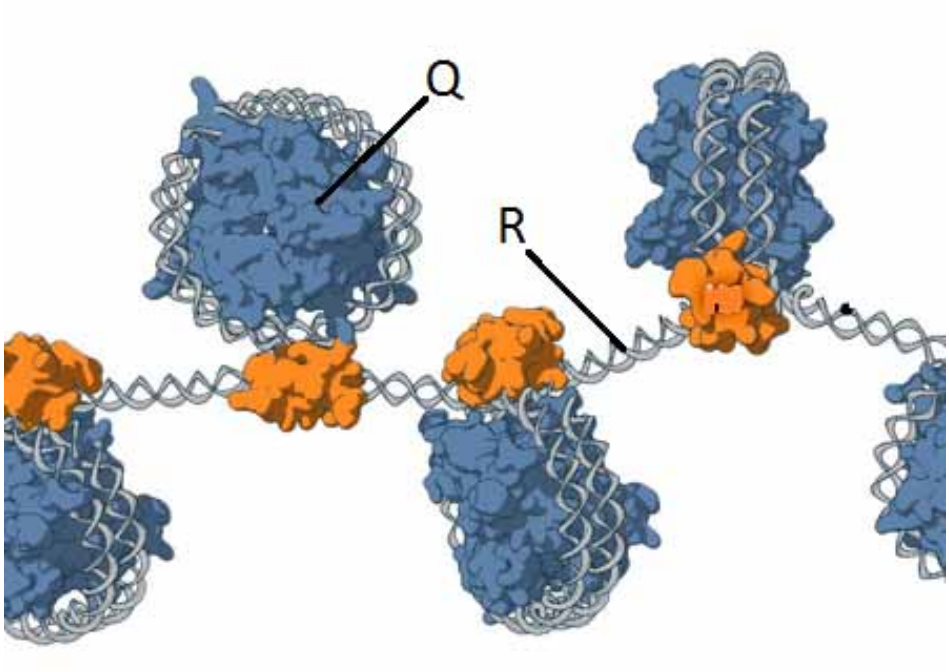

Fig. 2

(a)(i) Structures **R** and **Q** are two different biomolecules that make up a typical chromosome. Identify structures **R** and **Q**.

……

…… [1]

(ii) State two structural differences between **R** and **Q**.

……

……

……

…… [2]

(iii) With reference to Fig 2, discuss the significance of the interaction between **R** and **Q** in eukaryotes.

……

……

……

…… [2]

The centromere is part of a eukaryotic chromosome that links sister chromatids together. During nuclear division, spindle fibres attach to the centromere via a specific type of proteins known as kinetochore.

(b)(i) Suggest how the kinetochore proteins is able to bind specifically to the centromeric sequences.

……

……

……

…… [2]

(ii) Explain the consequences to the cell if the kinetochore protein is unable to bind successfully to the centromere during cellular division.

……

……

……

…… [2]

(iii) Suggest what would happen to a chromosome if a mutation causes it to contain more than one centromeric sequence.

……

……[1]

[Total: 10]

3 Fig 3 shows the forearms of different vertebrates.

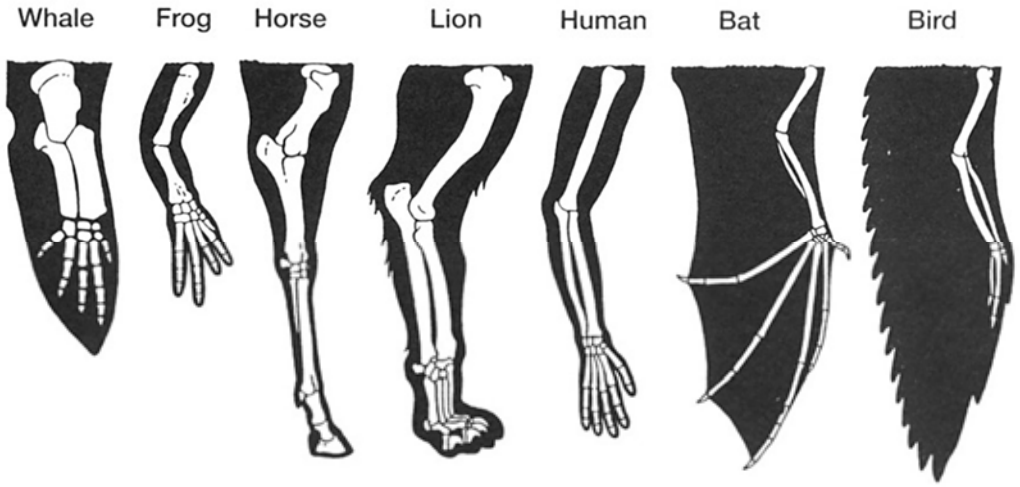

Fig 3

(a)(i) Using Fig 3, explain what is meant by “a homologous feature”.

……

……

……

…… [2]

(ii) Explain how this provides evidence in support of Darwin’s theory of natural selection.

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…… [4]

(b) DNA from the fossil material of these birds were extracted and amplified. State the name of the technique used and outline the major steps involved.

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…… [3]

(c) State two advantages of using molecular data over morphological data to establish relationships between different vertebrates.

……

……

……

…… [2]

[Total: 11]

4 Commercial aquaculture is the most rapidly growing segment of the agriculturalindustry, accounting for more than 60 million tons in 2012, versus 90 million tons of wild-caught fish. *AquAdvantage salmon* is a genetically modified (GM) Atlantic salmon developed by AquaBounty Technologies. The purpose of the modifications is to increase the speed at which the fish grows without affecting its ultimate size or other qualities. The fish grows to market size in 16 to 18 months rather than three years as shown in Fig 4.1 below.

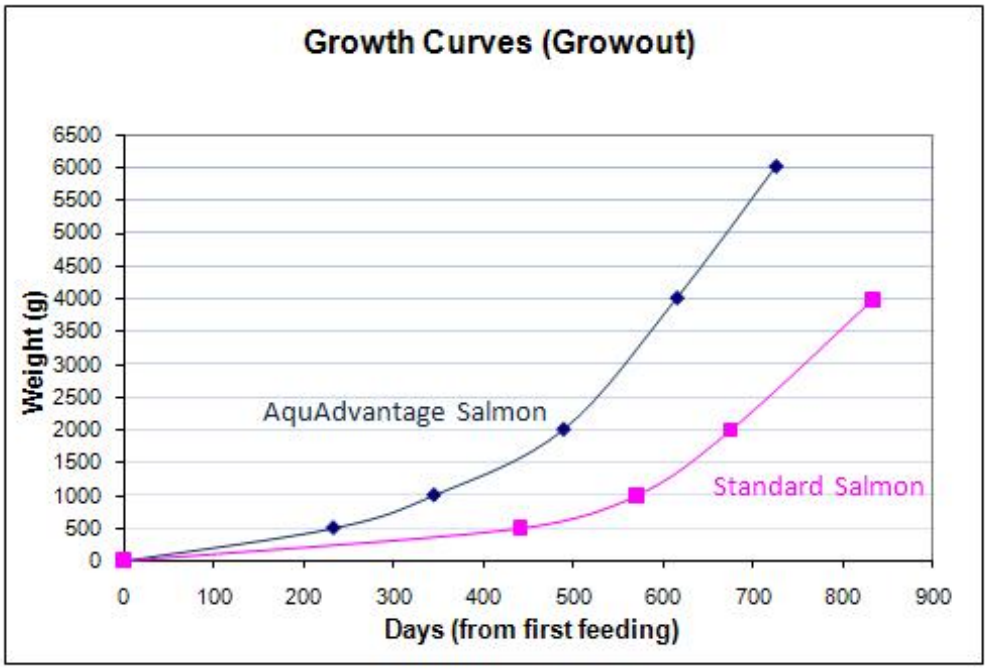

Fig 4.1

source: http://www.21stcentech.com/fishing-update-gmo-salmon-fda-approval-united-states/

(a) Describe how GM salmon is produced in the laboratory

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……

…… [4]

(b) Describe briefly the advantages of farming GM salmon (*AquAdvantage*) over normal salmon

……

……

……

…… [2]

There are many public concerns about the impact of GM organisms on the natural ecosystems. The following chart shows the results of an experiment conducted by Biotech companies who made GM salmon.

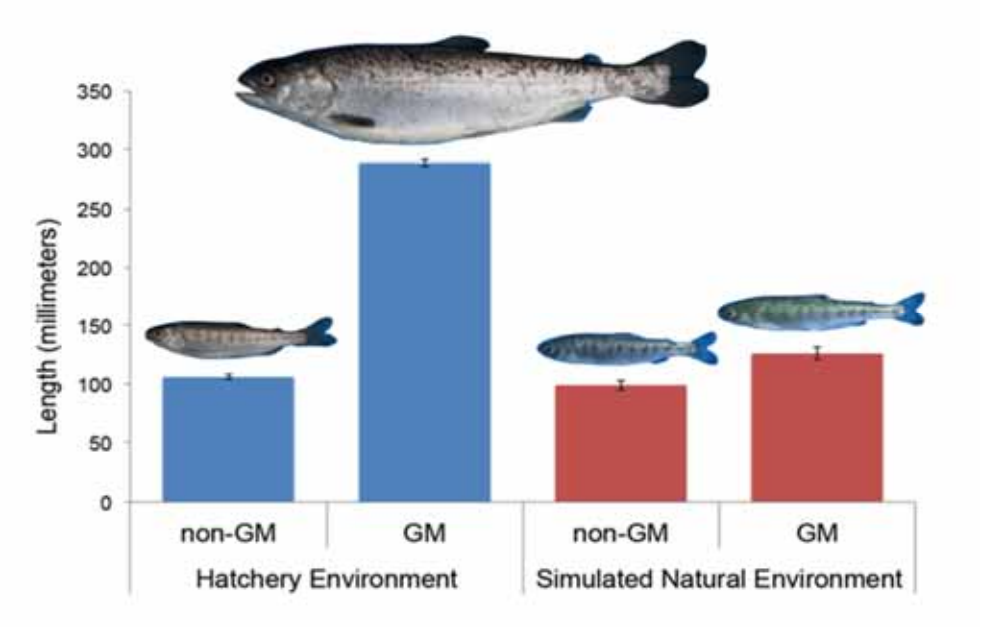


Fig 4.2

source: http://sitn.hms.harvard.edu/flash/2015/challenging-evolution-how-gmos-can-influence-genetic-diversity/

(c) With reference to Fig 4.2, explain why public worries on GMO could actually be unfounded.

……

……

……

……

……

…… [3]

[Total: 9]

Section B

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.
Begin each of sections **(a)**, **(b)** etc. on a **FRESH SHEET** of answer paper.

Either

5 **(a)** Methylene blue, a common stain used to dye cells for microscopy work, can function as an effective hydrogen acceptor. It changes from blue to colourless upon reduction.

Using methylene blue, describe an experiment to study the effects of different concentrations of glucose on the enzyme catalysed reactions in respiring yeast cells. Explain the principles behind the design of your experiment. [9]

(b) A small amount of inhibitor is added to reaction mixture, explain how you would go about determining the mode of action of this inhibitor. [7]

(c) Using a named example, explain the normal function of stem cells in a living organism. [4]

[Total: 20]

Or

6 **(a)** Explain how the structural features of the cell membrane enable it to transport materials in and out of the cell [9]

(b) Explain the significance of having double membranes in organelles like mitochondria and chloroplasts [5]

(c) Outline the role of hydrogen bonds in biomolecules [6]

[Total: 20]

VICTORIA JUNIOR COLLEGE
BIOLOGY DEPARTMENT
JC2 PRELIMINARY EXAMINATIONS 2017
HIGHER 1 8755
PAPER 2

1

(a) (i) Identify organelle A. Support your answer with one observable feature, other than vesicles, shown in Fig 1.

Golgi body/ golgi apparatus;;
A stack of membranes with swollen ends;;

(ii) Describe the differences in the role of the vesicles that fuse with the forming face and the vesicles that are formed at the maturing face. [4]

Box C: [2m]
- vesicles contain proteins and/or lipids;
- transported from rER and sER;
- that will undergo chemical **modification** within the golgi body;
- **examples** of modification: glycolysation, phosphorylation etc

Box B: [2m]
- Packaging and transport function: Vesicles containing modified products will be transported to the cell membrane;
- where they **fuse** and **release** the products to the outside of the cell
- via **exocytosis**;

(b) Explain how the lack of E3A expression can lead to a disruption in the structure and function of the Golgi apparatus.
- Lack of gene expression means that the enzyme E3A is not **produced**/ transcribed and translated;;
- Proteins that are tagged by ubiquitin, are meant for **degradation**;;
- These proteins are either **damaged/abnormal/excess**;;
- Removal of these proteins help to maintain the normal functions of the GA (idea of);; (A: reverse argument)

(c) Explain the importance of membrane-bound organelles in allowing the increase in size of eukaryotic cells. [3]

- Increases in the size of a cell is only possible if it can meet the increases in **nutrient and energy** demands;;
- Membrane-bound organelles allows **compartmentation and specialisation;;**
- All the enzymes and substrates involved are located in one place;

- allows the setting up of an environment that is **optimal** to the functioning of the enzymes;
- and increase **efficiency** of metabolic processes;

(A: named example with the same idea eg. mitochondria that increases efficiency of respiration)

[Total: 11]

2

(a) (i) Structures R and Q are two different biomolecules that make up a typical chromosome. Identify structures R and Q. [1]

- R – DNA; Q – (histone) proteins;

(ii) State two structural differences between R and Q. [2]

- Type of bonds – Q contains peptide bond while R contains phosphodiester bonds
- Type of monomers – Q consists of amino acids while R consists of nucleotides
- Shape – Q is globular, compact while R has double helical shape
- AVP

(iii) With reference to Fig 2, discuss the significance of the interaction between R and Q in eukaryotes. [2]

- Ref large size of eukaryotic genome / ref length of eukaryote DNA molecule;
- R (DNA) is wrapped / wound around Q (proteins);
- to allow tight packing of the DNA molecule;
- To enable it to fit into a small space eg. nucleus of a cell;

(b) **(i)** Suggest how the kinetochore proteins is able to bind specifically to the centromeric sequences. [2]

- Ref specific **DNA sequences** of centromere constitute a **specific 3D shape;;**
- Which is complementary to the shape of the binding site for the kinetochore;;

(ii) Explain the consequences to the cell if the kinetochore protein is unable to bind successfully to the centromere during cellular division. [2]

- Spindle fibres **unable to attach properly** to each chromosomes;
- **Non-disjunction;**
- **Unequal separation** of chromosomes to each daughter cells;
- Idea of daughter cells may not be viable;

(iii) Suggest what would happen to a chromosome if a mutation causes it to contain more than one centromeric sequence. [1]

- It may fragment / break into pieces when different spindle fibres become attached to the same chromosome and pull it apart;; AVP;;

3 (a)

(i) Using Fig 3.1, explain what is meant by "a homologous feature". [2]

- A structure with a <u>common evolutionary origin</u> / evidence that different species share a **common ancestor**;;
- that have been <u>modified to adapt</u> to a particular environment seen in different species / descent with modification to <u>serve different functions</u>;;

(ii) Explain how this provides evidence in support of Darwin's theory of natural selection. [4]

- Forelimbs of different species show the **same basic plan** in terms of the <u>arrangement of bones</u>;;
- Provides evidence that **vertebrates** share a **common ancestor**;;
- Basic plan has been structurally **modified** through **natural selection**;;/ **descent with modification** has occurred in different species/ trait held by a common ancestor evolves into different variations over time;;
- which allows the limb to adapt to a certain method of locomotion (e.g. flying, swimming, etc.) in a particular environment;;/ adapt to different selective pressures in different environments;;

(b) DNA from the fossil material of these birds were extracted and amplified. State the name of the technique used and outline the major steps involved. [3]

- Polymerase chain reaction (PCR);;
- Major steps of PCR;;
  30 3-step cycle: Denaturation (95^{o}C), Annealing (45-55^{o}C) and Extension (72^{o}C)
- require dNTPs, ATP, Taq polymerase, forward and reverse primers;;

(c) State two advantages of using molecular data over morphological data to establish relationships between different vertebrates. [2]

- All forms of life use the same genetic language of **DNA and RNA and the genetic code** is universal;
- Even dissimilar organisms share genes inherited from a common ancestor;
- Hence, molecular data can be used to compare across all organisms, even microscopic organisms, some of which like amoeba can **change shape** and difficult to categorise based on morphology;;
- Adults and young may also appear different and hence making morphological comparisons challenging;;
- Convergent evolution resulting in organisms from different ancestral lineages sharing similar morphological features will make morphological comparisons difficult too;;

[2max]

[Total:11]

4

(a) Describe how GM salmon is produced in the laboratory [4]

- *What?*
- *Gene of interest : Growth hormone from Chinook*
- *How?*
- *Technicality of GMO : Microinjection/ Electroporation*
- *Recombinant DNA plus Promoter from Ocean pout introduced to target species of salmon*
- *Selection and breeding of GM salmon*
- *Why?*
- *GM salmon with growth hormone can feed and grow continuously, so bigger*

GM salmon

Recombinant DNA

- Antifreeze promoter from an Ocean pout
- Growth hormone gene from a Pacific Chinook salmon
- Fusing of a strong gene promoter such as the ocean pout antifreeze promoter leads to enhancement in the expression of the gene construct
- The recombinant DNA is then introduced into fertilized eggs of Atlantic salmon

There are two methods to modify salmon eggs to produce GM salmon:

(1 Mark awarded for ANY ONE method)

- **Microinjection** – foreign gene was microinjected into the cytoplasm of one-to-four cell embryos

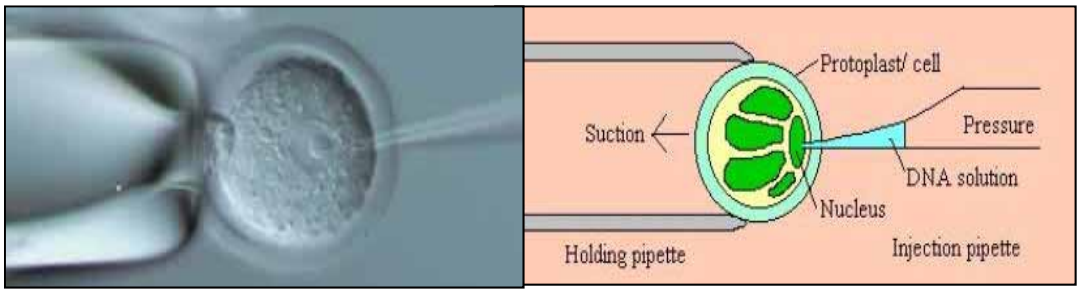


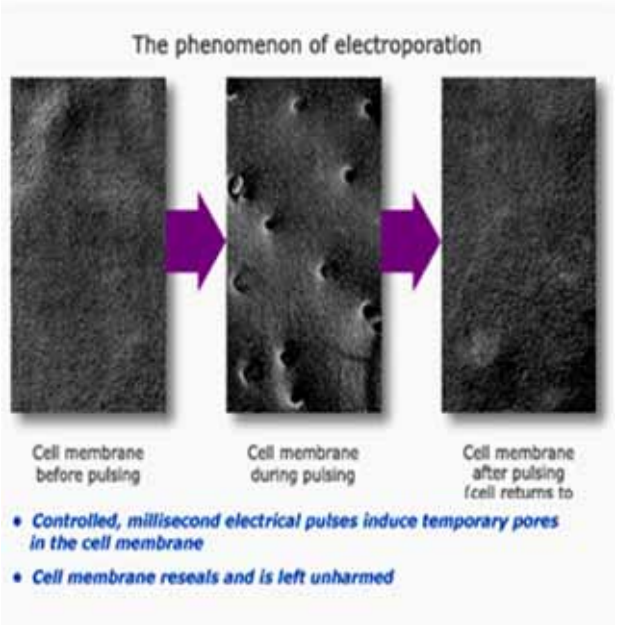
Figure 10: Techniques in production of GM salmon – (a) Microinjection
http://njms.umdnj.edu/departments/cell_biology_and_molecular_medicine/images/microinjection3.jpg)

OR

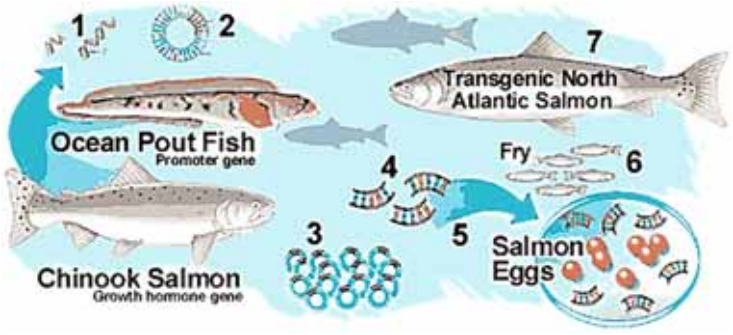
- **Electroporation** – involves placing the eggs in a buffer solution containing DNA and applying short electrical pulses to create transient openings of the

cell membrane, allowing the transfer of genetic material from solution into the cell

Figure 11: Techniques in production of GM salmon – (b) Electroporation http://www.inovio.com/images/IMG_electroporation.gif)



- Subsequent selection and breeding led to development of the genetically modified salmon
- Due to the **year-round production** of growth hormone (due to the antifreeze promoter), this allows for **continuous feeding and growth** of the GM salmon.
- The GM salmon is able to grow quicker in size while feeding more efficiently (less feed is consumed to reach a larger size)



Producing a GM salmon

[4 max]

(b) Describe briefly the advantages of farming GM salmon (AquAdvantage) over normal salmon [2]

- GM salmon showed a **faster growth rate** then standard salmon

- Lesser resources need to farm the GM salmon

It reached 500g within 250 days compared to standard salmon that took 450 days for the same weight gain (allow similar comparisons for other quoted values at 1000/2000/4000g);; OR
GM salmon grew bigger than standard salmon, reaching 6000g by 700th day but even with another 150 days of growing, at 850 days, standard salmon reached only 4000g in weight;;

(c) There are many public concerns about the impact of Genetically modified organisms on the natural ecosystems. The following chart shows the results of an experiment conducted by Biotech companies who made GM salmon. Explain why public worries on GMO could actually be unfounded. [2]

- Although GM salmon grew over twice bigger than non-GM salmon at 300mm in the hatchery;
- GM salmon remained roughly the same size, if not, only slight larger at 130mm compared to 100mm in a simulated natural environment;;
- This shows that GM salmon, even if released into the wild, might not have a higher survival fitness and outcompete the wild non-GM salmon by outgrowing them;;
- Hence it is safe to farm and even release them into natural ecosystems;

ESQ

5 (a) Using methylene blue, describe an experiment to study the effects of different concentrations of glucose on the enzyme catalysed reactions in respiring yeast cells. Explain the scientific theory behind the design of your experiment. [8]

- Aerobic respiration involves the stages of glycolysis, link reaction, Krebs cycle and the Electron transport chain;
- As respiration process occurs, hydrogen atom are released which instead of being taken up by the usual **coenzymes like NAD**; or **FAD**;
- will now reduce Methylene blue as it is an effective hydrogen acceptor;
- This is indicated by a colour change in Methylene blue from <u>blue to colourless;</u>
- The rate at which this colour change occurs can thus be used to measure the rate of respiration of the yeast cells;
- Higher concentrations of glucose will take longer to process and thus a slower colour change

[3]

Experimental method

(General idea of the various steps in bold)

1. **Prepare five concentrations of glucose, ranging from 0.5%, 1%, 2% 5% and 10% from a stock solution;;**
2. **Label six boiling tubes A – G;**
3. Starting from the 10% stock solution, add equal volumes of distilled water and glucose to make 10cm^3 of solution;;
4. Dilute each new solution made with equal volumes of distilled water and continue until all the five different concentrations of glucose are prepared, after which placing each tube in a rack;
5. **Into each tube add 3 drops of Methylene blue;**
6. **Add 5cm^3 yeast solution to each tube noting the time;**
7. **Shake each tube to mix the contents and place back into the rack;**
8. **Do not disturb the tubes again but note the time taken for the blue colour to disappear from each tube;**
9. Repeat step 1-8 with replicates;

[5 max]

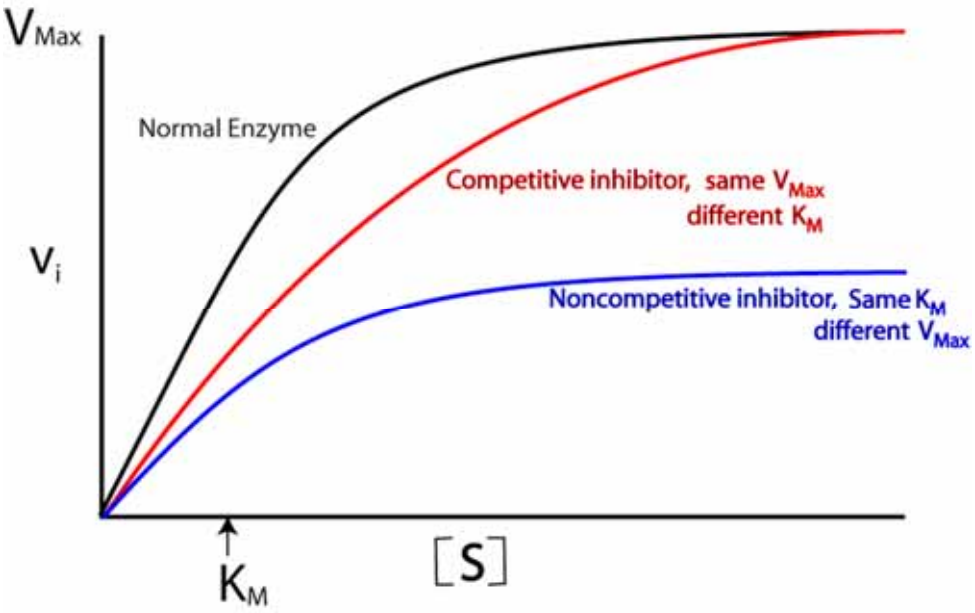
(b) A small amount of inhibitor is added to reaction mixture, explain how you would go about determining the mode of action of this inhibitor. [8]

Competitive inhibition (CI) (4max)

- Addition of a small amount of competitive inhibitor will have an impact on the lower concentrations of glucose;;
- At low substrate concentrations, CI molecules who have similar shapes to the original substrates, in this case glucose molecules, will compete for the active sites on the yeast enzymes;;
- Forming enzyme-inhibitor complexes instead of enzyme –substrate complexes;;
- This is because CI can also show affinity to the active sites but will have no enzymatic product at the end of the binding;;
- This results in a slower overall rate of enzymatic reaction;
- At higher substrate concentrations, say > 2%, the impact of adding CI is reduced by the presence of many more substrate molecules which result in a similar Kmax achieved for the enzymatic reaction. Km is changed;;

Non-competitive inhibition (NCI) (4max)

- Addition of NCI will have an impact on the Vmax and hence overall rate of reaction regardless of the substrate concentration;
- NCI molecules will probably bind to a site other than the active site, often called an allosteric site;;
- This alters the overall 3D conformation of the enzyme and hence changes the shape and configuration of the active site;;
- This prevents binding by the original substrates like glucose and hence no formation of enzyme-substrate complexes is possible;;.
- Depending on the concentration of NCI added, Vmax will be lowered but Km remains;;



(c) Using a named example, explain the normal function of stem cells in a living organism. [4]

Blood stem cell (**haematopoietic stem cells**);;

- Haematopoietic stem cells are **multipotent cells** with the ability to differentiate into the different **blood cells** and **immune cells**;;
- Major sources of haematopoietic stem cells include adult **bone marrow** and **umbilical cord blood**;;
- All the various types of blood cells are produced in the **bone marrow,** particularly in the ribs, vertebrae, breastbone and pelvis. These cells arise from a single type of cells called a **hematopoietic stem cell** (an adult multipotent stem cell);
- Umbilical cord blood is **human blood from the placenta and umbilical cord** that is rich in hematopoietic stem cells. The **haematopoietic stem cells** in the umbilical cord blood can be used to generate blood and immune cells;

OR
Embryonic stem cells;;

- **Pluripotent** stem cells derived from a group of cells called the inner cell mass, which is part of the early (4 – 5 day) embryo called the blastocyst;;
  Pluripotency refers to the ability to differentiate into almost any cell type to form any organ or type of cell;;

- Self-renewal- embryonic stem cells are “immortal”, i.e. these cells can **reproduce indefinitely** (can grow and divide for long periods in an undifferentiated state);;
  - Gives rise to cells from all three embryonic germ layers, ectoderm, mesoderm and endoderm;;

6 (a) Explain how the structural features of the cell membrane enable it to transport materials in and out of the cell [9]

- The cell membrane serves as boundary of cell;
- Selectively permeable to regulate movements of substances in and out;;
- Made up of mostly lipids (phospholipids and cholesterol), proteins and carbohydrates;;
- Phospholipid is most abundant, consists of two non-polar hydrocarbon chains and one polar phosphate head, phosphate molecules orientate to form a lipid bilayer;;
- Hydrophilic polar heads face the aqueous environment while the hydrophobic hydrocarbon tails face inwards and form a hydrophobic core within the lipid bilayer;;
- Only non-polar substances, like O_2 and CO_2 can move freely across the lipid bilayer via simple diffusion;
- Embedded within the lipid bilayers are protein carriers and protein channels which transport polar substances (eg glucose) and charged particles (eg ions) across the membrane;;
- These transport proteins are made up of both hydrophilic and hydrophobic amino acids;;
- The hydrophobic regions interact with the hydrophobic core of the lipid bilayer;
- The hydrophilic regions interact with the substances to be transported across;
- Pore of channel protein made of hydrophilic amino acids to allow ions to flow through down their concentration gradient via facilitated diffusion;;
- Ions like Na^+/K^+ will be transported against their concentration gradient via Na^+/K^+ pumps with the energy provided by ATP;;
- Conformational change in transport proteins allow substances to be moved across the membrane via facilitated diffusion or active transport;;
- Bulk transport can also take place with infolding of region of the plasma membrane which later pinches off to form a vesicle;
- Endocytosis allow larger substances to enter the cell enclosed within a membrane bound vesicle;
- Ref to pinocytosis (cell drinking) and phagocytosis (cell eating);
- Exocytosis is the secretion of substances out of the cell;
- Involves formation of vesicles from the Golgi apparatus;
- Secretory vesicles containing substances (digestive enzymes, peptide hormones) pinches from the trans face of the GA and migrates to the cell surface;
- The membrane of the secretory vesicle fuses with the plasma membrane and the contents are released out of the cell;

[9 max]

(b) Explain the significance of having double membranes in organelles like mitochondria and chloroplasts [5]

- Double membranes allow the compartmentalisation of space;;

- Creates the inner membrane space in mitochondria and thylakoid space in chloroplasts for the storage of protons (H^+ ions);;
- This is necessary for the build-up of a proton gradient that is the proton motive force behind the process of chemiosmosis that makes energy in the form of ATP;
- Increase in the surface area for **spatial arrangement** of reaction and attachment of components of the electron transport chain (ETC);;
- Without the inner membrane, the series of redox reactions occurring down the ETC as electrons are being passed on to the final electron acceptor will not be possible;;
- The creation of the matrix and stroma spaces in the mitochondria and chloroplasts respectively with the membrane segregation also allow separate reactions to occur and hence facilitate their **regulation** and control in cellular respiration and photosynthesis;;
- Double membranes also serve as evidence of the endosymbiont theory;
- Such inner membranes might have been derived from the ancestral cell membrane of the organelles who used to be free living while the outer membrane are remnants of the host cell membrane upon phagocytosis;

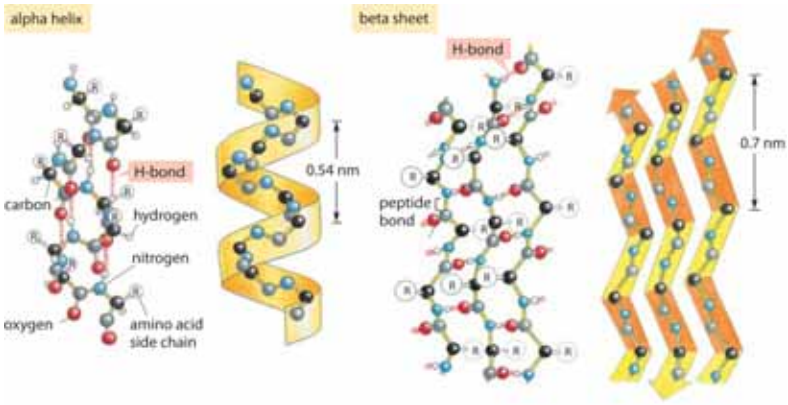
[5max]

(c) Outline the role of hydrogen bonds in biomolecules. [6]

Carbohydrates

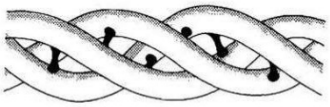
- In amylase, hydrogen bonserve to stabilise the helical structure
- In starch and glycogen, hydrogen bonds with water molecules forms a hydration shell that resulted in a partially soluble polysaccharide that can be approached and digested by hydrophilic enzymes;;
- In cellulose, the hydrogen atoms form **hydrogen bonds** with oxygen atoms in the same glucose molecule and other neighbouring glucose molecules;
- While these hydrogen bonds are individually weak, due to the large numbers of -OH groups, collectively they develop massive tensile strength;
- Also, between 60-70 cellulose molecules become tightly cross linked to form bundles called **microfibrils**, which are in turn held together in bundles called **fibres** by further hydrogen bonding, making the entire structure even stronger;;

Proteins



- Secondary structures like **alpha helix** and **beta pleated sheets** stabilised by H bonds;;
- At tertiary levels and above, a globular protein have non-polar, hydrophobic R groups point into the centre of the molecule, making them **water soluble**, since water clusters around their outward facing hydrophilic groups, but water cannot get into the molecule;;
- However, proteins that form long strands are known as **fibrous** proteins, and are mostly **insoluble** with hydrophobic R groups facing outwards;;
- **Interchain H bonds** within the triple helical structure of each tropocollagen, due to presence of many glycine residues, result in strong, tight coil with **high tensile strength;;**

❖Hydrogen bonds between the residues stabilise the 3d structure of the tropocollagen.



❖Covalent bonds form between tropocollagen molecules which stabilise the collagen fibre.

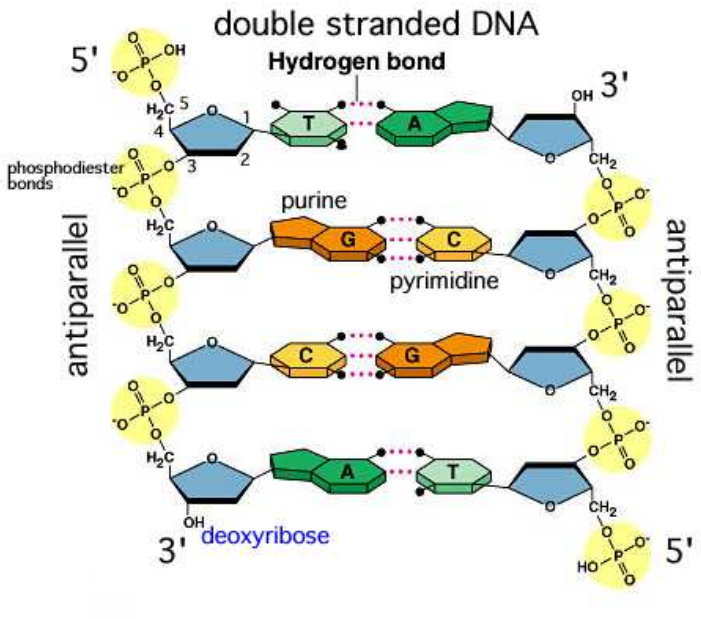
❖Steric repulsion between proline and hydroproline side chain stabilise the whole helix of collagen.

Lipids

- Lack of hydrophilic components within lipid structures meant that it will not form H bonds with water molecules and hence will be insoluble in water, important as storage material or to provide buoyancy and insulation;;

DNA

- H bonds between nitrogenous bases of nucleotides in double helix DNA structure helps to stabilise it and maintain same width throughout;;


double stranded DNA
Hydrogen bond
5'
3'
phosphodiester bonds
purine
pyrimidine
antiparallel
antiparallel
deoxyribose
3'
5'
T
A
G
C
C
G
A
T

[6 max]