Name	Index Number	CTG

YISHUN JUNIOR COLLEGE
JC 2 SEMESTRAL EXAMINATION 2018

BIOLOGY 8876/01

HIGHER 1 **14th SEPTEMBER 2018**
Fri 0800 – 0900

1 hour

Paper 1 Multiple Choice

Additional material: Optical Mark Sheet

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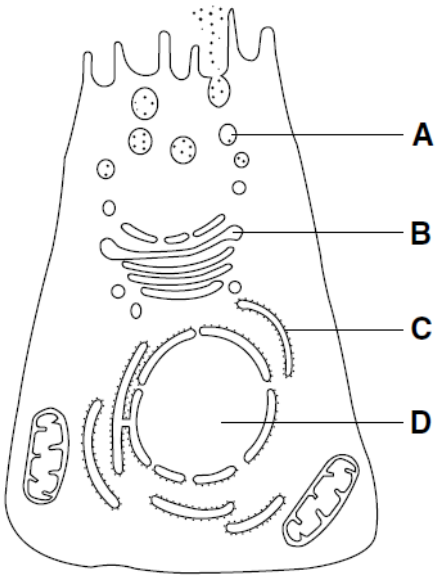
1 The diagram is taken from an electron micrograph of a cell which secretes digestive enzymes.

Where are these enzymes made?

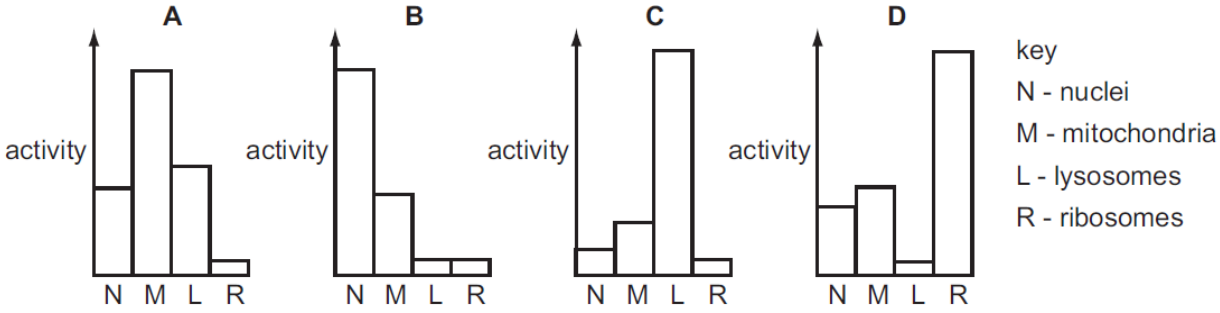


2 What is the order of size of cell components?

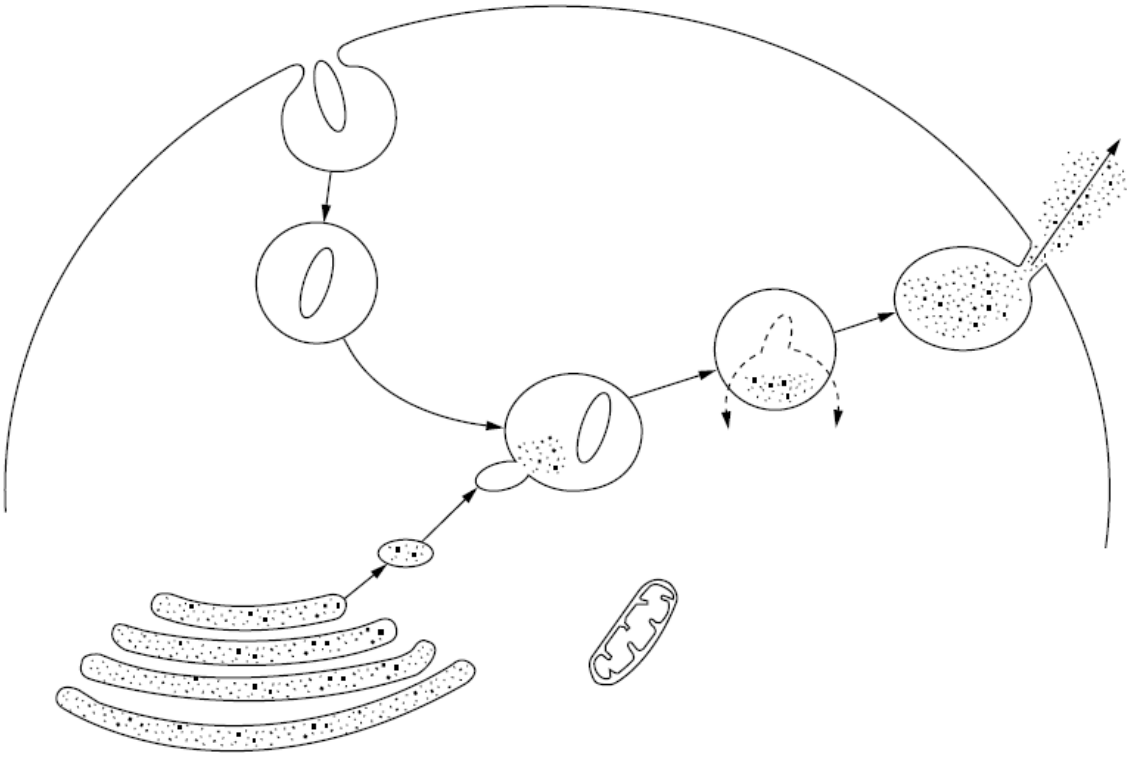
	Largest → Smallest			
A	Mitochondria	Ribosomes	Starch grains	Nuclei
B	Nuclei	Chloroplasts	Mitochondria	Ribosomes
C	Ribosomes	Mitochondria	Chloroplasts	Starch grains
D	Starch grains	Mitochondria	Chloroplasts	Ribosomes

3 A piece of mammalian tissue was homogenised and subjected to differential centrifugation to yield four subcellular fractions. The activity within each fraction, of four different types of enzyme, **A**, **B**, **C** and **D**, was investigated.

Which bar chart shows the results of investigating hydrolytic enzyme activity?



4 The diagram shows several processes taking place in a cell.



Which processes are shown in the diagram and involve the cell surface membrane of the cell?

A active transport and diffusion

B diffusion and osmosis

C endocytosis and exocytosis

D endocytosis and osmosis

5 A plant cell is placed in a solution with a less negative (higher) water potential than the cell contents.

Which change occurs in the cell and what causes the change?

	change	cause
A	cell becomes more flaccid	solution diffuses out of the cell
B	cell becomes more flaccid	water diffuses out of the cell
C	cell becomes more turgid	solution diffuses into cell
D	cell becomes more turgid	water diffuses into cell

6 Beetroot cells contain a water-soluble red pigment. Two test tubes were set up as described in the table.

tube 1	Pieces of washed raw beetroot in water
tube 2	Pieces of washed raw beetroot in water containing 3 drops of cyanide, a respiratory inhibitor.

After 30 minutes, the water in tube 2 contained a red pigment but the water in tube 1 did not.

Which of the following statements are false for tube 2?

1 Pigment molecules passed out and were replaced by cyanide.

2 The cell membrane was unable to retain the red pigment.

3 Water entered the tissue by osmosis and caused the cells to burst.

4 Water passed out of the cells by osmosis and carried the soluble pigment with it.

5 The same result will occur if ethanol was used instead of cyanide.

A 1 and 3 only

B 3 and 4 only

C 2 and 5 only

D 1, 3 and 4 only

7 Some features of haemoglobin are listed.

1 They are made up of a protein component called globin and a non-protein component called haem group.

2 There are two types of polypeptide chains: the α-helix globin chain and the β-globin chain.

3 Each polypeptide chain is held by hydrophobic interactions, hydrogen and ionic bonds and disulfide bonds.

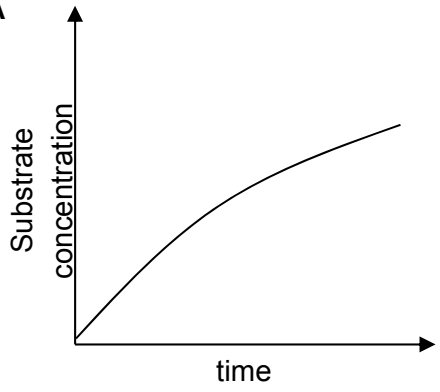
4 Most of its hydrophilic polar amino acid residues are on the external surface of the globular structure.

Which are these statements are true ?

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

8 Which graph represents the changes in substrate concentration during the course of an enzyme catalysed reaction?

A



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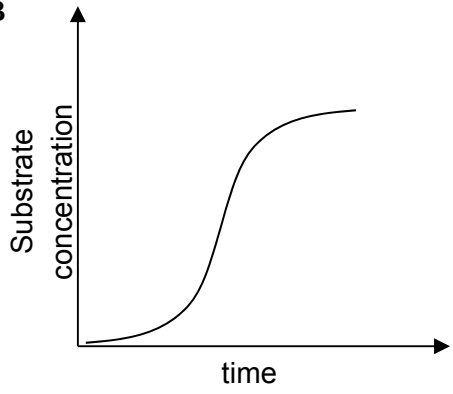
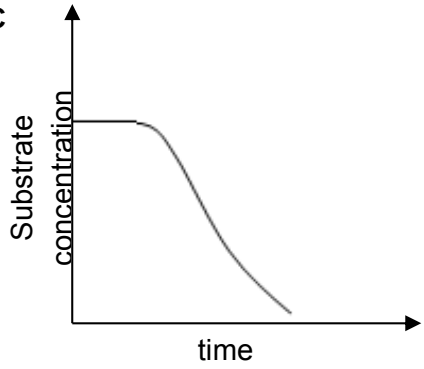
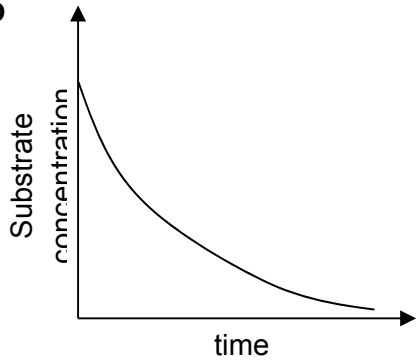


C



D



9 Which is a correct statement about obtaining human embryonic stem cells for research?

A Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.

B The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.

C The cells must be removed within a day following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.

D The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

10 Mesenchymal stem cells can differentiate into several types of cells belonging to our skeletal tissue, such as cartilage, bone and fat.

Which statement correctly describes mesenchymal stem cells?

A They are specialised cells that can give rise to a variety of cell types.

B They can be stimulated by chemical signals to express certain genes.

C They lose genetic information as they differentiate.

D They occur in large numbers in the bone marrow.

11 Which statements about ribosomal RNA(rRNA) is true?

1 rRNA is involved in the binding of mRNA and not tRNA.

2 rRNA with associated proteins, fold into complex tertiary structures within the ribosome.

3 The 3′ terminus of rRNA in prokaryotes is known to interact with the initiation region of mRNA via the Shine–Dalgarno sequence.

4 Nucleolus is the site of rRNA transcription and processing, and of ribosome assembly.

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

12 What is the basis for the difference in the synthesis of the leading and lagging strands of DNA molecules?

1 The anti-parallel arrangement of the DNA strands.

2 The RNA primers are required to initiate DNA elongation.

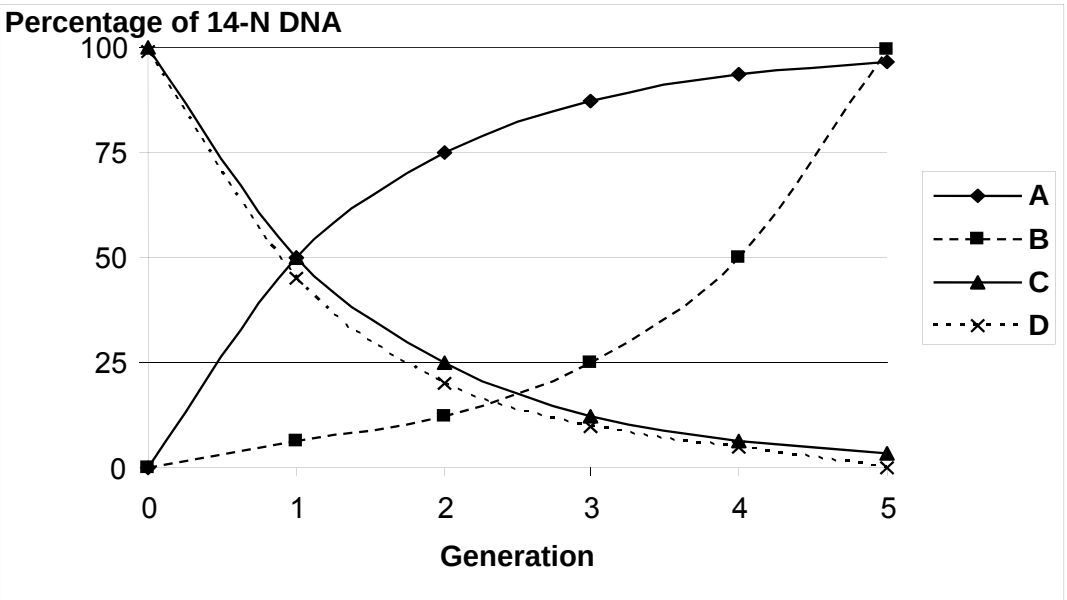
3 DNA polymerase can join new nucleotides to the 3' end of the growing strand.

4 Helicase and single-stranded binding proteins work at the 5'end of the DNA strand.

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

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

Which curve provides evidence that DNA replication is semi-conservative?



14 A new form of life is discovered. It has a genetic code much like that of organisms on Earth except that there are five different DNA bases instead of four and the base sequences are translated as doublets instead of triplets. How many different amino acids could be accommodated by this genetic code?

A 25

B 32

C 10

D 64

15 What do chromosomal aberrations and gene mutations have in common and how are they different?

	Similarity	**Difference**
A	Both may involve addition of nucleotides.	Gene mutations always produce dominant alleles but not chromosomal aberrations.
B	Both cause changes in number of chromosomes.	Gene mutations do not involve inversions but inversion of segments of chromosomes do occur.
C	Both affect DNA sequence.	Gene mutations occur within a chromosome but chromosomal aberrations may occur across chromosomes.
D	Both may not result in a difference in protein expression.	Chromosomal aberrations are more harmful than gene mutations.

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

Amino acid	DNA triplet code
Glycine	CCA, CCG, CCT, CCC
Leucine	AAT, AAC, GAA, GAG, GAT, GAC
Lysine	TTT, TTC
Methionine	TAC
Proline	GGA, GGG, GGT, GGC
Threonine	TGA, TGG, TGT, TGC

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

…TAC TTT AAT GGC CCT GAG GGC TAC TGT …

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

A …TAC TTT AAT GGC CCT GAG GGT CCA TGT

B …TAC TTC GAT GGC CCT GAG GGC TAC TGT

C …TAC TTT AAT GGC CCG GAG TGA TAC TGT

D TAC TTT AAT GGC CCT GAG GGC TTC TGT

17 Which environmental factor is associated with the development of melanomas (a type of skin cancer)?

A alcohol

B tar

C ultraviolet light

D X-radiation

18 Cancer research has found that gene amplification is involved in the development of cancer. This research has identified one type of sequence that causes a break in DNA before gene amplification.

How might the findings of this research be used?

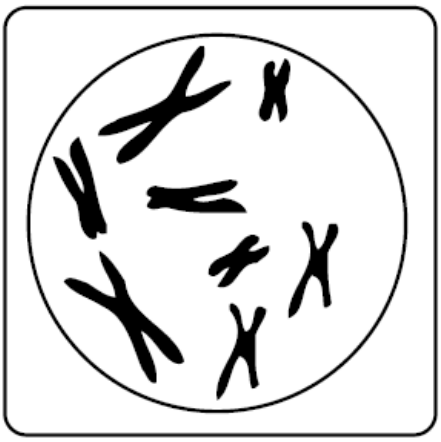
A to identify people at risk of developing cancer

B to prevent cancer from developing in 'at-risk' people

C to repair DNA breaks from amplification occurs

D to use restriction endonuclease to remove DNA

19 The diagram shows a diploid cell during mitosis.



Which stage of mitosis is shown?

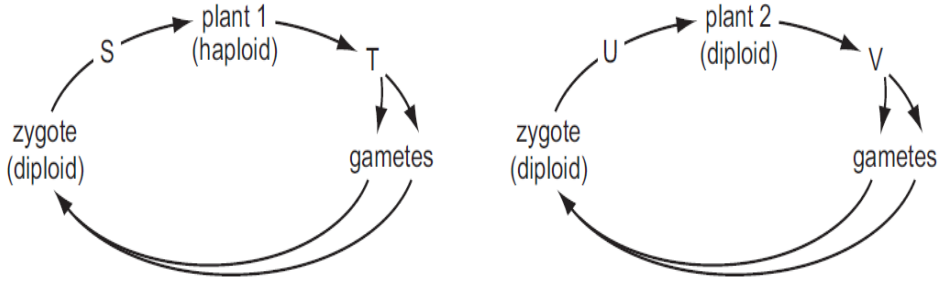
A anaphase

B metaphase

C prophase

D telophase

20 The diagram shows the life-cycles of two types of simple plant.



Where will reduction divisions occur in the life cycles?

A at S and U

B at S and V

C at T and U

D at T and V

21 In corn, the colour of the stem can be either wild type, which is dark green, or virescent, which is pale green.

Cross	Phenotype of parents	Temperature at which raised	Offspring
1	virescent X virescent	20°C	virescent
2	virescent X virescent	37°C	wild type
3	wild type X wild type	20°C	3 wild type: 1virescent
4	wild type X wild type	37°C	wild type

The parents of crosses 1 and 2 had the same genotypes. The parents of crosses 3 and 4 had the same genotypes.

Which of the following can be deduced from the data?

1 Wild type is dominant.

2 The wild type parents are heterozygotes.

3 Virescent is the recessive phenotype but the characteristic will only be expressed at lower temperature.

4 The parents of cross 1 are only recessive at 20°C.

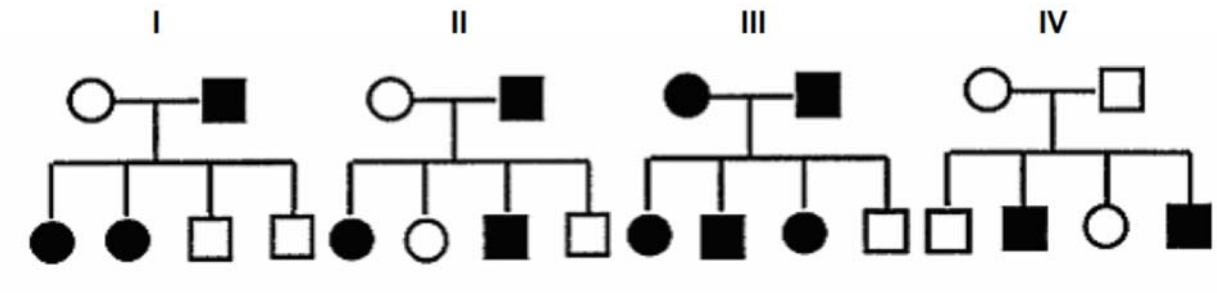
A 2 only

B 1 and 3 only

C 1, 2 and 3 only

D all of the above

22 The figure below shows 4 pedigrees. A shaded circle represents an affected female while a shaded square represents an affected male.



Which pedigree(s) show(s) a sex-linked dominant trait in humans?

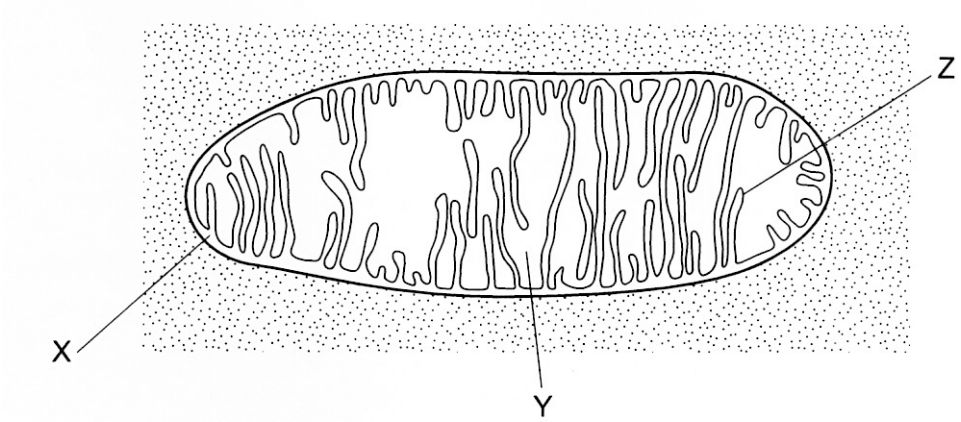
A I only

B I and III

C II and III

D III and IV

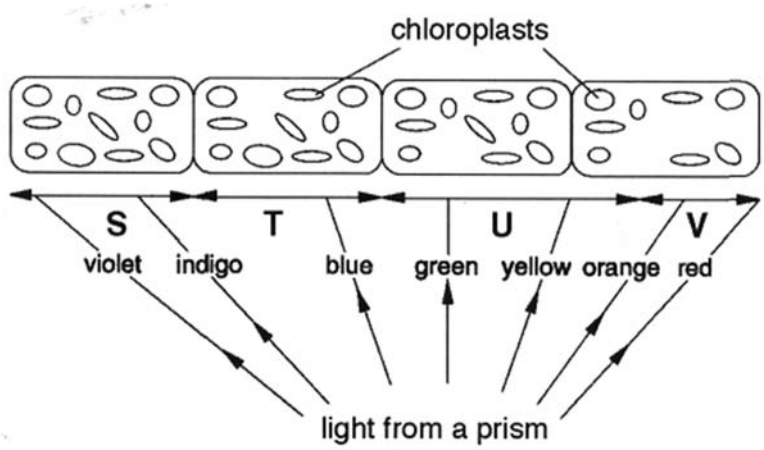
23 The electron micrograph shows an organelle found in a plant cell.



Which row shows the correct location of each named biological molecule?

	DNA	oxaloacetate	ATP
A	absent	Y	Z
B	Y	Z	Y
C	Y	Y	X
D	Y	Y	Y

24 A filament of the alga *Cladophora* was illuminated as shown in the diagram. Motile, aerobic bacteria were placed in the water with the alga and their position was determined by microscopic examination after 10 minutes.



In which two regions will the number of bacteria be highest?

A S and T

B S and U

C T and V

D U and V

25 The copying of DNA is not always accurate, resulting in occasional, random changes to its base sequence. For example, scientists have calculated that one amino acid in vertebrate haemoglobin protein is changed every 10 million years.

Which statement about this process is correct?

A A single amino acid change in a protein may be affected by natural selection.

B All changes in the base sequence of DNA are affected by natural selection.

C Natural selection can cause some of the amino acid changes in proteins.

D The variability of DNA in a population will be less than the variability of its proteins.

26 In 1954, copper waste in the Finniss River killed numerous fish. This caused various species in the area to die out. However, one species, the black-banded rainbow fish, increased in numbers. The black-banded rainbow fish have modified gills that enable the fish to filter and remove the copper before it enters their body.

With respect to the black-banded rainbow fish it is reasonable to conclude that

A a mutation occurred in their population in 1954.

B the ability of their gills to remove copper already existed in 1954

C the high levels of copper in the water changed the structure of their modified gills

D their genomes are identical with those of the other species of fish that existed in 1954.

27 Climate change has led to increasing temperature. The environments where birds, fishes, and other marine species live have become warmer. What is not an effect of climate change on these organisms?

A Certain fish species migrate in response to seasonal temperature changes, moving northward or to deeper, cooler waters in the summer and migrating back during the winter.

B The birds are moving north to feed and breed in the summer, then moving further south to spend the winter in warmer areas.

C The birds follow a regular seasonal migration pattern during wintering periods.

D As smaller marine prey species shift their habitats, larger predator species may follow them.

28 Other than melting land-based ice sheets, which of these factors has made the largest contribution to the rise in sea level over the past 100 years?

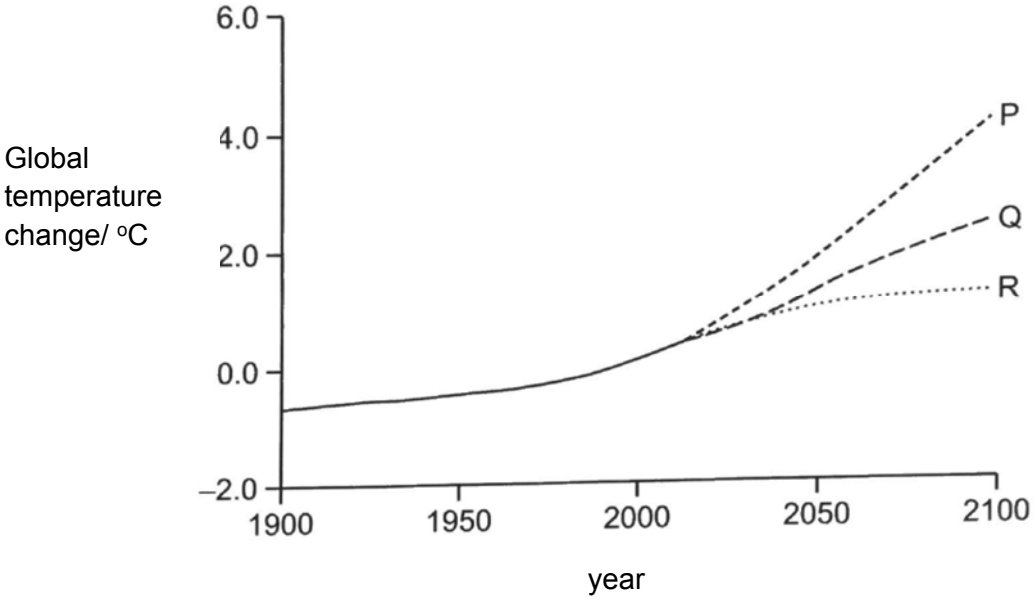
A Warming of ocean surface water

B Melting sea ice

C Increased river runoff

D Increased reflection of infrared radiation

29 The graph shows the predicted changes 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 Artic will begin to thaw as global temperature increase.

3 Rising sea temperature will cause increase growth of photosynthetic algae.

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

Which of these statements support predictions 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 Corals are among the first indicators of climate change. When ocean temperatures get too hot for too long, corals undergo a process called bleaching. Which statements are true about this process?

1 Increased levels of sediment in seawater, the zooxanthellae may lose substantial amounts of their photosynthetic pigmentation, which decreases rates of photosynthesis produces bleaching.

2 Bleaching occurs when abnormally high sea temperatures cause corals to expel the zooxanthellae living in them.

3 Zooxanthellae are able to use the oxygen and waste materials of the host, supplying carbon dioxide and food substances in return.

4 With high sea temperatures and decreasing planktons, corals use the zooxanthellae as their food source

A 1 and 2

B 1 and 4

C 2 and 4

D 2 and 3

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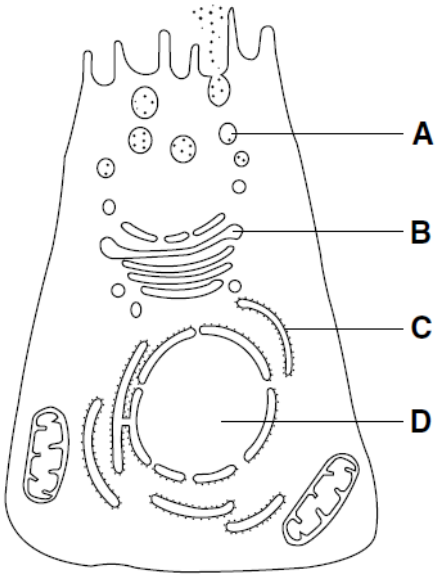
Where are these enzymes made? **Ans: C**



Explanation: digestive enzymes are proteins. Proteins are translated by 80S ribosomes bounded to ER (RER).

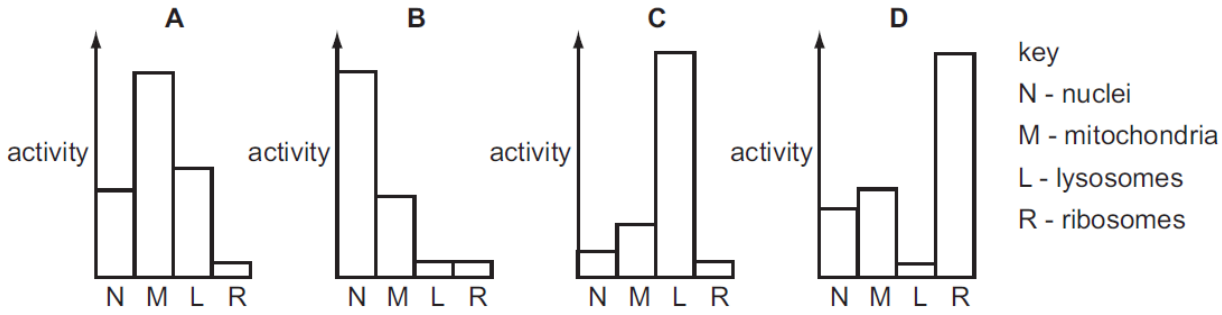
2 What is the order of size of cell components?

	Largest → Smallest			
A	Mitochondria	Ribosomes	Starch grains	Nuclei
B	Nuclei	Chloroplasts	Mitochondria	Ribosomes
C	Ribosomes	Mitochondria	Chloroplasts	Starch grains
D	Starch grains	Mitochondria	Chloroplasts	Ribosomes

Explanation: Nucleus has the largest molecular weight while ribosomes have the smallest molecular weight.

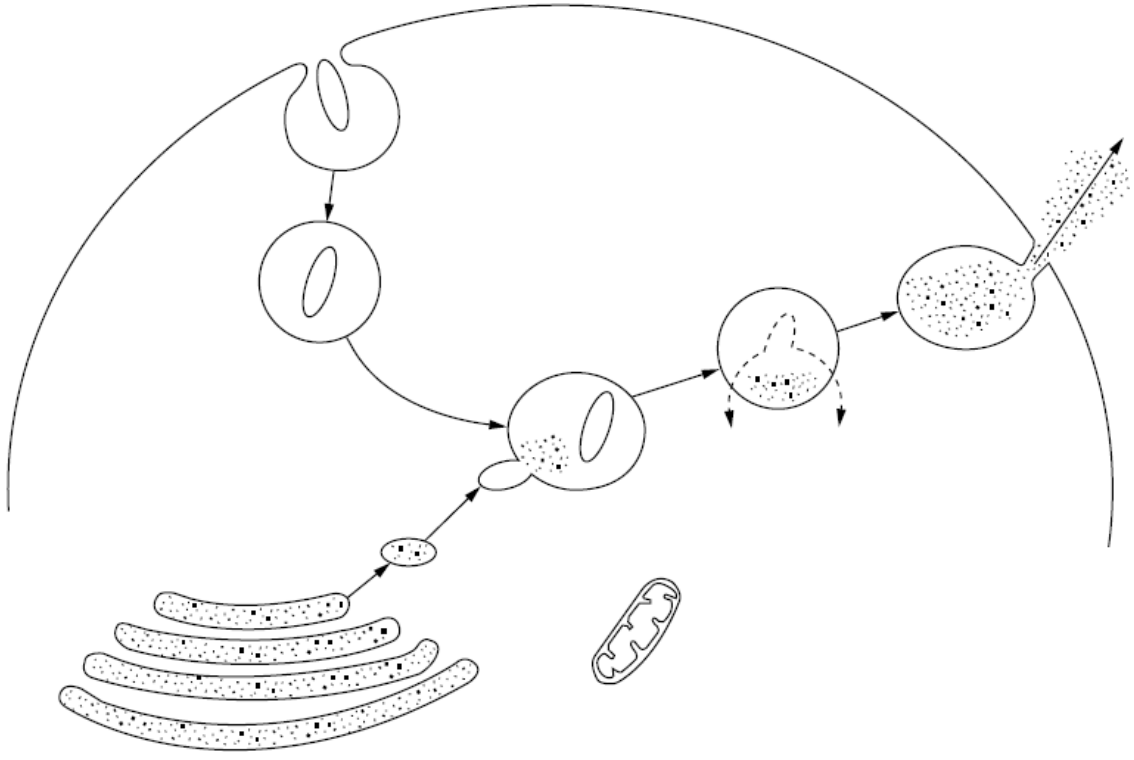
3 A piece of mammalian tissue was homogenised and subjected to differential centrifugation to yield four subcellular fractions. The activity within each fraction, of four different types of enzyme, **A**, **B**, **C** and **D**, was investigated.

Which bar chart shows the results of investigating hydrolytic enzyme activity?



Explanation: hydrolytic enzymes are found in the lysosomes. Therefore, the bar with the highest activity for lysosomes should reflect the investigative outcome for hydrolytic enzymes.

4 The diagram shows several processes taking place in a cell.



Which processes are shown in the diagram and involve the cell surface membrane of the cell?

A active transport and diffusion

B diffusion and osmosis

C endocytosis and exocytosis

D endocytosis and osmosis

Explanation: Endocytosis is in the intake of materials into the cell via the formation of the pseudopods and engulfment of materials in an endosome. Exocytosis is the discharge of materials via the fusion of endosome with the cell surface membrane.

5 A plant cell is placed in a solution with a less negative (higher) water potential than the cell contents.

Which change occurs in the cell and what causes the change?

	change	cause
A	cell becomes more flaccid	solution diffuses out of the cell
B	cell becomes more flaccid	water diffuses out of the cell
C	cell becomes more turgid	solution diffuses into cell
D	cell becomes more turgid	water diffuses into cell

Explanation: If solution water potential is higher than cell content, water will diffuse into the cell via osmosis causing the cells to become turgid.

6 Beetroot cells contain a water-soluble red pigment. Two test tubes were set up as described in the table.

tube 1	Pieces of washed raw beetroot in water
tube 2	Pieces of washed raw beetroot in water containing 3 drops of cyanide, a respiratory inhibitor.

After 30 minutes, the water in tube 2 contained a red pigment but the water in tube 1 did not.

Which of the following statements are false for tube 2?

1 Pigment molecules passed out and were replaced by cyanide.

2 The cell membrane was unable to retain the red pigment.

3 Water entered the tissue by osmosis and caused the cells to burst.

4 Water passed out of the cells by osmosis and carried the soluble pigment with it.

5 The same result will occur if ethanol was used instead of cyanide.

A 1 and 3 only

B 3 and 4 only

C 2 and 5 only

D 1, 3 and 4 only

Explanation: deduce what is true – the reason why tube 2 is red is because the red pigments leak out of the cell due to the disruption of the cell membrane (#1 and #5). Beetroot cells are plant cells; plant cells have cell wall; therefore, osmosis should not cause the cells to burst (contradict #3). Cyanide disrupts the membrane and do not replace the red pigments (contradict #1). Red pigments are too big to diffuse across the membrane (contradict #4).

7 Some features of haemoglobin are listed.

1 They are made up of a protein component called globin and a non-protein component called haem group.

2 There are two types of polypeptide chains: the α-helix globin chain and the β-globin chain.

3 Each polypeptide chain is held by hydrophobic interactions, hydrogen and ionic bonds and disulfide bonds.

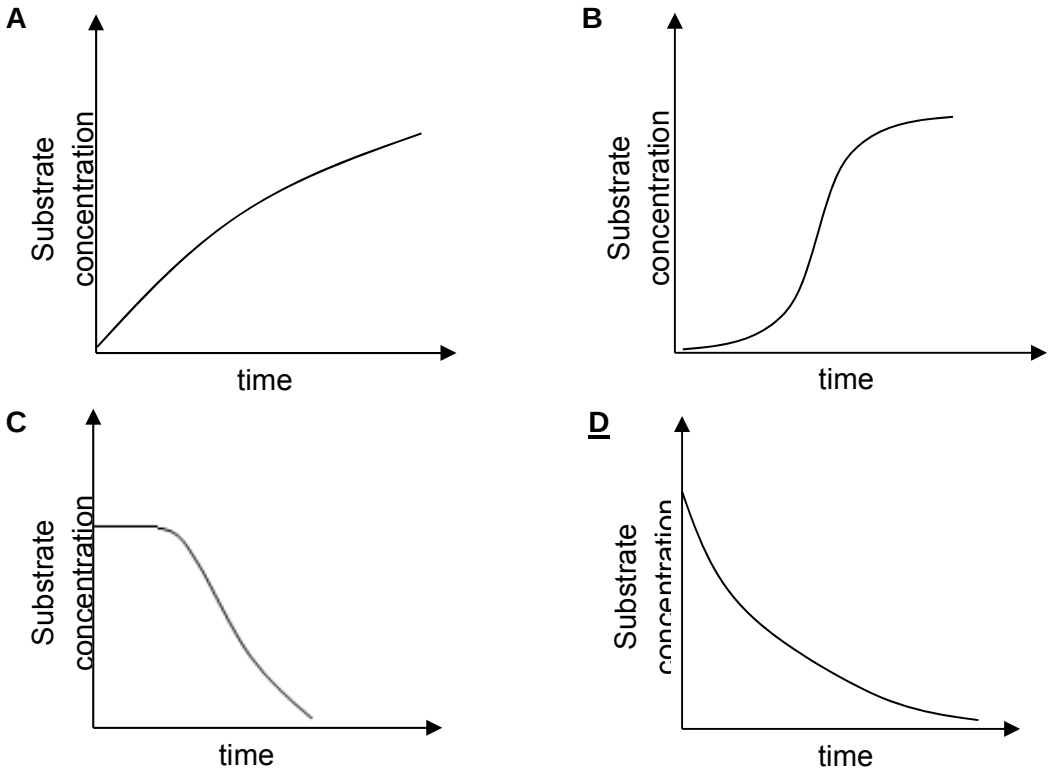
4 Most of its hydrophilic polar amino acid residues are on the external surface of the globular structure.

Which are these statements are true ?

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

Comments : there are no disulphide bonds and polypeptide is α-globin chain

8 Which graph represents the changes in substrate concentration during the course of an enzyme catalysed reaction?



9 Which is a correct statement about obtaining human embryonic stem cells for research?

A Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.

B The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.

C The cells must be removed within a day following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.

D The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

Explanation: A is not correct because it is not ethically accepted to remove ESCs from blastocyst as the blastocyst is deemed as a potential life. C is not correct because the cells removed within a day following successful fertilisation are zygotic stem cells. D is not correct because it is the trophoblast that will develop into a placenta, not the inner cell mass.

10 Mesenchymal stem cells can differentiate into several types of cells belonging to our skeletal tissue, such as cartilage, bone and fat.

Which statement correctly describes mesenchymal stem cells?

A They are specialised cells that can give rise to a variety of cell types.

B They can be stimulated by chemical signals to express certain genes.

C They lose genetic information as they differentiate.

D They occur in large numbers in the bone marrow.

Explanation: A is false because stem cells are not specialised cells. C is false because genetic information is condensed, not lost. D is false because haematopoietic stem cells are found in bone marrow.

11 Which statements about ribosomal RNA(rRNA) is true?

1 rRNA is involved in the binding of mRNA and not tRNA.

2 rRNA with associated proteins, fold into complex tertiary structures within the ribosome.

3 The 3′ terminus of rRNA in prokaryotes is known to interact with the initiation region of mRNA via the Shine–Dalgarno sequence.

4 Nucleolus is the site of rRNA transcription and processing, and of ribosome assembly.

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

Explanation: 1 is false because tRNA anticodon is complementary to the codon of the mRNA, not rRNA. 2 is true because rRNA is a component of ribosome. 3 is true because the rRNA in the small ribosomal subunit binds to the initiation region of the mRNA. 4 is true because rRNA is transcribed in nucleolus.

12 What is the basis for the difference in the synthesis of the leading and lagging strands of DNA molecules?

1 The anti-parallel arrangement of the DNA strands.

2 The RNA primers are required to initiate DNA elongation.

3 DNA polymerase can join new nucleotides to the 3' end of the growing strand.

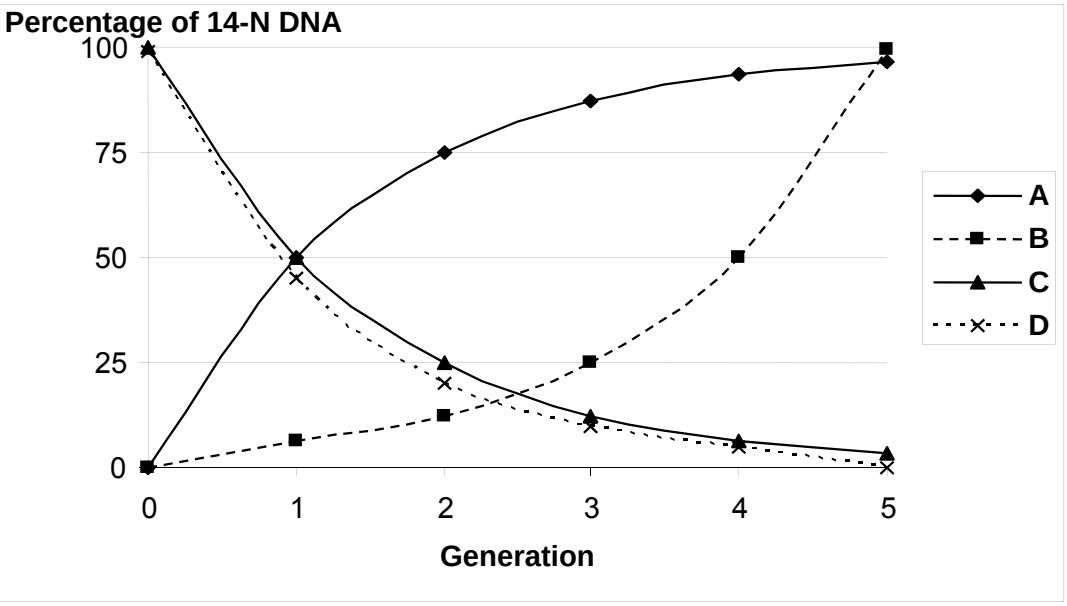
4 Helicase and single-stranded binding proteins work at the 5'end of the DNA strand.

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

Explanation: 2 is false because both leading and lagging strands require primers to initiate DNA elongation. 4 is false because helicase and ssbp work on the 3' end of the DNA strand because daughter strand is elongated from 5' → 3'

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

Which curve provides evidence that DNA replication is semi-conservative?



Answer A

14N DNA increases. Between A or B . first generation – 50 % (2 molecules of 14N : 15N)
Second generation : 2 molecules of 14N15N and 2 molecules of 14N14N) 6/8 = 75% etc

14 A new form of life is discovered. It has a genetic code much like that of organisms on Earth except that there are five different DNA bases instead of four and the base sequences are translated as doublets instead of triplets. How many different amino acids could be accommodated by this genetic code?

A 10

B 25

C 32

D 64

Explanation: $5^2 = 25$

15 What do chromosomal aberrations and gene mutations have in common and how are they different?

	Similarity	Difference
A	Both may involve addition of nucleotides.	Gene mutations always produce dominant alleles but not chromosomal aberrations.
B	Both cause changes in number of chromosomes.	Gene mutations do not involve inversions but inversion of segments of chromosomes do occur.
C	Both affect DNA sequence.	Gene mutations occur within a chromosome but chromosomal aberrations may occur across chromosomes.
D	Both may not result in a difference in protein expression.	Chromosomal aberrations are more harmful than gene mutations.

Option A : Gene mutations do not always produce dominant alleles. Option B : Gene mutation does not cause changes to the total number of chromosomes in an organism.

16 Which environmental factor is associated with the development of melanomas (a type of skin cancer)?

A alcohol

B tar

C ultraviolet light

D X-radiation

Explanation: melanomas are skin cancer, therefore, only UV aggravate the risk of cancer.

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

Amino acid	DNA triplet code
Glycine	CCA, CCG, CCT, CCC
Leucine	AAT, AAC, GAA, GAG, GAT, GAC
Lysine	TTT, TTC
Methionine	TAC
Proline	GGA, GGG, GGT, GGC
Threonine	TGA, TGG, TGT, TGC

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

…TAC TTT AAT GGC CCT GAG GGC TAC TGT …

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

A …TAC TTT AAT GGC CCT GAG GGT CCA TGT

B …TAC TTC GAT GGC CCT GAG GGC TAC TGT

C …TAC TTT AAT GGC CCG GAG TGA TAC TGT

D TAC TTT AAT GGC CCT GAG GGC TTC TGT

Explanation: no change in amino acid sequence → implies silent mutation

18 Cancer research has found that gene amplification is involved in the development of cancer. This research has identified one type of sequence that causes a break in DNA before gene amplification.

How might the findings of this research be used?

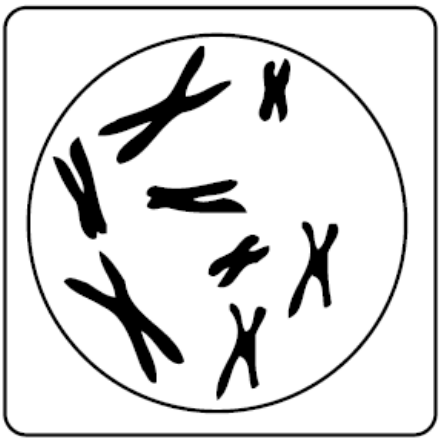
A to identify people at risk of developing cancer

B to prevent cancer from developing in 'at-risk' people

C to repair DNA breaks from amplification occurs

D to use restriction endonuclease to remove DNA

19 The diagram shows a diploid cell during mitosis.



Which stage of mitosis is shown?

A anaphase

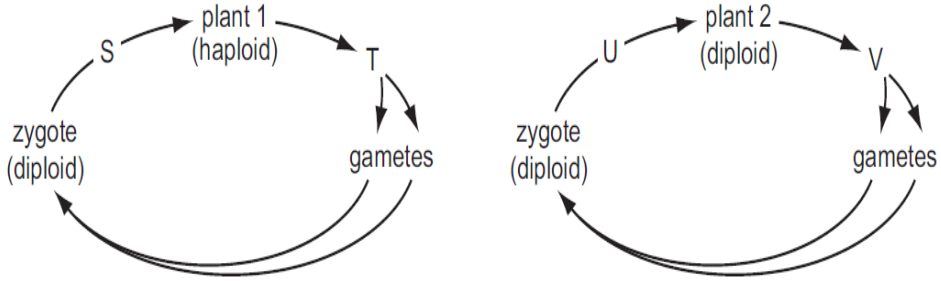
B metaphase

C prophase

D telophase

Explanation: Recall the behaviour of the chromosomes in the different stages of mitosis.

20 The diagram shows the life-cycles of two types of simple plant.



Where will reduction divisions occur in the life cycles?

A at S and U

B at S and V

C at T and U

D at T and V

Explanation: reductive divisions occur when there is a need reduced number of chromosomes from diploid to haploid.

21 In corn, the colour of the stem can be either wild type, which is dark green, or virescent, which is pale green.

Cross	Phenotype of parents	Temperature at which raised	Offspring
1	virescent X virescent	20°C	virescent
2	virescent X virescent	37°C	wild type
3	wild type X wild type	20°C	3 wild type: 1virescent
4	wild type X wild type	37°C	wild type

The parents of crosses 1 and 2 had the same genotypes. The parents of crosses 3 and 4 had the same genotypes.

Which of the following can be deduced from the data?

1 Wild type is dominant.

2 The wild type parents are heterozygotes.

3 Virescent is the recessive phenotype but the characteristic will only be expressed at lower temperature.

4 The parents of cross 1 are only recessive at 20°C.

A 2 only

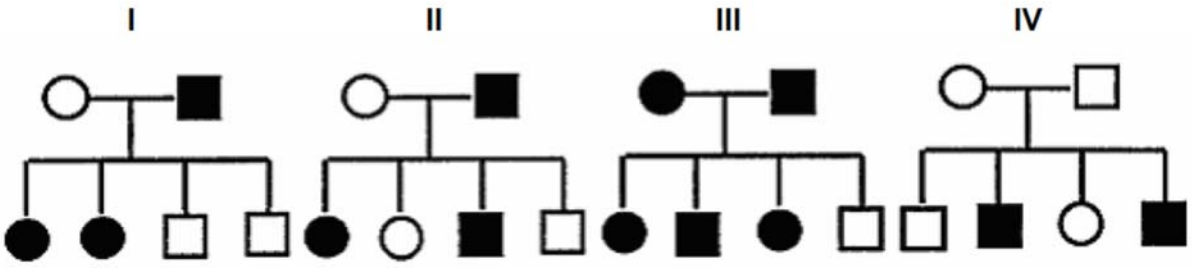
B 1 and 3 only

C 1, 2 and 3 only

D all of the above

Comments cross 3 has offspring virescent at lower temperature and not at 37°C even though genotypes are the same. Statement 4 is incorrect as dominant or recessive not affected by temperature but rather the expression is affected

22 The figure below shows 4 pedigrees. A shaded circle represents an affected female while a shaded square represents an affected male.



Which pedigree(s) show(s) a sex-linked dominant trait in humans?

A I only

B I and III

C II and III

D III and IV

Sex linked dominant :

I : shaded square male X^D Y → pass one X^D to female and diseased . Male not diseased

If diseased is recessive, X^d Y x X^D X^D female, then females should not be affected.

II : X^D Y or X^d Yshaded male. If dominant X^D Y → female diseased .

But male affected. Can be because of recessive allele from mother X^d X^d

Option III ;

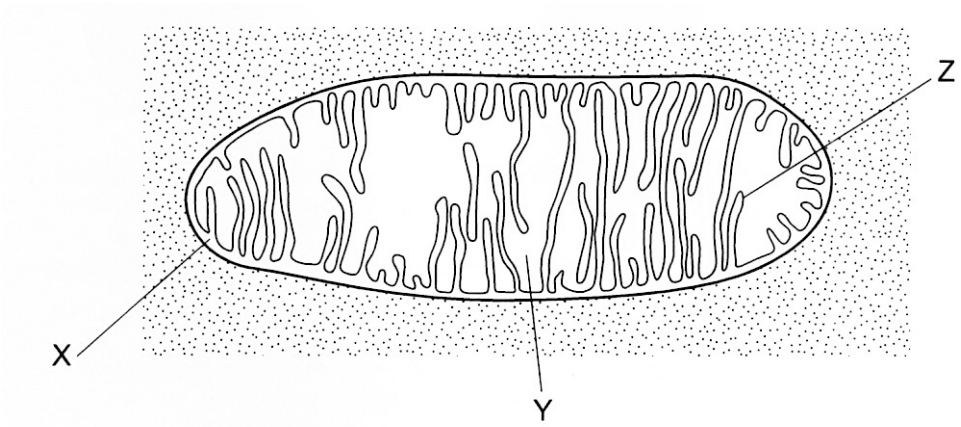
X^d X^d x X^d Y→ all males affected , But see one male unaffected

X^D X^D x X^D Y → all sexes affected

X^D X^d x X^D Y → females affected , males affected and males unaffected

Option IV : If dominant, at least one parents should be shaded

23 The electron micrograph shows an organelle found in a plant cell.

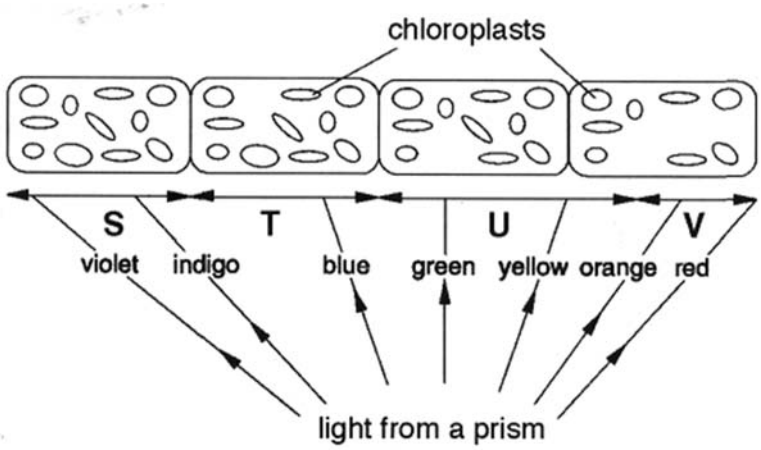


Which row shows the correct location of each named biological molecule?

	DNA	oxaloacetate	ATP
A	absent	Y	Z
B	Y	Z	Y
C	Y	Y	X
D	Y	Y	Y

Explanation: DNA is found as circular DNA in the matrix. Oxaloacetate is a substrate that is part of the Krebs cycle. ATP is produced during chemiosmosis into matrix.

24 A filament of the alga *Cladophora* was illuminated as shown in the diagram. Motile, aerobic bacteria were placed in the water with the alga and their position was determined by microscopic examination after 10 minutes.



In which two regions will the number of bacteria be highest?

A S and T

B S and U

C T and V

D U and V

Explanation: High light absorption in blue and red wavelengths → implies highest rate of photosynthesis → more bacteria

25 The copying of DNA is not always accurate, resulting in occasional, random changes to its base sequence. For example, scientists have calculated that one amino acid in vertebrate haemoglobin protein is changed every 10 million years.

Which statement about this process is correct?

A A single amino acid change in a protein may be affected by natural selection.

B All changes in the base sequence of DNA are affected by natural selection.

C Natural selection can cause some of the amino acid changes in proteins.

D The variability of DNA in a population will be less than the variability of its proteins.

Comments
A- One aa subject to NS to select for the haemoglobin protein
B – change in base sequence due to mutation, Silent mutation not affected by NS
C - change in aa due to mutation
D – no link to the process

26 In 1954, copper waste in the Finniss River killed numerous fish. This caused various species in the area to die out. However, one species, the black-banded rainbow fish, increased in numbers. The black-banded rainbow fish have modified gills that enable the fish to filter and remove the copper before it enters their body.

With respect to the black-banded rainbow fish it is reasonable to conclude that

A a mutation occurred in their population in 1954.

B the ability of their gills to remove copper already existed in 1954

C the high levels of copper in the water changed the structure of their modified gills

D their genomes are identical with those of the other species of fish that existed in 1954.

Comments : there existed the black banded rainbow fish that has the ability to remove copper within the population already. Mutation occurred prior to change in environment

27 Climate change has led to increasing temperature. The environments where birds, fishes, and other marine species live have become warmer. What is not an effect of climate change on these organisms?

A Certain fish species migrate in response to seasonal temperature changes, moving northward or to deeper, cooler waters in the summer and migrating back during the winter.

B The birds are moving north to feed and breed in the summer, then moving further south to spend the winter in warmer areas.

C The birds follow a regular seasonal migration pattern during wintering periods.

D As smaller marine prey species shift their habitats, larger predator species may follow them.

Comments
A, B and D are effect and consequences from an increase in temperature . Option C is the habit of birds and not an effect

28 Other than melting land-based ice sheets, which of these factors has made the largest contribution to the rise in sea level over the past 100 years?

A Warming of ocean surface water

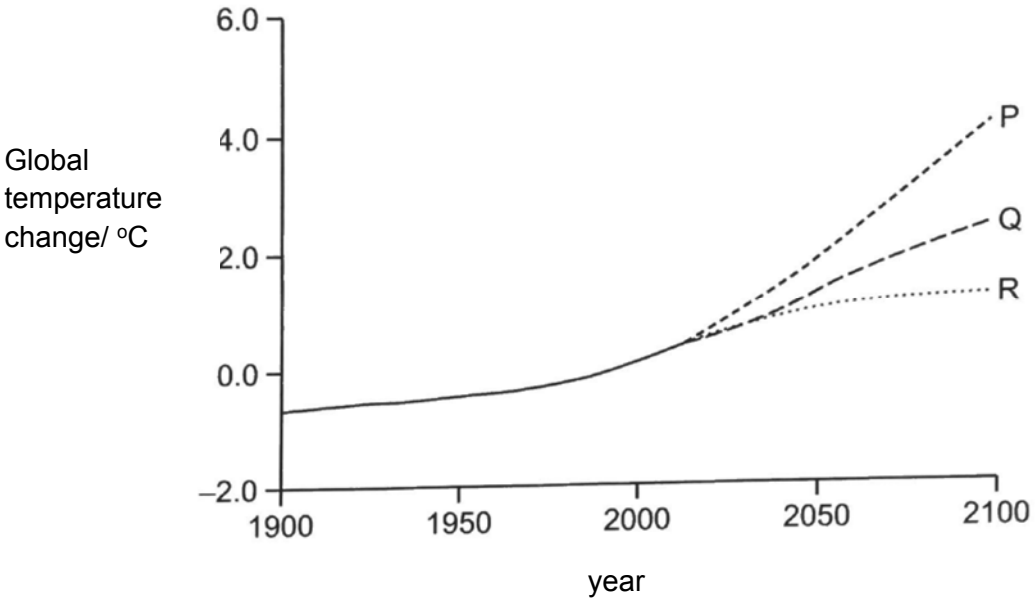
B Melting sea ice

C Increased river runoff

D Increased reflection of infrared radiation

Explanation: sea ice is formed from sea water, therefore melting of sea ice will not rise sea level.

29 The graph shows the predicted changes 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 Artic will begin to thaw as global temperature increase.

3 Rising sea temperature will cause increase growth of photosynthetic algae.

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

Which of these statements support predictions 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

Comments: Curve P shows a higher increase in global temperature. Statements 1, 2 and 4 lead to sharp increase in global temperature. Algal blooms absorb sunlight, making water even warmer and promoting more blooms.

30 Corals are among the first indicators of climate change. When ocean temperatures get too hot for too long, corals undergo a process called bleaching. Which statements are true about this process?

1 Increased levels of sediment in seawater, the zooxanthellae may lose substantial amounts of their photosynthetic pigmentation, which decreases rates of photosynthesis produces bleaching.

2 Bleaching occurs when abnormally high sea temperatures cause corals to expel the zooxanthellae living in them.

3 zooxanthellae unable to use the oxygen and waste materials of the host, supplying carbon dioxide and food substances in return.

4 With high sea temperatures and decreasing planktons, corals use the zooxanthellae as their food source

A 1 and 2

B 1 and 4

C 2 and 4

D 2 and 3

Statement 3 is wrong as zooxanthellae supply oxygen (from photosynthesis) to the corals and coral supply carbon dioxide to zooxnthellae.
Statement 4 is wrong as zooxanthellae is expelled out.

	Parent's signature

Name	Index Number	CTG

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2018

BIOLOGY **8876/02**

HIGHER 1 **29 AUGUST 2018**

Paper 2 Structured and Free-response Questions **Wed 1400 - 1600**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

YISHUN JUNIOR COLLEGE YISHUN JUNIOR COLLEGE YISHUN JUNIOR COLLEGE YISHUN JUNIOR COLLEGE YISHUN JUNIOR COLLEGE

READ THESE INSTRUCTIONS FIRST

Write your name and CTG in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen only.

You may use a soft pencil for any diagrams, graphs or rough working.

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

Section A
Answer **all** questions in the spaces provided on the Question paper.

Section B
Write your answers in the spaces provided on the Question Paper.

At the end of the examination, fasten all your work securely together.

This question paper consists of **20** printed pages.

FOR EXAMINER'S USE	
Paper 1	/ 30
Paper 2	
Section A	
Q1	/14
Q2	/10
Q3	/ 6
Q4	/ 5
Q5	/ 10
Section B	
Q6 OR 7	/ 15
Total	/ 60
Overall	/ 90

Section A

Answer **all** questions in this section.

1 In an experiment to study the effect of heat treatment on the digestibility of protein substrate and the effect of raw bean extract on protease activity, various reaction mixtures were prepared and were incubated for 30 minutes.

The protein concentration of each reaction mixture at the beginning and at the end of the incubation period was determined by the colorimetric method which measures colour intensity of these reaction mixtures. The results were shown in Table 1.1.

Table 1.1

Incubation period /min	**Colour intensity of the reaction mixture / arbitrary unit**		
	Tube A	**Tube B**	**Tube C**
	Protease + heated protein substrate	**Protease + unheated protein substrate**	**Protease + unheated protein substrate + raw bean extract**
0	10	10	10
30	4	7	9

Fig. 1.1 shows a standard graph obtained by using colorimetric method for determining concentration of protein solutions.

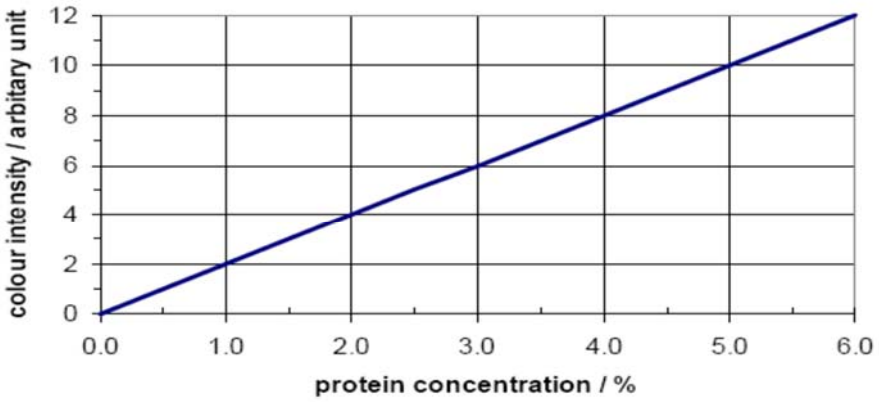


Fig. 1.1

(a) With reference to Table 1.1 and Fig 1.1,

(i) Determine the protein concentration of the three tubes at time 0 min.

…… [1]

(ii) Explain which protein substrate is more digestible by protease.

……...

……...

……...

…… [2]

(b) Based on your knowledge of protein structure, explain the effect of heat treatment on the digestibility of this protein substrate.

……

……

……

……

……

…… [3]

(c) Suggest the effect of raw bean extract on protease activity.

…… [1]

(d) Dextrin is a generic term applied to a variety of products obtained by heating starch in the presence of small amounts of moisture and an acid. Dextrins can be made from starch and is a polysaccharide similar to amylopectin.

Describe the differences in molecular structure between cellulose and dextrins.

……

……

……

…… [2]

Fig. 1.2 shows the structure of a triglyceride. Fig. 1.3 shows the structure of a glycolipid.

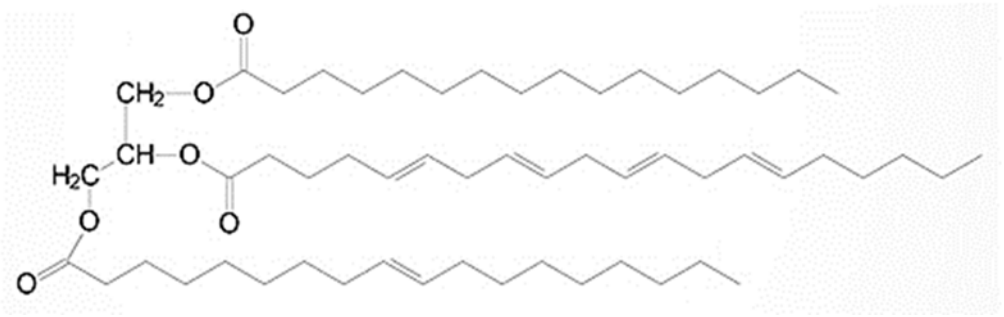


Fig. 1.2

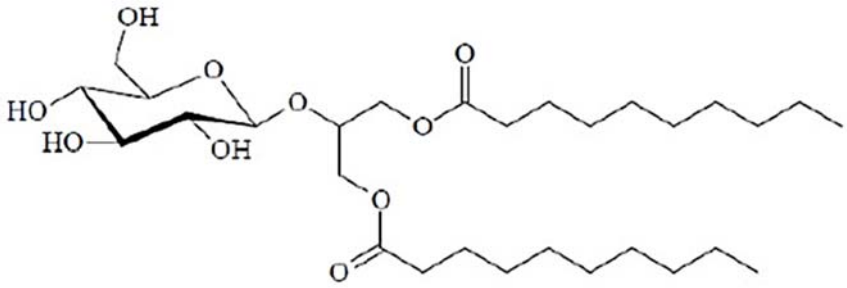


Fig. 1.3

(e) Explain the difference in solubility between triglycerides and the products of their hydrolysis.

……

……

……

……

……

…… [3]

(f) Describe the roles of triglycerides and glycolipids in relation to the differences in their molecular structures.

……

……

……

…… [2]

[Total: 14]

2 Fig. 2.1 shows two pairs of homologous chromosome carrying alleles **F/f and G/g** respectively.

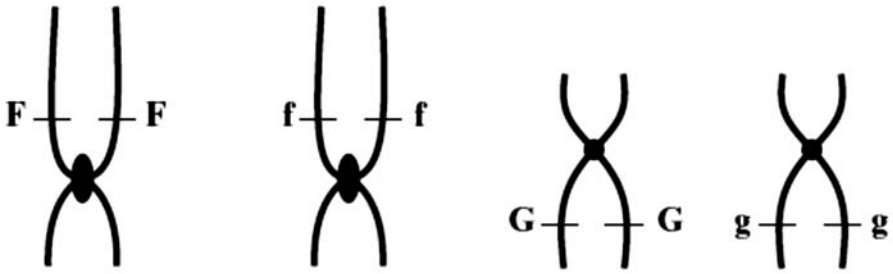


Fig. 2.1

(a) State the genotype of this cell.

…… [1]

(b) Explain why there are two copies of each allele for each gene present on the chromosomes in Fig. 2.1, before the start of nuclear division.

……

……

……

…… [2]

Fig. 2.2 shows a molecule of tRNA and the enzyme that attaches the correct amino acid to it.

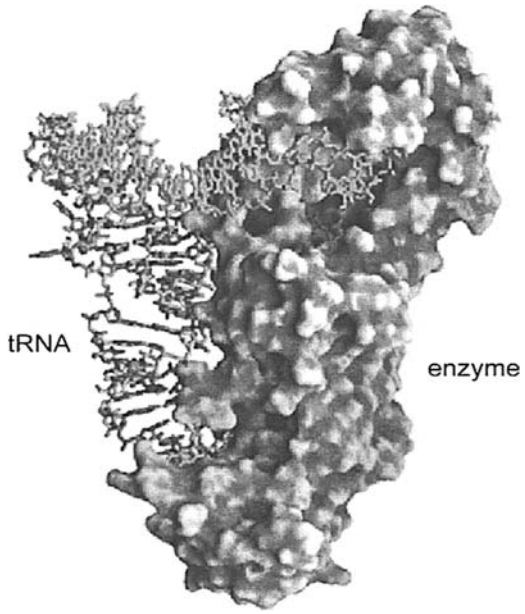


Fig. 2.2

(c) Describe **two** structural features which adapt tRNA to its role in translation.

……

……

……

…… [2]

(d) Explain how the enzyme in Fig. 2.2 is suited to its function.

……

……

……

……

……

…… [3]

(e) Fig. 2.3 below shows the base sequence on a length of mRNA and the amino acids represented by the respective codons.

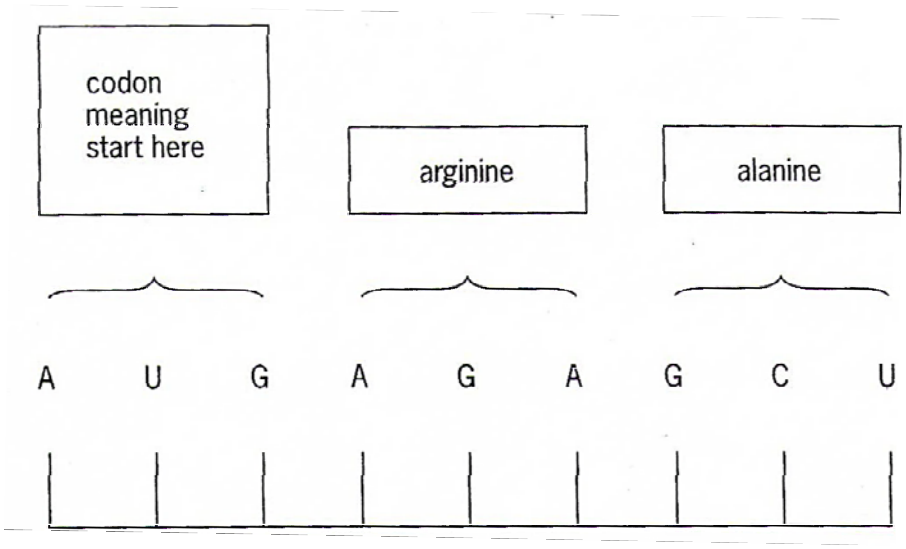


Fig. 2.3

The codon AGA codes for the amino acid arginine. However, arginine can also be represented by the codon AGG.

(i) Explain why the substitution of A by G in this case does not affect the amino acid represented.

……

…… [1]

(ii) The codons in the mRNA sequence do not overlap. Suggest one advantage of this.

……

…… [1]

[Total: 10]

3 An inbred variety of maize, **A**, with finely striped leaves was found to be resistant to the fungus that causes the disease, corn leaf blight.

Plants of variety **A** were crossed with another inbred variety of maize, **B**, which had entirely green leaves and low resistance to the fungus. All the F_1 generation had entirely green leaves and low resistance.

(a) Using appropriate symbols and indicating what they represent, state the genotype of **A**.

…… [1]

The above F_1 generation was back-crossed to variety **A**.

(b) Draw a genetic diagram to explain the expected results of the F_2 generation from this cross.

[5]

[Total: 6]

4 Dengue fever is an infectious disease transmitted by a vector.

(a) **(i)** State the name of the pathogen that causes dengue fever.

…… [1]

(ii) State the name of the vector that transmits the pathogen.

…… [1]

In 2002, the World Health Organization estimates that there might be 50 million cases of dengue infection worldwide every year. In Singapore, dengue fever is endemic with year-round transmission. Fig 4.1 shows the incidences of dengue fever from 1985 to 3 September 2005.

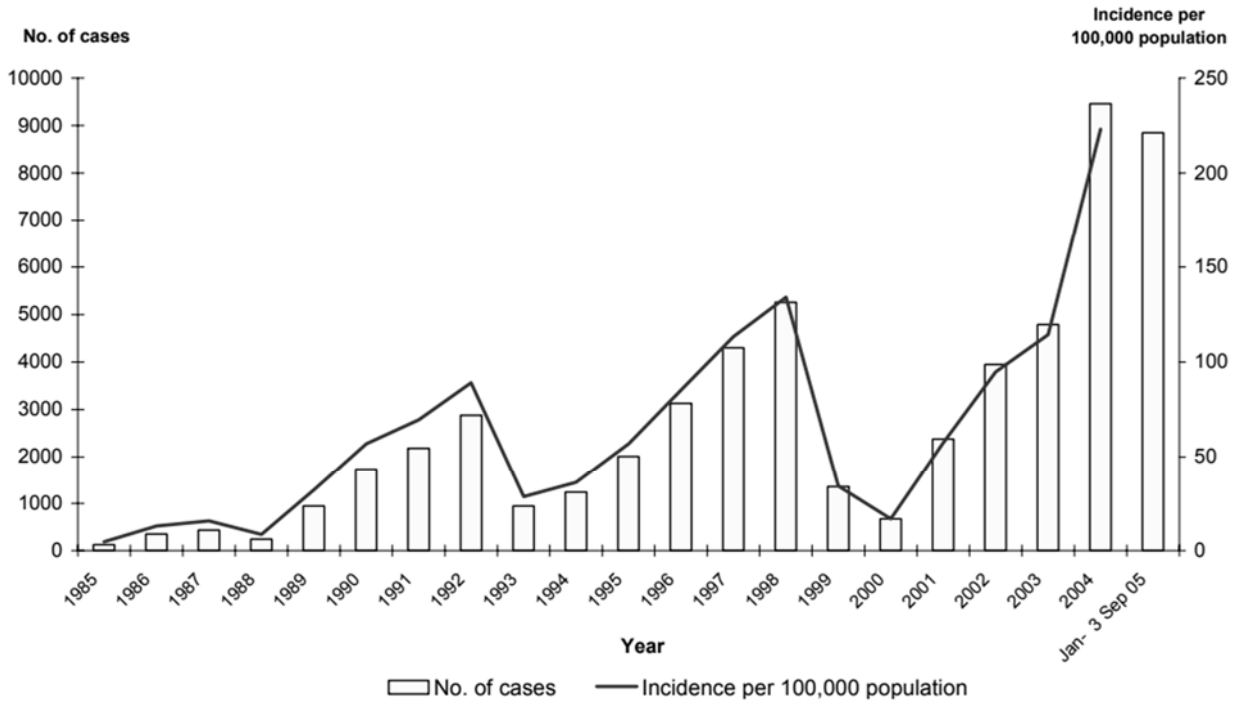


Fig. 4.1

(b) Suggest **two** reasons why the number of cases of dengue fever decreased in 1993 and 2000.

……

……

……

…… [2]

(c) Dengue fever is very difficult to control even though there has been improved understanding of the disease.

Explain why dengue fever is very difficult to control.

……

…… [1]

[Total: 5]

5 Fig. 5.1 shows the Calvin cycle which takes place inside a plant cell.

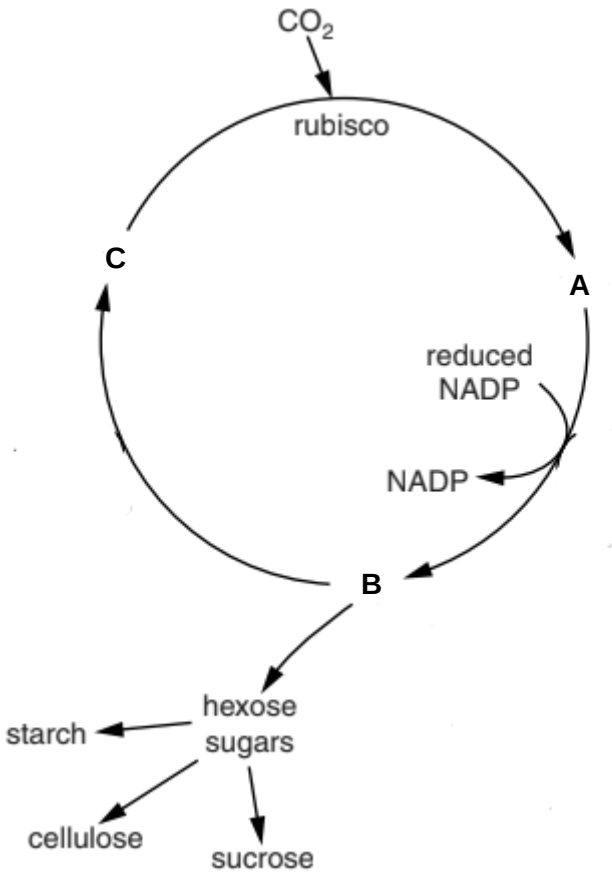


Fig. 5.1

(a) Identify substances **A**, **B** and **C**.

A ……

B ……

C …… [3]

(b) Describe the role of NADP in linking the light dependent reactions to the Calvin cycle in shown in Fig. 5.1.

……

……

……

…… [2]

(c) In aerobic respiration and photosynthesis, ATP is synthesised via chemiosmosis in oxidative phosphorylation and photophosphorylation.

(i) Outline the role of stalked particles in chemiosmosis in oxidative phosphorylation.

……...

……...

……...

……...

……...

…… [2]

(ii) Explain why less ATP is synthesised from the same mass of glucose in anaerobic respiration compared to aerobic respiration.

……...

……...

……...

……...

……...

…… [3]

[Total: 10]

Section B

Answer **one** question in this section.

Write your answers on the lined papers provided at the end of this Question Paper.

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

Your answers must be in continuous prose, where applicable.

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

6 **(a)** Discuss the role of complementarity in cellular mechanisms. [6]

(b) Red blood cells are replaced every 3 to 4 months.

Explain how haemoglobin is synthesised when haematopoietic stem cells form red blood cells. [9]

[Total: 15]

7 **(a)** With reference to named examples, describe the range of roles performed by ATP in living organisms. [6]

(b) Cytochrome *c* is primarily known as an electron-carrying mitochondrial protein. The amino acid sequence is highly conserved in eukaryotes, differing by a few residues.

Cytochrome *c* amino acid sequence in humans is more similar to that of chimpanzees but differs more from that of horses.

Explain how cytochrome *c* was conserved over time in eukaryotes. [9]

[Total: 15]

Parent's signature	

Name	Index Number	CTG

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2018

BIOLOGY **8876/02**

HIGHER 1 **29 AUGUST 2018**

Paper 2 Structured and Free-response Questions **Wed 1400 - 1600**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

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READ THESE INSTRUCTIONS FIRST

Write your name and CTG in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen only.

You may use a soft pencil for any diagrams, graphs or rough working.

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

Section A
Answer **all** questions in the spaces provided on the Question paper.

Section B
Write your answers in the spaces provided on the Question Paper.

At the end of the examination, fasten all your work securely together.

This question paper consists of **20** printed pages.

FOR EXAMINER'S USE	
Paper 1	/ 30
Paper 2	
Section A	
Q1	/14
Q2	/10
Q3	/ 6
Q4	/ 5
Q5	/ 10
Section B	
Q6 OR 7	/ 15
Total	/ 60
Overall	/ 90

Section A

Answer **all** questions in this section.

1 In an experiment to study the effect of heat treatment on the digestibility of protein substrate and the effect of raw bean extract on protease activity, various reaction mixtures were prepared and were incubated for 30 minutes.

The protein concentration of each reaction mixture at the beginning and at the end of the incubation period was determined by the colorimetric method which measures colour intensity of these reaction mixtures. The results were shown in Table 1.1.

Table 1.1

Incubation period /min	**Colour intensity of the reaction mixture / arbitrary unit**		
	Tube A	**Tube B**	**Tube C**
	Protease + heated protein substrate	**Protease + unheated protein substrate**	**Protease + unheated protein substrate + raw bean extract**
0	10	10	10
30	4	7	9

Fig. 1.1 shows a standard graph obtained by using colorimetric method for determining concentration of protein solutions.

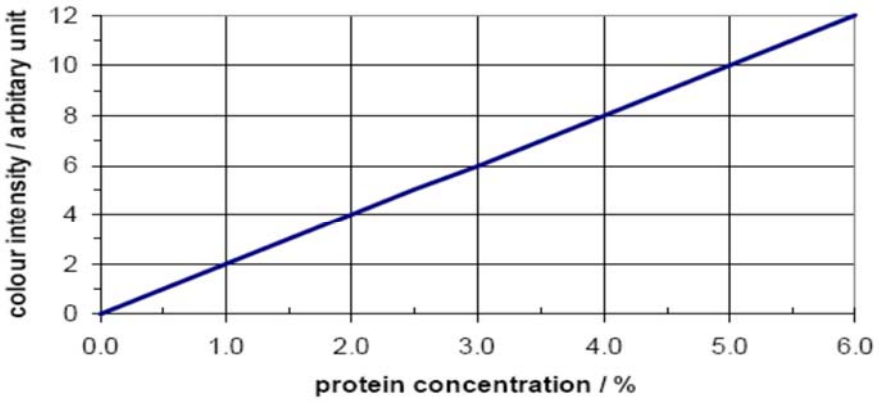

Fig. 1.1

(a) With reference to Table 1.1 and Fig 1.1,

(i) Determine the protein concentration of the three tubes at time 0 min.

5% protein concentration [1]

(ii) Explain which protein substrate is more digestible by protease.

1. **heated protein more digestible by protease;**
2. **less protein remained after incubation with protease / lowest colour intensity**
3. **unheated vs heated = 3% decreases** [2]

(b) Based on your knowledge of protein structure, explain the effect of heat treatment on the digestibility of this protein substrate.

1. **heating increases the digestibility of this protein substrate / digest more quickly / easier to digest;**
2. **heating causes protein substrate denaturation/ loss of 3D configuration;**
3. **breaking of bonds – H, hydrophobic, ionic, disulphide (name at least 2);**
4. **increase in surface area of substrate for protease action/ easier access of enzyme(s' active site) to substrate/peptide bonds;** [3]

(c) Suggest the effect of raw bean extract on protease activity.

inhibits protease activity [1]

(d) Dextrin is a generic term applied to a variety of products obtained by heating starch in the presence of small amounts of moisture and an acid. Dextrins can be made from starch and is a polysaccharide similar to amylopectin.

Describe the differences in molecular structure between cellulose and dextrins.

1. **Cellulose** is a polymer of around 10,000 **β-glucose molecules while d**extrin is a polymer of **α glucose molecules**,
2. Dextrin joined by **α (1→4) and α (1→6) glycosidic bonds at the branch points** while **cellulose** joined by **β (1→4) glycosidic bonds**,
3. In cellulose, **alternate β glucose molecules rotate 180^0** while α glucose molecules of dextrin are at the **same orientation** (i.e. do not rotate)
4. Dextrin is a **branched** chain of α glucose units, and **coiled into a helix while cellulose chains are long unbranched chains with a**djacent cellulose chains form hydrogen bonds / cross bridges between the chains to form **microfibrils.** [2]

Fig. 1.2 shows the structure of a triglyceride. Fig. 1.3 shows the structure of a glycolipid.

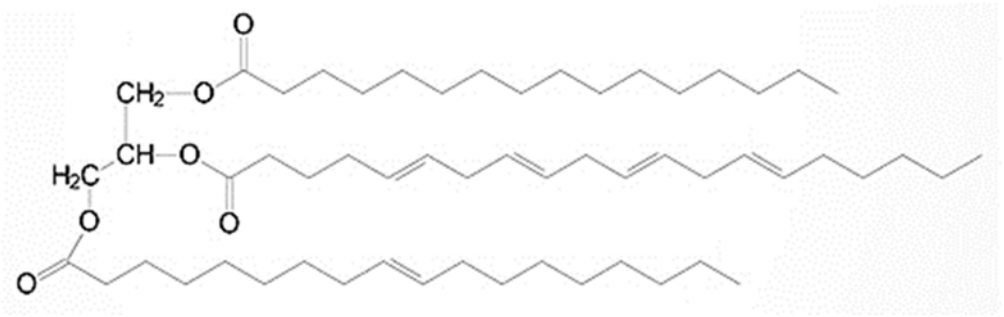

Fig. 1.2

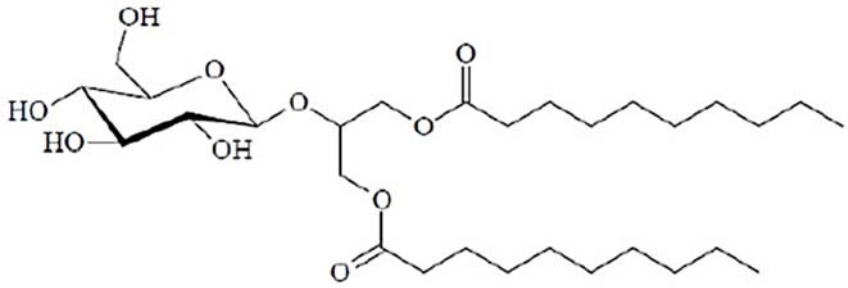

Fig. 1.3

(e) Explain the difference in solubility between triglycerides and the products of their hydrolysis.

1. Triglycerides are **non-polar molecules** that are **insoluble in water**. This is due to their incapability of forming hydrogen bonds with water molecules.
2. **Glycerol and fatty acids** are the **products of triglyceride hydrolysis**.
3. **Glycerol is an alcohol** that is **soluble** due to its ability (-OH groups in glycerol) to form hydrogen bonds with water, but **fatty acids** are **insoluble** due to their **long hydrocarbon tails** that are **non-polar** and **hydrophobic.** [3]

(f) Describe the roles of triglycerides and glycolipids in relation to the differences in their molecular structures.

1. **Has long hydrocarbon chains, acting as energy store that yield more energy** (38kJ per gram) than same mass of carbohydrates (17 kJ per g)
2. Releases **more metabolic water** during fat oxidation/ respiration.
3. Lipid molecule with a carbohydrate component and act as a recognition site for cell adhesion [2]

[Total: 14]

2 Fig. 2.1 shows two pairs of homologous chromosome carrying alleles **F/f and G/g** respectively.

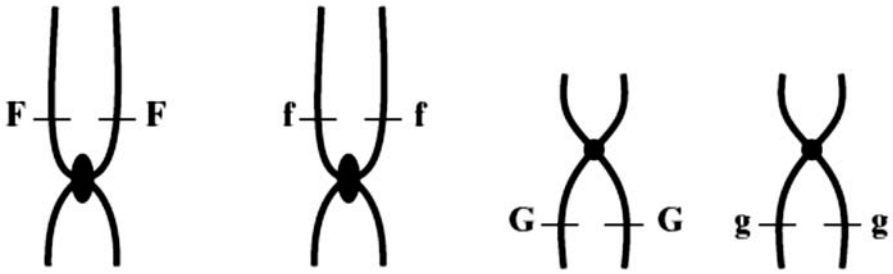

Fig. 2.1

(a) State the genotype of this cell.

FfGg [1]

(b) Explain why there are two copies of each allele for each gene present on the chromosomes in Fig. 2.1, before the start of nuclear division. [2]

1. DNA replication has occurred;
2. During interphase / S-phase of interphase before mitosis;
3. Giving rise to two chromatids;
4. With two copies of the allele, one on each chromatid;

Fig. 2.2 shows a molecule of tRNA and the enzyme that attaches the correct amino acid to it.

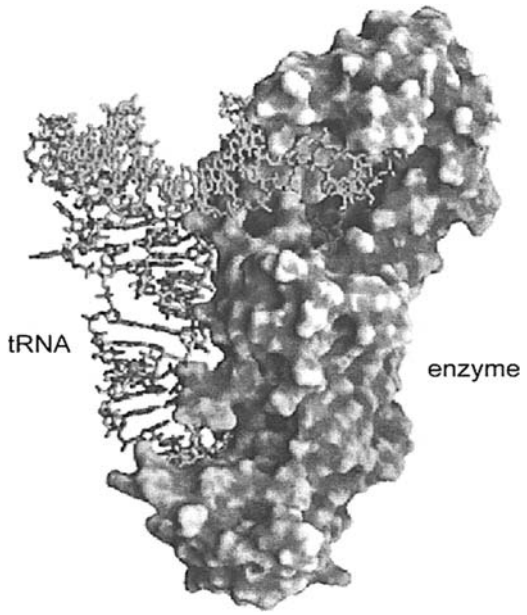

Fig. 2.2

(c) Describe **two** structural features which adapt tRNA to its role in translation.

1 3' / (CCA end) = allows specific amino acid molecule binds to the tRNA

2 loop with anticodon /region has specific triplet base sequence - complementary to a codon on mRNA. [2]

(d) Explain how the enzyme in Fig. 2.2 is suited to its function.

1) Identify the enzyme as aminoacyl-tRNA synthetase
2) has recognition/active site for both amino acid
3) and tRNA with specific anticodon;
4) with site being complementary in shape and charge to the substrates
5) able to catalyse formation of covalent bond between tRNA and amino acid
6) twenty different aminoacyl-tRNAase enzymes for each amino acid to ensure specificity in binding

[3]

(e) Fig. 2.3 below shows the base sequence on a length of mRNA and the amino acids represented by the respective codons.

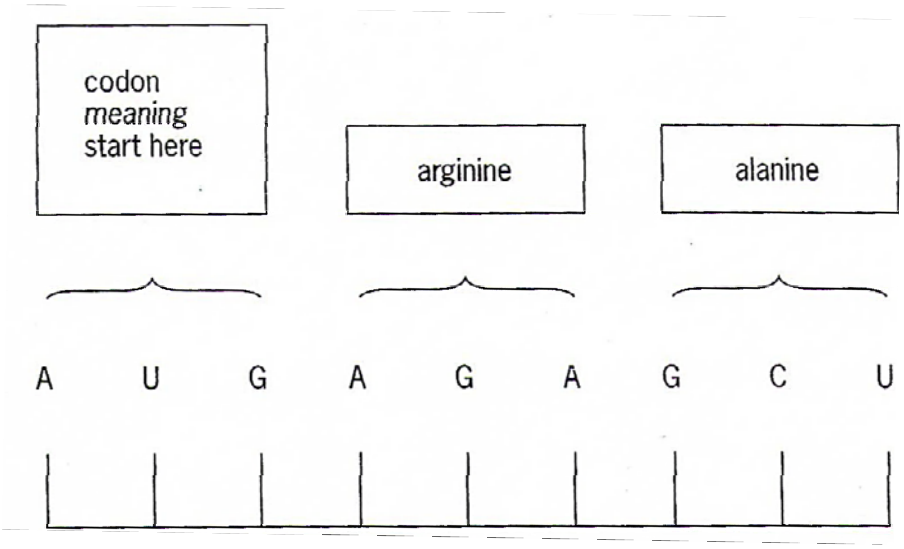

Fig. 2.3

The codon AGA codes for the amino acid arginine. However, arginine can also be represented by the codon AGG.

(i) Explain why the substitution of A by G in this case does not affect the amino acid represented.

1. Genetic code is degenerate/redundancy in genetic code;
2. 1 amino acid can be coded by more than 1 codon;
3. First two bases are most important in determining which amino acid is attached;
4. The third base is a wobble base/not as important;
5. It is a form of silent mutation [1]

(ii) The codons in the mRNA sequence do not overlap. Suggest one advantage of this.

1. Substitution of a base will only change one amino acid instead of two;;
2. Overlapping can cause difficulties in translation when the tRNA comes into the P site as it would be blocked by the previous tRNA;;
3. There is less restriction on the order of amino acids since the overlapped base of one codon has no effect on the next codon;; [1]

[Total: 10]

3 An inbred variety of maize, **A**, with finely striped leaves was found to be resistant to the fungus that causes the disease, corn leaf blight.

Plants of variety **A** were crossed with another inbred variety of maize, **B**, which had entirely green leaves and low resistance to the fungus. All the F_1 generation had entirely green leaves and low resistance.

(a) Using appropriate symbols and indicating what they represent, state the genotype of **A**.

G - entirely green leaf, R – low resistance
genotype of A: ggrr; [1]

The above F_1 generation was back-crossed to variety **A**.

(b) Draw a genetic diagram to explain the expected results of the F_2 generation from this cross.

Phenotype ***entirely green, low resistance*** ***x*** ***striped resistant*** ***leaves, [1]***

[Genotype ***GgRr*** ***x*** ***ggrr*** ***[2]***

Meiosis

Gametes ***(GR) (Gr) (gR) (gr)*** ***(gr)*** ***[3]***

Fertilisation

Using Punnett Square

	(GR)	***(gR)***	***(Gr)***	***(gr)***
(gr)	***GgRr***	***ggRr***	***Ggrr***	***ggrr***

F_2 genotype ***GgRr*** ***ggRr*** ***Ggrr*** ***ggrr*** ***[4]***

F_2 phenotype (offspring) ***entirely green, low resistance*** ***striped leaves, low resistance*** ***entirely green, resistant*** ***striped leaves, resistant*** ***[5]***

F_2 phenotypic ratio ***1 : 1 : 1 : 1***

[5]

[Total: 6]

4 Dengue fever is an infectious disease transmitted by a vector.

(a) **(i)** State the name of the pathogen that causes dengue fever.

Dengue virus; **A** DENV [1]

(ii) State the name of the vector that transmits the pathogen.

Aedes aegypti **R** mosquito, aedes, *A. aegypti* [1]
R genus and species are not underlined separately

In 2002, the World Health Organization estimates that there might be 50 million cases of dengue infection worldwide every year. In Singapore, dengue fever is endemic with year-round transmission. Fig 4.1 shows the incidences of dengue fever from 1985 to 3 September 2005.

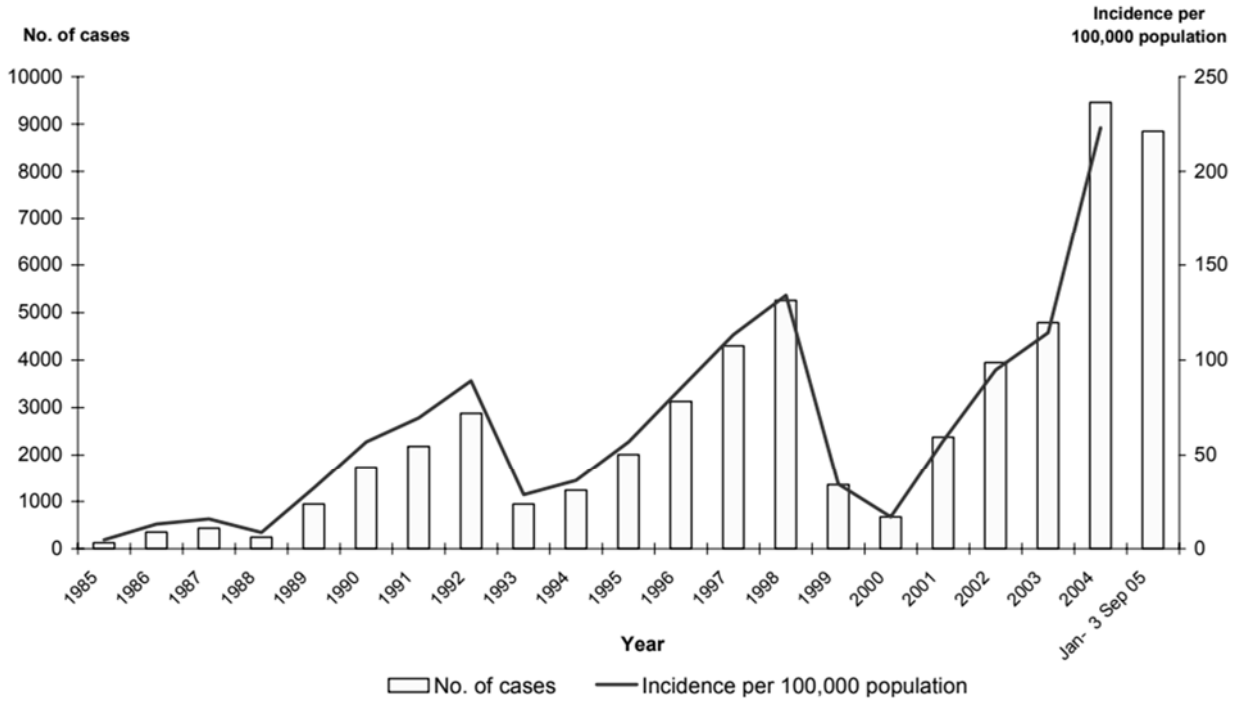

Fig. 4.1

(b) Suggest **two** reasons why the number of cases of dengue fever decreased in 1993 and 2000.

Give example of control of breeding of mosquitoes;
e.g. drainage of stagnant water / sterile males / aerial spraying of insecticide / applying oil on water / breeding of fishes in water

example of reduction of contact between mosquitoes and human;
e.g. use of bed nets / insect repellents

Improve in surveillance (by NEA);

Improve awareness of / education about, transmission / control methods;

AVP e.g. drop in ambience temperature → not suitable for breeding of mosquitoes

[Any 2] [2]

(c) Dengue fever is very difficult to control even though there has been improved understanding of the disease.

Explain why dengue fever is very difficult to control.

1 no vaccine **;** **A** no effective vaccine
2 any problem in developing a vaccine **;**
e.g. 4 serotypes of dengue viruses / antibody dependent enhancement of dengue virus infection
3 insecticide resistance in *Aedes* **;**
any example, e.g. DDT / dieldrin / pyrethroids **;**
4 *ref. to* conditions for breeding of *Aedes* **;**
5 problems with, funding research / AW **;**
6 cost of, drugs / insecticides, to government / health authorities / individuals **;**
7 people with HIV / AIDS are at high(er) risk than others **;**
8 lack of knowledge / lack of education / 'fatalism' / AW **;**
9 inaccessibility of some regions to healthcare **;**
10 infected people not, identified / diagnosed **;**
11 AVP **;**
e.g. migration of people with dengue fever to places without malaria; global warming promoting the growth and development of mosquitoes;

[Any 1] [1]

[Total: 5]

5 Fig. 5.1 shows the Calvin cycle which takes place inside a plant cell.

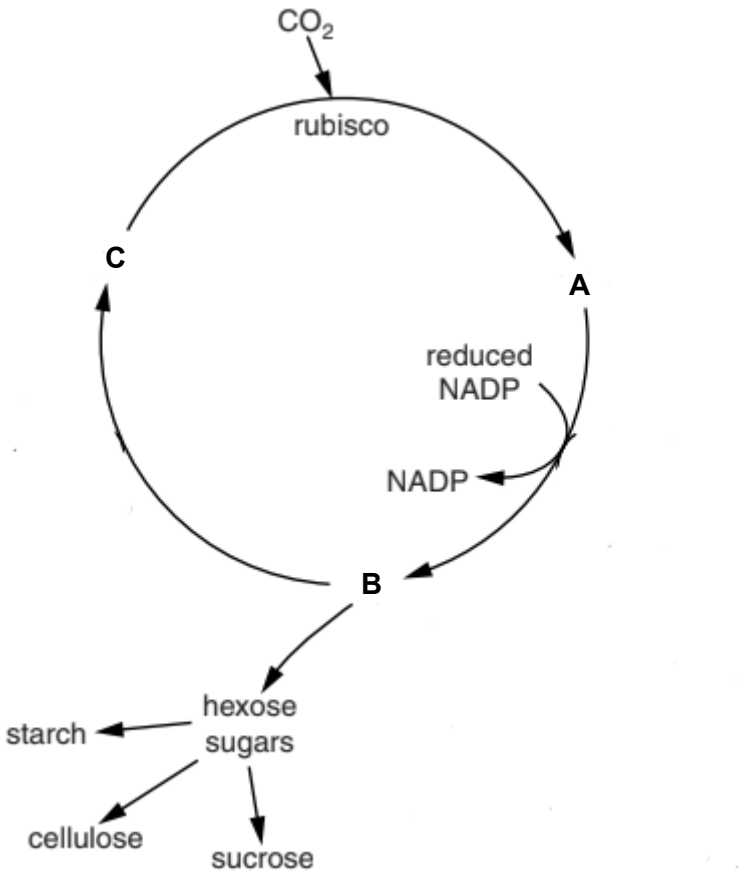

Fig. 5.1

(a) Identify substances **A**, **B** and **C**.

A – glycerate-3-phosphate / 3-phosphoglycerate (R! G3P, 3PG)

B – glyceraldehyde-3-phosphate / triose phosphate (R! G3P, TP)

C – ribulose bisphosphate / RuBP [3]

(b) Describe the role of NADP in linking the light dependent reactions to the Calvin cycle as shown in Fig. 5.1.

NADP is the final electron acceptor of the non-cyclic photophosphorylation, reduced to NADPH;

NADPH is required to reduced glycerate-3-phosphate (A! if student wrote 1,3-bisphosphoglycerate) to glyceraldehyde-3-phosphate; [2]

(c) In aerobic respiration and photosynthesis, ATP is synthesised via chemiosmosis in oxidative phosphorylation and photophosphorylation.

(i) Outline the role of stalked particles in chemiosmosis in oxidative phosphorylation.

Protons diffuse from intermembrane space back to matrix via the stalked particles, results in proton motive force;

Proton motive force drives ATP synthase to catalyse the formation of ATP from ADP and free phosphate; [2]

(ii) Explain why less ATP is synthesised from the same mass of glucose in anaerobic respiration compared to aerobic respiration.

anaerobic – accept ora for aerobic
1 idea that glucose not completely, broken down/oxidised
or
only glycolysis occurs;
or
pyruvate/lactate/ethanol, still contains energy;

2 ETC stops (because) no oxygen to act as (final) electron acceptor;

3 (so) no, Krebs cycle/link reaction/oxidative phosphorylation / chemiosmosis; [3]

[Total: 10]

Section B

Answer **one** question in this section.

Write your answers on the lined papers provided at the end of this Question Paper.

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

Your answers must be in continuous prose, where applicable.

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

6 **(a)** Discuss the role of complementarity in cellular mechanisms. [6]

Complementary shape (max 2)

1. Substrate(s) fit into the active site of enzyme;
2. via lock and key hypothesis;
3. And induced fit hypothesis;
4. To form enzyme-substrate complex;

5. DNA to fit into binding site of proteins
6. To regulate replication;
7. And gene expression;

8. Binding of substances to transport proteins;
9. Allows for movement of substances across cell membrane;
10. and viral entry;

Complementary interaction (max 2)

11. H bonds between polar groups;
12. Hydrophobic interaction between non-polar groups;
13. Ionic bonds between oppositely charged groups;
14. Allows for folding of polypeptide into 3D shape;
15. Stability of biomolecules;

Complementary base pair (max 2)

16. A-T (A-U) and C-G;
17. Allows for stability of DNA double helix;
18. Allows for replication of DNA;
19. Allows for the synthesis of mRNA/transcription;
20. allows for the binding of (anticodon on) tRNA to (codon on) mRNA;

(b) Red blood cells are replaced every 3 to 4 months.

Explain how haemoglobin is synthesised when haematopoietic stem cells form red blood cells. [9]

cells and organelles: max 2

1. haemoglobin a- and b- genes in DNA, DNA in nucleus;
2. transcription of haemoglobin a- and b- gene in nucleus by RNA polymerase;
3. export of mature mRNAs into cytoplasm via nuclear pores;
4. free 80S ribosomes bind to each mRNA, translation of each mRNA to form a-chain and b-chain separately;
5. each chain fold into the tertiary structure of a-globin and b-globin;

proteins: max 2

6. haemoglobin - quaternary structure, 4 polypeptide chains; 2 a- and 2 b-;
7. maintained by 3 types of intermolecular bonds;
8. ref to the primary, secondary, tertiary structure of globin;

stem cells: max 2

9. Hematopioetic stem cells multipotent;
10. can differentiate into myeloid progenitor, myleoid progenitor cell give rise to RBC;
11. ref to internal and external signals to stimulate differentiation;

DNA & genomics: max 2

12. ref to transcription mechanism;
13. ref to translation mechanism;
14. primary RNA from transcription needs to be processed (post-transcriptional modification) to form mature mRNA;
15. removal of introns by RNA excision; splicing of exons;
16. additional of 5'-methylguanosine cap;
17. additional of 3'-poly 'A' tail;

Energetics: max 1

18. idea that aerobic respiration releases energy (ATP) to support the various stages of immunoglobin production;

QWC (1m) points communicated clearly without ambiguity and with relevant connections as to how haemoglobin (protein) is expressed as HSC differentiate to form RBC

[Total: 15]

7 **(a)** With reference to named examples, describe the range of roles performed by ATP in living organisms. [6]

1. ATP – adenosine triphosphate, an energy currency in the cell produced by phosphorylation of ADP + P_i ;

2. when hydrolysed into ADP + P_i, releases a lot of energy to fuel many anabolic reactions within the cell ;;

3. In cellular/aerobic respiration: Activation of glucose to glucose-6-phosphate via phosphorylation using ATP during the energy investment phase of glycolysis.

OR

- ATP is required for the phosphorylation of fructose-6-phosphate to fructose-1,6-bisphosphate catalysed by phosphofructokinase ;
- ATP also serves as an allosteric inhibitor to the phosphofructokinase enzyme ;

4 needed in the endomembrane system i.e. to supply energy needed to power the migration of vesicles (transport / secretory) between organelles for protein / lipid trafficking ;;

5 Active transport of molecules against concentration gradient across the cell surface membrane via the action of a specific carrier proteins called "pump" which use ATP to change its conformation. E.g. is sodium-potassium pump ;

6 required for active transport processes i.e. to move large substances against concentration gradient through carrier proteins / in bulk transport processes, endocytosis and exocytosis ;;

7 synthesis of large biomolecules (proteins, carbohydrates) through formation of bonds between monomers (peptide bonds, glycosidic bonds / amino acids, monosaccharides) requires energy ;;

8 ATP required for amino acid activation prior to translation for the covalent attachment of the amino acid to the 3' acceptor stem of the corresponding tRNA, catalysed by amino acyl tRNA synthetase;

In photosynthesis:

8. energy from ATP is required in the convert glycerate-3-phosphate (GP) to glyceraldehyde-3-phosphate (GALP) in Calvin cycle, as well as in the regeneration of RuBP during light independent stage ;;
9. Energy from hydrolysis of ATP is also needed to regenerate ribulose bisphosphate in Calvin cycle ;

Role of ATP as a nucleotide:

10. ATP is a ribonucleotide and is incorporated into mRNA acid during transcription ;

Others

I. phosphorylation of proteins, where a phosphate group from ATP is added to proteins → activating / inactivating proteins by triggering a 3D conformational change → e.g. kinases in cell cycle /signal transduction pathways ;;

II. polymerisation of microtubules during cell division requires ATP → MTs can then be attached to kinetochores of chromosomes to align them at the metaphase plate / elongation of the cell ;;

III. act as an allosteric inhibitor in respiration i.e. high ATP inhibits glycolysis (phosphofructokinase enzyme) / Krebs cycle ;;

IV. ATP/AMP ratio acts as a biosensor in bacteria → low levels of ATP corresponding to high levels of AMP triggers increased transcriptional rates of the *lac* operon ;;

QWC (2m) points communicated clearly <u>without ambiguity</u> and with <u>relevant examples</u> as to how ATP is useful in living organisms (plants, animals, prokaryotes)

[Total: 6]

(b) Cytochrome *c* is primarily known as an electron-carrying mitochondrial protein. The amino acid sequence is highly conserved in eukaryotes, differing by a few residues.

Cytochrome *c* amino acid sequence in humans is more similar to that of chimpanzees but differs more from that of horses.

Explain how cytochrome *c* was conserved over time in eukaryotes. [9]

[Total: 15]

1 Cytochrome c important protein as participates in electron transfer as part of the mitochondrial electron transport chain (ETC)

2 is thus an indispensable part of the energy production process ATP in oxidative phosphorylation

3 eukaryotes : all have mitochondria in their cells for respiration

4. The variations in the amino acid sequences for cytochrome c are due to mutations in ancestral populations

5. There are different selection pressures that will select for advantageous alleles that express out functional cytochrome c

6 these advantageous alleles passed on to offsprings who survive to sexual maturity and reproduce

7 Increase in frequency of alleles expressing functional cyc c accumulate in the population

8 As new species evolved by the process of natural selection ,

9 any mutation that lead to non functional cytochrome c will lead to that variant not able to survive as unable to undergo respiration

10 because 3D conformation of protein disrupted

11 Due to ionic bonds or hydrogen bonds not formed between the R groups of the amino acids

12 The humans, horses could have mutations that occurred in the different eukaryotes : silent mutations

13 Mutation that are on non essential genes

14 Cyc c still functional and conserved in eukaryotes

[Total: 9]

QWC (1m) points communicated clearly