**TEMASEK JUNIOR COLLEGE**
**PRELIMINARY EXAMINATION**
**JC2 2018**

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|---|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | | |
| CLASS | C | G | | | / | 1 | 7 | | | |

# H1 BIOLOGY

Multiple Choice

**8876/01**

**Wednesday 14 September 2018**
**1 hour**

Additional materials: Multiple Choice Answer Sheet

**READ THESE INSTRUCTIONS FIRST**

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

**Read the instructions on the Multiple Choice Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **18** printed pages.

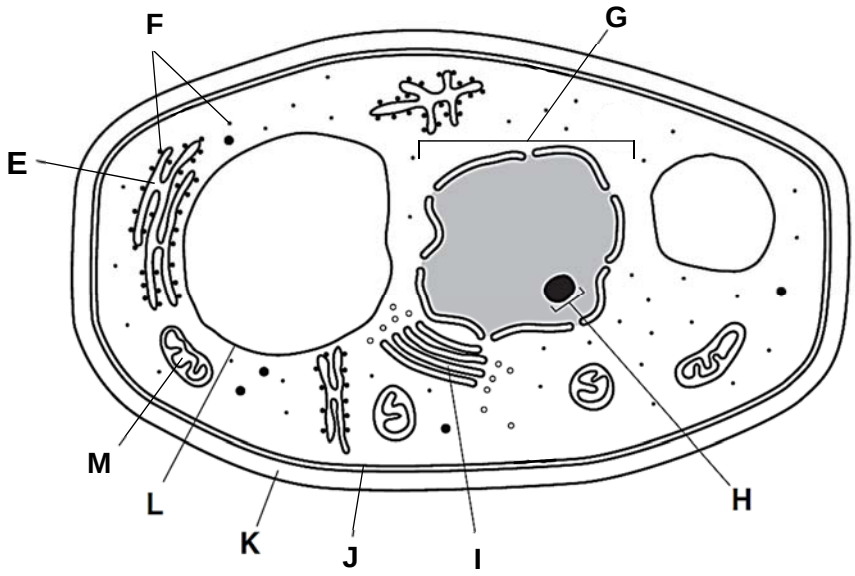
## Section A

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

**1** Tuberculosis and candidiasis are two opportunistic infections that may develop during AIDS.

Tuberculosis is caused by *Mycobacterium tuberculosis*, a prokaryote that lives in human lungs; whereas candidiasis is caused by *Candida albicans*, a yeast-like fungus that lives in human lungs.

The figure below shows the structure of *Candida*.




Which of the structure(s) can also be found in the causative agent that causes tuberculosis?

**A** None

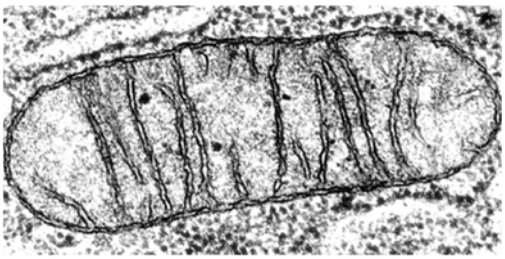
**B** **F** only

**C** **F**, **J**, **K** only

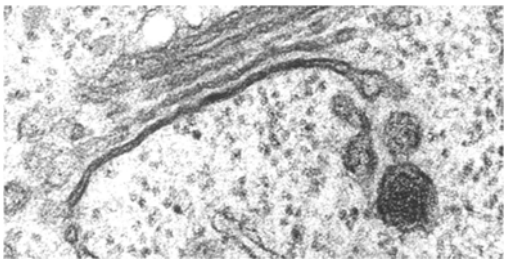
**D** **H**, **J**, **K** only

**2** The images below show the electron micrographs of some organelles found in eukaryotic cells.

**P**

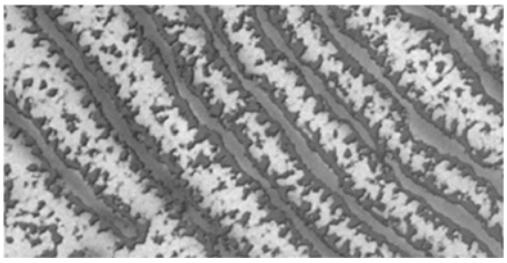


**Q**



**R**

**S**



The following statements are descriptions of membranous cell structures.

1 formed by a single membrane and enclosing a large fluid-filled space and regulating the osmotic pressure of the cell

2 formed by a single membrane and enclosing inactivated enzymes

3 formed by a single membrane that has flattened sacs and tubular structures inter-connected throughout the cell, sometimes with a complex of nucleic acid and protein attached

4 formed by a single membrane that has tubular structures and containing enzymes to add carbohydrate side chains to proteins

5 formed by two membranes and internal membranes that contain pigments

6 formed by two membranes whereby the inner membrane is folded extensively

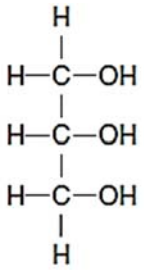
7 formed by two membranes, the outer membrane is continuous with another membranous organelle

Which of the following row correctly matches the descriptions of the cell structures?

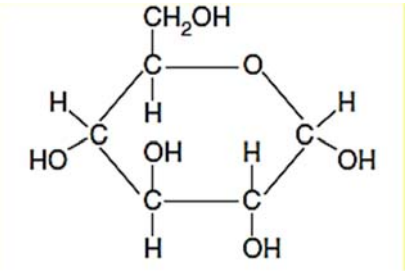
| | **P** | **Q** | **R** | **S** |
|---|---|---|---|---|
| **A** | 5 | 3 | 6 | 1 |
| **B** | 5 | 2 | 4 | 7 |
| **C** | 6 | 4 | 5 | 3 |
| **D** | 7 | 1 | 2 | 6 |

**3** Which molecule is found in glycogen?

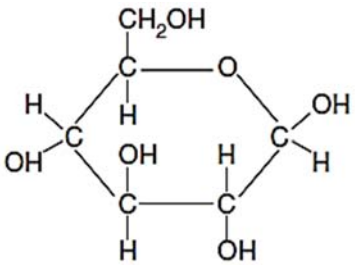
**A**



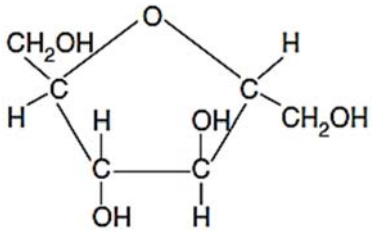
**B**



**C**



**D**



**4** Particular biological molecules react with chemicals called reagents to give distinct colour changes. The colour depends on the kind of biological molecule and the type of reagent used, as shown in the following table.

| chemical reagent | biological molecule | colour change observed |
|---|---|---|
| L | protein | violet |
| M | lipid | red |
| N | nucleic acid | green |

A researcher added different reagents to some isolated ribosomes.

The colour change observed are

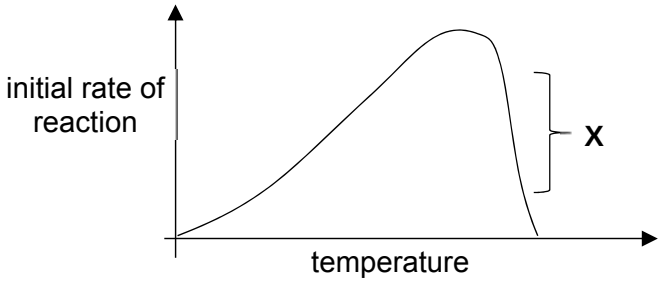
**A** green only.

**B** red and green.

**C** green and violet.

**D** violet, red and green.

**5** The diagram shows the initial rate of reaction using constant amounts of substrate and enzyme at different temperatures.




What is the reason for the decline in the level of activity in region **X**?

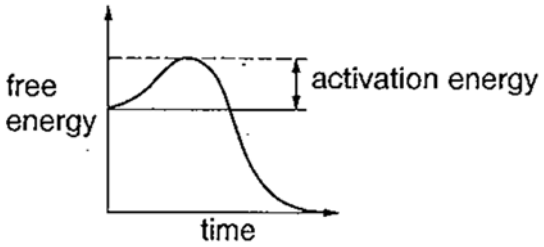
**A** breaking of sulphur bridges and ionic bonds in the enzymes

**B** competition between substrate and product for the active site

**C** breaking of hydrogen bonds and hydrolysis of peptide bonds in the enzyme

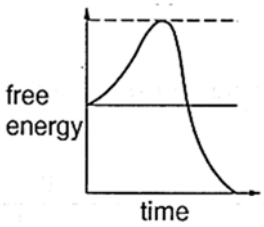
**D** insufficient substrates to occupy all the active sites

**6** The graph shows energy changes during an uncatalysed chemical reaction.

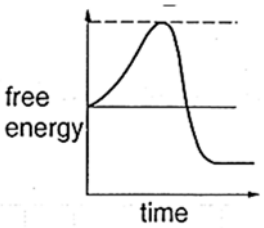



Which graph shows the energy changes for the same reaction when it is catalysed by an enzyme?

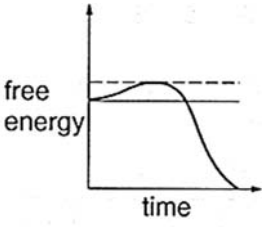
**A**



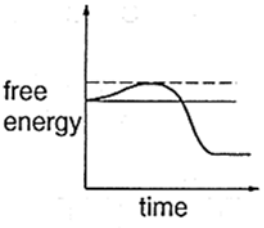

**B**




**C**




**D**



**7** Some of the molecules found in animal tissues are grouped into three lists.

1 glucose, cholesterol, triglycerides, water

2 glycogen, adenine, phospholipids

3 haemoglobin, carbon dioxide, mRNA, fructose

Which lists include one or more molecules that always contain nitrogen atoms?

**A** 1, 2 and 3

**B** 1 and 2 only

**C** 1 and 3 only

**D** 2 and 3 only

**8** Proteins in the cell surface membranes of human cells and mouse cells were labelled with red and green fluorescent dyes respectively.

When a human cell and a mouse cell were fused together, the red and green fluorescent dyes were at first found in different regions of the cell surface membrane of the hybrid cell, but after 40 minutes, they were evenly distributed in the entire cell surface membrane.

What explains this observation?

**A** All protein molecules in the cell surface membrane are fixed to structures within the cell, but phospholipid molecules move freely between them.

**B** Groups of protein and phospholipid molecules in the cell surface membrane are attached to each another and move together.

**C** Only protein molecules in the outer layer of the cell surface membrane can move freely between phospholipid molecules.

**D** Protein molecules in the outer layer of the cell surface membrane and those which span the bilayer can move freely between phospholipid molecules.

**9** At prophase of mitosis, a eukaryote chromosome consists of two chromatids.

What is the structure of a single chromatid?

**A** one molecule of single-stranded DNA coiled around protein molecules

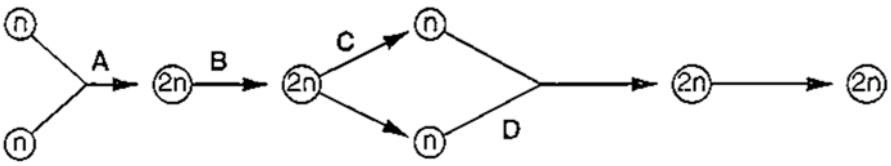
**B** two molecules of single-stranded DNA each coiled around protein molecules

**C** one double helix of DNA coiled around protein molecules

**D** two double helices of DNA each coiled around protein molecules

**10** The diagram represents the life cycle of an animal.

At which stage in the life cycle does mitosis occur?



**11** Which is the correct statement concerning cell and nuclear division?

**A** Haploid eukaryotes can reproduce by mitosis whereas diploid eukaryotes can reproduce by mitosis or meiosis.

**B** Just before prophase, the mass of DNA is double the normal mass. Following anaphase, this mass is reduced by half and following cytokinesis this mass halves again.

**C** Mutagens can cause mutations whereas carcinogens can cause cancer. This means that all mutagens are carcinogenic.

**D** Some of the roles of mitosis are growth, asexual reproduction, cell repair following tissue damage and cell replacement.

**12** The diagram shows the maternal and paternal chromosomes from a diploid cell.


If the cell divides by meiosis, which diagram shows a possible viable gamete?

**A**

**B**

**C**

**D**

**13** Stem cells are found in many tissues that require frequent cell replacement such as the skin, the intestine and the blood.

However, within their own environments, a blood cell cannot be induced to produce a skin cell and a skin cell cannot be induced to produce a blood cell.

Which statement explains this?

**A** Different stem cells have only the genes required for their particular cell line.

**B** Genes not required for the differentiation of a particular cell line are methylated.

**C** Binding of repressor molecules prevents the expression of genes not required for a particular cell line.

**D** Expression of gene not required for a particular cell line is controlled at translational level.

**14** Which row represents the correct features of the nitrogenous base adenine?

| | has a single ring structure | is a purine | joins its complementary base by three hydrogen bonds | pairs with uracil in RNA |
|---|---|---|---|---|
| **A** | ✓ | ✓ | ✗ | ✗ |
| **B** | ✓ | ✗ | ✓ | ✗ |
| **C** | ✗ | ✓ | ✗ | ✓ |
| **D** | ✗ | ✗ | ✗ | ✓ |

key

✓ = true

✗ = false

**15** The table shows the mode of action of two antibacterial drugs that can affect the synthesis of proteins.

| antibacterial drug | rifampicin | streptomycin |
|---|---|---|
| mode of action | binds to RNA polymerase | causes errors in translation |

If bacteria are treated with both drugs, what will be the immediate effects?

1 Transcription will stop, but non-functional proteins may continue to be synthesised.

2 If translation has started, proteins may be non-functional.

3 Translation will be inhibited.

**A** 1, 2 and 3

**B** 1 and 2 only

**C** 1 and 3 only

**D** 2 and 3 only

**16** A peptide consists of ten amino acids of four different kinds.

What is the theoretical minimum number of different kinds of tRNA molecules required to translate the mRNA for this peptide?

**A** 4

**B** 10

**C** 12

**D** 30

**17** Activation of an amino acid for translation requires

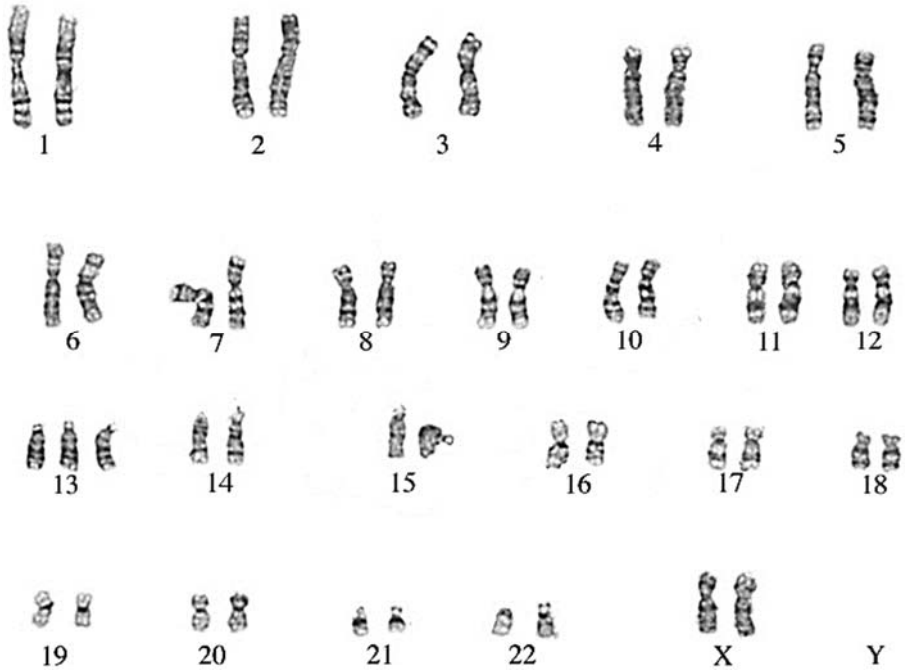
**A** joining the amino group of the amino acid to the 5'-end of the tRNA.

**B** matching the anticodon of the tRNA to the codon of the mRNA.

**C** hydrolysis of ATP.

**D** one enzyme that is specific for both a particular amino acid and a particular tRNA.

**18** A newborn baby was diagnosed with Patau syndrome. The diagram below shows her chromosomes.




This is an example of

**A** frameshift mutation

**B** silent mutation

**C** aneuploidy

**D** polyploidy

**19** Cancer cells divide out of control, forming tumours.

Which statement describes the difference between a cancer cell and a normal cell?

**A** Cancer cells do not undergo cytokinesis

**B** Cancer cells have a shorter interphase

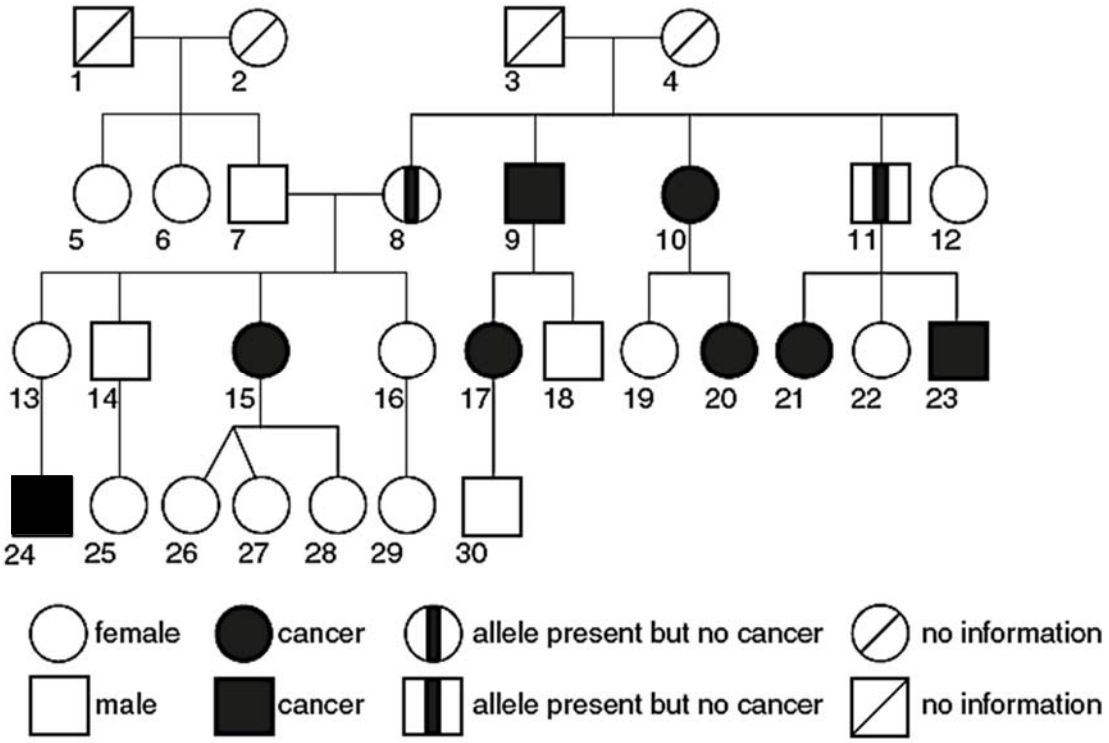
**C** Cancer cells do not have metaphase

**D** Only cancer cells have mutated DNA

**20** The BRCA2 protein is involved in suppressing the development of tumours. The gene that codes for this protein is on chromosome 13.

Several different dominant alleles of this gene, *BRCA2*, code for faulty versions of the protein. The presence of any one of these faulty alleles leads to an increased chance of developing several types of cancer, including breast cancer. Not everyone with one of these alleles develops cancer.

The pedigree (family tree) below shows the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele. For individuals 17 to 30, only one of their parents is shown in the pedigree. Individuals 24–30 are all under twelve years old.




Which one of the following statement is **not** correct?

**A** Individuals 8 and 11 have *BRCA2* allele and may develop cancer later in life.

**B** Individuals 8 to 11 may have inherited *BRCA2* allele from either of their parents.

**C** Individual 15 may have inherited one copy of *BRCA2* allele from her mother.

**D** Individual 24 may have inherited the *BRCA2* allele only from his mother and not his father.

**21** In mice, the gene for 'dappled' coat (**D**) and its recessive allele, the gene for 'plain' coat (**d**), are located on the X chromosome. The gene for 'straight' whiskers (**W**) and its recessive allele, the gene for 'bent' whiskers (**w**), are autosomal.

A male mouse with plain coat and bent whiskers was mated on several occasions to the same female and the large number of offspring consisted of the following phenotypes in equal proportion:

| | |
|---|---|
| dappled male with straight whiskers | plain male with straight whiskers |
| dappled female with straight whiskers | plain female with straight whiskers |
| dappled male with bent whiskers | plain male with bent whiskers |
| dappled female with bent whiskers | plain female with bent whiskers |

If $\mathbf{X^D}$ represents an **X** chromosome carrying an allele for 'dappled' coat and $\mathbf{X^d}$ represents an **X** chromosome carrying an allele for 'plain' coat, what is the genotype of the female parent?

**A** $\mathbf{X^DX^DWW}$

**B** $\mathbf{X^DX^DWw}$

**C** $\mathbf{X^DX^dWW}$

**D** $\mathbf{X^DX^dWw}$

**22** A trial breeding programme between Nepalese yaks and a breed of British cattle called the Dexter was carried out to develop a hybrid that was hardy, easy to handle, produced good quality meat and high milk yield. The preliminary results of the trial showed the relative strengths of the alleles of the genes for desired characteristics.

| desired characteristic | Dexter | Yak | hybrid |
|---|---|---|---|
| aggression | low | high | low |
| intelligence | low | high | high |
| hardiness | low | high | high |
| meat quality | high | low | high |
| milk yield | high | low | high |

Which combination shows the animals that appear to have alleles dominant for the desired characteristic?

| | aggression | intelligence | hardiness | meat quality | milk yield |
|---|---|---|---|---|---|
| **A** | Dexter | Dexter | Dexter | Yak | Yak |
| **B** | Dexter | Yak | Yak | Dexter | Dexter |
| **C** | Yak | Dexter | Dexter | Dexter | Dexter |
| **D** | Yak | Dexter | Dexter | Dexter | Yak |

**23** *Staphylococcus aureus* is a common bacterium, found on human skin. There are many strains of *S. aureus*. The antibiotic methicillin was then used to treat infection by *S. aureus*. Now there are at least 15 different strains of MRSA (methicillin resistant *Staphylococcus aureus*).

Which of the following are valid reasons for the emergence of 15 different strains of MRSA?

1 The bacteria mutated when it was exposed to methicillin, thus becoming resistant.

2 The bacteria underwent spontaneous mutation and some strains happened to be resistant to methicillin.

3 The antibiotic caused the bacteria to produce methicillin-resistant proteins.

**A** 2 only

**B** 1 and 2

**C** 2 and 3

**D** 1, 2 and 3

**24** During aerobic respiration ATP can be formed by glycolysis and oxidative phosphorylation in the electron transport system.

In the complete oxidation of one molecule of glucose, approximately what percentage of ATP is formed by oxidative phosphorylation?

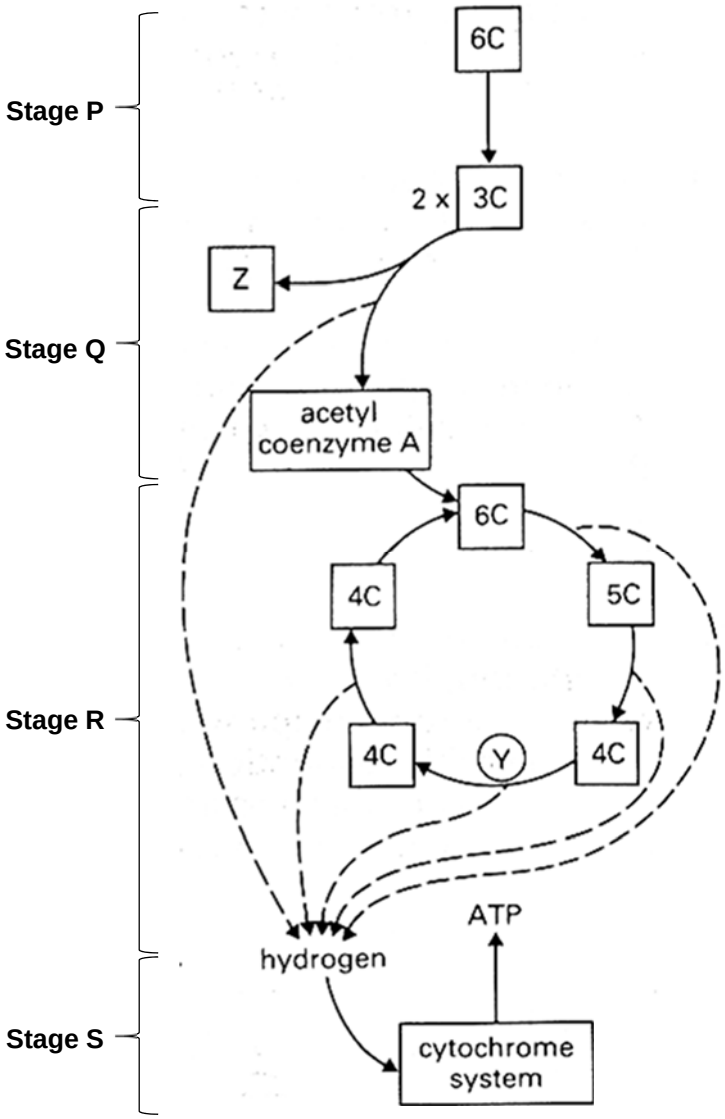
**A** 10%

**B** 25%

**C** 75%

**D** 90%

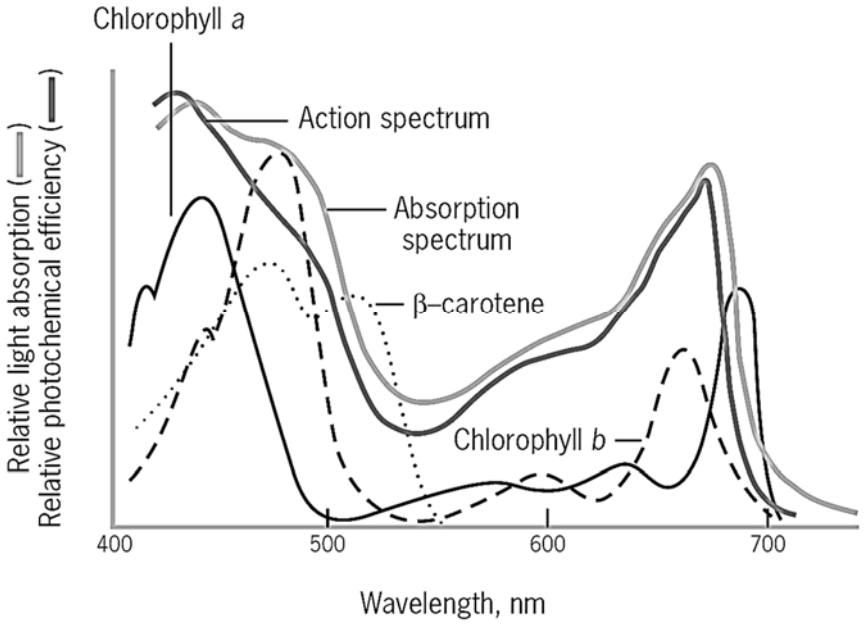
**25** The diagram shows a biochemical pathway in a typical eukaryotic cell.




Which of the following row is correct?

| | cristae | cytosol | mitochondrial matrix | final electron acceptor |
|---|---|---|---|---|
| **A** | **R** | **P, Q** | **R** | NADP |
| **B** | **R** | **P, Q** | **R** | Oxygen |
| **C** | **S** | **P** | **Q, R** | Oxygen |
| **D** | **S** | **P** | **Q, R** | NADP |

**26** The figure below shows the absorption spectrum of the photosynthetic pigments of a flowering plant and its action spectrum.




What can be concluded from the graph above?

1 The relative light absorption will be higher at higher temperatures, as temperature is a limiting factor.

2 The green leaves reflect light of wavelength 550 nm, hence the photochemical efficiency is low.

3 The compensation point of β-carotene, whereby the rate of photosynthesis equals the rate of respiration, occurs at 550nm.

4 The accessory pigments chlorophyll b and β-carotene absorb light energy mostly at 480nm.

**A** 2 and 4

**B** 1, 2 and 3

**C** 1, 3 and 4

**D** All of the above

**27** Homogenized leaf suspensions containing the cytoplasm and organelles were then placed in two different test-tubes.

Test-tube **A** contains non-labelled water ($H_2{}^{16}O$)

Test-tube **B** contains radioactively-labelled water ($H_2{}^{18}O$)

A few drops of DCPIP, a hydrogen acceptor, were added to each test-tube. DCPIP will turn from blue to colourless when it is reduced and this colourless DCPIP can be reoxidized to blue.

The test-tubes were then exposed to red light for 30 minutes.

Which of the following shows the results of the two test-tubes after 30 minutes?

| | Tube **A** | | Tube **B** | |
|---|---|---|---|---|
| | Gas evolved | DCPIP colour | Gas evolved | DCPIP colour |
| **A** | $^{16}CO_2$ | Blue | $^{18}CO_2$ | Blue |
| **B** | $^{16}CO_2$ | Colourless | $^{18}CO_2$ | Colourless |
| **C** | $^{16}O_2$ | Blue | $^{16}O_2$ | Blue |
| **D** | $^{16}O_2$ | Colourless | $^{18}O_2$ | Colourless |

**28** An investigation was carried out to assess the effect of diet on the milk yield and methane production of cows. The cows in group **A** were fed a traditional diet and those in group **B** were fed the same diet with a mixture of chopped hay and straw added.

The table below shows the results of this investigation.

| Group | Diet | Mean milk yield per cow/ $dm^3\ day^{-1}$ | Methane emission for each $dm^3$ milk produced / $dm^3$ |
|---|---|---|---|
| **A** | Traditional with no added material | 24.0 | 30.0 |
| **B** | Traditional with added chopped hay and straw | 27.6 | 24.0 |

Which of the following actions will help reduce the impact of global warming?

1 Decreasing consumption of beef and milk

2 Creating more foraging grounds to feed the cows

3 Adding chopped hay and straw to the cows' diet.

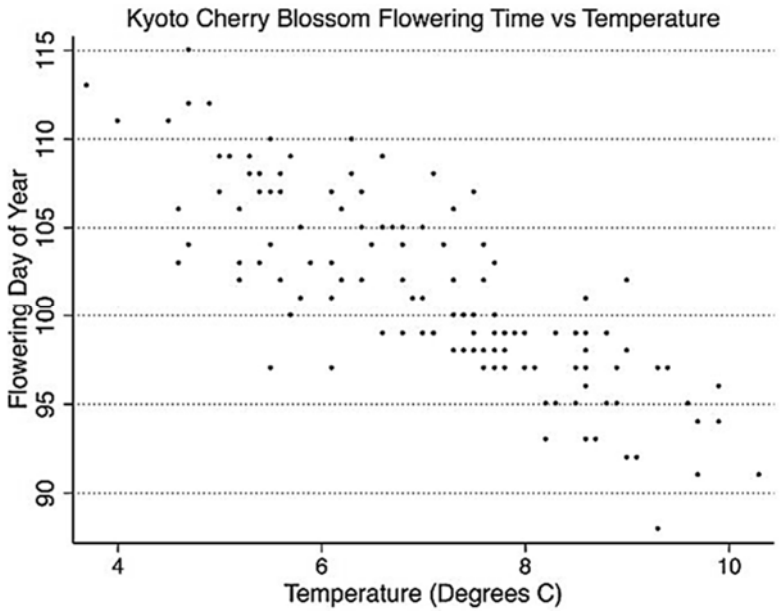
**A** 1 only

**B** 1 and 3 only

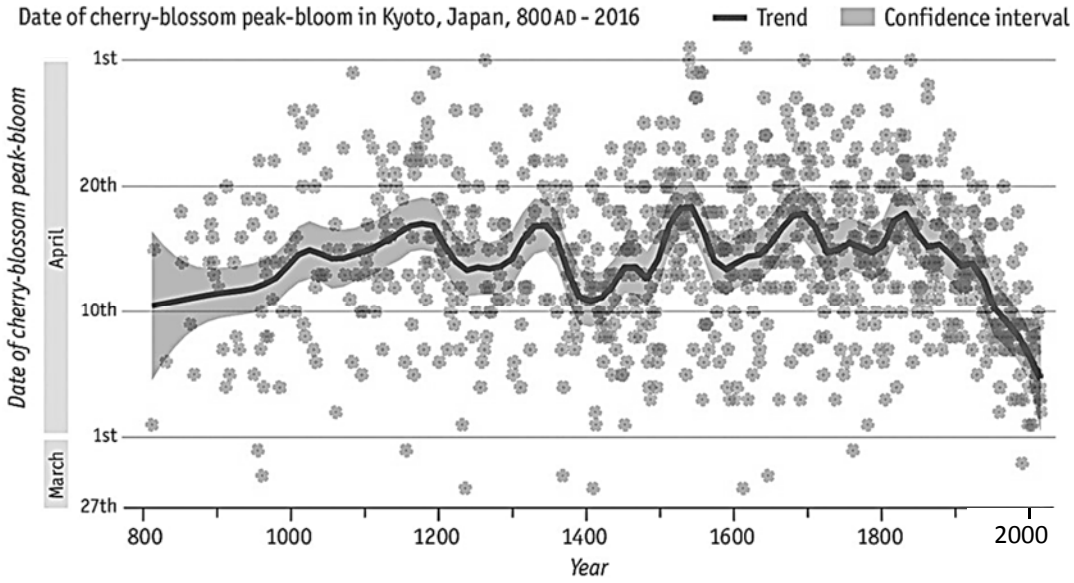
**C** 2 and 3 only

**D** All of the above

**29** The effect of temperature on cherry blossom flowering time (day of the year) is shown below.




The records of timing of cherry blossoms in Japan from 800 A.D is shown below.




Which conclusions can be made from both graphs?

1 The peak of cherry blossoms has consistently been earlier since 1850. Cherry blossoms begin earlier as temperature increases from 4 to 10°C.

2 The temperature in Japan has been increasing since 800 A.D., resulting in later blooming and pollinators are unable to pollinate the cherry trees.

3 No conclusion can be made as the data points are scattered and lack clear trend.

**A** 1 only

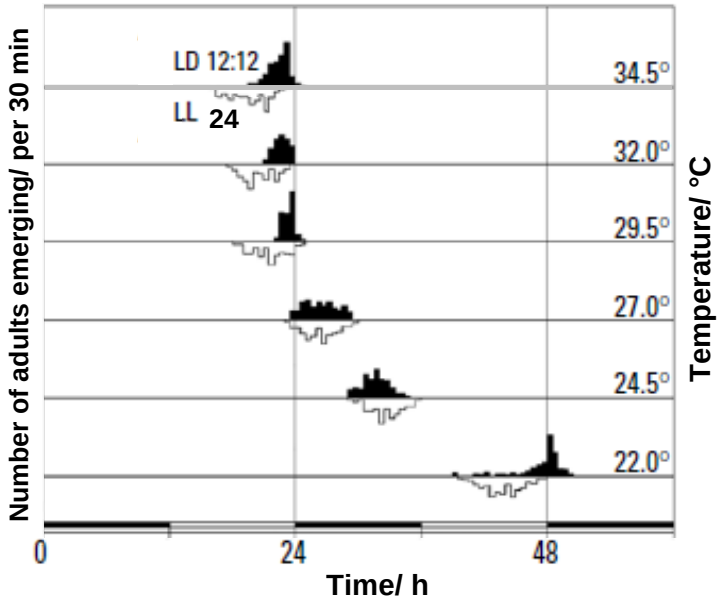
**B** 2 only

**C** 3 only

**D** 1 and 2

**30** The figure below shows the effect of temperature on the emergence of a particular species of mosquitoes.

The mosquitoes were bred either in a constant 24 hours light condition (LL white bars), or a 12 hours light followed by 12 hours dark condition (LD 12:12 black bars).




Which of the following row is correct?

| | life cycle of mosquito | descriptions |
|---|---|---|
| **A** | egg → larva → pupa → adult | As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h |
| **B** | egg → larva → pupa → adult | As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h |
| **C** | egg → pupa → larva → adult | As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h |
| **D** | egg → pupa → larva → adult | As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | | |
| CLASS | C | G | | | / | 1 | 7 | | | |

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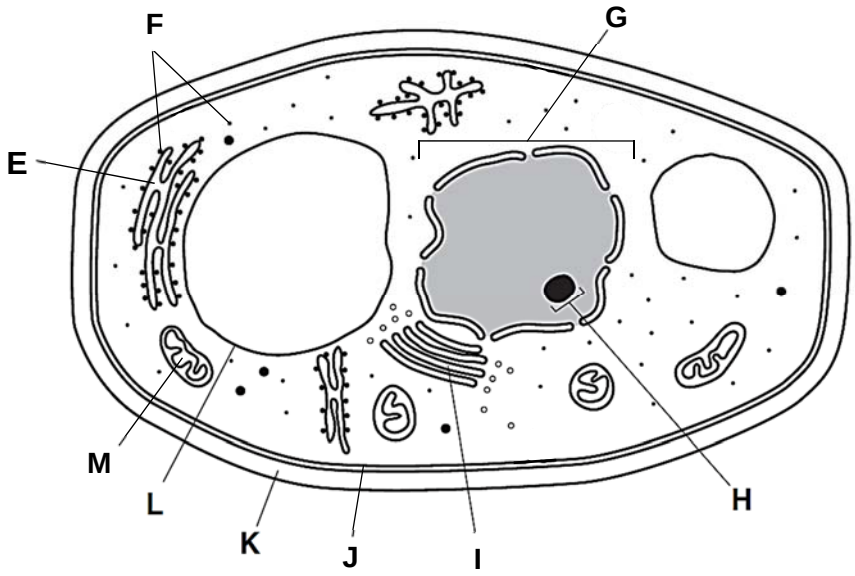
## Section A

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

**1** Tuberculosis and candidiasis are two opportunistic infections that may develop during AIDS.

Tuberculosis is caused by *Mycobacterium tuberculosis*, a prokaryote that lives in human lungs; whereas candidiasis is caused by *Candida albicans*, a yeast-like fungus that lives in human lungs.

The figure below shows the structure of *Candida*.




Which of the structure(s) can also be found in the causative agent that causes tuberculosis?

**A** None

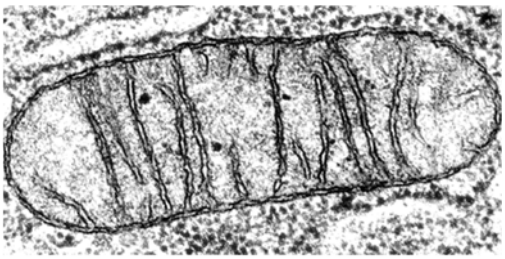
**B** **F** only

**C** **F**, **J**, **K** only

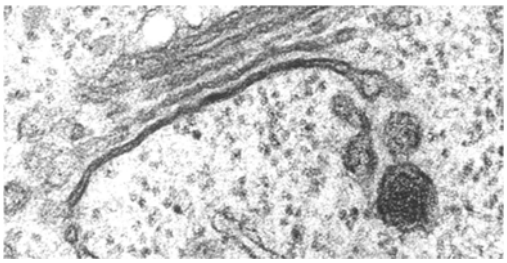
**D** **H**, **J**, **K** only

**2** The images below show the electron micrographs of some organelles found in eukaryotic cells.

**P**

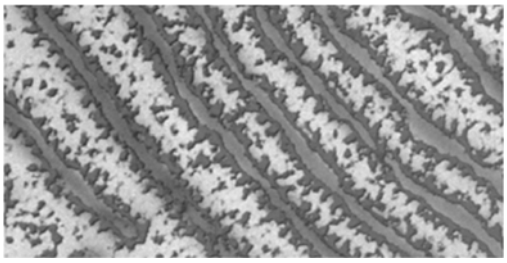


**Q**



**R**

**S**



The following statements are descriptions of membranous cell structures.

1 formed by a single membrane and enclosing a large fluid-filled space and regulating the osmotic pressure of the cell

2 formed by a single membrane and enclosing inactivated enzymes

3 formed by a single membrane that has flattened sacs and tubular structures inter-connected throughout the cell, sometimes with a complex of nucleic acid and protein attached

4 formed by a single membrane that has tubular structures and containing enzymes to add carbohydrate side chains to proteins

5 formed by two membranes and internal membranes that contain pigments

6 formed by two membranes whereby the inner membrane is folded extensively

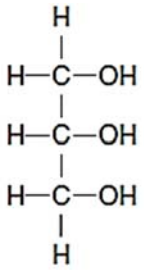
7 formed by two membranes, the outer membrane is continuous with another membranous organelle

Which of the following row correctly matches the descriptions of the cell structures?

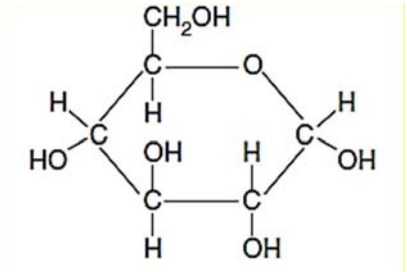
| | **P** | **Q** | **R** | **S** |
|---|---|---|---|---|
| **A** | 5 | 3 | 6 | 1 |
| **B** | 5 | 2 | 4 | 7 |
| **C** | 6 | 4 | 5 | 3 |
| **D** | 7 | 1 | 2 | 6 |

**3** Which molecule is found in glycogen?

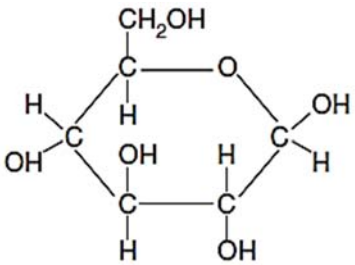
**A**



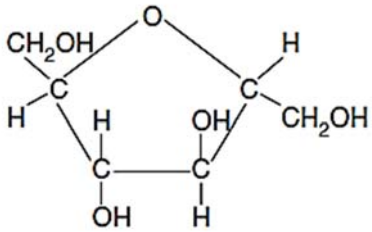
**B**



**C**



**D**



**4** Particular biological molecules react with chemicals called reagents to give distinct colour changes. The colour depends on the kind of biological molecule and the type of reagent used, as shown in the following table.

| chemical reagent | biological molecule | colour change observed |
|---|---|---|
| L | protein | violet |
| M | lipid | red |
| N | nucleic acid | green |

A researcher added different reagents to some isolated ribosomes.

The colour change observed are

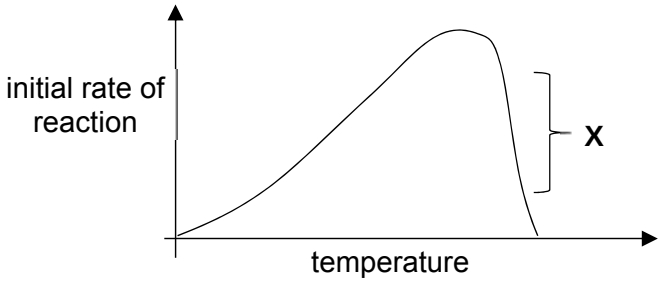
**A** green only.

**B** red and green.

**C** green and violet.

**D** violet, red and green.

**5** The diagram shows the initial rate of reaction using constant amounts of substrate and enzyme at different temperatures.




What is the reason for the decline in the level of activity in region **X**?

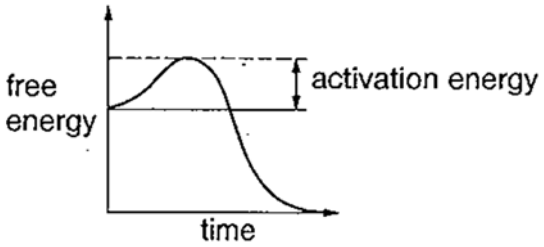
**A** breaking of sulphur bridges and ionic bonds in the enzymes

**B** competition between substrate and product for the active site

**C** breaking of hydrogen bonds and hydrolysis of peptide bonds in the enzyme

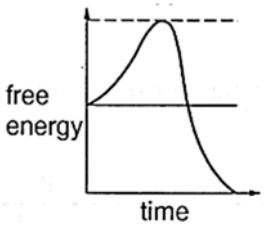
**D** insufficient substrates to occupy all the active sites

**6** The graph shows energy changes during an uncatalysed chemical reaction.

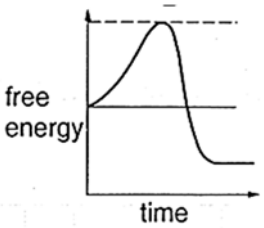



Which graph shows the energy changes for the same reaction when it is catalysed by an enzyme?

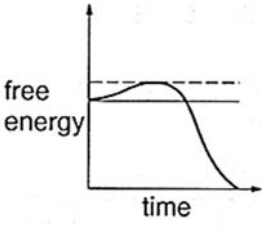
**A**



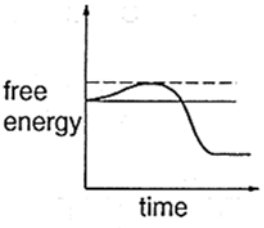

**B**




**C**




**D**



**7** Some of the molecules found in animal tissues are grouped into three lists.

1 glucose, cholesterol, triglycerides, water

2 glycogen, adenine, phospholipids

3 haemoglobin, carbon dioxide, mRNA, fructose

Which lists include one or more molecules that always contain nitrogen atoms?

**A** 1, 2 and 3

**B** 1 and 2 only

**C** 1 and 3 only

**D** 2 and 3 only

**8** Proteins in the cell surface membranes of human cells and mouse cells were labelled with red and green fluorescent dyes respectively.

When a human cell and a mouse cell were fused together, the red and green fluorescent dyes were at first found in different regions of the cell surface membrane of the hybrid cell, but after 40 minutes, they were evenly distributed in the entire cell surface membrane.

What explains this observation?

**A** All protein molecules in the cell surface membrane are fixed to structures within the cell, but phospholipid molecules move freely between them.

**B** Groups of protein and phospholipid molecules in the cell surface membrane are attached to each another and move together.

**C** Only protein molecules in the outer layer of the cell surface membrane can move freely between phospholipid molecules.

**D** Protein molecules in the outer layer of the cell surface membrane and those which span the bilayer can move freely between phospholipid molecules.

**9** At prophase of mitosis, a eukaryote chromosome consists of two chromatids.

What is the structure of a single chromatid?

**A** one molecule of single-stranded DNA coiled around protein molecules

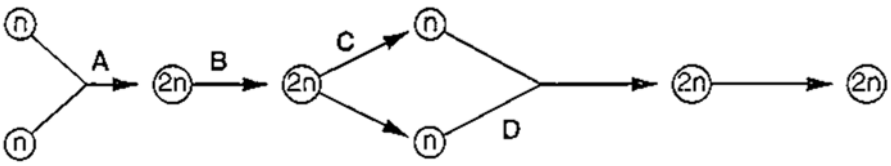
**B** two molecules of single-stranded DNA each coiled around protein molecules

**C** one double helix of DNA coiled around protein molecules

**D** two double helices of DNA each coiled around protein molecules

**10** The diagram represents the life cycle of an animal.

At which stage in the life cycle does mitosis occur?



**11** Which is the correct statement concerning cell and nuclear division?

**A** Haploid eukaryotes can reproduce by mitosis whereas diploid eukaryotes can reproduce by mitosis or meiosis.

**B** Just before prophase, the mass of DNA is double the normal mass. Following anaphase, this mass is reduced by half and following cytokinesis this mass halves again.

**C** Mutagens can cause mutations whereas carcinogens can cause cancer. This means that all mutagens are carcinogenic.

**D** Some of the roles of mitosis are growth, asexual reproduction, cell repair following tissue damage and cell replacement.

**12** The diagram shows the maternal and paternal chromosomes from a diploid cell.


If the cell divides by meiosis, which diagram shows a possible viable gamete?

**A**

**B**

**C**

**D**

**13** Stem cells are found in many tissues that require frequent cell replacement such as the skin, the intestine and the blood.

However, within their own environments, a blood cell cannot be induced to produce a skin cell and a skin cell cannot be induced to produce a blood cell.

Which statement explains this?

**A** Different stem cells have only the genes required for their particular cell line.

**B** Genes not required for the differentiation of a particular cell line are methylated.

**C** Binding of repressor molecules prevents the expression of genes not required for a particular cell line.

**D** Expression of gene not required for a particular cell line is controlled at translational level.

**14** Which row represents the correct features of the nitrogenous base adenine?

| | has a single ring structure | is a purine | joins its complementary base by three hydrogen bonds | pairs with uracil in RNA |
|---|---|---|---|---|
| **A** | ✓ | ✓ | ✗ | ✗ |
| **B** | ✓ | ✗ | ✓ | ✗ |
| **C** | ✗ | ✓ | ✗ | ✓ |
| **D** | ✗ | ✗ | ✗ | ✓ |

key

✓ = true

✗ = false

**15** The table shows the mode of action of two antibacterial drugs that can affect the synthesis of proteins.

| antibacterial drug | rifampicin | streptomycin |
|---|---|---|
| mode of action | binds to RNA polymerase | causes errors in translation |

If bacteria are treated with both drugs, what will be the immediate effects?

1 Transcription will stop, but non-functional proteins may continue to be synthesised.

2 If translation has started, proteins may be non-functional.

3 Translation will be inhibited.

**A** 1, 2 and 3

**B** 1 and 2 only

**C** 1 and 3 only

**D** 2 and 3 only

**16** A peptide consists of ten amino acids of four different kinds.

What is the theoretical minimum number of different kinds of tRNA molecules required to translate the mRNA for this peptide?

**A** 4

**B** 10

**C** 12

**D** 30

**17** Activation of an amino acid for translation requires

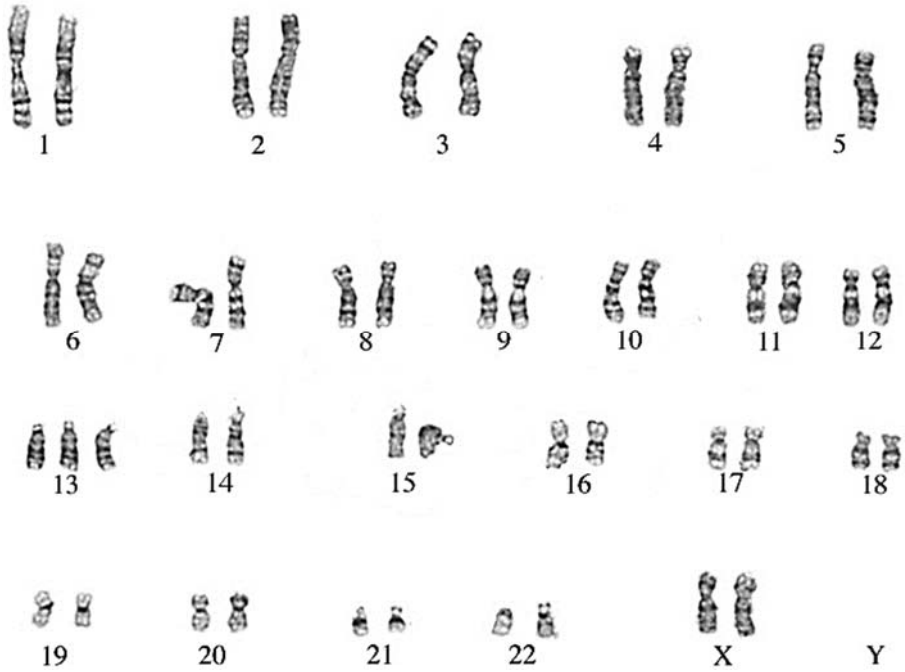
**A** joining the amino group of the amino acid to the 5'-end of the tRNA.

**B** matching the anticodon of the tRNA to the codon of the mRNA.

**C** hydrolysis of ATP.

**D** one enzyme that is specific for both a particular amino acid and a particular tRNA.

**18** A newborn baby was diagnosed with Patau syndrome. The diagram below shows her chromosomes.




This is an example of

**A** frameshift mutation

**B** silent mutation

**C** aneuploidy

**D** polyploidy

**19** Cancer cells divide out of control, forming tumours.

Which statement describes the difference between a cancer cell and a normal cell?

**A** Cancer cells do not undergo cytokinesis

**B** Cancer cells have a shorter interphase

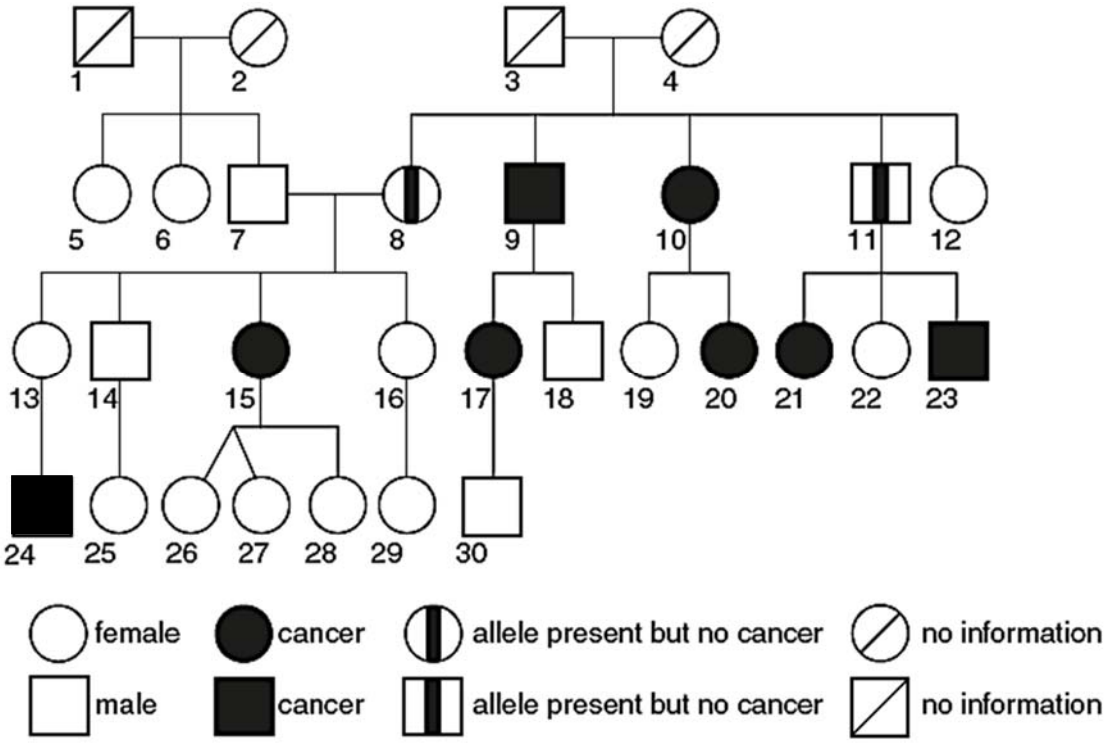
**C** Cancer cells do not have metaphase

**D** Only cancer cells have mutated DNA

**20** The BRCA2 protein is involved in suppressing the development of tumours. The gene that codes for this protein is on chromosome 13.

Several different dominant alleles of this gene, *BRCA2*, code for faulty versions of the protein. The presence of any one of these faulty alleles leads to an increased chance of developing several types of cancer, including breast cancer. Not everyone with one of these alleles develops cancer.

The pedigree (family tree) below shows the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele. For individuals 17 to 30, only one of their parents is shown in the pedigree. Individuals 24–30 are all under twelve years old.




Which one of the following statement is **not** correct?

**A** Individuals 8 and 11 have *BRCA2* allele and may develop cancer later in life.

**B** Individuals 8 to 11 may have inherited *BRCA2* allele from either of their parents.

**C** Individual 15 may have inherited one copy of *BRCA2* allele from her mother.

**D** Individual 24 may have inherited the *BRCA2* allele only from his mother and not his father.

**21** In mice, the gene for 'dappled' coat (**D**) and its recessive allele, the gene for 'plain' coat (**d**), are located on the X chromosome. The gene for 'straight' whiskers (**W**) and its recessive allele, the gene for 'bent' whiskers (**w**), are autosomal.

A male mouse with plain coat and bent whiskers was mated on several occasions to the same female and the large number of offspring consisted of the following phenotypes in equal proportion:

| | |
|---|---|
| dappled male with straight whiskers | plain male with straight whiskers |
| dappled female with straight whiskers | plain female with straight whiskers |
| dappled male with bent whiskers | plain male with bent whiskers |
| dappled female with bent whiskers | plain female with bent whiskers |

If $\mathbf{X^D}$ represents an **X** chromosome carrying an allele for 'dappled' coat and $\mathbf{X^d}$ represents an **X** chromosome carrying an allele for 'plain' coat, what is the genotype of the female parent?

**A** $\mathbf{X^DX^DWW}$

**B** $\mathbf{X^DX^DWw}$

**C** $\mathbf{X^DX^dWW}$

**D** $\mathbf{X^DX^dWw}$

**22** A trial breeding programme between Nepalese yaks and a breed of British cattle called the Dexter was carried out to develop a hybrid that was hardy, easy to handle, produced good quality meat and high milk yield. The preliminary results of the trial showed the relative strengths of the alleles of the genes for desired characteristics.

| desired characteristic | Dexter | Yak | hybrid |
|---|---|---|---|
| aggression | low | high | low |
| intelligence | low | high | high |
| hardiness | low | high | high |
| meat quality | high | low | high |
| milk yield | high | low | high |

Which combination shows the animals that appear to have alleles dominant for the desired characteristic?

| | aggression | intelligence | hardiness | meat quality | milk yield |
|---|---|---|---|---|---|
| **A** | Dexter | Dexter | Dexter | Yak | Yak |
| **B** | Dexter | Yak | Yak | Dexter | Dexter |
| **C** | Yak | Dexter | Dexter | Dexter | Dexter |
| **D** | Yak | Dexter | Dexter | Dexter | Yak |

**23** *Staphylococcus aureus* is a common bacterium, found on human skin. There are many strains of *S. aureus*. The antibiotic methicillin was then used to treat infection by *S. aureus*. Now there are at least 15 different strains of MRSA (methicillin resistant *Staphylococcus aureus*).

Which of the following are valid reasons for the emergence of 15 different strains of MRSA?

1 The bacteria mutated when it was exposed to methicillin, thus becoming resistant.

2 The bacteria underwent spontaneous mutation and some strains happened to be resistant to methicillin.

3 The antibiotic caused the bacteria to produce methicillin-resistant proteins.

**A** 2 only

**B** 1 and 2

**C** 2 and 3

**D** 1, 2 and 3

**24** During aerobic respiration ATP can be formed by glycolysis and oxidative phosphorylation in the electron transport system.

In the complete oxidation of one molecule of glucose, approximately what percentage of ATP is formed by oxidative phosphorylation?

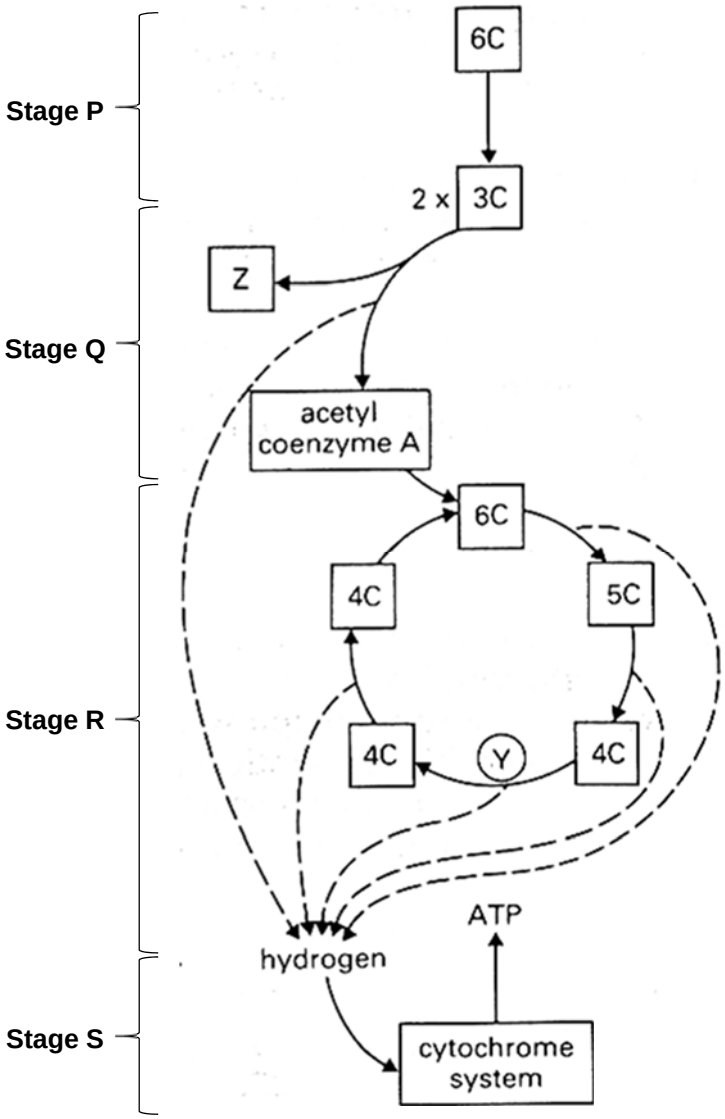
**A** 10%

**B** 25%

**C** 75%

**D** 90%

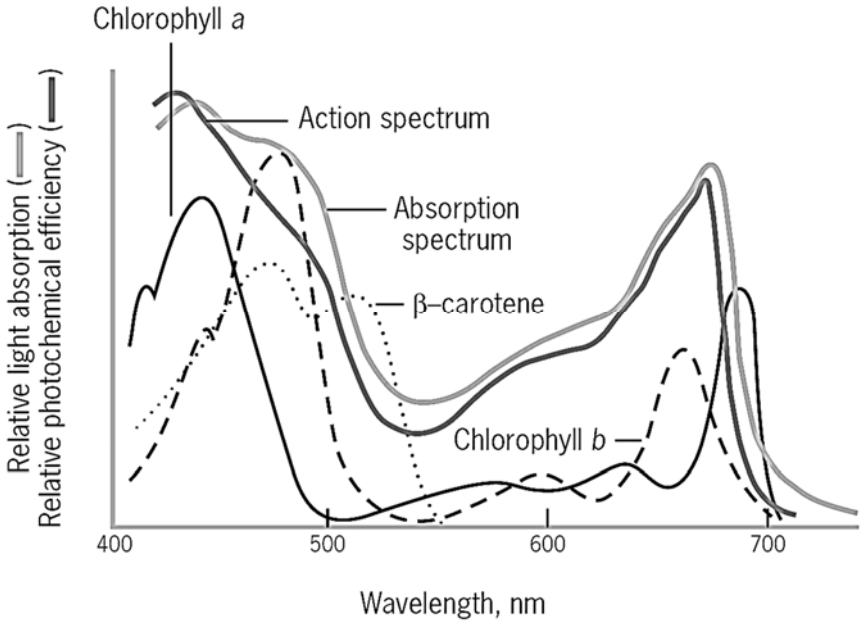
**25** The diagram shows a biochemical pathway in a typical eukaryotic cell.




Which of the following row is correct?

| | cristae | cytosol | mitochondrial matrix | final electron acceptor |
|---|---|---|---|---|
| **A** | **R** | **P, Q** | **R** | NADP |
| **B** | **R** | **P, Q** | **R** | Oxygen |
| **C** | **S** | **P** | **Q, R** | Oxygen |
| **D** | **S** | **P** | **Q, R** | NADP |

**26** The figure below shows the absorption spectrum of the photosynthetic pigments of a flowering plant and its action spectrum.




What can be concluded from the graph above?

1 The relative light absorption will be higher at higher temperatures, as temperature is a limiting factor.

2 The green leaves reflect light of wavelength 550 nm, hence the photochemical efficiency is low.

3 The compensation point of β-carotene, whereby the rate of photosynthesis equals the rate of respiration, occurs at 550nm.

4 The accessory pigments chlorophyll b and β-carotene absorb light energy mostly at 480nm.

**A** 2 and 4

**B** 1, 2 and 3

**C** 1, 3 and 4

**D** All of the above

**27** Homogenized leaf suspensions containing the cytoplasm and organelles were then placed in two different test-tubes.

Test-tube **A** contains non-labelled water ($H_2{}^{16}O$)

Test-tube **B** contains radioactively-labelled water ($H_2{}^{18}O$)

A few drops of DCPIP, a hydrogen acceptor, were added to each test-tube. DCPIP will turn from blue to colourless when it is reduced and this colourless DCPIP can be reoxidized to blue.

The test-tubes were then exposed to red light for 30 minutes.

Which of the following shows the results of the two test-tubes after 30 minutes?

| | Tube **A** | | Tube **B** | |
|---|---|---|---|---|
| | Gas evolved | DCPIP colour | Gas evolved | DCPIP colour |
| **A** | $^{16}CO_2$ | Blue | $^{18}CO_2$ | Blue |
| **B** | $^{16}CO_2$ | Colourless | $^{18}CO_2$ | Colourless |
| **C** | $^{16}O_2$ | Blue | $^{16}O_2$ | Blue |
| **D** | $^{16}O_2$ | Colourless | $^{18}O_2$ | Colourless |

**28** An investigation was carried out to assess the effect of diet on the milk yield and methane production of cows. The cows in group **A** were fed a traditional diet and those in group **B** were fed the same diet with a mixture of chopped hay and straw added.

The table below shows the results of this investigation.

| Group | Diet | Mean milk yield per cow/ $dm^3\ day^{-1}$ | Methane emission for each $dm^3$ milk produced / $dm^3$ |
|---|---|---|---|
| **A** | Traditional with no added material | 24.0 | 30.0 |
| **B** | Traditional with added chopped hay and straw | 27.6 | 24.0 |

Which of the following actions will help reduce the impact of global warming?

1 Decreasing consumption of beef and milk

2 Creating more foraging grounds to feed the cows

3 Adding chopped hay and straw to the cows' diet.

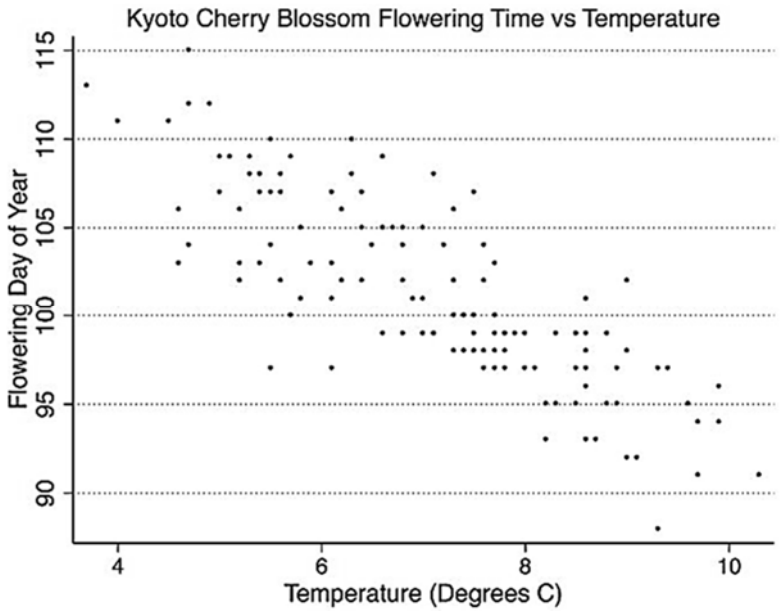
**A** 1 only

**B** 1 and 3 only

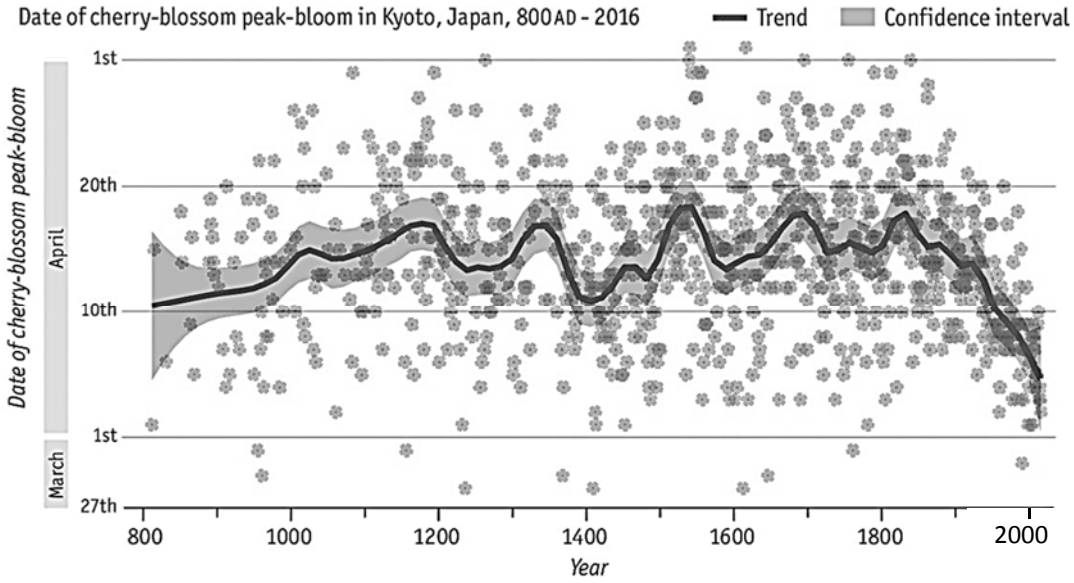
**C** 2 and 3 only

**D** All of the above

**29** The effect of temperature on cherry blossom flowering time (day of the year) is shown below.




The records of timing of cherry blossoms in Japan from 800 A.D is shown below.




Which conclusions can be made from both graphs?

1 The peak of cherry blossoms has consistently been earlier since 1850. Cherry blossoms begin earlier as temperature increases from 4 to 10°C.

2 The temperature in Japan has been increasing since 800 A.D., resulting in later blooming and pollinators are unable to pollinate the cherry trees.

3 No conclusion can be made as the data points are scattered and lack clear trend.

**A** 1 only

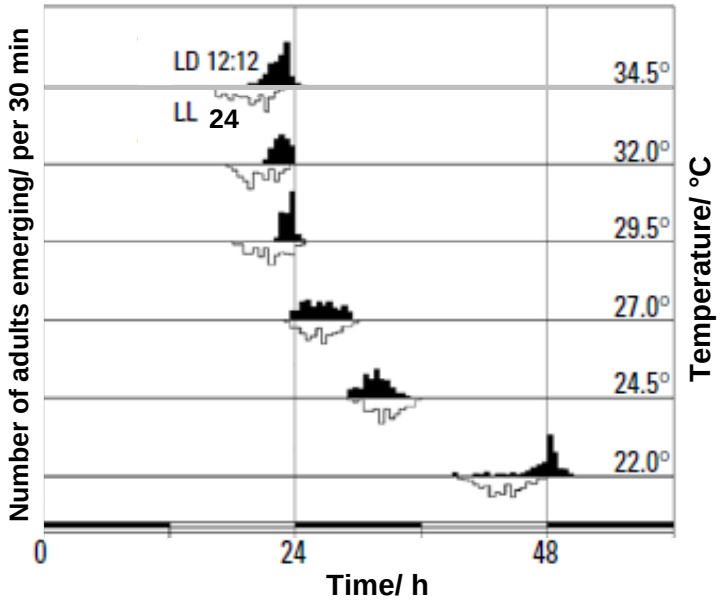
**B** 2 only

**C** 3 only

**D** 1 and 2

**30** The figure below shows the effect of temperature on the emergence of a particular species of mosquitoes.

The mosquitoes were bred either in a constant 24 hours light condition (LL white bars), or a 12 hours light followed by 12 hours dark condition (LD 12:12 black bars).




Which of the following row is correct?

| | life cycle of mosquito | descriptions |
|---|---|---|
| **A** | egg → larva → pupa → adult | As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h |
| **B** | egg → larva → pupa → adult | As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h |
| **C** | egg → pupa → larva → adult | As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h |
| **D** | egg → pupa → larva → adult | As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h |

**TEMASEK JUNIOR COLLEGE**
**PRELIMINARY EXAMINATION**
**JC 2 2018**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | | |
| CLASS | C | G | | | / | 1 | 7 | | | |

# H1 BIOLOGY

Paper 2 Structured Questions

**8876/02**
**Friday 24 August 2018**
**2 hours**

**READ THESE INSTRUCTIONS FIRST**

Write your name, Centre number, index number and class in the spaces at the top of the page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graph.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

| For Examiner's Use | | | |
|---|---|---|---|
| **Q1** | **/ 6** | **Q5** | **/ 8** |
| **Q2** | **/ 10** | **Q6** | **/ 7** |
| **Q3** | **/ 5** | **Q7 / 8** | **/ 15** |
| **Q4** | **/ 9** | | |
| **Total** | | | **/ 60** |

This document consists of **16** printed pages.

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

**1** Sugar molecules enter cells through transport proteins.

**(a)** Explain why transport proteins are required for the movement of sugar molecules, such as glucose and fructose, into cells.

_____

_____

_____

_____

_____ [2]

Some plant cells convert fructose and glucose into sucrose for transport from the leaves to the roots. Sucrose is moved into phloem sieve tubes as shown in Fig. 1.1.

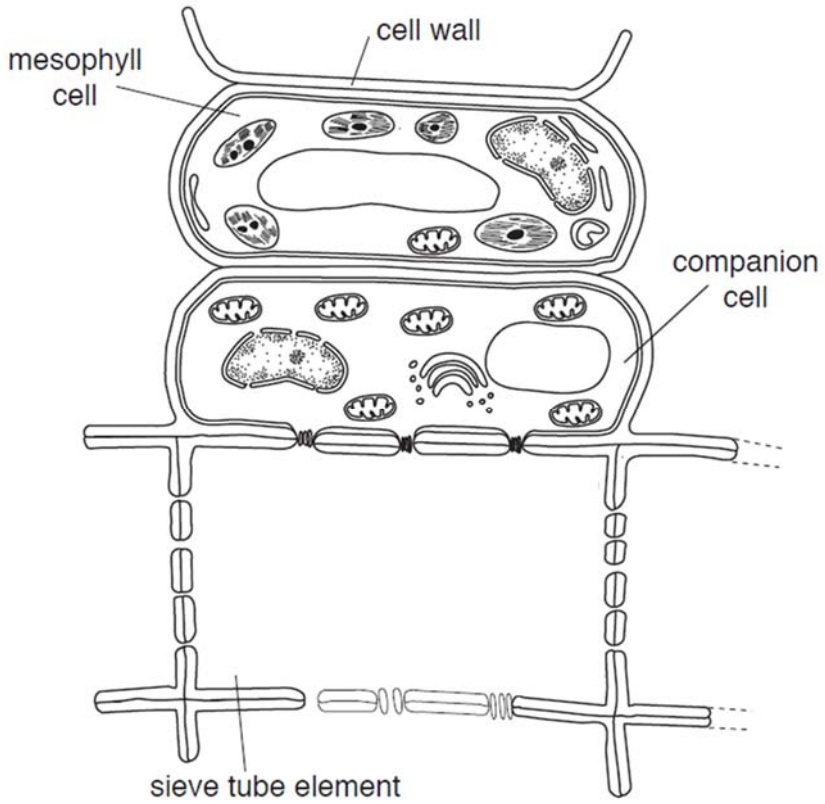



**Fig. 1.1**

Each cell has a specialized function.

**(b)** With reference to Fig. 1.1 and the information provided, state **one** difference between a mesophyll cell and companion cell.

_____

_____ [1]

Fig. 1.2 shows how sucrose is transported into the companion cell from mesophyll cell.

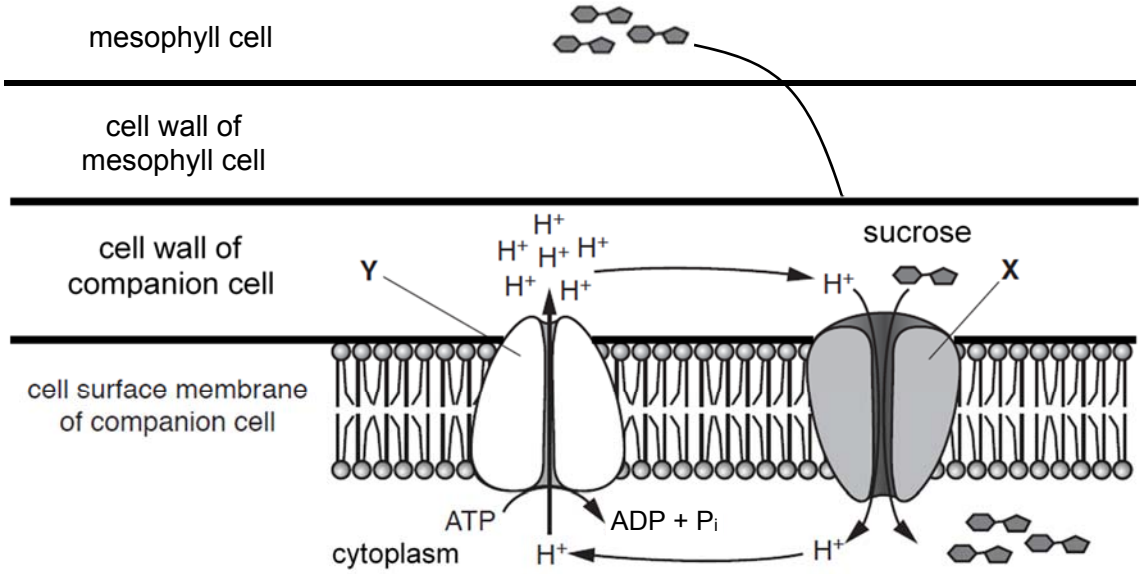



**Fig. 1.2**

**(c)** Using the information in Fig. 1.1 and Fig. 1.2, explain how sucrose moves into the companion cell.

_____

_____

_____

_____

_____

_____

_____ [3]

[Total: 6]

**2** The yeast, *Saccharomyces cerevisiae*, is a single-celled, eukaryotic organism that is often used in the laboratory.

When yeast is mixed with glucose solution, the yeast absorbs the glucose. Each molecule of glucose is then broken down into pyruvate molecules in exactly the same way as in any other eukaryotic organism.

**(a)** Outline the breakdown of glucose to pyruvate in this stage.

_____

_____

_____

_____

_____ [2]

Yeast cells sometimes carry out anaerobic respiration. Fig. 2.1 outlines the process of anaerobic respiration in yeast cells.

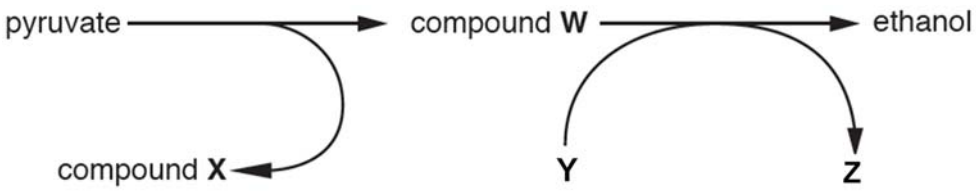



**Fig. 2.1**

**(b) (i)** Identify molecule **Z**.

_____ [1]

**(ii)** State why molecule **Y** is converted to **Z**.

_____

_____ [1]

Yeasts are often used in bread-making. The bread dough is kneaded to introduce and trap air so that the yeasts in the dough can respire aerobically. Besides carbon dioxide that is released during respiration, the evaporation of water or ethanol released during respiration also causes the dough to rise.

Table 2.1 shows the differences in the height of dough that was placed at different locations, after the dough was kneaded.

**Table 2.1**

| Time/ min | Height of dough/ cm | | |
|---|---|---|---|
| | Fridge | Room temperature | Next to window (hot day) |
| 0 | 2.5 | 2.5 | 2.5 |
| 20 | 2.5 | 2.9 | 3.3 |
| 40 | 2.7 | 3.7 | 4.0 |
| 60 | 2.9 | 3.9 | 4.7 |
| 80 | 3.0 | 4.0 | 5.2 |
| 100 | 3.0 | 4.0 | 5.8 |
| 120 | 3.0 | 4.0 | 6.0 |

**(c) (i)** Account for the difference in the overall increase in the height of dough that was placed in the fridge with that placed next to the window.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

**(ii)** Suggest why the increase in the height of dough that was placed at room temperature was higher between 0 and 40 minutes than between 40 minutes and 60 minutes.

_____

_____

_____

_____

_____ [2]

[Total: 10]

**3** Fig. 3.1 shows the effect of increasing substrate concentration on the rate of a particular reaction in the presence and absence of an enzyme.

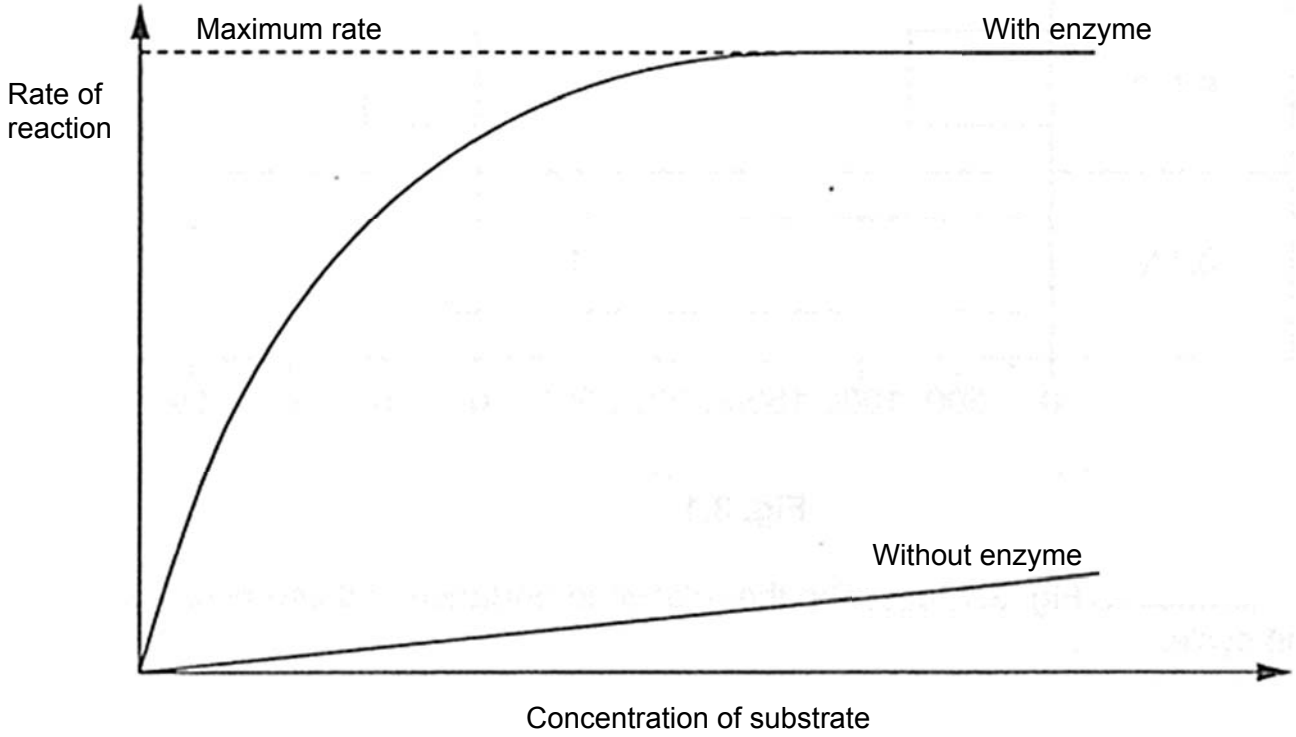



**Fig. 3.1**

**(a)** On Fig. 3.1, draw **two** labelled curves to show the effect on the rate of the enzyme catalysed reaction upon the addition of

**(i)** a competitive inhibitor;

**(ii)** a non-competitive inhibitor. [2]

**(b)** Explain the effect of a competitive inhibitor on the rate of enzyme activity.

_____

_____

_____

_____

_____

_____

_____ [3]

[Total: 5]

**4** Table 4.1 shows some of the common fatty acids and their melting points.

**Table 4.1**

| **Symbol** (number of carbon atoms : number of double bonds) | **Common Name** | **Melting point (ºC)** |
|---|---|---|
| *Saturated fatty acids* | | |
| 12 : 0 | Lauric acid | 44.2 |
| 14 : 0 | Myristic acid | 52 |
| 16 : 0 | Palmitic acid | 63.1 |
| 18 : 0 | Stearic acid | 69.6 |
| 20 : 0 | Arachidic acid | 75.4 |
| 22 : 0 | Behenic acid | 81 |
| *Unsaturated fatty acids* | | |
| 16 : 1 | Palmitoleic acid | -0.5 |
| 18 : 1 | Oleic acid | 13.4 |
| 18 : 2 | Linoleic acid | -9 |
| 18 : 3 | $\alpha$-linolenic acid | -17 |
| 20 : 4 | Arachnidonic acid | -49.5 |

**(a)** Arachidonic acid is a polyunsaturated fatty acid.

Explain the term *polyunsaturated fatty acid.*

_____

_____ [1]

**(b)** With reference to Table 4.1,

**(i)** describe the effect of increasing number of carbon atoms in saturated fatty acids on the melting point;

_____

_____

_____

_____

_____

_____

_____ [3]

**(ii)** describe the effect of the presence of double bonds in fatty acids on the melting point;

_____

_____ [1]

**(iii)** explain the trend described in **b(ii)**.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

[Total: 9]

**5** Table 5.1 provides statements regarding the bonds found in four biological molecules.

**Table 5.1**

| statement | protein | DNA | messenger RNA | cellulose |
|---|---|---|---|---|
| hydrogen bonds stabilise the molecule | | | | |
| subunits are joined by peptide bonds | | | | |

**(a)** Complete Table 5.1 by indicating with a tick (✓) or a cross (×) whether the statements apply to proteins, DNA, messenger RNA and cellulose.

You should put a tick or a cross in each box of the table. [2]

**(b)** A piece of mRNA is 660 nucleotides long but the DNA coding strand from which it was transcribed is 870 nucleotides long.

**(i)** Explain this difference in the number of nucleotides

_____

_____ [1]

**(ii)** What is the maximum number of amino acids in the protein translated from this piece of mRNA? Explain your answer.

Number of amino acids _____

Explanation

_____

_____

_____ [2]

**(c)** Identify **one** other process that lead the formation of mature mRNA and state its function.

_____

_____

_____

_____ [2]

**(d)** Describe **one** difference between the structure of mRNA and tRNA.

_____

_____ [1]

[Total: 8]

**6** The evolutionary origin of the four-legged amphibians (such as frogs and toads) from fish has been the subject of much debate for many years.

Among living fish, the rarely-caught coelacanth and the lungfish are thought to be most closely related to these amphibians.

Samples of blood were taken from two coelacanths that were captured recently near Comoros.

The amino acid sequences of the α and β chains of coelacanth and lungfish haemoglobin were compared with the known sequences of amphibian adults and their aquatic larvae (tadpoles).

Organisms with more matches in the amino acid sequence of a polypeptide chain share a more recent common ancestor than those with fewer matches.

The comparisons with three species of amphibians, *Xenopus laevis* (Xl), *X. tropicana* (Xt) and *Rana catesbeiana* (Rc) are shown in Table 6.1.

**Table 6.1**

| | | **percentage of matches of amino acid sequence** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **species of amphibian adults** | | | **species of amphibian larvae (tadpoles)** | | |
| | **fish species** | *Xl* | *Xt* | *Rc* | *Xl* | *Xt* | *Rc* |
| **α chains** | coelacanth | 42.0 | 47.5 | no data | 45.4 | 42.6 | 48.2 |
| | lungfish | 40.4 | 42.1 | no data | 40.7 | 39.0 | 37.9 |
| **β chains** | coelacanth | 42.1 | 43.2 | 40.7 | 52.1 | 52.1 | 58.2 |
| | lungfish | 44.1 | 45.9 | 41.4 | 47.3 | 45.9 | 48.6 |

**(a)** Explain whether or not the information in Table 6.1 supports the suggestion that coelacanths and amphibians share a more recent common ancestor than do lungfish and amphibians.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

**(b)** Coelacanth haemoglobin has a very high affinity for oxygen, suggesting that coelacanths, which have been captured at depths of between 200 m and 400 m, live in water that has a low concentration of oxygen.

Explain how an environmental factor, such as the low concentration of oxygen in deep water, can act as an evolutionary force in natural selection.

_____

_____

_____

_____

_____

_____

_____ [3]

[Total: 7]

**End of Section A**

**2018 PRELIMINARY EXAMINATION**

**H1 BIOLOGY PAPER 2 [SECTION B]:**

**Essay Question**

**Name**: _____

**Civics Group**: _____/17

| For Examiner's Use | |
|---|---|
| **Q7 / 8** | **/ 15** |

**Section B**

Answer **one** question.
Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must set out in sections **(a)**, **(b)** etc., as indicated in the question.

**EITHER**

**7** **(a)** Discuss the suggestion that all living organisms on earth depend on nitrogen. [6]

**(b)** Discuss the extent to which mitosis and the different types of stem cells can account for the principles behind the cell theory in humans, from one generation to the next. [9]

**OR**

**8** **(a)** Discuss possible impact of global warming on geographical patterns of distribution of mosquito-borne diseases. [6]

**(b)** DNA molecules are replicated with a high degree of accuracy yet not always perfectly. [9]

Describe how this occurs and discuss why the survival of a species depends on DNA molecules being stable, yet not *absolutely* stable.

**TEMASEK JUNIOR COLLEGE**
**PRELIMINARY EXAMINATION**
**JC 2 2018**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | | |
| CLASS | C | G | | | / | 1 | 7 | | | |

# H1 BIOLOGY

Paper 2 Structured Questions

**8876/02**
**Friday 24 August 2018**
**2 hours**

**READ THESE INSTRUCTIONS FIRST**

Write your name, Centre number, index number and class in the spaces at the top of the page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graph.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

| For Examiner's Use | | | |
|---|---|---|---|
| **Q1** | **/ 6** | **Q5** | **/ 8** |
| **Q2** | **/ 10** | **Q6** | **/ 7** |
| **Q3** | **/ 5** | **Q7 / 8** | **/ 15** |
| **Q4** | **/ 9** | | |
| **Total** | | | **/ 60** |

This document consists of **16** printed pages.

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

**1** Sugar molecules enter cells through transport proteins.

**(a)** Explain why transport proteins are required for the movement of sugar molecules, such as glucose and fructose, into cells. [2]

1. **Glucose and fructose are polar molecules.**

2. **They are unable to cross**
3. **the hydrophobic core of the phospholipid bilayer.**

4. **Transport proteins shield them from the hydrophobic core of plasma membrane (e.g. channel proteins provide a hydrophilic channel for their movement across the membrane).**

Some plant cells convert fructose and glucose into sucrose for transport from the leaves to the roots. Sucrose is moved into phloem sieve tubes as shown in Fig. 1.1.

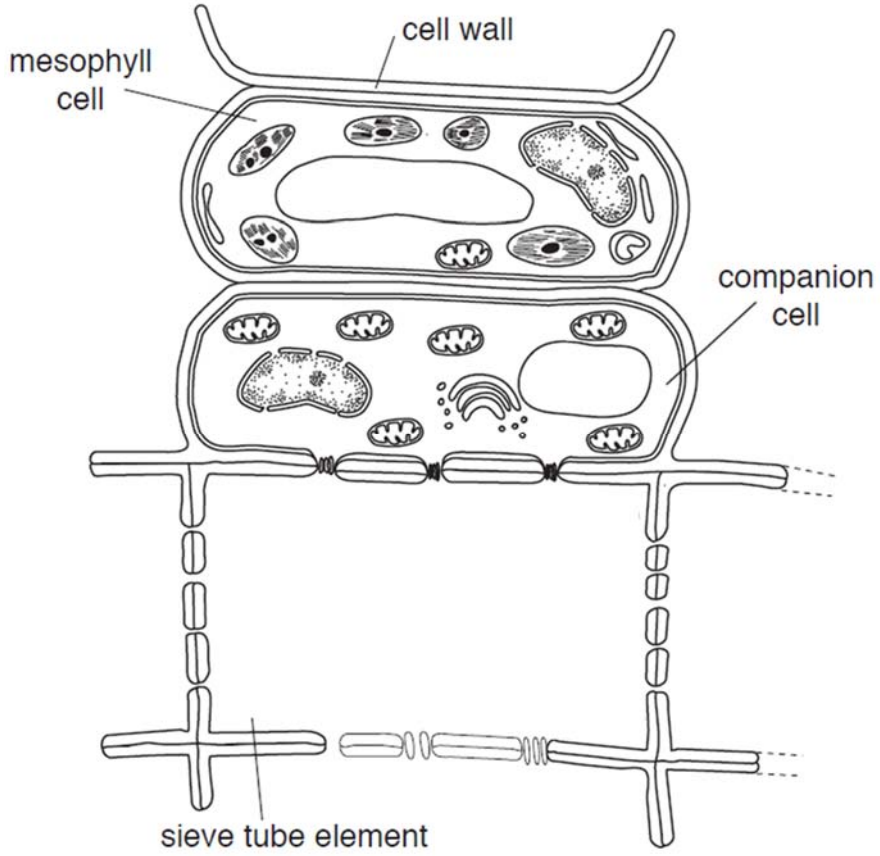



**Fig. 1.1**

Each cell has a specialized function.

**(b)** With reference to Fig. 1.1 and the information provided, state **one** difference between a mesophyll cell and companion cell. [1]

1. **Companion cells (6 mitochondria) have more mitochondria than mesophyll cells (1 mitochondrion). [1]**
   **OR**
   **Mesophyll cells (5 chloroplasts) have chloroplasts whereas companion cells have none. [1]**

Fig. 1.2 shows how sucrose is transported into the companion cell from the mesophyll cell.

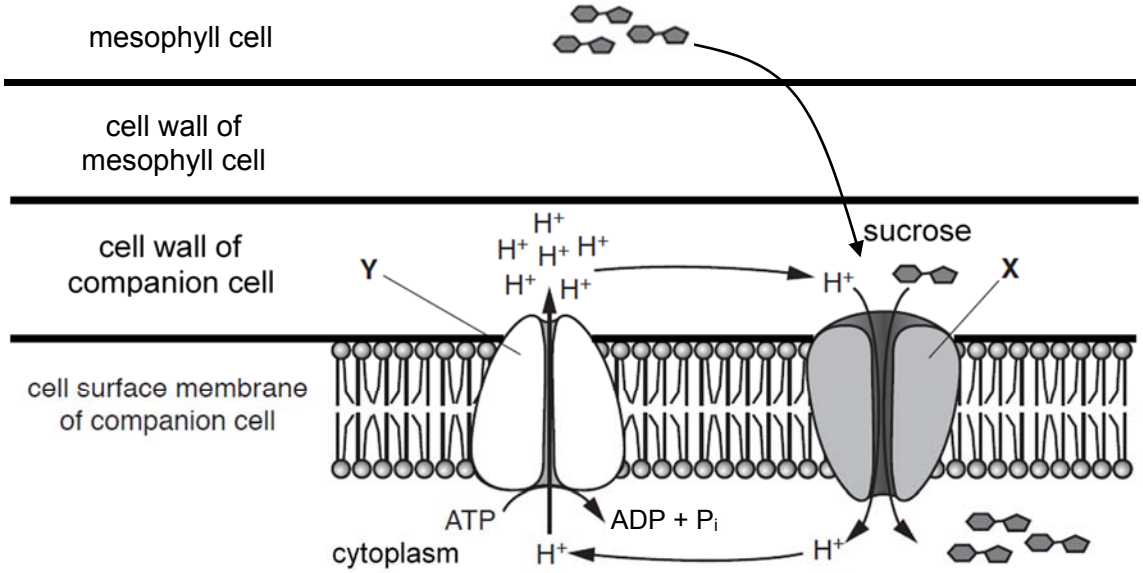



**Fig. 1.2**

**(c)** Using the information in Fig. 1.1 and Fig. 1.2, explain how sucrose moves into the companion cell. [3]

1. **Sucrose diffuses from mesophyll cell to the cell wall of companion cell.**

2. **Protons are actively pumped out from the cytoplasm of companion cell into its cell wall through carrier protein Y via active transport (hydrolysis of ATP). [1]**
   **[Reject: Diffuse]**

3. **Protons then diffuses from the cell wall of companion cells into the companion cell through transport protein X (cotransporter) via facilitated diffusion [1]**

4. **which is coupled with the transport of sucrose**
5. **against the sucrose concentration gradient.**

[Total: 6]

**Extension Question**

Plants vary greatly in terms of size.

**(d)** Explain whether the cell theory is applicable to plants. [2]

1. **Applicable.**
2. **Plants are living organisms, which are composed of (many, different plant) cells,**
3. **which are basic/ smallest unit of life.**

4. **All plant cells come from pre-existing plant cells via cell division (e.g. mitosis or meiosis).**

**2** The yeast, *Saccharomyces cerevisiae*, is a single-celled, eukaryotic organism that is often used in the laboratory.

When yeast is mixed with a glucose solution, the yeast absorbs the glucose. Each molecule of glucose is then broken down into pyruvate molecules in exactly the same way as in any other eukaryotic organism.

**(a)** Outline the breakdown of glucose to pyruvate in this stage. [2]

**Respiration Lecture Notes p.9, 10**

1. **Glucose is broken to pyruvate during glycolysis.**
2. **Glucose is first phosphorylated to glucose-6-phosphate**
3. **which is (isomerized to fructose-6-phosphate and then phosphorylated to) converted to fructose-1,6-bisphophate**
4. **before being cleaved/ broken down into 2 three-carbon sugars (OR glyceraldehyde-3-phosphate and dihydroxyacetone phosphate),**
5. **which is then oxidised/ converted to form 2 molecules of pyruvate.**

Yeast cells sometimes carry out anaerobic respiration. Fig. 2.1 outlines the process of anaerobic respiration in yeast cells.

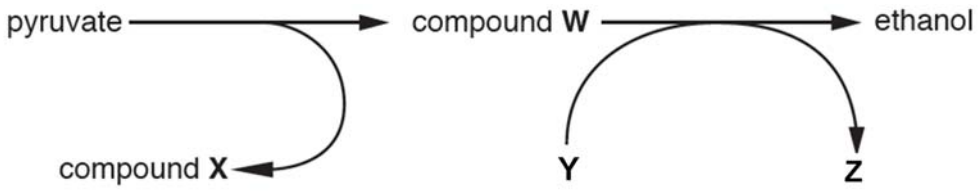



**Fig. 2.1**

**(b) (i)** Identify molecule **Z**. [1]

**NAD or $NAD^+$**

**(ii)** State why molecule **Y** is converted to **Z**. [1]

**Respiration Lecture Notes p.26**

1. **Regenerate NAD**
2. **required for glycolysis to continue.**

**[Accept: Reduce compound W (ethanal) to ethanol]**

Yeasts are often used in bread-making. The bread dough is kneaded to introduce and trap air so that the yeasts in the dough can respire aerobically. Besides carbon dioxide that is released during respiration, the evaporation of water or ethanol released during respiration also causes the dough to rise.

Table 2.1 shows the differences in the height of dough that was placed at different locations, after the dough was kneaded.

**Table 2.1**

| Time / min | Height of dough / cm | | |
|---|---|---|---|
| | Fridge | Room temperature | Next to window (hot day) |
| 0 | 2.5 | 2.5 | 2.5 |
| 20 | 2.5 | 2.9 | 3.3 |
| 40 | 2.7 | 3.7 | 4.0 |
| 60 | 2.9 | 3.9 | 4.7 |
| 80 | 3.0 | 4.0 | 5.2 |
| 100 | 3.0 | 4.0 | 5.8 |
| 120 | 3.0 | 4.0 | 6.0 |

**(c) (i)** Account for the difference in the overall increase in the height of dough that was placed in the fridge with that placed next to the window. [4]

1. **The height of the dough when placed in the fridge (F) increases from 2.5 at 0 min to 3.0cm at 120 min**
   **is LOWER than**
   **that when placed next to window (W) which increases from 2.5 to 6.0 cm. [1]**

2. **The temperature of the dough in F is lower than that of W.**
3. **Hence, the kinetic energy of respiratory enzymes and substrates is lower.**
   **[Accept: Enzymes are inactivated]**

4. **The frequency of effective collisions between enzymes and substrates is lower**
5. **hence the rate of formation of enzyme-substrate complexes is lower.**

6. **The rate of respiratory enzyme activity / rate of respiration is lower.**
7. **and less carbon dioxide are released and less evaporation of water or ethanol, which causes the dough to rise less.**

**(ii)** Suggest why the increase in the height of dough that was placed at room temperature was higher between 0 and 40 minutes than between 40 minutes and 60 minutes. [2]

1. **The height of dough increases from 2.5 to 3.7cm between 0 and 40 min**
   **is HIGHER than**
   **3.7 to 3.9cm between 40 and 60 minutes. [1]**

**WITH**

2. **There are more oxygen between 0 and 40 min, hence the yeast undergoes aerobic respiration which releases more molecules of $CO_2$ (6 molecules of $CO_2$**

**and 6 molecules of $H_2O$) than anaerobic respiration (2 molecules of $CO_2$ and 2 molecules of ethanol) from 40 minutes and 60 minutes. [1]**

**OR**

**There are more respiratory substrates at the start between 0 and 40 min, the rate of formation of enzyme-substrate complexes is higher, hence the rate of respiration is higher than between 40 minutes and 60 minutes. [1]**

**OR**

**From 40 minutes and 60 minutes, the yeast undergoes anaerobic respiration and high concentration of ethanol produced is toxic and kills the yeast. [1]**

[Total: 10]

**3** Fig. 3.1 shows the effect of increasing substrate concentration on the rate of a particular reaction in the presence and absence of an enzyme.

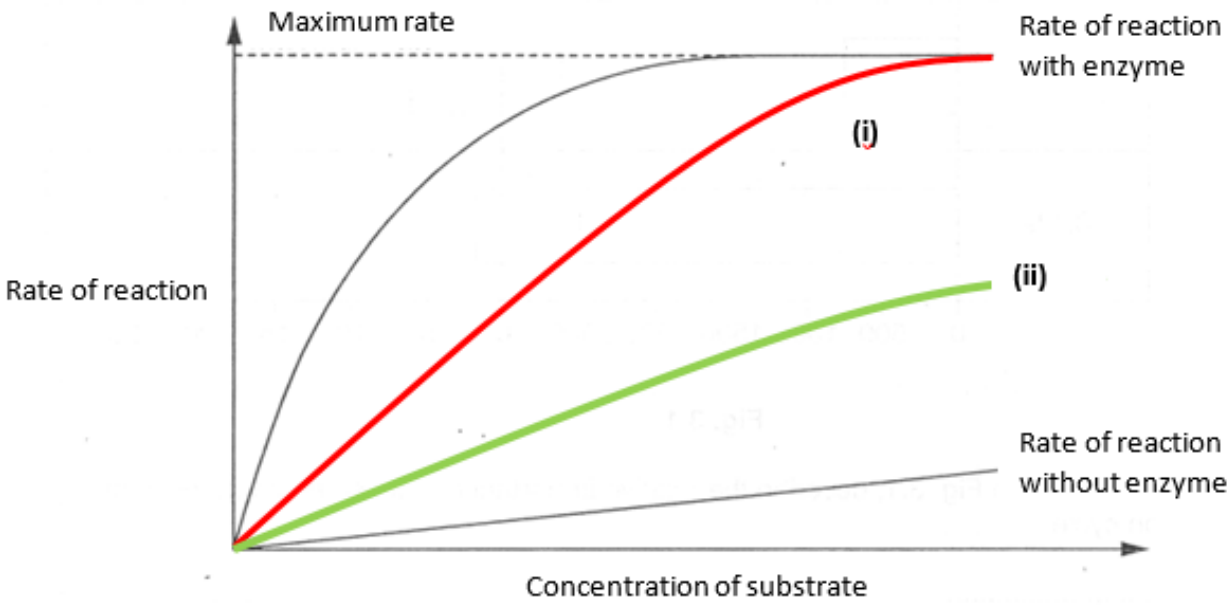



**Fig. 3.1**

**(a)** On Fig. 3.1, draw **two** labelled curves to show the effect on the rate of the enzyme catalysed reaction upon the addition of

**(i)** a competitive inhibitor;

**(ii)** a non-competitive inhibitor. [2]

**(b)** Explain the effect of a competitive inhibitor on the rate of enzyme activity. [3]

1. **Shape of inhibitor is similar in shape of substrate**
2. **Shape of inhibitor is complementary to the shape of active site**
3. **Competitive inhibitors compete with the substrate molecules for the active site and bind at the active site of the enzyme**
4. **blocking / prevents substrate molecules from binding to active site,**
5. **reducing**
   i. **number of enzyme-substrate complex formed per unit time**
   **or**
   ii. **rate of enzyme-substrate complex formation**
6. **thus decreasing rate of enzyme activity**

[Total: 5]

**4** Table 4.1 shows some of the common fatty acids and their melting points.

**Table 4.1**

| **Symbol** (number of carbon atoms : number of double bonds) | **Common Name** | **Melting point (°C)** |
|---|---|---|
| *Saturated fatty acids* | | |
| 12 : 0 | Lauric acid | 44.2 |
| 14 : 0 | Myristic acid | 52 |
| 16 : 0 | Palmitic acid | 63.1 |
| 18 : 0 | Stearic acid | 69.6 |
| 20 : 0 | Arachidic acid | 75.4 |
| 22 : 0 | Behenic acid | 81 |
| *Unsaturated fatty acids* | | |
| 16 : 1 | Palmitoleic acid | -0.5 |
| 18 : 1 | Oleic acid | 13.4 |
| 18 : 2 | Linoleic acid | -9 |
| 18 : 3 | α-linolenic acid | -17 |
| 20 : 4 | Arachnidonic acid | -49.5 |

**(a)** Arachidonic acid is a polyunsaturated fatty acid.

Explain the term *polyunsaturated fatty acid.* [1]

- **A fatty acid with many C=C double bonds.**
  **Reject : many kinks**

**(b)** With reference to Table 4.1,

**(i)** describe the effect of increasing number of carbon atoms in saturated fatty acids on the melting point; [3]

1. **As the number of carbon atoms increased 12 to 22, the melting point increased from 44.2 to 81 °C.**

2. **An initial increase of every 2 carbon atoms from 12 to 18 leads to a sharp increase in the melting point from 44.2 to 69.6 °C.**
3. **Further increase of every 2 cabon atoms from 18 to 22 lead to a lesser increase in melting point from 69.6 to 81°C.**
4. **As the number of carbon atoms increases, the melting point increases.**

**(ii)** describe the effect of the presence of double bonds in fatty acids on the melting point; [1]

1. **As the number of double bonds increases, the melting point decreases.**

2. **As the number of double bonds increased from 1 (in oleic acid) to 3 (in α-linolenic acid), the melting point decreased from 13.4 to -17 °C.**

**(iii)** explain the trend described in **b(ii)**. [4]

1. **Presence of double bonds results in the fatty acid molecules being bent/ kinked.**

2. **This means that the molecules cannot be closely packed together / less contact between molecules,**

3. **resulting in weaker hydrophobic interactions.**

4. **Therefore, less energy required to overcome the hydrophobic interactions / separate the fatty acid molecules during melting, resulting in the decrease in melting point.**

[Total: 9]

**5** Table 5.1 provides statements regarding the bonds found in four biological molecules.

**Table 5.1**

| statement | protein | DNA | messenger RNA | cellulose |
|---|---|---|---|---|
| hydrogen bonds stabilise the molecule | ✓ | ✓ | × | ✓ |
| subunits are joined by peptide bonds | ✓ | × | × | × |

**(a)** Complete Table 5.1 by indicating with a tick (✓) or a cross (×) whether the statements apply to proteins, DNA, messenger RNA and cellulose.

You should put a tick or a cross in each box of the table. [2]

**(b)** A piece of mRNA is 660 nucleotides long but the DNA coding strand from which it was transcribed is 870 nucleotides long.

**(i)** Explain this difference in number of nucleotides. [1]

- **Introns present in DNA**
- **Introns absent in mRNA**

**OR**

- **introns removed by RNA splicing**

**(ii)** What is the maximum number of amino acids in the protein translated from this piece of mRNA? Explain your answer. [2]

Number of amino acids **220 OR 219**
Explanation

1. **3 bases code** for **1 amino acids**

**(c)** Identify **one** other process that leads to the formation of mature mRNA and state its function. [2]

**1. Addition of 5' cap**

**[Significance]**
2. **facilitate the binding of** Translation Initiation Factors and **small ribosomal subunit** for translation to occur.
OR
2. **facilitate the export of mature mRNA** from nucleus to cytoplasm for translation
OR
2. **protect the mature mRNA from degradation** by RNase in the cytoplasm

**OR**

**1. Addition of 3' poly-A tail or 3' polyadenylation**

**[Significance]**
2. **facilitate the export of mature mRNA** from nucleus to cytoplasm for translation
OR
3. **protect the mature mRNA from degradation** by RNase in the cytoplasm

**(d)** Describe **one** difference between the structure of mRNA and tRNA. [1]

**Any one:**

1. **mRNA** has **no base-pairing within** its **structure** while **tRNA** has **base-pairing between** regions to **fold back on itself**.
2. **mRNA** has **3' poly-A tail** while **tRNA** has **3' CCA end**.
3. **mRNA** does **not** have **hydrogen bonds** different regions of the single strand while **tRNA** has **hydrogen bonds** at different regions which cause it to **fold back on itself**.
4. **mRNA** is **linear** while **tRNA cloverleaf** shape;
5. **mRNA** has **no binding site for amino acids** while tRNA has.
6. **mRNA longer**/larger/more nucleotides than tRNA
7. **Mrna different** for **each gene**/many kinds, **only few**/20/64 **kinds of tRNA**;

**6** The evolutionary origin of the four-legged amphibians (such as frogs and toads) from fish has been the subject of much debate for many years.

Among living fish, the rarely-caught coelacanth and the lungfish are thought to be most closely related to these amphibians.

Samples of blood were taken from two coelacanths that were captured recently near Comoros.

The amino acid sequences of the α and β chains of coelacanth and lungfish haemoglobin were compared with the known sequences of amphibian adults and their aquatic larvae (tadpoles).

Organisms with more matches in the amino acid sequence of a polypeptide chain share a more recent common ancestor than those with fewer matches.

The comparisons with three species of amphibians, *Xenopus laevis* (Xl), *X. tropicana* (Xt) and *Rana catesbeiana* (Rc) are shown in Table 6.1.

**Table 6.1**

| | | percentage of matches of amino acid sequence | | | | | |
|---|---|---|---|---|---|---|---|
| | | species of amphibian adults | | | species of amphibian larvae (tadpoles) | | |
| | **fish species** | *Xl* | *Xt* | *Rc* | *Xl* | *Xt* | *Rc* |
| **α chains** | coelacanth | 42.0 | 47.5 | no data | 45.4 | 42.6 | 48.2 |
| | lungfish | 40.4 | 42.1 | no data | 40.7 | 39.0 | 37.9 |
| **β chains** | coelacanth | 42.1 | 43.2 | 40.7 | 52.1 | 52.1 | 58.2 |
| | lungfish | 44.1 | 45.9 | 41.4 | 47.3 | 45.9 | 48.6 |

**(a)** Explain whether or not the information in Table 6.1 supports the suggestion that coelacanths and amphibians share a more recent common ancestor than do lungfish and amphibians. [4]

1. **Data largely support that coelacanth and amphibians share a more recent common ancestor. [1]**

2. **The α chain of all 3 species of ADULT amphibians have a higher match with that of coelacanth (42 and 47.5) than lungfish (40.4 and 42.1). [1]**

3. **The α chain of all 3 species of LARVAL amphibians also have a higher match with that of coelacanth (45.4, 42.6 and 48.2) than lungfish (40.7, 39.0 and 37.9). [1]**

4. **Only the β chain of all 3 species of LARVAL amphibians (rather than adults) have a higher match with that of coelacanth (52.1, 52.1 and 58.2) than lungfish (47.3, 45.9 and 48.6). [1]**

**(b)** Coelacanth haemoglobin has a very high affinity for oxygen, suggesting that coelacanths, which have been captured at depths of between 200 m and 400 m, live in water that has a low concentration of oxygen.

Explain how an environmental factor, such as the low concentration of oxygen in deep water, can act as an evolutionary force in natural selection. [3]

1. **Low oxygen concentration acts as selection pressure.**

2. **Individuals with haemoglobin with a higher affinity to oxygen are better adapted to low oxygen concentration are at selective advantage.**

3. **They survive to reproductive age to produce viable and fertile offspring,**
4. **hence passing their favourable alleles to their offspring.**

5. **This leads to an increase in frequency of favourable alleles in population, leading to more individuals with adaptation for low oxygen concentration.**

6. **Directional selection occurred.**

[Total: 7]

**End of Section A**

**2018 PRELIMINARY EXAMINATION**

**H1 BIOLOGY PAPER 2 [SECTION B]:**

**Essay Question**

**Name**: _____

**Civics Group**: _____/17

| For Examiner's Use | |
|---|---|
| **Q7 / 8** | **/ 15** |

**Section B**

Answer **one** question.
Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must set out in sections **(a)**, **(b)** etc., as indicated in the question.

**EITHER**

**7 (a)** Discuss the suggestion that all living organisms on earth depend on nitrogen. [6]

**1 mark EACH**

**[Proteins/ Enzymes]** **[Prot]**

1. **Amino group (containing N) of amino acid → Form peptide bond to form polypeptides / proteins → metabolic processes (e.g. enzymes for respiration)**

**[Haemoglobin]** **[Hb]**

2. **Nitrogen in porphyrin ring of haem in haemoglobin → Take up and release oxygen**

**[Phospholipid]** **[PL]**

3. **Nitrogen in choline bonded to phosphate head of phospholipid → Maintain cell structure / facilitate cell signaling / transport across membrane**

**[Nucleotides and nucleic acids]** **[NRep]**

4. **Nitrogenous bases in DNA (e.g. Adenine, Guanine, Cytosine, Thymine) → Stability of DNA structure via complementary base pairing**

5. **Nitrogenous bases in DNA (e.g. Adenine, Guanine, Cytosine, Thymine) → Hereditary material that is passed on to the offspring / Act as template for synthesis of daughter strands via complementary base pairing**

**[Nucleotides and nucleic acids]** **[DNA/ RNA-Transc/ RNA-Transl]**

6. **Nitrogenous bases in DNA (e.g. Adenine, Guanine, Cytosine, Thymine) → Store genetic information / Act as template for the synthesis of mRNA via complementary base pairing during transcription.**

**OR**

7. **Nitrogenous bases in RNA (e.g. Adenine, Guanine, Cytosine, Uracil) → Act as template → Form complementary base pairing between codon of mRNA and anticodon of tRNA during translation.**

**[Respiration / Cellular activities: ATP]** **[ATP]**

8. Nitrogen is found in structure of ATP → Hydrolysis of high-energy bonds of ATP to provide energy for cellular/ metabolic activities
[Reject: Produce energy]

[Accept: Other roles of ATP: Phosphorylation of glucose / fructose-6-phosphate for glycolysis; Involvement in Calvin cycle; Amino acid activation]

[Respiration: NAD/ FAD] [NAD/ FAD]

9. Nitrogen is found in structure of NAD → Electron carrier in glycolysis, link reaction and Krebs cycle → Donate electrons and protons for oxidative phosphorylation to synthesize ATP

10. Nitrogen is found in structure of FAD → Electron carrier in Krebs cycle → Donate electrons and protons for oxidative phosphorylation to synthesize ATP.

[Respiration: $NADP^+$] [$NADP^+$]

11. Nitrogen is found in structure of $NADP^+$ → Final electron acceptor of non-cyclic photophosphorylation to form NADPH → Reduce glycerate-3-phosphate to glyceraldehyde-3-phosphate in Calvin cycle

[Photosynthesis: Chlorophyll] [Chl]

12. Nitrogen is found in structure of chlorophyll → Photosynthetic pigments that harvest light energy during photophosphorylation to produce ATP and NADPH for Calvin cycle to occur.

[Respiration: GTP] [GTP]

13. Nitrogen is found in structure of GTP → Product of substrate-level phosphorylation in Krebs cycle before conversion to form ATP

[Accept: Other roles of GTP: Translocation of ribosomes during translation]

[QWC] [QWC]

14. Paragraphing + At least 2 different biomolecules mentioned

**(b)** Discuss the extent to which mitosis and the different types of stem cells can account for the principles behind the cell theory in humans, from one generation to the next. [9]

[Cell Theory] [CT]

1. All living organisms are made up of cells.
2. Cell forms basic unit of life.
3. All cells come from pre-existing cells via mitosis.
4. New cells arise from stem cells.

[From parental cell to daughter cells within individual and description of stem cells in terms of contribution to cell theory]

[F]

5. In humans, life started from the fusion of gametes to form a zygote during fertilisation. [1]

[TSC]

6. Zygotic stem cells are totipotent which can give rise to all cell types. [1]

[PSC]

7. Embryonic stem cells are pluripotent stem cells give rise to almost all cell types. Inner cell mass (ICM) forms all different cells and tissues of human body. [1]

[MSC]

8. Multipotent stem cells (e.g. blood stem cells) give rise to a limited range of cell types. [1]

[From one parental generation of organism to the next generation] [M]

9. From one generation to the next, gametes are produced by meiosis. [1]

[Comment on extent] [C]

10. Stem cells and mitosis account for cell theory within organisms but not from one generation to the next (meiosis and fertilization). [1]

[QWC] [QWC]

11. Paragraphing + Explains cell theory + Explain potency of stem cells + Comment [1]

**OR**

**8 (a)** Discuss possible impact of global warming on geographical patterns of distribution of mosquito-borne diseases. [6]

1 mark EACH:

[Example of disease] [E]

1. Increase in mosquito-borne diseases (e.g. dengue) in Singapore.

[Geographic distribution: Range] [R]

2. Global warming will result in increase in range in terms of latitude (geographical location), e.g. spread from equator to subtropical regions (e.g. Europe)

[Geographic distribution: Altitude] [A]

3. and altitude (elevation) from plains to hills (e.g. Nepal)

[Impact: Increased temperature on mosquitoes' survival] [MS, DT]

4. Increased temperature (up till 32°C) increases the survival and reproduction of the mosquito,
5. and the female mosquitoes bite more often, increasing the transmission of dengue.

[Impact: Increased temperature on viral replication] [VR]

6. Increased temperature may negatively affect the reproductive cycle of dengue virus, as viral enzymes may be denatured, hence reducing the number of dengue virus and decreasing the transmission of dengue.

[Impact: Increased rainfall on breeding grounds] [BG]

7. Increased rainfall may result in more stagnant water and increases the number of breeding habitats for mosquitoes.

[QWC] [QWC]

8. Paragraphing + Explains geographical changes based on reasoning linked to 2 aspects of climate change (temperature and rainfall) [1]

[Accept: Other trends with justified claims]

**(b)** DNA molecules are replicated with a high degree of accuracy yet not always perfectly.

[9]

Describe how this occurs and discuss why the survival of a species depends on DNA molecules being stable, yet not *absolutely* stable.

**1 mark EACH:**

**[High degree of accuracy: Complementary base pairing] [SCR, CBP]**

1. **During semi-conservative DNA replication, each parental strand acts as a template for the synthesis of daughter strand.**

2. **Complementary base pairing occurs between nucleotides of template strand and free nucleotides.**

3. **DNA polymerase proofreads the newly synthesized daughter strand (replace incorrectly paired deoxyribonucleotides) / DNA repair occurs to replace damaged DNA strands/ OWTTE.**

**[High degree of accuracy: Importance of genetic stability] [GI]**

4. **This ensures that daughter cells (NOT strands) have genetically identical DNA as parental cell for growth and development of a multicellular organism/ replacement of worn-out parts of the body/ asexual reproduction.**

**[Imperfect accuracy: Mutation] [M, ME]**

5. **Errors in proofreading/ DNA repair mechanisms can result in mutation,**
6. **(e.g. insertion, deletion, substitution) whereby sequence of nucleotides in a gene is changed.**

**[Imperfect accuracy: Disease] [D]**

7. **This may result in diseases (e.g. cancer), or genetic disease that threatens the survival of the organism.**
   **E.g. Sickle cell anaemia caused by a single nucleotide substitution (T→A), which results in mutant haemoglobin and sickle-shaped red blood cells that results in the less efficient transport of oxygen which may reduce the survivability of the individual.**

**[Imperfect accuracy: Genetic variation] [NA]**

8. **Gene mutation results in the formation of new alleles / is the ONLY source of new alleles, thus increasing the gene pool (genetic variation) and results in new phenotypes.**

**[Imperfect accuracy: Impacts of genetic variation on natural selection] [E]**

9. **Genetic variation (diversity) within a population is crucial to the survival of species especially when there is a change in the environment/ selection pressure/ allows them to best adapt to the environment.**
   **OR**
   **Individuals that have the favourable alleles are at selective advantage and they are selected for, thus they are more likely to survive and reproduce to produce more viable and fertile offspring, thus passing their favourable alleles to their offspring.**

**[Conclusion] [C]**

10. **Hence, the continuity of a species and its continued evolution relies on a balance between accurate transmission of nucleotide sequences to the offspring and variation needed to allow continued evolution of the species such that it does not lead to death, thus allowing the species to respond to environmental changes/ OWTTE.**

**[QWC] [QWC]**

**11. Paragraphing + Covers all requirements of questions (i.e. describe and explain stability and instability of DNA) + Explain how it affects survival of species**