H

NANYANG JUNIOR COLLEGE
PRELIMINARY EXAMINATIONS
Higher 2

CANDIDATE NAME

CLASS

BIOLOGY 9744/01

Paper 1 Multiple Choice **17 September 2024**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and CT on the Answer Sheet in the spaces provided unless this has been done for you.

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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

Calculators may be used.

1 Dialysis (Visking) tubing is an artificial partially permeable membrane with pore sizes of approximately 2.5 nm. Glucose molecules have a diameter of about 1.5 nm and can pass through the pores in the membrane.

What else can pass through the pores?

1 bacteria
2 haemoglobin
3 ribosomes
4 fructose

A 1 and 3

B 2 and 4

C 2 only

D 4 only

2 Which statements are correct for chloroplasts and also for mitochondria?

1 They contain 80S ribosomes.
2 They can transcribe their circular DNA.
3 They can translate mRNA.
4 They are enclosed by double membranes.

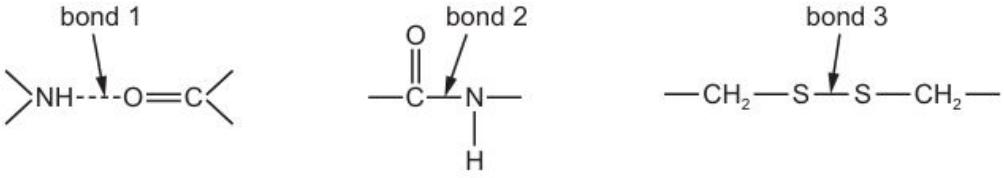
A 1, 2, 3 and 4

B 1 and 2 only

C 2, 3 and 4 only

D 3 and 4 only

3 The diagrams show three examples of different bonds.



Which bond(s) hold(s) the secondary structure of proteins together?

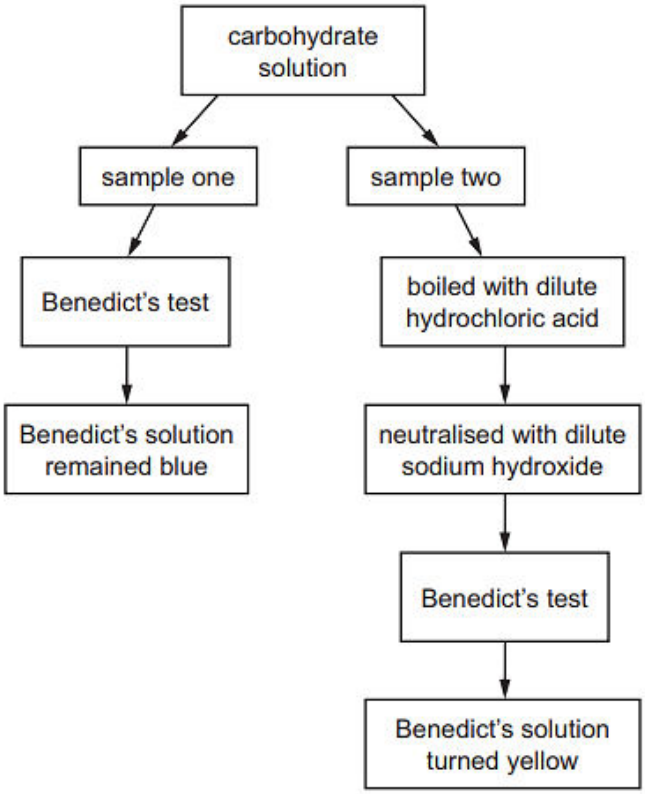
A 1, 2 and 3

B 1 and 3 only

C 1 only

D 2 and 3 only

4 A student was provided with a solution of carbohydrate. They removed two samples from the solution and performed tests on each sample, as shown.



Which statement explains the results?

A Condensation reactions occur in sample two to release reducing sugar.

B Glycosidic bonds in a polysaccharide have been broken to release reducing sugar.

C Sample one shows that sucrose is present in the carbohydrate solution.

D The change in colour to a yellow solution shows that glucose is present.

5 Influenza virus has an enzyme called neuraminidase which breaks down glycoproteins in the surface membrane of the cell that the virus will infect. The glycoprotein binds to the active site of neuraminidase by induced fit.

Which statements about the induced fit hypothesis of enzyme action are correct?

1 The active site must have the same shape as the substrate for them to bind together.
2 This enzyme is less likely to be affected by non-competitive inhibitors than an enzyme working by the lock-and-key mechanism.
3 The substrate is converted to product by specific R-groups in the active site just like the lock-and-key mechanism.

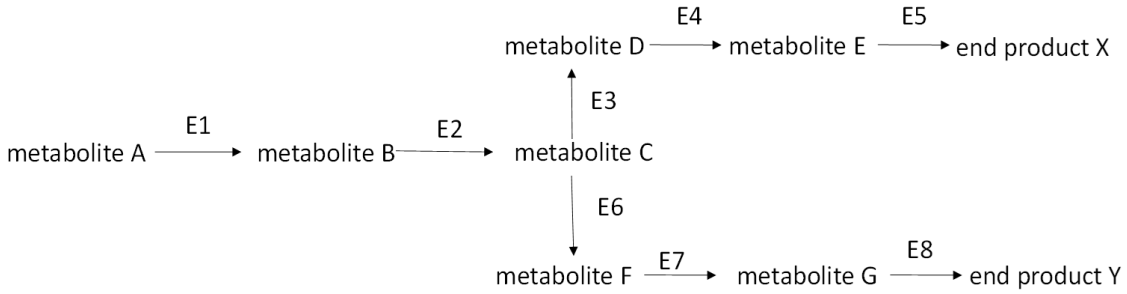
A 1 and 2 only

B 2 and 3 only

C 2 only

D 3 only

6 The diagram shows a metabolic pathway controlled by end product inhibition. Eight enzymes, E1 to E8 were used. As the concentration of the end product increases above a set level, an enzyme in the pathway leading to the end product is inhibited.



An increase in the concentration of end product X does not lead to a decrease in the synthesis of end-product Y. Identify the enzyme that is inhibited by an increase in end-product X.

A E1

B E2

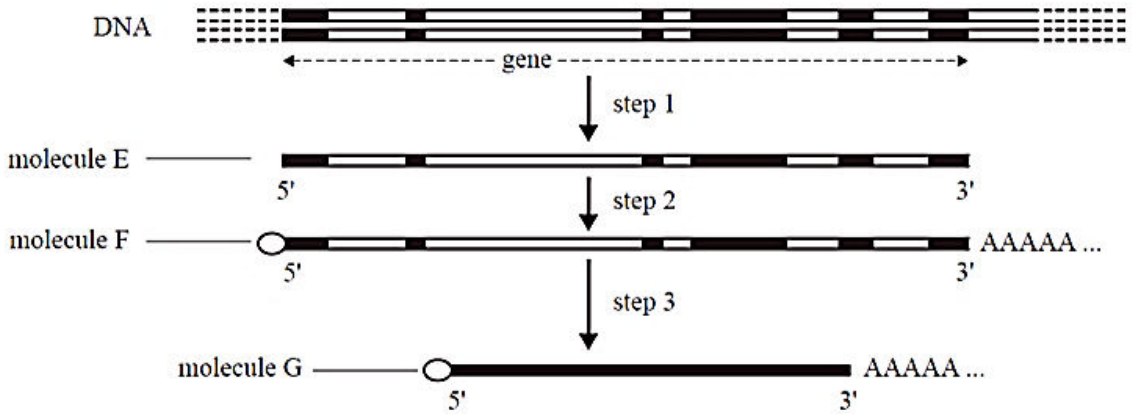
C E3

D E6

7 Which row describes some properties of stem cells?

	able to divide by mitosis to produce more stem cells	able to differentiate into specialised cells	able to repair damaged cells	Key ✓ = is a property × = is not a property
A	✓	✓	✓	
B	✓	✓	×	
C	✓	×	×	
D	×	×	✓	

8 The following diagram shows some of the steps in the production of a protein within a cell.



Which one of the following is a correct statement?

A Step 1 represents translation.

B There are six introns in the gene.

C RNA polymerase is required for Step 3.

D The circle on molecule F represents a modified guanine molecule.

9 The table below shows the role of four different proteins involved in DNA replication.

protein	helicase	topoisomerase	single-strand binding protein	DNA polymerase
role	unwinds the parental DNA double helix	breaks and rejoin the DNA strands	binds to separated DNA strands to stabilize them	synthesises strand of DNA

Which shows the function of these proteins?

	helicase	topoisomerase	single-strand binding protein	DNA polymerase
A	adds DNA nucleotides to the 3' end of a growing polynucleotide strand	prevents original strands reforming complementary base pairs	enables tension caused by unwinding to be released	makes strands available as templates
B	enables tension caused by unwinding to be released	prevents original strands reforming complementary base pairs	makes strands available as templates	adds DNA nucleotides to the 3' end of a growing polynucleotide strands
C	enables tension caused by unwinding to be released	makes strands available as templates	adds DNA nucleotides to the 3' end of a growing polynucleotide strands	prevents original strands reforming complementary base pairs
D	Makes strands available as templates	enables tension caused by unwinding to be released	prevents original strands reforming complementary base pairs	adds DNA nucleotides to the 3' end of a growing polynucleotide strands

10 What is an example of translational control of gene expression?

A activation of proteins by folding or enzymatic cleavage

B addition of chemical groups, such as phosphate groups, to free amino acids in the cytoplasm

C binding of protein factors to specific sequences in mRNA preventing ribosomes attaching

D formation of disulphide bridges in the protein being formed

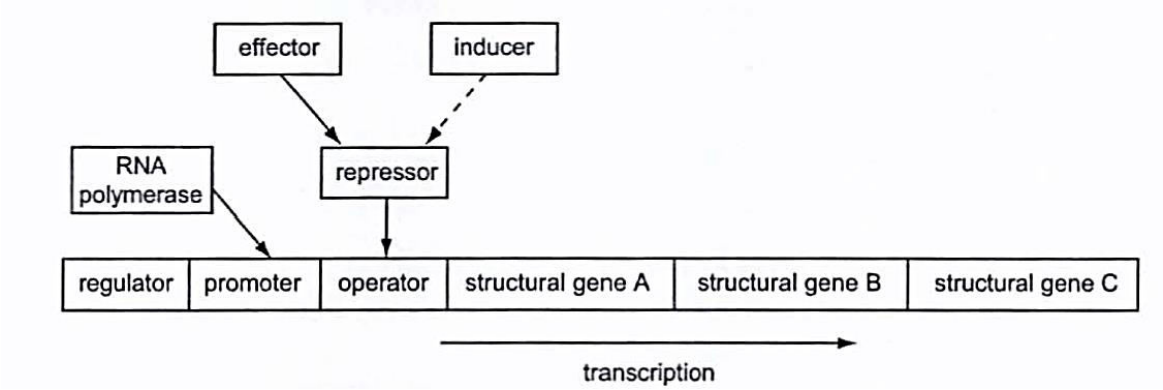
11 A biopsy was conducted on breast cancer patients to extract samples of cancer cells. DNA from these sample cells were isolated and treated with DNase I, an enzyme that degrades histone-free DNA in a non-specific manner. After digestion, the DNase I was removed. Any remaining intact DNA was extracted, made single stranded and mixed with radioactively labelled DNA probes specific for these genes.

Sample	DNase I treatment	Gene specific to radioactive DNA probes	% binding of radioactive DNA to remaining DNA after DNase I digestion
1	No	*PTEN* gene	90
2	Yes	*PTEN* gene	19
3	No	*BRCA* gene	88
4	Yes	*BRCA* gene	87

Which of the following conclusions may be drawn from the results shown above?

A PTEN and BRCA genes are both tumor suppressor genes.
B PTEN gene sequence is heavily methylated in these cells.
C There is reduced transcription of the BRCA gene in these cells.
D Mutation has occurred in PTEN gene while BRCA gene remained intact.

12 The diagram shows some of the molecules involved in controlling transcription in bacteria.

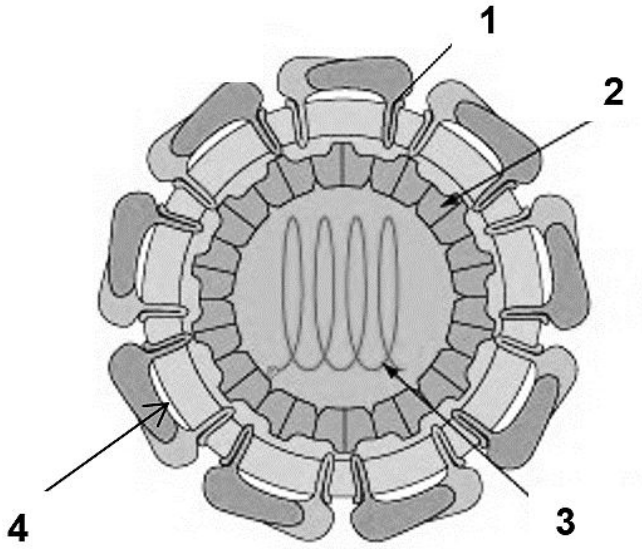


- RNA polymerase must bind to the promoter to start transcription of the structural genes.
- The regulator produces a repressor.
- The polypeptide synthesised from the structural gene A acts as an effector.
- The effector binds the repressor to the operator to block transcription.
- The inducer prevents the repressor binding.

Which molecule acts as an end product inhibitor?

A effector
B inducer
C regulator
D repressor

13 The Zika virus is a type of flavivirus. Its replication cycle is similar to that of the influenza virus. The diagram below shows the structure of the Zika virus.



Which of the following correctly matches the numbered structures?

	1	2	3	4
A	transmembrane protein	capsid	DNA genome	lipid bilayer
B	viral glycoprotein	capsomere	RNA genome	viral envelope
C	receptor	matrix protein	viral genome	capsid
D	viral glycoprotein	capsomere	nucleoprotein	matrix protein

14

With reference to the lambda phage shown in the diagram above, which of the following statements are **false**?

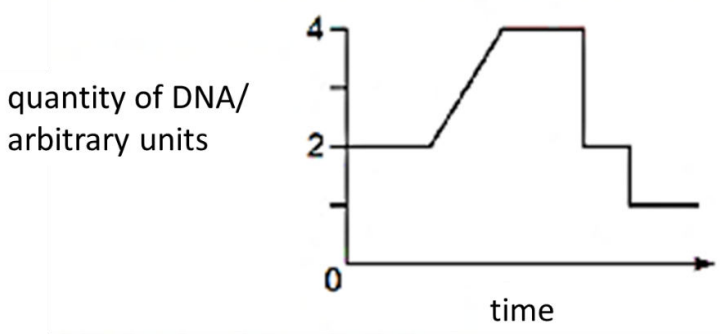
I The genetic material of the virus can be either DNA or RNA.
II The adsorption of viral particles to host cell is a chemical interaction in which strong covalent bonds are formed between the tail fibres of the virus and complementary receptor sites on the host cell wall.
III Once the viral genetic material has reached the cytoplasm of the host cell, viral proteins will be degraded.
IV The host genes can be transferred by the virus to another host cell through the process of generalized transduction.
V Mature infective virions have spontaneously assembled and are ready to leave host cell to infect other cells.
VI The virus is able to multiply via both the lytic and lysogenic cycles.

A III, IV and VI only
B I, II and V only
C I, V and VI only
D II, III and IV only

15 What are the conditions in a human cell during late prophase?

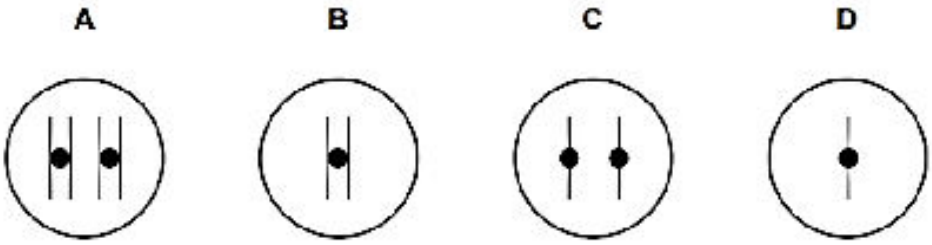
	number of chromatids	number of molecules of DNA in nucleus	spindle present	nuclear envelope present
A	46	46	yes	no
B	92	46	no	yes
C	46	92	yes	no
D	92	92	yes	no

16 The graph shows the change in the quantity of DNA in a cell during reduction division (meiosis).



A cell with one pair of chromosomes (2n=2) undergoes meiosis.

Which nucleus is formed as a result of this division?



17 Scallops, which are bivalve molluscs, are important commercially throughout the world. The marine bay scallop, *Agropecten irradians*, has three distinct shell colours, yellow, orange and black. The shell colour is controlled by a gene with three alleles, yellow S^Y, orange, S^O, and black, S^B.

Scallops are hermaphrodite and are able to fertilise themselves to produce offspring. Single mature adult specimens of yellow, orange and black scallops were collected and kept in separate tanks of seawater until they produced young. The young were then scored for shell colour. The results were as follows:

Yellow scallop – 25 yellow and 8 black
Orange scallop – 31 orange and 9 black
Black scallop – 27 black

Which of the following are possible conclusions based on the observations?

I S^Y allele is dominant over S^B allele.
II S^Y allele is dominant over S^O allele.
III S^O allele is dominant over S^B allele.
IV S^B allele is dominant over S^Y and S^O alleles.
V The alleles S^Y and S^O are codominant.

A IV only

B I and III only

C I, II and III only

D I, III and V only

18 In rats, the allele of a gene for 'mottled' coat (M) and the recessive allele (m) for 'normal' coat are sex linked. The allele of a gene for 'long' whiskers (W) and the recessive allele (w) for 'short' whiskers are autosomal.

A male rat with a normal coat and short whiskers was mated on several occasions to the same female. The offspring showed the following phenotypes in equal proportions.

- mottled females and males with long whiskers
- mottled females and males with short whiskers
- normal females and males with long whiskers
- normal females and males with short whiskers

What are the genotypes of the parents?

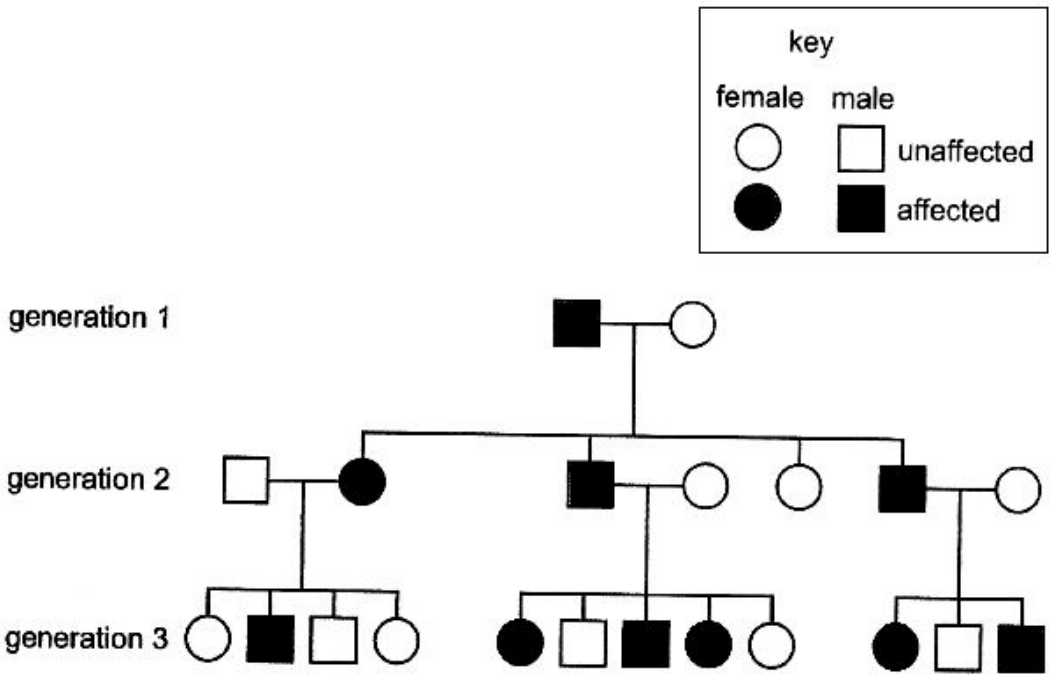
A X^mYww and X^MX^MWW

B X^mY^mww and X^MX^MWw

C X^mY^mww and X^MX^mWW

D X^mYww and X^MX^mWw

19 The pedigree shows the inheritance of a dominant genetic condition in a family for three generations.



Which evidence indicates that this genetic condition is autosomal?

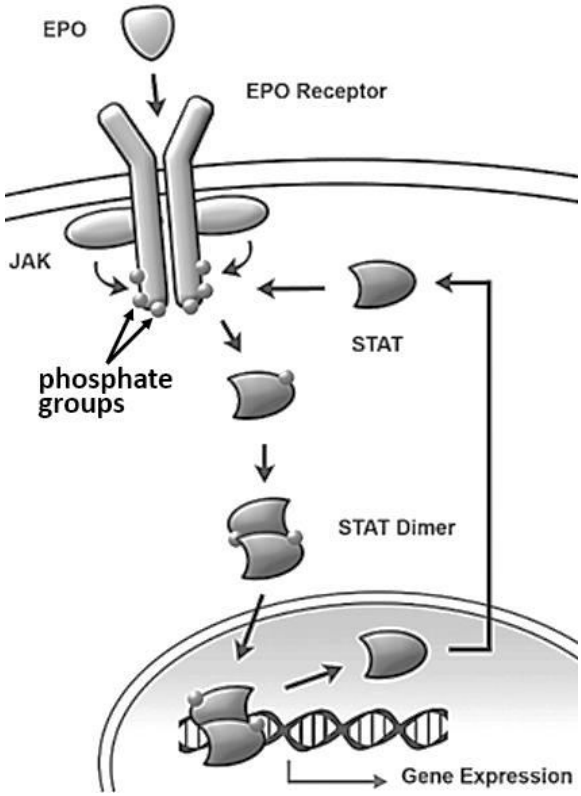
A Affected females always have affected sons.

B Affected males do not pass it on to their sons.

C Affected parents always have affected offspring.

D Males and females are equally affected.

20 The diagram shows the JAK-STAT cell signalling pathway.



Which of the following statements are correct?

1 EPO is a large and non-polar lipid hormone and hence it needs a cell surface receptor to cross the membrane.
2 Phosphorylation of STAT causes them to dimerize.
3 Gene expression is terminated when phosphatases remove phosphate groups from STAT dimers.
4 Signal amplification occurs as JAK phosphorylates multiple tyrosine residues on the EPO receptor.

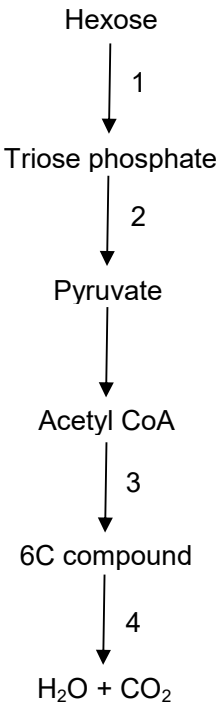
A 1 and 3 only

B 2 and 3 only

C 2 and 4 only

D 2, 3 and 4 only

21 The diagram summarises the pathway of glucose breakdown.



Which two steps result in a net increase of ATP?

A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

22 Which of the following statements are correct?

1 Chlorophyll b is an accessory pigment that is involved in the resonance transfer of electrons from one pigment molecule to the next in the light harvesting complex of both photosystems I and II.
2 ATP synthase is located at the thylakoid membrane and the membrane of the intergranal lamella.
3 When reduced, NADP can donate electrons to the electron carriers in the electron transport chain on the thylakoid membrane.
4 The electrons released during the photolysis of water can be used to reduce NADP during non-cyclic photophosphorylation.

A 1 and 2 only

B 2 and 4 only

C 3 and 4 only

D 1 and 3 only

23 The action spectrum and absorption spectrum of photosynthetic pigments are similar because

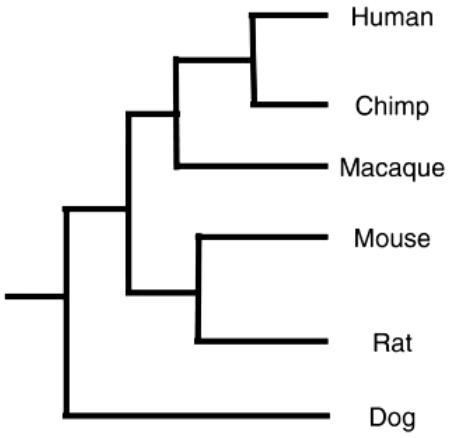
A the amount of energy absorbed by the pigments is the activation energy needed for photosynthesis.

B only certain wavelengths of light provide enough energy to make ATP during the light reaction.

C photosynthesis occurs when the whole spectrum is absorbed.

D wavelengths of light absorbed by the pigments are the ones used in photosynthesis.

24 The differences between the trypsin molecules from different species have been used to produce a phylogenetic tree.



Based on the above information, how many of the following statement(s) is/are true?

- Chimp and macaque share a more recent common ancestor than mouse and rat.
- A total of five speciation events are shown.
- Differences in the different levels of protein structures of trypsin between the six species was used to build the phylogenetic tree.
- Trypsin is a homologous protein.

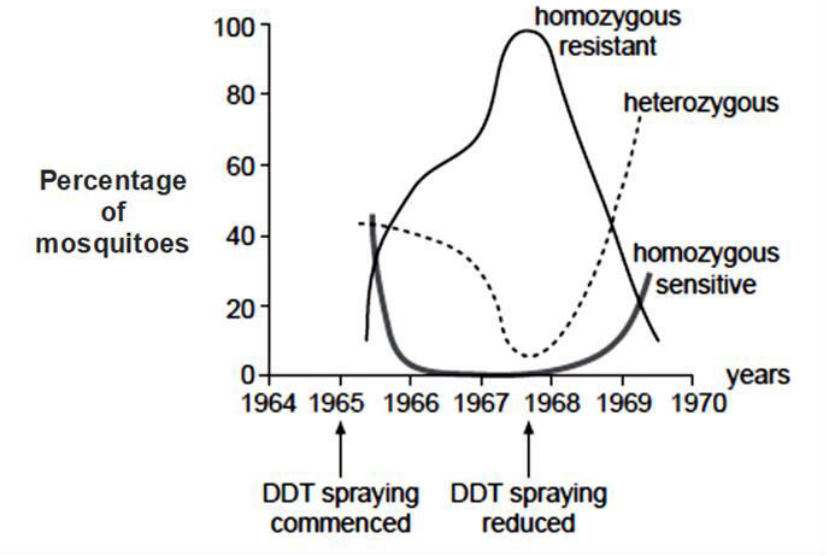
A 1 **B** 2 **C** 3 **D** 4

25 In the mid-1960s, DDT was widely used as an insecticide against mosquitoes. The sensitivity to insecticide in mosquitoes is determined by a single gene that has two alleles.

allele 1: resistant to DDT

allele 2: sensitive to DDT

Over several years, genotypic frequencies were measured in a population of mosquito larvae. The graph below shows the results.



Analysis of graph reveals that in the population, _____.

A allele 1 confers a selective disadvantage in the absence of DDT.

B A heterozygote advantage is demonstrated after DDT spraying is reduced.

C mutant allele 1 emerged as a result of the use of DDT in 1965.

D only one copy of allele 1 is required for resistant phenotype.

26 The goldenrod gall flies, Eurosta solidaginis, lay their eggs individually in developing shoots of the tall goldenrod plant (Solidago sp.). The fly larva that hatches from the egg makes a chemical that causes the plant tissue to swell around it, resulting in the formation of a mass of plant tissue called a gall. The gall serves as a home for the larva.

Downy woodpeckers attack large galls and eat the gall fly larva.

Parasitic wasps lay eggs inside small galls and the wasp larvae that hatch from the eggs eat the gall fly larva when it hatches. They are not able to lay eggs in large galls as the wall of the large gall is too thick for the ovipositor of a parasitic wasp to penetrate.

Based on the information given, which of the following conclusions can be drawn?

A This is an example of stabilising selection where larvae that produce high or low concentration of the chemical will be selected against.

B This is an example of stabilising selection where galls of large and small sizes are selected for as both the woodpeckers and parasitic wasps feed on them.

C This is an example of disruptive selection as the woodpecker and parasitic wasps select for the large and small sized galls respectively.

D This is an example of disruptive selection as larvae that produce high or low concentration of the chemical will be selected for.

27 Copies of a segment of DNA from species **X** were hybridised with copies of the homologous segment of DNA from species **P**.

The hybridised DNA segments were heated, and the temperature at which complete separation occurred (separation temperature) was recorded.

To determine evolutionary relationships, this process was repeated three times using DNA from species **Q**, **R**, and **S**. The results are shown in the table.

hybridised DNA	separation temperature / °C
P-X	30
Q-X	40
R-X	70
S-X	80

Which statement is supported by the data in the table?

A Species **P** and species **X** share a more distant common ancestor as they have the least percentage difference in their DNA.

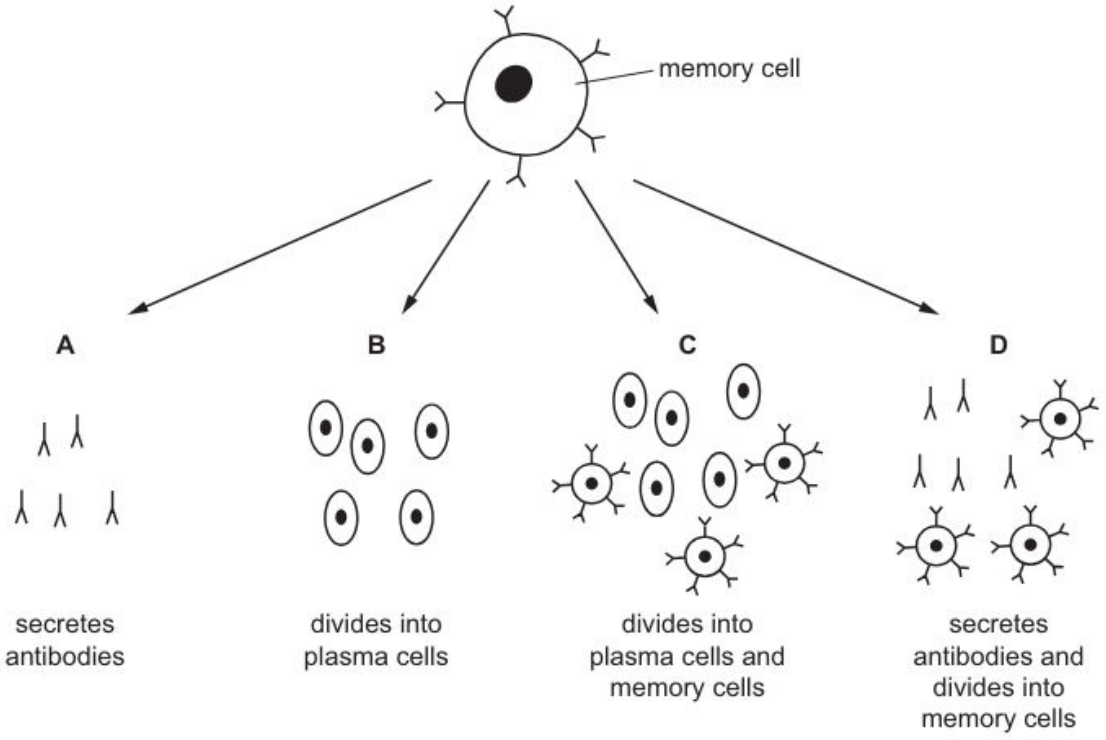
B Species **P** and species **Q** together have the same percentage difference in DNA from species **X** as has species **R**.

C Species **R** is more closely related to species **S** than it is to species **X**.

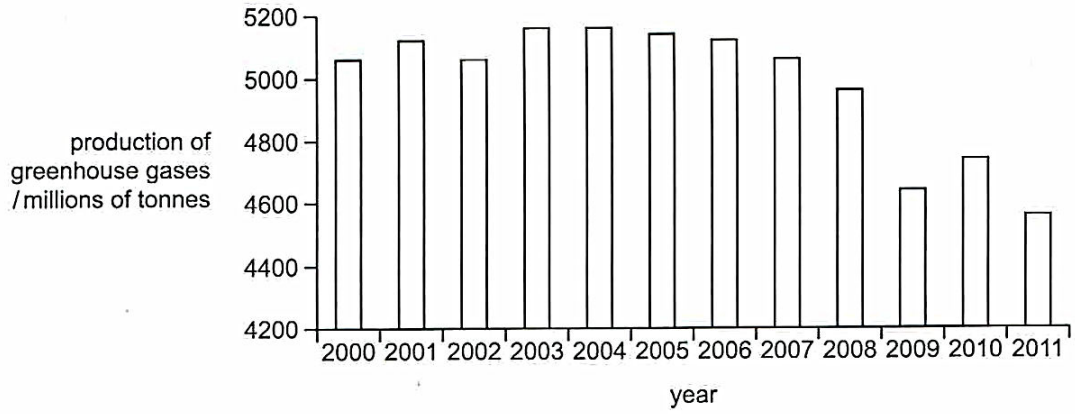
D Species **S** and species **X** share a more recent common ancestor as they have the least percentage difference in their DNA

28 When exposed to an antigen for a second time, memory cells stimulate a secondary immune response.

Which correctly shows the secondary immune response?



29 The bar chart shows the production of greenhouse gases (carbon dioxide and methane) from agriculture in the European Union (EU) from 2000 to 2011, measured in millions of tonnes.



Which of the following could contribute to the trend seen between 2003 and 2009?

A Increased consumption of meat-based products

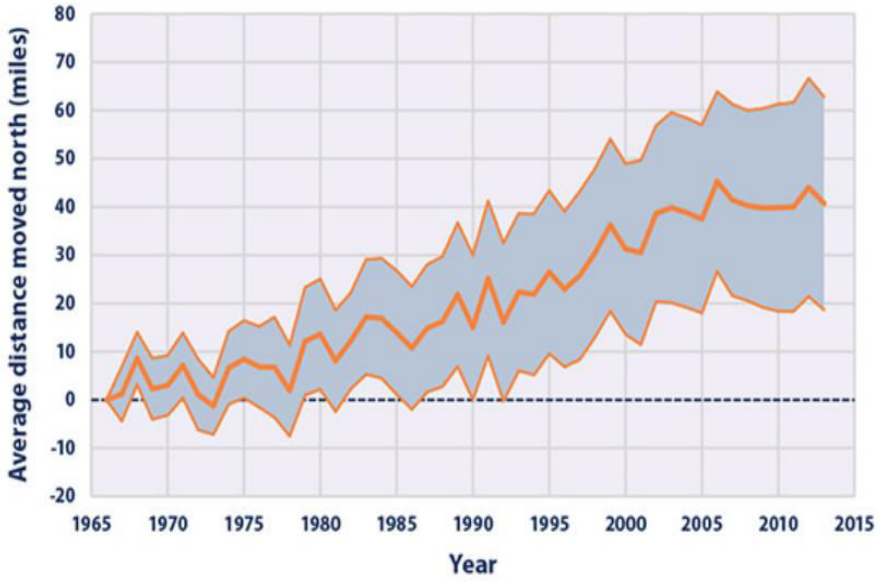
B Greater use of agricultural machinery for harvesting

C Conversion of intensive farmland into woodland reserves

D Increased import and export of crops between EU countries

30 Warmer temperatures are forcing birds in pine forests to breed farther north. Many species once found farther south are also expanding their ranges.

The graph below shows the average latitude occupied by 305 bird species in North America during the winters of 1966 to 2013. The shaded band shows the range of latitudes occupied by the birds.



What could explain the observation?

1 Seasonal birds begin their migration earlier, and lay eggs earlier, in response to warming forest climate.
2 Birds are mobile, thus they can switch their home ranges and habitat to find more suitable breeding grounds.
3 As temperature rises, pine forests found in the south now cover the northern region previously covered by hardwood forests.
4 As temperature rises, birds experience warmer winters that increases their reproductivity, resulting in larger bird populations.

A 2 only

B 2 and 3 only

C 1, 2 and 4 only

D 1, 3 and 4 only