H2

MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level

BIOLOGY **9477/01**

Paper 1 Multiple Choice **For examination from 2026**

SPECIMEN PAPER **1 hour**

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

0123456789

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and index number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use an approved calculator.

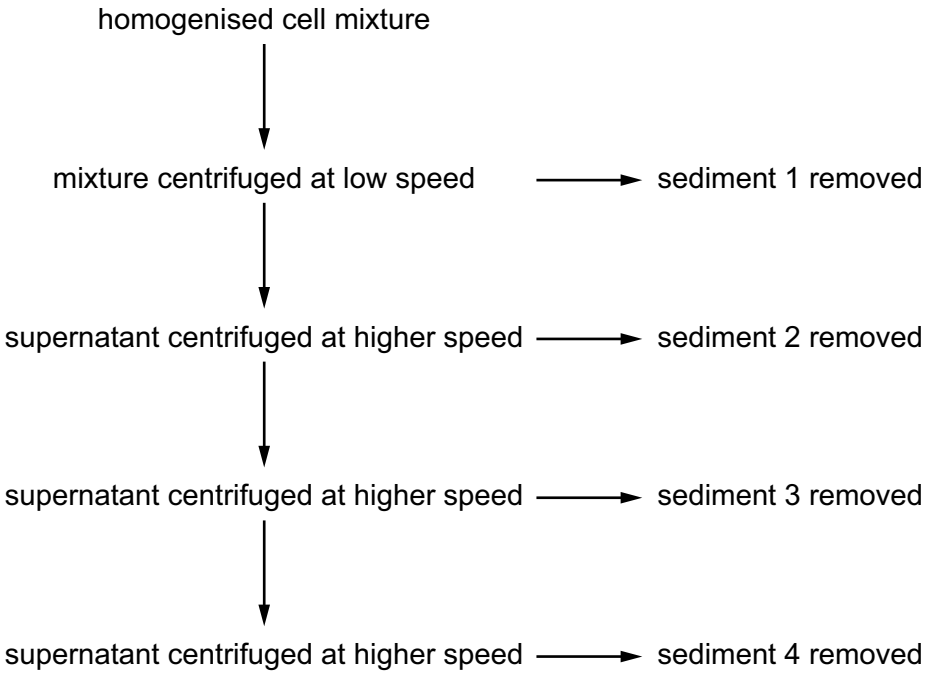
INFORMATION

- The total mark for this paper is 30.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.

Singapore Examinations and Assessment Board

CAMBRIDGE International Education

1 The flow diagram shows a technique called cell fractionation, which is used to separate cell organelles by their relative size. Cells are homogenised and mixed with buffer to prepare them for cell fractionation. The homogenised cell mixture contains a mixture of cell organelles.



Which organelle is found in each of the sediments?

	sediment 1	**sediment 2**	**sediment 3**	**sediment 4**
A	lysosome	ribosome	mitochondrion	nucleus
B	mitochondrion	nucleus	lysosome	free ribosome
C	nucleus	mitochondrion	lysosome	free ribosome
D	nucleus	free ribosome	mitochondrion	lysosome

2 The features of some cellular components are listed.

1 tubular single-membrane network fused to nuclear envelope

2 a stack of separate flattened layers, each with a single membrane

3 two membranes of which the outer is smooth and the inner is folded

4 single membrane with glycoproteins on one surface

Which row shows a function carried out by each of these cellular components?

	1	2	3	4
A	intracellular transport	lipid synthesis	light absorption	extracellular transport
B	intracellular transport	protein glycosylation	ATP synthesis	cell recognition
C	lipid synthesis	protein synthesis	electron transfer	ion transport
D	protein synthesis	intracellular transport	glycolysis	cell adhesion

3 Which features of viruses provide evidence that they are non-living?

1 Viral nucleic acids can be cut into small fragments by bacterial restriction enzymes.

2 Complete virus particles usually contain only one type of nucleic acid.

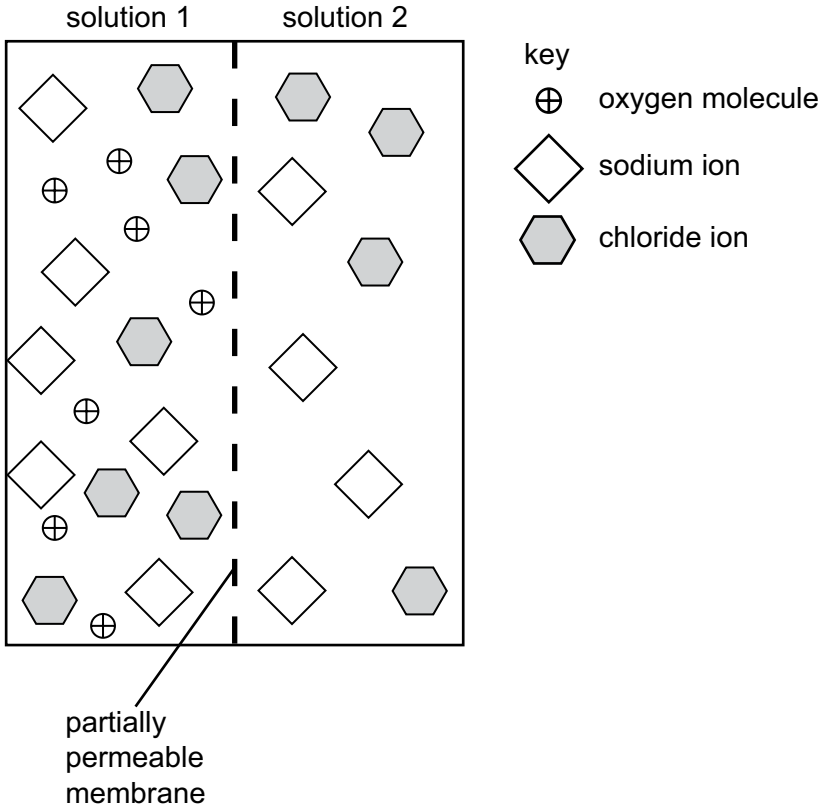
3 Virus particles can be isolated and crystallised.

4 Viruses **cannot** synthesise ATP.

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

4 The diagram represents a partially permeable membrane separating two aqueous solutions, solution 1 and solution 2.

The relative diameters and concentrations of the solute ions and solute molecules and the pore diameter of the partially permeable membrane are drawn proportionately in the diagram. Water molecules are **not** shown.



Which statement about the movement of the molecules and ions between solution 1 and solution 2 is correct?

A Sodium ions and chloride ions in solution 1 are at a higher concentration than sodium ions and chloride ions in solution 2. They therefore diffuse from solution 1 to solution 2. Oxygen molecules and water molecules diffuse in opposite directions until the water potentials of the two solutions are equal.

B Water molecules move down the water potential gradient by osmosis, from solution 1 to solution 2. Oxygen molecules are absent from solution 2 and, as a result, they move only from solution 1 to solution 2 until they are at equal concentrations in both solutions. Sodium ions and chloride ions do **not** cross the partially permeable membrane.

C Solution 1 has a more negative water potential than solution 2 because it has a higher concentration of solutes. As a result, there is a net movement of water molecules from solution 2 to solution 1 until the water potentials of both solutions are the same. All the solute molecules and ions are too large to pass through the membrane.

D Net movement of water molecules occurs down a water potential gradient from solution 2 to solution 1, net movement of oxygen molecules occurs down a diffusion gradient from solution 1 to solution 2, and no movement of sodium ions and chloride ions occurs between solution 1 and solution 2 across the partially permeable membrane.

5 Human hair is made up from bundles of a fibrous protein called keratin, which is similar to collagen.

The chains of amino acids in keratin coil to form a secondary structure called an α-helix.

When hair is wet, it can lengthen temporarily due to the breaking of bonds in the α-helix. When it dries, the hair returns to its original length.

What are broken to produce this temporary change in length of the α-helix?

A disulfide bonds

B hydrogen bonds

C hydrophobic interactions

D ionic bonds

6 The amino acid sequence in the polypeptide collagen is commonly a repeating unit of three amino acids, glycine-X-proline or glycine-X-hydroxyproline. X can be any other amino acid.

What is the role of glycine in the polypeptide?

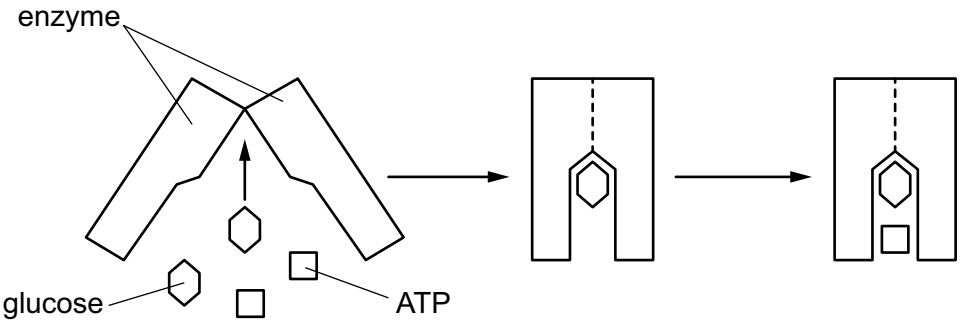
A It is small so it can form the interior of the axis of a triple helix.

B It forms hydrogen bonds in the tertiary structure of a collagen molecule.

C It can be compressed to allow a triple helix to form.

D It allows the secondary structure of each polypeptide to form a left-handed helix.

7 The enzyme hexokinase, which catalyses the transfer of a phosphate group from ATP to glucose, changes shape during the reaction, as shown in the diagram.



Which statements describe the behaviour of this enzyme?

1 The active site is formed only in the presence of glucose and ATP.

2 Binding ATP to the enzyme allows glucose to bind.

3 The reaction illustrates the 'induced-fit' hypothesis of enzyme action.

4 In the absence of glucose, ATP is **not** hydrolysed to release a phosphate group.

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

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

A bone marrow stem cell that is transferred to the skin is never induced to produce a skin cell, and a skin stem cell that is transferred to the bone marrow is never induced to produce a blood cell.

Which statement explains this?

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

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

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

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

9 The non-template strand of part of a DNA molecule has the sequence 5' GAATTA 3'.

Which row is correct for this part of the corresponding template strand and tRNA anticodons?

	the sequence of the template strand	**the anticodons of tRNA used in translation**
A	5′ CTTAAT 3′	5′ CUU 3′ and 5′ AAU 3′
B	5′ CTTAAT 3′	5′ UAA 3′ and 5′ UUC 3′
C	5′ TAATTC 3′	5′ CUU 3′ and 5′ AAU 3′
D	5′ TAATTC 3′	5′ UAA 3′ and 5′ UUC 3′

10 The table shows the mean lengths in kilobases (kb) of genes and of messenger RNA (mRNA) molecules in the bacterium *Escherichia coli* and the fruit fly *Drosophila melanogaster*.

organism	**mean length of genes / kb**	**mean length of mRNA molecules / kb**
E. coli	1.0	1.0
D. melanogaster	7.2	3.0

Which statement does **not** help to account for the differences between *E. coli* and *D. melanogaster* shown in the table?

A Fruit fly proteins are larger, on average, than the proteins of prokaryotes.

B The fruit fly genome is much longer than the bacterial genome.

C The initial transcripts of pre-mRNA are shortened by splicing in fruit flies.

D The majority of fruit fly genes are interrupted by introns.

11 Some features of the reproductive cycle of the human immunodeficiency virus (HIV) are listed.

- penetration
- integration with host DNA
- formation of cDNA
- transcription of viral DNA
- assembly of new virus particles

How many of these features also occur in the reproductive cycle of the influenza virus?

A 2

B 3

C 4

D 5

12 DH5α T1R is a laboratory strain of *Escherichia coli* bacteria that has a number of features that make it particularly useful for research. These features include:

1 low risk of causing infections in humans

2 lacks endonucleases that could degrade plasmids

3 can easily take up DNA from its external environment

4 resistant to infection by T1 phage.

A culture of DH5α T1R cells that contained an F plasmid conferring resistance to the antibiotic ampicillin was grown for several generations in nutrient broth containing ampicillin.

A small volume of this culture of DH5α T1R cells was then inoculated into a large volume of sterile nutrient broth, containing all of the requirements for optimal bacterial growth and without ampicillin. After incubating at 37 °C for eight hours, the number of bacterial cells present had increased by a factor of more than 15 million. Most, but **not** all, of these cells were found to be ampicillin resistant when tested.

Which method of gene transfer from one bacterial cell to another is responsible for the enormous increase in the number of DH5α cells that were resistant to ampicillin?

A binary fission

B conjugation

C transduction

D transformation

13 Which description defines all control elements?

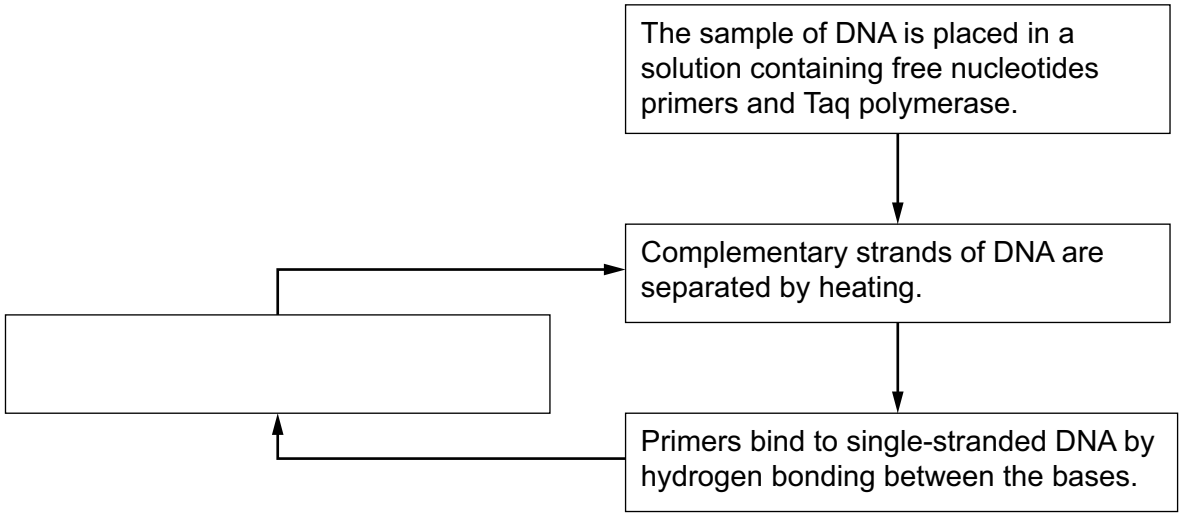
A a segment of DNA to which RNA polymerase binds preferentially

B a short region of DNA that can bind with proteins to enhance transcription levels

C DNA sequences that interact with proteins to determine the rate and timing of gene expression

D proteins found only in eukaryotes that bind to DNA sequences to control transcription

14 The polymerase chain reaction is summarised in this flowchart. One box has **not** been completed.



Which statement completes the flow chart?

A Hydrogen bonding links free nucleotides to the primers by complementary base pairing, resulting in DNA replication and amplification of the target sequence.

B DNA extension occurs as complementary nitrogenous bases bind to deoxyribose sugars to form a sugar–phosphate backbone of a new DNA strand.

C Taq polymerase joins complementary nucleotides to the 3' ends of single-stranded DNA molecules through phosphodiester bonds.

D Double-stranded DNA is formed by complementary base pairing of nucleotides to single-stranded DNA, ending at the primer binding sites.

15 Two forms of Down syndrome can occur.

1 Classic Down syndrome in which a chromosomal aberration affects all cells of an individual.

2 Mosaic Down syndrome in which the same chromosomal aberration affects only a proportion of the cells of an individual.

What could explain how the mosaic form of Down syndrome occurs?

A incorrect separation of chromosomes in meiosis during formation of the gametes

B incorrect separation of chromosomes in mitosis during fetal development

C chromosomal translocation in meiosis during formation of the gametes

D chromosomal translocation in mitosis during fetal development

16 What is a normal function of tumour suppressor genes?

A to dysregulate a checkpoint of cell division

B to prevent the mutation of proto-oncogenes

C to promote the death of cells with DNA damage

D to stimulate the activity of cellular oncogenes

17 The statements are about meiosis.

1 Pairs of homologous chromosomes form bivalents within which crossing-over occurs.

2 Daughter chromosomes segregate independently during anaphase II.

3 Alleles of the same genes are exchanged between sister chromatids during prophase I.

4 The two chromosomes of a homologous pair undergo independent segregation.

Which features of meiosis can contribute to genetic variation between gametes?

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

18 A pure-breeding tomato plant with the dominant phenotype of the gene Q/q and recessive phenotype of the gene R/r was crossed with another pure-breeding tomato plant with the recessive phenotype of the gene Q/q and the dominant phenotype of the gene R/r.

A test cross was carried out with the offspring of this cross. The results are shown.

- 33 plants phenotypically dominant for Q/q and recessive for R/r
- 8 plants phenotypically dominant for Q/q and R/r
- 7 plants phenotypically recessive for Q/q and R/r
- 35 plants phenotypically recessive for Q/q and dominant for R/r

What explains these results?

A autosomal linkage

B dihybrid inheritance

C epistasis

D incomplete dominance

19 In the dark, the concentration of Mg^{2+} ions in the stroma of chloroplasts is low. In the light, Mg^{2+} ions move into the stroma.

When the concentration of Mg^{2+} ions is high, CO_2 reacts with the active site of rubisco to form a carbamate group. This allows Mg^{2+} ions to bind to rubisco, which activates the enzyme.

When the concentration of Mg^{2+} ions is low, the carbamate group dissociates. Any RuBP that is present binds tightly to the active site of rubisco, which inactivates the enzyme.

When the concentration of Mg^{2+} ions increases again, rubisco can be reactivated by the enzyme rubisco activase (an ATPase). Rubisco activase releases RuBP from the active site of rubisco, allowing a carbamate group to form and activating rubisco.

Which statement is supported by this information?

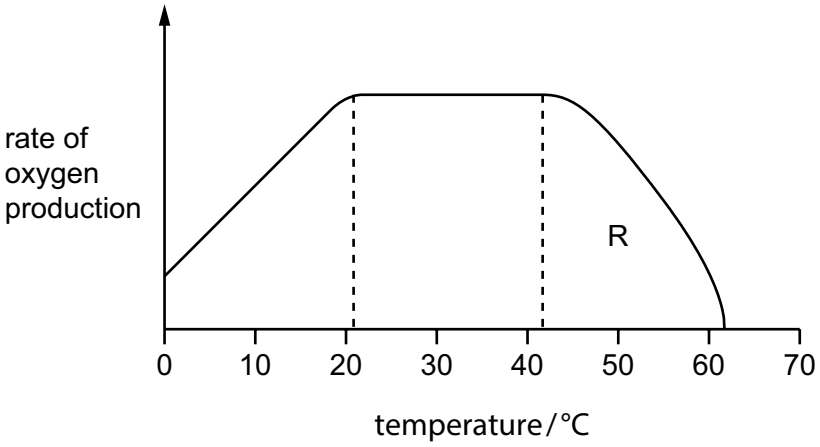
A Carbon dioxide fixation increases when the carbamate group dissociates from rubisco.

B Inactivated rubisco can be reactivated as light intensity decreases.

C In low concentrations of Mg^{2+}, an ATPase enables the activation of rubisco.

D Rubisco without the carbamate group is inhibited by RuBP.

20 The graph shows how the rate of oxygen production by the photosynthetic alga *Chlamydomonas* varies with temperature, when all other factors are kept constant.



Three factors that can limit the rate of oxygen production by *Chlamydomonas* are listed.

1 carbon dioxide concentration

2 light intensity

3 temperature

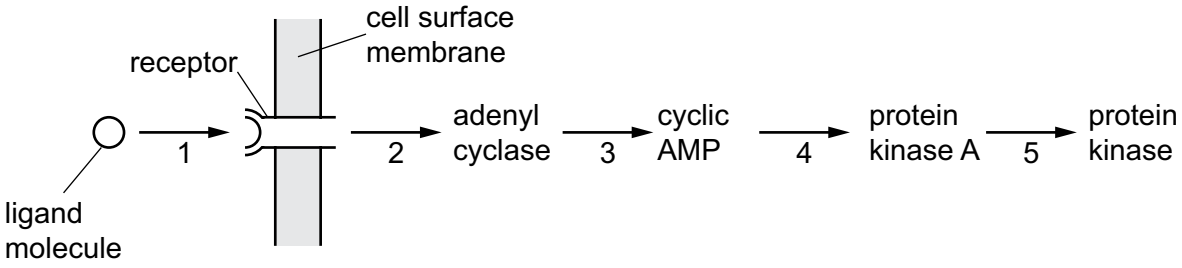
Which of these factors must be limiting the rate of oxygen production at R?

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

21 Which row shows where the link reaction and oxidative phosphorylation occur in a mitochondrion?

	link reaction	**oxidative phosphorylation**
A	intermembrane space	outer membrane
B	matrix	inner membrane
C	matrix	outer membrane
D	intermembrane space	inner membrane

22 The diagram shows five numbered stages in one example of cell signalling.



Which row correctly identifies the stages at which signal amplification and enzyme activation occur?

	signal amplification	**enzyme activation**
A	1, 2, 3, 4 and 5	2, 3, 4 and 5
B	2 and 3 only	4 and 5 only
C	3 and 5 only	2, 4 and 5 only
D	4 and 5 only	2 and 3 only

23 Some of the evidence for evolution is listed.

1 The bones found in the ears of reptiles and mammals have the same origin as the jaw bones of fish.

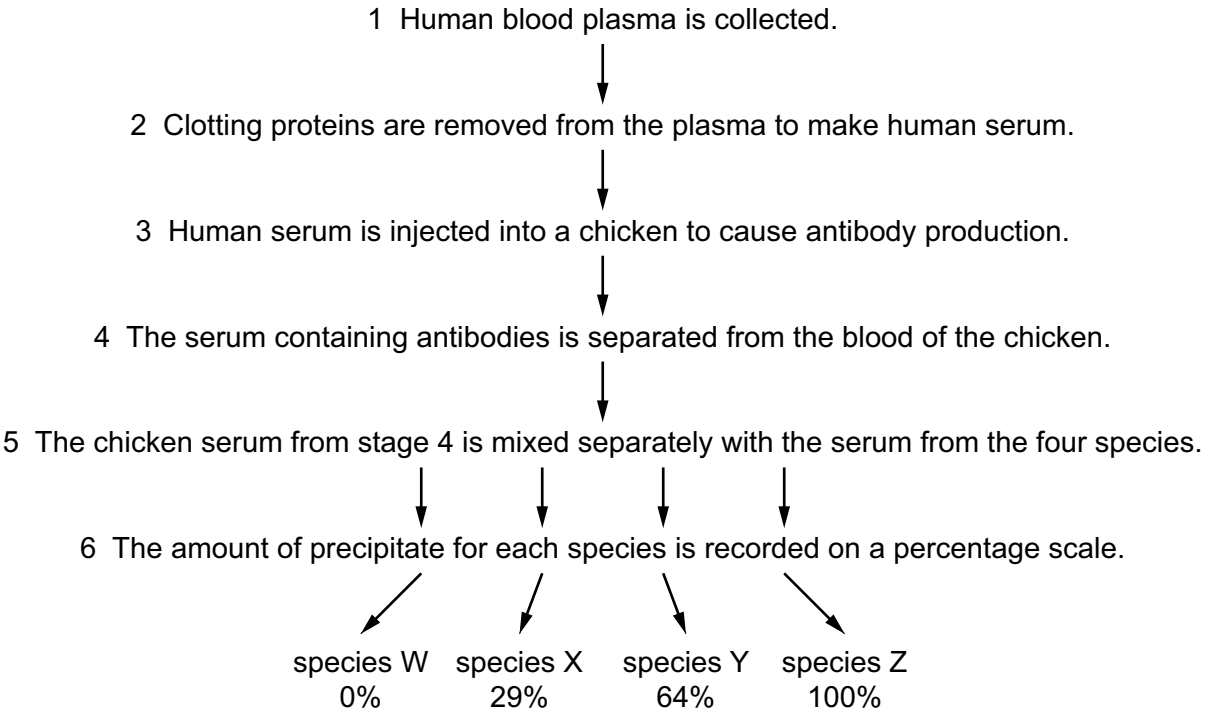
2 Many species that are present in more recent layers of sedimentary rock do **not** occur in older layers.

3 The fossil *Archaeopteryx* has many anatomical features in common with dinosaurs and some anatomical features in common with birds.

Which evidence is based on homologies?

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

24 The flow diagram shows an investigation into the blood proteins of four species, W, X, Y and Z. Foreign blood proteins cause the production of antibodies. Mixing an antibody with its corresponding protein causes a precipitate.



The four species, in alphabetical order, were chicken, chimpanzee, human and mouse.

Which row correctly identifies the species involved?

	species W	species X	species Y	species Z
A	chicken	chimpanzee	mouse	human
B	mouse	chimpanzee	chicken	human
C	human	mouse	chimpanzee	chicken
D	chicken	mouse	chimpanzee	human

25 Within populations, there can be large amounts of genetic variation, leading to a range of different phenotypes for some characteristics (polymorphisms). For example, shell pattern in the snail *Cepaea nemoralis* is under genetic control and is highly polymorphic. Shells can be yellow, pink or brown with a range of different banding patterns.

Which condition would maintain the polymorphism, in a population, of a characteristic that is under genetic control?

A preferential mating with individuals having recessive phenotypes

B occurrence of a natural disaster in which only a few, randomly selected individuals of a large population survive

C consistent selection pressure against characteristics controlled by dominant alleles

D population being in Hardy–Weinberg equilibrium

26 There are many greenhouse gases other than carbon dioxide. The overall contribution to global warming of emissions of any greenhouse gas can be calculated using the 100-year global warming potential (GWP). This is specific to each greenhouse gas. Multiplying the mass of greenhouse gas released by its 100-year GWP gives the mass of carbon dioxide that, over a 100-year period, would have the same contribution to global warming.

equivalent mass of carbon dioxide = mass of greenhouse gas released × 100-year GWP

The table shows the masses of five different greenhouse gases released in the UK in 2021, together with their 100-year GWPs.

greenhouse gas	mass of gas released / tonnes	100-year GWP
carbon dioxide (CO_2)	3.4×10^8	1
methane (CH_4)	2.0×10^6	28
nitrous oxide (N_2O)	7.2×10^4	265
sulfur hexafluoride (SF_6)	1.8×10^1	23 500
nitrogen trifluoride (NF_3)	2.1×10^{-2}	16 100

Which statement correctly describes the effect over a 100-year period of the emission of greenhouse gases in the UK in 2021?

A Of the gases listed in the table, methane was the greenhouse gas responsible for the greatest contribution to global warming.

B Sulfur hexafluoride is the most potent of the listed greenhouse gases but contributed to global warming by less than 0.1% of the contribution of carbon dioxide.

C The contribution of nitrous oxide emissions to global warming was just over one third of the contribution from methane emissions.

D The contribution to global warming of 18 tonnes of sulfur hexafluoride emissions was equivalent to a little over 27 tonnes of nitrogen trifluoride emissions.

27 Which statement helps to explain the role of mangrove forests in mitigating the impact of climate change?

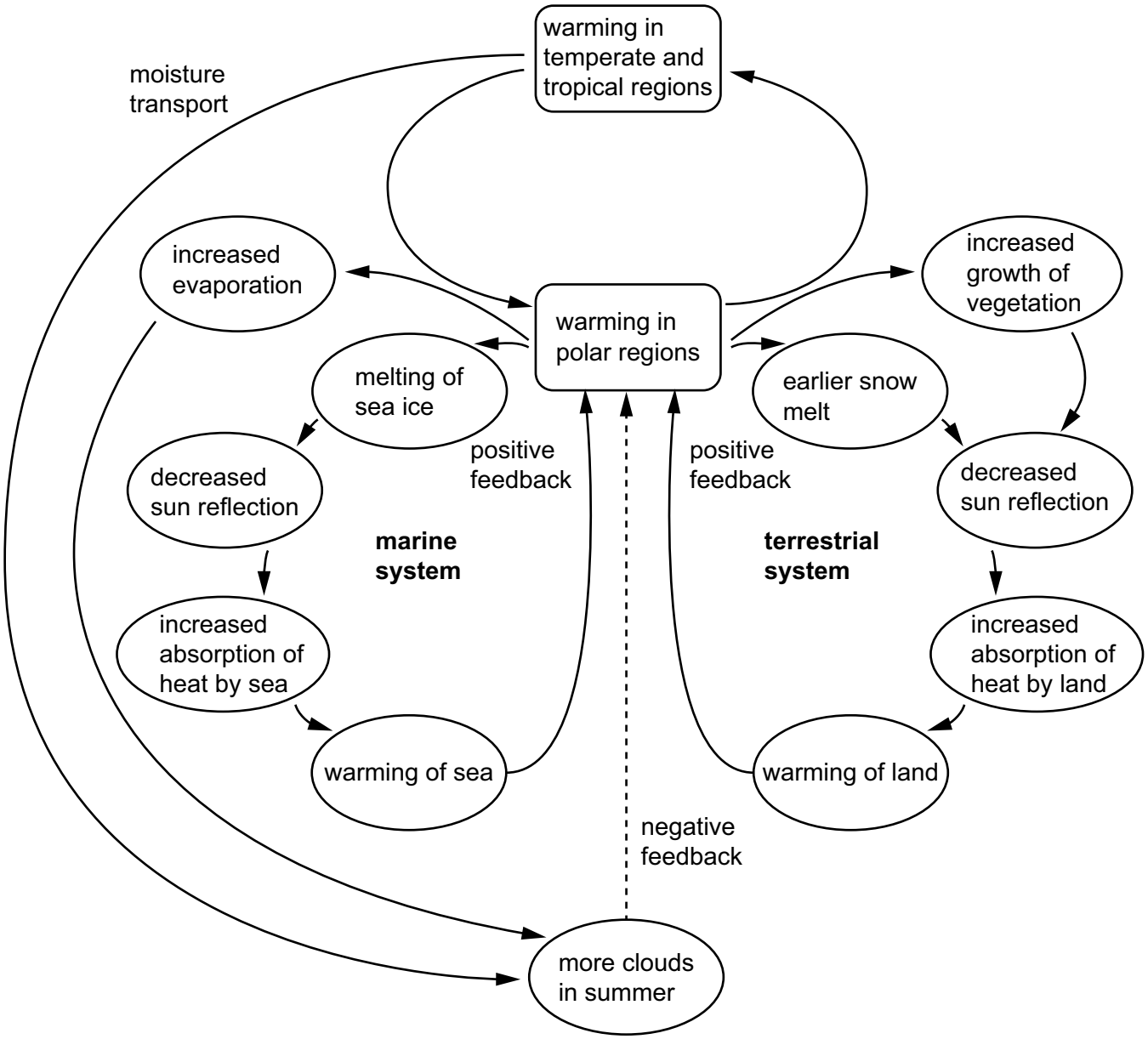
A Mangrove roots form a dense mass that slows the flow of water, causing suspended organic material to settle out and become trapped in oxygen-poor sediments that limit further decomposition.

B The roots of mangrove trees absorb organic carbon from sediments and store it in their cell walls in biomolecules such as lignin and cellulose that are highly resistant to chemical breakdown.

C When the leaves of mangroves die and fall, they are carried quickly to the sea where the carbon fixed in photosynthesis is trapped in deep ocean sediments before it can be released in the process of decomposition.

D Mangrove forests provide a buffer zone between the sea and land which reduces the rate at which sea levels can rise as a result of the melting of the polar ice caps and retreat of glaciers to higher altitudes.

28 The diagram shows some of the possible effects of global warming.



Which effect of warming in the polar regions could help to reduce global warming, according to this diagram?

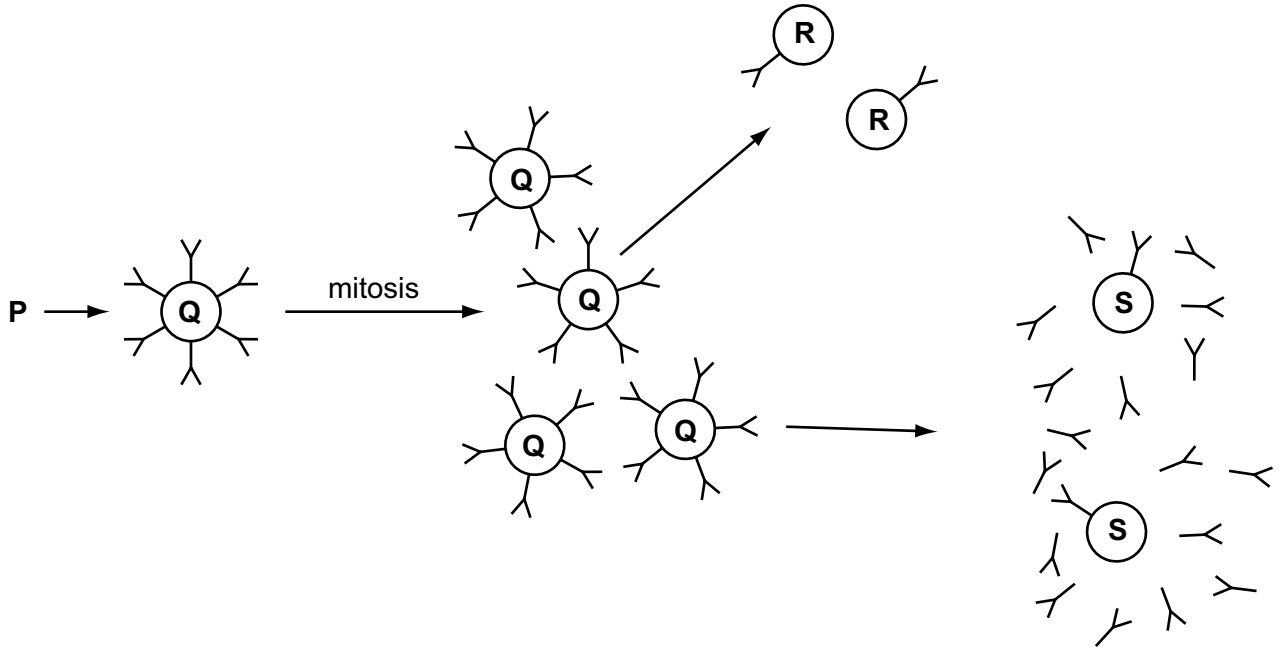
A increased moisture transport from tropical regions

B increased growth of vegetation

C melting of sea ice

D earlier snow melt

29 The diagram shows part of a primary immune response. Different types of cells together with antibodies and receptors are represented.



Which row shows possible identities for P, Q, R and S?

	P	Q	R	S
A	antigen	T lymphocyte	B lymphocyte	memory cell
B	T lymphocyte	B lymphocyte	memory cell	plasma cell
C	antigen-presenting cell	T lymphocyte	plasma cell	B lymphocyte
D	pathogen	B lymphocyte	T lymphocyte	plasma cell

30 The basic reproduction number, R_0, of a disease depends on a number of factors.

Which conditions are expected to lead to an increase in the R_0 number of viral dengue disease?

A migration of people from where the disease is frequent to an area that the disease does **not** occur

B increased travel between countries in which viral dengue disease is well established

C increased rainfall in an area where the disease is always present but occurs at a low frequency

D an increase in the incidence of the disease in a population where outbreaks of the disease are frequent

