

Helping you Achieve Highest Grades in IB

IB Biology SL

Question Paper

Fully in-lined with the First Teaching in 2023 & First
Assessment Examinations in 2025 & Beyond

Paper: 1 (Multiple Question Choices Across All Themes)

- Theme A: Unity & Diversity
- Theme B: Form & Function
- Theme C: Interaction & Interdependence
- Theme D: Continuity & Change

Marks: 269

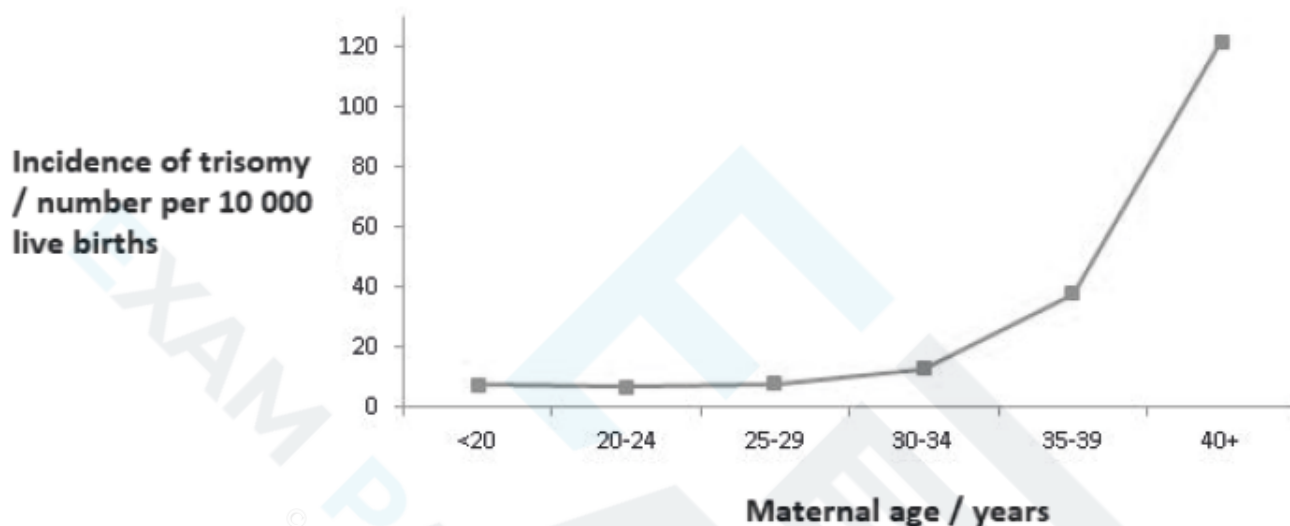
Total Marks: / 269

Suitable for Students sitting the 2026 exams onwards
However, students in HL might find it useful

Questions

19M.1A.SL.TZ2.13

The graph shows the incidence of trisomy resulting from non-disjunction in pregnancies at different maternal ages.



[Source: Center for Disease Control]

What can be inferred from the graph?

- A. The incidence of three copies of a chromosome increases directly in proportion with the age of the mother.
- B. The incidence of three sets of chromosomes increases from age 20.
- C. The incidence of three copies of a chromosome increases the most from age 35.
- D. The incidence of three sets of chromosomes increases the most from age 30.

[1]

23M.1A.SL.TZ1.26

What happens during blood clotting?

- A. A chain reaction causes platelets to release antibodies to avoid infections.
- B. Thrombin is converted into fibrinogen after a series of chemical reactions.
- C. Sealing of wounds by fibrinogen makes platelets release antibodies for clotting.
- D. Chemical reactions cause wounds to seal after platelets release clotting factors.

[1]

22M.1A.SL.TZ2.10

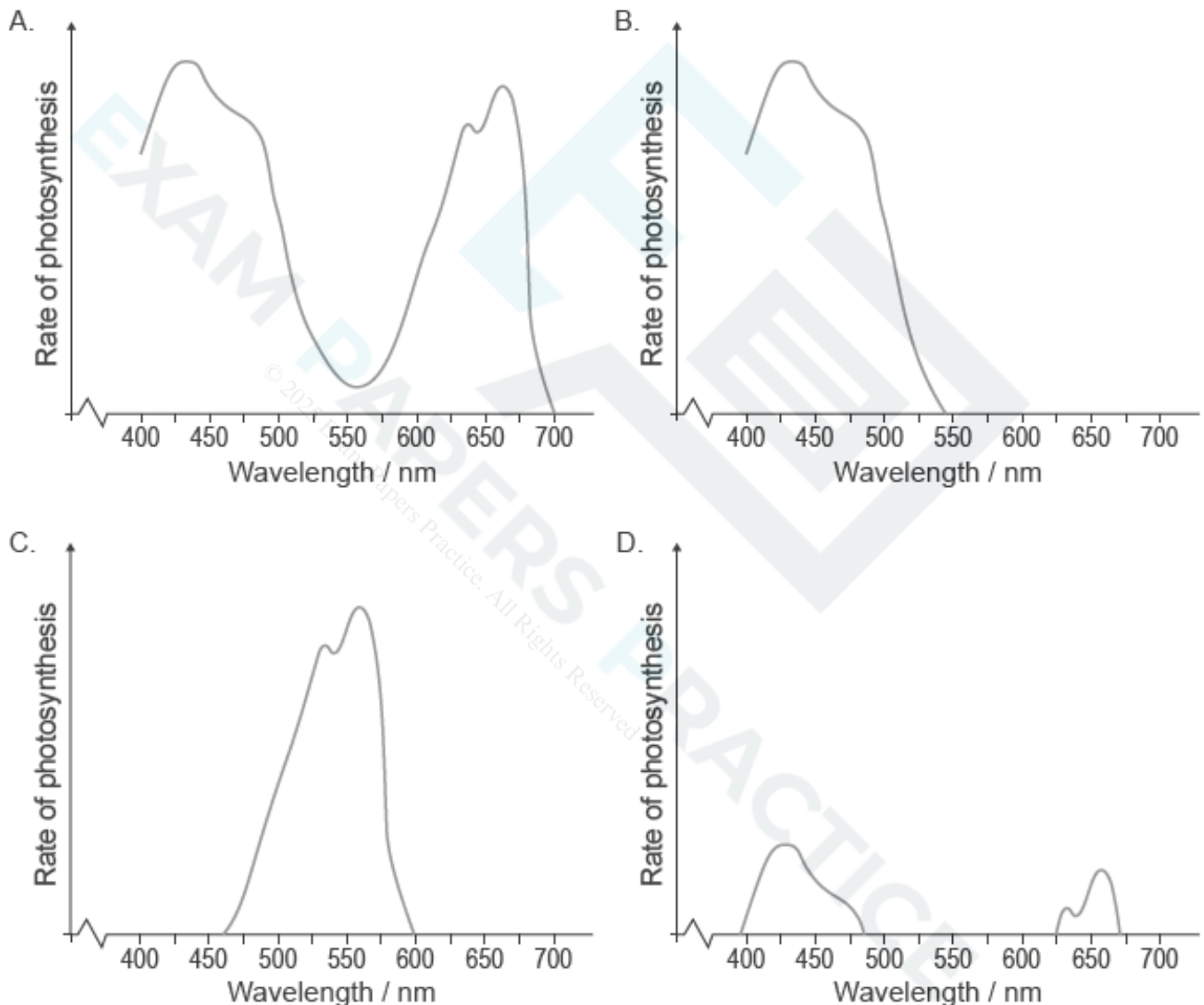
Where can the entire genome of an organism be found?

[1]

- A. In the **DNA** present in plasmids of a bacterial cell
- B. In the **DNA** present in the nucleus of a eukaryotic cell
- C. In the **DNA** present in the nucleus and chloroplasts of a plant cell
- D. In the **DNA** present in the nucleus and mitochondria of an animal cell

23M.1A.SL.TZ2.13

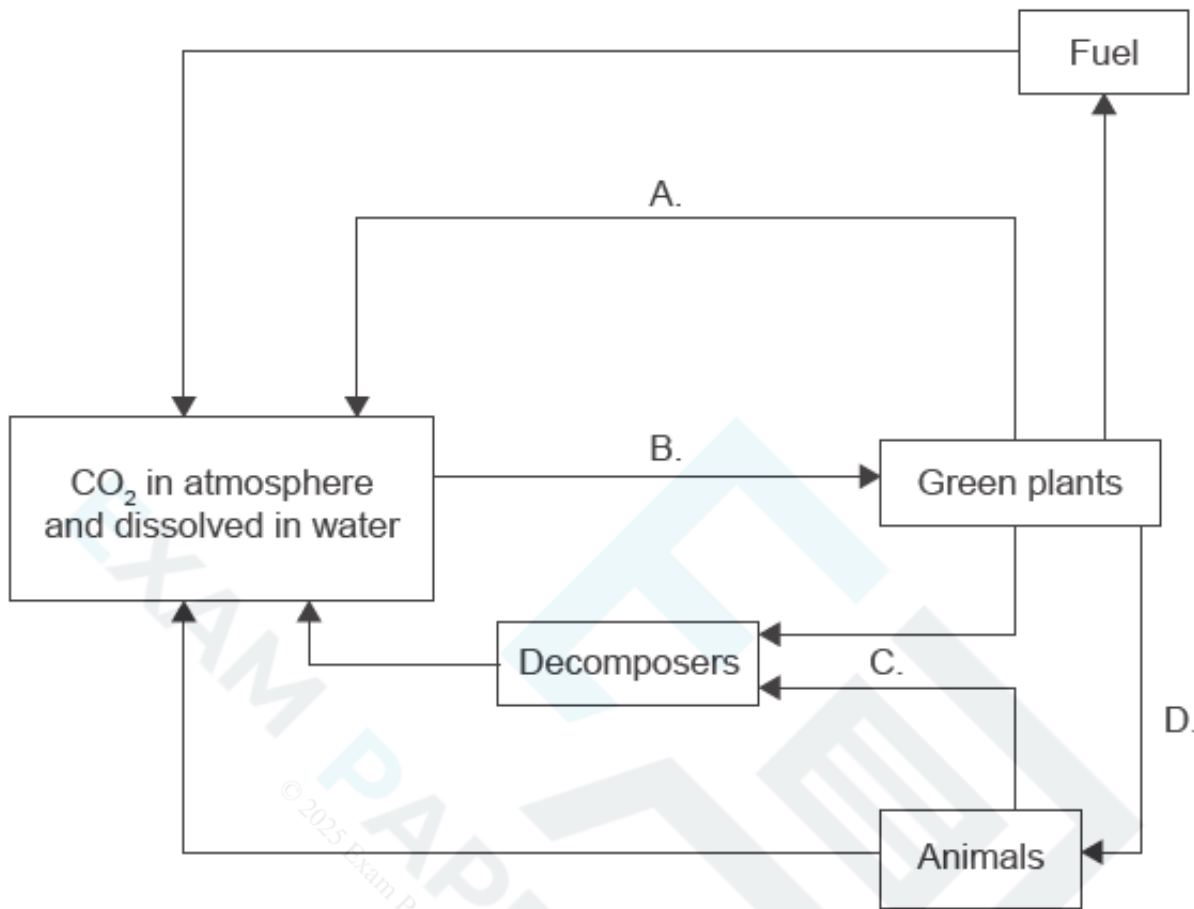
Which graph represents the action spectrum for a green plant receiving only blue light?



[1]

19N.1A.SL.TZ0.19

In the diagram, which of the processes labelled A to D transfers the largest mass of carbon per year in a woodland ecosystem?



[Source: © International Baccalaureate Organization 2019]

[1]

23M.1A.SL.TZ1.32

What is always needed for seed germination? [1]

- A. Light
- B. Oxygen
- C. Carbon dioxide
- D. Fertilizer

21N.1A.SL.TZ0.25

What occurs as a result of a cut in the skin of a finger? [1]

- A. Prothrombin is transformed into thrombin.
- B. Fibrin is converted to insoluble fibrinogen.
- C. Platelets produce antibodies to prevent infection.
- D. Clotting factors are released from red blood cells.

20N.1A.SL.TZ0.20

What process best explains the formation of different pentadactyl limbs? [1]

- A. Adaptive radiation
- B. Interbreeding
- C. Selective breeding
- D. Convergence

21N.1A.SL.TZ0.19

How do greenhouse gases contribute to global warming? [1]

- A. They destroy the ozone layer, allowing radiation to reach the Earth's surface.
- B. They prevent radiation from the Earth escaping into space.
- C. They trap short wavelength radiation in the atmosphere.
- D. They are a product of combustion, which generates heat.

19M.1A.SL.TZ2.17

The diagram shows a stage in cell division. [1]



[Source: © International Baccalaureate Organization 2019]

What is the stage shown?

- A. Anaphase I of mitosis
- B. Anaphase II of mitosis
- C. Anaphase I of meiosis
- D. Anaphase II of meiosis

22M.1A.SL.TZ1.7

What is a universal characteristic of the genetic code? [1]

- A. There are more than 64 different anticodons.
- B. There are more nucleotides than codons.
- C. There are more codons than amino acids.
- D. There are two or more amino acids for each codon.

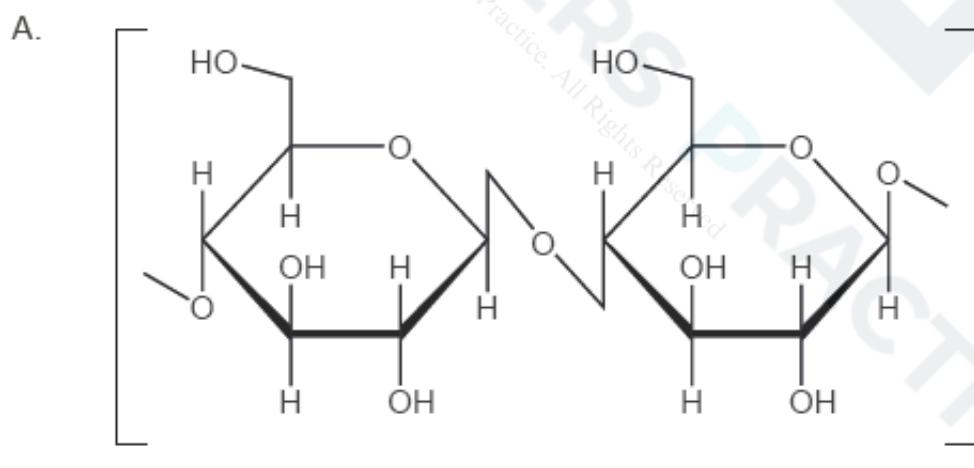
22M.1A.SL.TZ1.3

What is/are required for facilitated diffusion? [1]

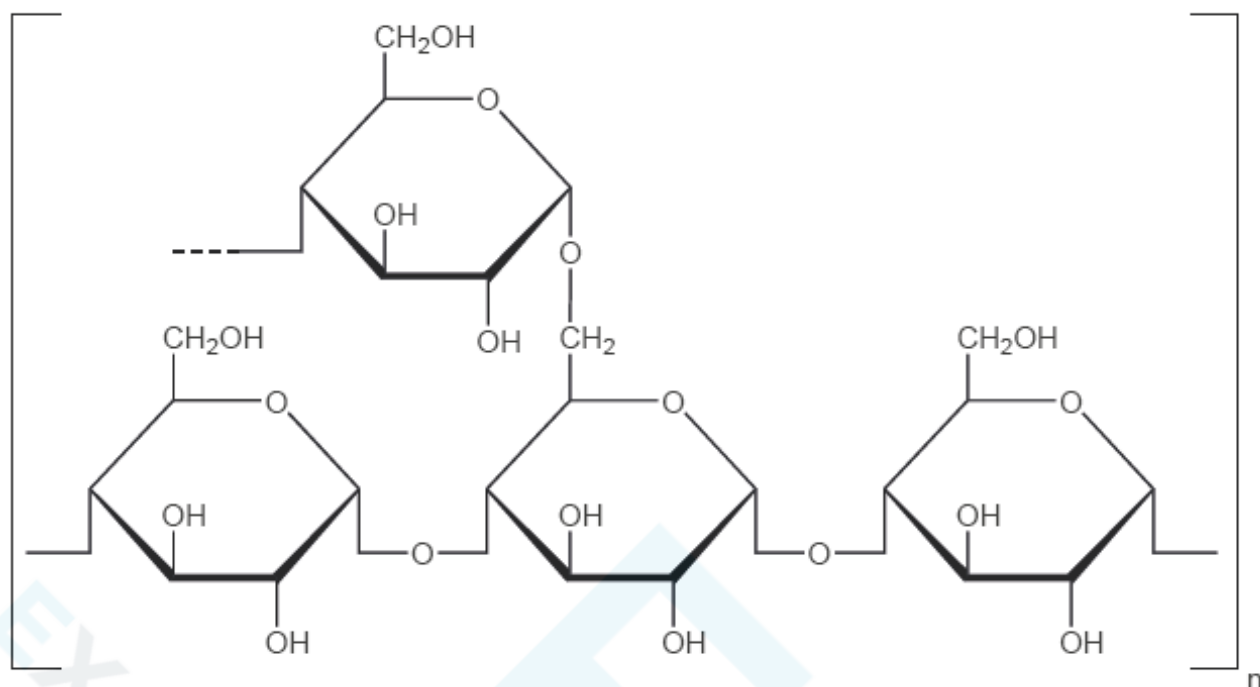
- I. A concentration gradient
 - II. ATP
 - III. A channel protein
- A. I only
B. I and III only
C. II and III only
D. I, II and III

23M.1A.SL.TZ1.7

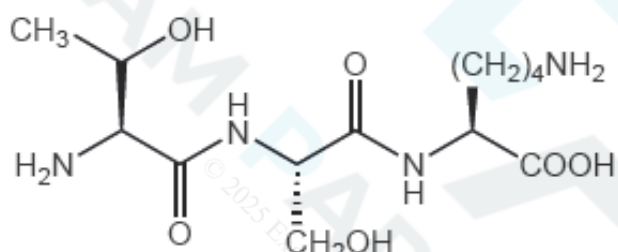
Which molecular diagram shows part of a cellulose molecule?



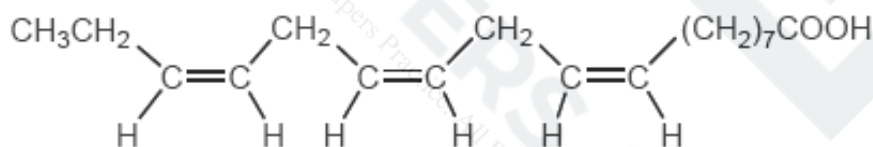
B.



C.



D.



[1]

23M.1A.SL.TZ2.5



The image shows a cell from the root tip of an onion (*Allium cepa*) ($2n = 16$) during late prophase of mitosis.



[Source: David Holt, M. Wyman, Molecular Expressions of Florida State University, <http://www.molecular-expressions.com/education/Allium%20Root%20Tip%20Mitosis.html>. [Accessed 7 October 2021]]

How many chromatids are present in the cell?

- A. 8
- B. 16
- C. 32
- D. 64

[1]

21M.1A.SL.TZ2.14

What feature of eukaryotic chromosomes distinguishes them from the chromosomes of prokaryotes?

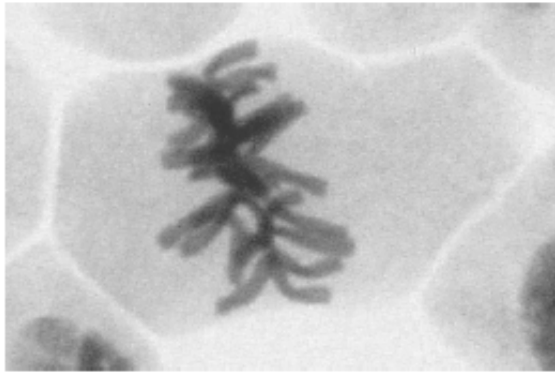
- A. Histone proteins
- B. Circular DNA
- C. Double-stranded DNA molecules
- D. Multiple genes along the length of each chromosome

[1]

19M.1A.SL.TZ2.3



The image shows a micrograph of a cell.



[Source: © 2014,

[https://commons.wikimedia.org/wiki/File:Mitosis_\(261_13\)_Pressed_root_meristem_of_in_prophase,_metaphase,_anaphase,_telophase\).jpg](https://commons.wikimedia.org/wiki/File:Mitosis_(261_13)_Pressed_root_meristem_of_in_prophase,_metaphase,_anaphase,_telophase).jpg) by Doc. RNDr. Josef Reischig

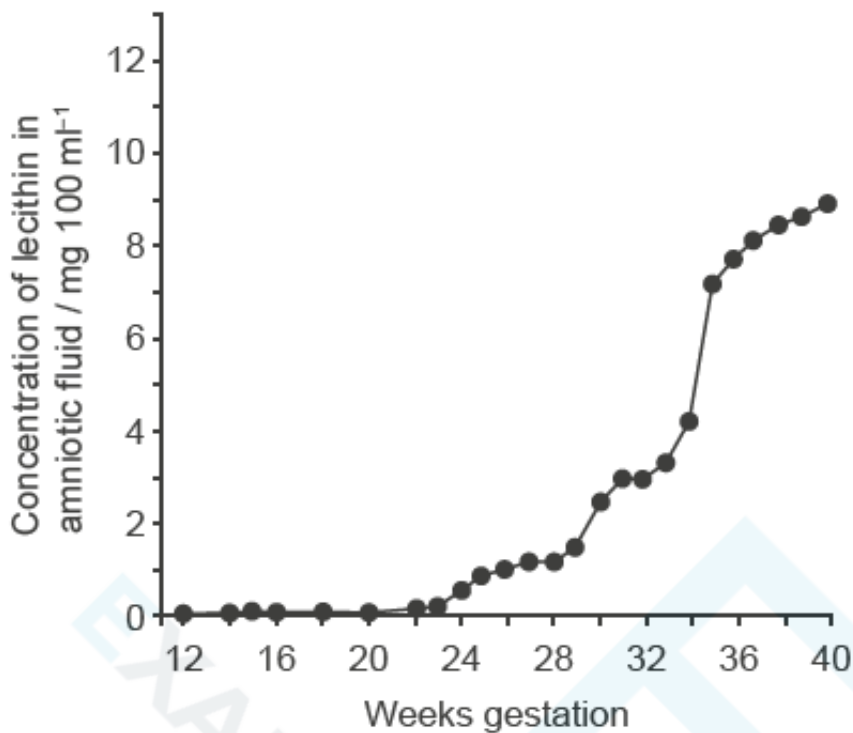
What explains the appearance of the cell in the micrograph?

- A. The cell is dying.
- B. The DNA is replicating.
- C. The cell is in metaphase.
- D. The cell is in telophase.

[1]

22N.1A.SL.TZ0.28

The graph shows the concentration of the lipid lecithin in the amniotic fluid surrounding the fetus during normal gestation. This lipid is produced in the lungs of the fetus and acts as a surfactant.



[Source: Gluck, L. and Kulovich, M., n.d. [*Concentrations of phospholipids*]. [graph online] Available at: <http://www.columbia.edu/itc/hs/medical/humandev/2004/Chpt12-LungDev.pdf> [Accessed 28 October 2021].]

What problem may occur in a baby born before 34 weeks gestation?

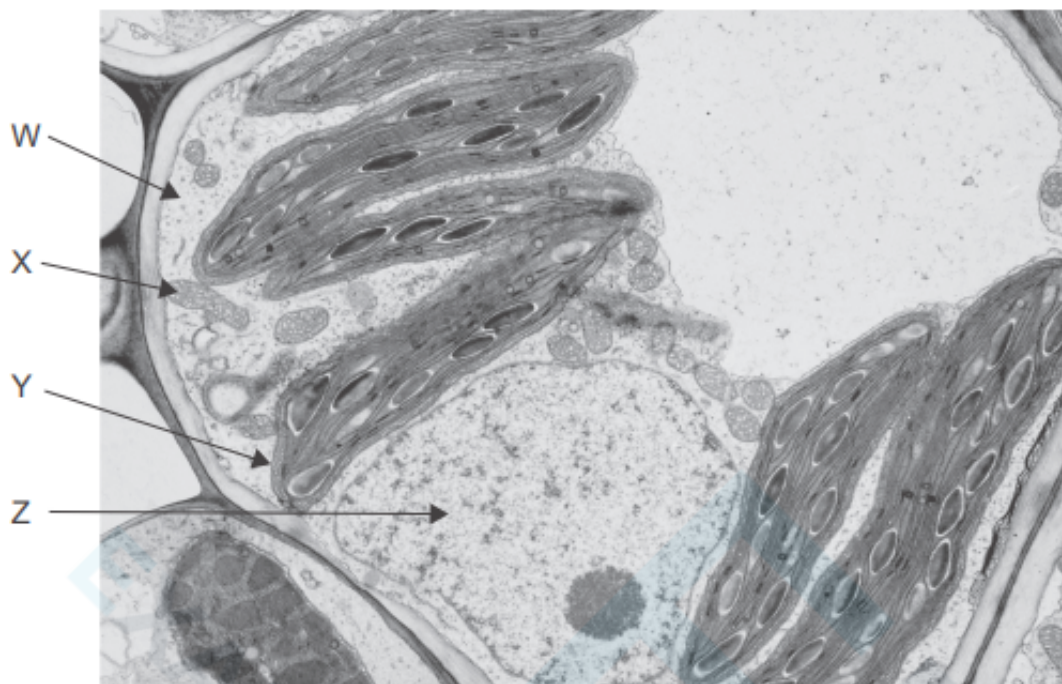
- A. Type I pneumocytes do not produce sufficient surfactant for lungs to inflate.
- B. There are no type II pneumocytes.
- C. The alveolar walls stick together.
- D. The alveoli are too large.

[1]

21M.1A.SL.TZ2.13

The electron micrograph shows a section through a plant cell.

[1]



[Source: Photo © E. Newcomb.]

In which structure(s) is the genome of the cell contained?

- A. Z only
- B. X, Y and Z only
- C. W and X only
- D. X and Y only

19N.1A.SL.TZ0.35

Which event happens in meiosis II but not in meiosis I? [1]

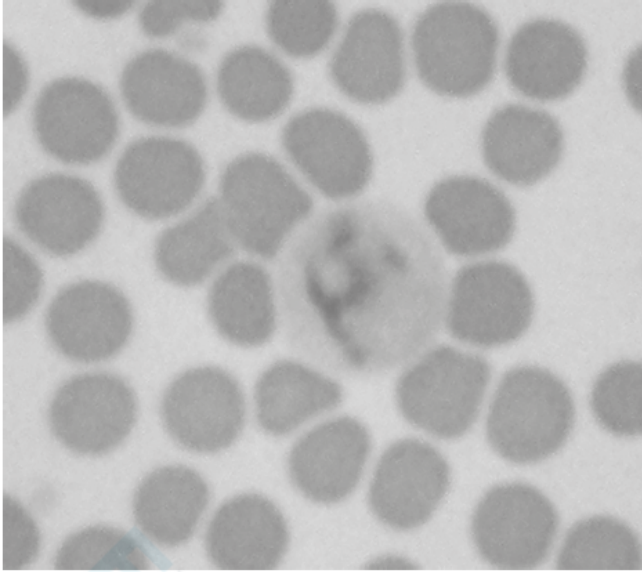
- A. Spindle microtubules attach to centromeres.
- B. Crossing over occurs.
- C. Sister chromatids move to opposite poles.
- D. Chromosomes become shorter and thicker by coiling.

23M.1A.SL.TZ1.1



The micrograph shows two types of blood cell.

[1]



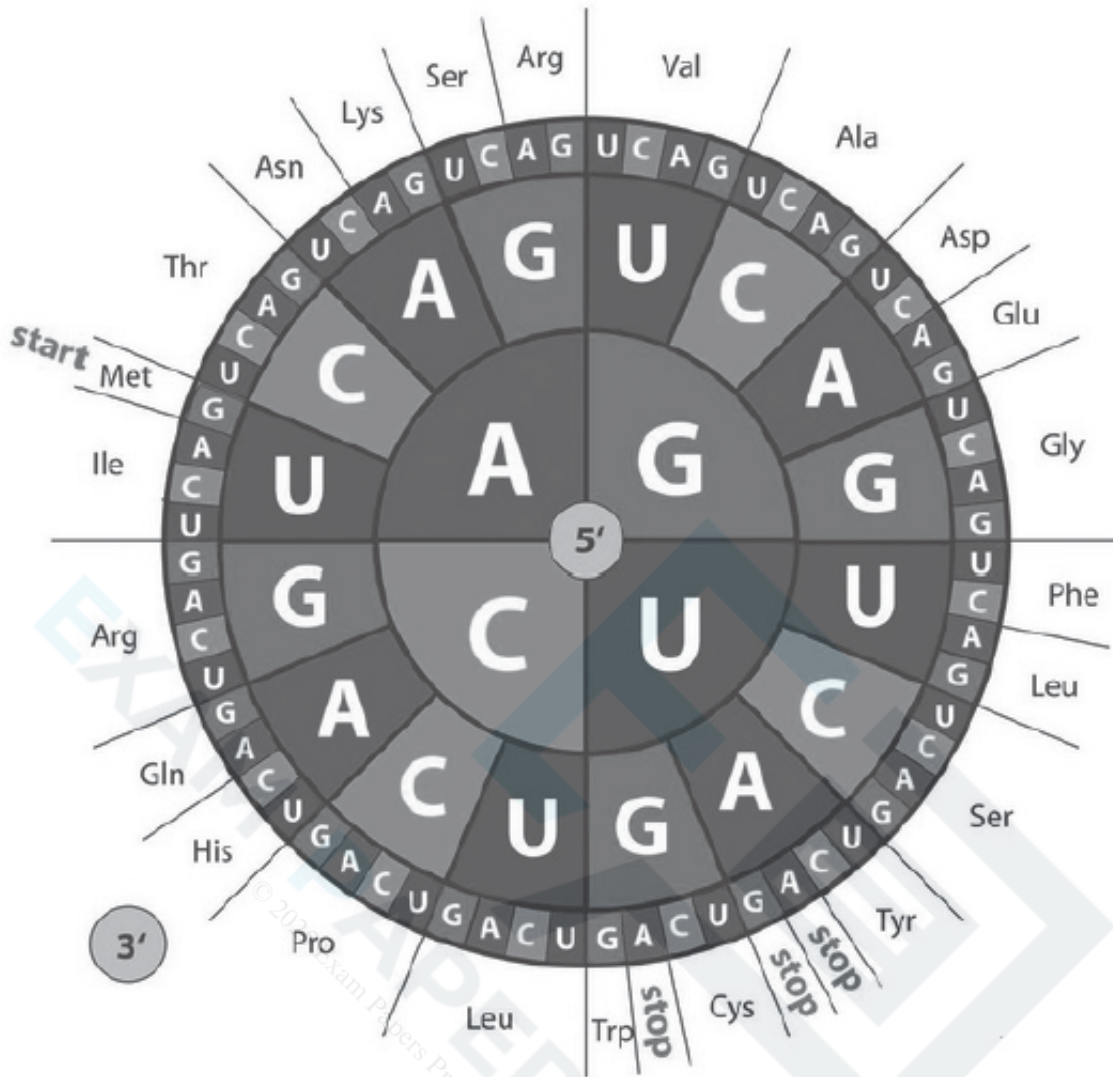
What determines the differences between the two types of cell?

- A. Different number of mitotic cycles
- B. Different expression of some genes
- C. Reaction to oxygen of red blood cells
- D. Reaction to antigens of white blood cells

19N.1A.SL.TZ0.7

The diagram shows mRNA codons.

[1]



[Source: elementix / Alamy Stock Photo]

The mRNA sequence UGGAACGUA codes for what amino acid sequence?

- A. Glycine-Glutamine-Methionine
- B. Methionine-Glutamine-Glycine
- C. Threonine-Valine-Histidine
- D. Tryptophan-Asparagine-Valine

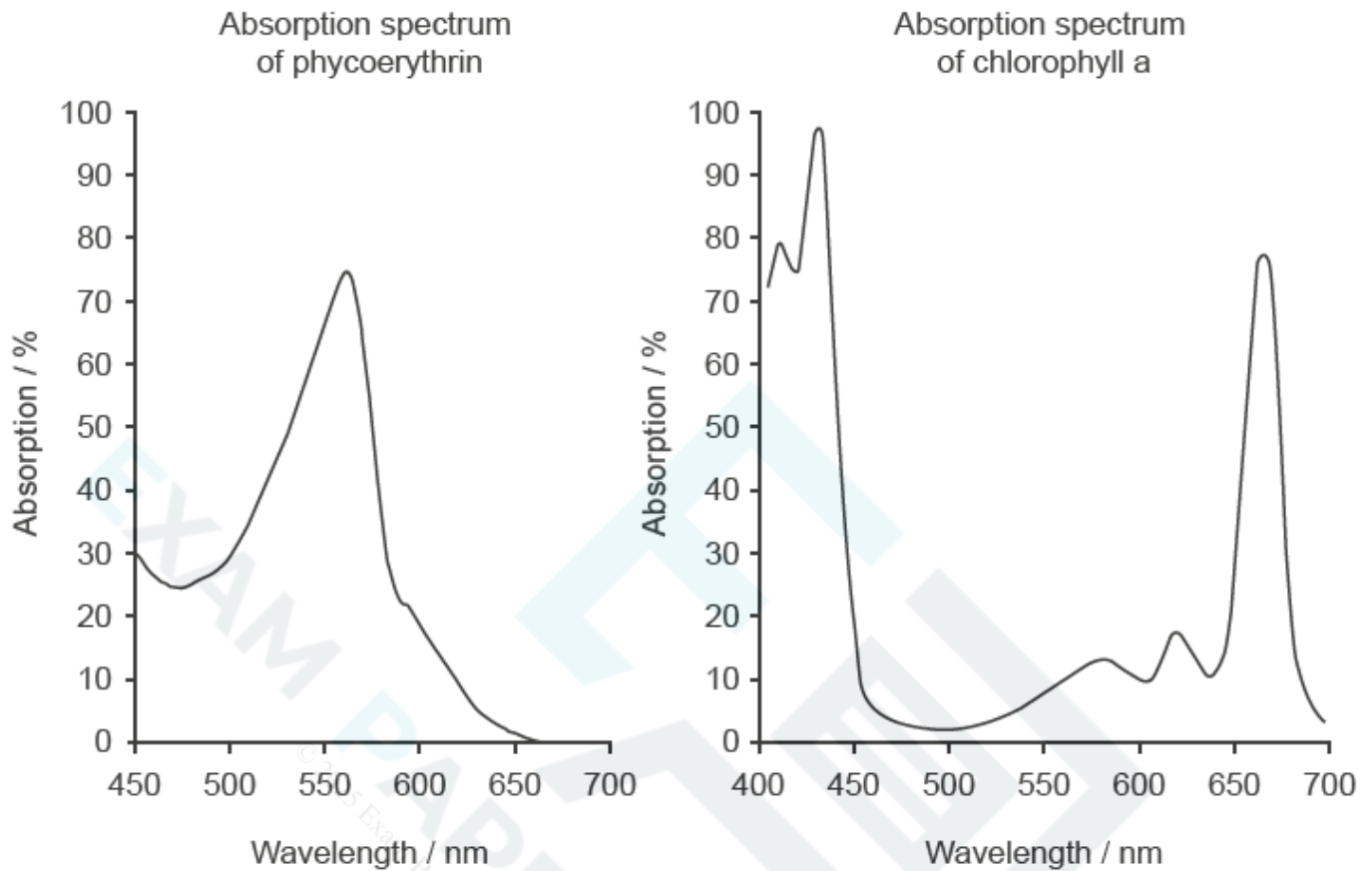
21N.1A.SL.TZ0.30

What is a function of luteinizing hormone (LH) in the female menstrual cycle? [1]

- A. To promote secondary sexual characteristics
- B. To inhibit progesterone secretion
- C. To stimulate the follicle to release estrogen
- D. To trigger ovulation

22N.1A.SL.TZ0.12

Absorption spectra of two photosynthetic pigments are shown. Phycoerythrin is a red pigment found in many marine red algae, while chlorophyll a is the major pigment in green plants and algae.



What do the absorption spectra show about the pigments?

- A. Phycoerythrin absorbs mostly red light.
- B. Chlorophyll a reflects more green light than phycoerythrin.
- C. Chlorophyll a photosynthesizes more at 550 nm than phycoerythrin.
- D. Phycoerythrin does not absorb blue light.

[1]

20N.1A.SL.TZ0.26

What is a feature of phagocytic white blood cells? [1]

- A. Stimulate blood clotting
- B. Found only in the circulatory system
- C. Form part of non-specific immunity
- D. Produce antibodies

20N.1A.SL.TZ0.1

Chlorella and *Paramecium* are both unicellular eukaryotic organisms living in freshwater. *Chlorella* is photosynthetic and has a cell wall. Which organelle will be found in *Paramecium* but not in *Chlorella*?

- A. Chloroplast
- B. Contractile vacuole
- C. Rough endoplasmic reticulum
- D. Mitochondrion

[1]

23M.1A.SL.TZ1.2

What is a difference between eukaryotic and prokaryotic cells? [1]

- A. Cell walls are found only in prokaryotes.
- B. Naked DNA with histones is found only in prokaryotes.
- C. Compartmentalization is found only in eukaryotes.
- D. Cilia and flagella are found only in prokaryotes.

21M.1A.SL.TZ2.6

Which process is an example of catabolism? [1]

- A. Translation of mRNA
- B. Replication of DNA
- C. Hydrolysis of protein
- D. Synthesis of a disaccharide

22M.1A.SL.TZ2.6

The diagram shows the structure of the protein CXCL12.



[Source: Lu, J., Chatterjee, M., Schmid, H. et al. CXCL14 as an emerging immune and inflammatory modulator.

J Inflamm 13, 1 (2016). <https://doi.org/10.1186/s12950-015-0109-9> Distributed under the terms of the

Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>).]

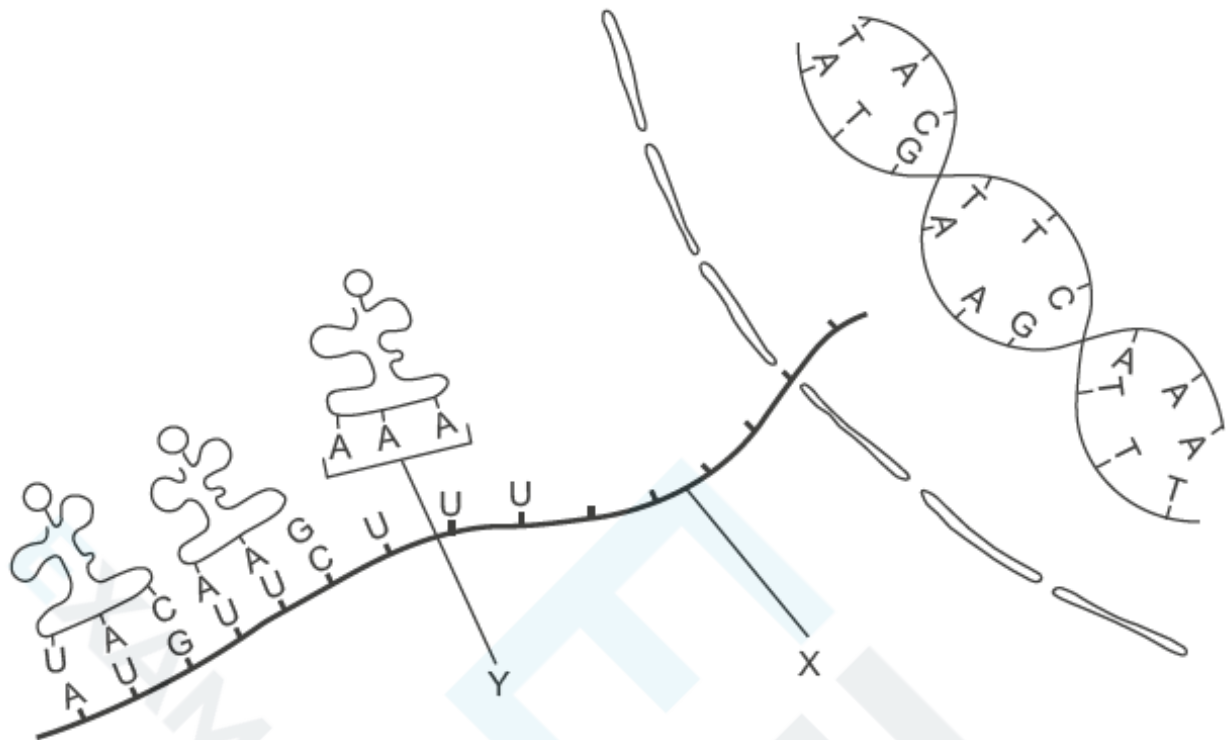
Which chemical group is found at X?

- A. NH_2
- B. NOH
- C. COH
- D. COOH

[1]

20N.1A.SL.TZ0.9

The diagram represents transcription and translation.



[Source: © International Baccalaureate Organization 2020.]

What structures do the letters X and Y represent?

	X	Y
A.	DNA	anticodon
B.	mRNA	anticodon
C.	DNA	codon
D.	mRNA	codon

[1]

21N.1A.SL.TZ0.27



What occurs during inhalation?

[1]

	External intercostal muscles	Movement of ribs
A.	relax	fall
B.	contract	fall
C.	relax	rise
D.	contract	rise

21N.1A.SL.TZ0.13

John Cairns used the technique of autoradiography to produce photographs of DNA from the bacterium *E. coli*.



[Source: © Cold Spring Harbor Laboratory Press. Autoradiography of bacterium *E. coli* DNA micrograph, *The Chromosome of Escherichia coli* Cairns, J.P., 1963. Cold Spring Harbor Symposia, *Quantitative Biology*, 28(44).]

Which conclusion was drawn from his experiments?

- A. The DNA in all organisms is circular.
- B. DNA in *E. coli* naturally contains thymidine.
- C. DNA replication is conservative.
- D. The DNA in *E. coli* is 900 μm in length.

[1]

SPM.1A.SL.TZ0.26



Which row of the table describes a type of nutrition?

	Type of nutrition	Source of energy	Source of carbon	Method of acquiring energy
A.	Autotrophic	sunlight	organic molecules containing carbon	respiration
B.	Heterotrophic	sunlight	carbon dioxide	photosynthesis
C.	Mixotrophic	sunlight and energy-rich organic molecules	carbon dioxide and organic molecules containing carbon	photosynthesis and ingestion
D.	Consumer	energy-rich organic molecules	organic molecules containing carbon	photosynthesis and respiration

[1]

21M.1A.SL.TZ2.15

A woman with blood type A has three children with a man who has blood type AB. The first child has blood type B. What is the probability that the second child born to the couple will have blood type AB?

- A. 0.75
- B. 0.50
- C. 0.25
- D. 0.00

[1]

23M.1A.SL.TZ2.15

The image shows a human karyogram.

[1]

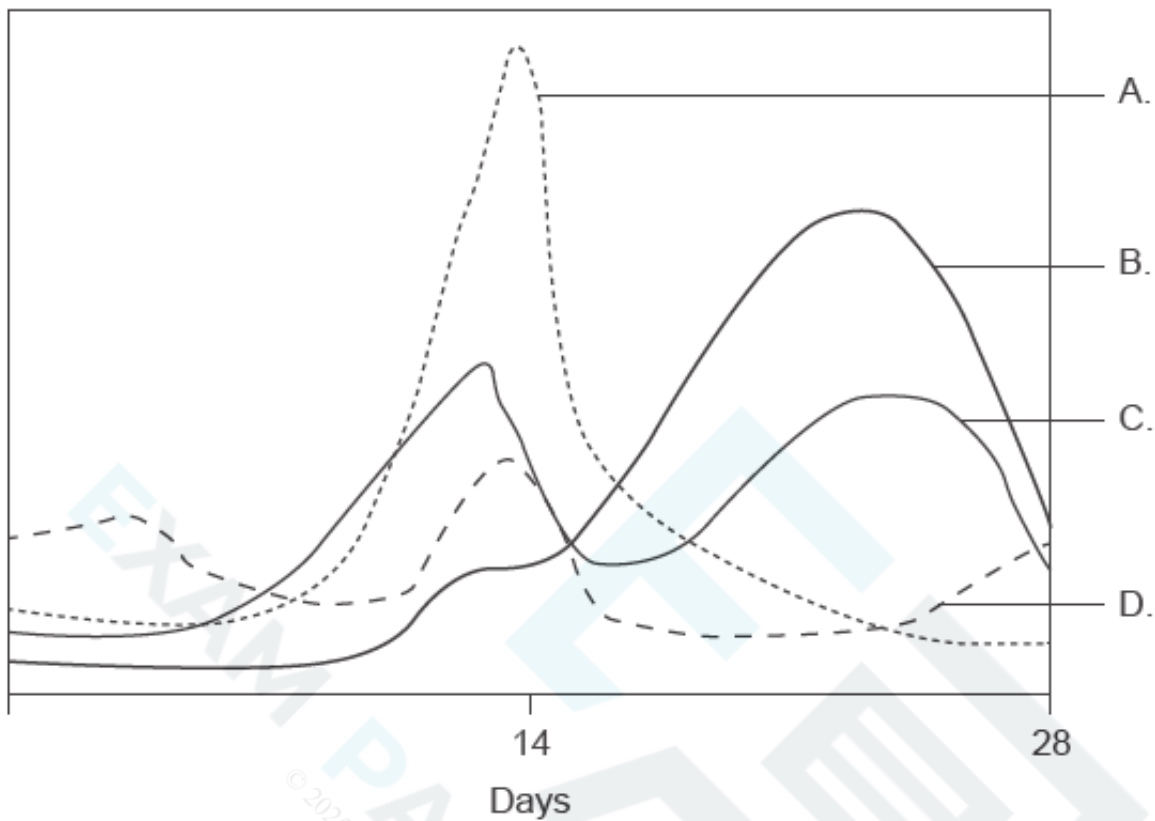


File:Karyotype (standard) https://www.exampaperspractice.co.uk/ Not a real karyotype. All rights reserved. From which person was the karyogram obtained?

- A. A female with Down syndrome
- B. A female without Down syndrome
- C. A male with Down syndrome
- D. A male without Down syndrome

19N.1A.SL.TZ0.30

On the graph, which curve represents the change in **FSH** levels during the menstrual cycle?



[1]

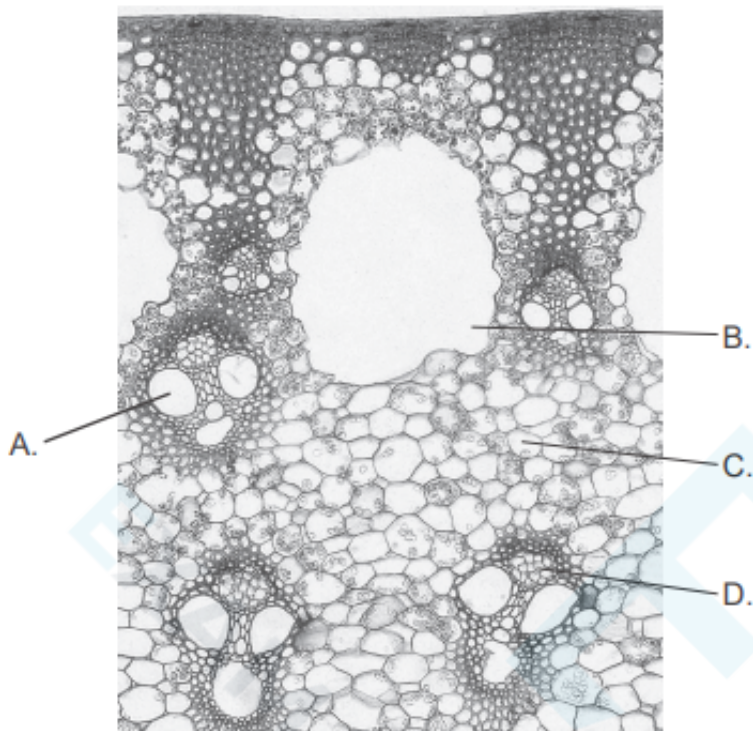
23M.1A.SL.TZ1.30

Which hormone helps control levels of glucose in blood? [1]

- A. Insulin secreted by the liver cells
- B. Thyroxine secreted by the thyroid gland
- C. Glucagon secreted by the α cells of the pancreas
- D. Melatonin secreted by the β cells of the pancreas

21M.1A.SL.TZ2.33

The image shows part of a section through the stem of a non-woody plant. Where does transport of sucrose occur?



[Source: Courtesy of Kelly Cude, PhD, Professor Biological Sciences, College of the Canyons.]

[1]

19M.1A.SL.TZ1.10

The gene that codes for a particular polypeptide includes the base sequence shown.

GAGTACCCT

What is the base sequence of the mRNA molecule which is complementary to this sequence?

- A. GAGTACCCT
- B. CTCATGGGA
- C. GUGTUCCCT
- D. CUCAUGGGA

[1]

19M.1A.SL.TZ2.20

What is required for natural selection to occur? [1]

- I. Acquired characteristics
- II. Advantageous characteristics
- III. Genetic variation

- A. I only
- B. I and III only
- C. II and III only
- D. I, II and III

21M.1A.SL.TZ1.30

Which reaction occurs in blood clotting? [1]

- A. $\text{fibrinogen} \xrightarrow{\text{thrombin}} \text{fibrin}$
- B. $\text{fibrin} \xrightarrow{\text{platelets}} \text{fibrinogen}$
- C. $\text{thrombin} \xrightarrow{\text{fibrin}} \text{fibrinogen}$
- D. $\text{platelets} \xrightarrow{\text{fibrinogen}} \text{fibrin}$

23M.1A.SL.TZ1.15

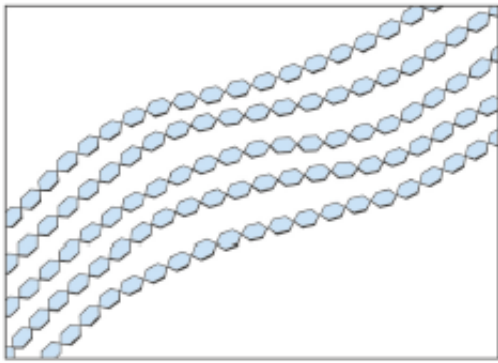
Non-disjunction of chromosome 21 causes trisomy. What can be said about the incidence of non-disjunction in chromosome 21?

- A. It increases greatly with maternal age after 30 years.
- B. Chromosome 21 always suffers non-disjunction.
- C. Very young mothers have no chance of non-disjunction.
- D. There is no relation between age and the probability of non-disjunction.

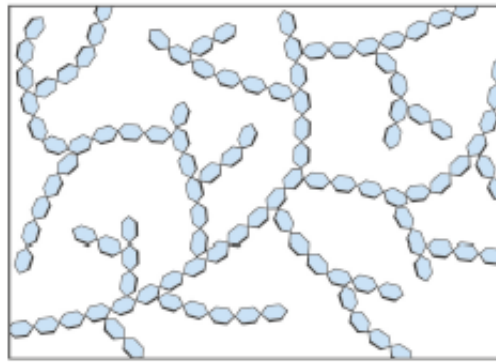
[1]

21N.1A.SL.TZ1.9

The diagrams show how monosaccharide molecules are joined to form chains in two polysaccharides.



P



Q

[Source: Amelse, J. Achieving Net Zero Carbon Dioxide by Sequestering Biomass Carbon. *Preprints* 2020, 2020070576

(doi: 10.20944/preprints202007.0576.v1). Fig S19. Distributed under a Creative Commons CC BY license Attribution

4.0 International (CC BY 4.0), <https://creativecommons.org/licenses/by/4.0/> .]

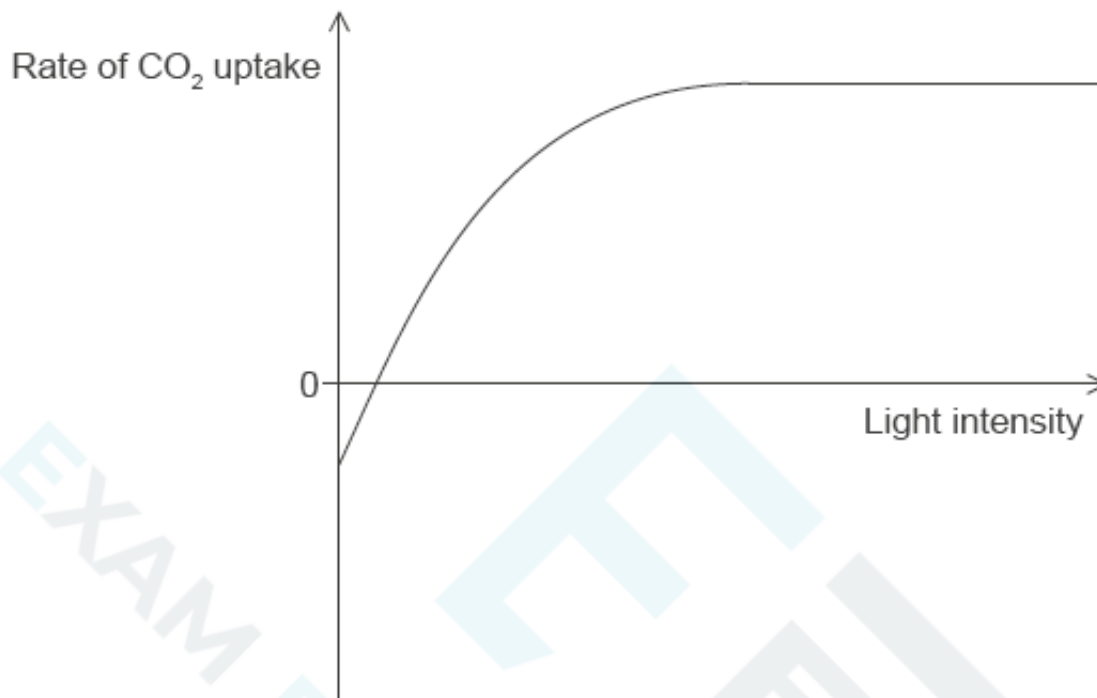
Using the diagram and the table, which diagram and monosaccharide represent glycogen?

	Diagram	Monosaccharide that makes up the chain
A.	P	glucose
B.	P	maltose
C.	Q	glucose
D.	Q	maltose

[1]

19M.1A.SL.TZ1.12

The graph shows the effect of increasing light intensity on the rate of CO_2 uptake by a species of green plant maintained in conditions of constant temperature and CO_2 concentration.



[Source: © International Baccalaureate Organization 2019]

Which statement is consistent with the graph?

- A. Photosynthesis stops at high light intensity.
- B. Rates of photosynthesis increase with temperature.
- C. Cell respiration leads to net production of CO_2 at low light intensity.
- D. There is a negative correlation between CO_2 uptake and light intensity.

[1]

20N.1A.SL.TZ0.27

Which are two proteins that assist in the unwinding and separation of DNA strands during replication?

- A. Helicase and DNA polymerase III
- B. DNA gyrase and DNA polymerase I
- C. Helicase and DNA primase
- D. Single-strand binding protein and DNA gyrase

[1]

23M.1A.SL.TZ1.13

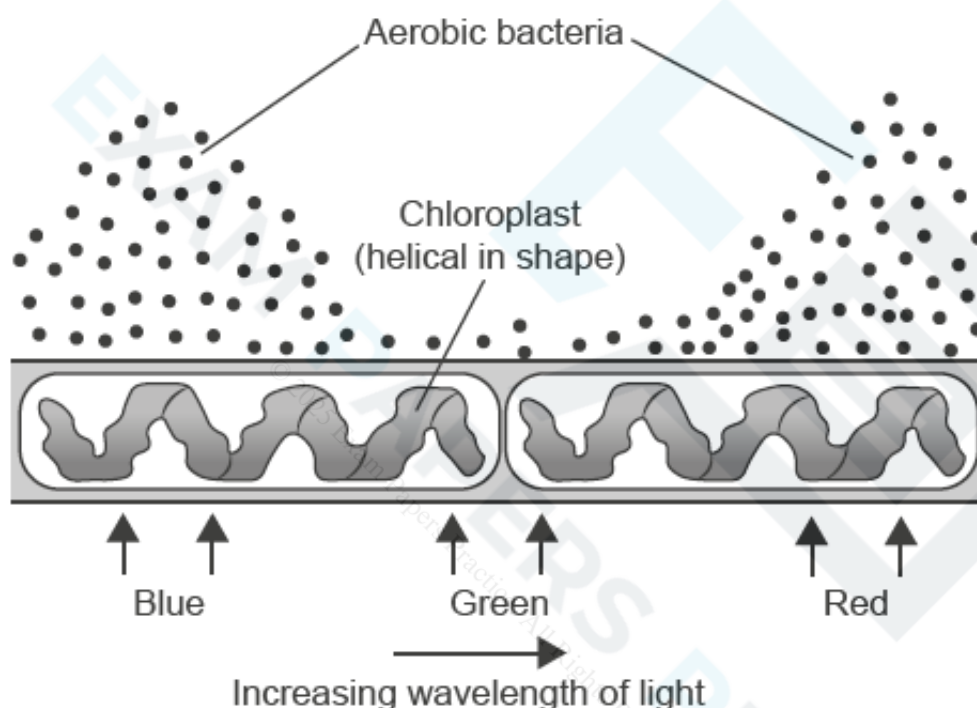
What is a consequence of anaerobic cell respiration in muscles?

[1]

- A. Large yield of readily available ATP and ethanol production
- B. Small yield of readily available ATP and lactate accumulation
- C. Large yield of ATP and production of carbon dioxide and lactic acid
- D. Small yield of ATP that is not readily available and carbon dioxide production

21N.1A.SL.TZ1.8

In 1882, Engelmann investigated photosynthesis by shining light of varying wavelength on a green alga. He observed where aerobic bacteria accumulated.



[Source: Republished with permission of Oxford University Press, from *Plant Physiology and Development*, *Sixth Edition* by Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy, 2015. Permission conveyed through Copyright Clearance Center, Inc.]

What can be deduced from this experiment?

- A. Only parts of the chloroplast contained chlorophyll.
- B. The distribution of bacteria indicates the action spectrum of photosynthesis.
- C. Most oxygen is released from the algae in green light.
- D. Chloroplasts reflect blue and red light.

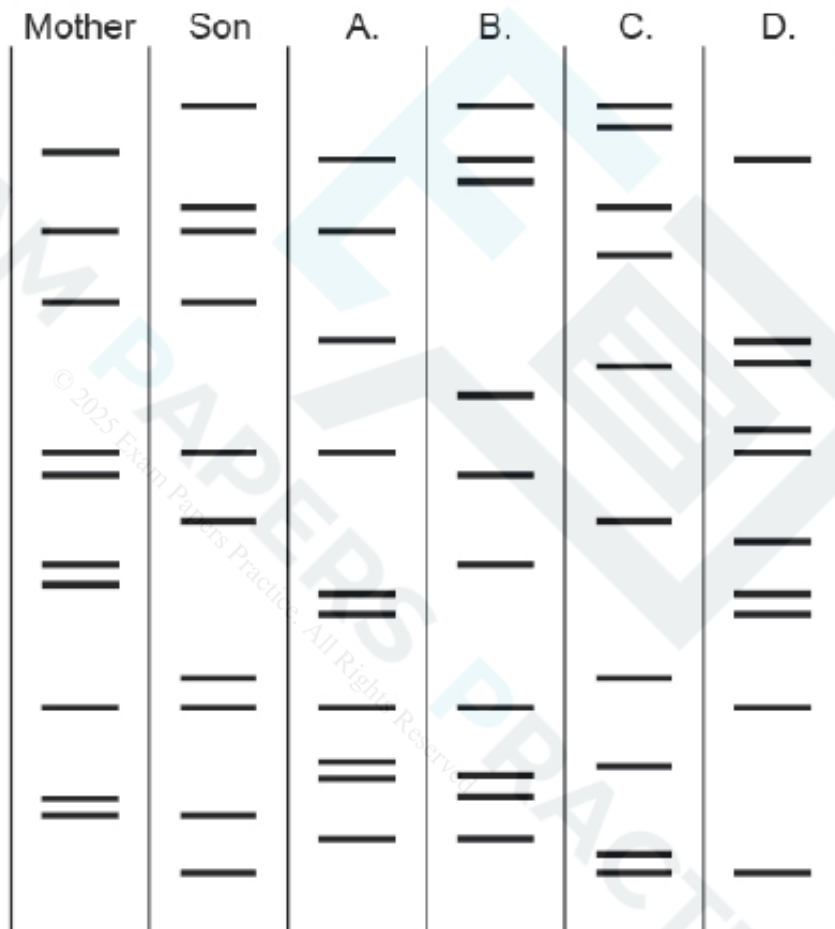
[1]

22M.1A.SL.TZ1.12

- Which process occurs in meiosis but not in mitosis? [1]
- A. Attachment of spindle fibres to the centromeres of each chromosome
 - B. Movement of homologous chromosomes to opposite ends
 - C. Replication of DNA prior to the start of cell division
 - D. Separation of sister chromatids during anaphase

21N.1A.SL.TZ0.16

The image shows the result of DNA profiling of a mother, a child and four men. Which man is most probably the father of the child?

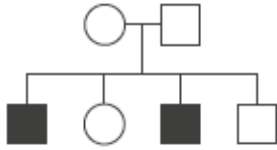


[1]

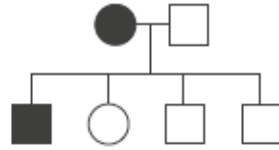
19M.1A.SL.TZ1.16

Which pedigree chart is consistent with the inheritance of red-green colour blindness?

A.



B.



Key:

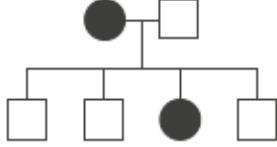
○ normal-vision female

□ normal-vision male

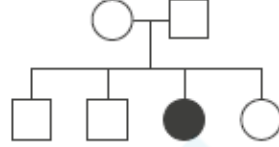
● colour-blind female

■ colour-blind male

C.



D.



[Source: © International Baccalaureate Organization 2019]

[1]

19M.1A.SL.TZ2.21

If seeds of an unknown species of plant are discovered, what assumption can be made about the species?

- A. Its male gametes are contained within pollen.
- B. Its seeds are contained within fruits.
- C. It is in the domain archaea.
- D. It is in the phylum angiospermophyta.

[1]

22N.1A.SL.TZ0.3

What would happen if the unicellular organism was placed in a solution slightly less concentrated than the cytoplasm of the cell, rather than in distilled water?

- A. The cell would become larger.
- B. More water would be expelled from the cell.
- C. X would fill more slowly.
- D. X would not appear.

[1]

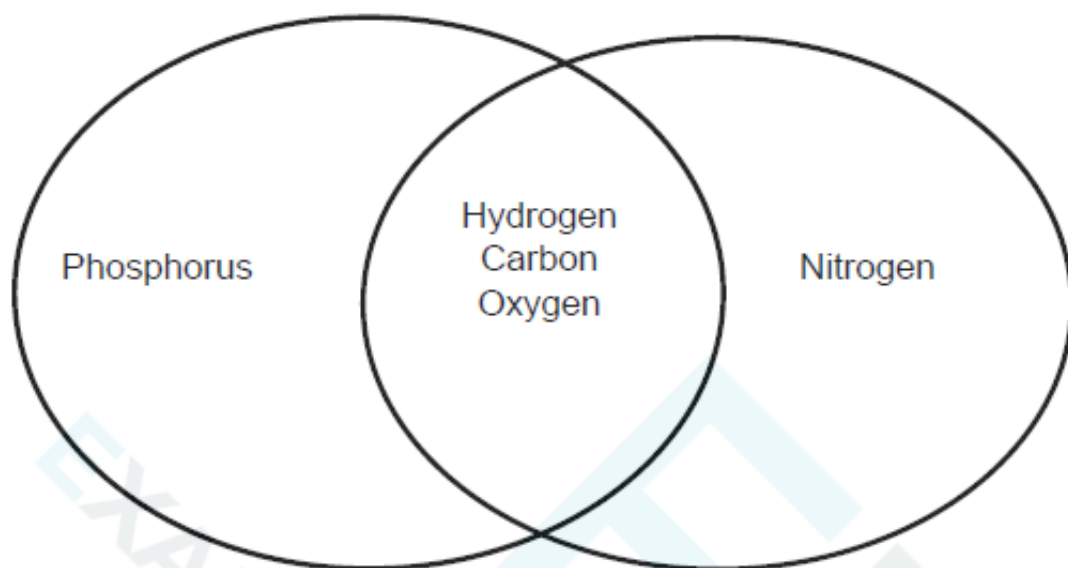
SPM.1A.SL.TZ0.1



The diagram shows the elements present in two organic molecules, W and X. [1]
Which molecules could W and X be?

Molecule W

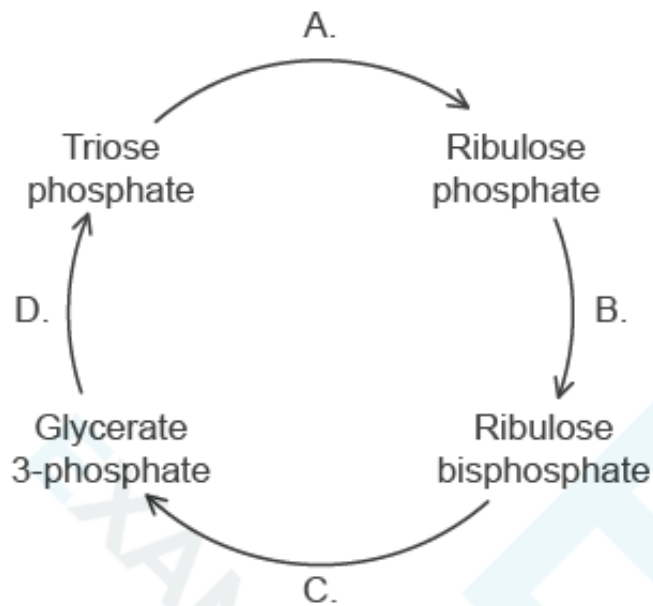
Molecule X



	Molecule W	Molecule X
A.	monosaccharide	amino acid
B.	nucleic acid	triglyceride
C.	phospholipid	protein
D.	triglyceride	fatty acid

21N.1A.SL.TZ1.31

The diagram shows some of the intermediate compounds produced during the Calvin cycle. At what stage does carboxylation take place?



[1]

21M.1A.SL.TZ1.8

What distinguishes cellulose from glycogen and starch?

- A. Only cellulose is found in plants.
- B. Only cellulose is made up of glucose monomers.
- C. Cellulose is far more branched than starch and glycogen.
- D. Cellulose has a structural role whereas starch and glycogen function in energy storage.

[1]

21M.1A.SL.TZ2.10

What is a feature of the human genome? [1]

- A. Plasmids
- B. Messenger RNA
- C. Transfer RNA
- D. Mitochondrial DNA

SPM.1A.SL.TZ0.14

What is a function of histones?

[1]

- A. Supercoiling of **DNA** during binary fission in prokaryotes
- B. Synthesis of proteins
- C. Formation of microtubules during mitosis
- D. Condensation of **DNA**

21M.1A.SL.TZ1.19

An individual was presented with a stimulus resulting in the release of epinephrine. What was the most likely nature of the stimulus?

- A. Sunset and the onset of darkness
- B. An image of a close friend
- C. The intake of glucose
- D. A coach shouting to begin physical activity

[1]

22M.1A.SL.TZ2.15

The table shows features of greenhouse gases in the atmosphere.

Greenhouse gas	Concentration / ppm	Average lifespan / years
Carbon dioxide	397.00	50–200
Methane	1.79	12
Nitrous oxides	0.30	114
CFCs	0.00	100

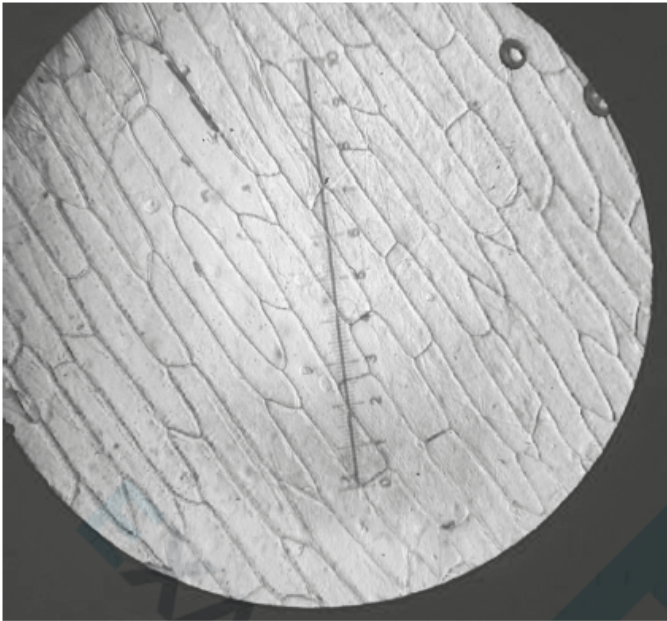
According to the data in the table, which greenhouse gas contributes the most to climate change?

- A. Carbon dioxide because it is the most abundant greenhouse gas
- B. Methane because it has the shortest lifespan
- C. Nitrous oxides because they absorb the greatest amount of shortwave radiation
- D. CFCs because they destroy the ozone layer

[1]

23M.1A.SL.TZ1.4

Onion (*Allium cepa*) epidermis was placed in pure water and observed with a light microscope using high magnification.



What would happen to these cells if they were transferred to a hypertonic solution?

- A. Cells would gain mass.
- B. Cells would take in water by osmosis and swell.
- C. Cells would burst open, releasing their content.
- D. Cell membranes would detach from walls at some points.

[1]

22N.1A.SL.TZ0.18

A self-sustaining system is set up in a sterile, sealed, transparent glass bottle with damp, sterilized soil and a small garden plant. If the system remains sterile, what could be the reason that the plant fails to grow and dies?

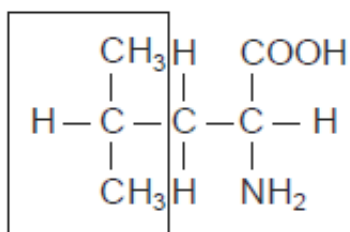
- A. Lack of soil nutrients
- B. Lack of oxygen
- C. Lack of space
- D. Lack of water

[1]

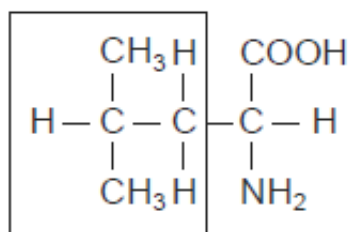
SPM.1A.SL.TZ0.4

The diagrams show the structure of leucine, an essential amino acid. Which diagram highlights the part of leucine that distinguishes it from other amino acids?

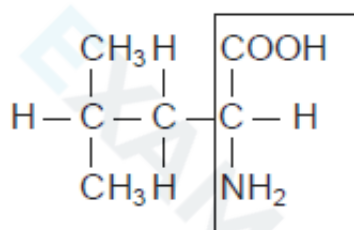
A.



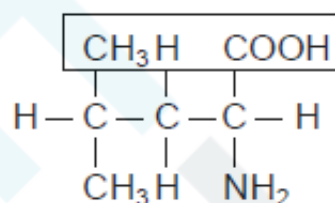
B.



C.



D.



[1]

SPM.1A.SL.TZ0.6

What distinguishes aerobic respiration from anaerobic respiration in humans? [1]

- A. Mitochondria are only used in anaerobic respiration.
- B. Aerobic respiration yields lower quantities of ATP.
- C. Only aerobic respiration can use glucose as a starting substrate.
- D. Only aerobic respiration produces carbon dioxide.

22M.1A.SL.TZ1.26



What is a method of transmission of **HIV** and its effect on the immune system?

	Method of transmission	Effect on the immune system
A.	Breastfeeding	Decrease in number of active lymphocytes
B.	Blood transfusion	Overall, a general increase in antibody production
C.	Waterborne	Overall, a general reduction in antibody production
D.	Mosquito bites	Increase in number of active lymphocytes

[1]

SPM.1A.SL.TZ0.28

Black walnut (*Juglans nigra*) secretes the chemical juglone into the soil surrounding its roots. Juglone inhibits cell respiration in other species of plants. What does this example illustrate?

- A. Mutualism
- B. Intraspecific competition
- C. Allelopathy
- D. Parasitism

[1]

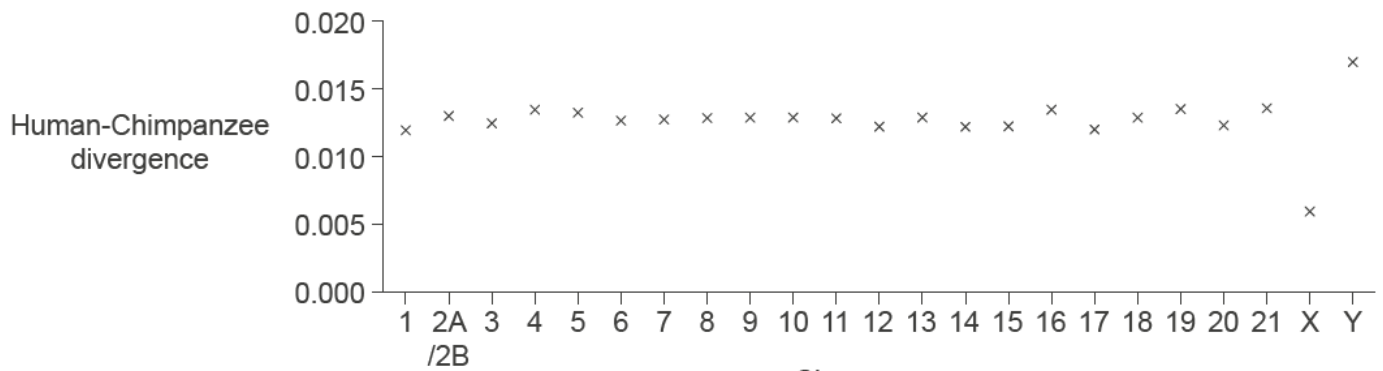
21M.1A.SL.TZ2.27

Which is an adaptation to increase rates of gas exchange in the lung? [1]

- A. Small surface area
- B. Dry surface
- C. High vascularization
- D. Muscular alveoli

23M.1A.SL.TZ1.14

Scientists sequenced the genes in each chromosome of chimpanzees (*Pan troglodytes*) and humans (*Homo sapiens*). The graph shows the mean divergence between the genes of these species by chromosome.



(Source: Material from Human Genome Project, 2005. Material reproduced with permission of SNE SC)

What can be deduced from this data?

- A. Autosomes are more similar than Y chromosomes.
- B. There is the same number of chromosomes in humans and chimpanzees.
- C. Humans are more closely related to chimpanzees than to other species.
- D. Smaller chromosomes are more similar than larger chromosomes.

[1]

19N.1A.SL.TZ0.10

Which statements are characteristics of alleles?

[1]

- I. Alleles differ significantly in number of base pairs.
- II. Alleles are specific forms of a gene.
- III. New alleles are formed by mutation.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

22M.1A.SL.TZ1.39



Glucose moves from the filtrate in the nephron into the bloodstream during normal kidney function. Which location and method describe this movement of glucose?

	Location	Method
A.	Glomerulus	Ultrafiltration
B.	Proximal convoluted tubule	Ultrafiltration
C.	Glomerulus	Active transport
D.	Proximal convoluted tubule	Active transport

[1]

22M.1A.SL.TZ1.17

What is a community?

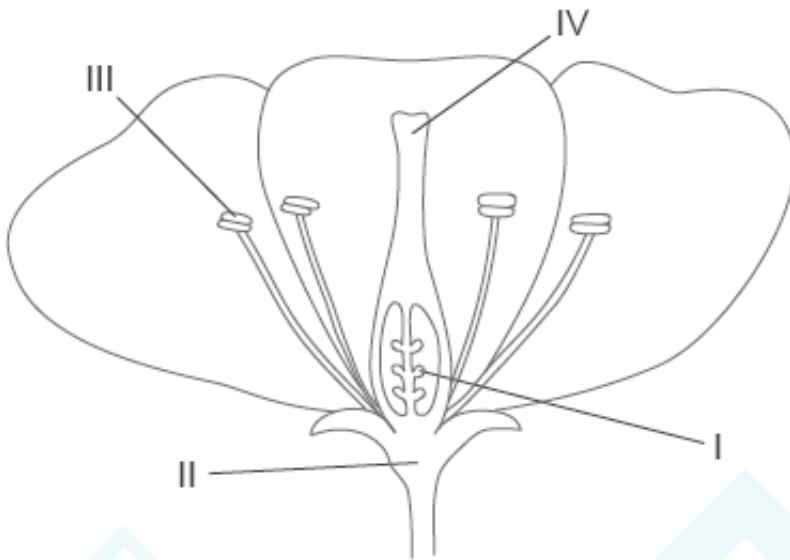
[1]

- A. A group of individuals of the same species in a given area
- B. A group of animals that interact socially
- C. A group of organisms interacting with the abiotic environment
- D. A group of populations interacting with each other within a given area

19M.1A.SL.TZ1.32

The image shows a cross-section of a flower.

[1]



[Source: © International Baccalaureate Organization 2019]

Where does production of haploid gametes occur?

- A. I and II only
- B. III and IV only
- C. I and III only
- D. II and IV only

23M.1A.SL.TZ1.11

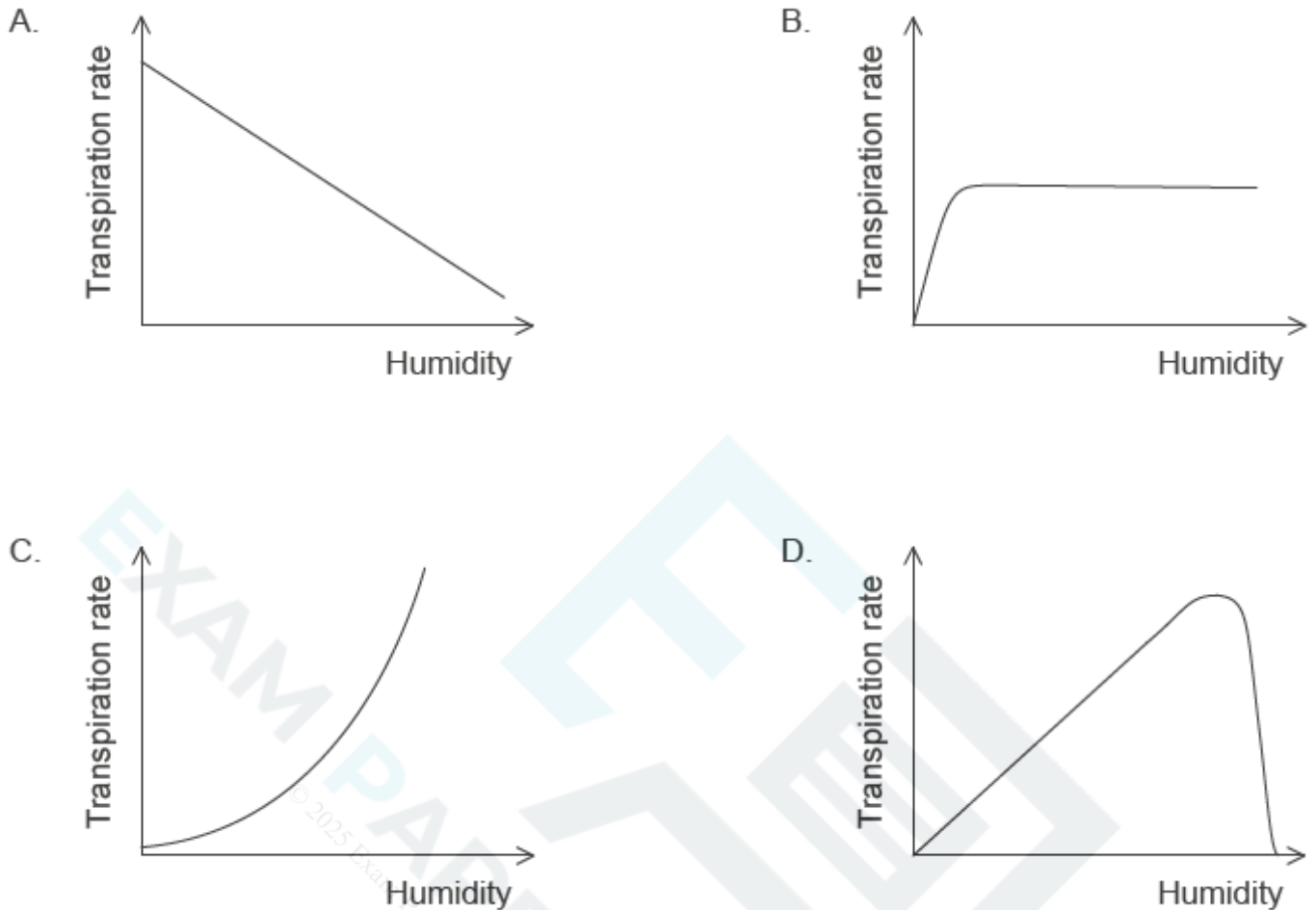
How do DNA and messenger RNA (mRNA) molecules differ in eukaryotes? [1]

- A. mRNA is twice the size of DNA and is formed from four different bases.
- B. DNA contains ribose while mRNA contains deoxyribose.
- C. mRNA has the same bases as DNA but contains ribose.
- D. DNA has two strands while mRNA has only one.

22M.1A.SL.TZ1.32



Which graph represents the effect of humidity on the transpiration rate in plants?



[1]

21M.1A.SL.TZ1.1

In mammals, mature red blood cells are specialized in that they lack nuclei, mitochondria or ribosomes. Which statement applies to red blood cells?

- A. No chemical reactions take place within their cytoplasm.
- B. They cannot produce new enzymes.
- C. Materials cannot enter red blood cells.
- D. Materials cannot exit red blood cells.

[1]

23M.1A.SL.TZ1.21

What happens during blood clotting?

- A. A chain reaction causes platelets to release antibodies to avoid infections.
- B. Thrombin is converted into fibrinogen after a series of chemical reactions.
- C. Sealing of wounds by fibrinogen makes platelets release antibodies for clotting.
- D. Chemical reactions cause wounds to seal after platelets release clotting factors.

[1]

22N.1A.SL.TZ0.14

Which event occurs in the first division of meiosis? [1]

- A. Synthesis of DNA
- B. Pulling apart of sister chromatids
- C. Halving of the chromosome number
- D. Division of centromeres

SPM.1A.SL.TZ0.18

What is always a consequence of the evaporation of water from mesophyll cells in leaves of a healthy plant?

- A. Plasmolysis occurs in mesophyll cells.
- B. Photosynthesis stops.
- C. Stomata close to reduce transpiration.
- D. Water moves up the stem in the xylem.

[1]

19N.1A.SL.TZ0.34

A pollen tube grows down the style to an egg inside the ovary of a flower. What is the next process that occurs?

- A. Dispersal
- B. Fertilization
- C. Germination
- D. Pollination

[1]

19N.1A.SL.TZ0.32

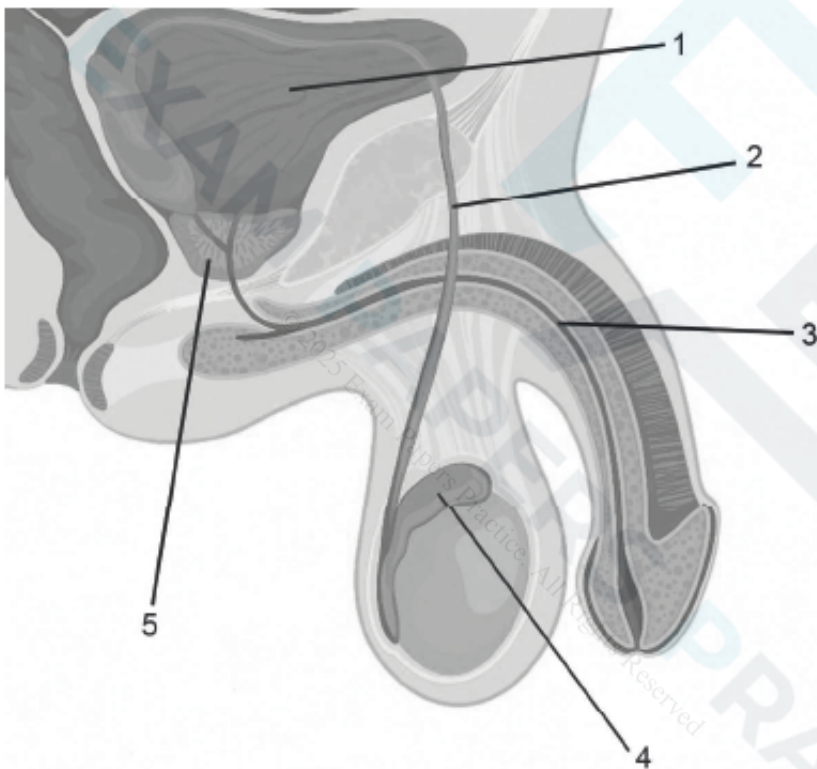
Which process is most responsible for movement of water from roots to leaves of a plant on a hot sunny day?

- A. Active translocation of mineral ions in roots
- B. Active transport of organic compounds into sieve tubes
- C. Raised hydrostatic pressure gradients
- D. Evaporation of water from mesophyll cell walls

[1]

19M.1A.SL.TZ2.31

The diagram shows the human male reproductive system.



[Source: logika600/Shutterstock]

Which numbers indicate a gland providing fluid for sperm and a tube that transports sperm only?

	Gland providing fluid for sperm	Tube transporting sperm only
A.	1	2
B.	5	3
C.	4	3
D.	5	2

[1]

21M.1A.SL.TZ1.11

What is a difference between aerobic respiration and anaerobic respiration in yeast?

- A. Anaerobic respiration requires enzymes, aerobic respiration does not.
- B. Anaerobic respiration requires glucose, aerobic respiration does not.
- C. Anaerobic respiration produces ethanol, aerobic respiration does not.
- D. Anaerobic respiration does not produce oxygen, aerobic respiration does.

[1]

23M.1A.SL.TZ2.9

The anticodons of three tRNAs and the amino acids they carry are shown in the table.

tRNA anticodon	Amino acid
GCA	Arginine
AAU	Leucine
CAG	Valine

Which base sequence of an mRNA molecule would code for an arginine-leucine-valine tripeptide?

- A. GCA AAU CAG
- B. GCA AAT CAG
- C. CGT TTA GTC
- D. CGU UUA GUC

[1]

19N.1A.SL.TZ0.20

What material is formed when organic matter is not fully decomposed in acidic waterlogged soils?

- A. Coal
- B. Hydrogen
- C. Oil
- D. Peat

[1]

23M.1A.SL.TZ1.20

Which characteristic of the subclavian vein distinguishes it from the subclavian artery?

- A. Larger lumen
- B. Absence of valves
- C. Presence of pores
- D. Two layers of muscle

[1]

22M.1A.SL.TZ1.1

[1]

	Cell I	Cell II
Ribosomes	✓	✓
Nucleus	X	✓
Cell wall	✓	✓
Cytoplasm	✓	✓
Cell respiration	✓	✓
Ability to photosynthesize	✓	X

Which deduction is supported by this information?

- A. Both cells are from plants.
B. Cell I is more complex than cell II.
C. Cell II is an animal cell.
D. Cell I is prokaryotic.

21N.1A.SL.TZ0.10

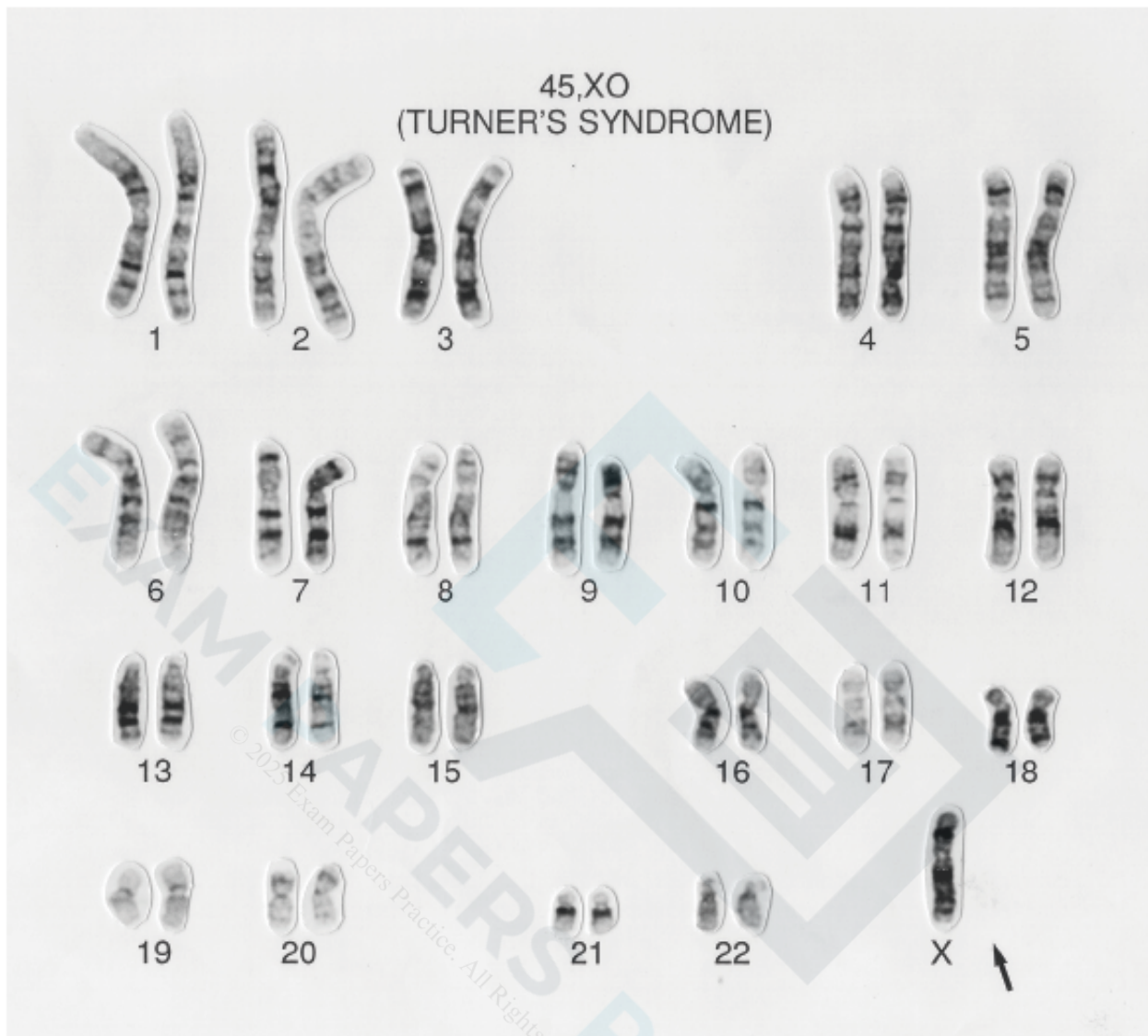
What is the correct arrangement for the components of one strand in a **DNA** molecule?

- A. — phosphate — deoxyribose — base — phosphate — deoxyribose — base —
- B. — base — deoxyribose — base — deoxyribose — base — deoxyribose —
| | |
phosphate phosphate phosphate
- C. — phosphate — deoxyribose — phosphate — deoxyribose — phosphate — deoxyribose —
| | |
base base base
- D. — phosphate — base — phosphate — base — phosphate — base —
| | |
deoxyribose deoxyribose deoxyribose

[1]

20N.1A.SL.TZ0.13

Testing the chromosomes of a girl with Turner syndrome produced the following karyogram.



[Source: Turner's syndrome karyotype 45,XO. This female lacks the second X chromosome present in the

normal karyotype. Symptoms include short stature, neck webbing, elbow deformity, widely spaced nipples with shield chest, primary amenorrhea, sexual infantilism and sterility. The ovaries are reduced to fibrous streaks. Also known as XO syndrome or ovarian short-stature syndrome. Credit: Wessex Reg. Genetics Centre. Attribution 4.0 International (CC BY 4.0).]

The condition can result from non-disjunction occurring in anaphase I of meiosis in an egg cell. Two cells result from the first division, one of which would lead to Turner syndrome. Which chromosomes will be in the other cell (polar body) at the end of meiosis I?

- A. 44 autosomes and X
- B. 44 autosomes and XX
- C. 22 autosomes and X
- D. 22 autosomes and XX

22M.1A.SL.TZ2.25

Many blood-feeding insects inject an anticoagulant into their host in order to prevent blood from clotting. Female mosquitoes of the genus *Anopheles* inject the anticoagulant anophelin, which inhibits the action of the enzyme thrombin. Which statement explains how anophelin prevents blood clotting?

- A. Platelets are no longer produced.
- B. Platelets cannot produce fibrin.
- C. Fibrinogen is not converted to fibrin.
- D. Prothrombin is not converted to thrombin.

[1]

22N.1A.SL.TZ0.27

Despite continuous scientific research into the control of pathogens, it has proved very difficult to eliminate them. What is/are the reason(s) for this?

- I. Development of antibiotic resistance in viruses
 - II. Development of antibiotic resistance in bacteria
 - III. Mutations of pathogens
- A. II only
 - B. I and II only
 - C. II and III only
 - D. I, II and III

[1]

23M.1A.SL.TZ2.19

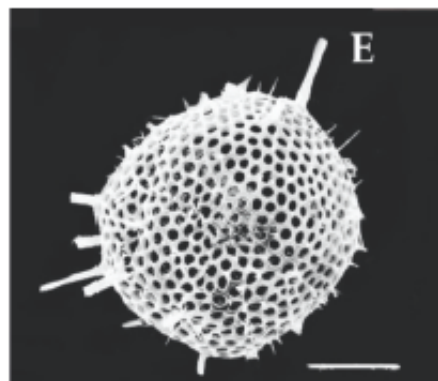
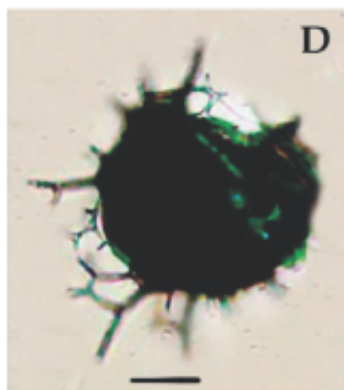
Which statement applies to transfers in an ecosystem?

- A. Green plants can transfer heat energy from the sun into chemical energy.
- B. The greatest loss of energy occurs towards the end of a food chain.
- C. Production of carbon dioxide by respiration results in loss of biomass in a food chain.
- D. Both energy and nutrients are finite and must be recycled.

[1]

22M.1A.SL.TZ2.2

The images of the radiolarian, a single-celled marine organism, were produced using a light microscope (left) and a scanning electron microscope (right).



[Source: Munir, S.; Sun, J.; Morton, S.L. The First Record and Classification of Planktonic Radiolarian

(*Phylum Retaria*) and Phaeodarian (*Phylum Cercozoa*) in the Eastern Indian Ocean. *Biology* 2021, 10, 202.

<https://doi.org/10.3390/biology10030202> Copyright: © 2021 by the authors. This article is an open access

article distributed under the terms and conditions of the Creative Commons

Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).]

What is a reason for the difference in quality of these images?

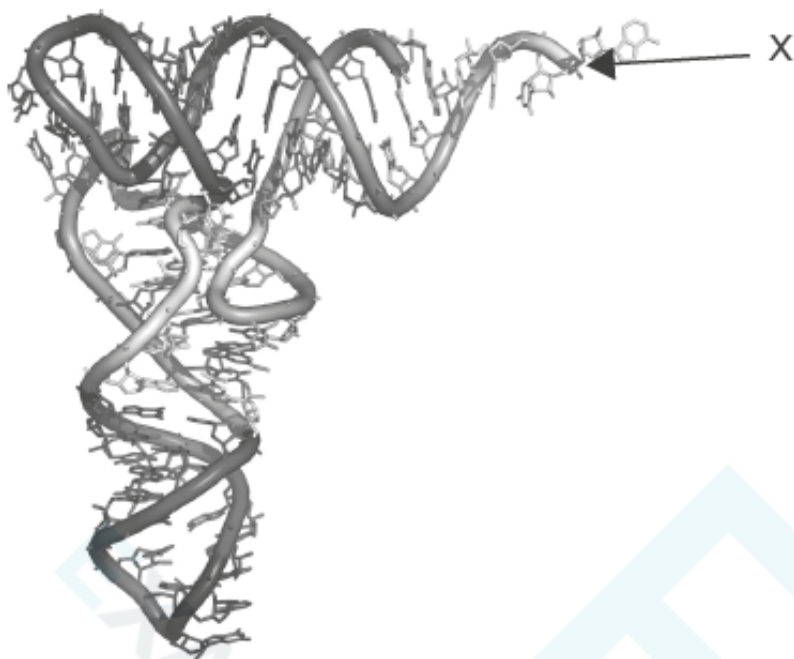
- A. Light cannot pass through the specimen.
- B. Higher magnification can be achieved with the electron microscope.
- C. The resolution of the electron microscope is higher.
- D. Samples are stained with methylene blue when viewed with the light microscope.

[1]

20N.1A.SL.TZ0.28

The diagram shows the three-dimensional structure of tRNA.

[1]



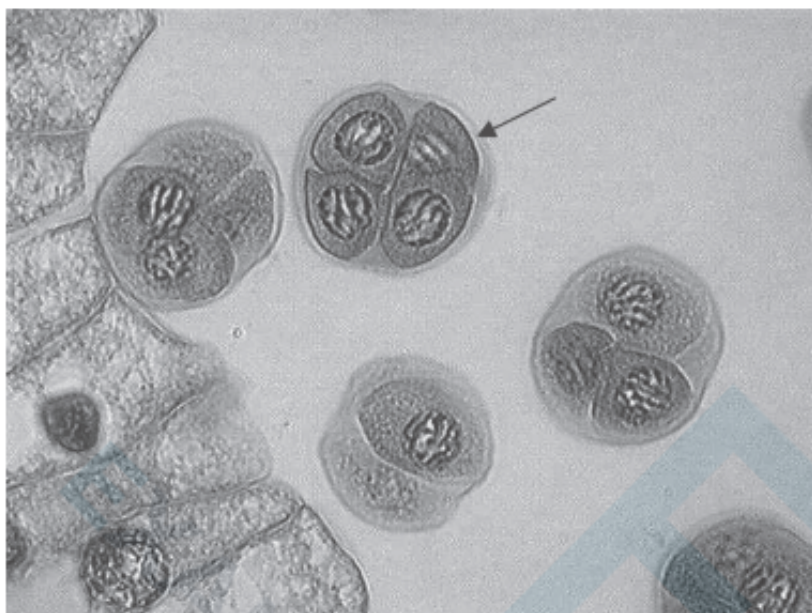
[Source: Structure reproduced with the kind permission of N.R. Voss.]

What can attach to the region marked X?

- A. mRNA
- B. An amino acid
- C. An anticodon
- D. The P site of the ribosome

21M.1A.SL.TZ2.12

The image shows tetrads in the anther of a lily. A tetrad is a group of four cells, produced when one mother cell divides by meiosis. The tetrad indicated by the arrow contains a total of 48 chromosomes.



[Source: [Tetrad], 2012. [image online] Available at: <https://www.iaspr.org/old/iaspr-pix/lily/tetrad.jpg> [accessed: 4 April 2019]. Photo courtesy of Professor Scott D. Russell.]

What is the diploid number of the plant?

- A. 12
- B. 24
- C. 48
- D. 96

[1]

20N.1A.SL.TZ0.18

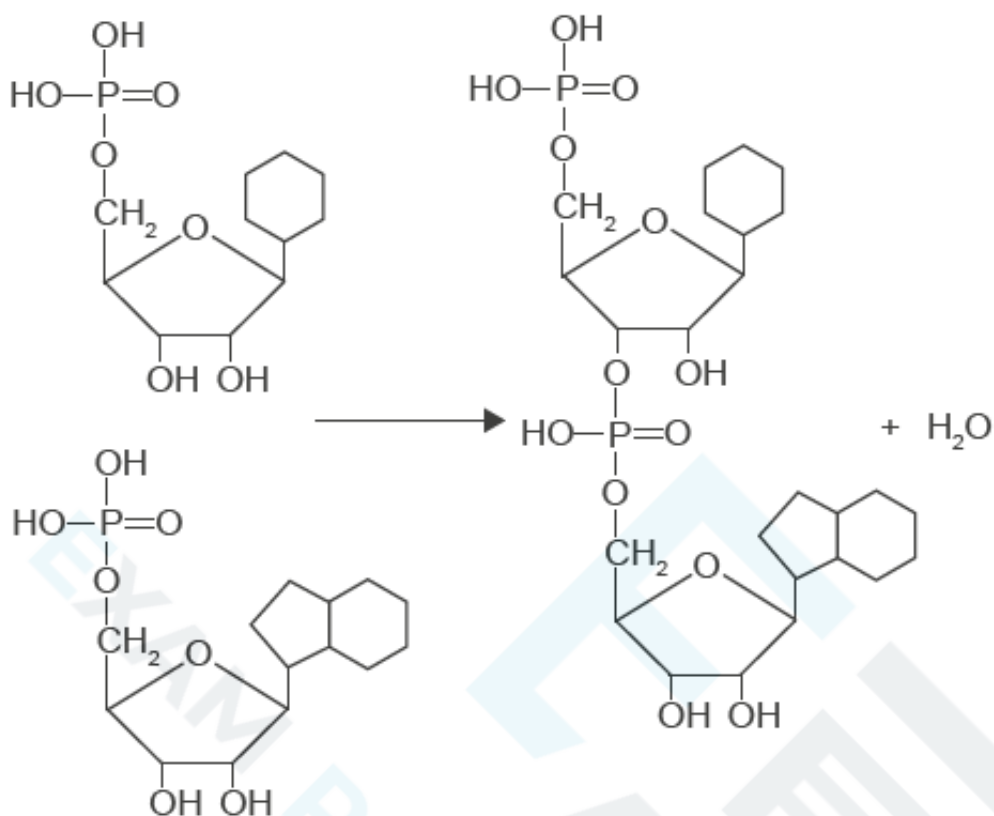
Under certain conditions, living organisms on Earth produce and release methane. What favours the production of methane?

- A. Forest fires
- B. High light intensity
- C. Anaerobic conditions
- D. Dry conditions

[1]

20N.1A.SL.TZ0.6

What are the type of reaction and the product(s) shown in this reaction? [1]



	Reaction	Product(s)
A.	condensation	two nucleotides
B.	condensation	one dinucleotide
C.	hydrolysis	two nucleotides
D.	hydrolysis	one dinucleotide

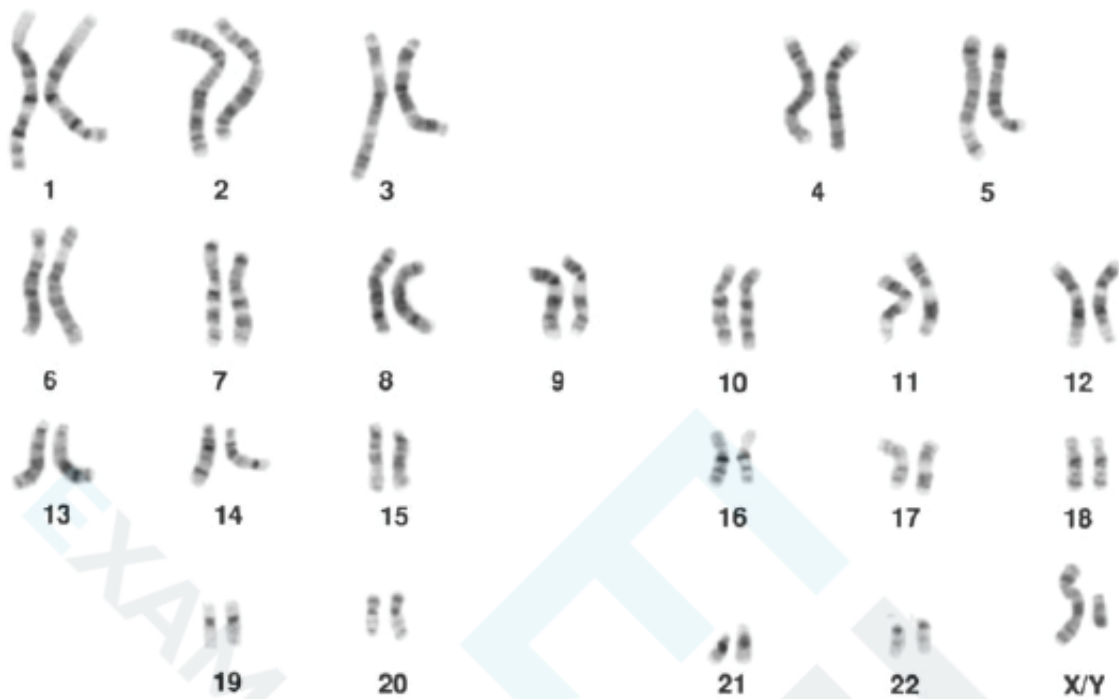
SPM.1A.SL.TZ0.23

What can lead to the emergence of analogous structures? [1]

- A. Divergent evolution from a recent common ancestor
- B. Convergent evolution of unrelated species
- C. Splits in the fundamental niche of a species
- D. Splits in the realized niche of a species

19N.1A.SL.TZ0.14

A pregnant woman had fetal cells removed by chorionic villus sampling and tested. The following karyogram was produced.



[Source: Mediscan / Alamy Stock Photo]

What does this show?

- A. The child is female with **Down syndrome**.
- B. The child is female without **Down syndrome**.
- C. The child is male with **Down syndrome**.
- D. The child is male without **Down syndrome**.

[1]

20N.1A.SL.TZ0.30

A female is overweight, feels cold and tired, and often fails to ovulate during the menstrual cycle. Which two hormones are probably secreted at insufficient levels?

- A. Estrogen and **FSH**
- B. **LH** and thyroxine
- C. Insulin and glucagon
- D. Epinephrine and leptin

[1]

22M.1A.SL.TZ1.4

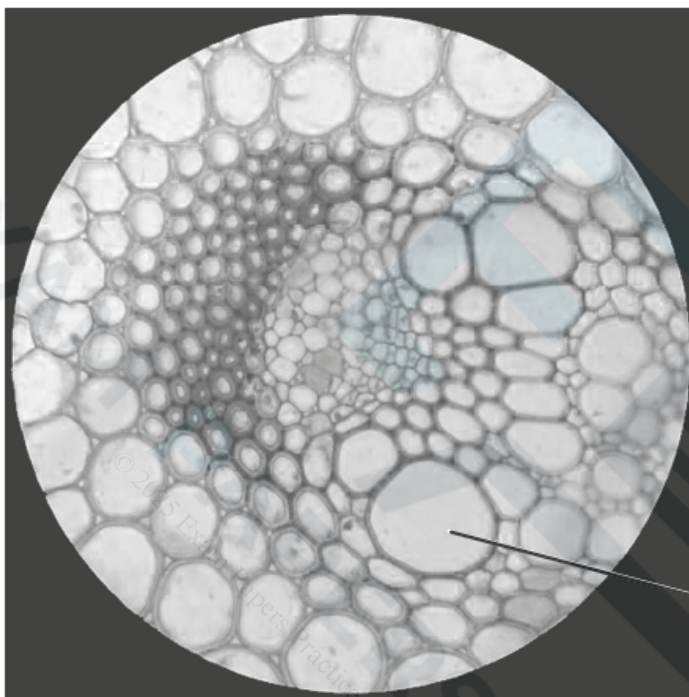
Which cell component arose first during the formation of the earliest cells? [1]

- A. Chloroplast
- B. Plasma membrane
- C. Mitochondria
- D. Cell wall

23M.1A.SL.TZ1.33

The micrograph shows tissues in a plant stem.

[1]



What is the reason that no nucleus is visible in Z?

- A. Xylem vessels are formed from dead lignified cells.
- B. Staining of cells destroys their nucleus.
- C. Phloem companion cells lack a nucleus.
- D. The nucleus is too small to be seen in a light microscope slide preparation.

23M.1A.SL.TZ1.19

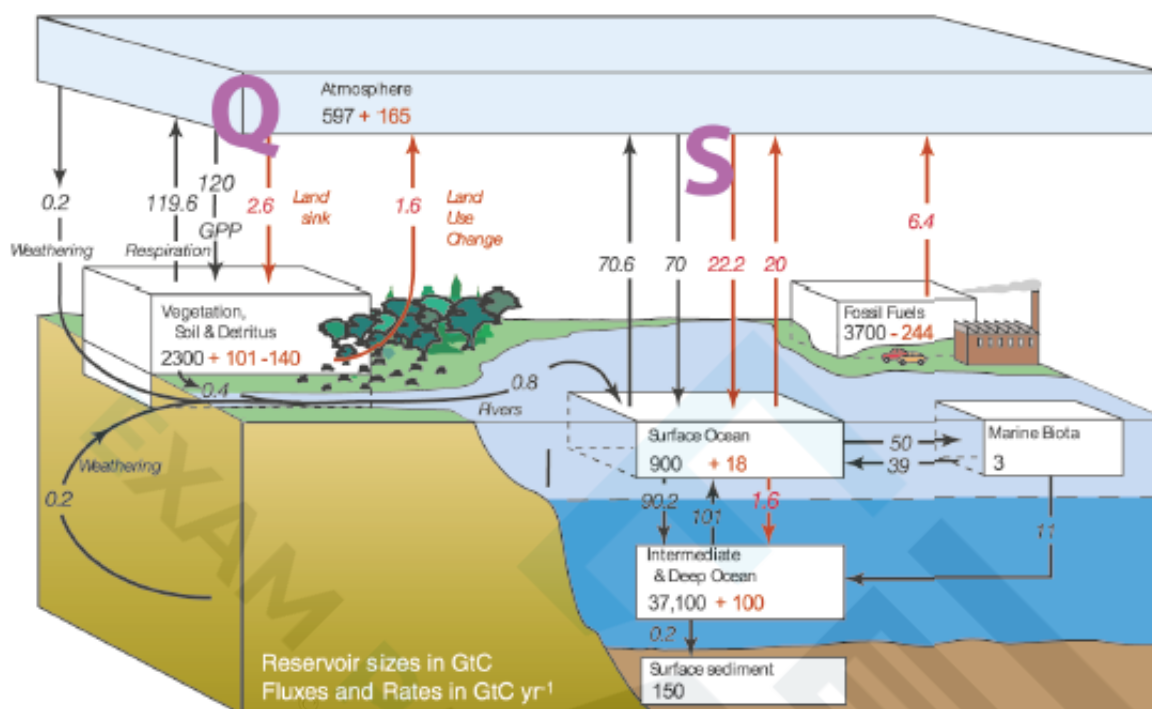
What is the main contribution of greenhouse gases to global warming?

- A. Absorbing long wave radiation, therefore retaining atmospheric heat
- B. Converting long wave radiation to short wave radiation
- C. Producing a hole in the ozone layer, therefore allowing more heat into atmosphere
- D. Reflecting short wave radiation, therefore increasing the atmospheric temperature

[1]

21N.1A.SL.TZ1.16

The diagram shows the carbon flux in gigatonnes per year between some of the Earth's global reservoirs.



[Source: Figure 7.3 and Table 7.1 from Denman, K.L., G. Brasseur, A. Chidthaisong, P. Ciais, P.M. Cox, R.E. Dickinson, D. Hauglustaine, C. Heinze, E. Holland, D. Jacob, U. Lohmann, S Ramachandran, P.L. da Silva Dias, S.C. Wofsy and X. Zhang, 2007: Couplings Between Changes in the Climate System and Biogeochemistry. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.]

What can be deduced from the information in the diagram?

- A. Arrows S are mainly due to respiration of marine plants and animals.
- B. Photosynthesis is a component of both arrows Q and S.
- C. Every day, more carbon is removed from the ocean than is added.
- D. Ocean carbon is stored as dissolved calcium carbonate.

[1]

22M.1A.SL.TZ1.6

What are linked by hydrogen bonds? [1]

- A. Hydrogen and oxygen within a water molecule
- B. Phosphate and sugar within a **DNA** molecule
- C. Base and sugar between **DNA** nucleotides
- D. Hydrogen and oxygen in different water molecules

23M.1A.SL.TZ2.2

What cell component is found in eukaryotic cells but not in prokaryotic cells? [1]

- A. Mitochondria for respiration
- B. **DNA** containing genetic information
- C. Ribosomes for protein synthesis
- D. Cell wall to maintain shape

23M.1A.SL.TZ2.17

Which is an example of evolution by selective breeding?

- A. Selection of prey animals that can run faster than their predators
- B. The variation in the size of different breeds of dogs
- C. The tendency, during breeding, for birds to produce more offspring than will survive
- D. Some female spiders only breeding with males which make the right signals

[1]

19N.1A.SL.TZ0.37

What is a role of activated **B** cells? [1]

- A. Secrete antibiotics in response to specific antigens
- B. Activate T cells in the immune response
- C. Release histamine in response to allergens
- D. Multiply to form clones of plasma cells

20N.1A.SL.TZ0.10

What is the reason for Taq DNA polymerase being used in the polymerase chain reaction (PCR)?

- A. It does not denature at high temperatures.
- B. It produces Okazaki fragments more rapidly.
- C. It allows translation to proceed rapidly.
- D. It works efficiently with helicase in PCR.

[1]

19M.1A.SL.TZ1.4

Which process(es) occur(s) by osmosis?

[1]

- I. Uptake of water by cells in the wall of the intestine
- II. Loss of water from a plant cell in a hypertonic environment
- III. Evaporation of water from sweat on the skin surface

- A. I only
- B. I and II only
- C. II and III only
- D. I, II and III

21N.1A.SL.TZ1.12

Huntington's disease can develop in middle age and leads to death of brain cells. It is carried by an autosomal dominant gene. What can be deduced about a man who has the disease?

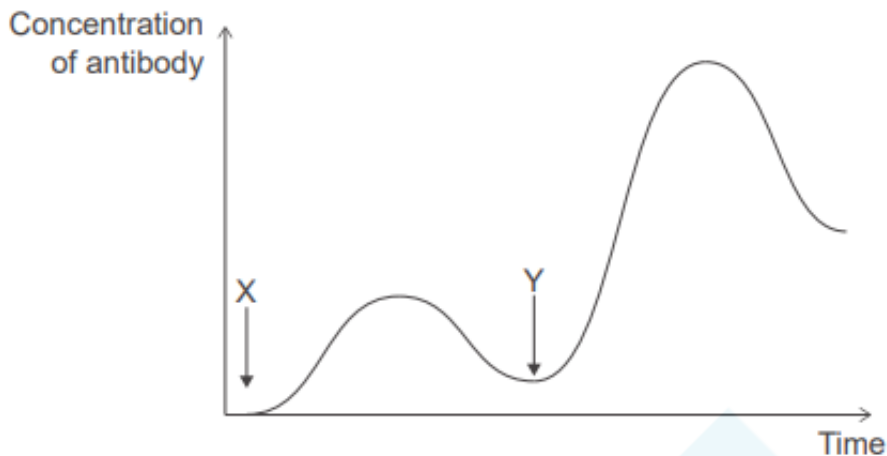
- A. Half of his children will get the disease.
- B. Neither of his parents had the disease, but one must have been a carrier.
- C. At least one of his grandparents must have had the disease.
- D. His sons are more likely to have the disease than his daughters.

[1]

21M.1A.SL.TZ2.37



The graph shows changes in the concentration of an antibody in the blood of an individual subjected to two separate infections at time X and time Y.



[Source: Illustration from Anatomy & Physiology, Connexions Web site.
<http://cnx.org/content/col11496/1.6/> , Jun 19, 2013 OpenStax College © 1999-2021,
Rice University. Except where otherwise noted, textbooks on this site are licensed
under a Creative Commons Attribution 4.0 International License (
<https://creativecommons.org/licenses/by/4.0/>).]

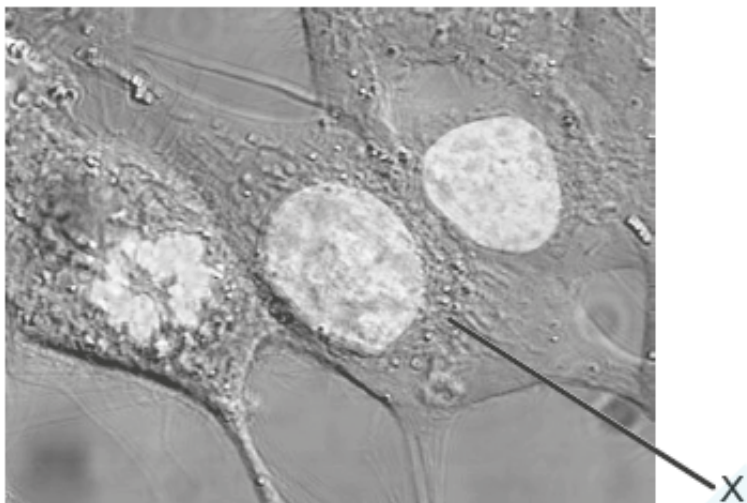
What distinguishes the events occurring at Y from those occurring at X?

- A. The individual was infected with different pathogens at X and Y.
- B. Memory B cells are involved in antibody production at Y but not at X.
- C. There is no clonal selection involved.
- D. There are no T lymphocytes involved.

[1]

19M.1A.SL.TZ2.2

The magnification of the micrograph is $2000\times$.



[Source:

https://upload.wikimedia.org/wikipedia/commons/6/6c/HeLa_cells_stained_with_Hoechst_dye.jpg
by TenOfAllTrades.]

What is the maximum diameter of the nucleus in the cell labelled X?

- A. $10\text{ }\mu\text{m}$
- B. 10 nm
- C. $20\text{ }\mu\text{m}$
- D. 20 nm

[1]

19N.1A.SL.TZ0.6

In which processes are macromolecules broken down into monomers? [1]

- A. Anabolism and catabolism
- B. Catabolism and hydrolysis
- C. Hydrolysis and reduction
- D. Reduction and anabolism

21M.1A.SL.TZ1.15

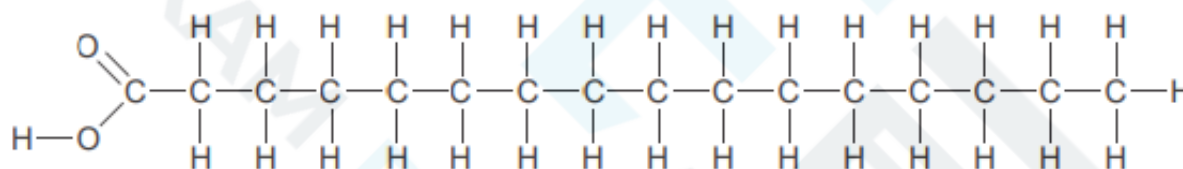


What are the evolutionary origins and functions of homologous structures? [1]

	Evolutionary origin	Function
A.	common or different origin	same function
B.	common origin	same or different function
C.	different origin	same function
D.	different origin	same or different function

21M.1A.SL.TZ1.10

Which molecule is depicted in the diagram? [1]

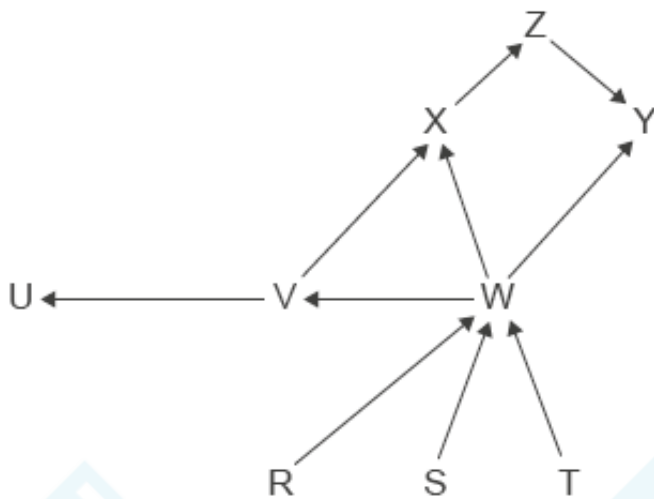


- A. A saturated fatty acid
- B. An unsaturated fatty acid
- C. A trans fat
- D. A vegetable oil

19M.1A.SL.TZ1.18



The diagram shows the food web for an aquatic ecosystem in which letters R–Z represent individual species.



[Source: © International Baccalaureate Organization 2019]

Which organism is a tertiary consumer?

- A. Organism T
- B. Organism U
- C. Organism W
- D. Organism Y

[1]

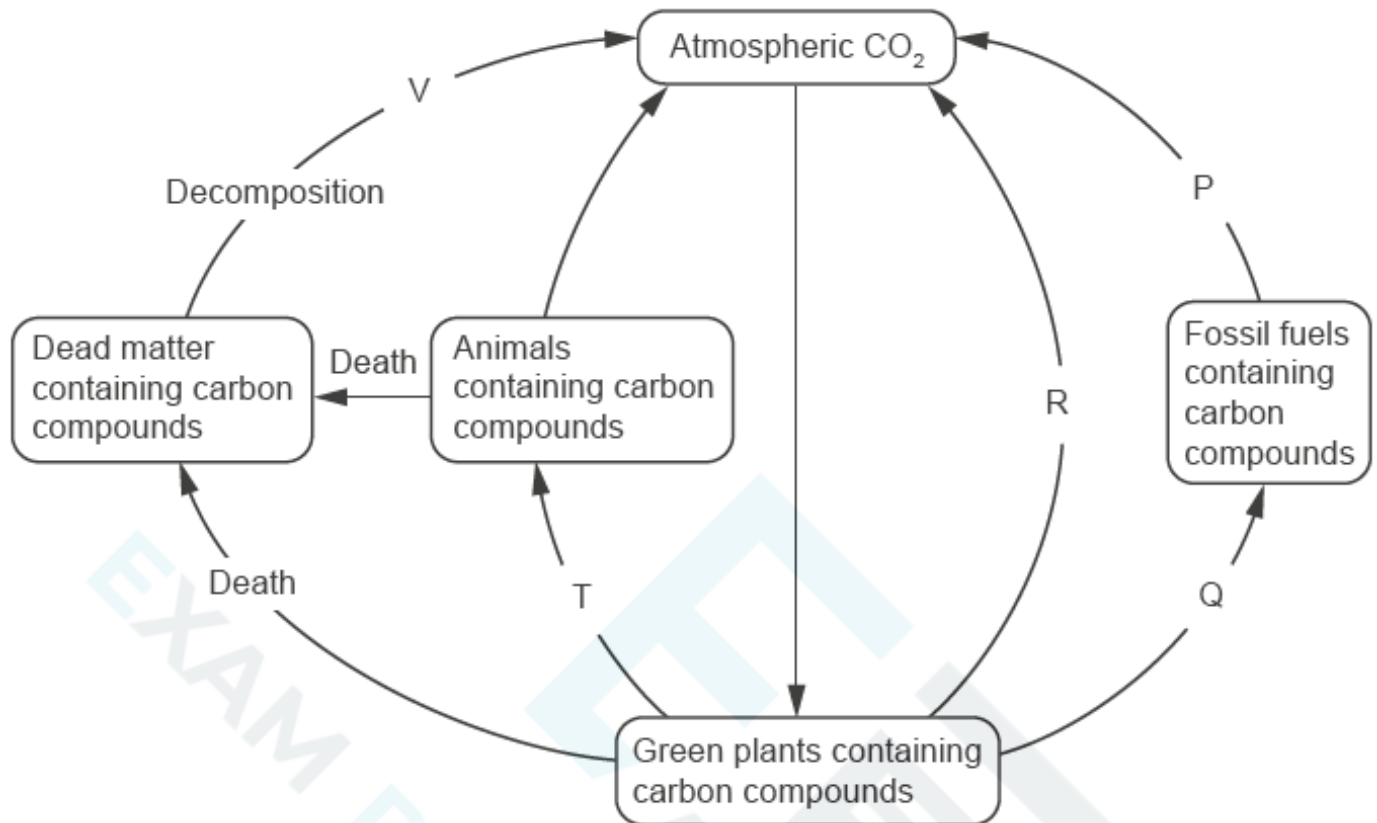
21M.1A.SL.TZ2.4

When does DNA replication occur? [1]

- A. S phase of interphase
- B. Early prophase
- C. G phase of interphase
- D. Late prophase

23M.1A.SL.TZ2.20

The diagram shows the carbon cycle.



Which letters represent respiration?

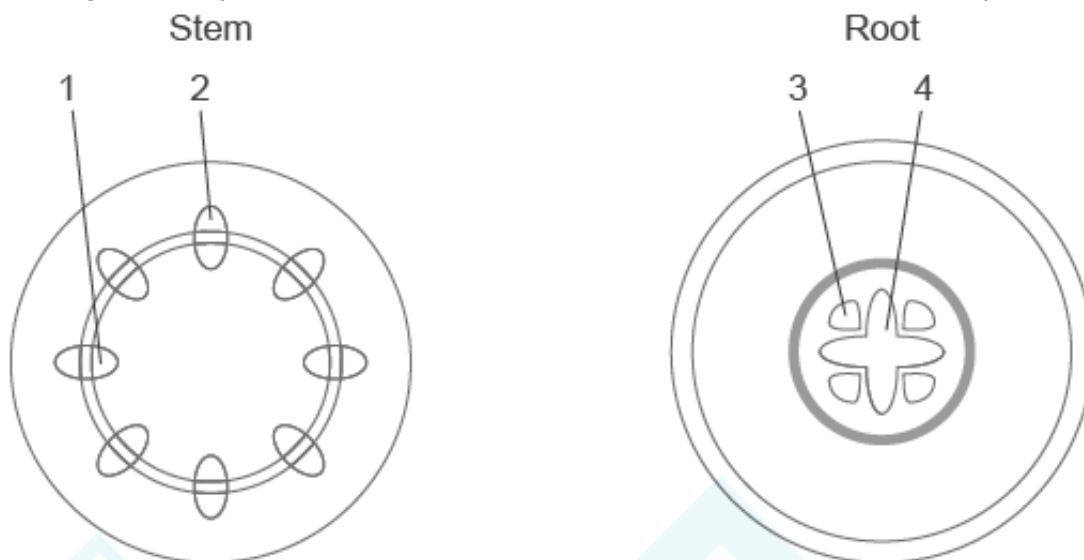
- A. R and T
- B. P and V
- C. Q and R
- D. R and V

[1]

22M.1A.SL.TZ1.33

The diagrams represent cross sections of the stem and root of a plant.

[1]

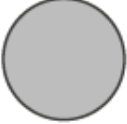
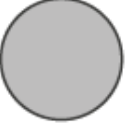


Which tissues transport water in the stem and the root?

	Stem	Root
A.	1	3
B.	2	3
C.	1	4
D.	2	4

19M.1A.SL.TZ1.37

The table shows the results of blood type tests on samples from four individuals. Which row represents an individual who can accept transfusions from people with blood type AB?

	Anti-A	Anti-B	Control, no antibody
A.			
B.			
C.			
D.			

Key:



No clumping,
no antibody reaction



Clumping due to
antibody reaction

[Source: © International Baccalaureate Organization 2019]

[1]

19N.1A.SL.TZ0.12

Which compound is a waste product of anaerobic respiration in humans? [1]

- A. Carbon dioxide
- B. Ethanol
- C. Lactate
- D. Pyruvate

21M.1A.SL.TZ2.30

What is a similarity between the testes of males and the ovaries of females in humans?

- A. They produce gametes throughout the life of the individual.
- B. They secrete hormones into the blood stream.
- C. Their development is controlled by a gene on the Y chromosome.
- D. They release products to the outside of the body directly through the urethra.

[1]

19M.1A.SL.TZ2.15

The children in a family have blood groups A, B and O. What are the genotypes of their parents?

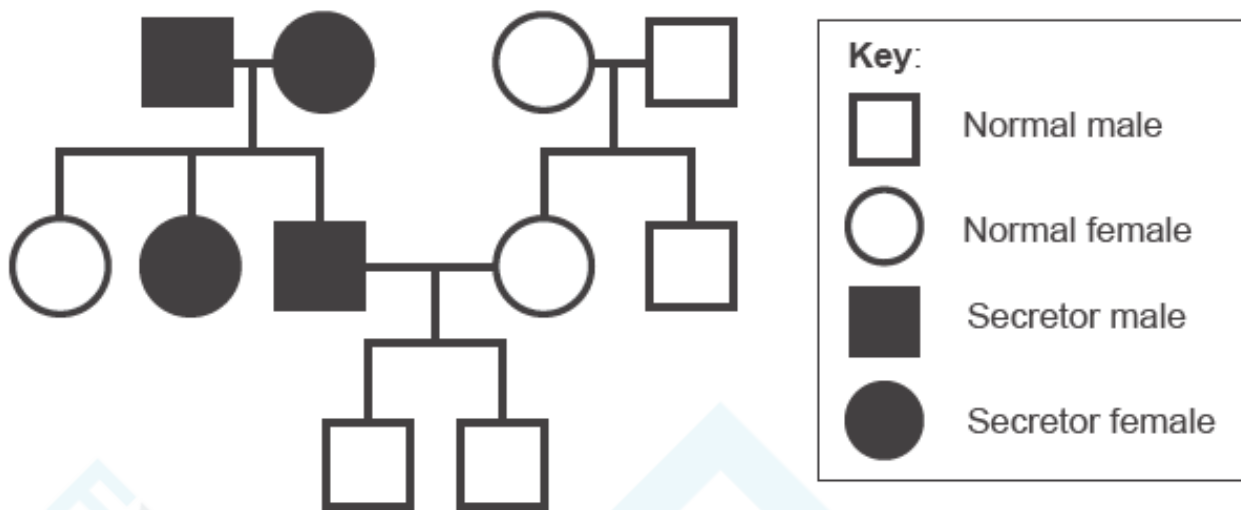
- A. $I^A I^A$ and $I^B i$
- B. $I^A i$ and $I^B i$
- C. $I^A I^B$ and ii
- D. $I^A I^B$ and $I^B i$

[1]

19N.1A.SL.TZ0.16

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A pair of alleles controls the secretion of antigens corresponding to blood group in saliva. Examine the pedigree chart.



[Source: © International Baccalaureate Organization 2019]

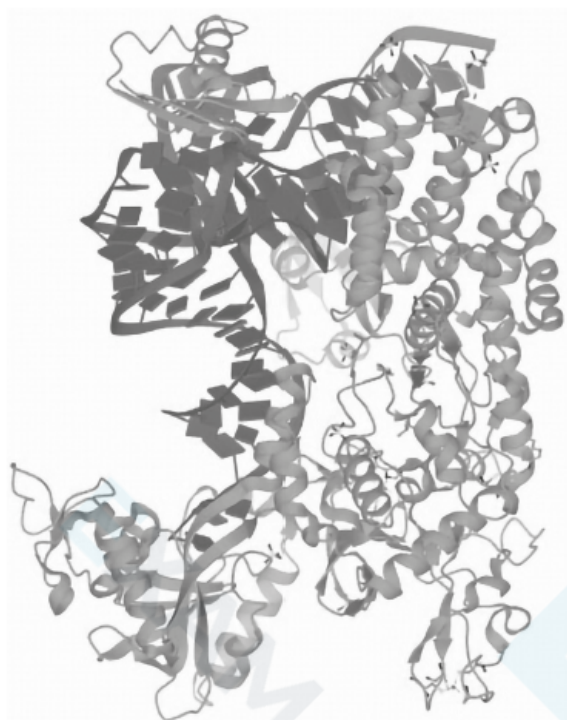
Based on this pedigree chart, which best describes the allele conferring antigen secretion in saliva?

- A. Dominant
- B. Recessive
- C. Sex-linked
- D. Co-dominant

[1]

23M.1A.SL.TZ1.27

The image shows leucyl-tRNA synthetase from *Thermus thermophilus* complexed with a tRNA. This tRNA-activating enzyme joins the amino acid leucine to tRNA using ATP.



Why is leucyl-tRNA synthetase not used to join the amino acid valine to tRNA?

- A. Phosphorylation of valine occurs at a later stage.
- B. Valine does not need to be activated to attach to tRNA.
- C. Leucyl-tRNA synthetase is substrate-specific.
- D. Valine has a different anticodon from leucine.

[1]

SPM.1A.SL.TZ0.21

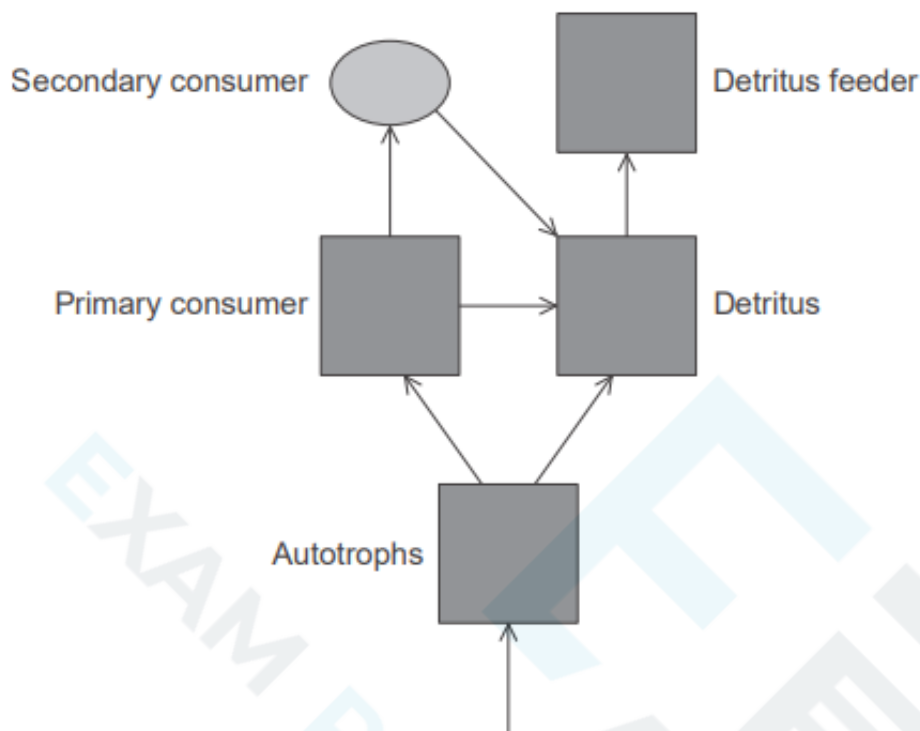
How would the body respond to a rise above normal body temperature?

[1]

	Type of feedback	Response
A.	positive	increased secretion from sweat glands
B.	positive	spread limbs to increase surface area
C.	negative	vasodilation of skin blood vessels
D.	negative	shivering

21M.1A.SL.TZ1.21

The diagram shows the energy flow between five "sinks" in a terrestrial ecosystem.



In a typical terrestrial ecosystem, which trophic level would have the highest biomass?

- A. Autotrophs
- B. Primary consumers
- C. Secondary consumers
- D. Detritus feeders

[1]

20N.1A.SL.TZ0.8

The genetic code is shown.

		2nd base					
		U	C	A	G		
1st base	U	Phe	Ser	Tyr	Cys	U	3rd base
		Phe	Ser	Tyr	Cys	C	
		Leu	Ser	STOP	STOP	A	
		Leu	Ser	STOP	Trp	G	
	C	Leu	Pro	His	Arg	U	
		Leu	Pro	His	Arg	C	
		Leu	Pro	Gln	Arg	A	
		Leu	Pro	Gln	Arg	G	
	A	Ile	Thr	Asn	Ser	U	
		Ile	Thr	Asn	Ser	C	
		Ile	Thr	Lys	Arg	A	
		Met	Thr	Lys	Arg	G	
	G	Val	Ala	Asp	Gly	U	
		Val	Ala	Asp	Gly	C	
		Val	Ala	Glu	Gly	A	
		Val	Ala	Glu	Gly	G	

In a coding gene, the DNA triplet in the transcribed strand is changed from AGG to TCG.

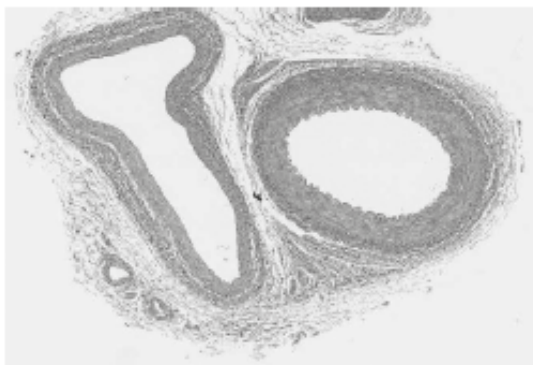
What would be the result of this change in the genome?

- A. A non-functional protein
- B. A different but functional protein
- C. No change in the protein
- D. Termination of the polypeptide

[1]

22M.1A.SL.TZ2.26

The light micrograph shows two blood vessels, an artery and a vein, in transverse section



[Source: Columbia Center for New Media Teaching and Learning, n.d. Epithelium: Simple Squamous Epithelium. [image online] Available at: http://www.columbia.edu/itc/hs/medical/sbpm_histology_old/lab/lab02_squamous.html [Accessed 29 November 2019].]

What explains the different shapes of these blood vessels?

- A. Arteries do not have valves.
- B. Muscle cells are found only in the walls of veins.
- C. Arteries have a larger lumen-to-wall thickness ratio.
- D. There are fewer elastic fibres in the walls of veins.

[1]

SPM.1A.SL.TZ0.7

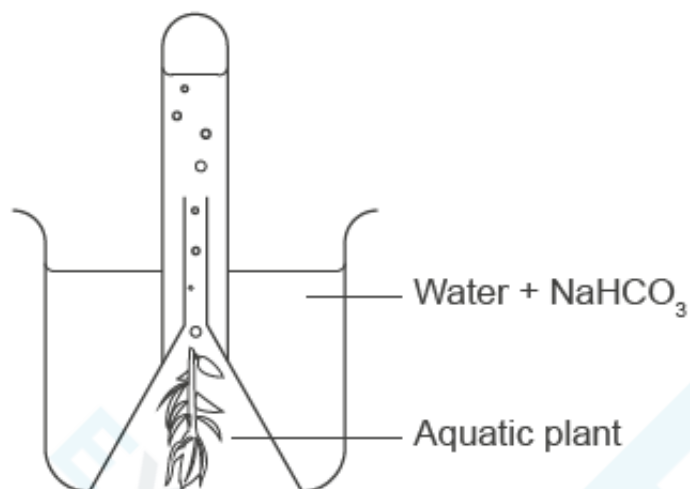
What is a reason that Taq polymerase is a suitable enzyme for use in the polymerase chain reaction (PCR)?

- A. It can work at a wide range of pH.
- B. It works at higher temperatures than most enzymes.
- C. It can separate two strands of DNA.
- D. It allows DNA to be replicated without the use of primers.

[1]

22M.1A.SL.TZ2.12

The apparatus shown was used to investigate the effect of varying carbon dioxide concentration on the rate of photosynthesis. Carbon dioxide concentrations were varied by adding different amounts of sodium hydrogen carbonate (NaHCO_3) to water.



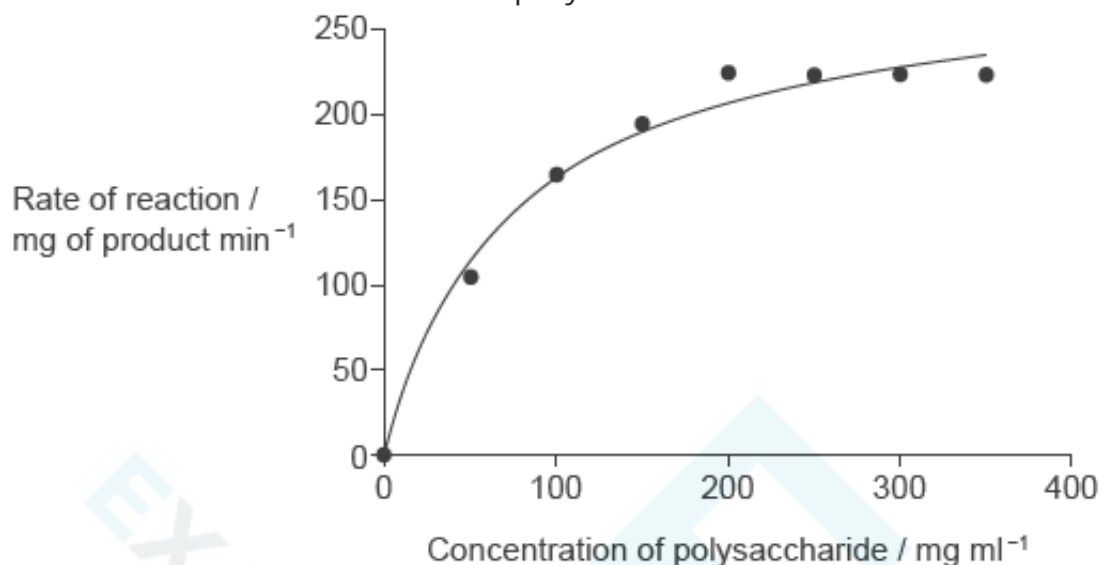
What is the dependent variable in this investigation?

- A. Temperature
- B. Light intensity
- C. Amount of NaHCO_3 added
- D. Volume of oxygen produced

[1]

23M.1A.SL.TZ2.8

In the grass plant *Halopyrum mucronatum*, the enzyme amylase breaks bonds in polysaccharides during germination. The graph shows how the activity of the enzyme varies with the concentration of polysaccharide.



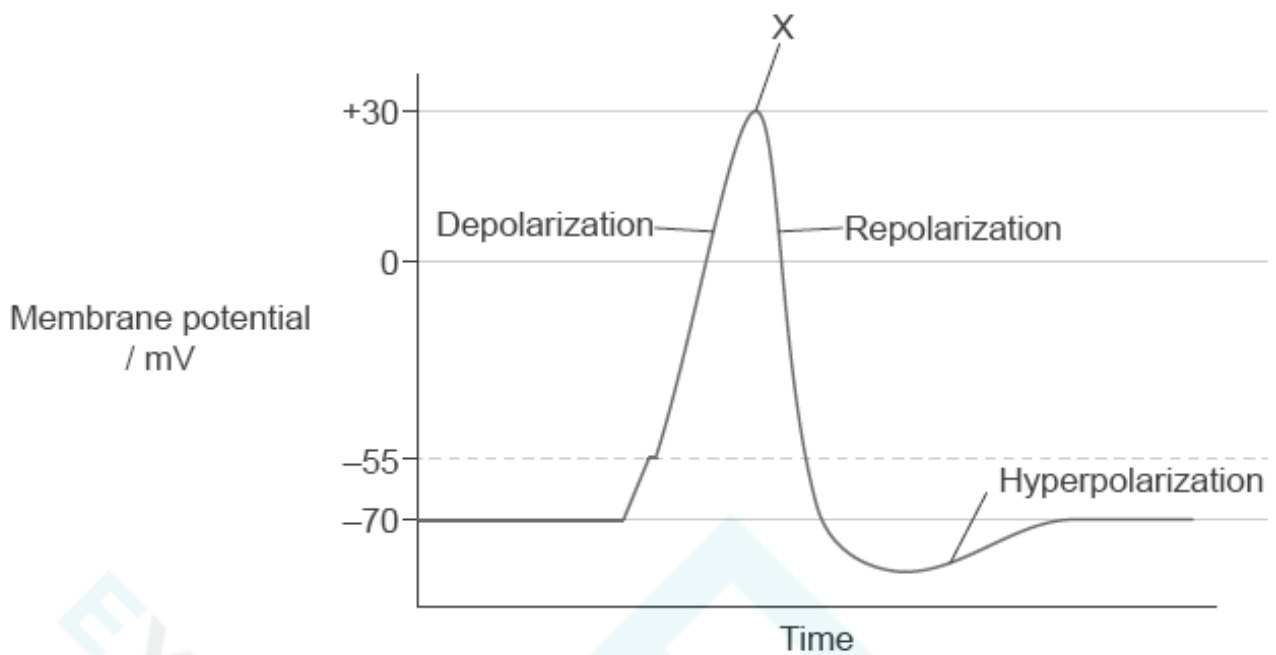
What is the reason for the curve levelling off?

- A. There is insufficient substrate for the enzyme to act on.
- B. The product acts as an enzyme inhibitor.
- C. The enzymes have all been consumed in the reaction.
- D. All the enzyme active sites are occupied by substrate.

[1]

19M.1A.SL.TZ1.29

The diagram shows a graph of an action potential.



[Source: <https://www.ncbi.nlm.nih.gov/books/NBK538143/figure/article-17127.image.f1/?report=objectonly>

Physiology, Action Potential by Michael H. Grider and Carolyn S. Glaubenslee.

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<https://creativecommons.org/licenses/by/4.0/>]

What is happening at X?

- A. Sodium channels close.
- B. Calcium channels open.
- C. Sodium channels open.
- D. Potassium channels close.

[1]

23M.1A.SL.TZ1.8

The table shows the approximate energy stores in a man with an average mass. [1]

Organ or tissue	Available energy / kJ		
	Carbohydrates	Lipids	Proteins
Brain	30	0	0
Liver	1700	2000	1700
Adipose tissue	330	560 000	170

[Source: C.E. Rennie, Separation from Macromolecules (1976), copyright permission from Elsevier.]

What can be concluded from the data?

- A. The brain contains no short-term stored energy.
- B. The liver contains less long-term than short-term stored energy.
- C. The adipose tissue provides for most of the long-term energy storage.
- D. Carbohydrates provide more energy per gram than lipids or proteins.

23M.1A.SL.TZ1.9

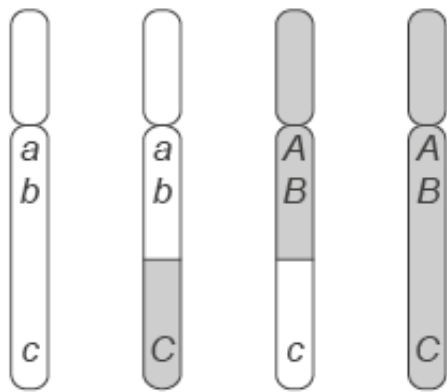
What is a consequence of anaerobic cell respiration in muscles?

[1]

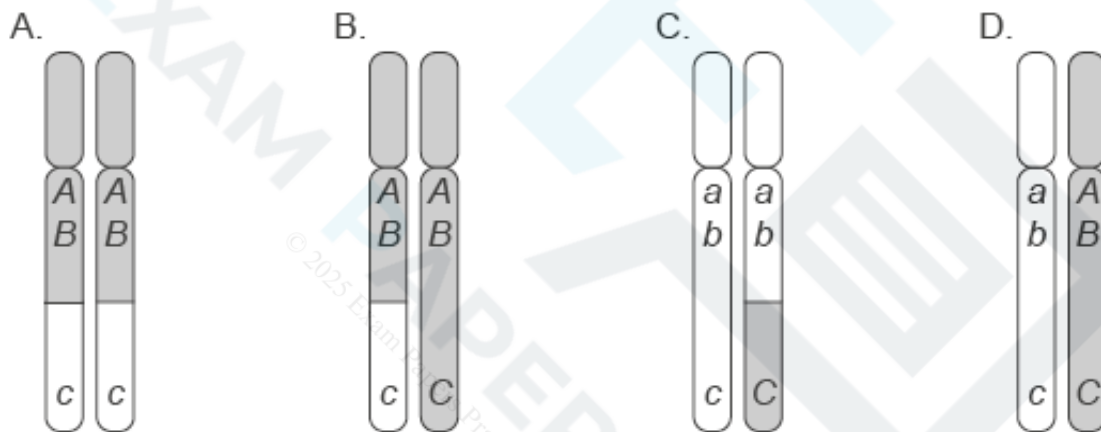
- A. Large yield of readily available ATP and ethanol production
- B. Small yield of readily available ATP and lactate accumulation
- C. Large yield of ATP and production of carbon dioxide and lactic acid
- D. Small yield of ATP that is not readily available and carbon dioxide production

19M.1A.SL.TZ1.36

The diagram shows the chromosomes derived from a single homologous pair following meiosis in a diploid cell.



Which diagram represents the homologous pair from which these chromosomes were derived?



[Source: © International Baccalaureate Organization 2019]

[1]

19M.1A.SL.TZ1.21

Which is an example of natural selection?

[1]

- A. A giraffe stretching its neck to reach higher leaves
- B. A juvenile bird learning to sing
- C. Development of antibiotic resistance in bacteria
- D. Selective breeding of tail-less cats

22M.1A.SL.TZ2.11

What is a function of the enzyme helicase?

[1]

- A. It coils **DNA** up into a double helical shape.
- B. It links **DNA** nucleotides in a new **DNA** strand.
- C. It breaks hydrogen bonds between the **DNA** strands.
- D. It forms temporary hydrogen bonds to produce messenger **RNA**.

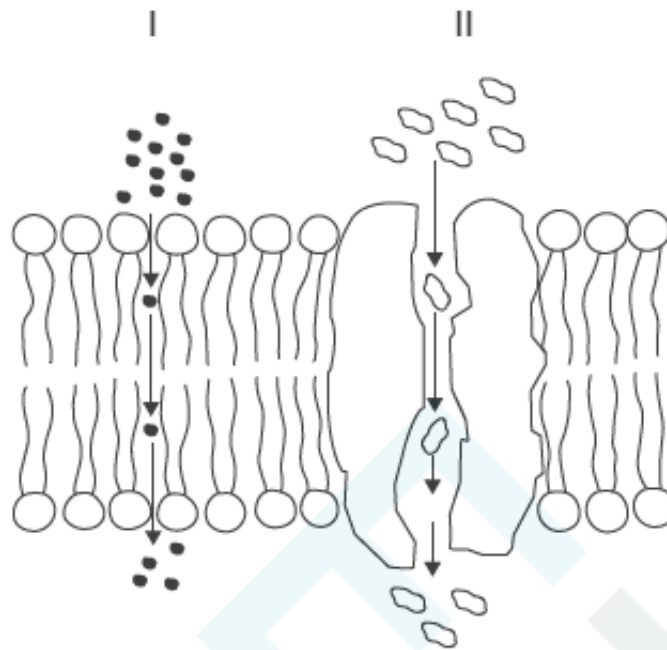
23M.1A.SL.TZ2.12

Which equation represents a process in yeast that causes bread to rise? [1]

- A. Glucose + oxygen → ethanol + carbon dioxide
- B. Glucose → carbon dioxide + water
- C. Glucose + oxygen → carbon dioxide + water
- D. Glucose → ethanol + carbon dioxide

20N.1A.SL.TZ0.4

The diagram shows a section through a membrane. What are the modes of transport in the diagram?



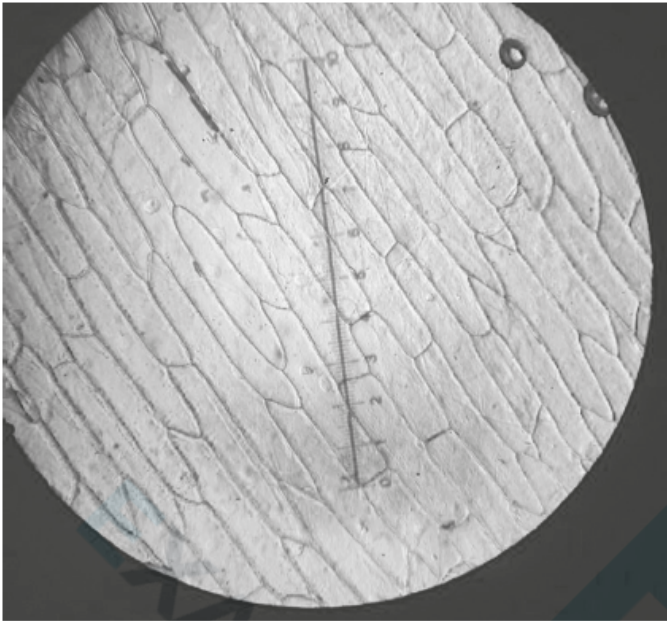
[Source: © International Baccalaureate Organization 2020.]

	I	II
A.	simple diffusion	osmosis
B.	active transport	facilitated diffusion
C.	simple diffusion	facilitated diffusion
D.	facilitated diffusion	active transport

[1]

23M.1A.SL.TZ1.3

Onion (*Allium cepa*) epidermis was placed in pure water and observed with a light microscope using high magnification.



What would happen to these cells if they were transferred to a hypertonic solution?

- A. Cells would gain mass.
- B. Cells would take in water by osmosis and swell.
- C. Cells would burst open, releasing their content.
- D. Cell membranes would detach from walls at some points.

[1]

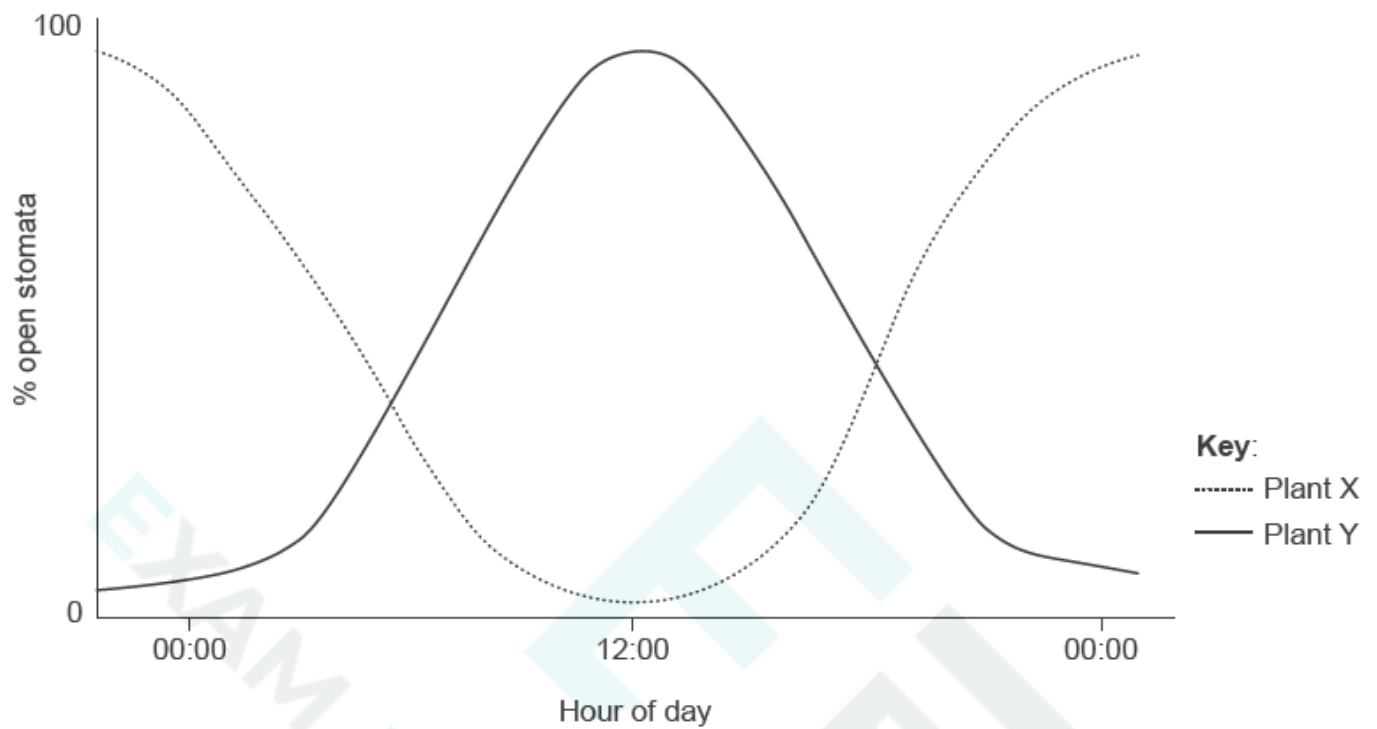
SPM.1A.SL.TZ0.10

Which is a feature of phloem sieve tube cells? [1]

- A. Numerous chloroplasts
- B. No nucleus
- C. Lignified walls
- D. No cytoplasm

20N.1A.SL.TZ0.32

The graph shows the percentage of stomata that are open in two different species of plants over a 24-hour period.



What does this graph show about plants X and Y?

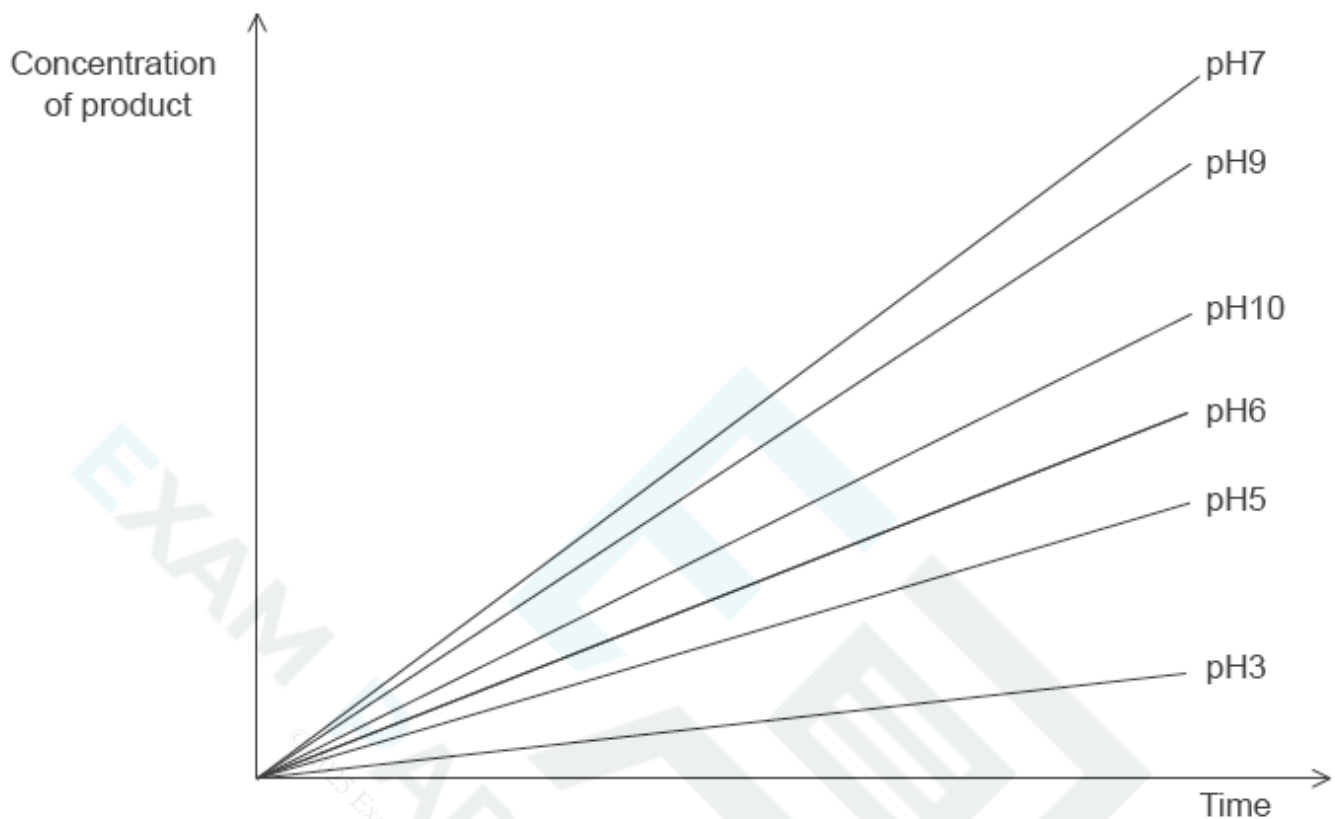
- A. Plant X absorbs most carbon dioxide at night.
- B. Plant Y is adapted to desert conditions.
- C. Plant X photosynthesises most at midday.
- D. Plant Y only respire during the day.

[1]

19M.1A.SL.TZ1.9



The graph shows the results of an investigation into the activity of turnip peroxidase. The accumulation of the product of the reaction catalysed by the enzyme is shown at different pH values.



[Source: © International Baccalaureate Organization 2019]

Based on the data in the graph, what is most probably the optimum pH for turnip peroxidase?

- A. Between 3 and 5
- B. Between 10 and 11
- C. Between 7 and 8
- D. Between 9 and 10

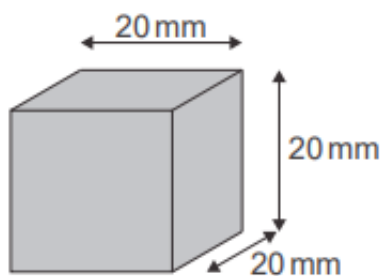
[1]

21M.1A.SL.TZ2.1

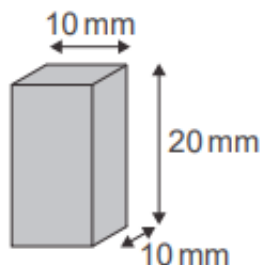


The diagrams represent cells with the same concentration of dissolved substances in their cytoplasm. If all the cells were placed in the same hypertonic sucrose solution, which cell would show the greatest rate of change in the concentration of its cytoplasm?

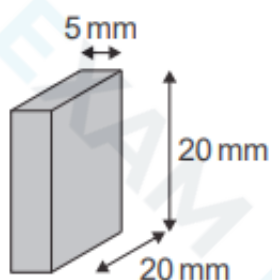
A.



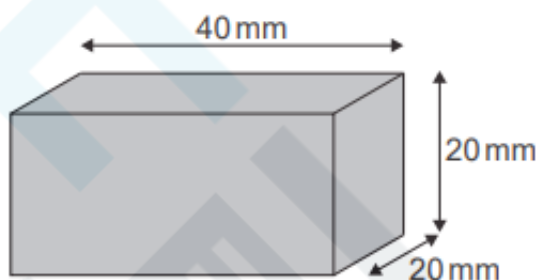
B.



C.



D.

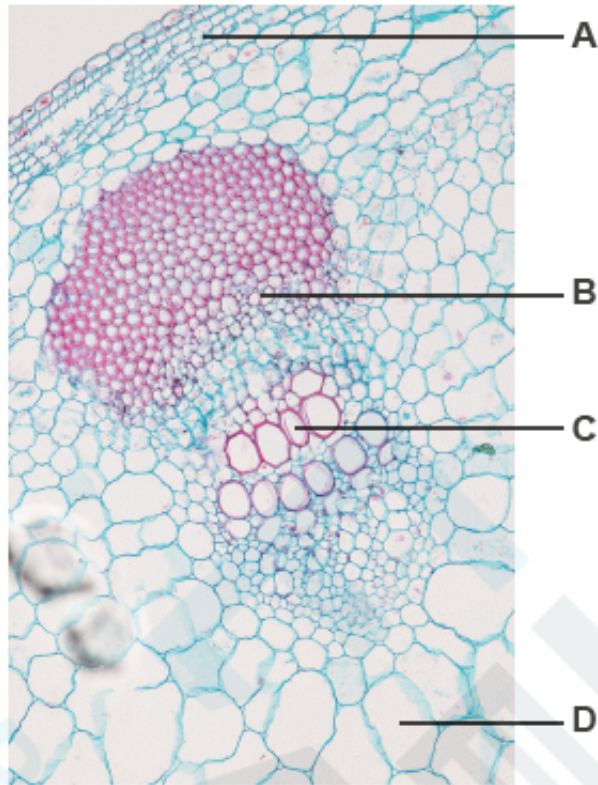


[1]

21N.1A.SL.TZ1.32



A plant is allowed to photosynthesize in an atmosphere containing radioactive ^{14}C . Where in the plant stem would radioactive sugars be found?



[Source: sinhyu/123rf.com.]

[1]

22M.1A.SL.TZ1.13

The table shows the estimated total number of genes in several organisms.

Species	Estimated number of genes
<i>Saccharomyces cerevisiae</i> (a yeast)	6000
<i>Escherichia coli</i> (a bacterium)	3200
<i>Drosophila melanogaster</i> (fruit fly)	14 000
<i>Canis familiaris</i> (domestic dog)	19000
<i>Oryza sativa</i> (rice)	51 000
<i>Homo sapiens</i> (human)	25000

What can be deduced from the information in this table?

- A. Throughout evolution, the number of genes increases.
- B. The domestic dog is more closely genetically related to the fruit fly than to the human.
- C. The number of genes does not determine evolutionary success.
- D. Humans produce about half as many proteins as rice.

[1]

SPM.1A.SL.TZ0.22

The first day of the menstrual cycle is when menstruation begins. What occurs around day 15 of the cycle?

- A. Formation of a corpus luteum
- B. The placenta starts to secrete progesterone
- C. The end of menstruation
- D. Blood progesterone concentration reaches its maximum

[1]

23M.1A.SL.TZ1.36

What happens in the first division of meiosis?

- A. Formation of chiasmata where two sister chromatids join
- B. Exchange of chromatids between homologous chromosomes
- C. Exchange of **DNA** between non-sister chromatids of homologous chromosomes
- D. Formation of chiasmata between non-homologous chromosomes

[1]

22N.1A.SL.TZ0.19

Carbon sinks are any reservoirs that absorb and store carbon dioxide from the atmosphere. Which process increases the size of the carbon sink in oceans?

- A. Photosynthesis
- B. Respiration
- C. Ocean acidification
- D. Decomposition

[1]

22N.1A.SL.TZ0.10

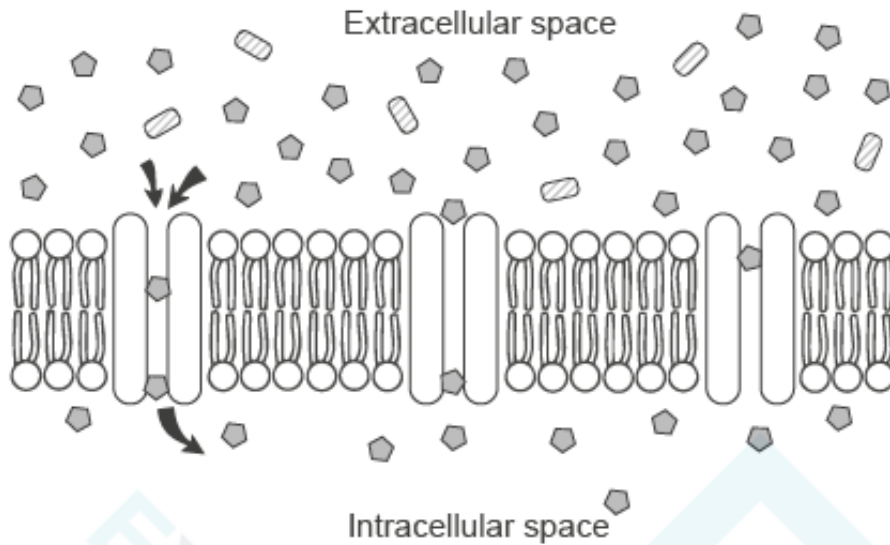
A **DNA** triplet on the strand that is transcribed has the bases TAG. Which anticodon on tRNA is used in translation?

- A. AUC
- B. UAG
- C. TAG
- D. ATC

[1]

23M.1A.SL.TZ2.3

The diagram shows protein channels involved in the passive movement of a substance into the cell across the cell membrane.



What describes this movement?

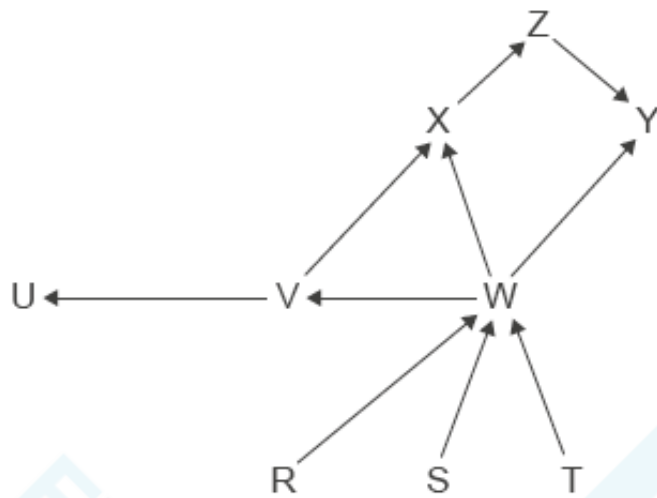
- A. Energy of ATP is used to transport substances into the cell.
- B. Substances can move from areas of low to areas of high concentration.
- C. The proteins ensure that movement of substances is only in one direction.
- D. Net movement occurs until the concentrations in and out of the cell are equal.

[1]

19M.1A.SL.TZ1.14



The diagram shows the food web for an aquatic ecosystem in which letters R–Z represent individual species.



[Source: © International Baccalaureate Organization 2019]

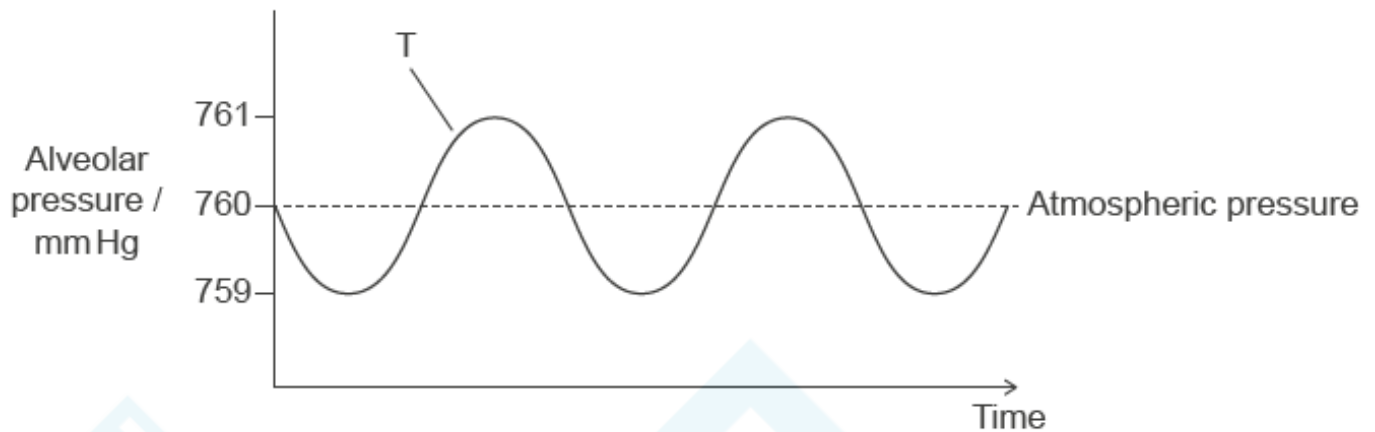
Which organism is a tertiary consumer?

- A. Organism T
- B. Organism U
- C. Organism W
- D. Organism Y

[1]

22M.1A.SL.TZ2.27

Pressure changes inside the thorax cause the movement of air in and out of the lung alveoli during ventilation. Alveolar pressure correlates to thoracic pressure. The diagram shows pressure changes in lung alveoli during ventilation in relation to normal atmospheric pressure. What causes forced movement of air out of the lungs at T?



A.	external intercostal muscles contract	diaphragm relaxes
B.	internal intercostal muscles contract	abdominal muscles contract
C.	internal intercostal muscles contract	diaphragm contracts
D.	external intercostal muscles relax	abdominal muscles relax

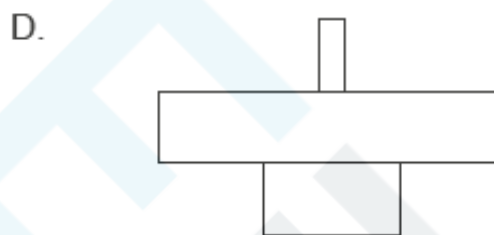
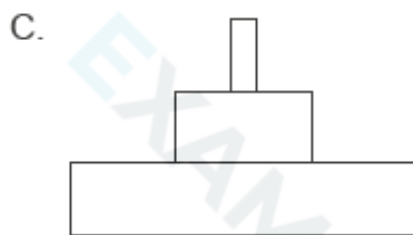
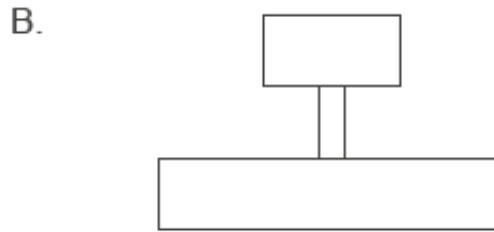
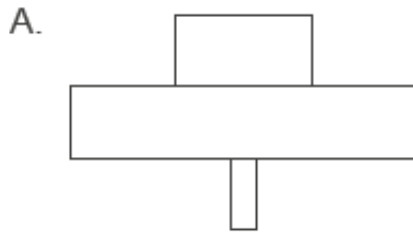
[1]

21N.1A.SL.TZ0.18

In a woodland ecosystem, each tree provides food for numerous aphids which feed on the sap of the tree. The aphids are eaten by carnivorous beetles, as shown in the food chain.

Oak Tree → Aphids → Beetles

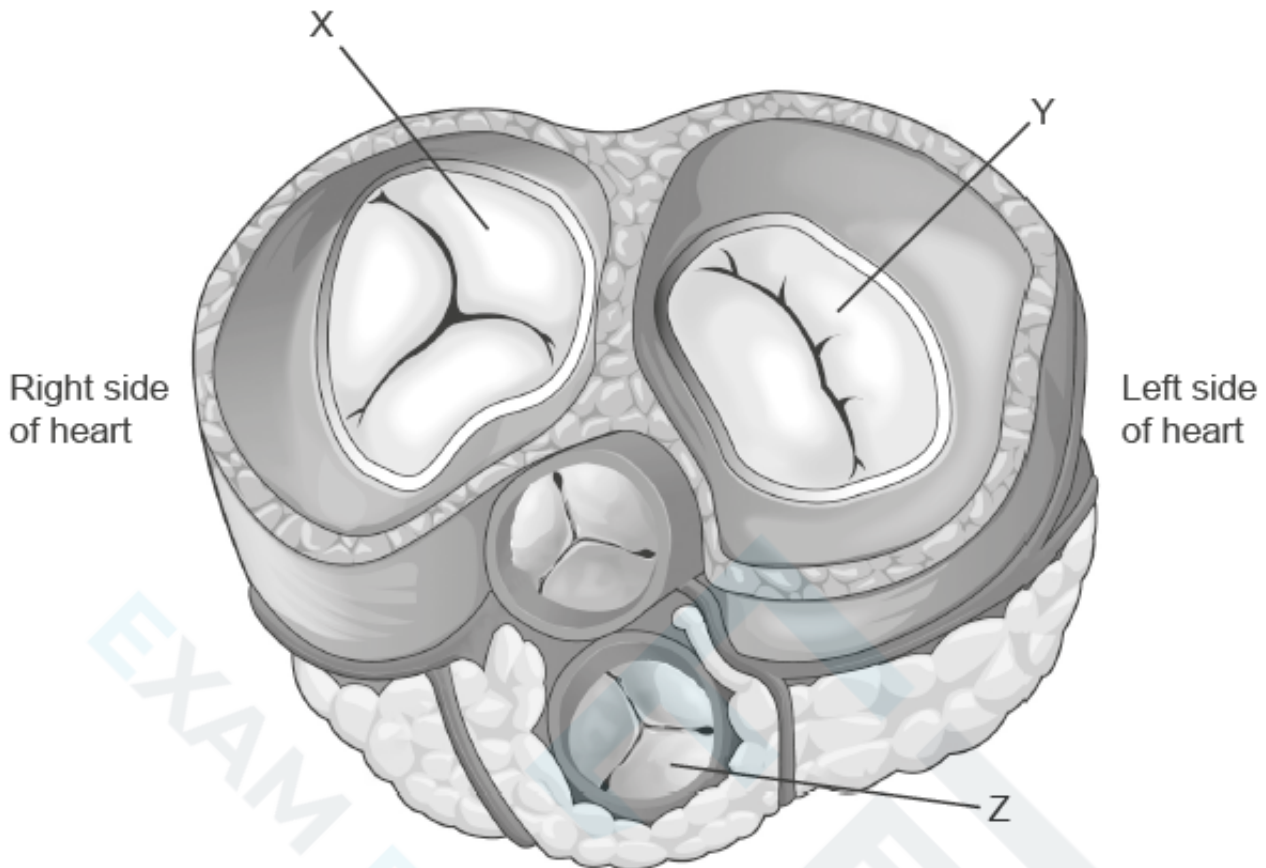
Which pyramid of energy represents this relationship?



[1]

22N.1A.SL.TZ0.26

The diagram shows a staggered transverse section (cut across rather than down) through the heart.



[Source: Oregon State University, n.d. *Heart Anatomy*. [diagram online] Available at: <https://open.oregonstate.edu/aandp/chapter/19-1-heart-anatomy/> [Accessed 28 October 2021].]

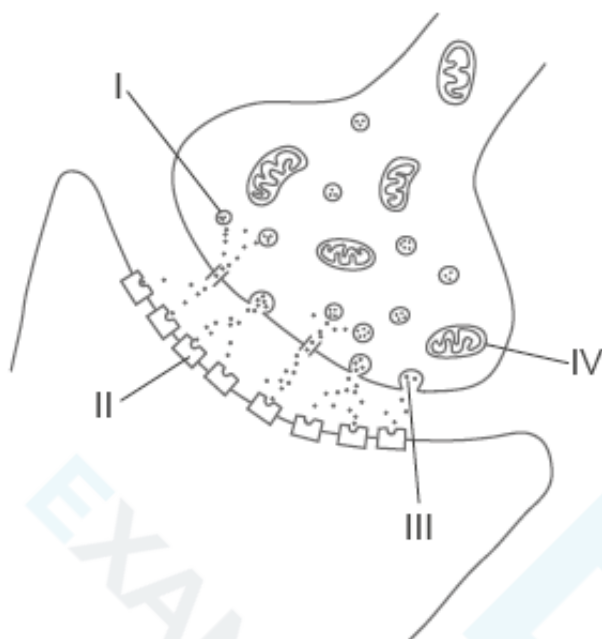
In what state are the valves when the ventricles are contracting?

	X	Y	Z
A.	Open	Closed	Closed
B.	Closed	Closed	Open
C.	Closed	Open	Open
D.	Open	Open	Closed

[1]

19M.1A.SL.TZ1.24

The diagram shows a neural synapse in the central nervous system of a honey bee (*Apis mellifera*).



[Source: © International Baccalaureate Organization 2019]

How do neonicotinoid pesticides cause paralysis and death of honey bees?

- A. They destroy I.
- B. They bind to II.
- C. They inhibit the release of III.
- D. They block the activity of IV.

[1]

21M.1A.SL.TZ2.26

Which cells are subject to attack by HIV? [1]

- A. Lymphocytes
- B. Erythrocytes
- C. Platelets
- D. Phagocytes

21M.1A.SL.TZ1.4

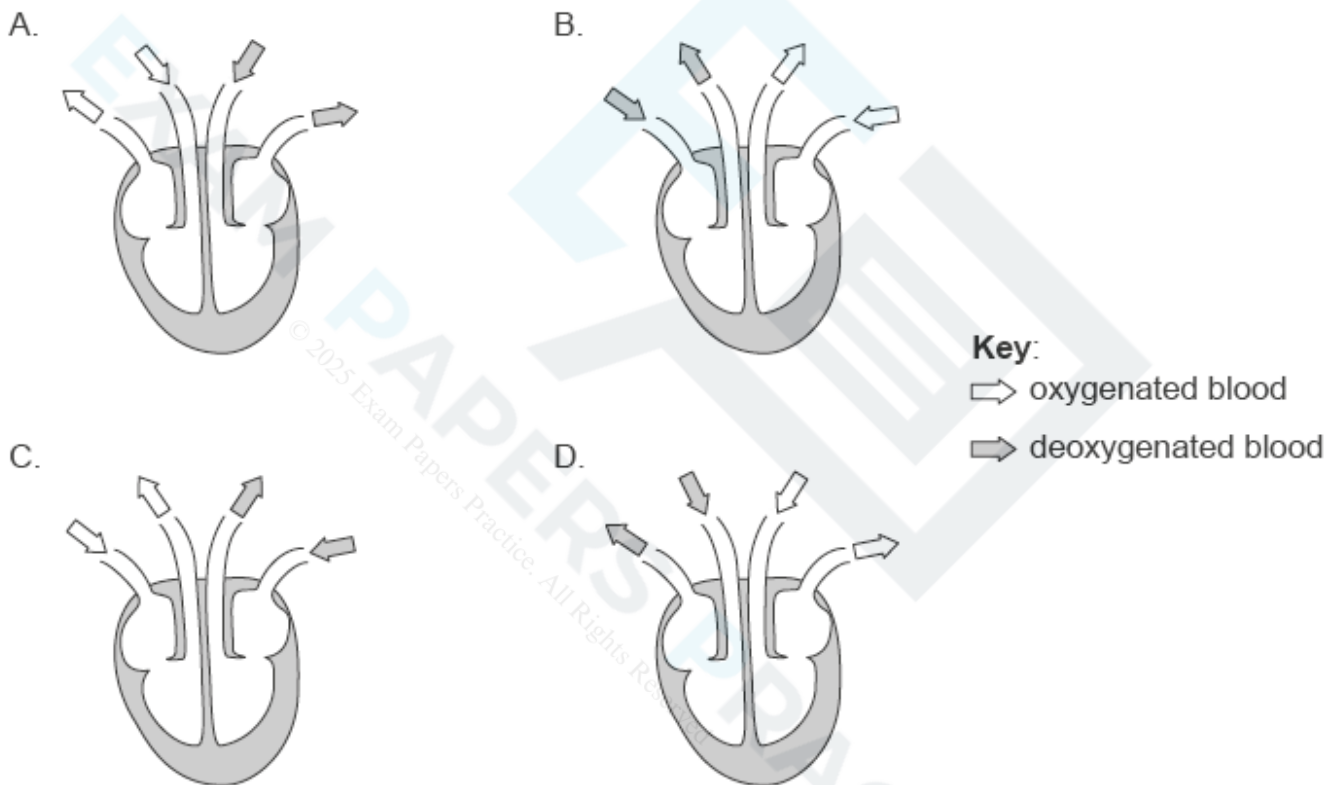
A human organ is being prepared for transplant. In what type of solution must it be bathed?

- A. A hypertonic solution
- B. A hypotonic solution
- C. Pure water containing no solutes
- D. A solution with the same osmolarity as the organ tissue

[1]

19M.1A.SL.TZ1.20

Which diagram represents blood flow through the mammalian heart?



[Source: © International Baccalaureate Organization 2019]

[1]

19M.1A.SL.TZ2.6

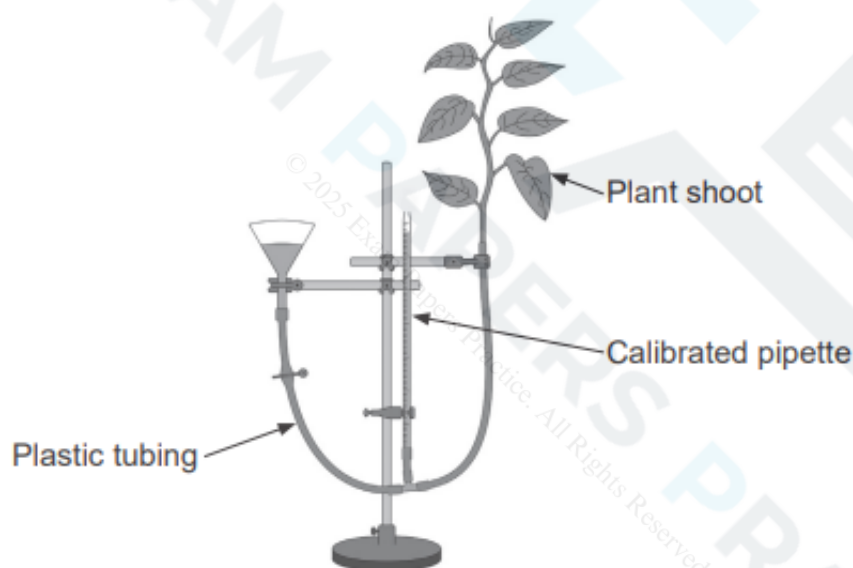
Where do hydrogen bonds form?

- A. Between the slight negative charge of hydrogen and slight positive charge of oxygen within a water molecule
- B. Between the slight positive charge of hydrogen and slight negative charge of oxygen within a water molecule
- C. Between the slight positive charge of hydrogen and slight negative charge of oxygen in different water molecules
- D. Between the slight negative charge of hydrogen and slight positive charge of oxygen in different water molecules

[1]

21M.1A.SL.TZ2.32

The apparatus in the diagram was used to assess the effects of factors on transpiration rates.



[Source: Republished with permission of Springer-Verlag from *Experimentelle Pflanzenphysiologie: Band 2*, Peter Schopfer, 1st edition, 1st Jan 1989; permission conveyed through Copyright Clearance Center, Inc.]

Which factor would be a controlled variable in an experiment designed to assess the effects of temperature on transpiration rate?

- A. The opening and closing of stomata
- B. The intensity of light striking the plant
- C. The height of the water in the reservoir
- D. The evaporation of water from the leaves

[1]

19M.1A.SL.TZ1.27

The diagram shows the arrangement of introns and exons in a segment of pre-mRNA. Pre-mRNA is immature mRNA containing introns and exons.



Which is a mature mRNA molecule derived from the pre-mRNA by splicing?

- A. 
- B. 
- C. 
- D. 

[Source: © International Baccalaureate Organization 2019]

[1]

21N.1A.SL.TZ0.8

What prevents plants from converting carbon dioxide into glucose in the dark? [1]

- A. They do not have a source of energy.
- B. It is too cold.
- C. They do not require glucose during the night.
- D. Their enzymes are inhibited.

20N.1A.SL.TZ0.35

Andalusian fowl have varied colours and types of feathers. The allele for black feathers is codominant with the allele for white, producing blue feathers in the heterozygote. The texture of feathers is controlled by another gene, with silky feathers recessive to normal. Blue silky birds are crossed with black silky birds. What is the expected proportion of blue silky offspring?

- A. 0%
- B. 25%
- C. 50%
- D. 100%

[1]

21N.1A.SL.TZ0.2

Which features of phospholipids give them their amphipathic properties? [1]

- A. Basic phosphate groups and acidic lipids
- B. Acidic phosphate groups and basic lipids
- C. Hydrophobic phosphate groups and hydrophilic fatty acids
- D. Hydrophilic phosphate groups and hydrophobic fatty acids

21M.1A.SL.TZ1.14

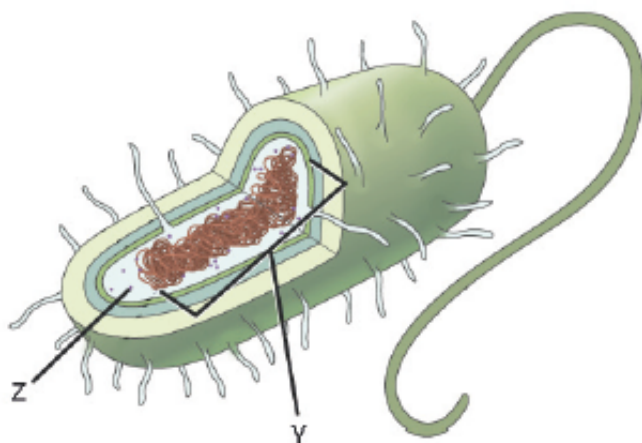
Which statement applies to enzymes?

[1]

- A. Enzyme function depends on collisions between substrate and active sites.
- B. One active site typically binds to a broad range of substrates.
- C. The active site on the substrate is specific to one enzyme.
- D. When enzymes are immobilized they stop working.

22N.1A.SL.TZ0.1

The diagram shows a prokaryotic cell.



[Source: © Rice University. 1999–2023 *Figure 4.5 Prokaryotic cell* . [image online <https://openstax.org/apps/archive/20220815.182343/resources/50163f8ff80f335574f4> [Accessed 13 January 2023].]

What are the structures labelled Y and Z?

	Y	Z
A.	Nucleus	70S ribosome
B.	Nucleoid	80S ribosome
C.	Nucleus	80S ribosome
D.	Nucleoid	70S ribosome

[1]

20N.1A.SL.TZ0.17

How can a chi-squared test be used in ecological research?

[1]

- A. To test the effect of an abiotic factor on one plant species
- B. To test whether two species tend to live together
- C. To test whether one population of plants is taller than another
- D. To test whether one species is more tolerant to heavy metals than another

SPM.1A.SL.TZ0.29



Which is a density-independent limiting factor for a kangaroo? [1]

- A. A forest fire
- B. Predation
- C. Climate change
- D. Eutrophication

23M.1A.SL.TZ1.6

What is an example of anabolism? [1]

- A. Formation of peptides after protein digestion
- B. Formation of glucose and fructose from sucrose
- C. Formation of maltose from two glucose molecules
- D. Formation of glycerol and fatty acids from triglycerides

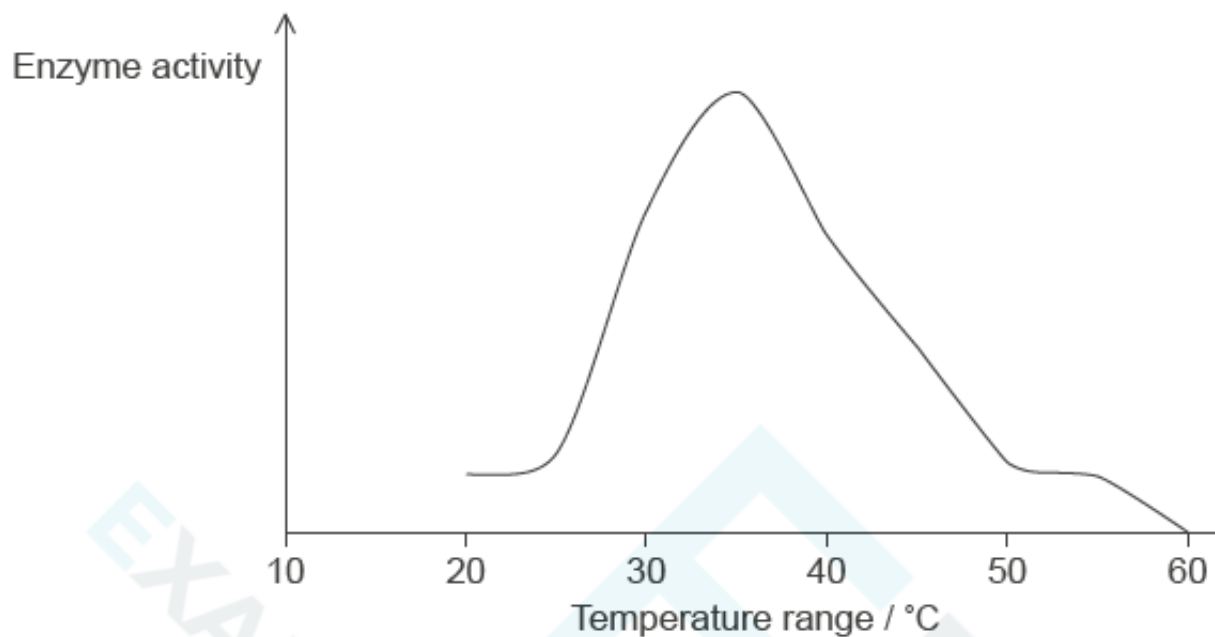
19M.1A.SL.TZ2.19

Which is **not** essential in a viable mesocosm? [1]

- A. Light source
- B. Autotroph
- C. Saprotroph
- D. Herbivore

22M.1A.SL.TZ1.5

The graph shows the activity of an enzyme at various temperatures. The pH of the experiment was kept constant at pH 8.



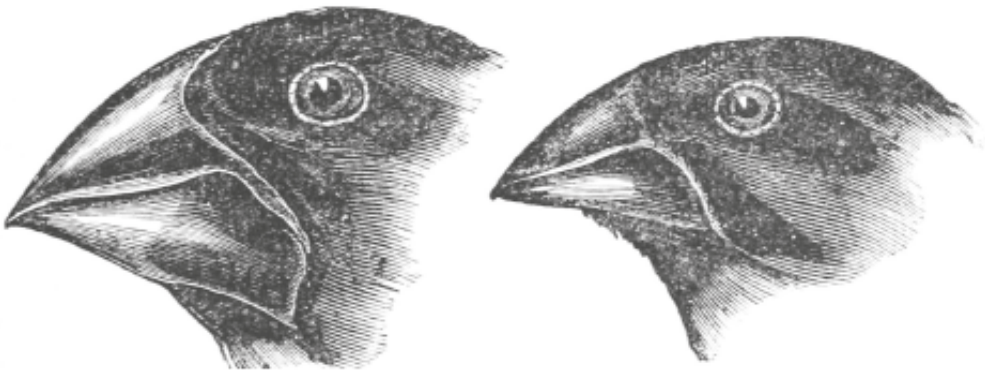
Based on the data, what would the result be if the experiment was repeated at pH 9?

- A. The enzyme activity would be higher.
- B. The results of the enzyme activity would be almost the same.
- C. The enzyme activity would be lower.
- D. There is not enough information to make a reliable prediction.

[1]

21N.1A.SL.TZ0.21

Scientists studying ground finches (*Geospiza fortis*) on the island of Daphne Major in Galapagos found great differences in the shapes of the beaks.



[Source: Public domain.]

What is the explanation for this variation in beak shape between the birds?

- A. Ground finches grow larger beaks if there is competition for food.
- B. They belong to different species.
- C. They are adapted for different diets.
- D. The more a beak is used by a ground finch, the larger it becomes.

[1]

21M.1A.SL.TZ2.19

Which gases have made the most significant contributions to global warming? [1]

- A. Water and carbon dioxide
- B. Carbon dioxide and methane
- C. Methane and nitrous oxide
- D. Carbon dioxide and ozone

19N.1A.SL.TZ0.22

How does HIV affect the immune system adversely? [1]

- A. Progressive reduction in number of active lymphocytes
- B. Continuous overproduction of antibodies
- C. Rapid production of clone of plasma cells
- D. Immediate development of AIDS

19M.1A.SL.TZ2.7

The diagram shows two polysaccharides, formed from condensation of many glucose molecules.



[Source: © International Baccalaureate Organization 2019]

What are the names of X and Y?

	X	Y
A.	glycogen	amylose
B.	amylopectin	amylase
C.	amylase	glycogen
D.	amylose	amylopectin

[1]

20N.1A.SL.TZ0.15

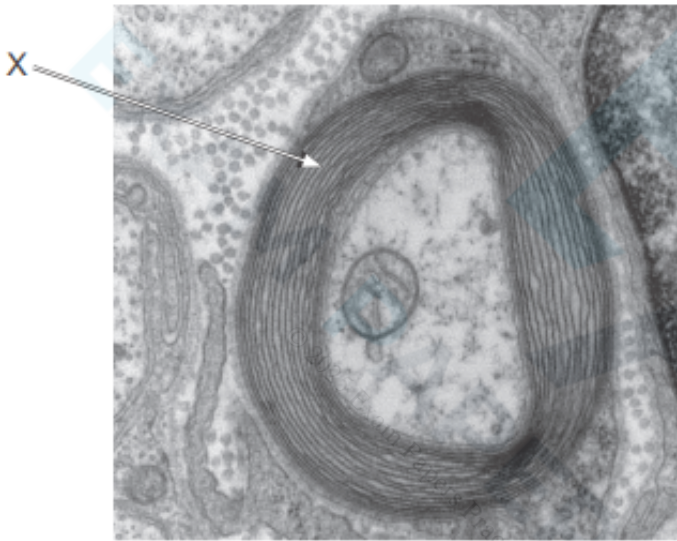
What are all the possible phenotypes of children born to a mother with blood group AB and a father with blood group A?

- A. AB only
- B. A and B
- C. AB, A and B
- D. AB, A and O

[1]

21M.1A.SL.TZ2.24

The electron micrograph shows a transverse section through a myelinated neuron.



[Source: Transmission electron micrograph of a myelinated axon.

https://commons.wikimedia.org/wiki/File:Myelinated_neuron.jpg . This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license (<https://creativecommons.org/licenses/by-sa/3.0/deed.en>).]

What process is facilitated by the presence of the structure labelled X?

- A. Repolarization of the nerve cell membrane
- B. Generation of an action potential
- C. Saltatory conduction
- D. Synaptic transmission

[1]

SPM.1A.SL.TZ0.17

What occurs at gas exchange surfaces in the lungs of mammals? [1]

- I. Gases diffuse across a moist surface.
- II. Concentration gradients are maintained by ventilation.
- III. Water is lost.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

22M.1A.SL.TZ2.20

Humans have been improving crop species for thousands of years by cross-breeding plants with desirable characteristics. The photograph shows the changes in dry cobs of corn (*Zea mays*) over 10 000 years.



[Source: Evolution of Maize Cobs © Robert S. Peabody Institute of Archaeology, Phillips Academy, Andover, Massachusetts. All Rights Reserved.]

What is the name of the process that was used to produce modern corn?

- A. Selective breeding
- B. Adaptive radiation
- C. Discontinuous variation
- D. Natural selection

[1]

SPM.1A.SL.TZ0.2

What is a consequence of the ability of water to form many intermolecular hydrogen bonds?

- A. Ice has a higher density than water and floats, providing habitats for fish-eating mammals.
- B. Light can pass through water, so algae can photosynthesise.
- C. Some small invertebrates can walk on water surfaces.
- D. Small amounts of energy are needed to change water from one state to another, so that evaporation rates and condensation rates are rapid.

[1]

SPM.1A.SL.TZ0.16

Which term describes the whole of the genetic information of an organism? [1]

- A. Genome
- B. DNA
- C. Gene pool
- D. Allele frequency

22M.1A.SL.TZ1.9

A molecule of DNA is found to contain 200 guanine bases, representing 25 % of the total number of bases. How many phosphate groups does this molecule of DNA contain?

- A. 50
- B. 200
- C. 800
- D. 1000

[1]

19M.1A.SL.TZ1.28

Which statement applies to HIV?

[1]

- A. HIV infects red blood cells resulting in decreased production of hemoglobin.
- B. HIV can be effectively treated using antibiotics.
- C. HIV can only be transmitted by sexual intercourse.
- D. HIV causes a reduction in production of antibodies.

21M.1A.SL.TZ1.27

What is a property of arteries? [1]

A. Arteries have elastic walls.
 B. Arteries have valves.
 C. All arteries carry oxygenated blood.
 D. Arteries receive blood from the atria.

21N.1A.SL.TZ0.7

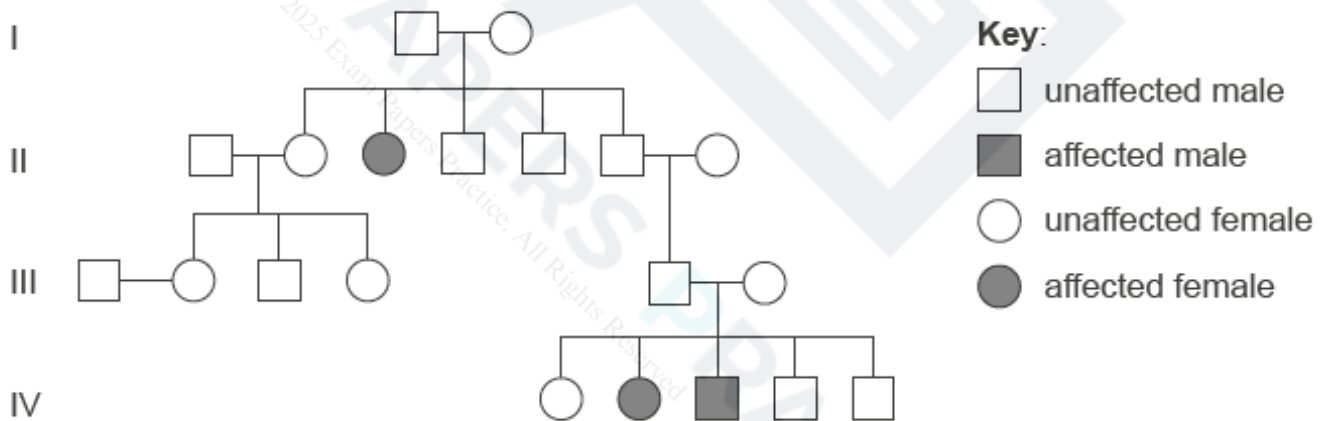
What is the benefit to living organisms that water has a high specific heat capacity?

A. Heat can be lost from the skin when sweat evaporates.
 B. Aquatic environments do not have a great fluctuation in their temperature.
 C. The amount of heat stored by water is highly predictable.
 D. It allows water to be a solvent for chemical reactions at body temperature.

[1]

19M.1A.SL.TZ2.14

The pedigree chart shows a family affected by cystic fibrosis.



[Source: © International Baccalaureate Organization 2019]

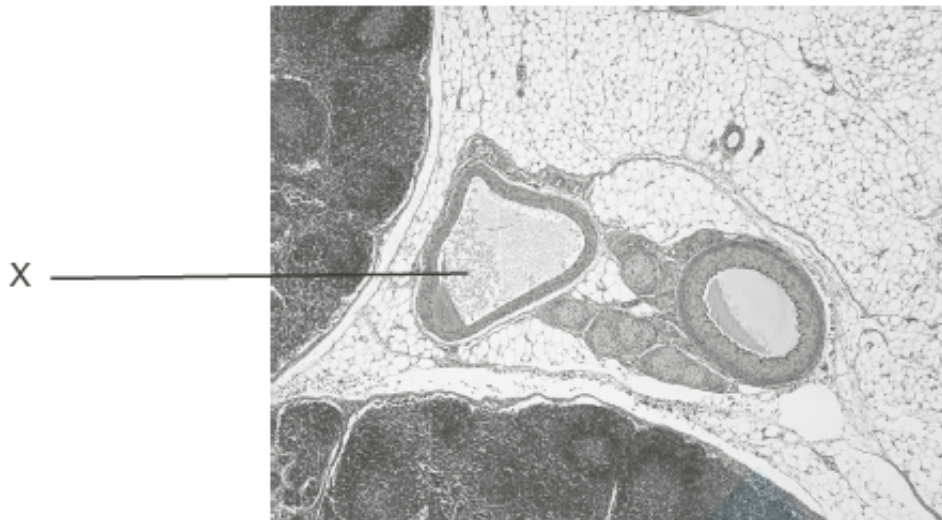
What is the genotype of the affected boy's father?

- A. AA only
 B. Either AA or Aa
 C. Aa only
 D. aa only

[1]

23M.1A.SL.TZ1.25

The light micrograph shows the structure of blood vessels in a muscle.



[Source: Calvo, J.L., n.d. [image online] Available from: <https://www.khanacademy.com/science/biology/cell-biology/a/light-micrograph-of-muscle-tissue/a/light-micrograph-of-muscle-tissue-text> (accessed 21 January 2021)./image-photo/muscular-artery-

Which blood vessel is shown by X?

- A. A vein
- B. An artery
- C. An arteriole
- D. A capillary

[1]

SPM.1A.SL.TZ0.13

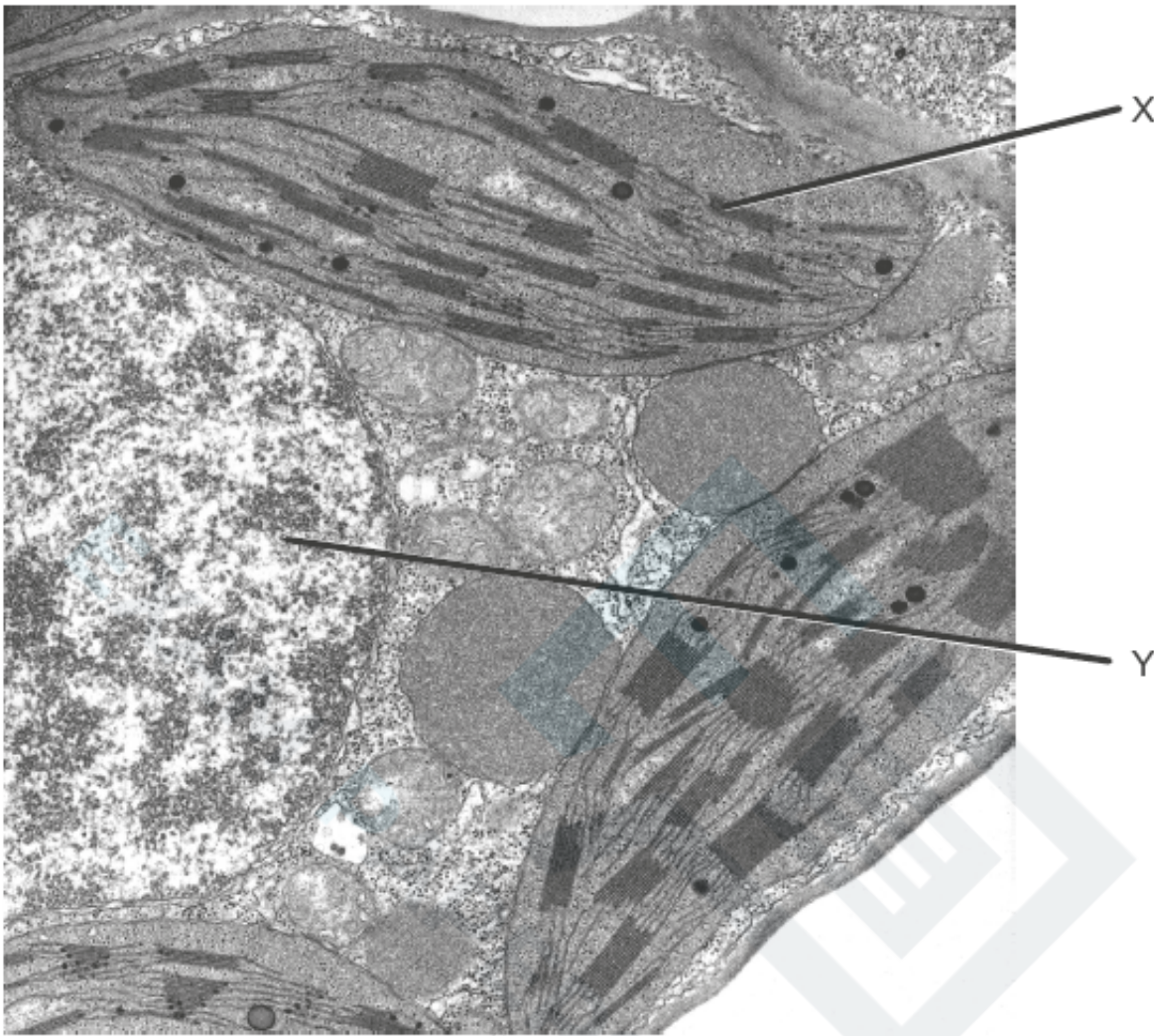
How is the Na/K ion ratio established during the resting potential phase of neuron activity?

	Na ions	K ions
A.	Actively transferred in	Actively transferred out
B.	Actively transferred out	Actively transferred in
C.	Passively diffused in	Passively diffused out
D.	Passively diffused out	Passively diffused in

[1]

19M.1A.SL.TZ1.2

The image shows an electron micrograph of part of a cell.



[Source: Dr. Eldon Newcomb – Emeritis Professor at The University of Wisconsin – Madison.]

Which features do the two structures labelled X and Y have in common?

- A. They are surrounded by a double membrane.
- B. They contain 70S ribosomes.
- C. They contain naked DNA.
- D. They are only found in leaf cells.

[1]

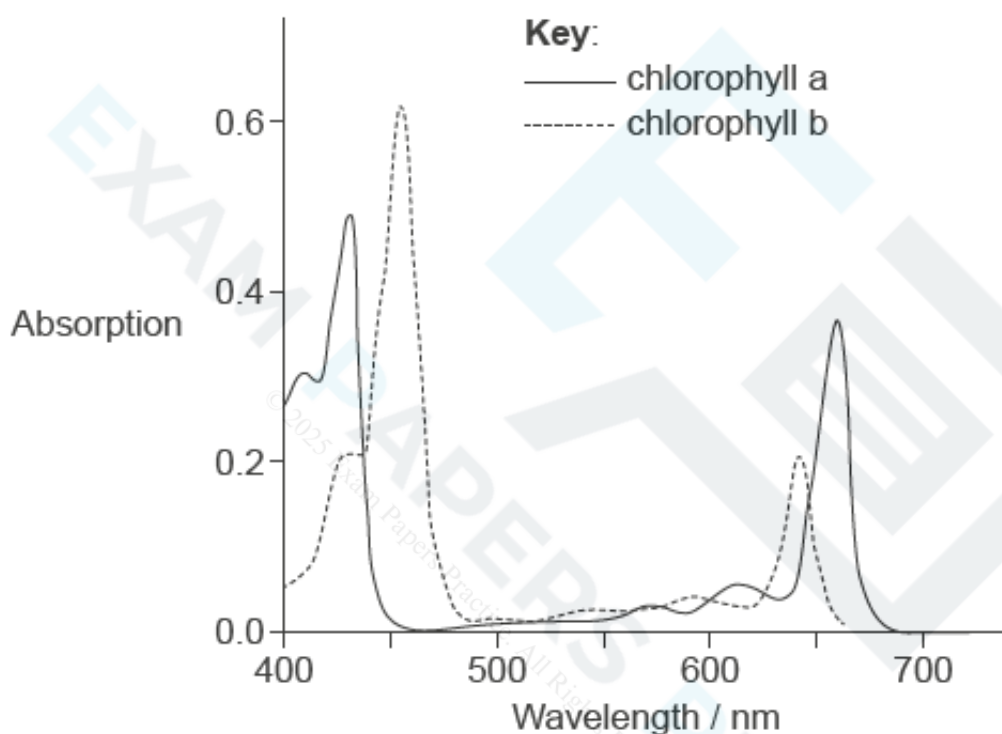
23M.1A.SL.TZ2.1

What cell component is found in eukaryotic cells but not in prokaryotic cells? [1]

- A. Mitochondria for respiration
- B. DNA containing genetic information
- C. Ribosomes for protein synthesis
- D. Cell wall to maintain shape

19M.1A.SL.TZ2.11

The graph shows the absorption spectra of chlorophyll a and chlorophyll b.



[Source: adapted from F. P. Zscheile and C. L. Comar, 'Influence of Preparative Procedure on the Purity of Chlorophyll Components as Shown by Absorption Spectra.' *Int. J. Plant Sciences*, Volume 102, Number 3, Mar., 1941, pp. 463-481.

Used with the kind permission of University of Chicago Press.]

What can be concluded from the graph?

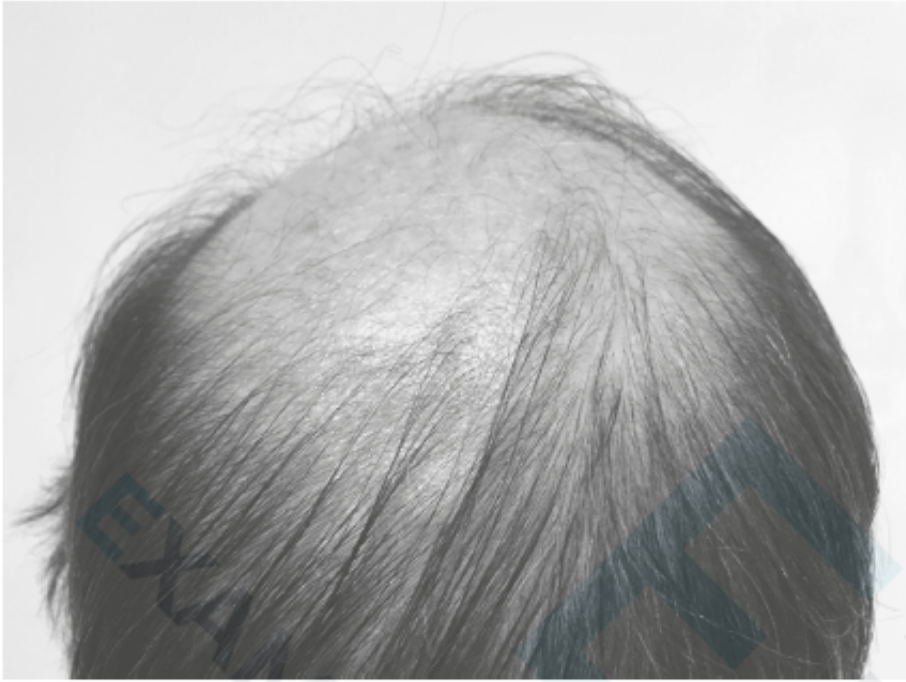
- A. Both chlorophyll a and chlorophyll b absorb a large amount of green light
- B. Chlorophyll b absorbs red light more efficiently than blue light
- C. Other pigments must absorb light between blue and red in the spectrum
- D. Chlorophyll a and chlorophyll b have different absorption peaks

[1]

21N.1A.SL.TZ0.15



In humans, male pattern baldness is caused by a recessive sex-linked gene found only on the X chromosome.



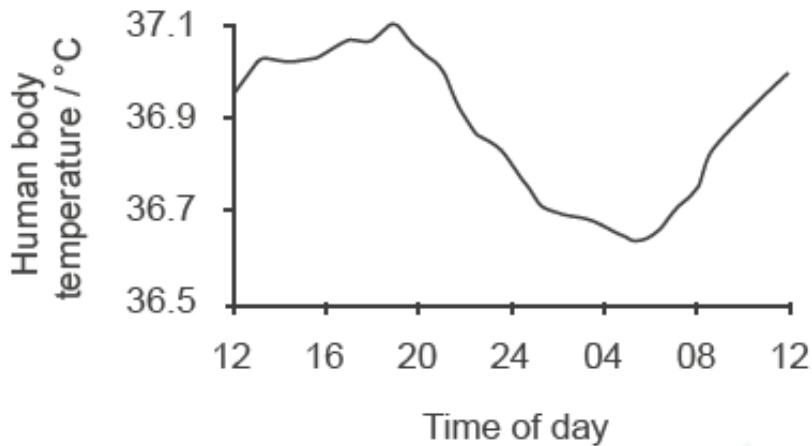
If a father who does not have male pattern baldness and a mother who is a carrier for it have a child, what is the probability that the child will develop male pattern baldness in adulthood?

- A. 0 %
- B. 25 %
- C. 50 %
- D. 75 %

[1]

22N.1A.SL.TZ0.29

The graph shows human body temperature variation in a daily rhythm of 24 hours. [1]



Which hormone controls this variation?

- A. Progesterone
- B. Insulin
- C. Glucagon
- D. Thyroxine

21M.1A.SL.TZ2.9

Which feature is common to both mRNA and DNA? [1]

- A. Covalent bonds between adjacent nucleotides
- B. Hydrogen bonds between guanine and cytosine
- C. Ribose sugar attached to phosphate
- D. Antiparallel arrangement of polynucleotide strands

22M.1A.SL.TZ2.23

Which factor(s) would favour evolution by natural selection? [1]

- I. Long lifespans
- II. Favourable characteristics acquired by individuals during their lifetime
- III. Variation within a species

- A. II only
- B. III only
- C. I and II
- D. I and III

22M.1A.SL.TZ2.1



Cell metabolism involves anabolic and catabolic reactions. Which process directly involves anabolism?

- A. Active transport of ions
- B. Release of energy from glucose
- C. Production of intracellular enzymes
- D. Breakdown of worn-out cell organelles by lysosomes

[1]

21M.1A.SL.TZ1.20

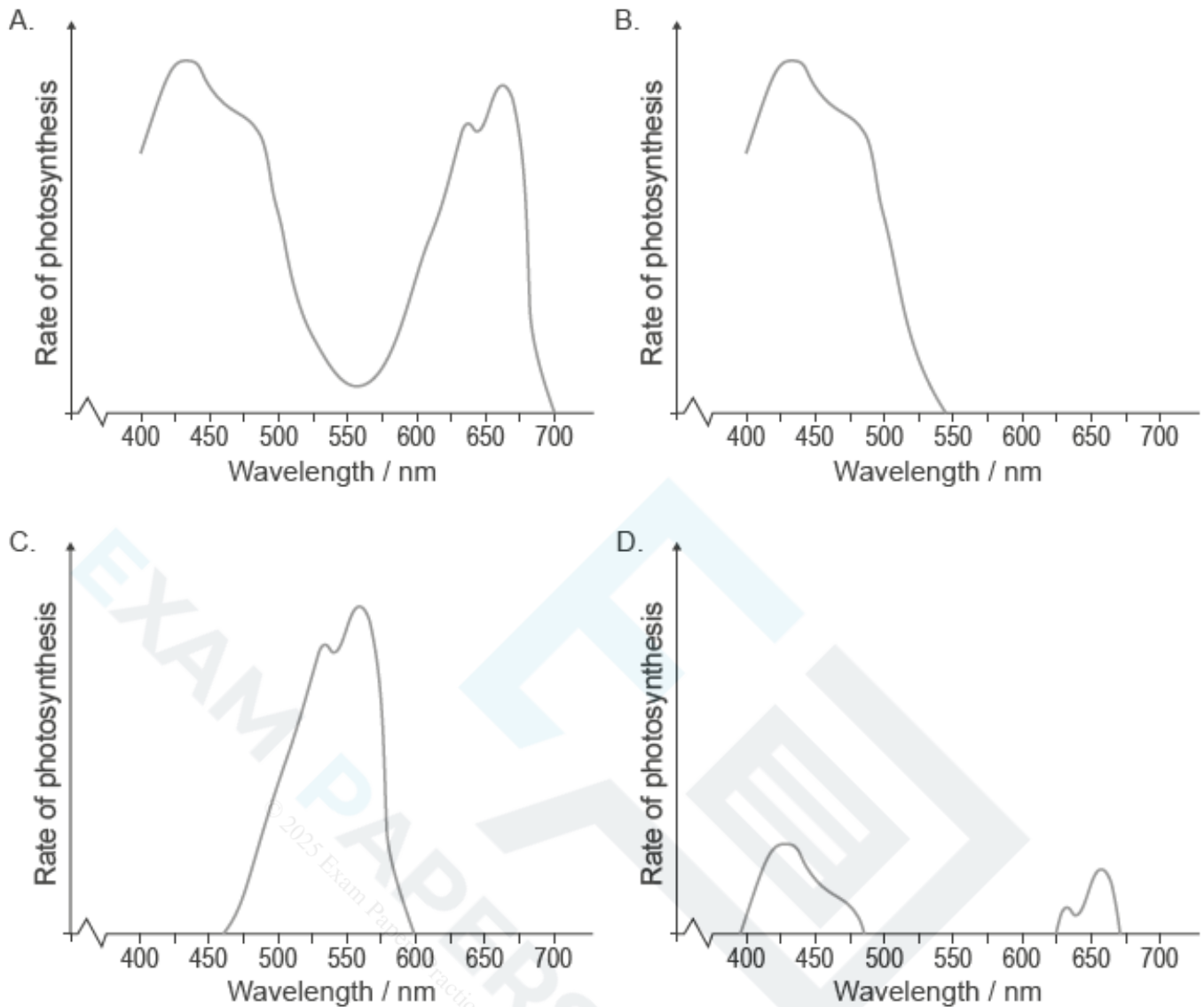
Over time, the hull of a sunken ship may become colonized by a wide range of marine organisms. What term is used to describe all of the organisms living in and on a sunken ship?

- A. A community
- B. An ecological niche
- C. A population
- D. An ecosystem

[1]

23M.1A.SL.TZ2.10

Which graph represents the action spectrum for a green plant receiving only blue light?



[1]

22M.1A.SL.TZ1.16

Huntington's disease is an autosomal dominant genetic disease. What are the chances of two parents that are heterozygous for the gene having a child with Huntington's disease?

- A. 25 %
- B. 50 %
- C. 75 %
- D. 100 %

[1]

22M.1A.SL.TZ1.22

Blood clotting involves a cascade of reactions. Which statement describes the blood-clotting process?

- A. Red blood cells release clotting factors that result in the production of fibrin.
- B. Clotting factors trigger the conversion of the inactive thrombin to prothrombin.
- C. Insoluble fibrinogen is converted into soluble fibrin.
- D. Fibrin forms a mesh that traps platelets and blood cells.

[1]

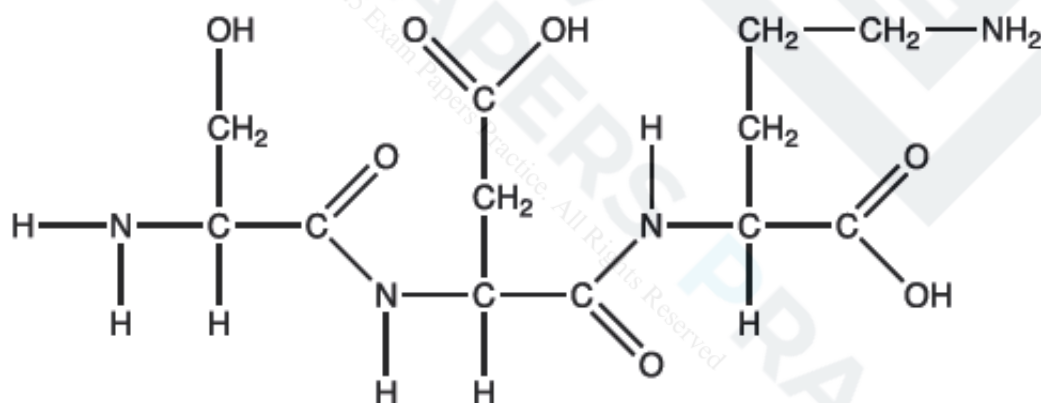
22N.1A.SL.TZ0.13

What is a difference between two alleles of a gene? [1]

- A. Their positions on homologous chromosomes
- B. Their amino acid sequence
- C. The characteristic they influence
- D. Their base sequence

22N.1A.SL.TZ0.7

The diagram shows the product of a polymerization reaction. [1]



What is formed in this polymerization reaction?

- A. A dipeptide formed by the hydrolysis of two nucleotides
- B. A tripeptide formed by the hydrolysis of three amino acids
- C. A dipeptide formed by the condensation of two amino acids
- D. A tripeptide formed by the condensation of three amino acids

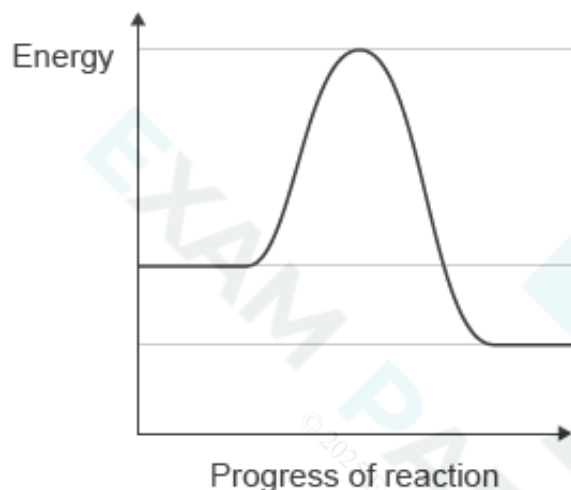
19M.1A.SL.TZ2.27

What is the reason for antibiotics not damaging human cells? [1]

- A. The dose is too small to be harmful.
- B. The dose is taken for only a short time.
- C. Antibiotics occur naturally in humans.
- D. Human metabolism is different from bacterial metabolism.

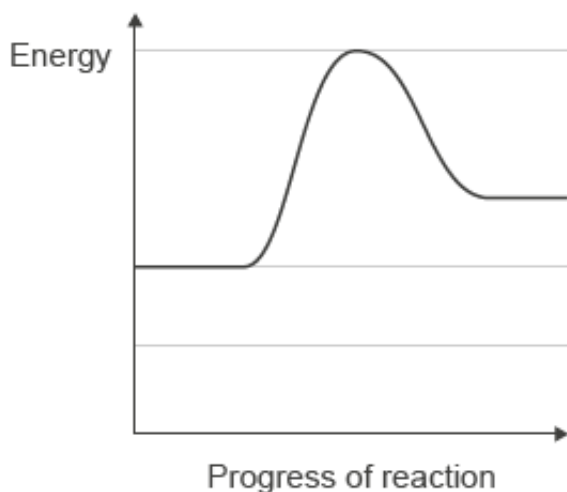
23M.1A.SL.TZ2.25

The graph shows the energy changes during a chemical reaction. The horizontal lines represent the original energy values.

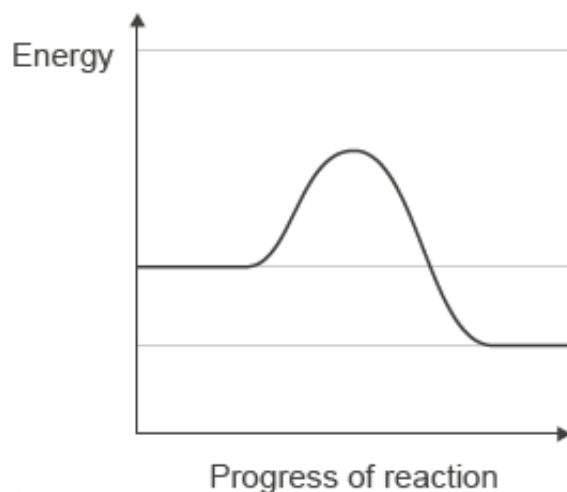


Which graph represents the energy changes once a suitable enzyme has been added?

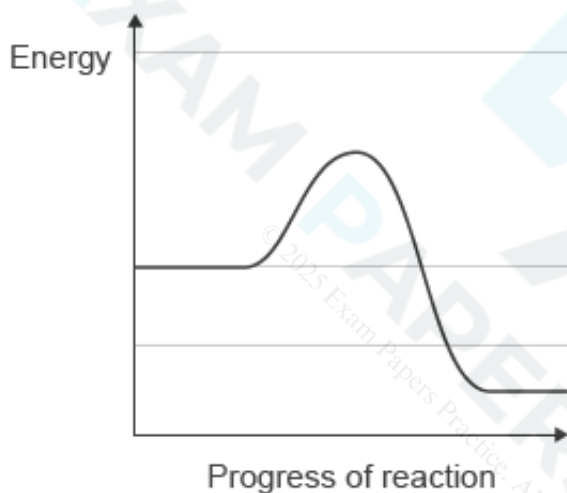
A.



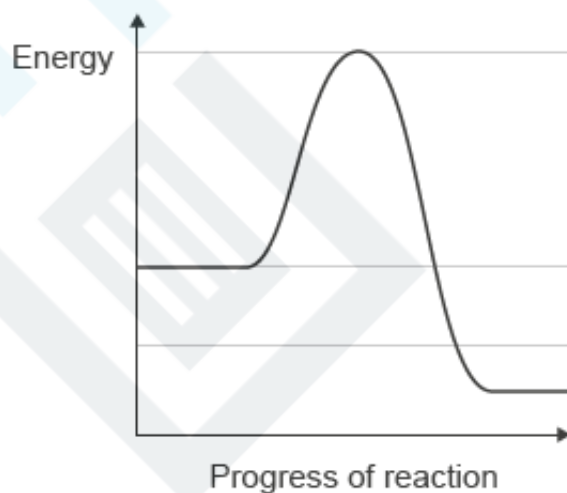
B.



C.



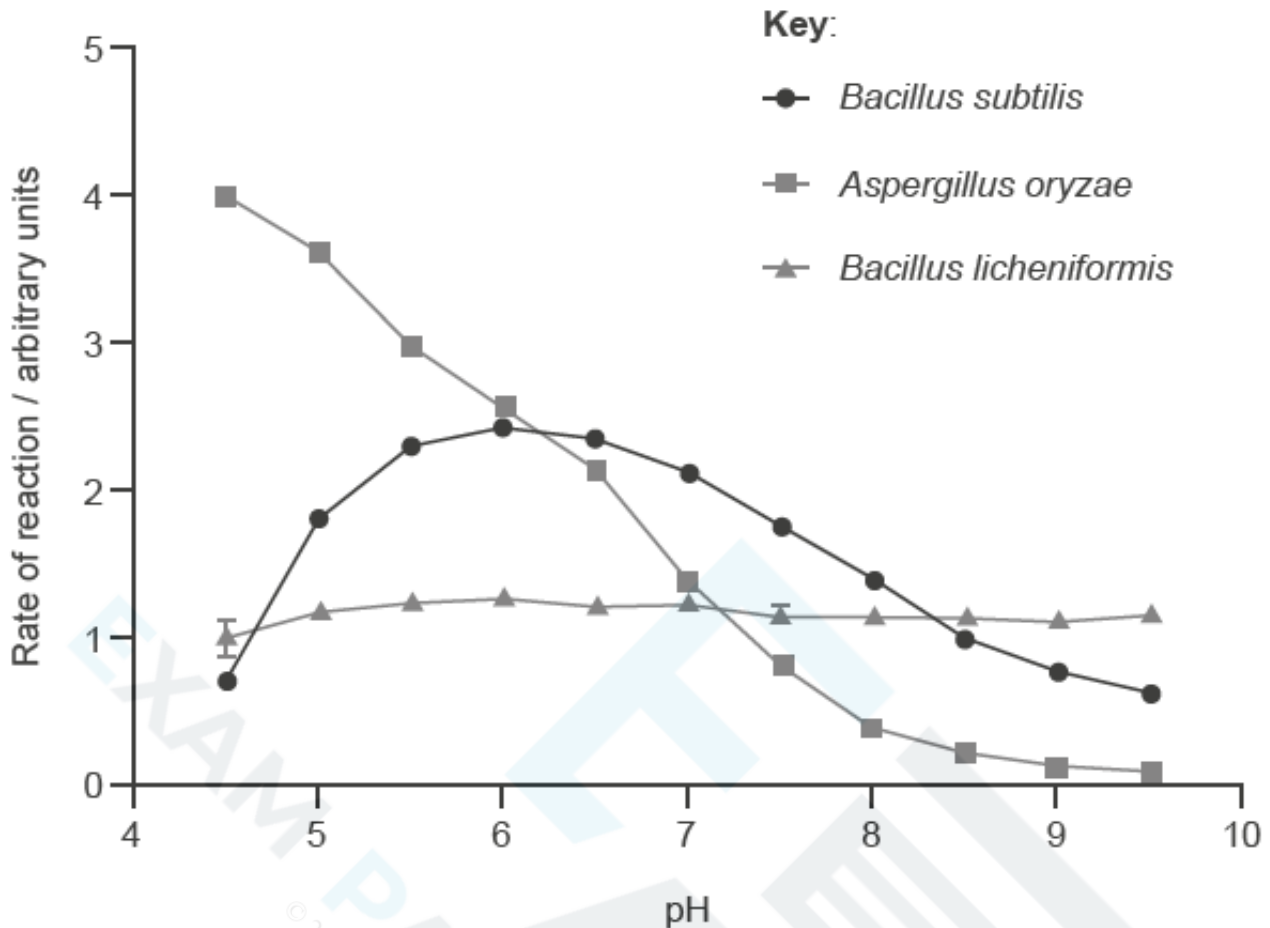
D.



[1]

22N.1A.SL.TZ0.9

The activity of amylase from two bacterial species and a fungus was measured at different pH levels and constant temperature. The results are shown in the graph.



[Source: Held, P., 2012. *Enzymatic Digestion of Polysaccharides. Part II: Optimization of Polymer Digestion and Glucose Production in Microplates*. Available at: <https://www.agilent.com/cs/library/applications/enzymatic-digestion-of-polysaccharides-part-II-59943304EN-agilent.pdf>.]

Which statement about the effect of pH on amylase can be concluded?

- A. *A. oryzae* amylase has the highest optimum pH.
- B. A change in pH affects amylase most in *B. licheniformis*.
- C. The optimum pH is 6 in *B. subtilis*.
- D. Amylase activity at pH 8 is the lowest in *B. licheniformis*.

[1]

21M.1A.SL.TZ1.35

Which statement is valid regarding chromatids?

[1]

- A. Sister chromatids separate during meiosis I.
- B. Chiasmata form between non-sister chromatids.
- C. Crossing over is the exchange of DNA between sister chromatids only.
- D. Non-sister chromatids have the same combination of alleles.

21M.1A.SL.TZ2.11



What feature of eukaryotic chromosomes distinguishes them from the chromosomes of prokaryotes?

- A. Histone proteins
- B. Circular DNA
- C. Double-stranded DNA molecules
- D. Multiple genes along the length of each chromosome

[1]

21N.1A.SL.TZ0.17

What is exchanged between a sealed mesocosm and the surrounding external environment?

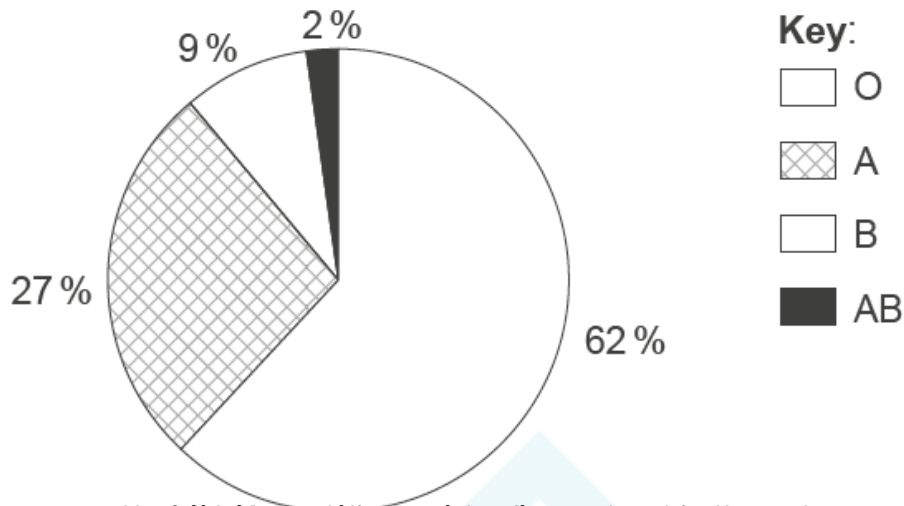
- A. Energy
- B. Water
- C. Air
- D. Nothing can pass

[1]

23M.1A.SL.TZ1.34

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A total of 271 164 people were tested for blood groups in Mexico. The pie chart summarizes the ABO blood group distribution.



[Source: Canizales, R. and Soto, A. (2008) Blood Group Distribution in Mexico and Gene Diversity

What can be concluded from the ABO blood group distribution in Mexico?

- A. Allele frequencies are not the same for all blood group alleles.
- B. The majority of the Mexican population shows a co-dominant phenotype.
- C. Most of the Mexican population can receive blood from all blood groups.
- D. Only 2 % of the Mexican population have a heterozygous genotype for blood groups.

[1]

SPM.1A.SL.TZ0.5

What is a common feature of enzymes?

[1]

- A. They all react with substrates.
- B. They all decrease the rate of reaction.
- C. They are all secreted from cells in vesicles.
- D. They all bind to the active site of their substrate.

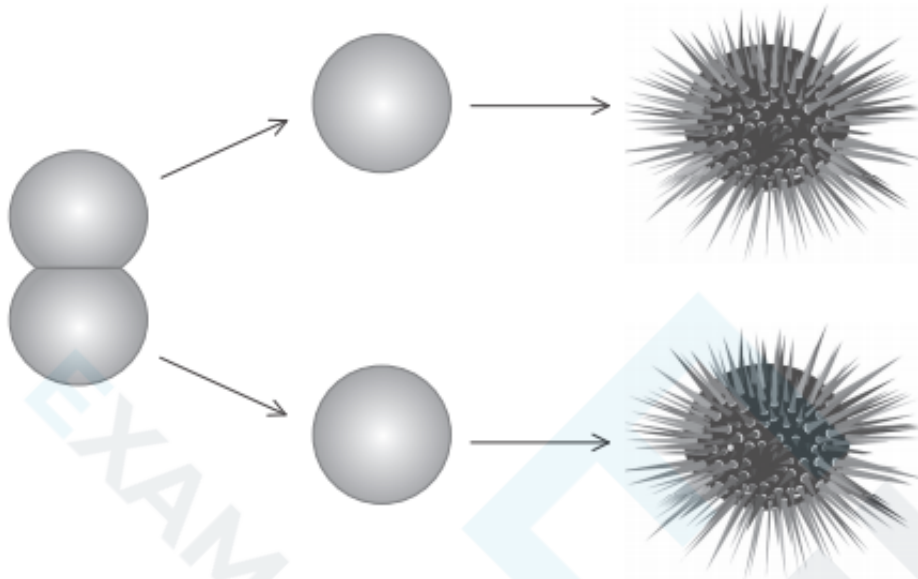
SPM.1A.SL.TZ0.30

What is an outcome of natural selection? [1]

- A. Evolution
- B. Mutations
- C. Reproductive isolation
- D. Variation

21M.1A.SL.TZ1.17

A two-cell sea urchin (*Echinoidea*) embryo was physically separated by scientists into two cells. Each cell, through further embryonic development, became an adult sea urchin.



[Source: Clker-Free-Vector-Images/Pixabay.]

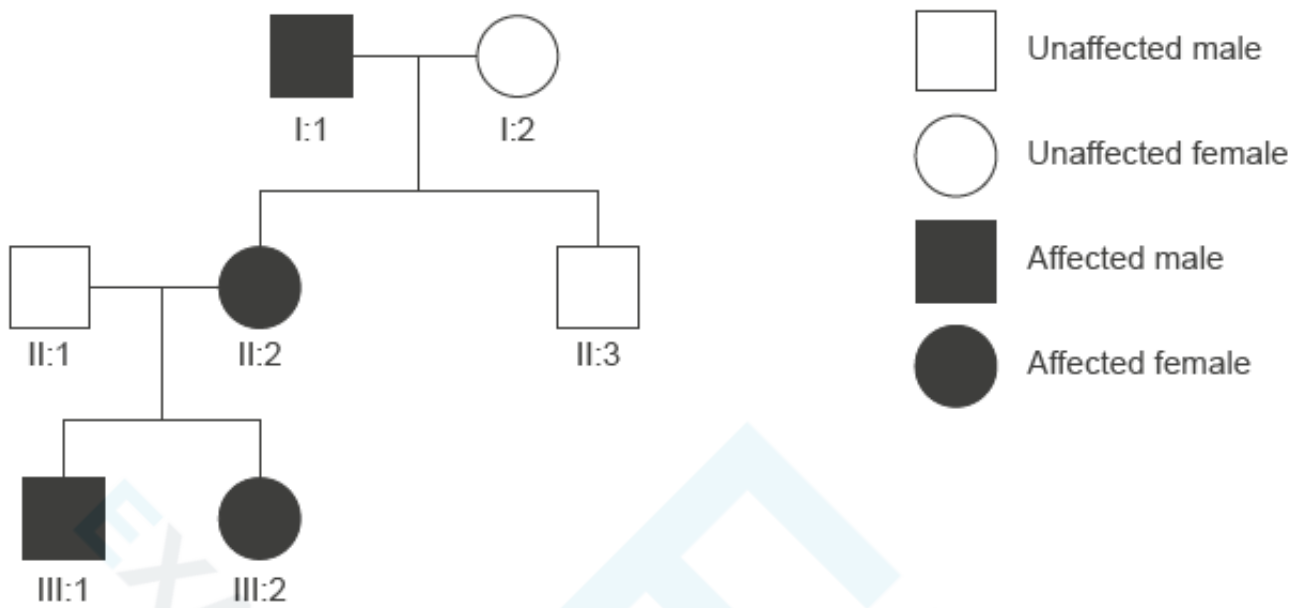
What is the relationship between the two adult sea urchins?

- A. They are equivalent to non-identical twins.
- B. Half of the genes would be the same.
- C. Both adults would have haploid cells.
- D. They are clones.

[1]

23M.1A.SL.TZ2.16

The pedigree chart shows the inheritance of three generations of Duane syndrome, a condition caused by a dominant allele that affects alignment of the eyes.



If individuals II:1 and II:2 had a third child, what is the probability that the child would have Duane syndrome?

- A. 25 %
- B. 50 %
- C. 75 %
- D. 100 %

[1]

22M.1A.SL.TZ1.15

What is produced by meiosis in a cell of a male animal? [1]

- A. Four gametes, each with the same number of chromosomes
- B. Two gametes, each with the same number of chromosomes
- C. Four gametes, each with different numbers of chromosomes
- D. Two gametes, each with different numbers of chromosomes

23M.1A.SL.TZ2.29

What is a benefit of having xylem vessels close to phloem sieve tubes in plants? [1]

- A. Sugars can flow in both xylem vessels and phloem.
- B. Water can be supplied more easily to the phloem.
- C. A high concentration of solutes can be established at the source.
- D. Hydrostatic pressure can be established to move sugars to the source.

21M.1A.SL.TZ1.12

What is the term for the attraction of water molecules to other water molecules? [1]

- A. Surface tension
- B. Capillary action
- C. Cohesion
- D. Adhesion

19M.1A.SL.TZ2.1

Which structures are found only in prokaryotic cells? [1]

- A. Ribosomes
- B. Pili
- C. Cell walls
- D. Flagella

21M.1A.SL.TZ1.9

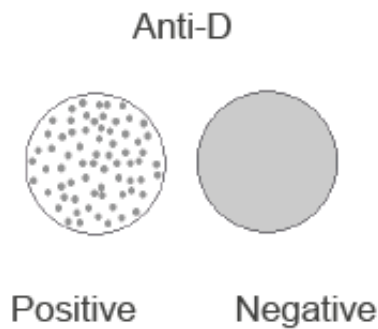
The hydrolysis of a pure sample of an organic molecule produces a pentose sugar, thymine, guanine and cytosine. What other substances could be expected to be present in the hydrolysed sample?

- A. RNA
- B. Uracil
- C. Phosphate
- D. ATP

[1]

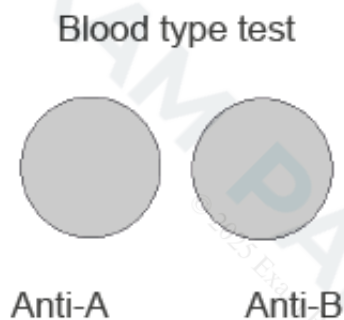
19M.1A.SL.TZ2.36

The blood of two men was tested and the results are shown. Anti-D refers to the rhesus blood group. Clotting indicates that antigens associated with a particular factor or blood group are present in a blood sample.



[Source: © International Baccalaureate Organization 2019]

The man who tested positive for anti-D was then tested for ABO blood group. These results were obtained.



[Source: © International Baccalaureate Organization 2019]

What ABO blood group does the man testing positive for anti-D have?

- A. A
- B. B
- C. AB
- D. O

[1]

19M.1A.SL.TZ2.29

Which hormone is part of a negative feedback control system and acts on cells in the hypothalamus?

- A. Insulin
- B. Glucagon
- C. Melatonin
- D. Leptin

[1]

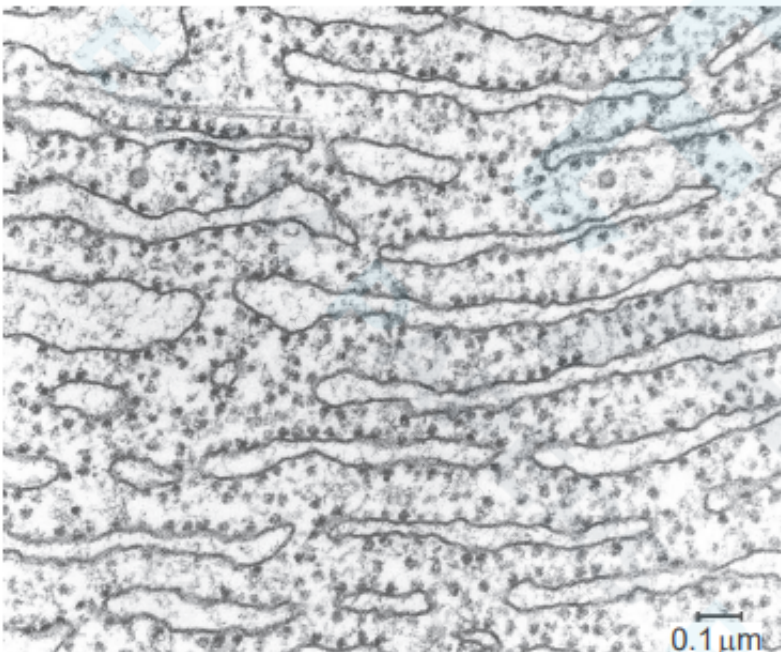
SPM.1A.SL.TZ0.20

Which cell is a component of the innate immune system? [1]

- A. T lymphocyte
- B. Phagocyte
- C. B lymphocyte
- D. B memory cell

21M.1A.SL.TZ2.2

What function is performed by the part of the cell shown in the electron micrograph?



[Source: George E. Palade Electron Microscopy Slide Collection Harvey Cushing/John Hay Whitney Medical Library Yale University Library.]

- A. Locomotion
- B. Synthesis of proteins
- C. Movement of chromosomes
- D. Breakdown of cellular organelles

[1]

23M.1A.SL.TZ1.23

What occurs during the establishment of a resting membrane potential of a neuron?

- A. Both sodium and potassium ions are pumped outside the neuron.
- B. Sodium ions are pumped out while potassium ions are pumped into the neuron.
- C. Both sodium and potassium ions are at rest inside the membrane of the neuron.
- D. Sodium ions leave by diffusion and potassium ions enter the neuron by active transport.

[1]

22M.1A.SL.TZ2.19

Which activity directly contributes the most to recent increases in atmospheric CO₂ concentrations?

- A. Landfills
- B. Planting trees
- C. Cattle rearing
- D. Burning of fossil fuels

[1]

20N.1A.SL.TZ0.5

How many chromosomes are there in a cell during anaphase of mitosis, if the diploid number of the cell is $2n$?

- A. n
- B. $2n$
- C. $4n$
- D. $8n$

[1]

21N.1A.SL.TZ0.20

The pentadactyl limbs of mammals, birds, reptiles and amphibians are examples of which kind of structures?

- A. Homologous
- B. Analogous
- C. Vestigial
- D. Convergent

[1]

19N.1A.SL.TZ0.26

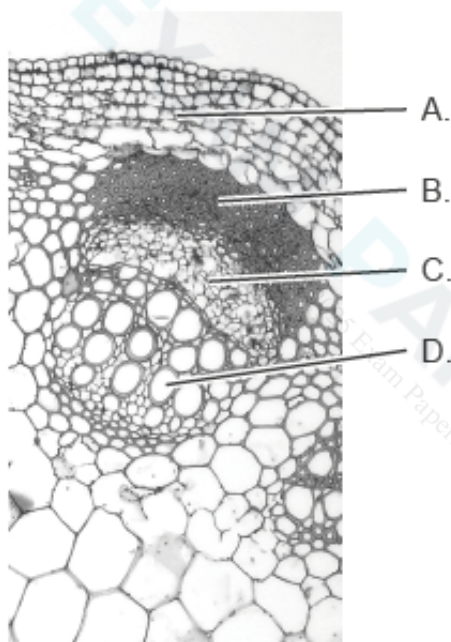
What is a function of **DNA** polymerase I?

[1]

- A. Adds nucleotides in a 5' to 3' direction to elongate the chain
- B. Uncoils the **DNA** double helix and splits it into two template strands
- C. Removes **RNA** primer and replaces it with **DNA**
- D. Produces sugar-phosphate bonds to link **Okazaki** fragments

23M.1A.SL.TZ2.28

The stem of a young plant is cut through and the cut end is immersed in water containing a red dye. The plant continues to transpire as normal. In what region of the stem would the red colour be visible soon after immersion?



[1]

22M.1A.SL.TZ1.10

What is the minimum number of nucleotides needed to code for a polypeptide composed of 210 amino acids?

- A. 70
- B. 210
- C. 420
- D. 630

[1]

22M.1A.SL.TZ2.8

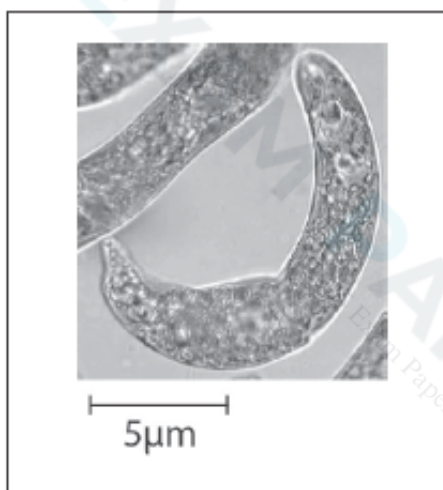
Cell metabolism involves anabolic and catabolic reactions. Which process directly involves anabolism?

- A. Active transport of ions
- B. Release of energy from glucose
- C. Production of intracellular enzymes
- D. Breakdown of worn-out cell organelles by lysosomes

[1]

19N.1A.SL.TZ0.1

The electron micrograph shows a thin section through a plant mesophyll cell.



[Source: https://commons.wikimedia.org/wiki/File:Euglena_sp.jpg, by Deuterostome
<https://creativecommons.org/licenses/by-sa/3.0/legalcode>]

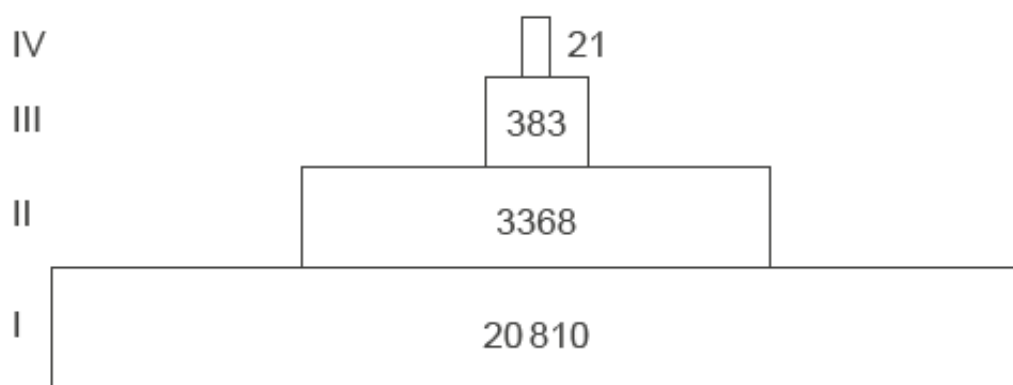
What is the magnification of the image?

- A. $\times 75$
- B. $\times 300$
- C. $\times 3000$
- D. $\times 7500$

[1]

19M.1A.SL.TZ2.18

The Silver Springs feed into the Silver River in Florida. The diagram shows a pyramid of energy for the Silver Springs ecosystem. The units are $\text{kJ m}^{-2} \text{y}^{-1}$.



[Source: © International Baccalaureate Organization 2019]

What do level I and level III represent in the pyramid of energy?

	I	III
A.	sunlight	secondary consumer
B.	producer	tertiary consumer
C.	producer	secondary consumer
D.	primary consumer	tertiary consumer

[1]

SPM.1A.SL.TZ0.8

A strand of DNA containing four codons with base sequence ACT GTA CTC TAC mutates, changing the base sequence to ACT ATG CTC TAC. What type of mutation has occurred?

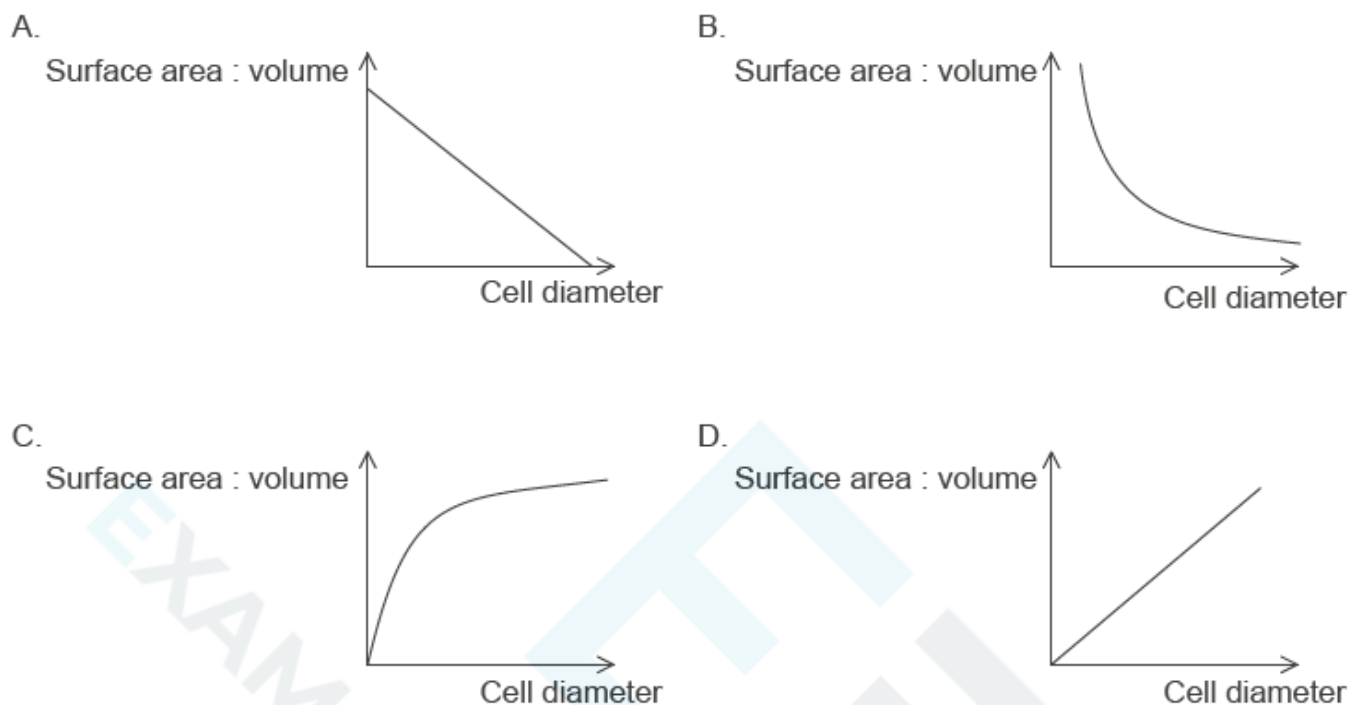
- A. Insertion
- B. Substitution
- C. Deletion
- D. Degeneracy

[1]

19M.1A.SL.TZ1.1



Which graph represents the change in cell surface area to volume ratio with increasing cell diameter?



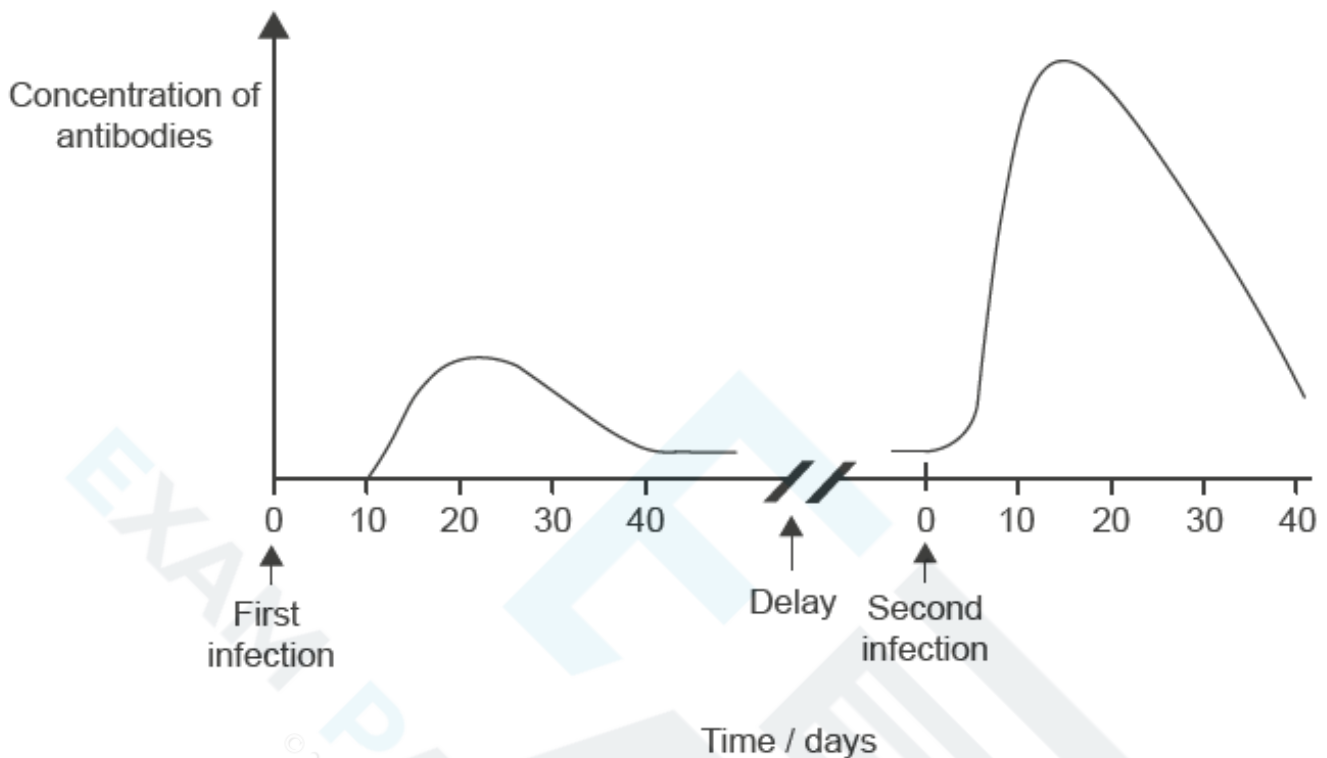
[Source: © International Baccalaureate Organization 2019]

[1]

21N.1A.SL.TZ0.26



A person was infected with a pathogen and then later in life they were re-infected with the same pathogen. The graph shows the concentration of antibodies found in the blood that were produced in response to these two infections.



What is the reason for the faster rise in antibody concentration after the second infection?

- A. The patient had previously been vaccinated with the antibody.
- B. Antibodies had been stored after the first exposure.
- C. Lymphocytes rapidly reproduced to form plasma cells.
- D. The second exposure was more infectious.

[1]

21M.1A.SL.TZ1.18

Which genotype would be normally found in a gamete? [1]

- A. Rr
- B. RS
- C. rStt
- D. TUt

19N.1A.SL.TZ0.8



What is a property of water?

- A. Water has a low specific heat capacity so large increases in heat energy cause a small temperature change.
- B. Water is an excellent solvent for non-polar substances.
- C. Covalent bonds between adjacent water molecules are responsible for its unique properties.
- D. Water molecules are highly cohesive which is important for transport in xylem.

[1]

SPM.1A.SL.TZ0.19

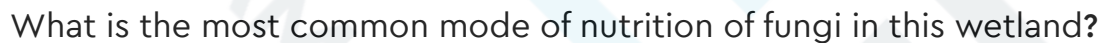
What conveys messages from the central nervous system to an endocrine gland? [1]

- A. Sensory neurons
- B. Hormones
- C. Interneurons
- D. Motor neurons

23M.1A.SL.TZ1.18

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[Source: Fei Xue, An Zhong, Ma Ning, and Jing Zhen, *Yanhuangchunqiu* (Spring and Autumn), Fudan University Press, Shanghai, 2010.



- [1]

What special property of phospholipid molecules explains their ability to spontaneously assemble into a lipid bilayer?

- [1]

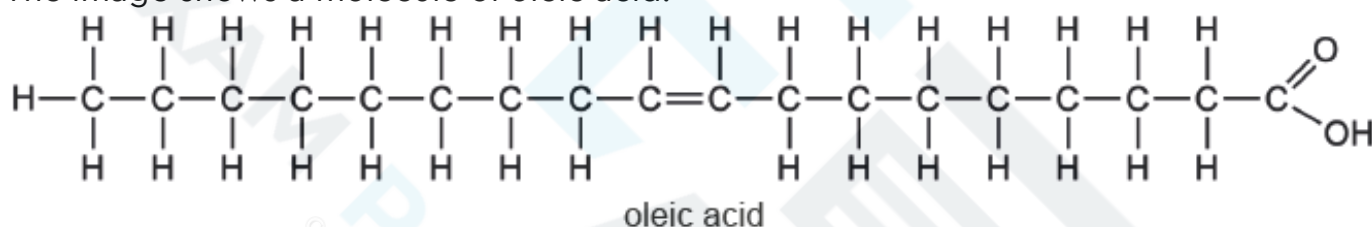
Creeper in chickens is a condition in which the chickens are born with very short legs. The creeper allele (C) is dominant over the normal allele (c). Embryos which are homozygous for the dominant allele fail to develop into viable chickens and die before they hatch. What phenotypic ratio would you expect in the live offspring of a cross between two creeper chickens?

- A. All creeper
- B. 1 creeper; 2 normal
- C. 2 creeper; 1 normal
- D. 3 creeper; 1 normal

[1]

23M.1A.SL.TZ2.7

The image shows a molecule of oleic acid.



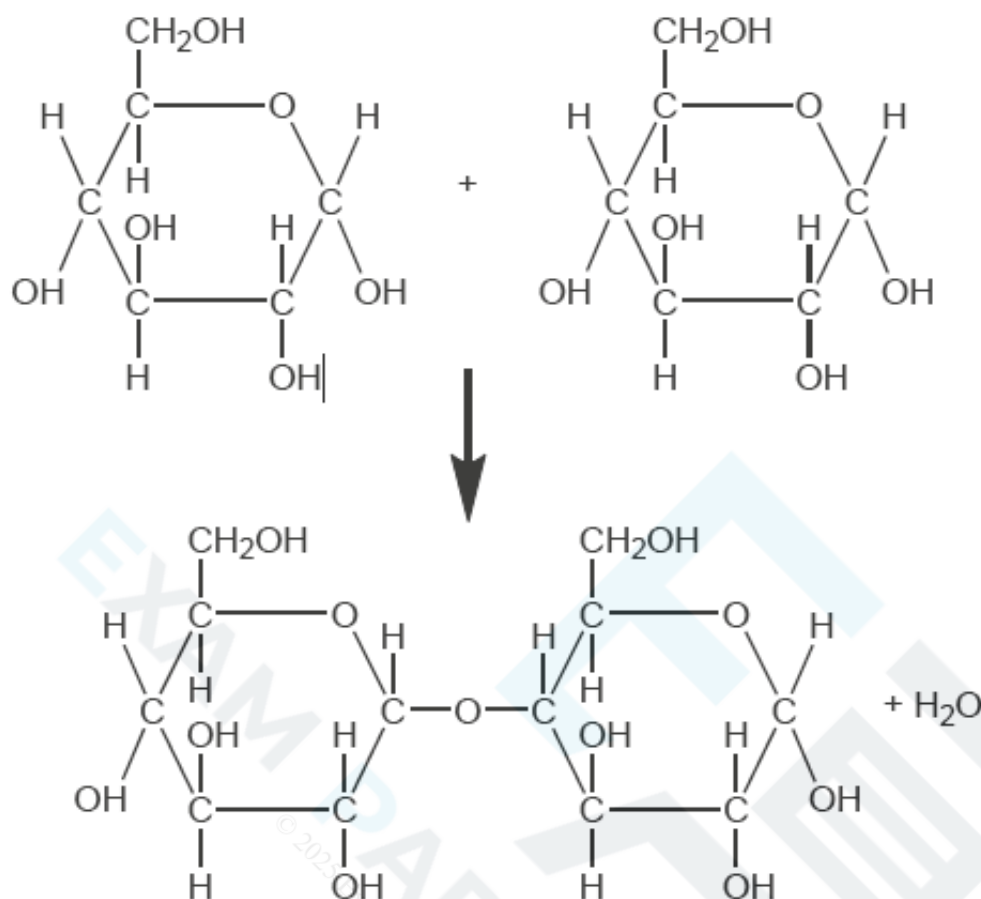
What describes oleic acid?

- A. Cis polyunsaturated
- B. Cis monounsaturated
- C. Trans polyunsaturated
- D. Trans monounsaturated

[1]

19M.1A.SL.TZ1.6

What type of molecule is formed by the chemical reaction shown in the diagram? [1]



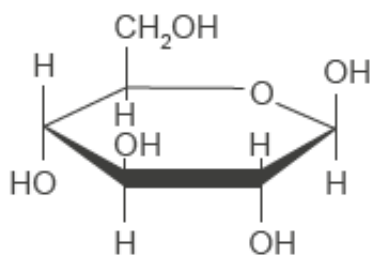
- A. Dipeptide
- B. Disaccharide
- C. Diglyceride
- D. Cellulose

23M.1A.SL.TZ2.6

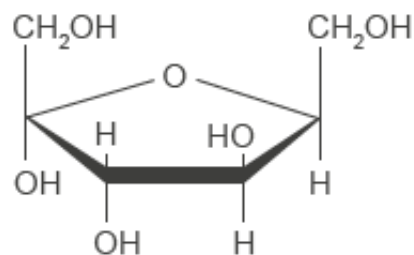
Which drawing represents beta-D-glucose?

[1]

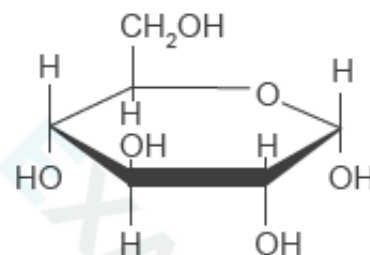
A.



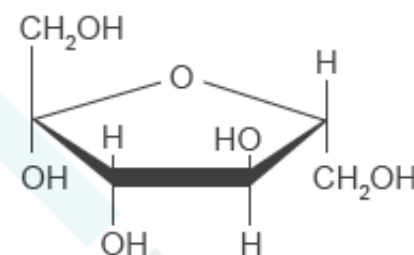
B.



C.



D.



19M.1A.SL.TZ2.23

The global carbon cycle involves sinks where carbon is stored, and fluxes where carbon is transferred. What are the largest sink and flux?

	Sink	Flux
A.	atmosphere	combustion
B.	oceans	respiration
C.	oceans	photosynthesis
D.	limestone	photosynthesis

[1]

22M.1A.SL.TZ2.7

What does an action spectrum for photosynthesis show?

- A. The range of conditions over which photosynthesis can occur in a plant
- B. The percentage of light absorbed at each wavelength by photosynthetic pigments
- C. The percentage of light absorbed at each energy level by a plant
- D. The relative amount of photosynthesis at each wavelength of light

[1]

23M.1A.SL.TZ2.32

In the fruit fly *Drosophila*, the alleles for red eyes and brown bodies are dominant to the alleles for white eyes and yellow bodies. Which cross would be suitable to determine whether the genes are linked?

- A. Heterozygous red-eyed flies crossed with yellow-bodied flies
- B. White-eyed flies crossed with homozygous brown-bodied flies
- C. Homozygous red-eyed, brown-bodied flies crossed with white-eyed, yellow-bodied flies
- D. Heterozygous red-eyed, brown-bodied flies crossed with white-eyed, yellow-bodied flies

[1]

20N.1A.SL.TZ0.25

What feature of arteries is most important in maintaining sufficiently high blood pressure?

- A. A wide lumen
- B. Elastic fibres in the wall
- C. Valves at intervals
- D. A thin wall

[1]

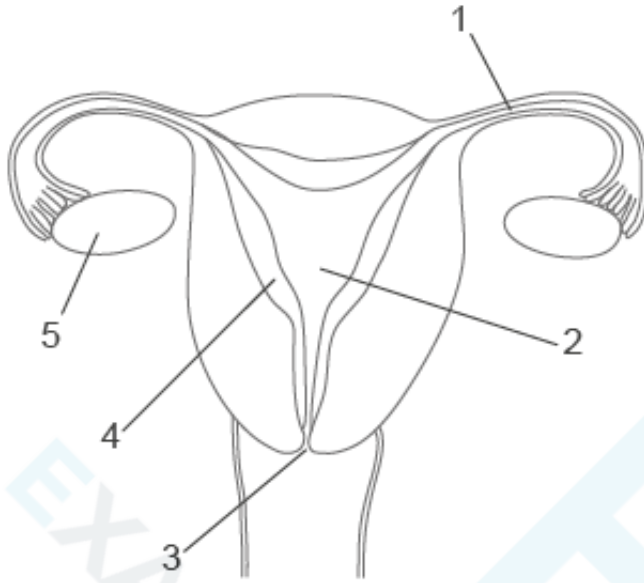
23M.1A.SL.TZ2.31

What is a result of crossing over in meiosis? [1]

- A. Gene linkage
- B. Non-disjunction
- C. Haploid cells
- D. Variation in gametes

19M.1A.SL.TZ2.30

The diagram shows the human female reproductive system



[Source: © International Baccalaureate Organization 2019]

Which labels indicate where fertilization occurs and where luteinizing hormone (LH) acts?

	Where fertilization occurs	Where LH acts
A.	1	3
B.	2	5
C.	3	4
D.	1	5

[1]

22M.1A.SL.TZ1.25

Which structures are part of the walls of both capillaries and veins? [1]

- I. Cells
- II. Pores
- III. Elastic fibres

- A. I only
- B. I and II
- C. I and III
- D. I, II and III

22M.1A.SL.TZ2.17

A group of students used quadrat sampling to gather data on the presence of two plant species in an area. They performed a chi-squared test to assess whether the distribution of the two species was associated. The calculated value of the chi-squared test was below the critical value. What can be deduced from the results of the chi-squared test?

- A. The alternative hypothesis is accepted.
- B. The distribution of one species is independent from the other.
- C. Both species are evenly distributed in the grassland ecosystem.
- D. The distribution of both species is correlated with abiotic factors.

[1]

19M.1A.SL.TZ1.13

The system of sex determination in chimpanzees (*Pan troglodytes*) is the same as in other mammals. A chimpanzee has 48 chromosomes in the nuclei of its body cells. What can be deduced from this information?

- A. The sex of the chimpanzee
- B. The number of genes in each chromosome
- C. Whether non-disjunction has occurred
- D. The number of autosomes in a diploid cell

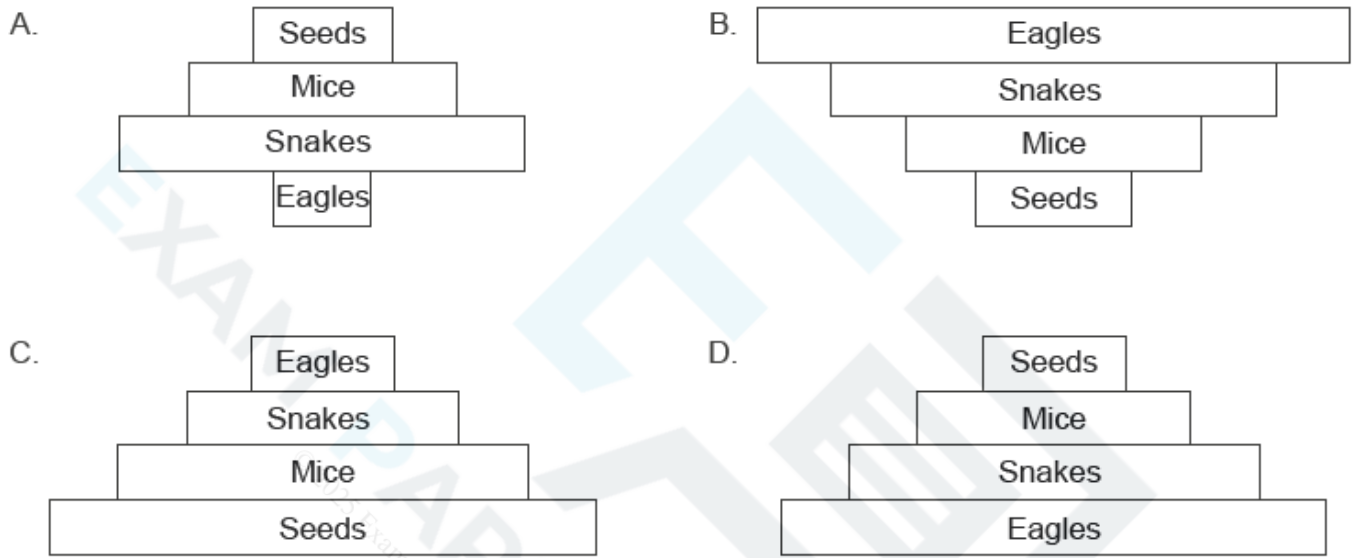
[1]

22M.1A.SL.TZ1.18

The table contains information about the diet of some animals.

Animal	Diet
Snakes	Mice
Eagles	Snakes
Mice	Seeds

Which pyramid of energy represents this information?



[1]

22M.1A.SL.TZ1.14

Chromosome numbers vary between species. Which statement refers to humans? [1]

- A. An egg cell has **22** autosomes.
- B. A sperm cell has **23** autosomes.
- C. An egg cell has two **X** chromosomes.
- D. A zygote has two autosomes.

19M.1A.SL.TZ1.26

Which feature of capillaries distinguishes them from arteries and veins? [1]

- A. Narrow diameter
- B. Valves to prevent backflow
- C. Thick muscular walls
- D. Elastic tissue

19M.1A.SL.TZ2.24

What is an advantage of capillary walls being one cell thick in the systemic circulation?

- A. To allow carbon dioxide to diffuse into tissues
- B. To allow oxygen to diffuse out of tissues
- C. To allow glucose to diffuse into tissues
- D. To allow urea to diffuse into tissues

[1]

22N.1A.SL.TZ0.20

By the end of the 19th century in England, the dark form of the moth *Biston betularia* formed up to 98 % of the total population in industrial areas. From 1970, the percentage of dark forms decreased significantly. What is an explanation for the decrease?

- A. An increase in environmental pollution killed the dark forms more than the light forms.
- B. Reduction of pollution resulted in greater camouflage for light forms of the moth.
- C. Dark forms could no longer find mates.
- D. Light forms had superior feeding mechanisms.

[1]

19M.1A.SL.TZ1.17

Which organism can best be described as a saprotroph?

- A. A fungus that digests its food externally and absorbs the products of digestion
- B. A beetle that feeds by ingesting the dung of other animal species and digesting its food internally
- C. A single-celled eukaryote that is able to photosynthesize and consumes smaller organisms by endocytosis
- D. A giraffe that feeds by ingesting leaves from an acacia tree

[1]

20N.1A.SL.TZ0.14

Tall heterozygous pea plants were crossed and the resulting seeds grown. Out of 360 plants, 270 were tall and 90 dwarf. What describes the expected genotypes resulting from the cross?

- A. All 270 tall plants were heterozygous.
- B. All 270 tall plants were homozygous.
- C. Only 90 plants were homozygous.
- D. All dwarf plants were homozygous.

[1]

22N.1A.SL.TZ0.22

The foxglove, *Digitalis purpurea*, was once classified in the figwort family. The figwort family has been reclassified and is now much smaller.



Foxglove



Figwort species

[Source: Shiva A., 2008 [image online] Available at:

[https://en.wikipedia.org/wiki/File:Purple_Foxglove_\(Digitalis_purpurea\)_2008_02.jpg](https://en.wikipedia.org/wiki/File:Purple_Foxglove_(Digitalis_purpurea)_2008_02.jpg) [Accessed 14 January 2023] CC BY SA 4.0.

Funhoff, D., 2017. Figwort (*Scrophularia canina*) flowers, Theisbergstegen, Pfalz, Germany . [image online]

Available at: [https://www.naturepl.com/stock-photo/figwort-\(scrophularia-canina\)-flowers-theisbergstegen-pfalzgermany-june/search/detail-o_01550655.html](https://www.naturepl.com/stock-photo/figwort-(scrophularia-canina)-flowers-theisbergstegen-pfalzgermany-june/search/detail-o_01550655.html)

[Accessed 28 October 2021].]

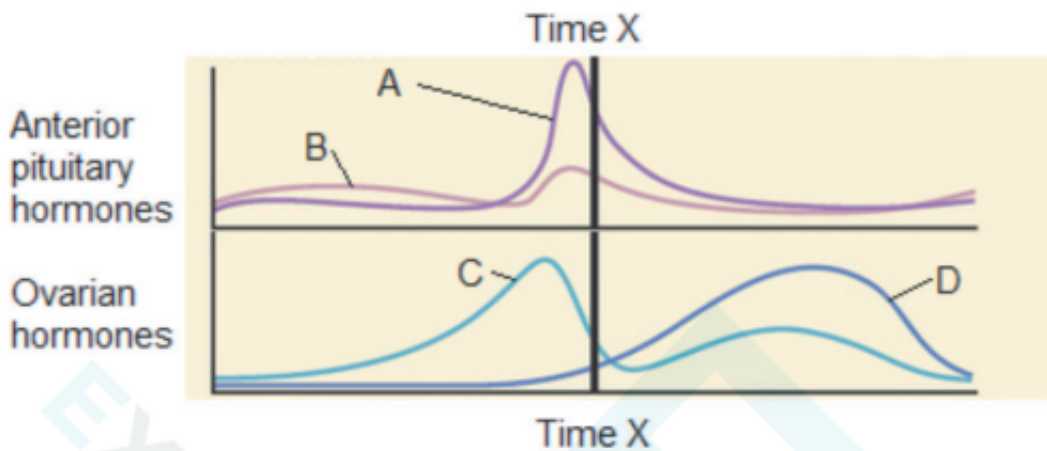
Why were species such as the foxglove moved into other families?

- A. The appearance was too dissimilar.
- B. The plants are found in different locations.
- C. The genera were different.
- D. The DNA sequences indicated different ancestry.

[1]

21M.1A.SL.TZ1.28

The graph shows the blood levels of hormones associated with the menstrual cycle.



[Source: By OpenStax College Anatomy & Physiology, Connexions Web site.
<http://cnx.org/content/col11496/1.6/> , Jun 19, 2013., CC BY 3.0 (
<https://creativecommons.org/licenses/by/3.0/>),
<https://commons.wikimedia.org/w/index.php?curid=30148641> .]

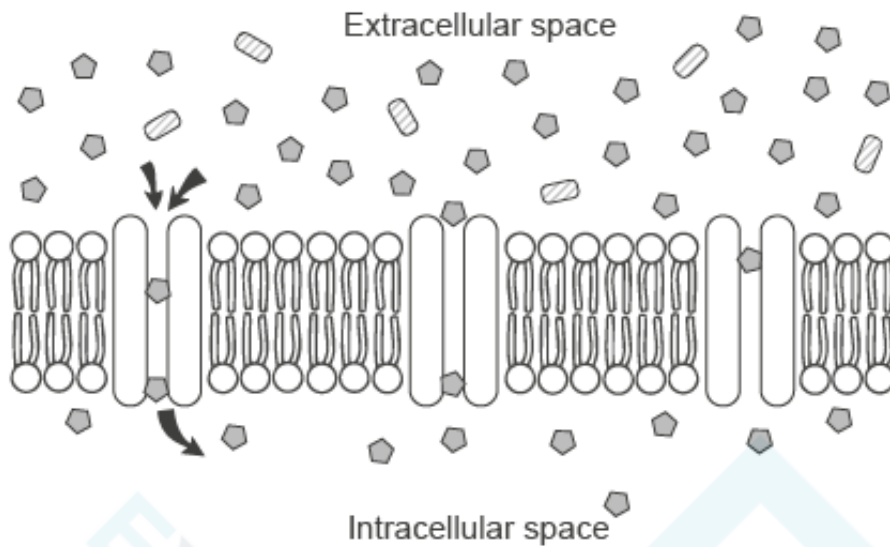
Which line on the graph represents progesterone?

- A. Line A
- B. Line B
- C. Line C
- D. Line D

[1]

23M.1A.SL.TZ2.4

The diagram shows protein channels involved in the passive movement of a substance into the cell across the cell membrane.



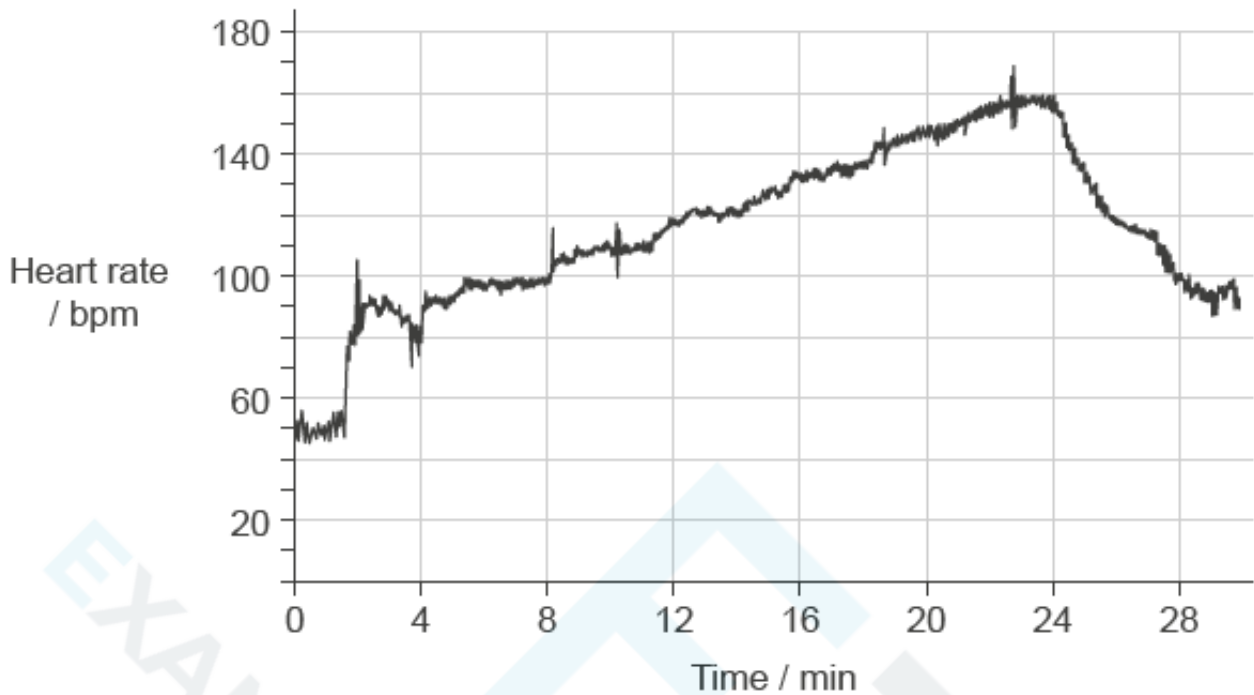
What describes this movement?

- A. Energy of ATP is used to transport substances into the cell.
- B. Substances can move from areas of low to areas of high concentration.
- C. The proteins ensure that movement of substances is only in one direction.
- D. Net movement occurs until the concentrations in and out of the cell are equal.

[1]

22M.1A.SL.TZ1.21

The image shows the changes in heart rate of an athlete during exercise.



[Source: Liddle, P.F., 2010. Heart Rate Variability (HRV) during exercise. [online] Available at: <https://canute1.wordpress.com/2010/07/> [Accessed 1 August 2019].]
 What is likely to have occurred between 0 and 4 minutes and between 24 and 28 minutes?

	Between 0 and 4 minutes	Between 24 and 28 minutes
A.	Epinephrine is secreted	More blood is sent to the rest of the body than to the lungs
B.	More blood is sent to the lungs than to the rest of the body	Epinephrine is secreted
C.	Epinephrine is secreted	Impulses are sent from the medulla of the brain to the heart
D.	Impulses are sent from the medulla of the brain to the heart	Epinephrine is secreted

[1]

21N.1A.SL.TZ0.3

How is facilitated diffusion in axons similar to active transport?

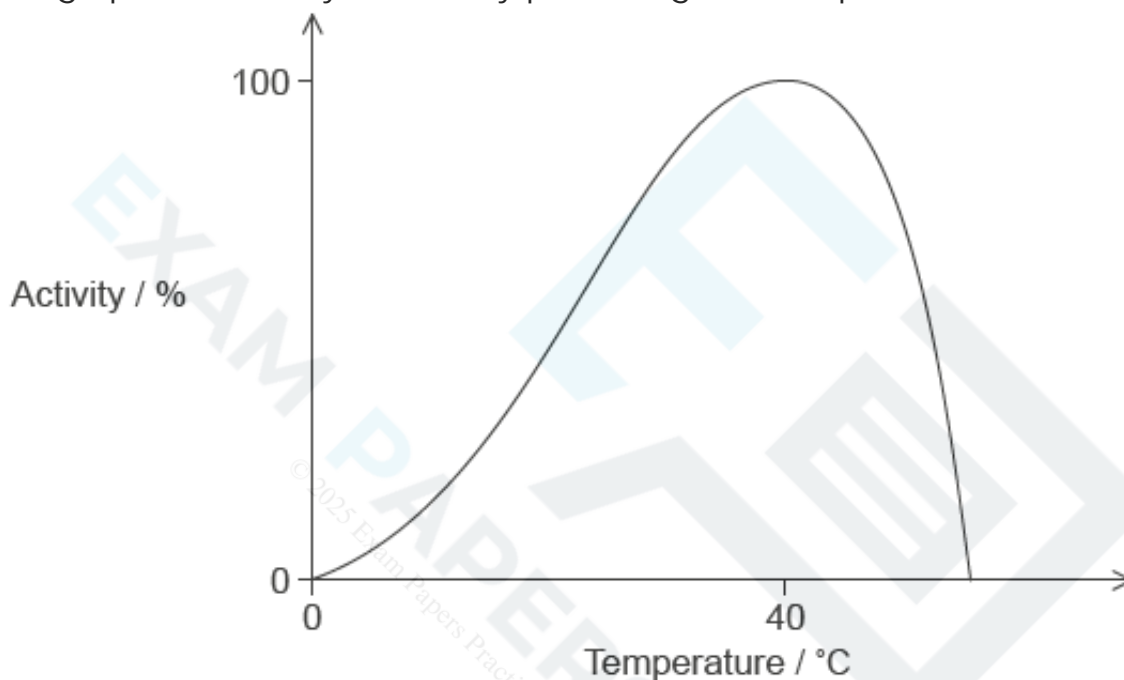
[1]

- A. They both require the energy of ATP.
- B. They both move substances against a concentration gradient.
- C. They both use sodium-potassium pumps.
- D. They are both carried out by proteins embedded in the axon membrane.

22M.1A.SL.TZ1.8

The graph shows enzyme activity plotted against temperature.

[1]



What is the reason for the drop in enzyme activity above 40 °C?

- A. A decrease in the enzyme concentration
- B. Reaction is saturated because active sites are occupied
- C. Insufficient activation energy for the reaction to proceed
- D. Changes to the conformation of the enzyme

19N.1A.SL.TZ0.15

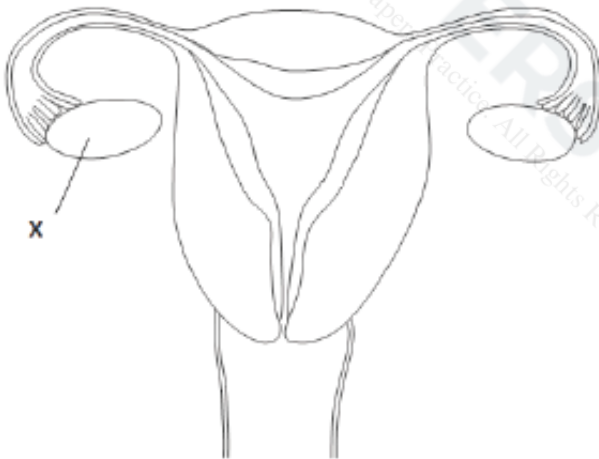
A variety of *Pelargonium* has yellow leaves. When plants of this variety are crossed, the resulting seeds produce green, yellow and white seedlings in the ratio 1 : 2 : 1. If plants with yellow leaves are crossed with plants with green leaves, what would the expected ratio of phenotypes in the offspring be?

	Green	Yellow	White
A.	1	2	1
B.	3	1	0
C.	2	2	0
D.	2	1	1

[1]

19M.1A.SL.TZ1.30

The diagram shows the human female reproductive system. [1]



[Source: © International Baccalaureate Organization 2019]

What is produced by structure X?

- A. FSH
- B. X chromosomes
- C. Fertilized eggs
- D. Estrogen and progesterone

21M.1A.SL.TZ1.22

Which process results in decreased variation? [1]

- A. Meiosis
- B. Mutation
- C. Sexual reproduction
- D. Natural selection

19M.1A.SL.TZ1.23

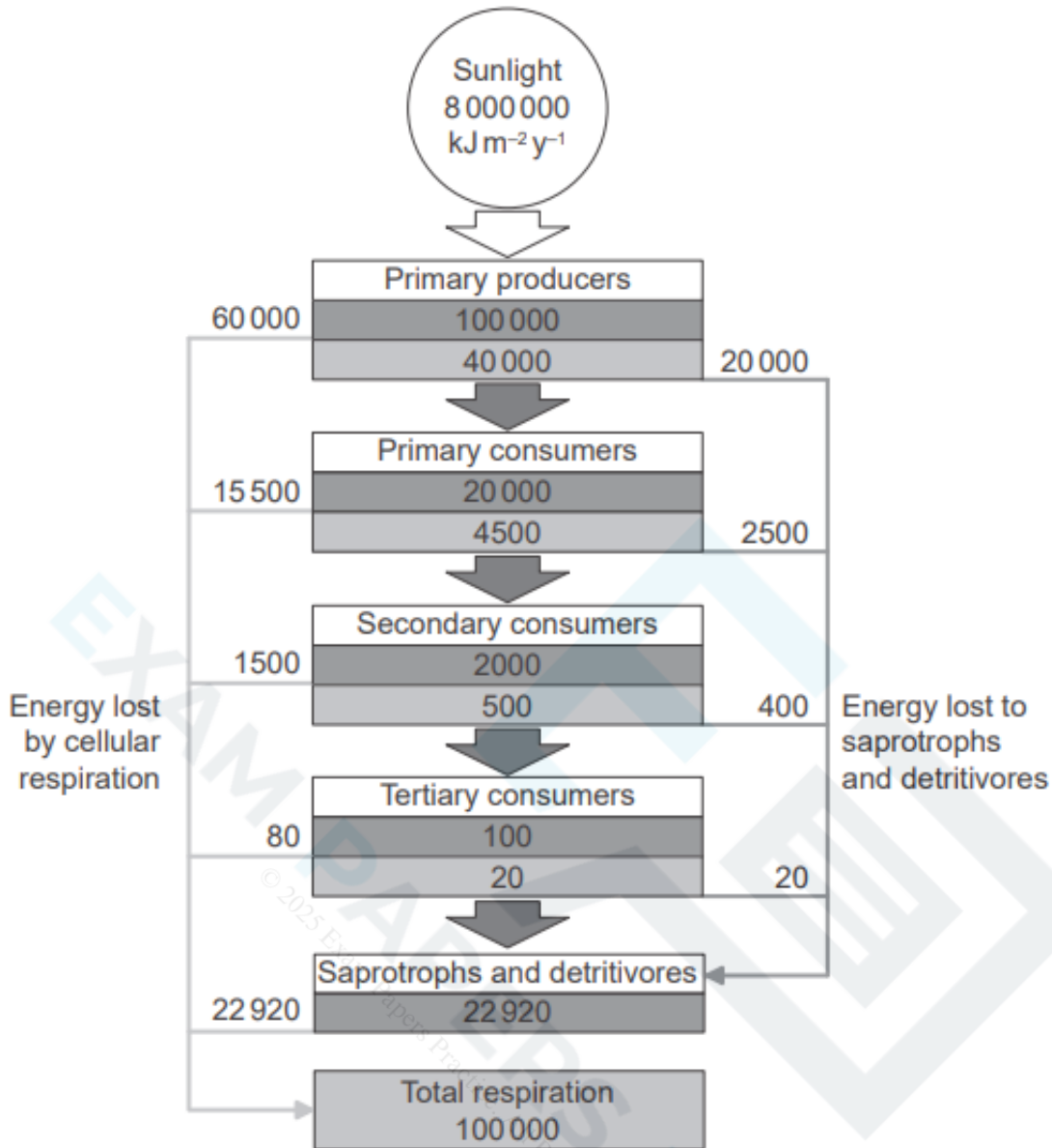
What is produced by type II pneumocytes? [1]

- A. Epinephrine
- B. Elastase
- C. Pulmonary surfactant
- D. Alpha 1-antitrypsin

21M.1A.SL.TZ2.18

The diagram shows the flow of energy through an ecosystem in $\text{kJ m}^{-2} \text{y}^{-1}$.

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Key: Gross productivity: the amount of chemical energy that is stored as biomass per unit time

Net productivity: the amount of chemical energy that is stored as biomass per unit time after cellular respiration

[Source: "Energy flow: Figure 3," (<https://cnx.org/contents/24nl-KJ8@24.18:fbNheNoN@8/Energy-Flow>) by OpenStax College, Biology CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0/>).]

What percentage of the energy passed from primary producers to primary consumers is lost to cellular respiration by tertiary consumers?

- A. 0.001%
- B. 0.08%
- C. 0.2%
- D. 0.4%

[1]

21M.1A.SL.TZ2.35

What process occurs in both mitosis and meiosis? [1]

- A. Formation of chiasmata
- B. Reduction division
- C. Separation of chromatids
- D. Exchange of alleles between non-sister chromatids

22N.1A.SL.TZ0.15

A couple have four children whose blood groups are A, B and AB. What is the likely combination of the parents' genotypes?

- A. $I^A i$ and $I^B i$
- B. $I^A i$ and $I^B I^B$
- C. $I^A I^B$ and ii
- D. $I^A I^A$ and $I^B I^B$

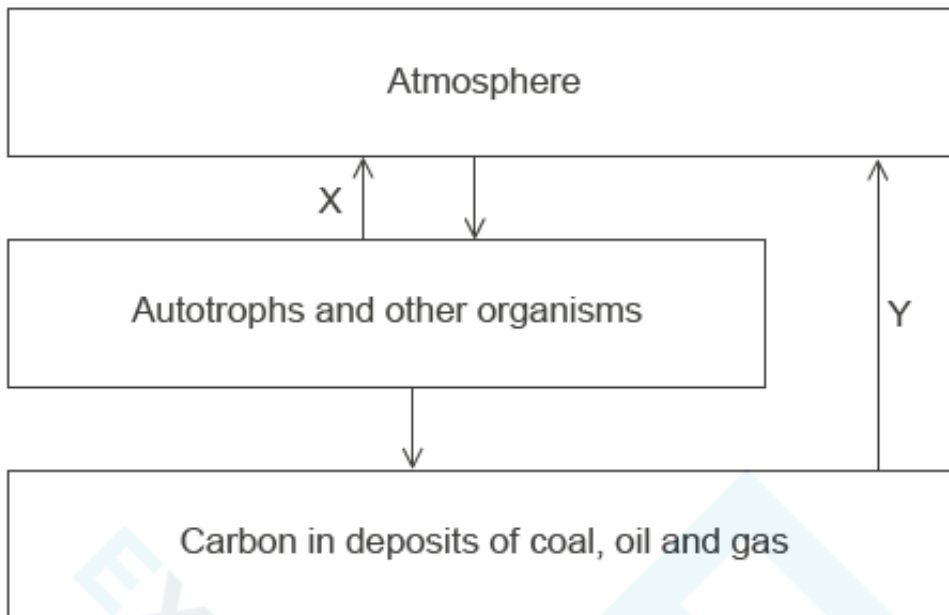
[1]

22M.1A.SL.TZ1.19

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The diagram shows a simplified carbon cycle.

[1]



Which processes are taking place at X and Y?

	X	Y
A.	photosynthesis	fossilization
B.	respiration	fossilization
C.	photosynthesis	combustion
D.	respiration	combustion

21N.1A.SL.TZ0.11



The data shows part of the genetic code for mRNA. Which anticodon could be found on a tRNA molecule bonded to lysine?

UUU	Phenylalanine
UUC	
AAA	Lysine
AAG	

- A. AAG
- B. UUC
- C. TTT
- D. GAA

[1]

19N.1A.SL.TZ0.17

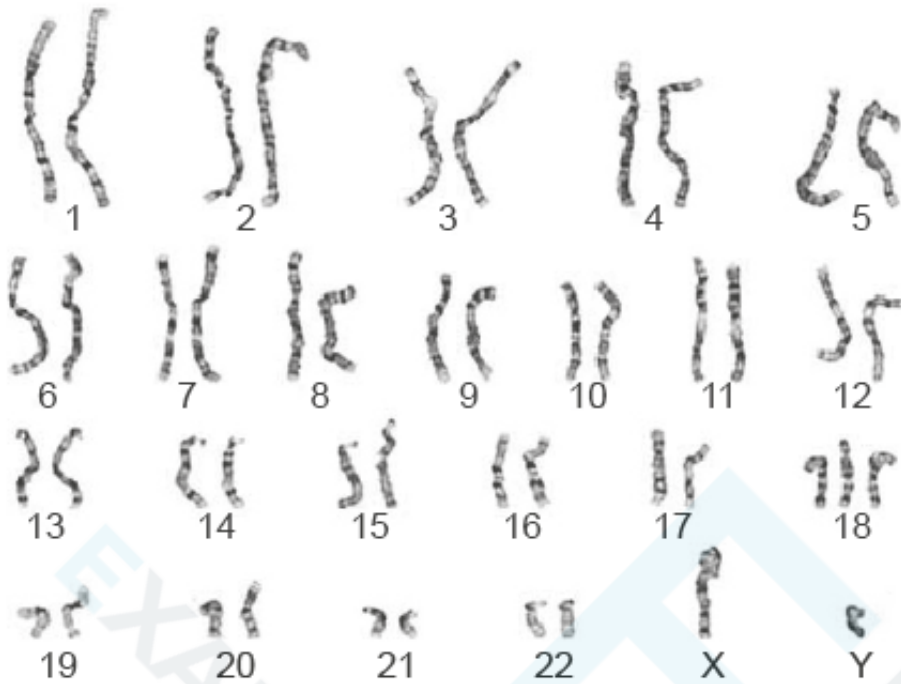
What is PCR used for?

[1]

- A. Separate fragments of DNA by size
- B. Amplify small amounts of DNA
- C. Compare DNA samples
- D. Genetically modify organisms' DNA

22M.1A.SL.TZ2.14

The karyogram shown belongs to a human being.



[Source: Reproduced from Tennakoon J, Kandasamy Y, Alcock G, Koh TH. Edwards syndrome with double trisomy. *Singapore Med J*. 2008 Jul;49(7):e1901. PMID: 18695855.]

What can be deduced from this karyogram?

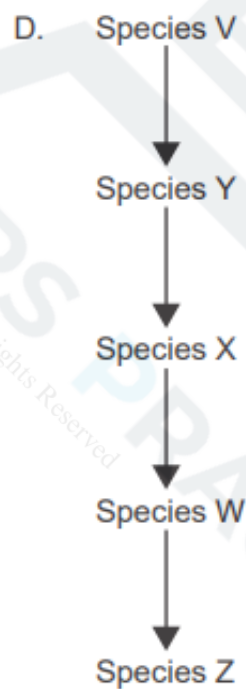
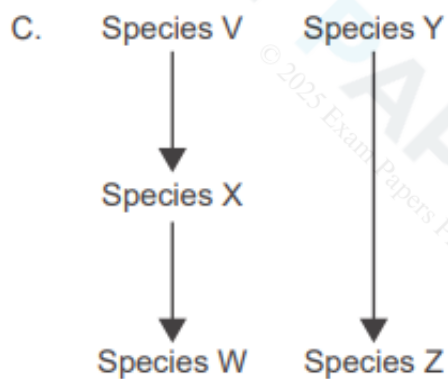
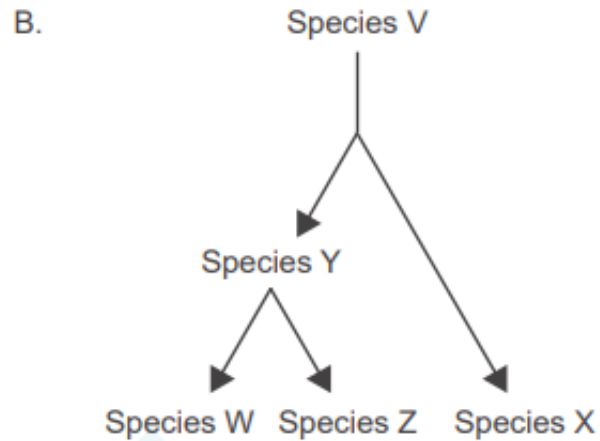
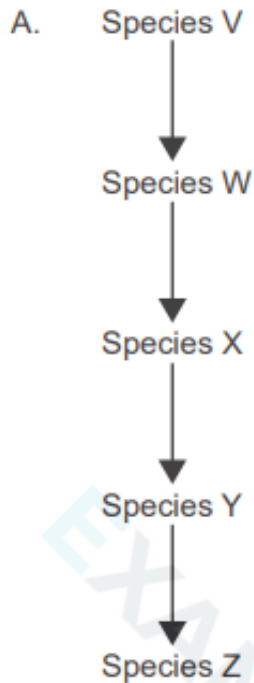
- A. The person is a male with Down syndrome.
- B. The person is a female with Down syndrome.
- C. The person is a male with a genetic disorder.
- D. The person is a female with a missing chromosome.

[1]

21M.1A.SL.TZ2.21



Which evolutionary pathway is most likely to result in the evolution of analogous structures in Species W and Z?



[1]

22M.1A.SL.TZ2.13

Which statement defines alleles?

- A. They are the different forms of a gene that have the same effect on the phenotype.
- B. They are the similar forms of a gene in different positions of a chromosome.
- C. They are the various forms of a gene with slight differences in their base sequences.
- D. They are the different forms of a gene coding for identical polypeptide chains.

[1]

21M.1A.SL.TZ2.20

Which is an example of speciation?

- A. Selective breeding to produce new varieties of the wheat *Triticum aestivum* with higher crop yield
- B. Evolution of different courtship behaviours in separate populations of the cricket *Gryllus rubens*
- C. Natural selection leading to an increase in the frequency of darker individuals of *Biston betularia*
- D. Selective feeding by koalas (*Phascolarctos cinereus*) on *Eucalyptus* species

[1]

22N.1A.SL.TZ0.2

What life function is illustrated? [1]

- A. Nutrition
- B. Homeostasis
- C. Endocytosis
- D. Response

21M.1A.SL.TZ2.17

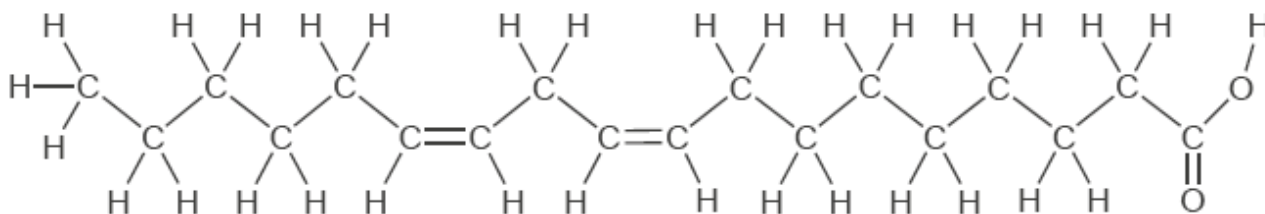
Which organism would be classified as a saprotroph?

- A. A single-celled eukaryote that obtains its carbon compounds by photosynthesis and ingestion of other single-celled organisms
- B. A jellyfish that uses the stinging cells in its tentacles to paralyse its prey, which is passed to an internal gastric cavity through a single opening
- C. A fungus that feeds by secretion of digestive enzymes onto its food and absorption of digested material
- D. A dung beetle that feeds on the fecal material left behind by other animals

[1]

19M.1A.SL.TZ2.12

The diagram shows a type of fatty acid.



What type of fatty acid is shown?

- A. Trans unsaturated
- B. Cis unsaturated
- C. Trans saturated
- D. Cis saturated

[1]

22N.1A.SL.TZ0.6

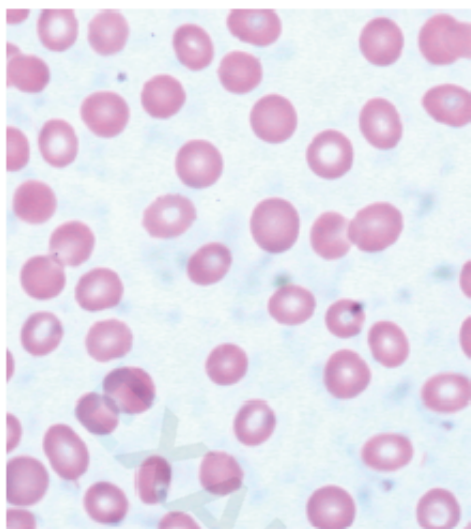
What is the arrangement of subunits in a **DNA** nucleotide? [1]

- A. sugar – base – phosphate
- B. sugar – phosphate – base
- C. phosphate – sugar – base
- D. sugar – phosphate – base – base – phosphate – sugar

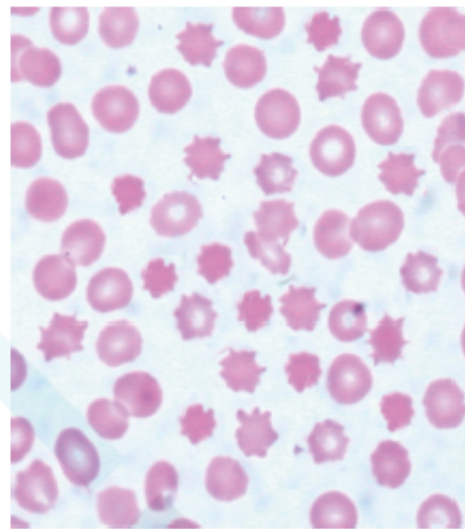
22M.1A.SL.TZ2.3

In an experiment on osmosis, red blood cells were immersed in a salt solution for two hours. The micrographs show the appearance of these cells before and after immersion in the salt solution.

before immersion



after immersion



[Source: Ed Uthman, Acanthocytes, from peripheral blood [image online] Available at: [https://en.wikipedia.org/wiki/Acanthocyte#/media/File:Acanthocytes,_Peripheral_Blood_\(3884092551\).jpg](https://en.wikipedia.org/wiki/Acanthocyte#/media/File:Acanthocytes,_Peripheral_Blood_(3884092551).jpg)

This file is licensed under the Creative Commons Attribution 2.0 Generic (CC BY 2.0) <https://creativecommons.org/licenses/by/2.0/> Source adapted.]

What explains the observed changes?

- A. The salt solution was hypertonic and entered the red blood cells.
- B. The salt solution was hypotonic and disrupted the membranes of the red blood cells.
- C. The salt solution was hypertonic and water moved into it from the red blood cells.
- D. The salt solution was hypotonic and mineral salts were lost from the red blood cells.

[1]

21M.1A.SL.TZ2.7

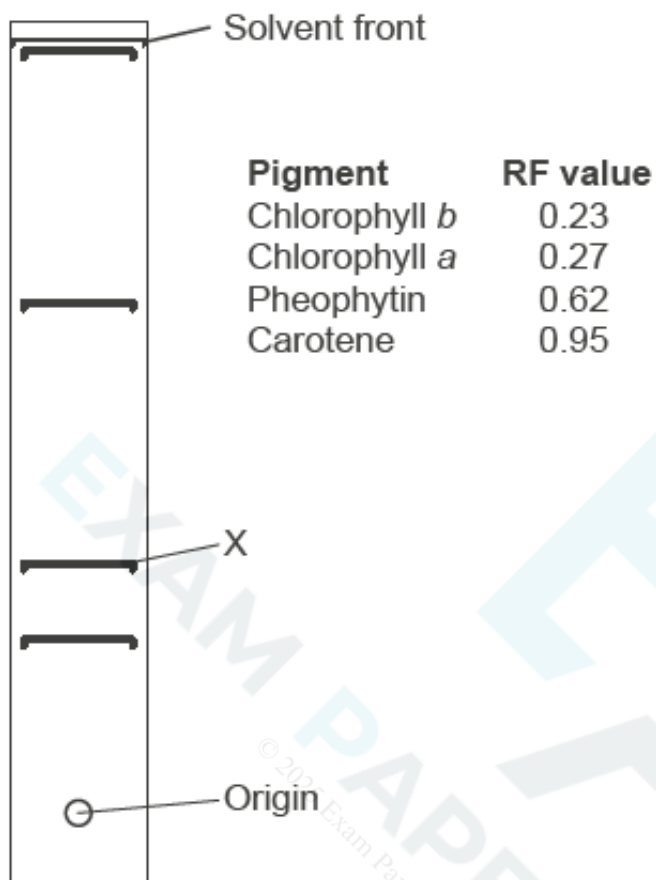
What property of water accounts for its usefulness as a coolant in sweat? [1]

- A. High specific heat capacity
- B. High latent heat of vaporization
- C. High boiling point
- D. High melting point

20N.1B.SL.TZ0.3D

(d)

A chromatograph was made of the photosynthetic pigments of a leaf of the plant.



[Source: Adapted from "Diversity of Photosynthetic Pigments" by Alexander F. Motten in Tested Studies for Laboratory Teaching, Volume 16 of the Association for Biology Laboratory Education and used by permission of the author.]

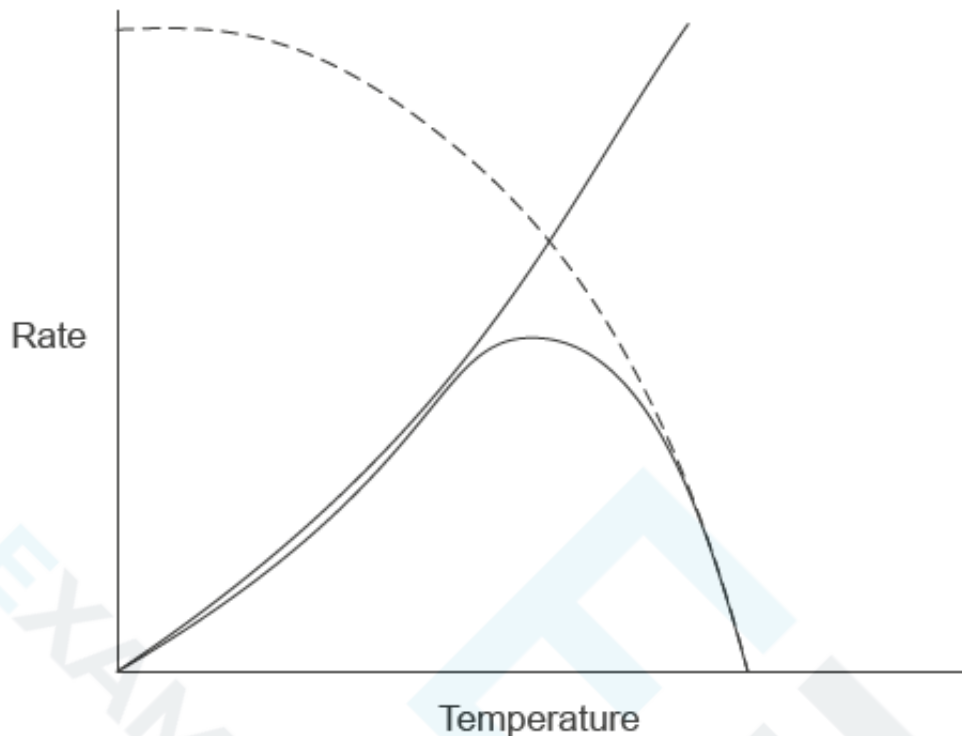
Outline what measurements would be taken to identify pigment X.

[2]

19M.1A.SL.TZ2.9

The graph shows the activity of an enzyme at different temperatures.

[1]



[Source: © International Baccalaureate Organization 2019]

What does the dashed line in the graph represent?

- A. Increasing temperature increases substrate concentration.
- B. Increasing temperature affects the active site.
- C. Increasing temperature increases the rate of reaction.
- D. Increasing temperature decreases the movement of particles.

23M.1A.SL.TZ1.16

For what reason do gametes contain only one allele of each gene? [1]

- A. To prevent inbreeding in a population
- B. Haploid cells contain only one set of chromosomes
- C. The two alleles of a gene are separated during mitosis
- D. Crossing over will always produce one allele of a gene

23M.1A.SL.TZ2.18

Which statement best describes how evolution occurs?

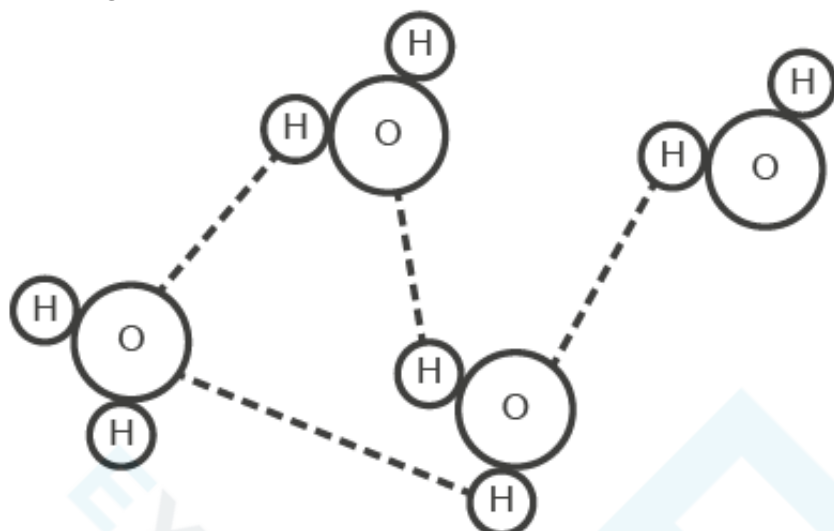
[1]

- A. Species which produce the most offspring are favoured by natural selection.
- B. Mutations in somatic cells are passed on to offspring.
- C. Natural selection decreases the frequency of unfavourable characteristics.
- D. Changes in species lead towards greater complexity over time.

22N.1A.SL.TZ0.8

The diagram shows water molecules.

[1]



Which property of water is **not** illustrated?

- A. Cohesion
- B. Dipolarity
- C. Hydrogen bonding
- D. Adhesion

20N.1A.SL.TZ0.19

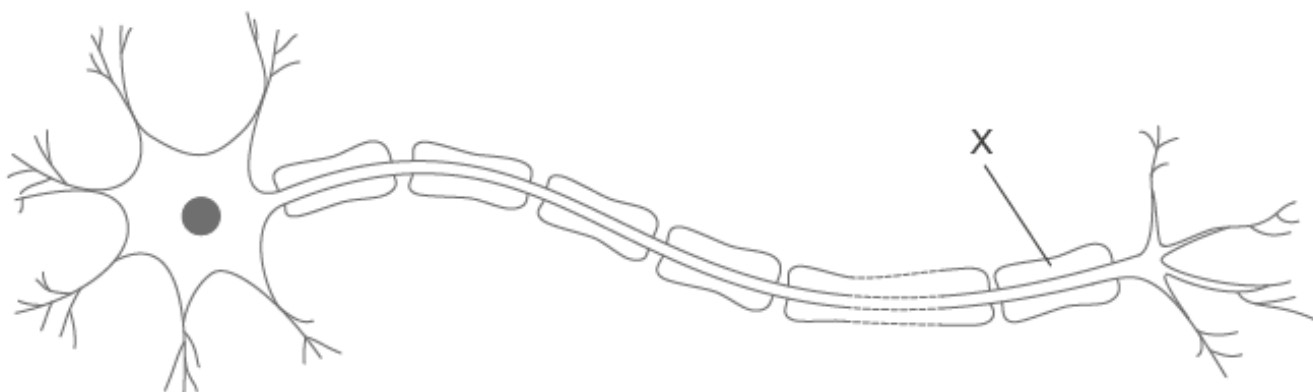
The oceans absorb much of the carbon dioxide in the atmosphere. The combustion of fossil fuels has increased carbon dioxide ocean concentrations. What adverse effect does this have on marine life?

- A. Heterotrophs consume more phytoplankton.
- B. Phytoplankton have increased rates of photosynthesis.
- C. Corals deposit less calcium carbonate to form skeletons.
- D. Increased pH reduces enzyme activity in marine organisms.

[1]

22M.1A.SL.TZ1.28

The image shows a neuron.



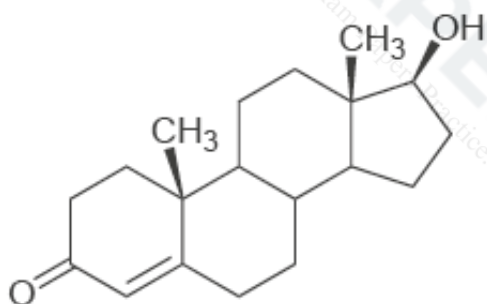
What is the function of X?

- A. Increases the speed of transmission along the axon
- B. Increases the rate of exchange of sodium and potassium ions
- C. Holds bundles of neurons together to form a nerve
- D. Determines the direction of the action potential

[1]

21N.1A.SL.TZ0.6

Testosterone is a hormone that is important for male reproductive development. [1]



To which group of compounds does testosterone belong?

- A. Nucleotides
- B. Carbohydrates
- C. Lipids
- D. Amino acids

22M.1A.SL.TZ2.29

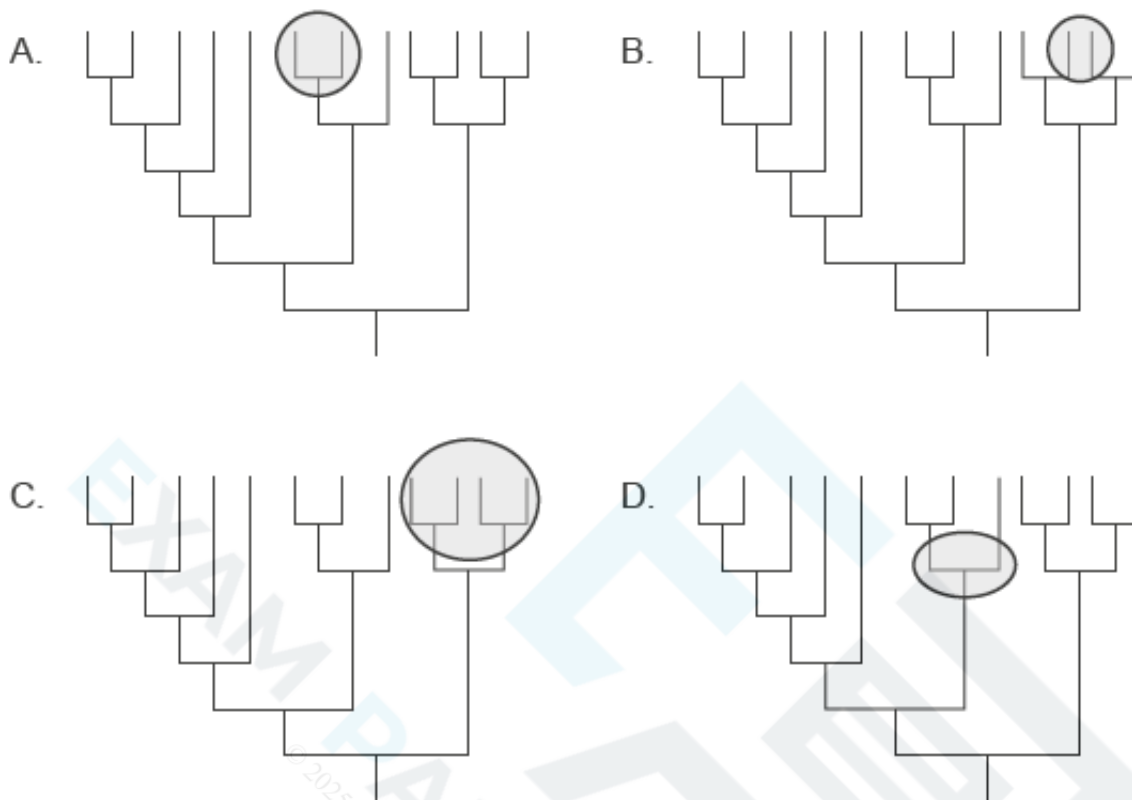
What is an example of negative feedback in the menstrual cycle? [1]

- A. High levels of estrogen inhibit **FSH** secretion.
- B. High levels of **LH** stop progesterone secretion.
- C. High levels of **FSH** delay ovulation.
- D. High levels of progesterone make follicles less receptive to **FSH**.

22M.1A.SL.TZ2.21

Which encircled area shows a clade?

[1]



23M.1A.SL.TZ2.22

Which is an example of evolution by selective breeding?

- A. Selection of prey animals that can run faster than their predators
- B. The variation in the size of different breeds of dogs
- C. The tendency, during breeding, for birds to produce more offspring than will survive
- D. Some female spiders only breeding with males which make the right signals

[1]

23M.1A.SL.TZ1.29

What occurs during the establishment of a resting membrane potential of a neuron?

- A. Both sodium and potassium ions are pumped outside the neuron.
- B. Sodium ions are pumped out while potassium ions are pumped into the neuron.
- C. Both sodium and potassium ions are at rest inside the membrane of the neuron.
- D. Sodium ions leave by diffusion and potassium ions enter the neuron by active transport.

[1]

22M.1A.SL.TZ1.30

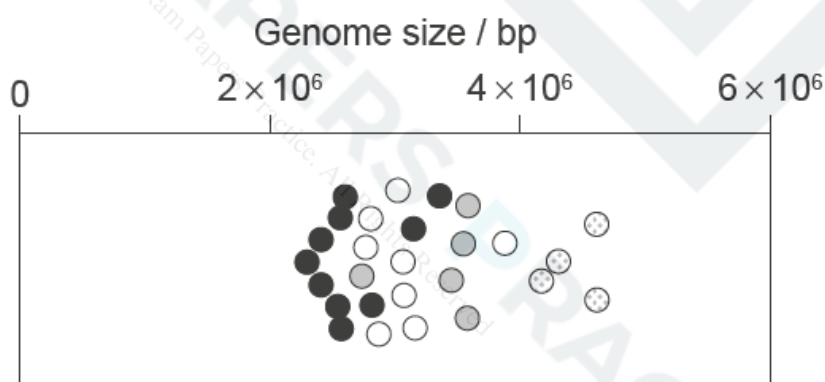
What is most likely to increase in the presence of insulin? [1]

- A. The rate of anaerobic respiration
- B. The chances of Type I diabetes
- C. The uptake of glucose by muscles
- D. The concentration of glucagon

23M.1A.SL.TZ1.12

The scattergraph shows the genome sizes of four *Enterococcus* species.

[1]



Key: ● *E. columbae*
 ○ *E. faecium*
 ● *E. faecalis*
 ⊗ *E. pallens*

What can be concluded about the genomes in *Enterococcus*?

- A. *E. pallens* has the greatest number of genes.
- B. *E. faecalis* and *E. faecium* have the same mean number of genes.
- C. The total genetic information in *Enterococcus* is constant within each species.
- D. *E. columbae* has more DNA than *E. faecium*.

21M.1A.SL.TZ1.16

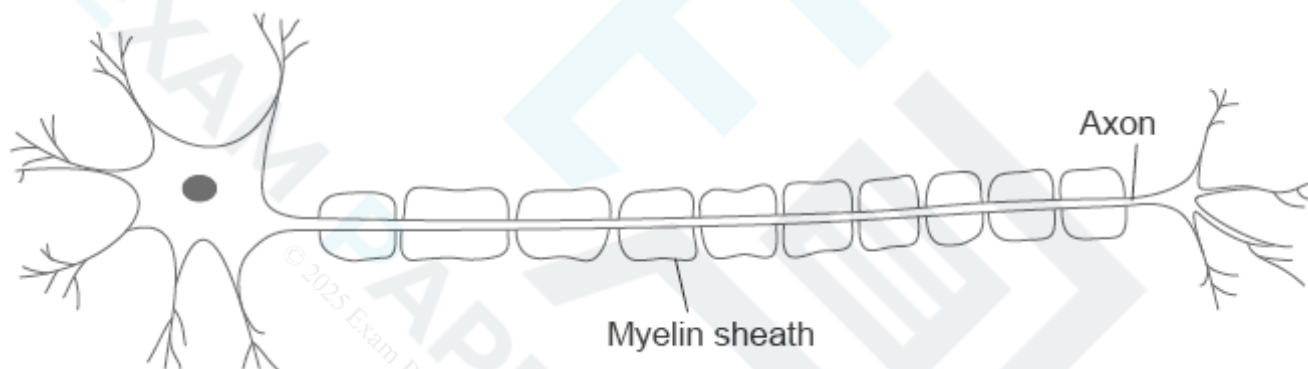
If a plant is exposed to light, which colour of light would lead to the lowest rate of oxygen release by a green plant?

- A. Blue
- B. Red
- C. Green
- D. White

[1]

19M.1A.SL.TZ2.28

The diagram shows a motor neuron.



[Source: © International Baccalaureate Organization 2019]

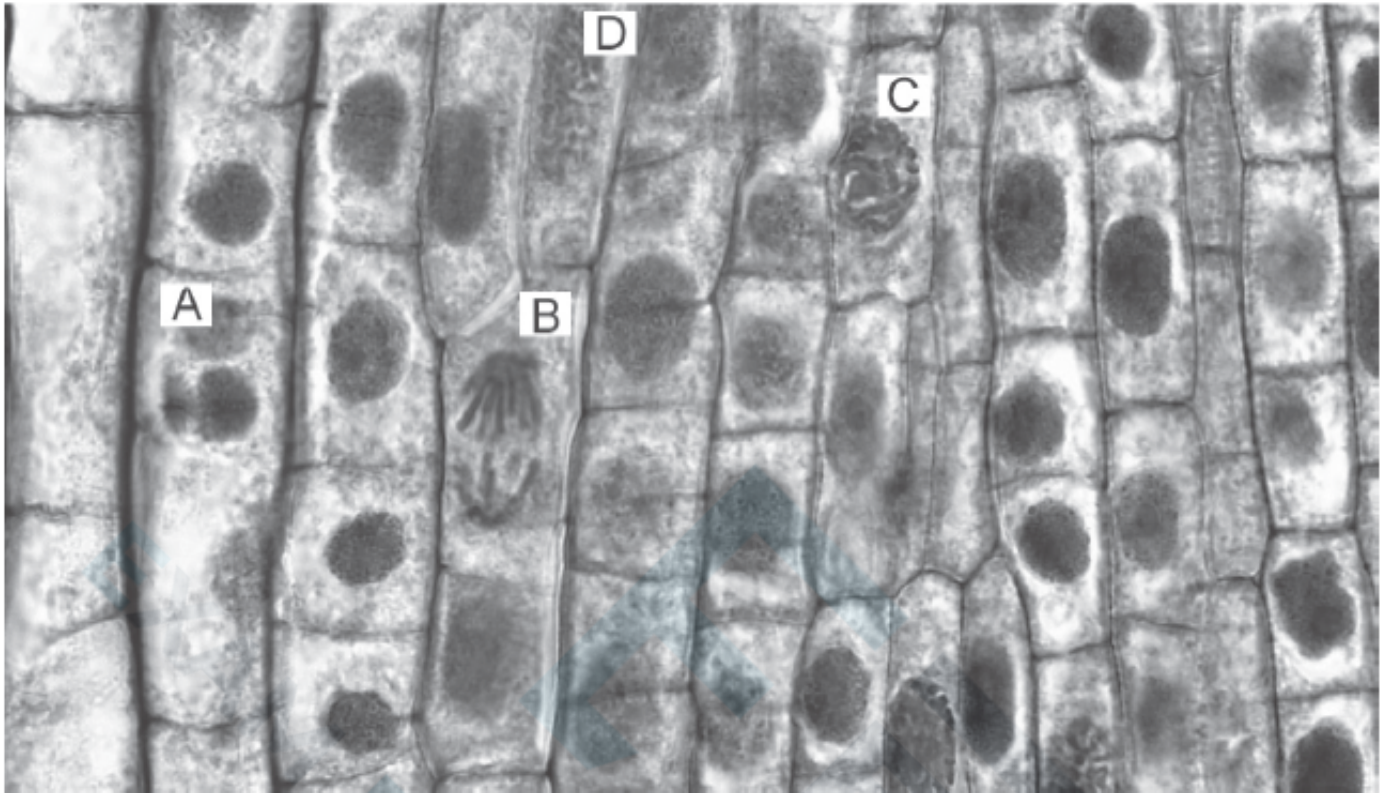
What are the biochemical nature and function of the myelin sheath?

- A. The myelin sheath is mainly protein which allows growth of the axon.
- B. The myelin sheath is mainly protein which acts as membrane carriers.
- C. The myelin sheath is mainly lipid which allows saltatory conduction.
- D. The myelin sheath is mainly lipid which provides an energy source.

[1]

19N.1A.SL.TZ0.4

In the micrograph, which letter points to a cell in anaphase?



[Source: Berkshire Community College Bioscience Image Library
https://commons.wikimedia.org/wiki/File:Mitotic_Stages_in_Apical_Meristem_of_Allium
 licensed under Creative Commons CC0 1.0 Universal Public Domain D

[1]

23M.1A.SL.TZ2.23

Which statement best describes how evolution occurs?

[1]

- A. Species which produce the most offspring are favoured by natural selection.
- B. Mutations in somatic cells are passed on to offspring.
- C. Natural selection decreases the frequency of unfavourable characteristics.
- D. Changes in species lead towards greater complexity over time.

23M.1A.SL.TZ1.5

What is an example of anabolism?

[1]

- A. Formation of peptides after protein digestion
- B. Formation of glucose and fructose from sucrose
- C. Formation of maltose from two glucose molecules
- D. Formation of glycerol and fatty acids from triglycerides

23M.1A.SL.TZ2.11

The anticodons of three tRNAs and the amino acids they carry are shown in the table.

tRNA anticodon	Amino acid
GCA	Arginine
AAU	Leucine
CAG	Valine

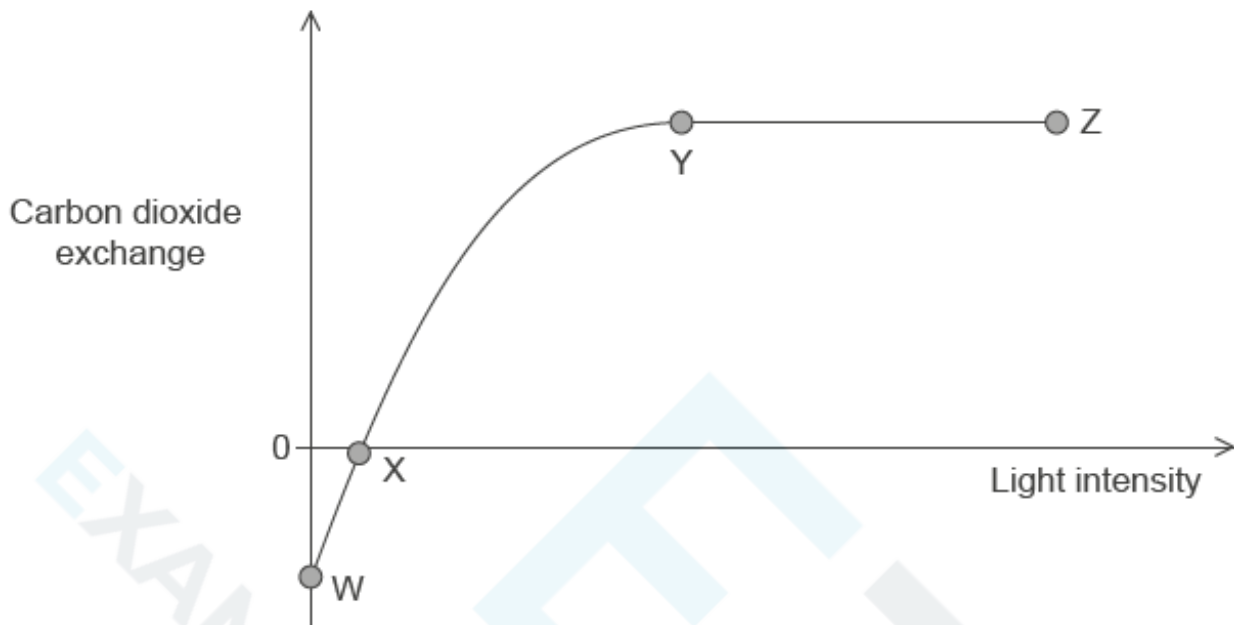
Which base sequence of an mRNA molecule would code for an arginine-leucine-valine tripeptide?

- A. GCA AAU CAG
- B. GCA AAT CAG
- C. CGT TTA GTC
- D. CGU UUA GUC

[1]

20N.1A.SL.TZ0.12

Plants produce carbon dioxide in respiration and use carbon dioxide in photosynthesis. The graph shows the volume of carbon dioxide exchanged in a plant at different light intensities.



What is shown by the graph?

- A. There is no photosynthesis between W and X.
- B. There is no photosynthesis between Y and Z.
- C. There is more respiration than photosynthesis between Y and Z.
- D. There is more respiration than photosynthesis between W and X.

[1]

19M.1A.SL.TZ1.7

What is common to RNA and DNA? [1]

- A. Thymine
- B. Nitrogenous bases
- C. Histones
- D. Deoxyribose