EXAM PAPERS PRACTICE

Helping you Achieve Highest Grades in IB

IB Biology HL

Question Paper

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

Paper: 1 (Multiple Questions Choices Across All Themes)

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

Marks: 190

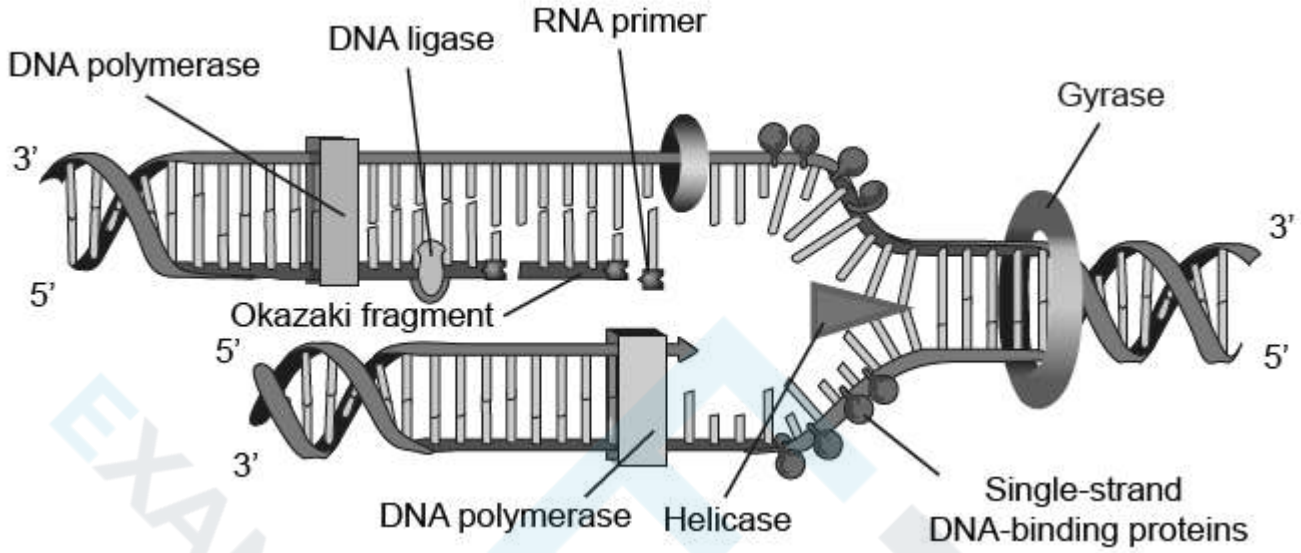
Total Marks: / 190

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

Questions

22N.1A.HL.TZ0.27

The diagram illustrates some of the processes involved in DNA replication.



[Source: Rohrmann, G., 2019. *AcMNPV DNA replication* . [diagram online] Available at: https://www.ncbi.nlm.nih.gov/books/NBK543453/figure/ch05.F1/ [Accessed 26 October 2021].]

What is shown in the diagram?

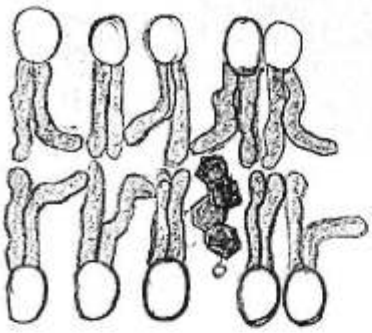
A. DNA polymerase bonding nucleotides in a 3′ to 5′ direction
B. Single-stranded DNA-binding proteins on the old strands
C. Gyrase reforming the double helix
D. DNA ligase joining Okazaki fragments in the leading strand

[1]

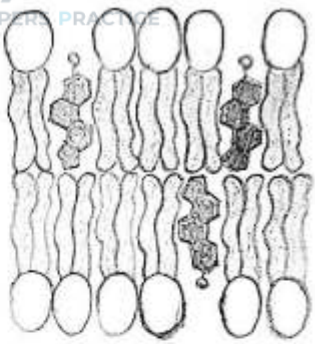
22M.1A.HL.TZ2.3

Which plasma membrane is the least fluid at high temperatures? [1]

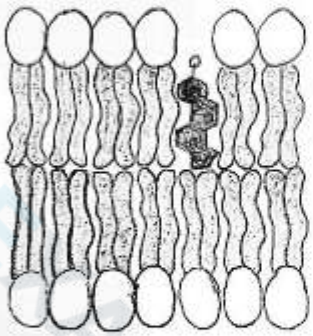
A.



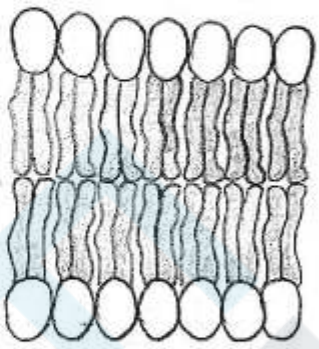
B.



C.



D.



Key:

Phospholipids

Cholesterol

22M.1A.HL.TZ1.31

Which products of the light-dependent reactions are used in the Calvin cycle? [1]
A. O_2 and hydrogen ions
B. ATP and CO_2
C. Electrons and reduced NADP
D. ATP and reduced NADP

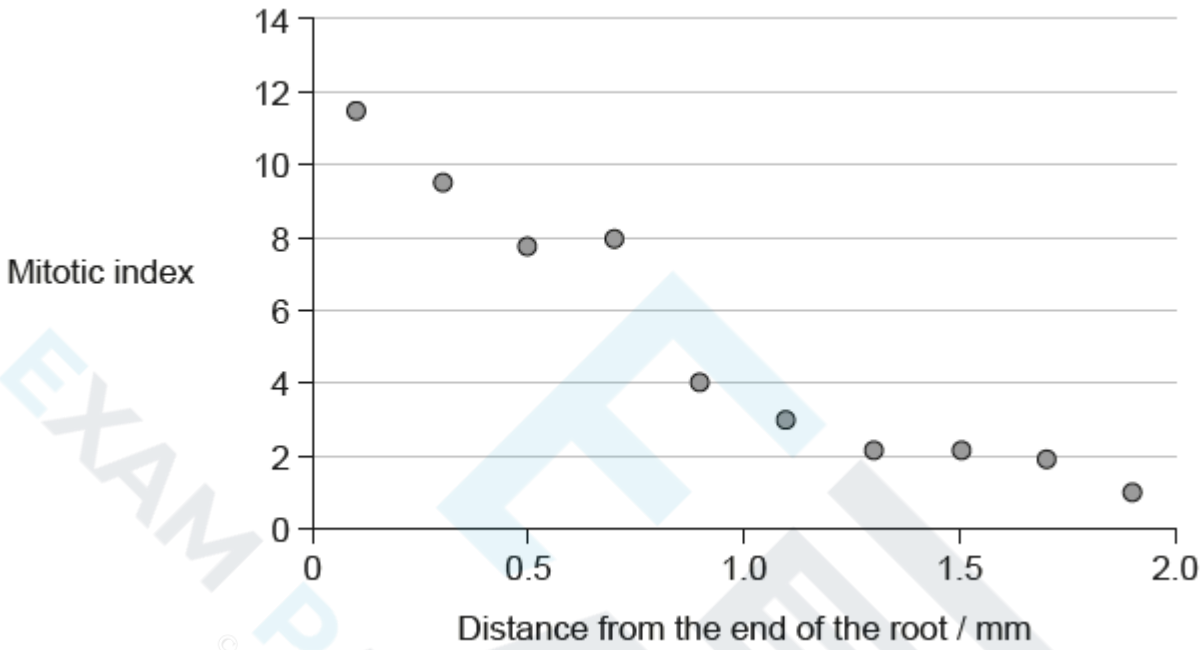
21N.1A.HL.TZ1.35

A dihybrid cross was carried out between two plants to determine whether the genes for seed shape and colour are linked. If the genes are unlinked, the expected ratio of 9:3:3:1 should occur. A chi-squared test was carried out on the observed results of the cross. The critical value for chi squared at the 5 % level of significance in this test was 7.82. The calculated value for chi squared was 6.25. What can be concluded from this data?
A. The results prove that the genes are linked.
B. The results prove that the genes are unlinked.
C. There is significant evidence that the genes are linked.
D. There is significant evidence that the genes are unlinked.

[1]

21N.1A.HL.TZ0.5

The graph shows the mitotic index in the roots of lentil plants at different distances from the end of the root.



[Source: *Physiologia Plantarum* , Volume 105, Issue 1, January 1999, Pages 171–178, Effect of microgravity on the cell cycle in the lentil root F. Yu, D. Driss-Ecole, J. Rembur, V. Legué, G. Perbal Wiley Online Library: https://onlinelibrary.wiley.com/doi/abs/10.1034/j.1399-3054.1999.105125.x]

What can be deduced from the graph?

A. As the distance from the end of the root increases, more cells are undergoing mitosis.

B. At 0.5 mm from the end of the root, most of the cells are in prophase.

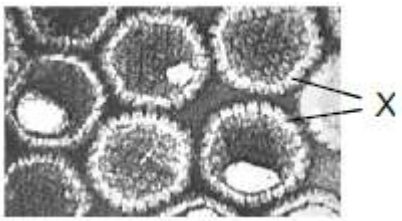
C. There were fewer cells observed at 1.5 mm than at 0.5 mm.

D. As the distance from the end of the root increases, the percentage of cells in interphase increases.

[1]

SPM.1A.HL.TZ0.14

The image shows a group of enveloped viral particles.



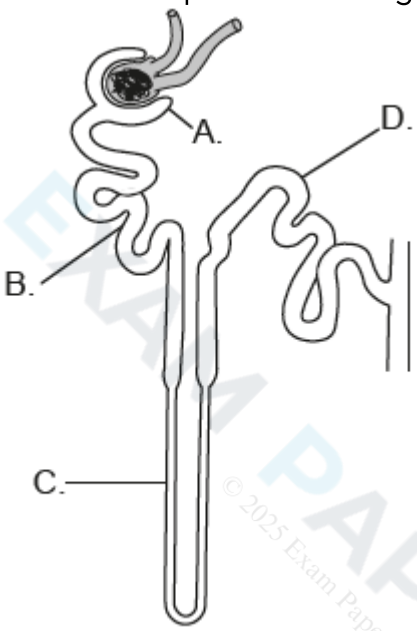
What is the most likely composition of the structure labelled X?

A. Membrane derived from the host cell
B. Viral DNA
C. Viral cell walls
D. Viral enzymes

[1]

21N.1A.HL.TZ1.39

Where in the nephron is most glucose reabsorbed?

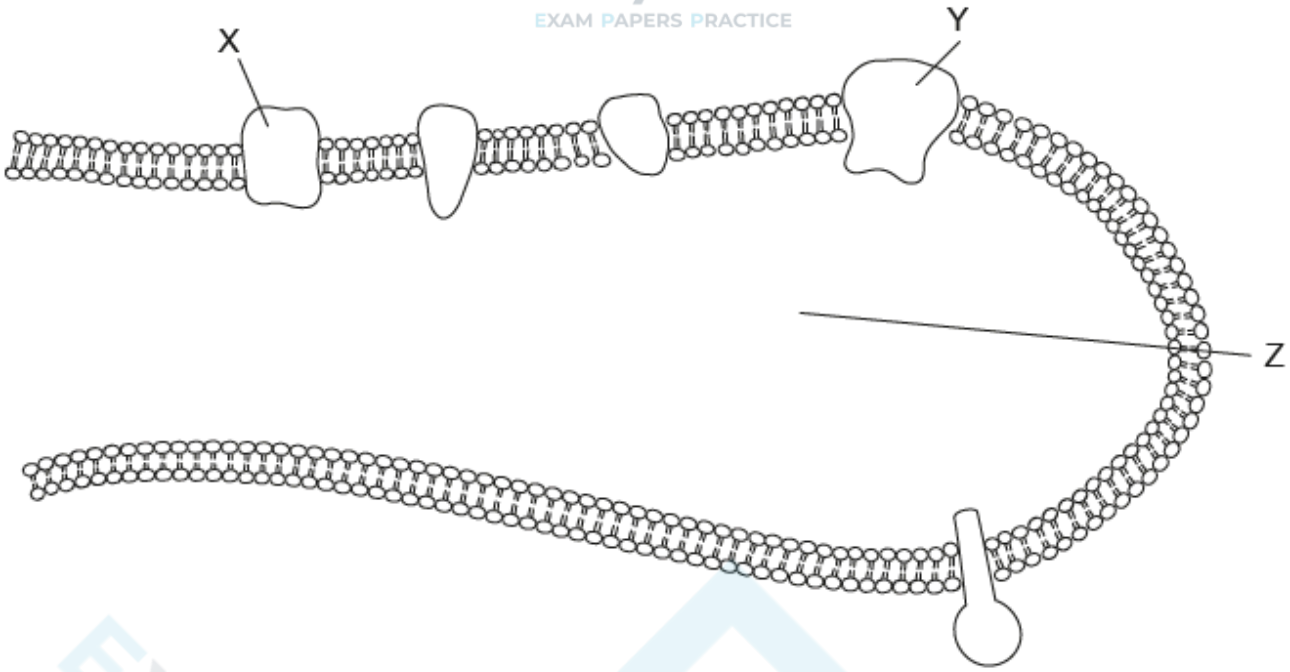


[Source: National Institute of Diabetes and Digestive and Kidney Diseases, n.d. [*Nephron*]. [diagram online] Available at: https://www.niddk.nih.gov/news/media-library/9164 [Accessed 23 March 2020].]

[1]

20N.1A.HL.TZ0.30

The diagram shows a section through a thylakoid. Electrons move from X to Y.



[Source: Courtesy Alyse Da Quynh.]

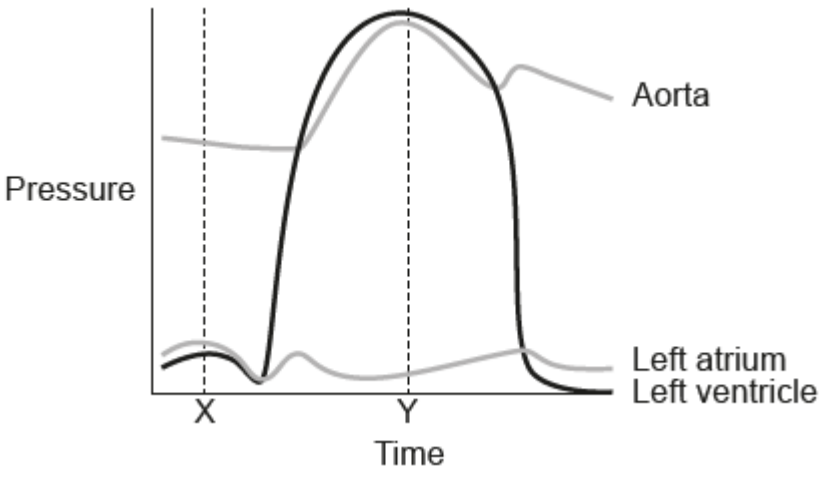
What do the letters X, Y and Z represent?

	X	Y	Z
A.	photosystem I	photosystem II	thylakoid space
B.	photosystem II	photosystem I	thylakoid space
C.	ATP synthase	photosystem II	stroma
D.	photosystem II	ATP synthase	stroma

[1]

23M.1A.HL.TZ2.27

The diagram shows the pressure changes in the left atrium, left ventricle and aorta during part of the cardiac cycle.



Are the valves between the atria and the ventricles open or closed at time X and time Y?

A. open open

B. open closed

C. closed open

D . closed closed

[1]

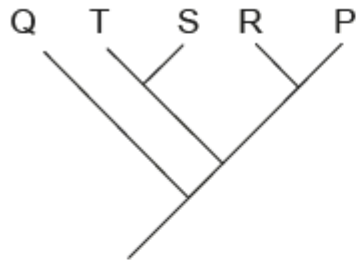
22M.1A.HL.TZ1.23

Data regarding the presence (+) or absence (–) of five traits in several different species are shown in the table.

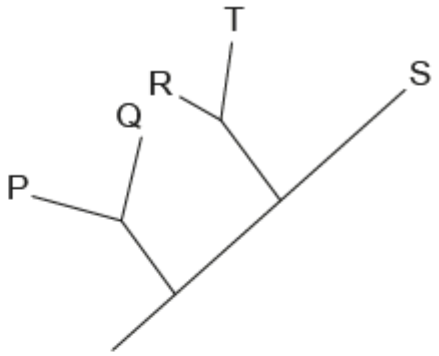
	Traits				
Species	**1**	**2**	**3**	**4**	**5**
P	+	–	–	+	+
Q	–	–	–	–	–
R	+	–	–	–	+
S	+	+	+	–	–
T	+	+	–	–	–

Which cladogram best represents the relationship between the five species?

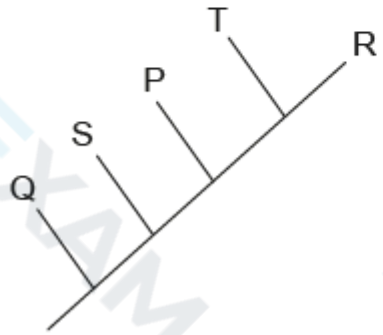
A.



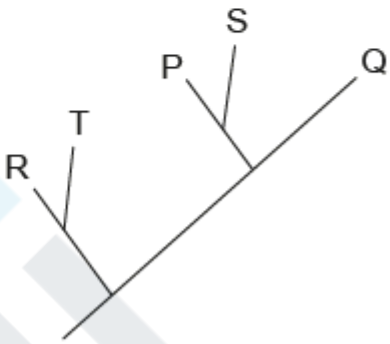
B.



C.



D.



[1]

19M.1A.HL.TZ2.14

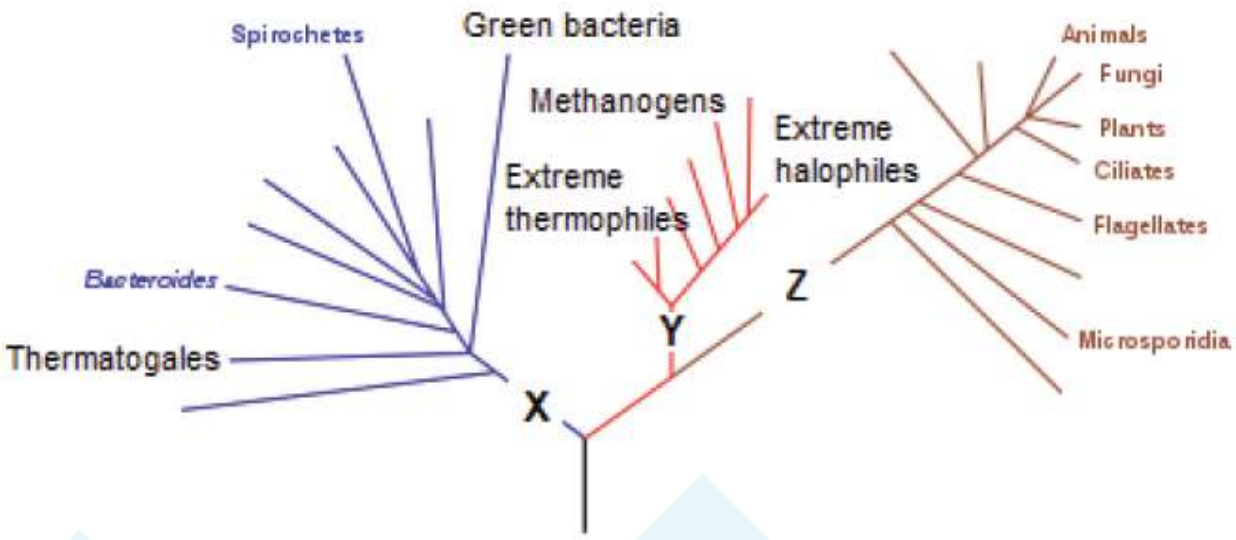
What applies to DNA base sequences? [1]

I. Some genes do not code for proteins.
II. Promoters are transcribed along with the gene.
III. Introns are only found within genes coding for proteins.

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

20N.1A.HL.TZ0.23

The cladogram shows some of the groups in the three domains.



[Source: Adapted from Eric Gaba (Sting, fr:Sting), Cherkash, Public domain, via Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Phylogenetic_tree.svg.]

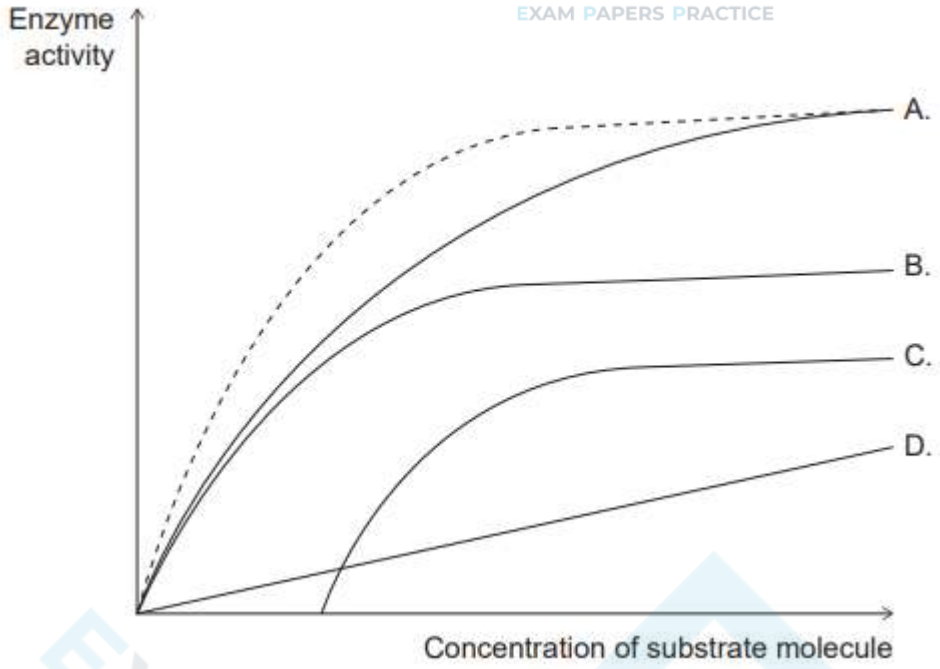
What domains do X, Y and Z represent?

	Domains		
	X	Y	Z
A.	prokaryote	archaea	eukaryote
B.	archaea	eubacteria	prokaryote
C.	eubacteria	archaea	eukaryote
D.	eubacteria	prokaryote	eukaryote

[1]

21M.1A.HL.TZ2.29

The dashed line shows the relationship between the activity of an enzyme and the concentration of its substrate. Which curve shows the effect of a non-competitive inhibitor on this relationship?



[1]

19M.1A.HL.TZ1.31

Which process is common to photosynthesis and cell respiration? [1]
A. Photolysis
B. The Calvin cycle
C. The Krebs cycle
D. Chemiosmosis

SPM.1A.HL.TZ0.13

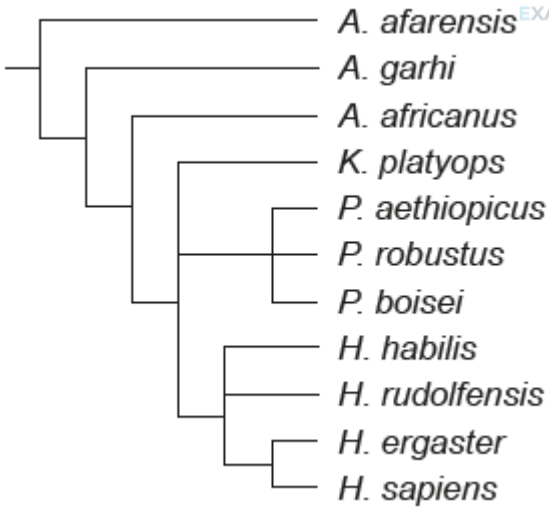
How does the Miller-Urey experiment contribute to an explanation of the origin of life?

A. It shows how phospholipids form protocells in specific laboratory conditions.
B. It explains how organic molecules arise from inorganic ones under certain environmental conditions.
C. It explains the synthesis of RNA, recreating deep sea vent conditions in the laboratory.
D. It shows how the last universal common ancestor (LUCA) evolved from vesicles.

[1]

21N.1A.HL.TZ0.23

The cladogram shows one theory of how species of hominin evolved. [1]



What can be deduced using the information in the cladogram?
A. The closest species to *K. platyops* is *A. africanus* .
B. *A. afarensis* is extinct.
C. The DNA of *H. sapiens* is the same as that of *H. ergaster* .
D. *H. sapiens* and *P. robustus* shared a common ancestor.

SPM.1A.HL.TZ0.29

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

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

22N.1A.HL.TZ0.34

A hummingbird is shown visiting a large flower.

[Source: Nussbaumer, R./Naturepl.com, n.d. Black chinned hummingbird (*Archilochus alexandri*). Available at:

https://www.naturepl.com/stock-photo/black-chinned-hummingbird-archilochus-alexandri-male-feeding-at-sageflower/search/detail-0_01140572.html.]

What makes this a mutualistic relationship?

A. The bird feeds on nectar and transfers pollen to the stamen of a flower of the same species.

B. The bird obtains nutrients and the plant is assisted with pollination for sexual reproduction.

C. The bird requires pollen as a protein source and, while obtaining this, disperses seeds for the plant.

D. The bird transfers pollen to the stigma of flowers of a different species while feeding.

[1]

19N.1A.HL.TZ0.28

How do R group interactions contribute to protein structure? [1]

I. Determining the sequence of amino acids in the primary structure

II. Stabilizing beta pleated sheets in the secondary structure

III. Stabilizing further foldings of a polypeptide into a tertiary structure

A. I only

B. II and III only

C. III only

D. I, II and III

21M.1A.HL.TZ1.23

Which structural feature enables saltatory conduction? [1]

A. Nodes of Ranvier between Schwann cells

B. Na^+ channels under Schwann cells

C. K^+ channels under Schwann cells

D. Sodium–potassium pumps under Schwann cells

21M.1A.HL.TZ2.7

Which organic molecules may contain the element sulphur? [1]

A. Proteins

B. Carbohydrates

C. Phospholipids

D. Nucleic acids

22M.1A.HL.TZ2.27

Promoters are non-coding regions in DNA. What is the role of a promoter? [1]

A. It starts translation.

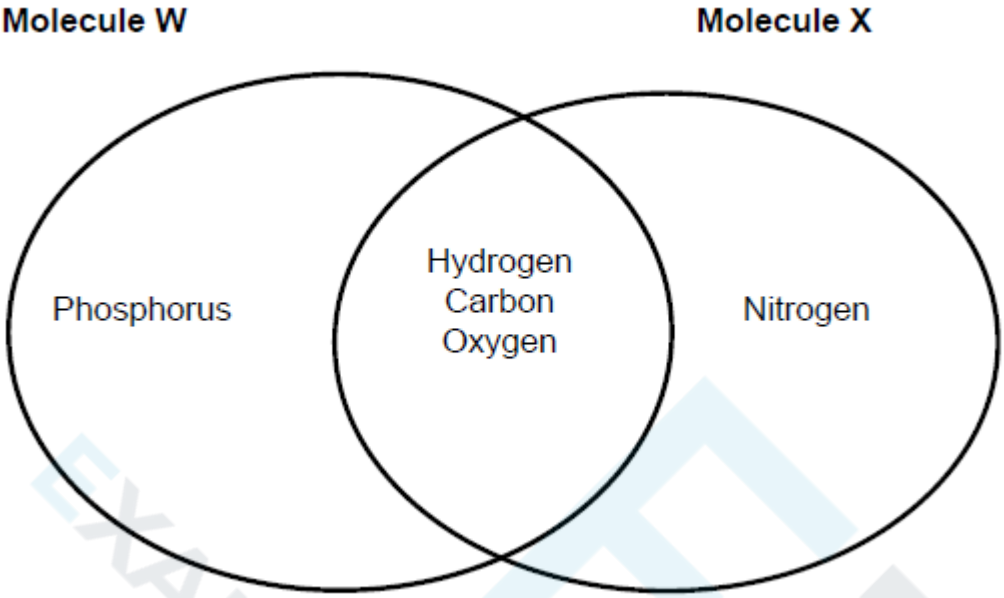
B. It starts mRNA splicing.

C. It is a binding site for DNA polymerase during DNA replication.

D. It is a binding site for RNA polymerase during transcription.

SPM.1A.HL.TZ0.2

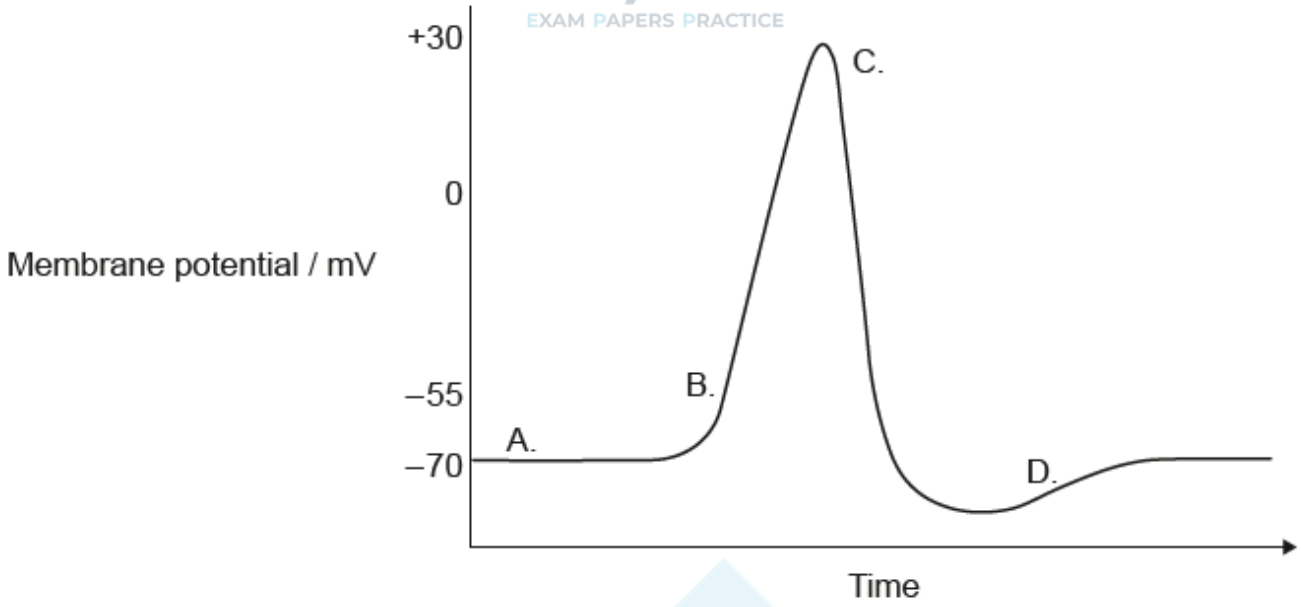
The diagram shows the elements present in two organic molecules, W and X. [1]
Which molecules could W and X be?



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

20N.1A.HL.TZ0.25

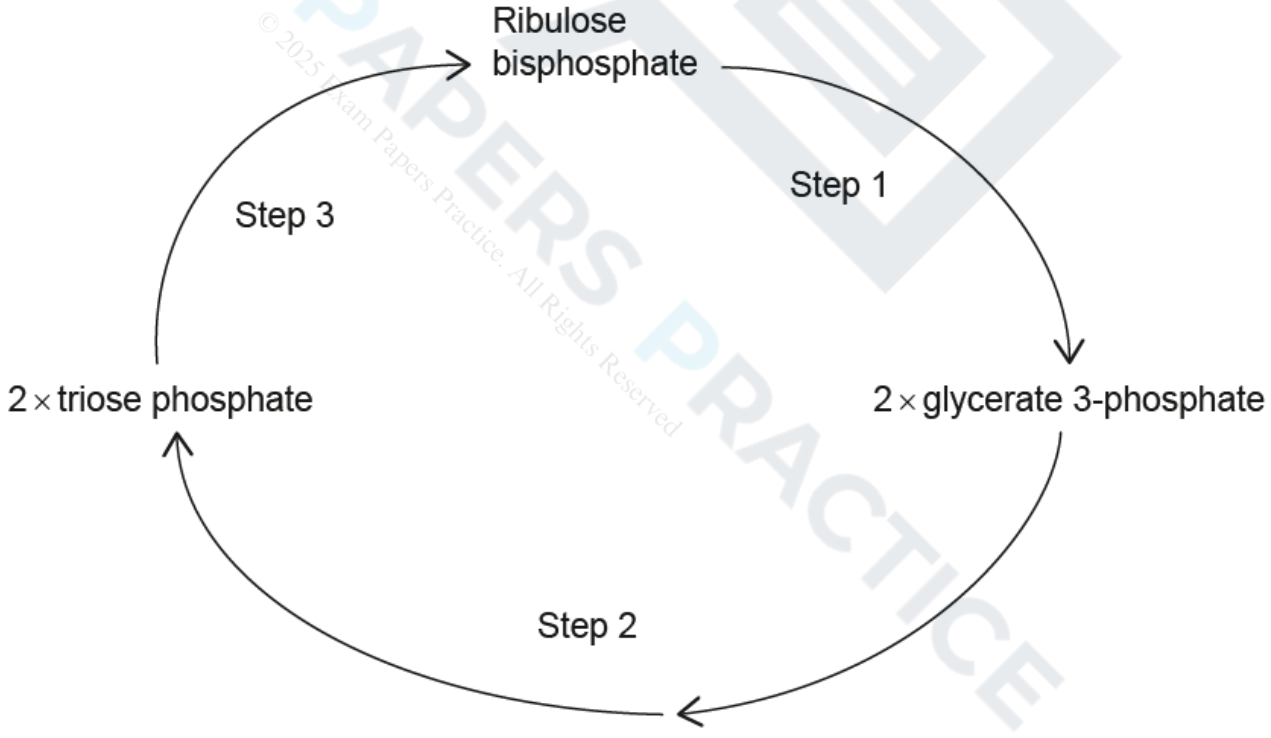
The graph shows the changing membrane potential during a nerve impulse. Which letter indicates when the potassium channels open?



[1]

23M.1A.HL.TZ1.30

The cycle shows part of the light-independent reactions in photosynthesis.



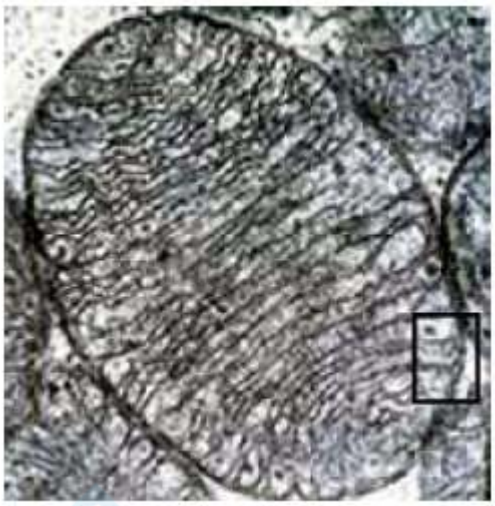
What occurs in Step 1?

A. ATP is formed for Step 2.
B. Rubisco catalyses the hydrolysis of ribulose bisphosphate.
C. A carboxylase catalyses the carboxylation of ribulose bisphosphate.
D. NADP is converted to reduced NADP.

[1]

22N.1A.HL.TZ0.30

An electron micrograph of a mitochondrion is shown.



The distance between the inner and outer membranes, which are shown by the box, is always very small. What is the advantage of this small distance?

A. Enables a high concentration of electrons to build up quickly
B. Enables a high concentration of protons to build up quickly
C. Allows fast diffusion of glucose into the mitochondrion
D. Allows fast diffusion of reduced NAD out of the mitochondrion

[1]

22M.1A.HL.TZ2.19

Some strains of the pathogenic bacterium *Staphylococcus aureus* have developed mechanisms that protect them against foreign DNA. What effect does this have on the evolution of antibiotic resistance in these strains of *S. aureus* ?

A. Slower evolution, as bacteria with the antibiotic resistance gene will not reproduce
B. Slower evolution, as the antibiotic resistance gene from other species will not be accepted
C. Faster evolution, as mutations within a population are less likely to occur
D. Faster evolution, as antibiotic resistance genes can only be passed to individuals of the same species

[1]

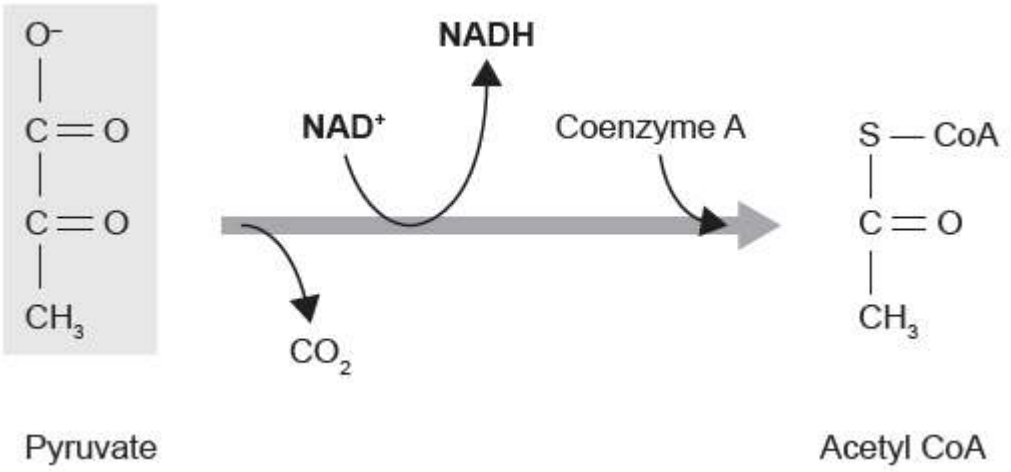
19M.1A.HL.TZ2.33

What is the function of the loop of Henle? [1]

A. To reabsorb salt
B. To maintain a hypertonic solution in the medulla
C. To transport liquid from the collecting ducts to the convoluted tubules
D. To reabsorb glucose

19N.1A.HL.TZ0.30

The diagram shows the link reaction between glycolysis and the Krebs cycle. [1]



[Source: © International Baccalaureate Organization 2019]

Which type of reaction is occurring?
A. Pyruvate is carboxylated.
B. CO2 is oxidized.
C. NAD+ is reduced.
D. Pyruvate is phosphorylated.

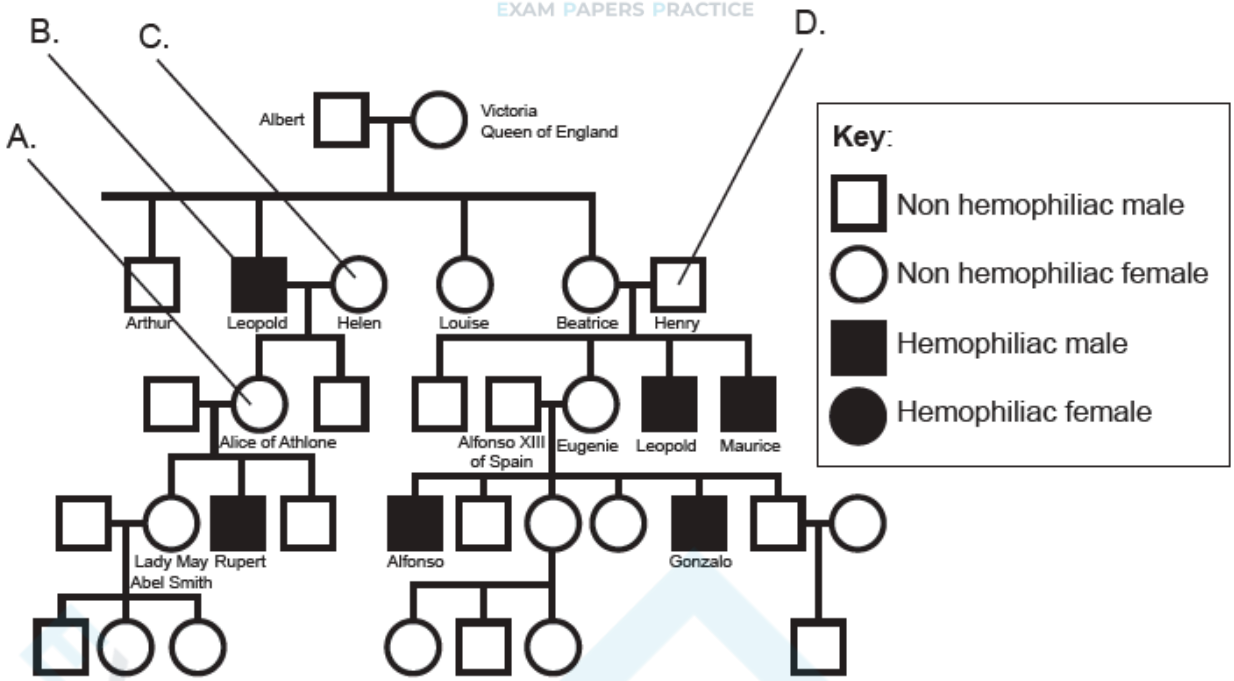
21M.1A.HL.TZ1.28

Which statement applies to the tertiary structure of enzymes?
A. Tertiary structure is the sequence of amino acids in an enzyme.
B. Some enzymes do not have a tertiary structure.
C. An example of tertiary structure in an enzyme is the alpha helix.
D. A change in the tertiary structure of an enzyme may result in a change in the structure of the active site.

[1]

19N.1A.HL.TZ0.12

The pedigree chart shows the inheritance of hemophilia in some of the descendants of Queen Victoria. Which letter points to a family member certain to be heterozygous?



[Source: © International Baccalaureate Organization 2019]

[1]

SPM.1A.HL.TZ0.35

What are common features of holozoic nutrition and saprotrophic nutrition?

	Mostly fungi and bacteria	Secretion of enzymes to digest food	Ingestion of food particles
A.	✓	✓	✗
B.	✓	✗	✓
C.	✗	✓	✗
D.	✗	✗	✗

[1]

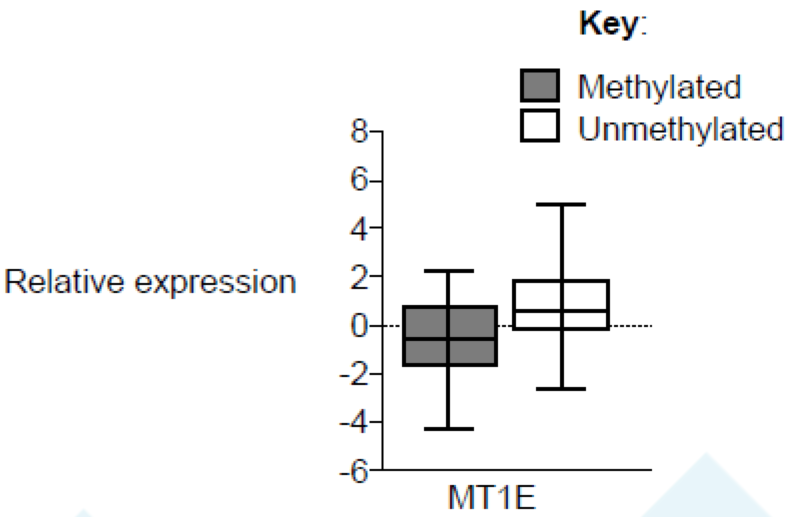
19N.1A.HL.TZ0.6

What is a proteome? [1]

A. The genes that code for all the proteins in the ribosome
B. The group of proteins that generate a proton gradient in mitochondria
C. The entire genome of a prokaryote
D. The entire set of proteins expressed by an organism at a certain time

SPM.1A.HL.TZ0.19

The graph shows the effect of methylation on the expression of MT1E, a gene involved in the control of prostate cancer development. Patients with a reduced expression of this gene are more likely to develop prostate cancer.



prostate ca[illegible] Commons

What are effects of MT1E methylation?

A. It reduces transcription of MT1E, increasing the risk of prostate cancer.
B. It increases translation of MT1E, reducing the risk of prostate cancer.
C. It reduces replication of MT1E, reducing the risk of prostate cancer.
D. It increases the chances of mutation in proto-oncogenes, increasing the risk of prostate cancer.

[1]

22M.1A.HL.TZ1.27

A cell from the lungs, observed under the microscope, contains a large number of secretory organelles. Which conclusion can be drawn about the cell?
A. It is a type I pneumocyte.
B. It is a type II pneumocyte.
C. It could be either a type I or type II pneumocyte.
D. It is a red blood cell.

[1]

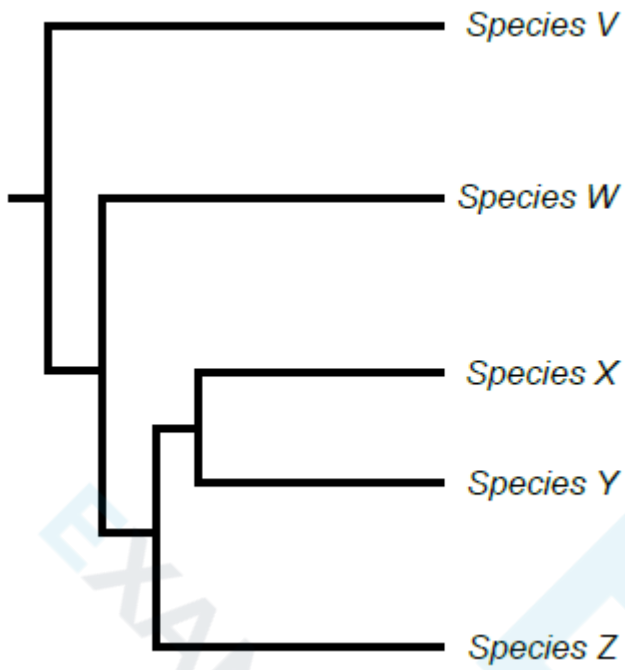
20N.1A.HL.TZ0.2

Which feature of the cell in the micrograph is consistent with the endosymbiotic theory?
A. X has a single membrane.
B. Y has a double membrane.
C. X contains 70S ribosomes.
D. Y contains 80S ribosomes.

[1]

SPM.1A.HL.TZ0.25

Scientists studied differences in the base sequences of a gene found in five animal species in order to determine their evolutionary relationships. A cladogram was constructed based on these differences.



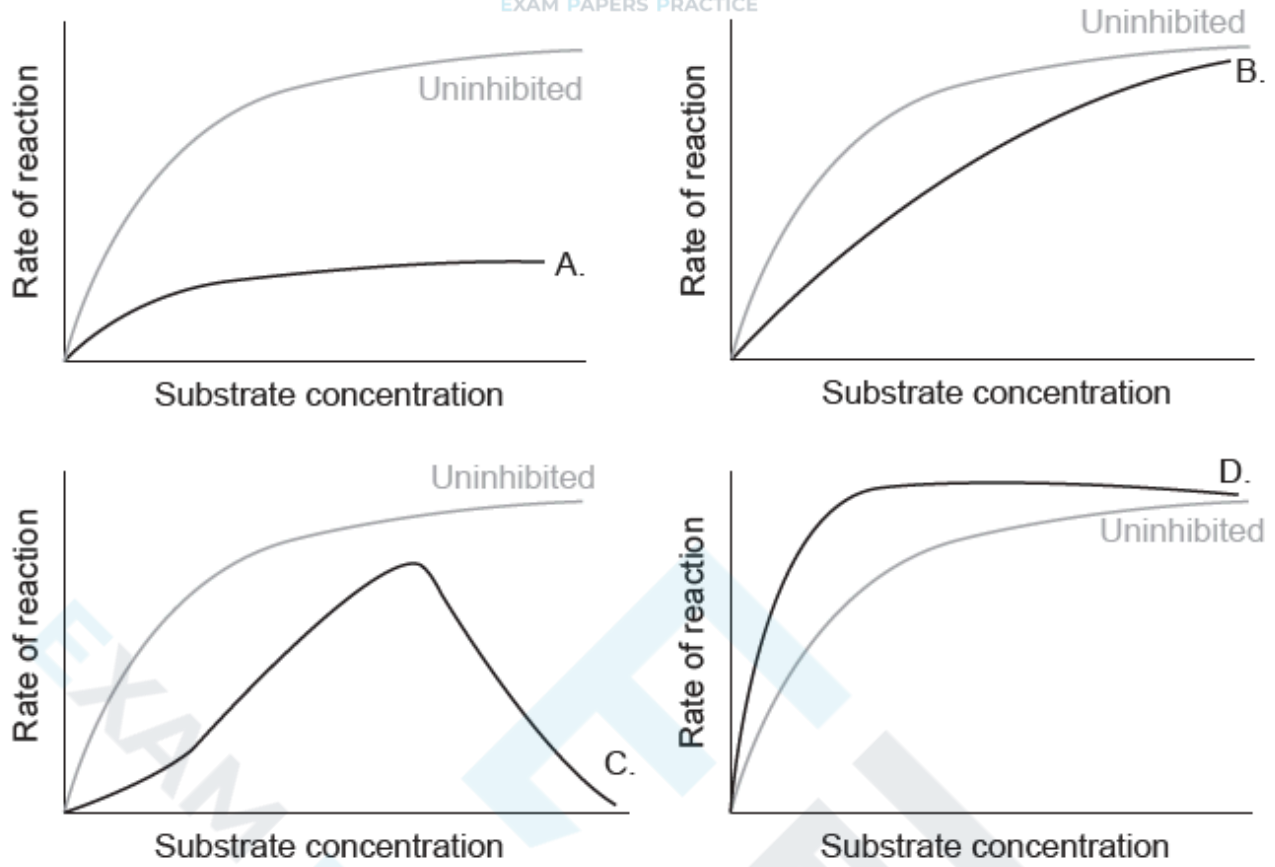
What can be deduced from the cladogram?

A. There are only three clades shown.
B. Morphological differences between V and Z increase with time.
C. There is only one difference between the amino acid sequences of X and Y.
D. Y and Z have a more recent common ancestor than W and X.

[1]

19N.1A.HL.TZ0.29

The grey line in each of the graphs below represents the rate of reaction catalysed by an uninhibited enzyme as substrate concentration is increased.
Which graph shows expected results if a competitive inhibitor was added to the reaction?



[Source: © International Baccalaureate Organization 2019]

[1]

SPM.1A.HL.TZ0.5

The structure of monomers affects the structure and function of the polymers they form. Which row
describes the structural features of polysaccharides made from alpha-glucose and beta-glucose?

	Monomer	Polymer	Shape of polymer
A.	alpha-glucose beta-glucose	starch cellulose	unbranched, straight branched, helical
B.	alpha-glucose beta-glucose	starch cellulose	branched, helical unbranched, straight
C.	alpha-glucose beta-glucose	cellulose starch	branched, helical unbranched, straight
D.	alpha-glucose beta-glucose	cellulose starch	unbranched, straight branched, helical

[1]

SPM.1A.HL.TZ0.9

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]

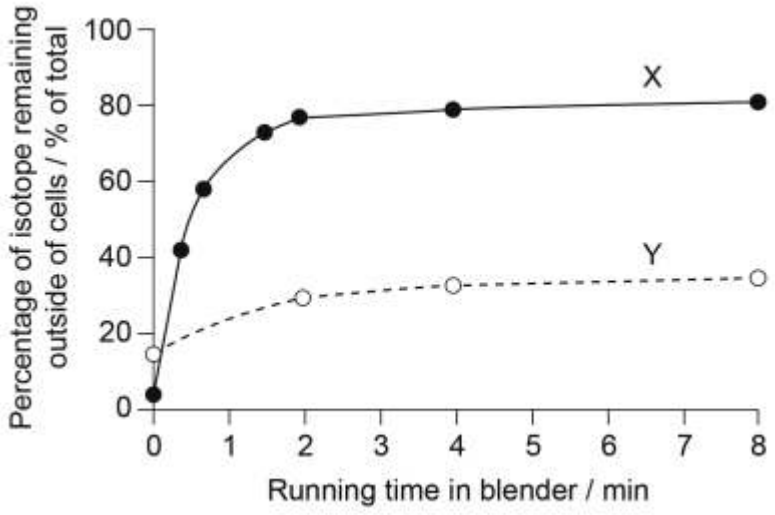
21N.1A.HL.TZ0.4

How do both mitochondria and chloroplasts provide evidence for the endosymbiotic theory?
A. They have double membranes.
B. They have 80S ribosomes similar to prokaryotes.
C. They contain the same DNA as the nucleus of the cell.
D. They exist together in eukaryote cells for their mutual benefit.

[1]

21M.1A.HL.TZ2.26

The graph shows results of an experiment by Hershey and Chase in 1952 in which bacteria were infected with a mixture of virus particles labelled with either ^{32}P or ^{35}S. A suspension of the infected bacteria was agitated with a blender, and samples collected from the suspension were centrifuged to record the percentage of isotope remaining on the outside of the cells.



[Source: Republished with permission of ROCKEFELLER UNIVERSITY PRESS, from Independent functions of protein and nucleic acid in growth of bacteriophage. Hershey, A.D. and Chase, M., 1952. (*Journal of General Physiology* , 36(1), p.47). Society of General

Physiologists, Rockefeller Institute for Medical Research, Rockefeller Institute; permission conveyed through Copyright Clearance Center, Inc.]

What do curves X and Y represent?

	Curve X	Curve Y
A.	^{32}P in sediment	^{35}S in supernatant
B.	^{35}S in supernatant	^{32}P in supernatant
C.	^{32}P in supernatant	^{35}S in sediment
D.	^{35}S in sediment	^{32}P in sediment

[1]

23M.1A.HL.TZ1.37

What is used in a pregnancy test kit? [1]

A. Monoclonal antibodies against hybridoma cells
B. Antibodies against monoclonal hybridoma cells
C. HCG produced by plasma cells fused with tumour cells
D. Monoclonal antibodies produced by hybridoma cells against HCG

20N.1A.HL.TZ0.4

What would show that a person has developed metastatic cancer? [1]
A. Alveolus cells forming a tumour in the lungs
B. Cancer cells producing the skin pigment melanin in the liver
C. A tumour in the prostate gland increasing levels of prostate-specific antigen
D. Cancerous lymphocytes in blood plasma

SPM.1A.HL.TZ0.3

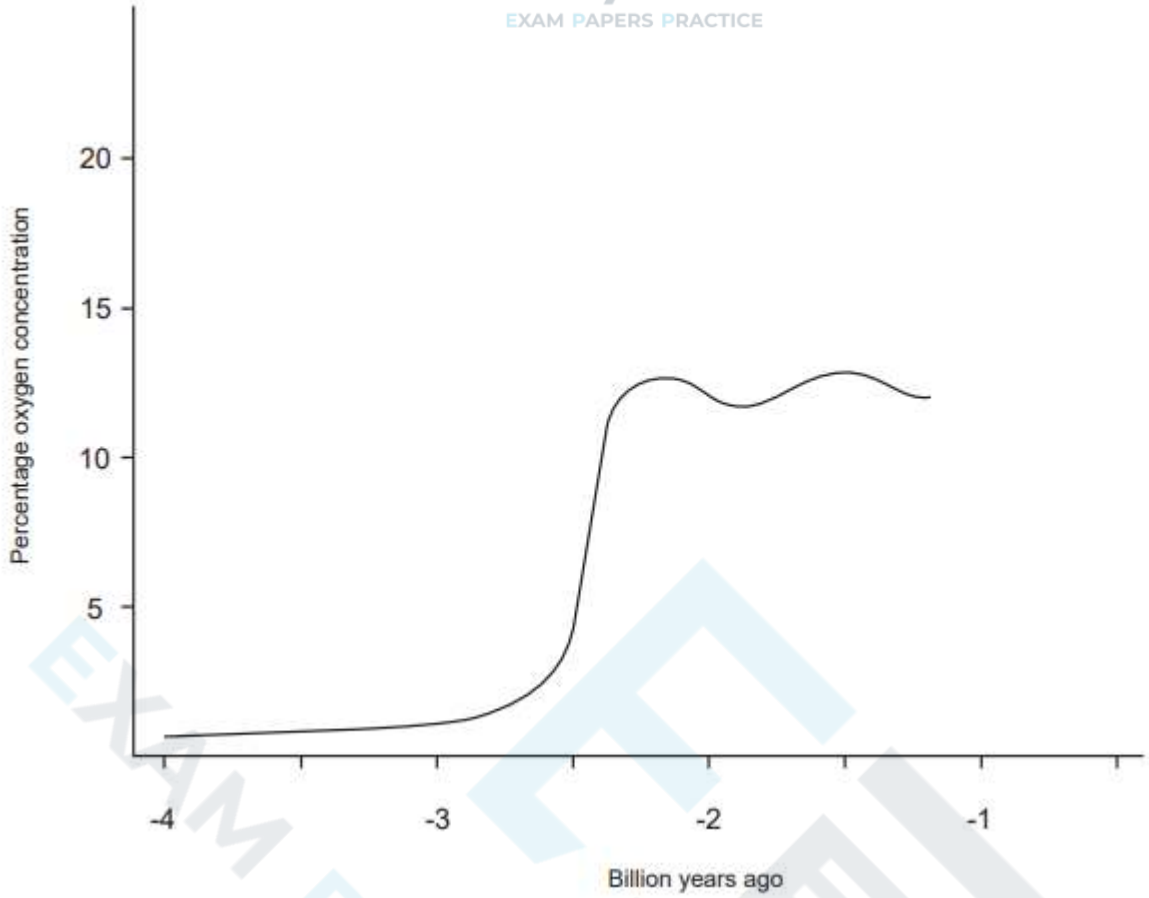
Which property of DNA explains how genetic information can be replicated accurately?

A. Complementary base pairing
B. The double helical shape
C. 5′ – 3′ bonding in the sugar-phosphate backbone
D. The ability of DNA to bind to histones

[1]

21M.1A.HL.TZ1.10

The graph shows atmospheric oxygen levels over time.



About 2.5 billion years ago, a significant rise in atmospheric oxygen occurred. What was the cause of this rise?
A. Photosynthesis by non-vascular land plants
B. Photosynthesis by vascular land plants
C. Oxygen produced by photosynthetic bacteria being released from the ocean into the atmosphere
D. Volcanic activity

[1]

21M.1A.HL.TZ1.6

Which statement applies to cholesterol? [1]
A. It is hydrophobic and found on the outside of the phospholipid bilayer.
B. It is hydrophilic and found inside the phospholipid bilayer.
C. It impacts membrane fluidity.
D. It is transported in association with glucose in the blood.

SPM.1A.HL.TZ0.12

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

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

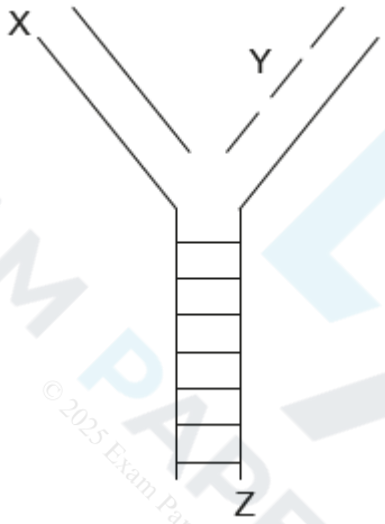
23M.1A.HL.TZ2.4

What is evidence for the endosymbiotic theory? [1]

A. Eukaryote mitochondria contain DNA.
B. Prokaryotes evolved before eukaryotes.
C. Unicellular organisms exist as both prokaryotes and eukaryotes.
D. Prokaryote cells have no double membranes.

22M.1A.HL.TZ1.26

The image shows a replication fork. [1]

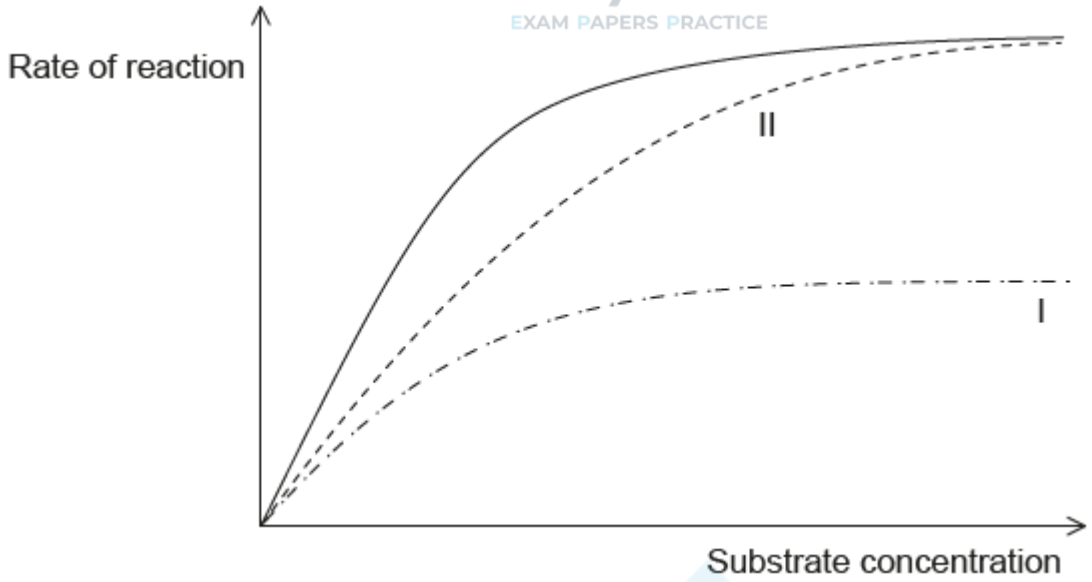


Which row identifies X, Y and Z in the diagram?

	X	Y	Z
A.	5′ end	DNA leading strand	5′ end
B.	3′ end	Okazaki fragment	3′ end
C.	3′ end	DNA leading strand	5′ end
D.	5′ end	Okazaki fragment	3′ end

22M.1A.HL.TZ1.29

The graph shows the effect of increasing substrate concentration on the rate of an enzyme-catalysed reaction.



Which type of inhibition corresponds to the labelled curves?

	I	II
A.	Competitive inhibition	No inhibition
B.	Non-competitive inhibition	Competitive inhibition
C.	Competitive inhibition	Non-competitive inhibition
D.	No inhibition	Competitive inhibition

[1]

19M.1A.HL.TZ1.35

Natural selection can operate in different ways. What is the effect of disruptive selection?
A. It eliminates individuals with intermediate forms of a characteristic.
B. It eliminates individuals at random regardless of their characteristics.
C. It favours individuals with intermediate forms of a characteristic.
D. It favours individuals at one extreme of the range of variation in a characteristic.

[1]

19M.1A.HL.TZ2.9

The base sequences of a short section of DNA are shown, together with mRNA that has been transcribed from it and one of the tRNA anticodons that could be used to translate the mRNA.

DNA strand 1 A-C-G-G-C-A-T-T-A-G-C-T-A **tRNA anticodon** U-U-A

DNA strand 2 T-G-C-C-G-T-A-A-T-C-G-A-T **mRNA** U-G-C-C-G-U-A-A-U-C-G-A-U

Which strand of DNA is transcribed and to which codon in the mRNA would the tRNA anticodon bind during translation?

	DNA strand transcribed	mRNA codon that tRNA anticodon binds to
A.	DNA strand 1	second
B.	DNA strand 2	second
C.	DNA strand 1	third
D.	DNA strand 2	third

[1]

19M.1A.HL.TZ2.37

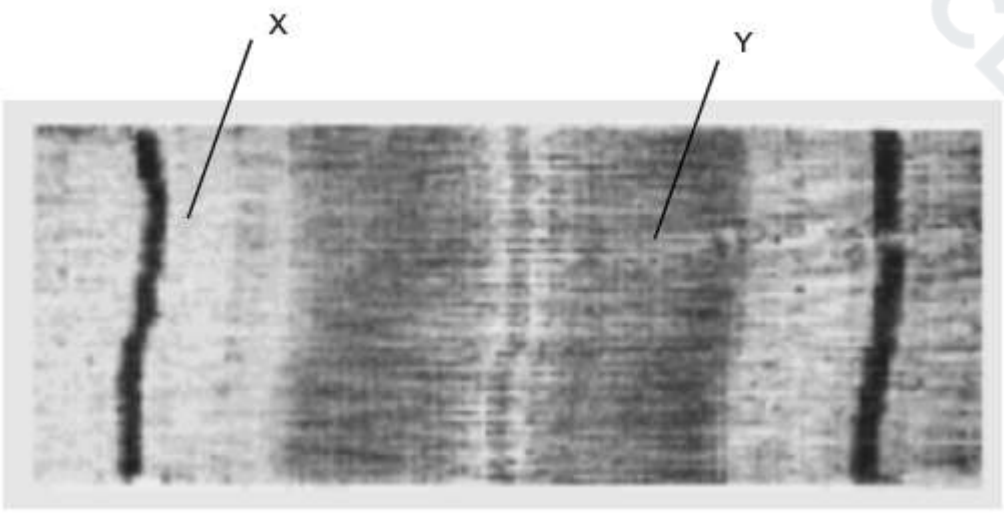
What is the order of increasing size of muscle structures? [1]
A. muscle, muscle fibre, myofibril, sarcomere
B. myofibril, muscle fibre, sarcomere, muscle
C. sarcomere, myofibril, muscle fibre, muscle
D. muscle fibre, sarcomere, myofibril, muscle

22M.1A.HL.TZ1.40

What is the role of HCG in early pregnancy? [1]
A. It prevents the degeneration of the corpus luteum in the ovary.
B. It initiates the development of the uterus lining.
C. It inhibits the production of estrogen.
D. It stimulates uterine contractions.

21N.1A.HL.TZ1.38

The image shows part of a myofibril from a relaxed muscle fibre.



[Source: Sarcomere. Sameerb. Available at https://commons.wikimedia.org/wiki/File:Sarcomere.gif [Accessed 30 November 2021].]

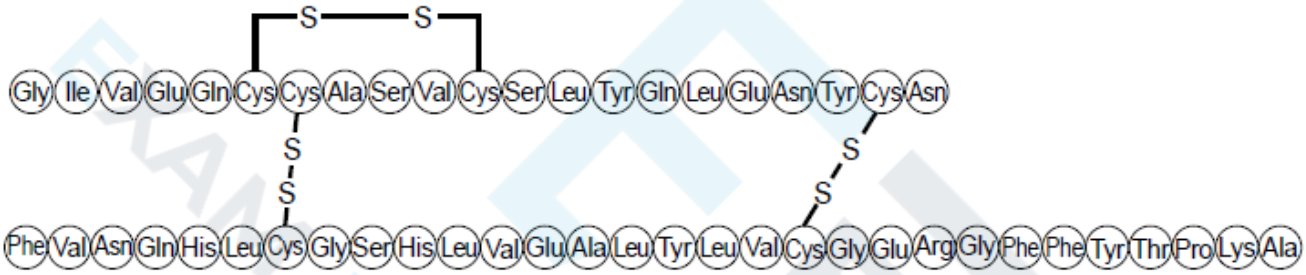
What occurs during muscle contraction?

A. Myosin binding sites are blocked.
B. The bands labelled Y get shorter.
C. The bands labelled X get shorter.
D. Calcium ions bind to myosin.

[1]

SPM.1A.HL.TZ0.6

The diagram shows the structure of insulin.



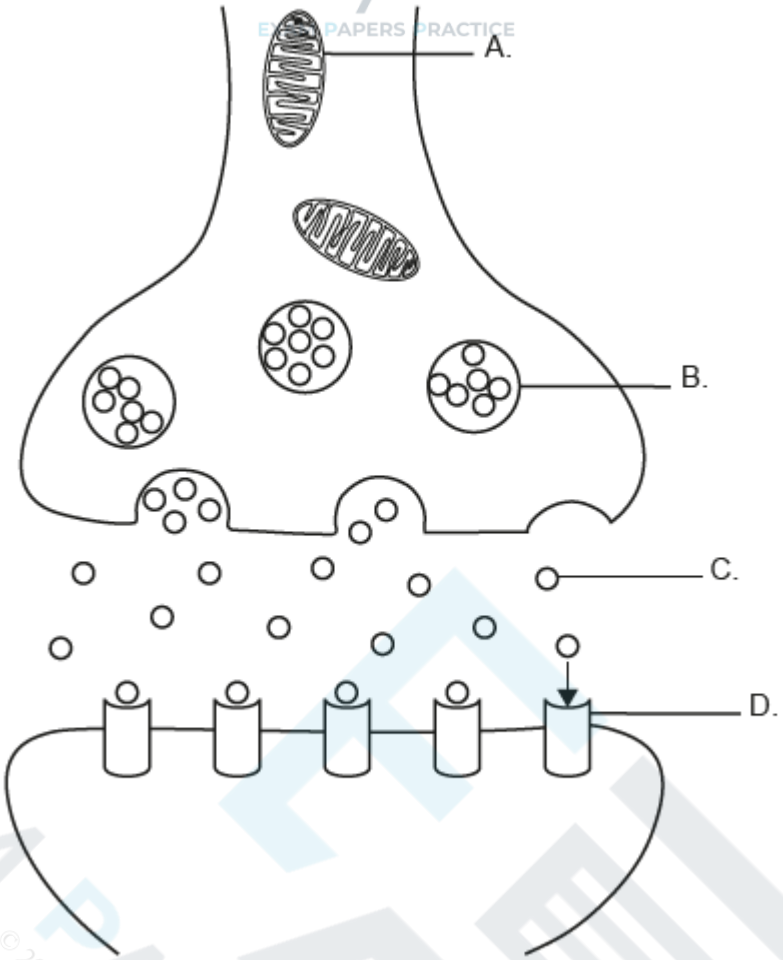
From the diagram, what can be concluded about the structure of insulin?

A. It is composed of two polypeptide chains stabilized by disulfide bonds.
B. It is a simple protein composed of one continuous polypeptide chain.
C. It is a fibrous protein.
D. Its molecules do not display quaternary structure.

[1]

23M.1A.HL.TZ2.29

The diagram represents transmission across a cholinergic synapse. Where would a neonicotinoid pesticide act to prevent synaptic transmission?



[1]

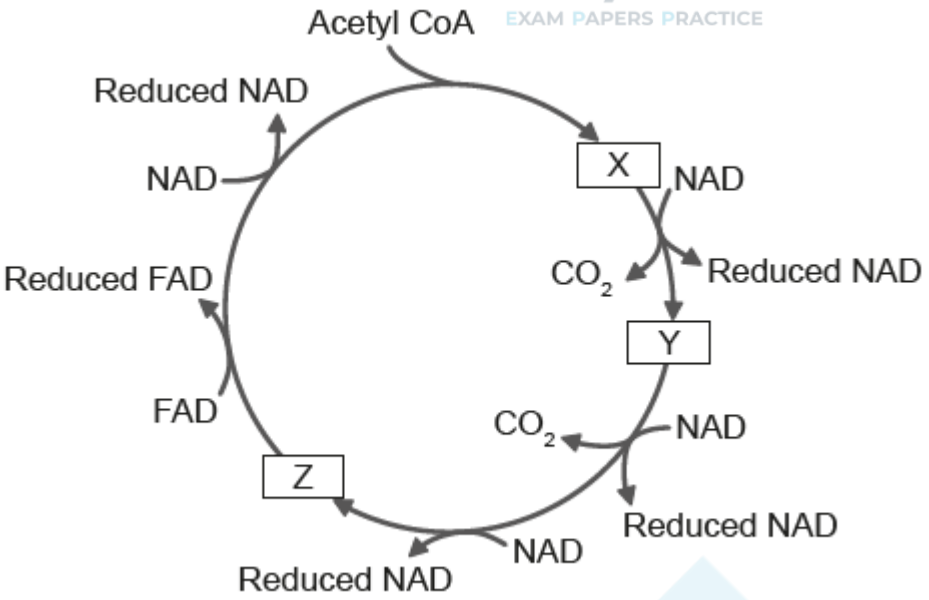
SPM.1A.HL.TZ0.37

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

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

19M.1A.HL.TZ2.15

The diagram shows compounds in the Krebs cycle labelled as X, Y and Z. [1]



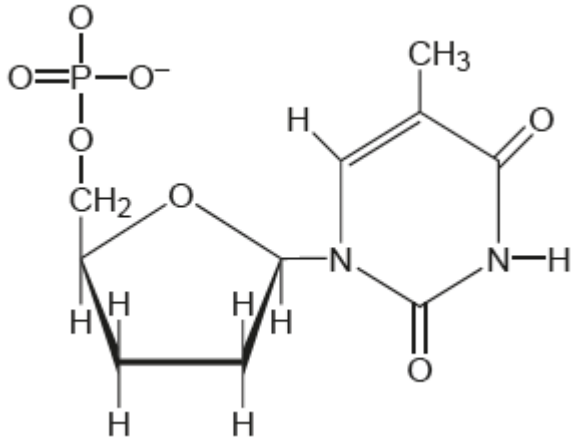
[Source: © International Baccalaureate Organization 2019]

How many carbon atoms are there in Y and in the acetyl group of acetyl CoA?

	Number of carbon atoms	
	Y	Acetyl CoA
A.	5	2
B.	4	2
C.	5	3
D.	4	3

19M.1A.HL.TZ2.13

A nucleotide containing dideoxyribose is shown.



What is the reason for the use of dideoxyribonucleotides to terminate sequences in base sequencing?

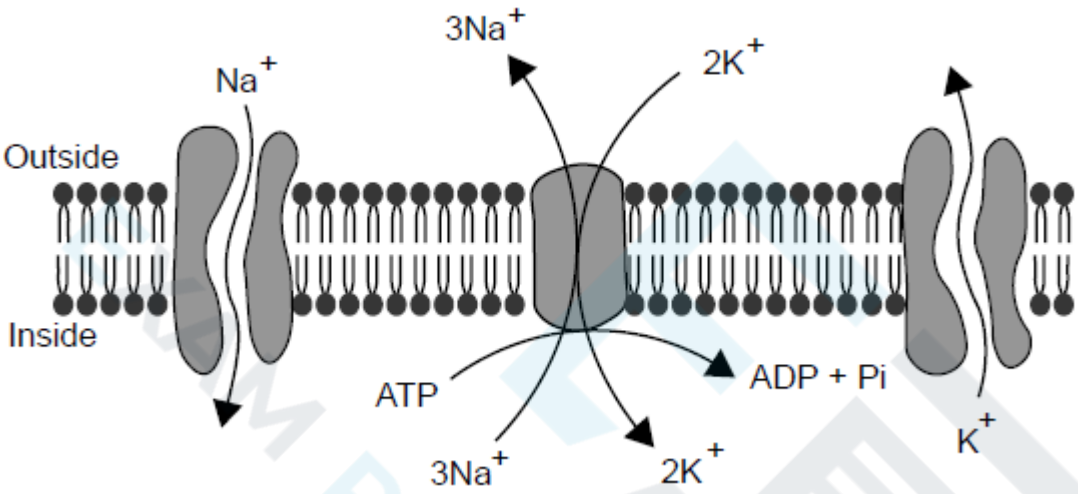
A. Nucleotides cannot form 5′ to 3′ linkages with dideoxyribonucleotides.

B. Nucleotides cannot form base pairs with dideoxyribonucleotides.
C. Dideoxyribonucleotides cannot form hydrogen bonds with deoxyribose.
D. Dideoxyribonucleotides do not have all four nitrogenous bases.

[1]

SPM.1A.HL.TZ0.15

The diagram shows the movement of ions that can occur across the membrane of a neuron.



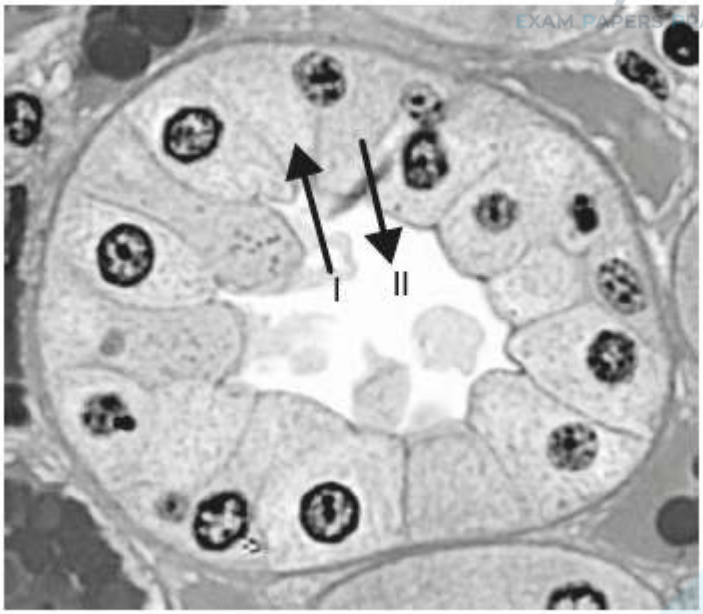
From the diagram, what can be deduced about the movement of sodium ions?

A. They are actively pumped out and some re-enter by facilitated diffusion.
B. They are actively pumped out and some re-enter by simple diffusion.
C. They diffuse out of the cell along with potassium ions.
D. There is a net movement of sodium ions into the cell.

[1]

19M.1A.HL.TZ1.39

The image shows a transverse section through a collecting duct in a vertebrate kidney.



[Source: Professor Peter Takizawa, Yale University]

How is the movement of materials across the wall of the collecting duct affected by the release of ADH from the pituitary gland?

A. There is increased movement of water in the direction of arrow I.
B. There is increased movement of sodium in the direction of arrow I.
C. There is increased movement of water in the direction of arrow II.
D. There is increased movement of sodium in the direction of arrow II.

[1]

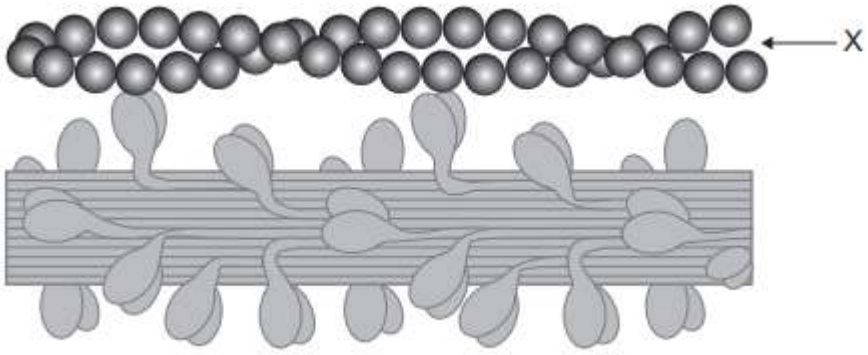
22M.1A.HL.TZ1.37

Which mechanism prevents polyspermy? [1]

A. Polar body formation
B. The acrosome reaction
C. Spermatogenesis
D. The cortical reaction

21M.1A.HL.TZ2.38

The diagram shows structures involved in contraction of a sarcomere.



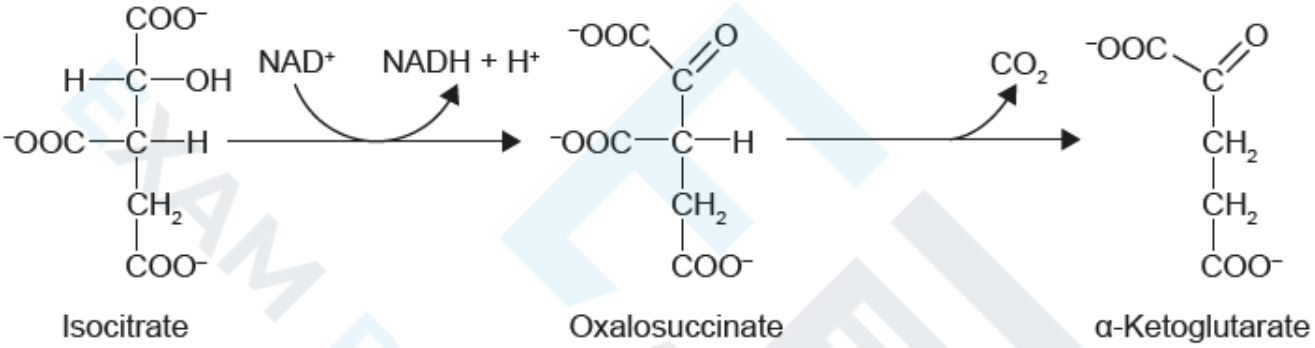
[Source: Anatomy & Physiology by Lindsay M. Biga, Sierra Dawson, Amy Harwell, Robin Hopkins, Joel Kaufmann, Mike LeMaster, Philip Matern, Katie Morrison-Graham, Devon Quick & Jon Runyeon is licensed under a Creative Commons Attribution-ShareAlike 4.0

What is X?
A. Myosin filament
B. Sarcomere
C. Actin filament
D. Myofibril

[1]

20N.1A.HL.TZ0.31

Two reactions of the Krebs cycle are shown.



What type of reactions are isocitrate and oxalosuccinate undergoing?

	Isocitrate	Oxalosuccinate
A.	oxidation	reduction
B.	reduction	decarboxylation
C.	reduction	oxidation
D.	oxidation	decarboxylation

[1]

20N.1A.HL.TZ0.33

How does auxin exert its effect on plant cells? [1]
A. Acts directly on the cell wall, causing expansion
B. Binds to a receptor resulting in expression of genes
C. Causes the vacuole to absorb water and expand the cell
D. Causes the cell to undergo cell division

SPM.1A.HL.TZ0.28

How is involuntary peristalsis in the intestine directly controlled in humans? [1]

A. By the endocrine system
B. By the central nervous system (CNS)
C. By the sympathetic nervous system
D. By the enteric nervous system (ENS)

21N.1A.HL.TZ1.27

What is the difference between the DNA of adult identical (monozygotic) twins? [1]
A. Order of genes
B. Sequence of nucleotides
C. Methylation pattern
D. Ratio of complementary base pairs

22N.1A.HL.TZ0.23

Some vaccinations, such as the smallpox vaccine, provide lifelong immunity against the disease. For others, such as tetanus, this immunity lasts for a shorter period of time. Why is a tetanus booster vaccination recommended every 10 years?
A. Antibodies that formed after the first vaccination persist in the blood for up to 10 years.
B. Memory cells are not produced after the first vaccination.
C. Only non-specific immunity is stimulated after the first vaccination.
D. Memory cells gradually decline over 10 years.

[1]

SPM.1A.HL.TZ0.38

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]

SPM.1A.HL.TZ0.16

In multicellular animals, embryonic stem cells have the ability to differentiate into a range of cells with different functions. What is the term used to describe cells with this property?

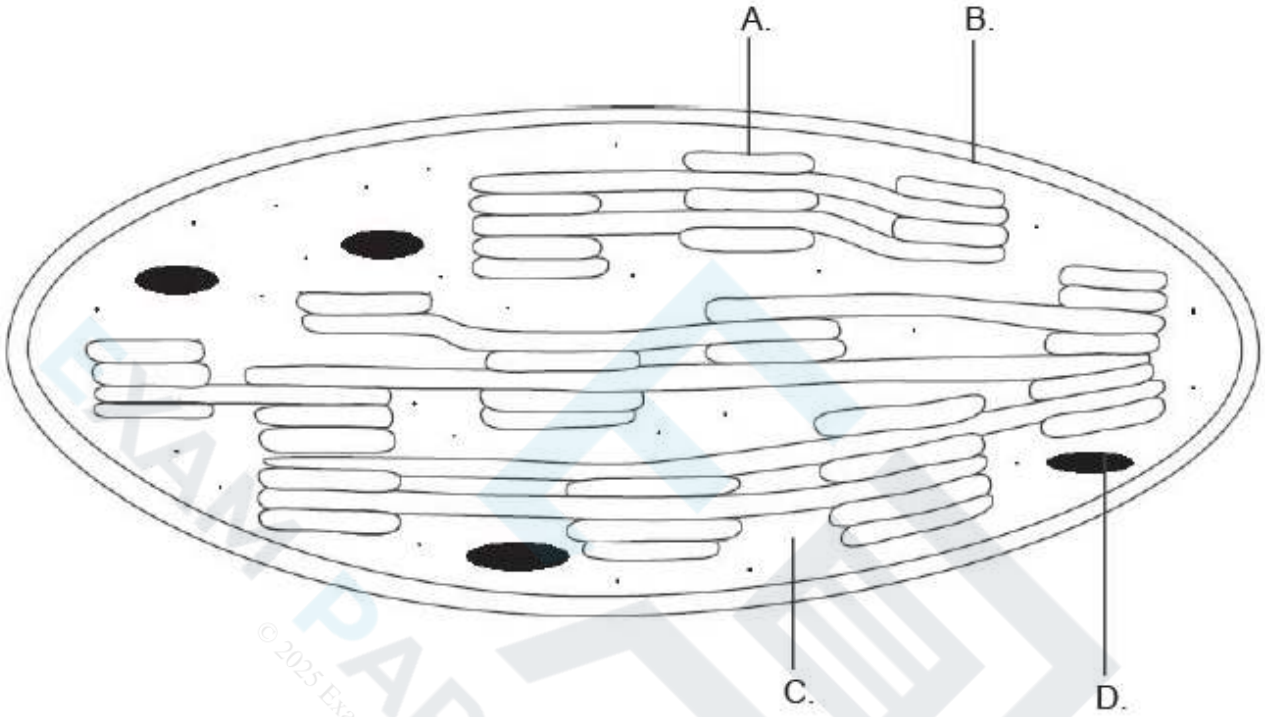
A. Pluripotent
B. Multipotent
C. Totipotent

D. Specialized

[1]

19N.1A.HL.TZ0.31

Which structure in the chloroplast diagram is adapted to carry out chemiosmosis?



[Source: © International Baccalaureate Organization 2019]

[1]

SPM.1A.HL.TZ0.22

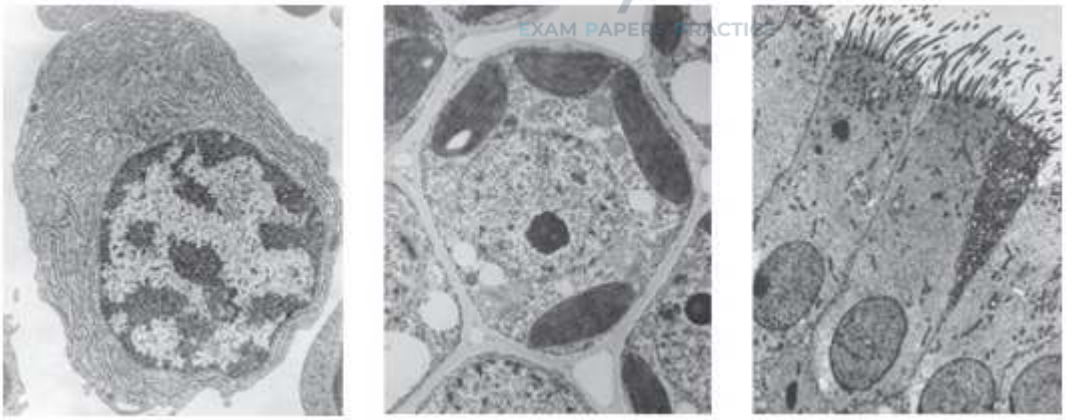
Which role does positive feedback play in fruit ripening?

A. The production of ethylene leads to fruit ripening, which stops the production of ethylene.
B. The production of ethylene leads to fruit ripening, which causes more ethylene production.
C. The production of RuBP leads to fruit ripening, which stops the production of RuBP.
D. The production of RuBP leads to fruit ripening, which causes more RuBP production.

[1]

21M.1A.HL.TZ2.2

Three cell types are shown in the micrographs.



[Source: left: UCSF School of Medicine, Courtesy of Prof. D Schmucker. middle: Professor Roger Meicenheimer, Miami University, Department of Botany. right: Courtesy of visualhistology.com.]

What feature distinguishes striated muscle fibres from the three cell types shown in the images?

A. Mitochondria
B. Nucleoid regions
C. Multinucleate structure
D. Membrane-bound organelles

[1]

19N.1A.HL.TZ0.2

By which process do potassium ions move through potassium channels in axons? [1]

A. Active transport
B. Exocytosis
C. Facilitated diffusion
D. Simple diffusion

21M.1A.HL.TZ1.36

In fruit flies (*Drosophila melanogaster*), grey bodies (b^+) are dominant to black bodies (b) and normal wings (vg^+) are dominant to vestigial wings (vg). Homozygous vestigial winged, black bodied flies were crossed with individuals that were heterozygous for both traits. 2300 individuals were counted and the phenotypes observed were recorded as shown.

965 normal wings, grey bodies
944 vestigial wings, black bodies
206 vestigial wings, grey bodies
185 normal wings, black bodies

Which statement is valid?

A. The predicted phenotypic ratio was 9:3:3:1.
B. There is independent assortment of wings but not body colour.
C. The expected number of vestigial winged, grey bodied flies was 575.
D. The traits are on different chromosomes.

[1]

21M.1A.HL.TZ2.34

How does auxin contribute to phototropism? [1]
A. It increases production of light-sensitive proteins.
B. It increases growth of cells on the shaded side of the stem.
C. It inhibits growth of axillary buds.
D. It inhibits stem elongation.

22M.1A.HL.TZ1.2

More than 90 % of cellular cholesterol is located in the cell's plasma membrane. What is the main role of cholesterol in the plasma membranes of mammalian cells?
A. To regulate membrane fluidity
B. To increase membrane solubility
C. To increase membrane permeability
D. To regulate membrane temperature

[1]

SPM.1A.HL.TZ0.40

Domestic dogs (*Canis familiaris*) have evolved from grey wolves (*Canis lupus*). Evidence suggests that the domestication of dogs first occurred around 30 000 years ago. Which best describes the evolution giving rise to the domestic dog?

A. The wolf produced offspring in large numbers which underwent natural selection.
B. Variations in the wolf population that resembled modern dogs favoured wolf survival.
C. Wolves showing favourable traits were selected for breeding.
D. Dogs were better suited to changes in the natural environment than wolves.

[1]

21M.1A.HL.TZ1.26

Which regions of DNA code for the production of specific proteins? [1]
A. Telomeres
B. Genes for ribosomal RNA
C. Exons
D. Regulators of gene expression

19M.1A.HL.TZ2.20

William Bateson and Reginald Punnett used the sweet pea (*Lathyrus odoratus*) in genetics studies in the early 20 th century. Pure-breeding plants that produced purple flowers and long pollen grains were crossed with pure-breeding plants that produced red flowers and round pollen grains. The resulting offspring all produced purple flowers and long pollen grains. Two of the F_1 generation plants were crossed. The table shows the ratio of phenotypes in the F_2 generation.

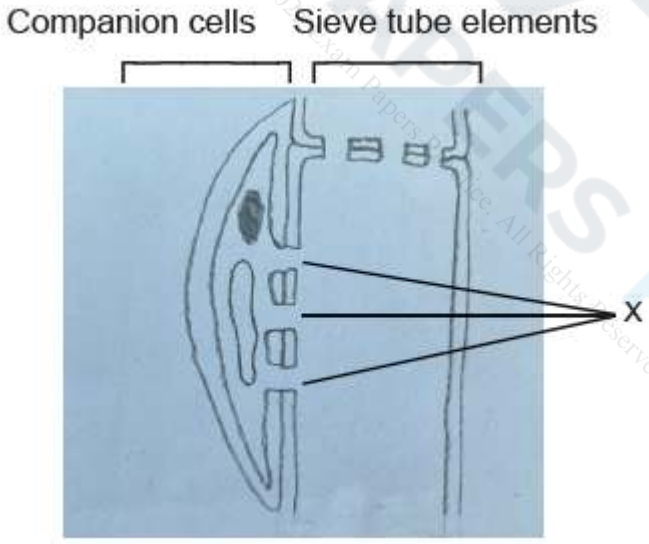
Flower colour	Pollen grain shape	Number of plants
purple	long	4831
purple	round	390
red	long	393
red	round	1138

What is an explanation for these experimental results?
A. Purple flowers and long pollen grains are dominant and the alleles have assorted independently.
B. The genes for flower colour and pollen shape are linked and all plants producing long pollen grains are recombinants.
C. The genes for flower colour and pollen shape are linked and all plants producing red flowers are recombinants.
D. Plants producing purple flowers and round pollen grains arose through crossing over.

[1]

22M.1A.HL.TZ2.32

The diagram shows the longitudinal section of phloem tissue at a plant source. [1]



What is a function of the structures labelled X?
A. To provide the companion cell with carbon dioxide
B. To provide the companion cell with glucose
C. To allow movement of sucrose into the sieve tube
D. To allow movement of starch into the sieve tube

22M.1A.HL.TZ1.36

An individual is heterozygous for two linked genes

$$\frac{AB}{ab}$$

.

To investigate the frequency of crossing over, a test cross is carried out between the individual and another that is homozygous recessive for both genes. What are the possible recombinants in the offspring of this cross?

A. $\frac{Ab}{ab}$ and $\frac{Ab}{ab}$

B. $\frac{AB}{ab}$ and $\frac{Ab}{aB}$

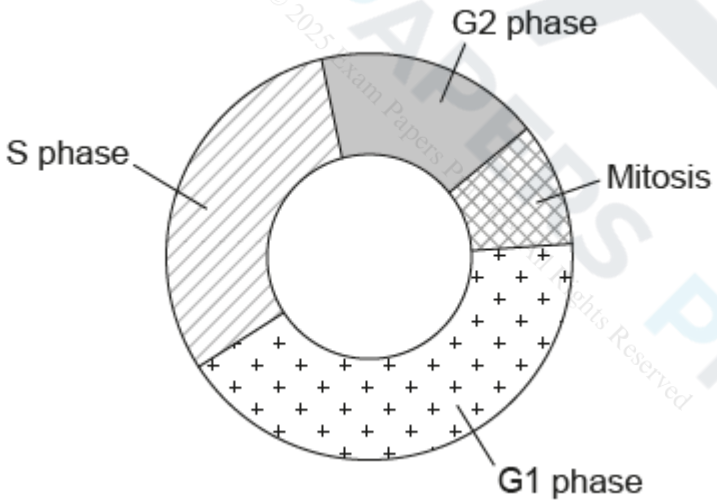
C. $\frac{Ab}{ab}$ and $\frac{aB}{ab}$

D. $\frac{AA}{aa}$ and $\frac{BB}{bb}$

[1]

22M.1A.HL.TZ1.4

In which stage of the cell cycle are chromosomes duplicated?



[Source: M1llx, 2019. Cell cycle simple pl. [online] Available at: https://commons.wikimedia.org/wiki/File:Cell_cycle_simple_ pl.png This file is licensed under the Creative Commons Attribution-Share Alike 4.0 International license. https://creativecommons.org/licenses/by-sa/4.0/deed.en [Accessed 1 August 2019].]

A. G1 phase
B. G2 phase
C. S phase
D. Mitosis

[1]

22M.1A.HL.TZ2.33

The picture shows lentils sprouts growing towards a light source from the left.

[Source: Russell Neches, Lentil sprouts reaching for the sun [image online] Available at https://www.flickr.com/photos/rneches/2081938105/ This file is licensed under the Creative Commons Attribution 2.0 Generic (CC BY 2.0) https://creativecommons.org/licenses/by/2.0/ .]

How has this response been brought about?

A. A higher concentration of auxins on the light side caused faster photosynthesis.
B. A higher concentration of auxins on the shaded side caused faster meiosis.
C. A higher concentration of auxins on the shaded side caused faster cell elongation.
D. A higher concentration of chloroplasts on the light side allowed for more photosynthesis.

[1]

SPM.1A.HL.TZ0.1

What allows the movement of water under tension in the xylem? [1]

A. Adhesion of water molecules to dissolved mineral salts
B. Cohesion of water molecules due to hydrogen bonding
C. Adhesion between water molecules due to uneven sharing of charges
D. Cohesion between water molecules and other polar substances

SPM.1A.HL.TZ0.20

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

19M.1A.HL.TZ2.5

The table shows concentrations of potassium ions and sodium ions inside and outside human cells.

	Concentration of ions / 10^{-3} mol dm^{-3}	
Ions	**Intracellular**	**Extracellular**
Potassium ions	135	4
Sodium ions	10	145

[Source: © International Baccalaureate Organization 2019]

What explains these concentrations?

A. Potassium ions diffuse in and sodium ions diffuse out.
B. Sodium ions diffuse in and potassium ions diffuse out.
C. Active transport pumps sodium ions in and potassium ions out.
D. Active transport pumps sodium ions out and potassium ions in.

[1]

SPM.1A.HL.TZ0.33

Polyploidy has been a cause of rapid speciation in some plant genera, such as *Helianthus* . Which observation is evidence that speciation has occurred?

A. A polyploid plant reproduces asexually.
B. A polyploid plant produces male and female gametes.
C. Fertile offspring are produced when a polyploid plant crosses with a diploid plant.
D. Fertilization can occur between polyploid individuals.

[1]

23M.1A.HL.TZ1.17

The table compares ribosomal RNA (rRNA) sequences of two organisms from each of the three domains by showing an association coefficient. The more similar the rRNA sequences of the organisms, the larger the coefficient.

	S. cerevisiae	***L. minor***	***E. Coli***	***B. firmus***	***M. ruminantium***	***M. barkeri***
S. cerevisiae	—	0.29	0.05	0.08	0.11	0.08
L. minor		—	0.10	0.06	0.10	0.07
E. Coli			—	0.25	0.12	0.12
B. firmus				—	0.13	0.12
M. ruminantium					—	0.24
M. barkeri						—

[Source: Woese, C. R. and Fox, G. E., 1977. Phylogenetic structure of the prokaryotic domain: The primary kingdoms. *Proc. Natl. Acad. Sci. USA*, 74(11), pp. 5088–5090.]

What can be concluded from the data?

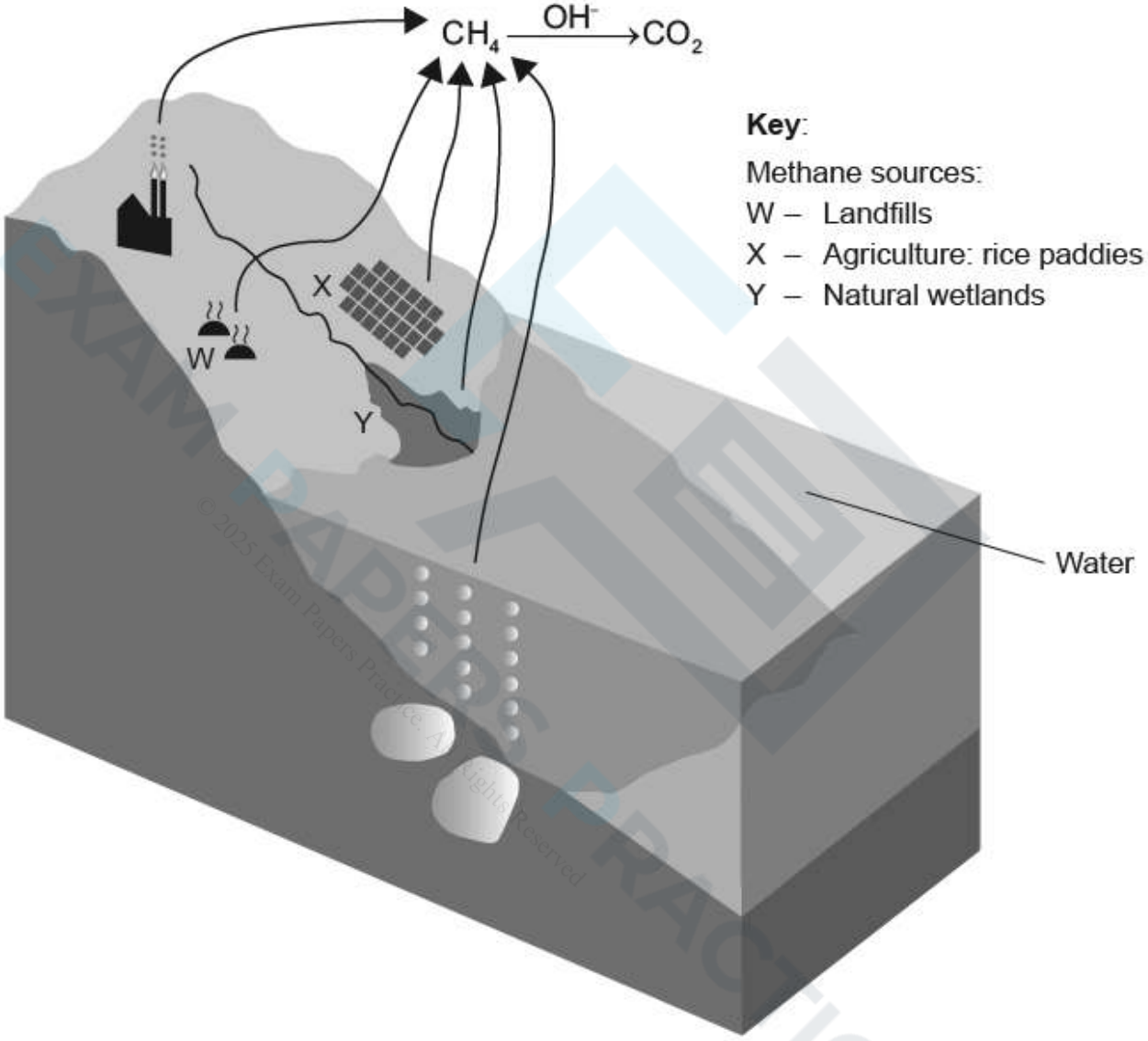
A. *L. minor* and *E. coli* are both eubacteria.

B. *S. cerevisiae* and *M. barkeri* are in the same domain.
C. *M. ruminantium* is an archaean, therefore so is *B. firmus* .
D. *E. coli* and *B. firmus* are in the same domain.

[1]

22N.1A.HL.TZ0.16

The diagram shows part of the carbon cycle involving methane.



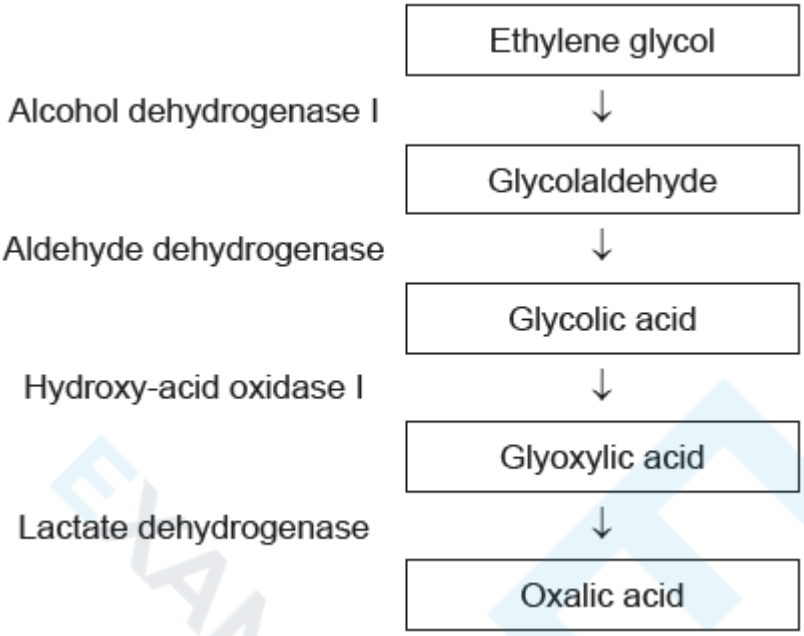
[Source: NASA GISS, n.d. *Rough schematic of methane sources and sinks* . [diagram online] Available at: https://www.giss.nasa.gov/research/features/200409_methane/ [Accessed 26 October 2021].]

Which conditions favour methane production in W, X and Y?
A. Presence of eubacteria and organic matter
B. Presence of archaeans and waterlogged soil
C. Presence of eubacteria and waterlogged soil
D. Presence of archaeans and oxygen

[1]

22M.1A.HL.TZ2.29

Ethylene glycol is used as an antifreeze chemical. If a person ingests it accidentally, ethylene glycol is rapidly converted by a series of enzyme-catalysed reactions in the liver to oxalic acid, which is toxic. The diagram summarizes the steps and enzymes involved in the conversion of ethylene glycol to oxalic acid.



The production of oxalic acid can be prevented if the person drinks ethanol, a competitive inhibitor of the enzyme alcohol dehydrogenase I. Which statement explains the mode of action of ethanol on the reaction?

A. It causes end product inhibition.

B. It disrupts the shape of the active site by binding to another site on alcohol dehydrogenase I.

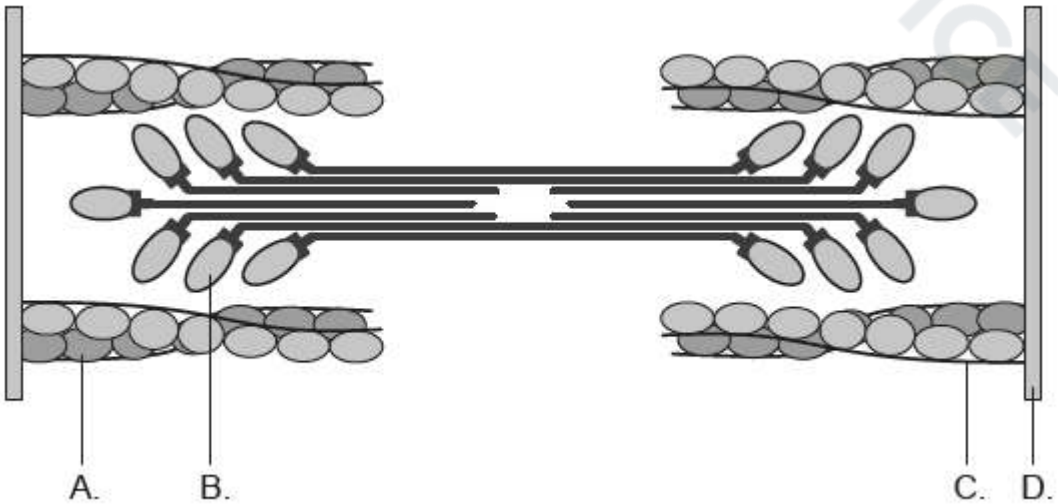
C. It occupies the active site of alcohol dehydrogenase I, preventing ethylene glycol from binding.

D. It binds to ethylene glycol, preventing it from fitting into the active site of alcohol dehydrogenase I.

[1]

21M.1A.HL.TZ1.37

The diagram represents a sarcomere. Which structure is myosin?



[Source: MPI of Molecular Plant Physiology. [*Sarcomere*]. [diagram online] Available at: http://www.macroevolution.net/sarcomere.html [accessed 4 April 2019]. Source adapted.]

[1]

SPM.1A.HL.TZ0.26

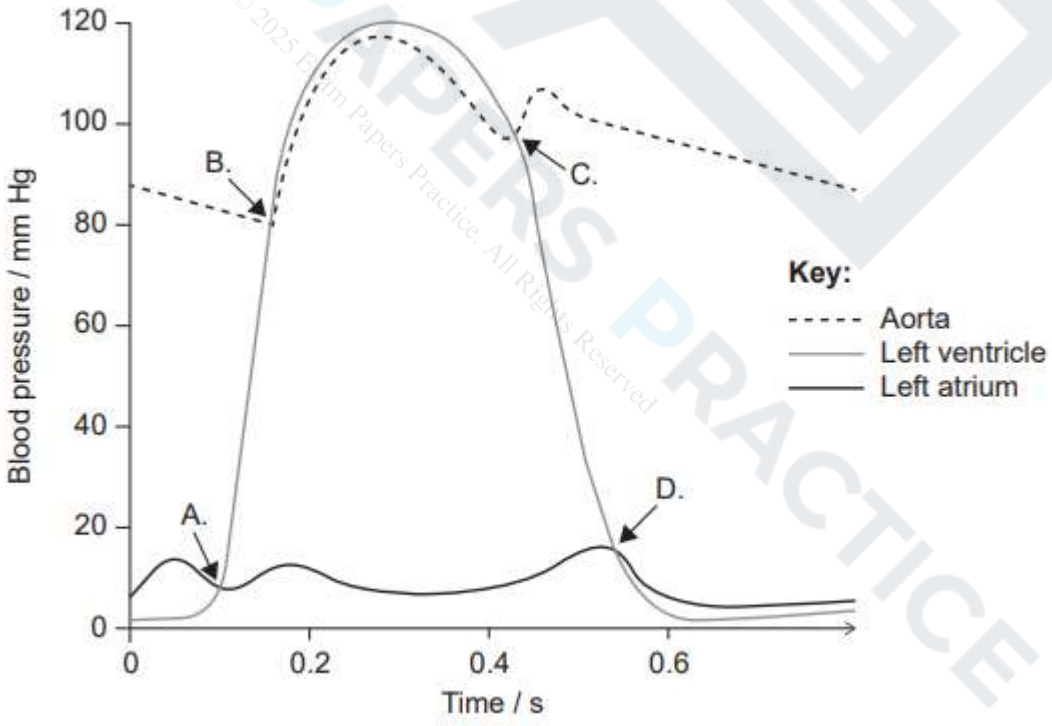
What is always a consequence of the evaporation of water from mesophyll cells in leaves of a healthy plant?

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]

21M.1A.HL.TZ2.25

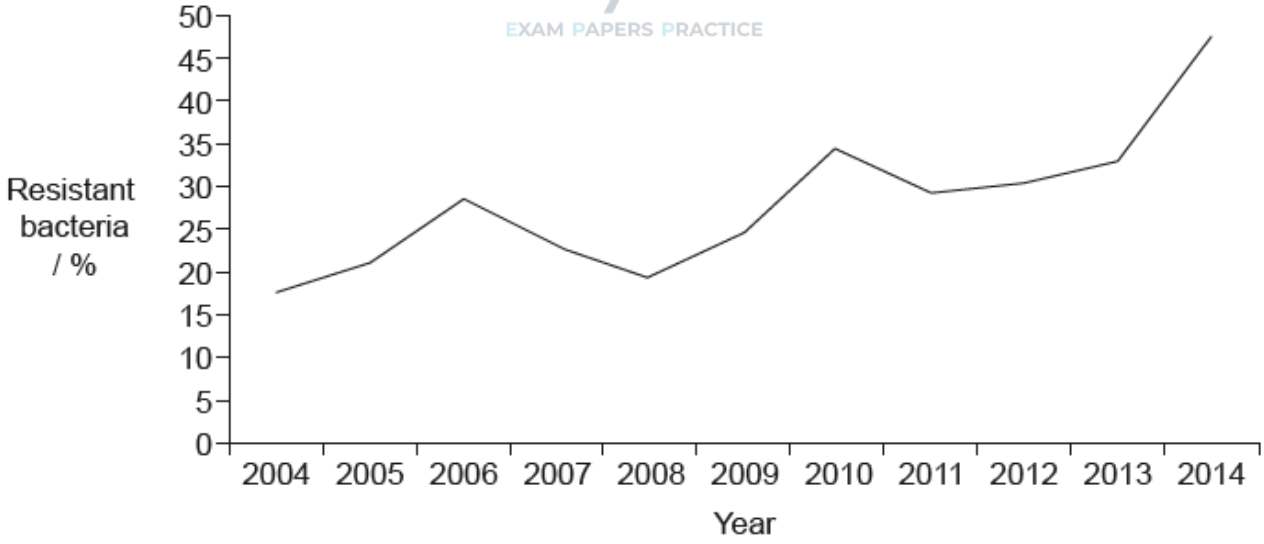
The diagram shows changes in pressure in the left atrium, left ventricle and aorta during a single cardiac cycle. At what point during the cycle does the atrioventricular valve close?



[1]

22M.1A.HL.TZ1.21

The graph shows the proportion of a bacterial population of *Neisseria gonorrhoeae* , displaying resistance to the antibiotic tetracycline.



[Source: © All rights reserved. *Canadian Antimicrobial Resistance Surveillance System Report, 2016* . Public Health Agency of Canada. Adapted and reproduced with permission from the Minister of Health, 2022.]

What can be deduced from this graph?

A. Bacteria with beneficial adaptations survive and pass on their genes.
B. Immunity to tetracycline is triggered by over-use of the antibiotic.
C. Genetic variation in this bacterial population is increasing.
D. Use of tetracycline inhibits the growth of antibiotic-resistant *N. gonorrhoeae* .

[1]

23M.1A.HL.TZ2.26

Which part of aerobic respiration directly involves oxygen molecules? [1]

A. Conversion of glucose to pyruvate
B. Accepting electrons from the electron transport chain
C. Oxidizing acetyl groups in the Krebs cycle
D. Production of NAD from reduced NAD

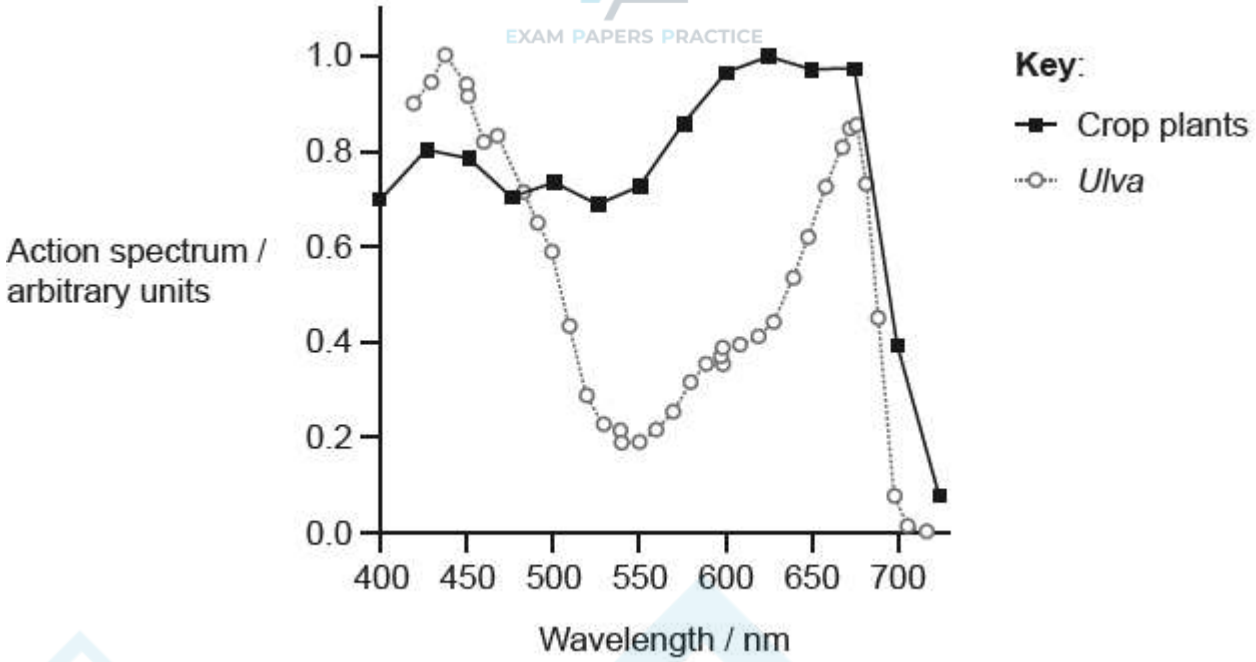
SPM.1A.HL.TZ0.10

Which are examples of non-coding DNA? [1]

A. Dominant and recessive alleles
B. Promoters and telomeres
C. Oncogenes and tumour suppressor genes
D. Introns and exons

22N.1A.HL.TZ0.8

The action spectra for two different types of photosynthetic organisms are shown. *Ulva* , or sea lettuce, is a green marine alga composed of two layers of cells. The action spectrum for crop plants was plotted from an average of 22 species of plants.

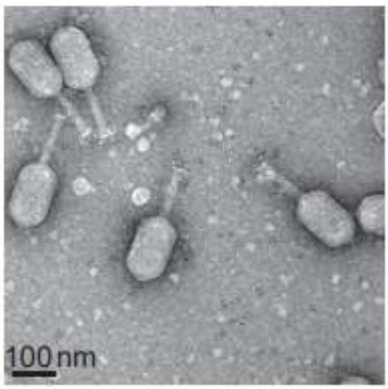


What describes photosynthesis in these organisms?
A. *Ulva* photosynthesizes more than crop plants at red wavelengths.
B. Crop plants photosynthesize more than *Ulva* in green light.
C. Photosynthesis by *Ulva* is highest in red light while that of crop plants is highest in blue.
D. Both have zero photosynthesis at 750 nm.

[1]

21M.1A.HL.TZ2.1

The image shows an electron micrograph of virus particles known to infect the bacterium *Vibrio parahaemolyticus* , which is associated with gastroenteritis, wound infections and septicemia in humans and animals.



[Source: Lin, Y. and Lin, C., 2012. Transmission electron micrograph of phage ϕpp2 particles with several structural proteins. [micrograph] (*BMC Genomics* , 13:224).]

What does a virus have in common with a living cell?
A. 70S ribosomes
B. Genetic material
C. Reproduction by binary fission
D. Anaerobic respiration

[1]

SPM.1A.HL.TZ0.34

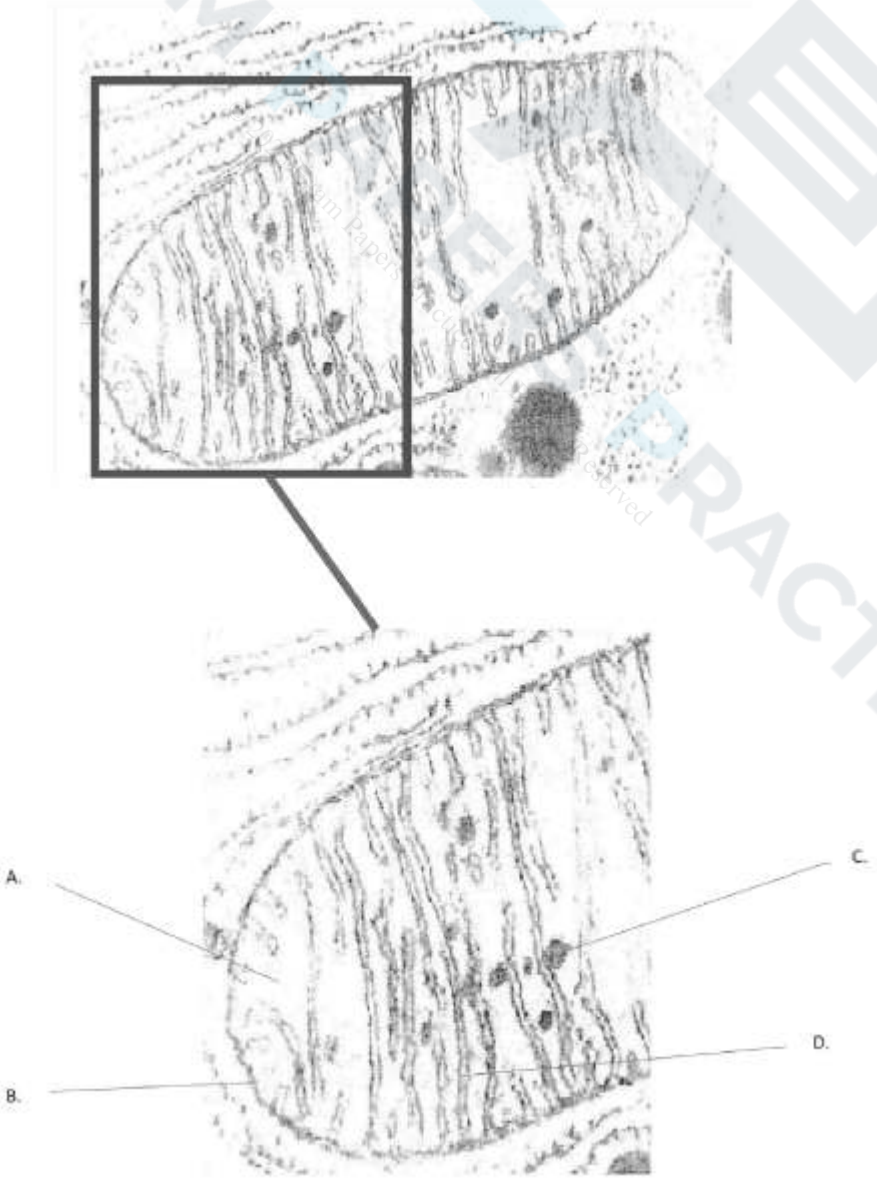
Yersinia pestis is a bacterium that caused an outbreak of bubonic plague in the 14th century. It normally produces ATP in the presence of oxygen but can still produce ATP if oxygen is absent.
Which term describes this characteristic?

A. Facultative respiration
B. Facultative anaerobe
C. Obligate anaerobe
D. Obligate aerobe

[1]

22M.1A.HL.TZ2.30

The mitochondrion in the electron micrograph shows some features that make it efficient for its function. Which labelled feature allows a rapid build-up of proton concentration for chemiosmosis?



[1]

22M.1A.HL.TZ2.31

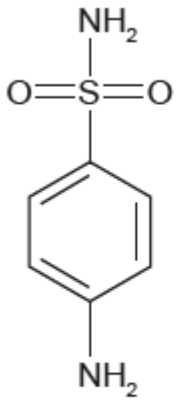
Photolysis and carboxylation of RuBP occur during photosynthesis. Where in the chloroplast do these reactions occur?

	Photolysis	Carboxylation of RuBP
A.	Outer membrane of the chloroplast envelope	Grana
B.	Thylakoids	Stroma
C.	Inner membrane of chloroplast envelope	Stroma
D.	Stroma	Grana

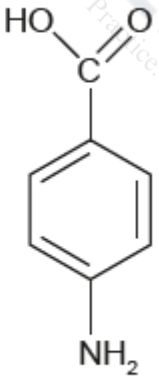
[1]

20N.1A.HL.TZ0.29

Sulfanilamide inhibits an enzyme that catalyses a reaction involving PABA, an intermediate in the synthesis of folate in bacteria. The structures of sulfanilamide and PABA are shown.

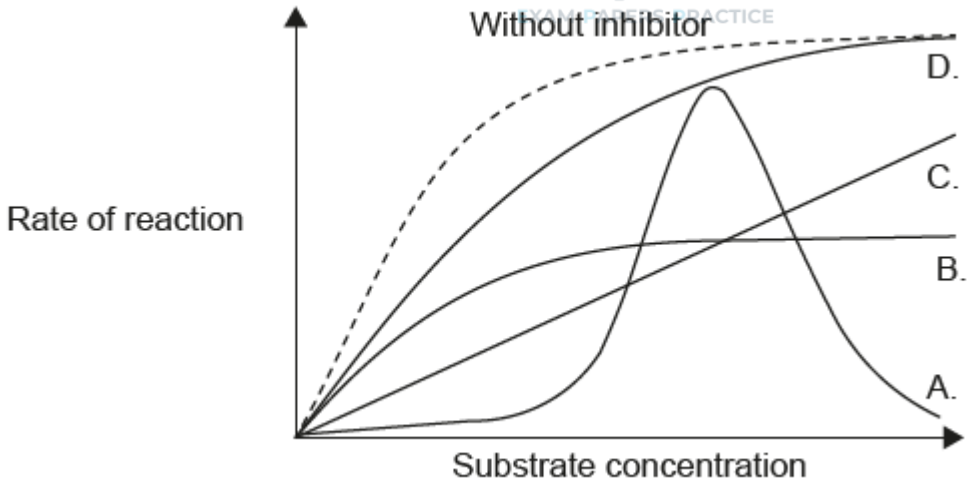


Sulfanilamide



PABA

The graph shows the rate of reaction with increasing substrate concentration and with fixed low concentration of different types of inhibitors. Which line on the graph represents the effect of sulfanilamide?



[1]

21M.1A.HL.TZ1.29

What blood flow does the right semilunar valve prevent?
A. Backflow of blood to the right atrium during ventricular contraction
B. Blood flowing from the aorta back into the heart when the ventricle is filling
C. Blood flowing from the pulmonary artery to the right ventricle when the heart is relaxing
D. Blood flowing from the right atrium to the vena cava when the right atrium contracts

[1]

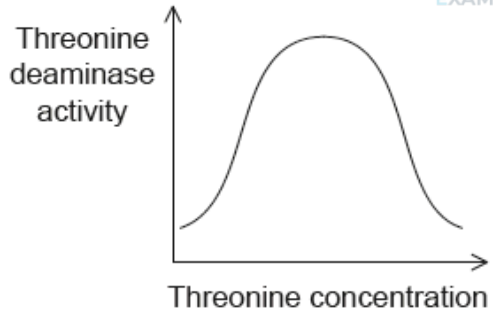
22M.1A.HL.TZ1.35

What is polyploidy? [1]
A. Having an extra set of chromosomes
B. Having an extra sex chromosome
C. Having an extra autosome
D. Having two or more nuclei

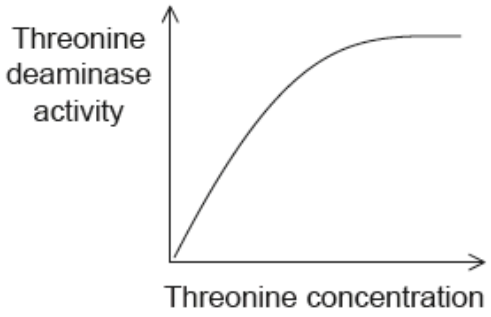
19M.1A.HL.TZ1.29

The first enzyme in the metabolic pathway that produces isoleucine is threonine deaminase. Which graph illustrates the relationship between threonine deaminase activity and threonine concentration?

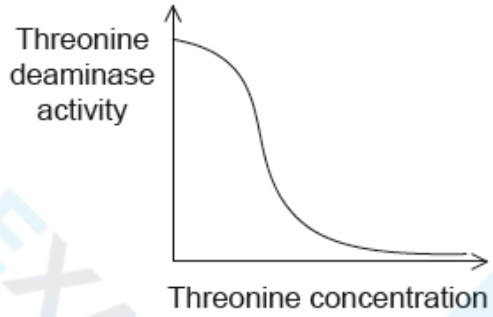
A.



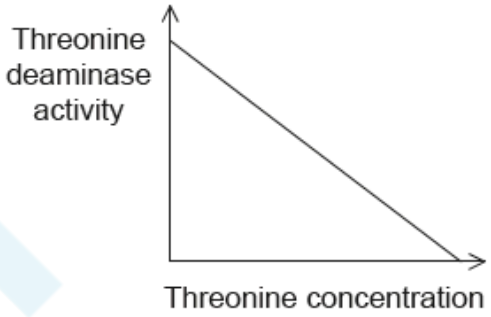
B.



C.



D.



[Source: © International Baccalaureate Organization 2019]

[1]

22N.1A.HL.TZ0.7

What is the arrangement of the components of nucleotides in a single DNA strand? [1]

A. …S—P—S—P…
B
B

B. …P—S—P—S…
B
B

C. …B—S—B—S…
P
P

D. …B—S—P—B—S—P…

Key:

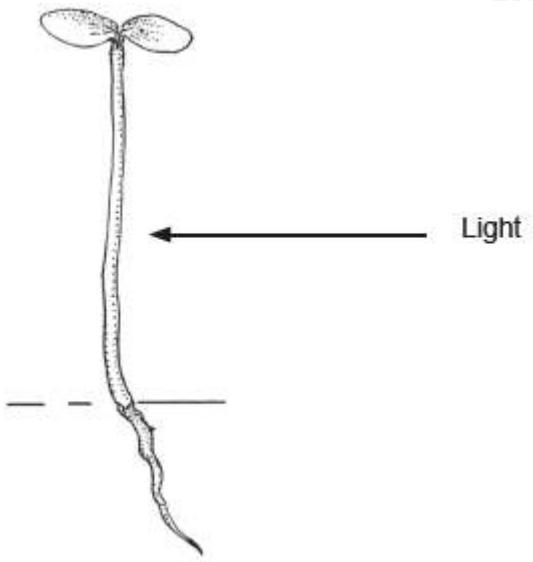
S – sugar

P – phosphate group

B – organic base

21N.1A.HL.TZ1.33

The diagram shows a plant shoot and the direction of the light which the shoot received.



[Source: USDA-NRCS PLANTS Database. Available at: https://commons.wikimedia.org/wiki/File:Alnus_seedling_drawing.png [Accessed 30 November 2021].]

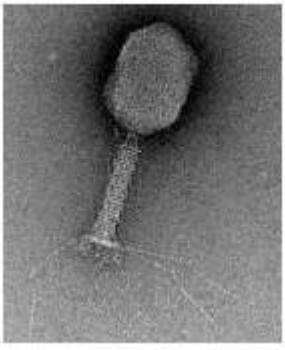
What are the direction of movement and the effect of auxin in the tip of a plant shoot when receiving light from one side?

	Direction of movement of auxin	Effect of auxin on cell elongation
A.	Towards light	promotes
B.	Towards light	inhibits
C.	Away from light	promotes
D.	Away from light	inhibits

[1]

19M.1A.HL.TZ2.11

Hershey and Chase used a bacteriophage (a virus that infects bacteria) to investigate the chemical nature of genes. The diagram shows a bacteriophage.



[Source: Graham Knott and Christel Genoud, 'Commentary: is EM dead?', *Journal of Cell Science* (2013),

126 : 4545–4552, reproduced with permission.
http://jcs.biologists.org/content/126/20/4545.figures-only
doi: 10.1242/jcs.124123 http://www.biologists.com/journal-of-cell-science]

The sulphur in the protein and the phosphorus in the DNA of the bacteriophage were radioactively labelled. The data obtained after bacterial infection and centrifugation are shown in the table.

Sample source	Supernatant	Pellet
Radioactive sulphur	80 %	20 %
Radioactive phosphorus	30 %	70 %

What did Hershey and Chase conclude from their experiment?
A. DNA was mainly outside the bacterial cells.
B. Viruses infect bacterial cells with proteins.
C. Viral DNA was found within the bacterial cells.
D. Neither protein nor DNA were chemicals making up genes in viruses.

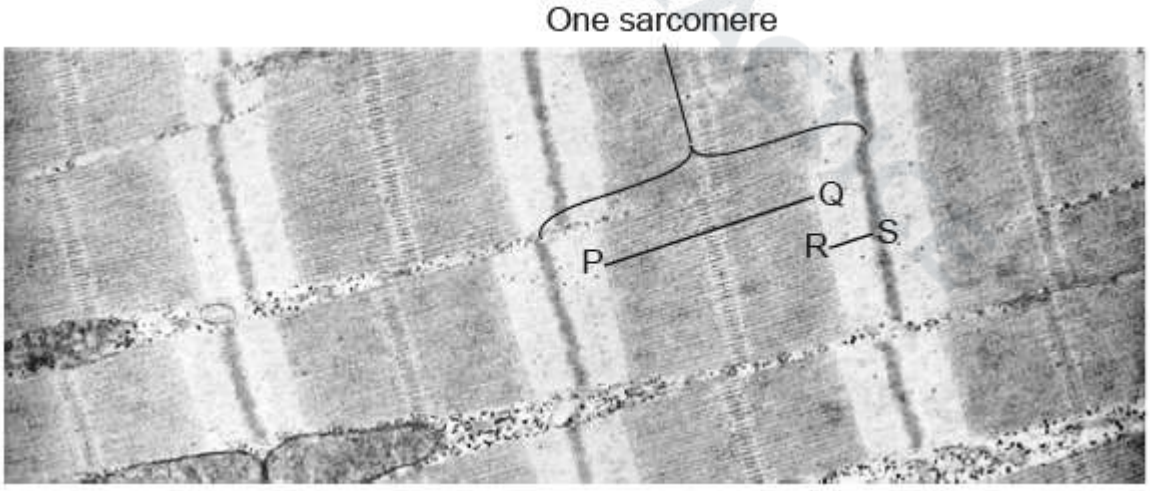
[1]

22N.1A.HL.TZ0.26

In transcription, which enzyme has a role similar to that of helicase in replication? [1]
A. DNA polymerase III
B. Ligase
C. RNA polymerase
D. DNA polymerase I

22M.1A.HL.TZ2.38

The electron micrograph shows sarcomeres in myofibrils of striated muscle during muscle contraction. The lines P–Q and R–S show two regions of one sarcomere.



[Source: Republished with permission of Elsevier Health Sciences Division from *Cell* by Don W. Fawcett 1981 ; permission conveyed through Copyright Clearance Center, Inc.]

How would regions P–Q and R–S change when the muscle relaxes?

	P–Q	R–S
A.	wider	narrower
B.	narrower	wider
C.	wider	no change
D.	no change	wider

[1]

23M.1A.HL.TZ1.40

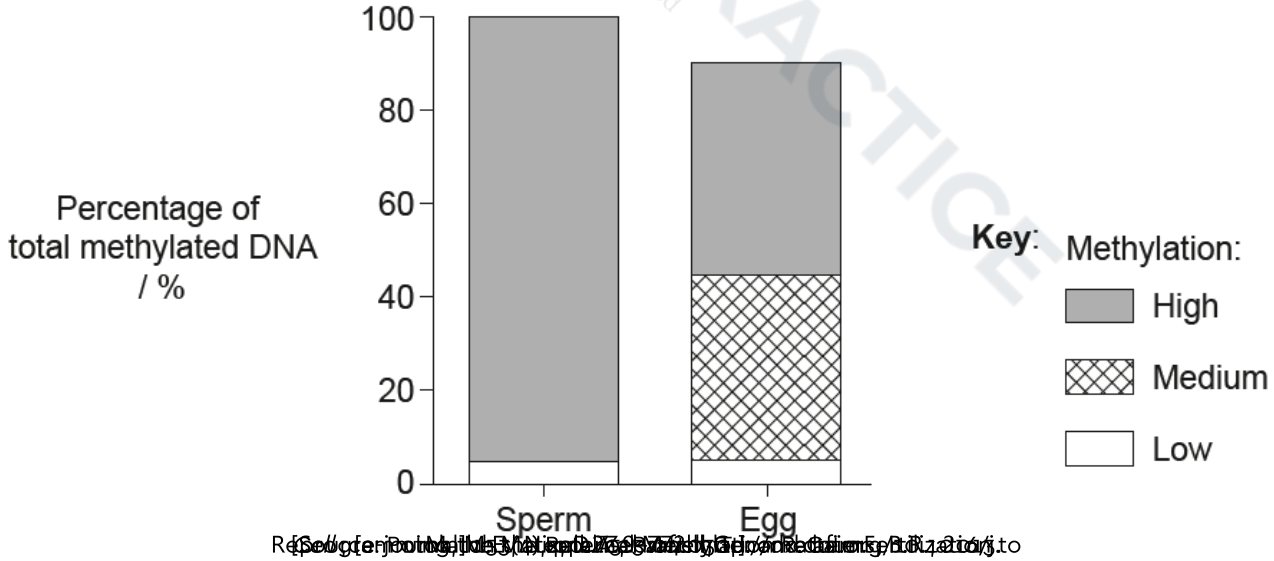
What happens in the acrosome reaction?

A. Enzymes digest the zona pellucida around an ovum, allowing a sperm to enter.
B. Enzymes digest the binding proteins of the zona pellucida so that no more sperm enter.
C. Acrosomes release binding proteins to the zona pellucida for sperm entrance.
D. Acrosomes react with the cortical granules to allow fertilization.

[1]

23M.1A.HL.TZ1.26

DNA methylation profiles in zebrafish (Danio rerio) gametes were determined. The methylated areas were divided into three groups according to the amount of methylation: high, medium and low methylation.



Methylation of DNA in sperm and egg is removed immediately after fertilization. What is the reason for this?

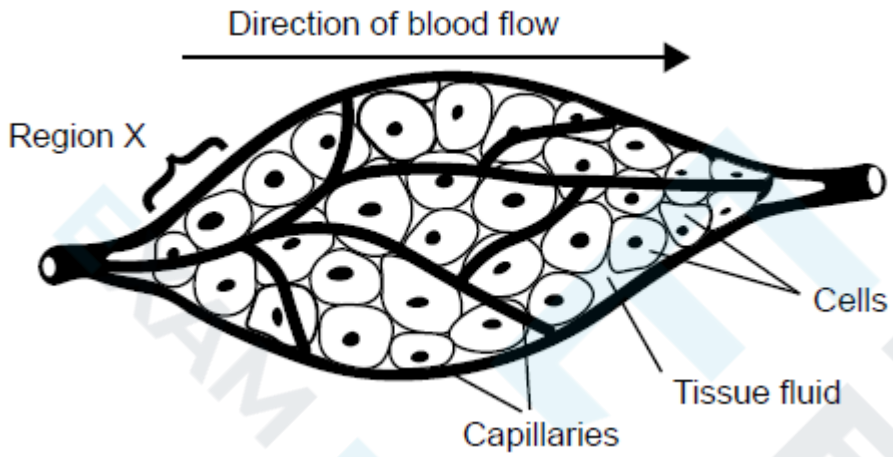
A. Methylation allows RNA polymerase to join the promoter.

B. It is needed to form homologous pairs of chromosomes.
C. It allows expression of genes linked to early development.
D. Transcription of promoters only occurs in methylated genes.

[1]

SPM.1A.HL.TZ0.27

The diagram shows where the exchange of substances between blood and tissue fluid occurs in a capillary bed.



What explains the movement of solutes between blood and tissue fluid at region X?

A. Blood plasma has a higher concentration of solutes than tissue fluid.
B. Tissue fluid has a more negative water potential than blood plasma.
C. Hydrostatic pressure is higher in blood than in tissue fluid.
D. The permeability of capillary walls is highest at region X.

[1]

23M.1A.HL.TZ1.31

Which adaptation would allow plants to live in saline irrigated soil? [1]

A. Small, shallow roots
B. Active uptake and compartmentalization of mineral ions to maintain homeostasis
C. Increased transpiration to replace water in stems
D. Leaves with a large surface area for increased photosynthesis

22N.1A.HL.TZ0.35

Black, short-haired guinea pigs, heterozygous for both characteristics, were crossed. They produced offspring with the phenotypes black short-haired, black long-haired, white short-haired and white long-haired in the ratio 9:3:3:1. A different cross produced offspring with phenotypes in the ratio 1:1:1:1. What were the genotypes of the parents in the second cross?
A. BbSs × BbSs

B. BBSs × BbSS
C. BbSs × bbss
D. bbSS × BBss

[1]

23M.1A.HL.TZ1.4

What is evidence for the endosymbiotic theory in eukaryotic cells? [1]

A. Mitochondrion with DNA
B. Golgi complex in cytoplasm
C. Single nuclear membrane
D. Ribosomes in cytoplasm

22N.1A.HL.TZ0.39

Which step occurs in **both** spermatogenesis and oogenesis?
A. First division of meiosis is stopped in prophase I until puberty begins.
B. Germinal epithelium cells divide by mitosis.
C. At the end of the first division in meiosis, the cytoplasm is divided equally between daughter cells.
D. Four haploid gametes are produced at the end of meiosis II.

[1]

20N.1A.HL.TZ0.26

The number of protein-coding genes in the human genome is estimated to be about 20 000, which is much less than the size of the proteome. What is one reason for this?
A. Exons are removed from RNA before translation.
B. There are more types of amino acids than nucleotides.
C. mRNA can be spliced after transcription.
D. Base substitutions occur during transcription.

[1]

19M.1A.HL.TZ2.12

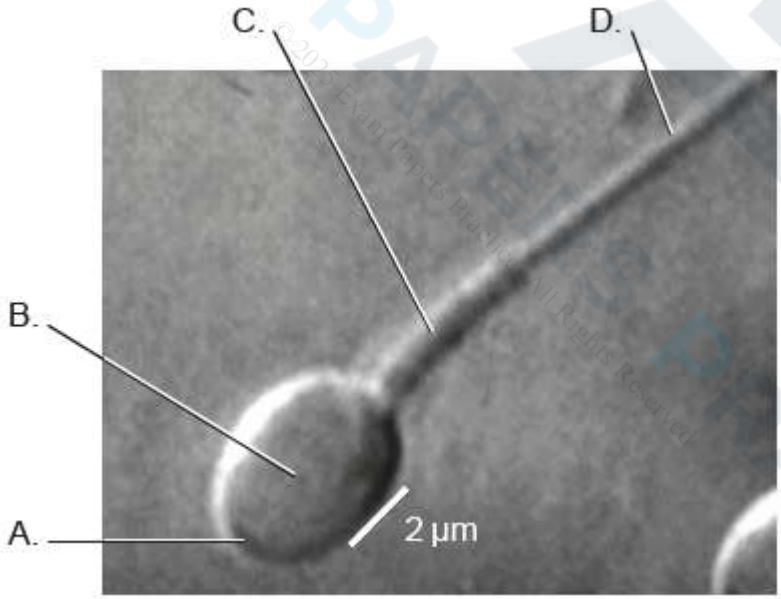
What are the functions of DNA primase and DNA polymerase I in DNA replication?

	DNA primase	DNA polymerase I
A.	adds a short DNA primer to the template strand	replaces RNA with DNA in the Okazaki fragments of the leading strand
B.	adds a short DNA primer to the template strand	replaces DNA primers with RNA
C.	adds a short RNA primer to the template strand	replaces RNA with DNA in the Okazaki fragments of the leading strand
D.	adds a short RNA primer to the template strand	replaces RNA primers with DNA

[1]

21N.1A.HL.TZ1.40

The micrograph shows part of a human sperm cell. Which region of the cell is responsible for the greatest production of ATP?



[Source: Oliveira, J.B.A., Petersen, C.G., Massaro, F.C. et al. Motile sperm organelle morphology examination (MSOME):
intervariation study of normal sperm and sperm with large nuclear vacuoles. *Reprod Biol Endocrinol* 8, 56 (2010).
https://doi.org/10.1186/1477-7827-856.
https://embryology.med.unsw.edu.au/embryology/index.php/File:Single_human_spermatozoa.jpg Creative Commons Attribution License (CC BY 2.0) (http://creativecommons.org/licenses/by/2.0).]

[1]

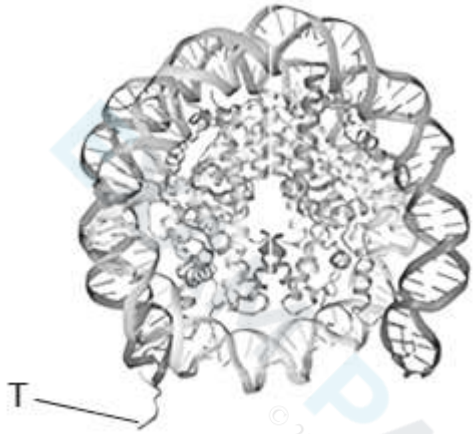
21M.1A.HL.TZ1.39

The pregnancy test for humans is based on detection of the hormone HCG. What is the reason for detection of this hormone indicating pregnancy?
A. HCG is involved in milk production.
B. HCG production is blocked by negative feedback during menstruation.
C. HCG is produced by an embryo.
D. HCG is released during the acrosome reaction.

[1]

22M.1A.HL.TZ2.26

The diagram shows the structure of a nucleosome.



[Source: Zephyris. Nucleosome 1KX5 colour coded. Available at https://en.wikipedia.org/wiki/Nucleosome#/media/File:Nucleosome_1KX5_colour_coded.pn
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 is the structure labelled T?
A. 5′ end of RNA
B. 5′ end of uncoiled DNA
C. N-terminal tail of one DNA strand
D. N-terminal tail of one histone

[1]

SPM.1A.HL.TZ0.11

The table shows the mRNA codons for three amino acids.

Valine	Threonine	Proline
GUU	ACU	CCU
GCC	ACC	CCC
GCA	ACA	CGA
GCG	ACG	CCG

Which substitution mutation of a base triplet on a DNA strand will lead to the same polypeptide being formed at translation?

A. TGA to TCA
B. CGT to CTA
C. CAA to CGA

D. GCT to GGA

[1]

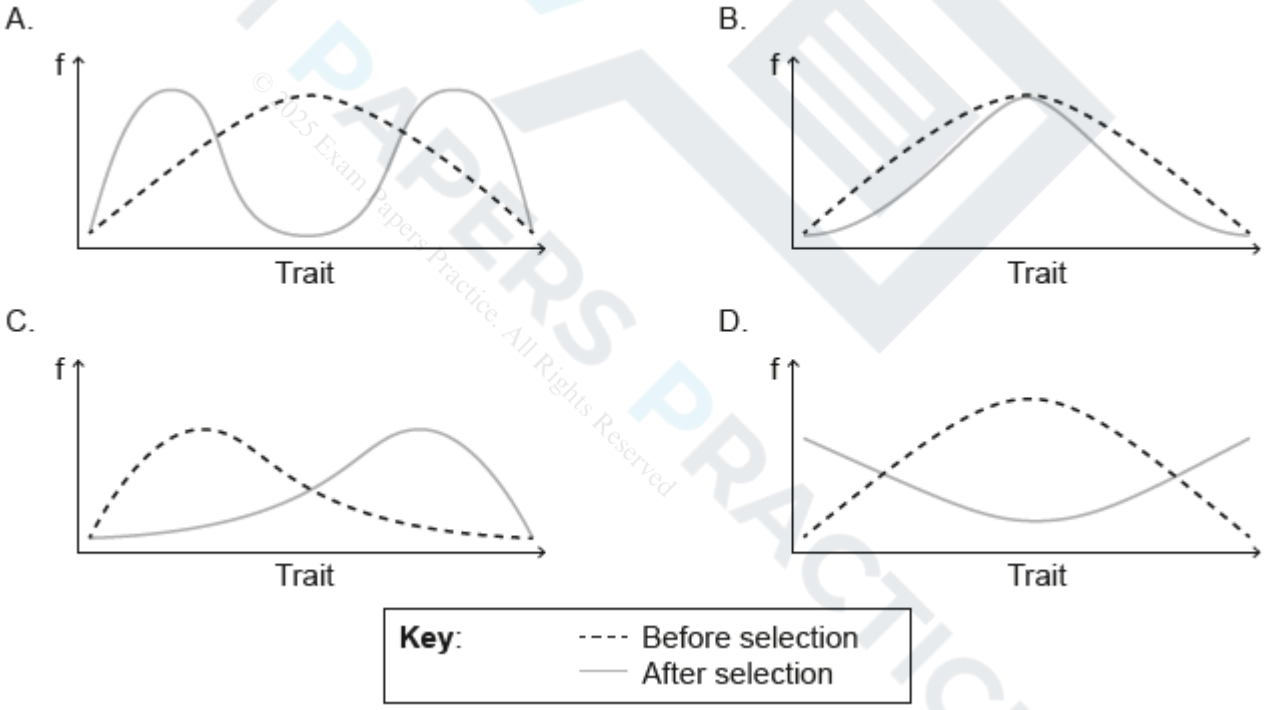
22M.1A.HL.TZ2.5

Cisplatin is an anti-cancer drug that prevents tumour cells from dividing by mitosis as it inhibits cell processes at stage S of interphase. How does cisplatin prevent cancer cells from dividing?
A. It inhibits the replication of DNA.
B. It inhibits the growth of the spindle fibres.
C. It prevents the breakdown of the nuclear membrane.
D. It prevents the condensation of chromosomes.

[1]

23M.1A.HL.TZ2.33

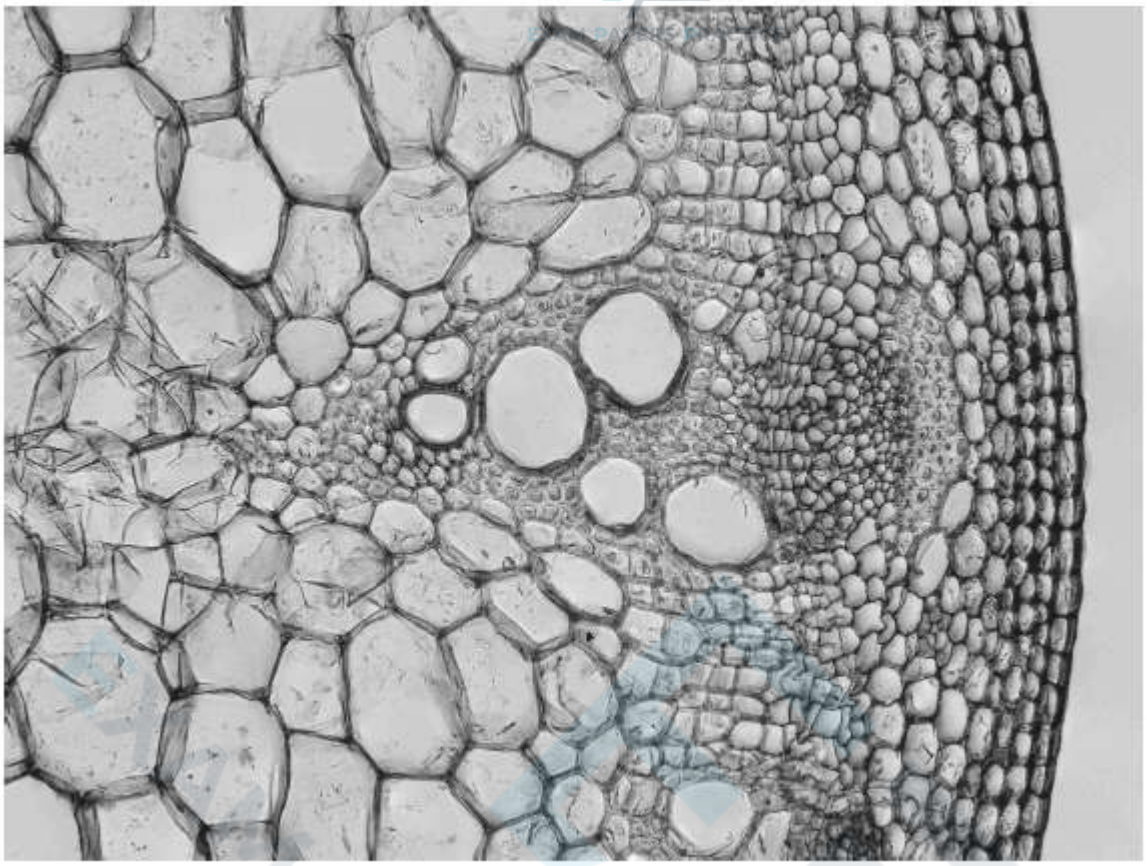
The graphs show how the frequency (f) of a trait within a population changes when subjected to selection pressures. Which graph shows stabilizing selection?



[1]

22M.1A.HL.TZ2.6

The micrograph of a section through a plant stem shows at least ten different types of cells.



[Source: Joan Carles Juarez / Shutterstock.com.]

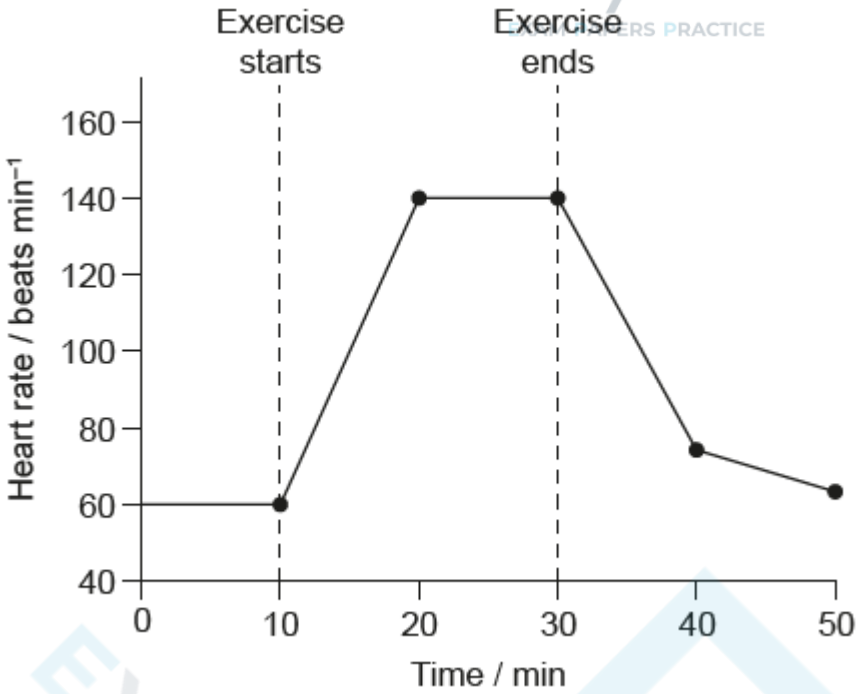
What explains the differences between these cells?

A. Only one gene is expressed in each cell type.
B. Different genes are expressed in each cell type.
C. Only useful genes remain in the DNA of each cell type.
D. Changes in the DNA sequence take place when these cells develop.

[1]

22M.1A.HL.TZ2.25

Changes in heart rate occur during and after a period of exercise.



Which structure sends messages to the sinoatrial node of the heart to cause changes in heart rate?
A. Adipose tissue
B. Medulla of the brain
C. Pineal gland
D. Thyroid gland

[1]

19M.1A.HL.TZ2.16

Which protein is identified with its function?

	Protein	Function
A.	collagen	provides strength and support for tissues and organs
B.	rhodopsin	enzyme found in tears
C.	insulin	raises blood glucose concentrations
D.	immunoglobulin	helps in blood clotting

[1]

21M.1A.HL.TZ1.24

A dichotomous key can be used to distinguish four types of plant. Which of the plants could be a bryophyte?

1. Vascular tissue present . . . . go to 2
Vascular tissue not present . . . . Plant A.

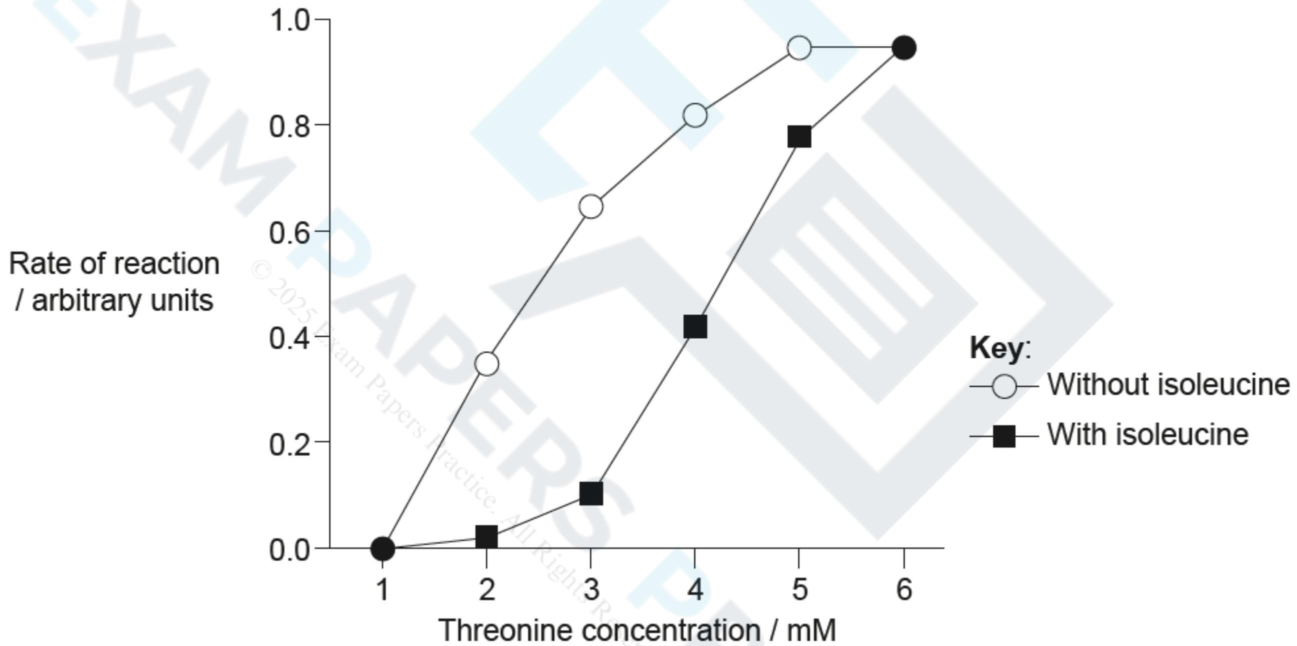
2. Produces seeds . . . . go to 3
Does not produce seeds . . . . Plant B.

3. Seeds found in cones . . . . Plant C.
Seeds found in fruit . . . . Plant D.

[1]

23M.1A.HL.TZ1.28

Through a series of enzymatic reactions, the amino acid threonine is converted to isoleucine. The graph shows the rate of reaction of threonine deaminase according to the concentration of its substrate threonine, with and without the presence of isoleucine.



What can be seen from these results?

A. Threonine deaminase only works in the presence of isoleucine.
B. Isoleucine inhibits threonine deaminase at low concentrations of threonine.
C. Production of isoleucine is inhibited at high concentration of threonine.
D. End-product inhibition controls the production of threonine deaminase.

[1]

21M.1A.HL.TZ2.30

What molecule functions as the final electron acceptor in the mitochondrial electron transport chain?
A. Oxygen
B. ATP
C. Reduced NAD
D. Reduced FAD

[1]

SPM.1A.HL.TZ0.39

What assumption is made when using the Hardy-Weinberg equation for calculating changes in allele frequencies in a population?

A. The population size is large.
B. Natural selection is taking place.
C. Mutations are occurring in the population.
D. There is variation among the phenotypes of the population.

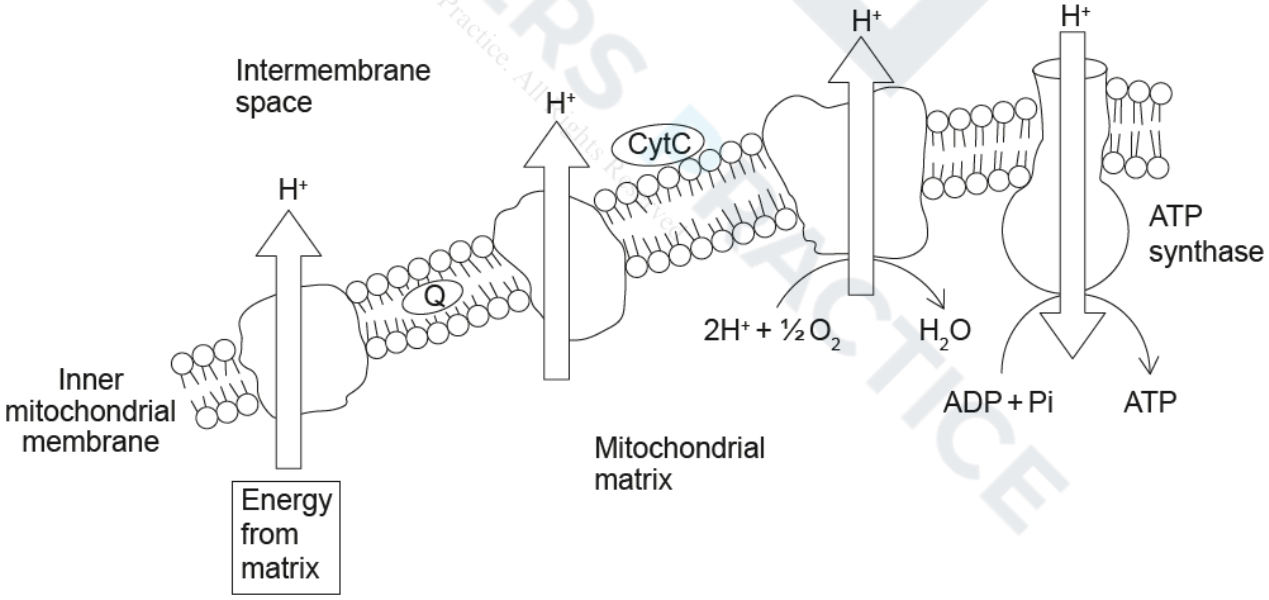
[1]

21M.1A.HL.TZ2.40

What function is maintained as a result of the release of HCG? [1]
A. Production of milk by the mammary glands
B. Release of oxytocin by the posterior pituitary gland
C. Production of FSH by the anterior pituitary gland
D. Production of progesterone by the ovary

23M.1A.HL.TZ1.29

The diagram shows some reactions occurring during respiration in the mitochondrion.



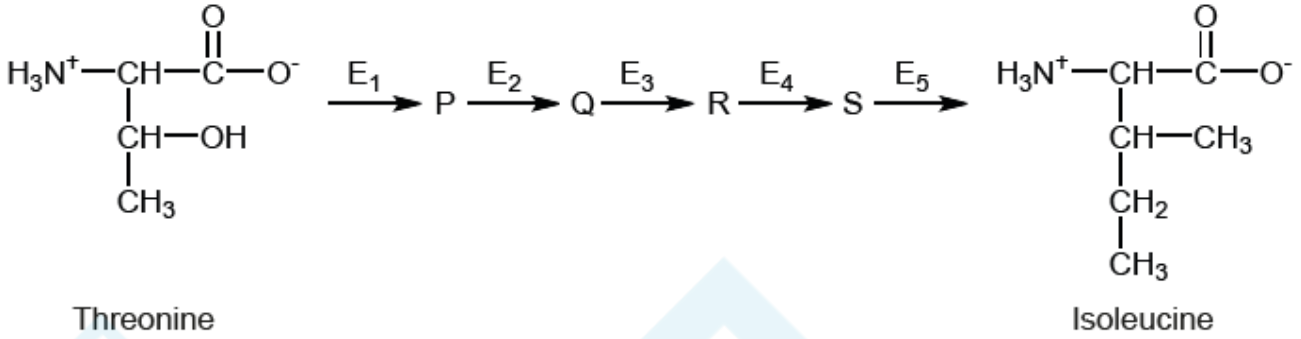
Energy that is released by oxidation reactions in the mitochondrial matrix is carried to the cristae of the mitochondria. How is this energy carried?

A. As ATP
B. As glucose
C. In lysed water
D. As reduced NAD

[1]

21N.1A.HL.TZ1.29

Some bacteria can synthesize the amino acid isoleucine from threonine, a process involving five enzymes (E_1 to E_5) and four intermediary products (P, Q, R and S). The production of isoleucine is controlled by end-product inhibition.



Threonine Isoleucine

Which statement describes this end-product inhibition?
A. If isoleucine accumulates, it inhibits the production of P.
B. End-product inhibition causes a build-up of intermediary products.
C. Isoleucine inhibits E_5, so no more isoleucine is produced.
D. Isoleucine affects the structure of threonine.

[1]

22N.1A.HL.TZ0.36

Two kinds of wolf spider rub specialized body parts together in order to produce distinct sounds to attract females. Females of both groups will only allow a male of the same kind to mate with them. It has been found through experimentation, however, that offspring can be produced from crossings between the two groups. What can be hypothesized?

I. The groups are reproductively isolated.
II. They could be the same species.
III. This is an example of behavioural isolation.

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

[1]

19M.1A.HL.TZ1.22

The image shows an organism belonging to the Kingdom Animalia.

[Source: Titan beetle male. Locality: "RK4,5 route Cacao", French Guiana © 2011, Didier Descouens https://creativecommons.org/licenses/by-sa/4.0/]

What feature does this organism have in common with all members of the phylum chordata?
A. Legs and wings
B. Mouth but no anus

C. Bilateral symmetry
D. Chitinous exoskeleton

[1]

19M.1A.HL.TZ1.5

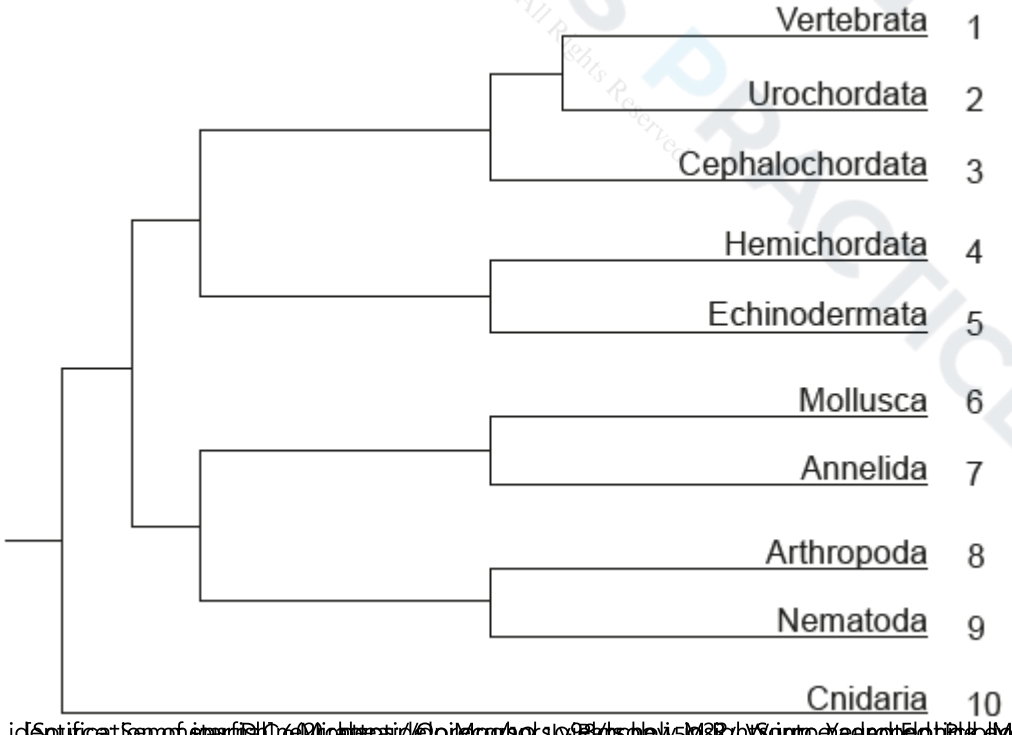
The table shows the number of cells in various stages of the cell cycle in four samples of ovarian tissue from different patients. Which tissue sample A, B, C or D has the highest mitotic index?

	Number of cells					
	Interphase	**Prophase**	**Metaphase**	**Anaphase**	**Telophase**	**Total**
A.	46	1	1	1	1	50
B.	96	0	1	2	1	100
C.	21	2	0	1	1	25
D.	72	0	1	1	1	75

[1]

23M.1A.HL.TZ2.25

The diagram shows a cladogram for part of the animal kingdom.



[Source: ...]

Which group does **not** represent a clade?

A. 1 to 3
B. 1 to 5

C. 4 to 7
D. 1 to 10

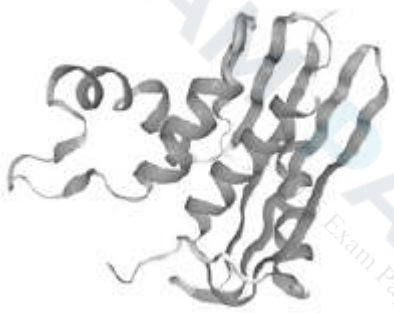
[1]

19M.1A.HL.TZ2.23

Which is the hierarchy of taxa in order of decreasing numbers of species? [1]
A. domain, phylum, order, family
B. phylum, order, family, class
C. domain, phylum, order, class
D. phylum, class, family, order

22M.1A.HL.TZ2.28

The diagram shows the structure of *E. coli* ribonuclease HI, a bacterial protein consisting of **one** polypeptide chain.



[Source: RCSB PDB. 1JL1 D10A E. coli ribonuclease HI. PDB DOI: 10.2210/pdb1JL1/pdb Mol* (Goedken, E.R., Marqusee, S. Native-state energetics of a thermostabilized variant of ribonuclease HI. (2001) *J Mol Biol* 314: 863–871 DOI:10.1006/jmbi.2001.5184) [image online] Available at: https://www.rcsb.org/structure/1jl1 [Accessed 25 November 2019]. This file is licensed under the Creative Commons CC0 1.0 Universal (https://creativecommons.org/ publicdomain/zero/1.0/).]

Which level(s) of protein structure is/are shown?
A. Alpha helix only
B. Quaternary only
C. Primary and secondary
D. Secondary and tertiary

[1]

SPM.1A.HL.TZ0.8

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.

19M.1A.HL.TZ2.4

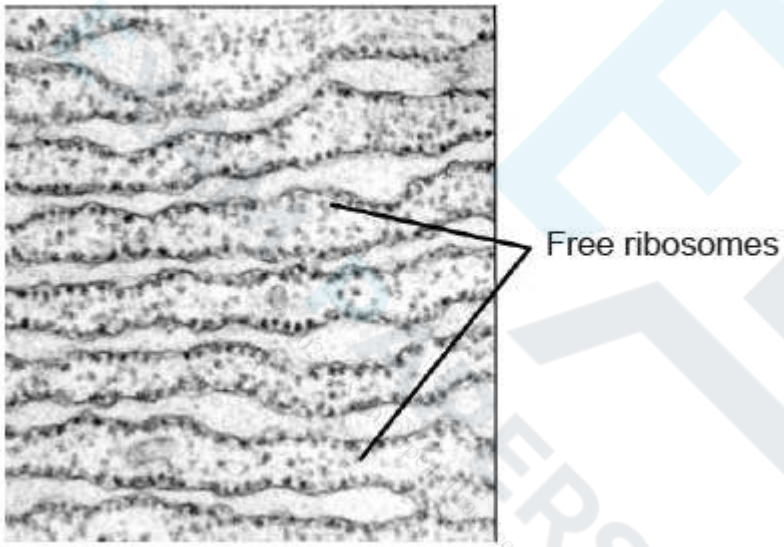
Which processes are involved in the development of cancer? [1]

I. Mutations occur in oncogenes.
II. Oncogenes prevent cancer.
III. Oncogenes affect cell cycle regulatory proteins.

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

21N.1A.HL.TZ1.28

What is the primary function of the free ribosomes shown in the electron micrograph?



[Source: J Gordon Betts, et al. *Anatomy and Physiology* . Houston Texas: OpenSta https://openstax.org/books/anatomy-and-physiology/pages/3-2-the-cytoplasm-and-cellular-organelles. Image fil https://commons.wikimedia.org/wiki/File:0313_Endoplasmic_Reticulum.jpg#/media/File:0313_Endoplasmic_R png . This file is licensed under the Creative Commons Attribution 3.0 Unported https://creativecommons.org/licenses/by/3.0/deed.en .]

A. Synthesize proteins to be used within the cell
B. Synthesize proteins for use in lysosomes
C. Carry amino acids to mRNA for protein synthesis
D. Synthesize proteins for secretion

[1]

22M.1A.HL.TZ2.8

Lipids are more efficient energy stores than carbohydrates. What is a reason for this? [1]

A. Lipids are bigger molecules than carbohydrates.
B. Lipids release more energy per gram than carbohydrates.
C. Lipids can be more easily mobilized than carbohydrates when needed.

D. Lipids can be used in aerobic and anaerobic respiration when needed.

21N.1A.HL.TZ1.30

Where are protons pumped, to allow chemiosmosis in aerobic respiration to occur?
A. From outside the mitochondrion through the double membranes
B. From carrier to carrier in the inner mitochondrial membrane
C. From the matrix of the mitochondrion to the space between the membranes
D. From the space between the membranes to the cytoplasm outside the mitochondrion

[1]

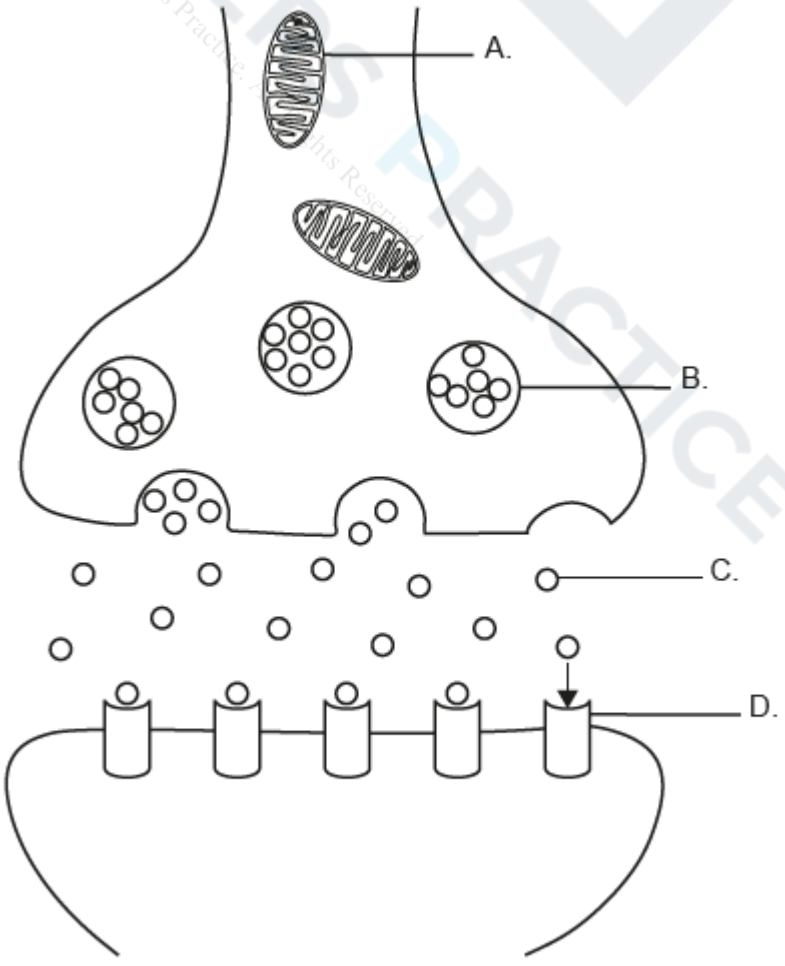
SPM.1A.HL.TZ0.21

What is the cause of positive phototropism? [1]

A. Increased concentration of auxin on the side of the stem closest to the light
B. Degradation of auxin on the side of the stem closest to the light
C. Increased concentration of auxin on the side of the stem furthest from the light
D. Degradation of auxin on the side of the stem furthest from the light

23M.1A.HL.TZ2.20

The diagram represents transmission across a cholinergic synapse. Where would a neonicotinoid pesticide act to prevent synaptic transmission?



[1]

21M.1A.HL.TZ1.30

Succinate dehydrogenase is an enzyme that catalyses the oxidation of succinic acid. If malonic acid is added to the mixture, the rate of reaction is reduced. An increase in succinic acid will increase the rate of reaction again. For this system, which term best describes malonic acid?
A. Substrate
B. End product
C. Non-competitive inhibitor
D. Competitive inhibitor

[1]

21M.1A.HL.TZ1.7

A tissue sample was examined under the microscope in order to determine a mitotic index. The number of cells in each stage of the cell cycle was determined and the data were entered into a table.

Stage of life cycle	Interphase	Prophase	Metaphase	Anaphase	Telophase	Total
Number of cells	120	20	10	8	2	160

What is the mitotic index?
A. 0.125
B. 0.25
C. 0.75
D. 1.00

[1]

23M.1A.HL.TZ1.22

What are functions of type I and type II alveolar pneumocytes? [1]

	Type I	Type II
A.	Produce surfactant	Exchange CO_2
B.	Exchange CO_2	Exchange CO_2
C.	Phagocytic cells	Protective epithelial cells
D.	Carry out gas exchange	Produce surfactant

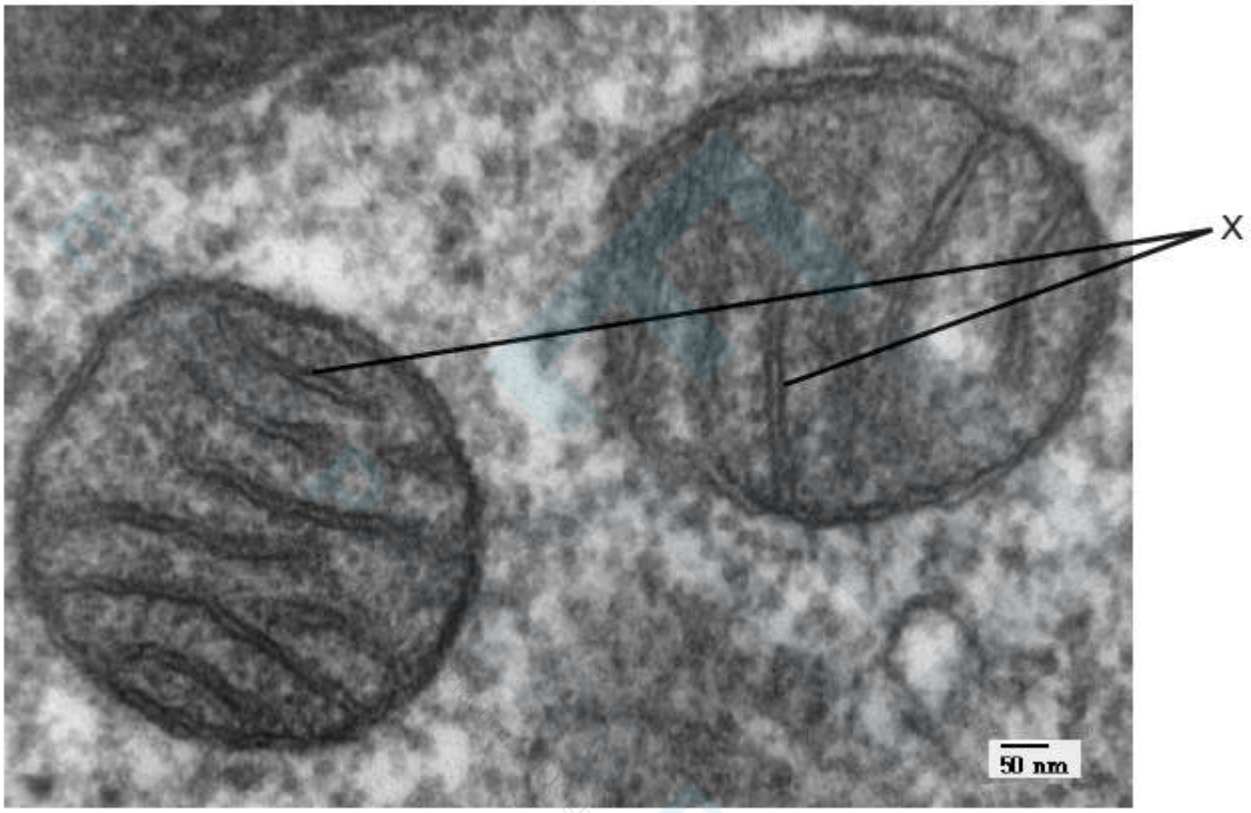
23M.1A.HL.TZ1.38

What is contained in skeletal muscle? [1]

A. Cross bridges between muscle fibres
B. Sarcomeres formed of contractile myofibrils
C. Myosin filaments forming cross bridges with troponin and tropomyosin
D. Multinucleate cells with numerous microfibrils made of contractile sarcomeres

19M.1A.HL.TZ1.30

The electron micrograph shows a section through part of an animal cell.



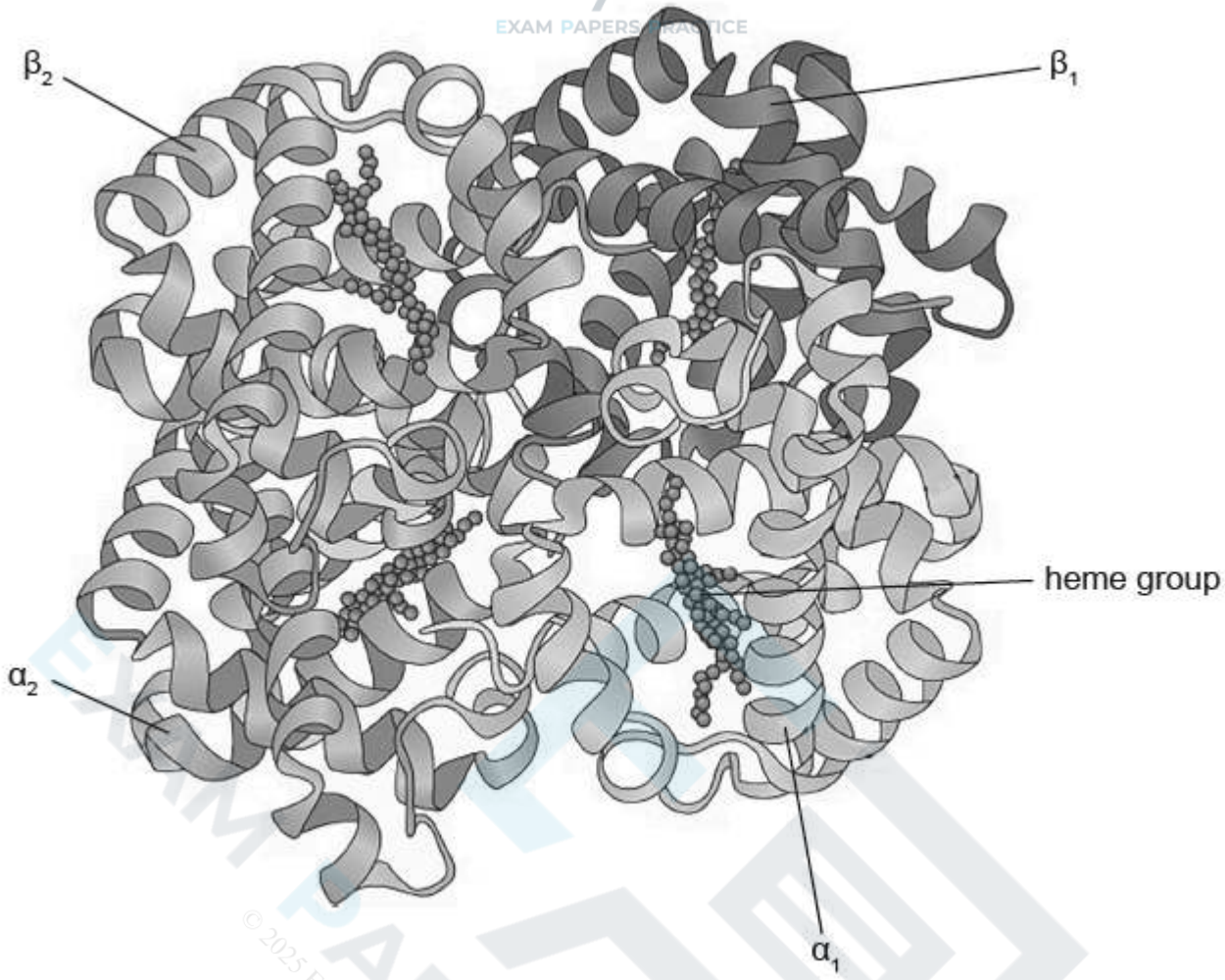
[Source: https://en.wikipedia.org/wiki/Mitochondrion#/media/File:Mitochondria,mammalian_lung_-TEM.jpg, by Louisa Howard.]

Which process is occurring on the structures labelled X?
A. The Krebs cycle
B. The link reaction
C. Glycolysis
D. Phosphorylation of ADP

[1]

21N.1A.HL.TZ1.6

The image shows the structure of the protein hemoglobin



[Source: Hemoglobin molecule, Microbiology ID: e42bd376624b-4c0f-972f-e0c57998e765@4.4 OpenStax Microbiology https://cnx.org/contents/5CvTdmJL@4.4 and https://commons.wikimedia.org/wiki/File:OSC_Microbio_07_04_hemoglobin.jpg Licensed under a Creative Commons Attribution 4.0 International License, https://creativecommons.org/licenses/by/4.0 .]

What level of protein structure bonds the α and β chains together?

A. Primary
B. Secondary
C. Tertiary
D. Quaternary

[1]

SPM.1A.HL.TZ0.4

Which molecules are produced during the hydrolysis of a triglyceride molecule? [1]

A. Water and glycerol
B. Fatty acids and glycerol
C. Water and fatty acids
D. Water and lipids

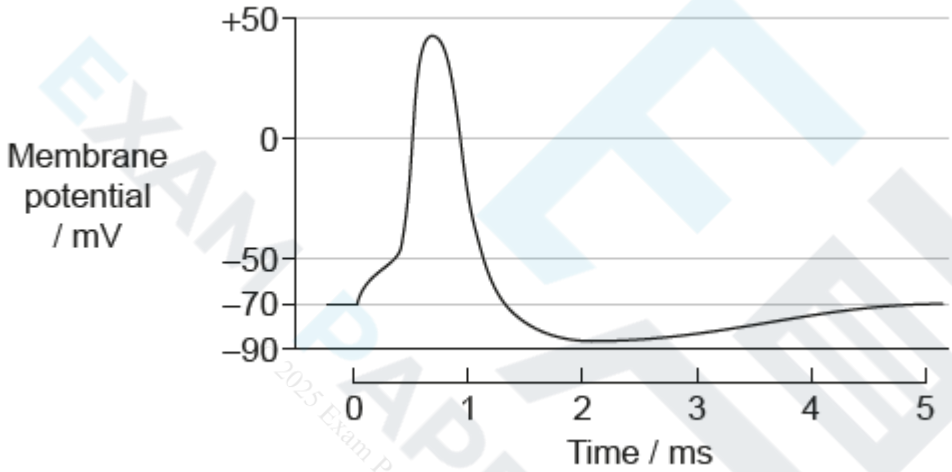
19N.1A.HL.TZ0.3

Which statement provides evidence for endosymbiosis?
A. Early prokaryotes contributed to a large increase in oxygen in the atmosphere.
B. Eukaryotic mitochondria and chloroplasts have their own circular DNA.
C. Certain groups of ancient prokaryotes developed mechanisms to carry out aerobic respiration.
D. Experiments by Miller and Urey produced simple organic molecules in abiotic conditions.

[1]

21N.1A.HL.TZ0.28

The graph shows changes in the membrane potential in an action potential. [1]



What is the approximate value of the threshold potential?
A. −88 mV
B. −70 mV
C. −50 mV
D. +45 mV

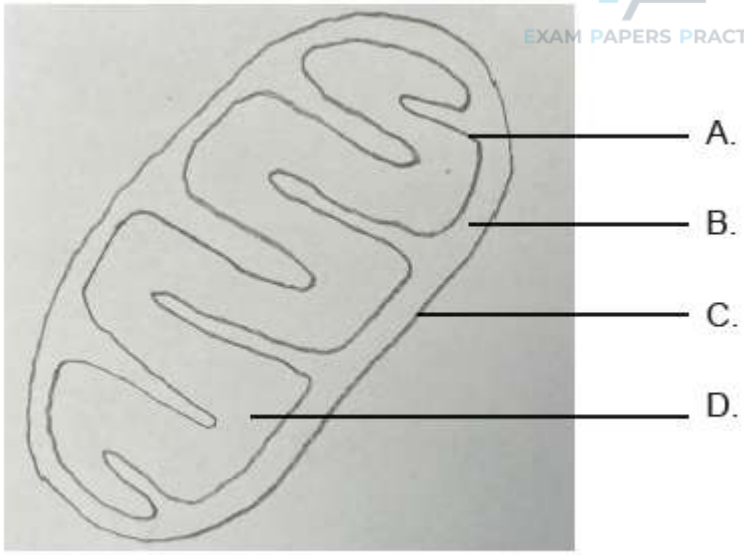
22N.1A.HL.TZ0.40

What is the role of HCG in pregnancy?
A. It is secreted by the embryo to stimulate progesterone secretion by the ovary during early pregnancy.
B. Together with oxytocin, it is involved in the positive feedback required for uterine contractions during birth.
C. It sustains the secretion of progesterone by the placenta throughout pregnancy.
D. It stimulates the ovary to maintain secretion of estrogen in early pregnancy.

[1]

22M.1A.HL.TZ1.30

Where in the mitochondrion does the formation of acetyl CoA occur? [1]



SPM.1A.HL.TZ0.30

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

19N.1A.HL.TZ0.5

Students examined micrographs and counted cells in the different stages of mitosis as well as those cells with no visible chromosomes. The table shows their results.

Stage	Prophase	Metaphase	Anaphase	Telophase	Interphase
Number of cells	10	3	2	5	30

What is the mitotic index?
A. 0.2
B. 0.4
C. 0.6
D. 0.7

[1]

20N.1A.HL.TZ0.38

What is the role of calcium ions in muscle contraction? [1]
A. To enable actin to expose binding sites on myosin
B. To bind to troponin, exposing binding sites on actin
C. To prevent an action potential in the muscle membrane
D. To bind to tropomyosin, blocking binding sites on actin

23M.1A.HL.TZ2.38

Where is the greatest quantity of water reabsorbed from the nephron? [1]

A. Bowman's capsule
B. Proximal convoluted tubule
C. Loop of Henle
D. Collecting duct

23M.1A.HL.TZ2.23

What happens to an RNA molecule in eukaryotes after transcription in order to process it into mRNA?

A. Introns are added.
B. Exons are removed.
C. Adenine nucleotides are added at the 3′ end.
D. Adenine nucleotides are removed from the 5′ end.

19M.1A.HL.TZ2.26

In premature babies born earlier than the 30 th week of pregnancy, type II pneumocytes are usually not fully developed, so they do not carry out their function normally. What is a possible consequence of this?
A. The number of alveoli reduces.
B. The size of the alveoli increases.
C. Capillary networks do not develop fully and oxygen is not absorbed.
D. Surface tension between alveoli does not decrease and the alveoli stick together.

[1]

23M.1A.HL.TZ1.39

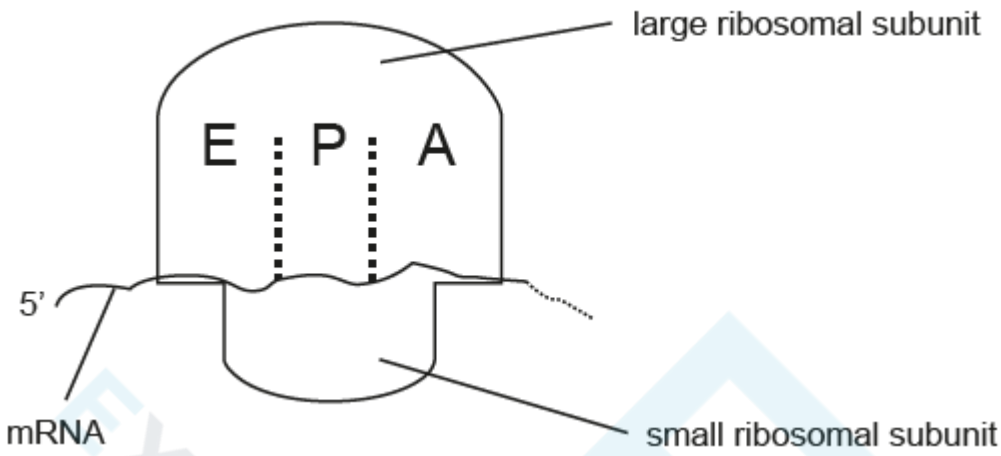
Merriam's kangaroo rat (*Dipodomys merriami*) is a small mammal found in desert biomes in the southwestern USA and Mexico. What would help these kangaroo rats to conserve water in order to survive high temperatures in desert biomes?

A. Increased sweating
B. A long loop of Henle
C. Decreased secretion of ADH
D. Decreased reabsorption from the collecting duct

[1]

22N.1A.HL.TZ0.28

The diagram shows a ribosome and associated mRNA [1]

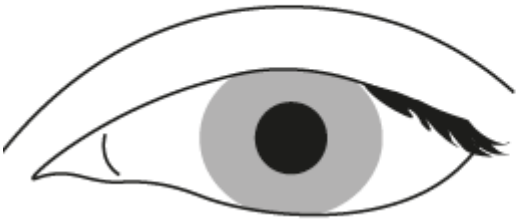


Which of these events occurs first in translation?
A. Small ribosomal subunit binds to mRNA.
B. Large ribosomal subunit binds to mRNA.
C. Initiator tRNA enters E site.
D. Initiator tRNA enters A site.

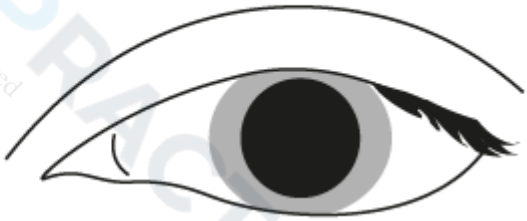
22N.1A.HL.TZ0.24

Atropine drops are used by opticians to dilate the pupil, so that a thorough examination of the retina can be performed. Atropine binds to acetylcholine receptors in synapses.

Normal pupil



Dilated pupil

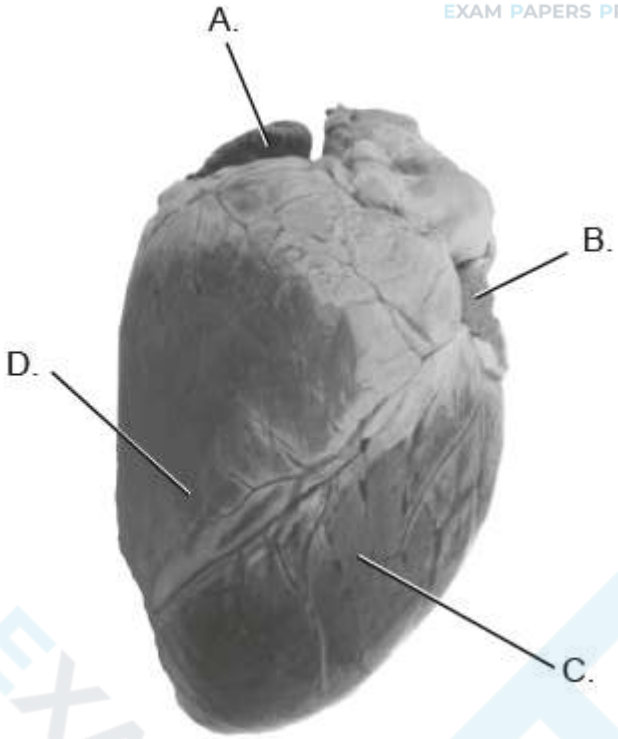


What is the effect of atropine binding in synapses?
A. Inhibits the binding of acetylcholine at the presynaptic membrane
B. Inhibits the release of acetylcholine from the presynaptic neuron
C. Prevents binding of acetylcholine at the postsynaptic membrane
D. Prevents transport of acetylcholine through the postsynaptic membrane

[1]

21N.1A.HL.TZ1.24

The image shows the four chambers of the mammalian heart viewed from the ventral side. The sinoatrial node is located in the wall of one of these chambers. Which chamber is it?



[Source: Anatomy Corner, n.d. [*Elk heart*]. [image online] Available at: http://anatomycorner.com/main/image-gallery/elk-heart/ [Accessed 23 March 2020].]

[1]

23M.1A.HL.TZ2.40

Which statement applies to the placenta? [1]

A. Carbon dioxide diffuses from fetus to mother across the placenta.
B. Maternal and fetal blood mix at the placenta.
C. If an ovum is not fertilized the placenta is lost during menstruation.
D. The umbilical cord connects the placenta to the mother's abdomen.

22M.1A.HL.TZ1.28

This DNA sequence was used to synthesize a polypeptide. [1]

DNA (sense strand): 3′ T A C T G A 5′
DNA (template strand): 5′ A T G A C T 3′

Which are the bases of the tRNA (anticodons)?

A. T A C T G A
B. U A C U G A
C. A U G A C U
D. A T G A C T

23M.1A.HL.TZ1.16

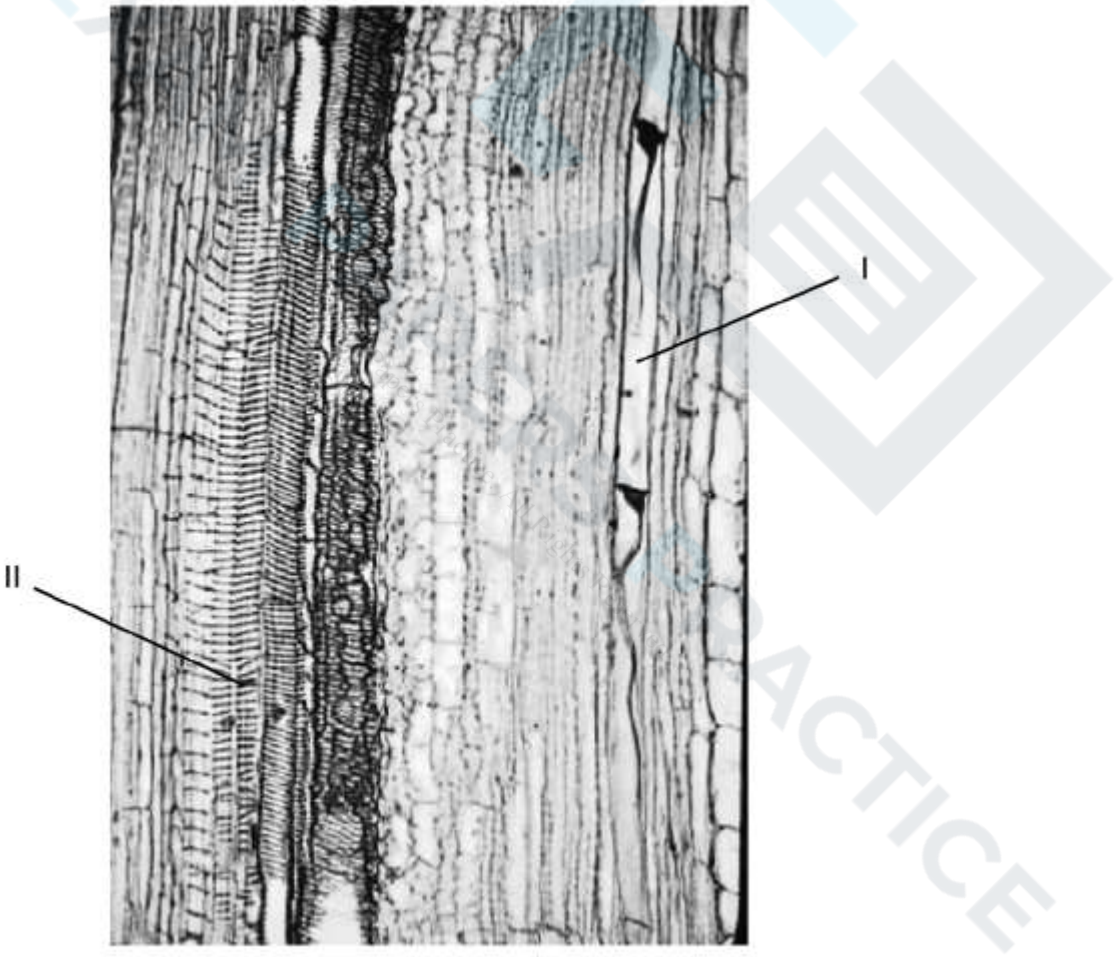
The ability to digest lactose in adulthood appeared due to a mutation in the lactase gene. The frequency of the lactase persistence allele was recorded as 0.8 in present-day European populations and as 0.05 in fossils from populations of their prehistoric ancestors.
What could have caused the change in the allele frequency?

A. Drinking more milk caused the mutation to occur.
B. There was a strong positive selection for the lactase persistence allele.
C. Lactase persistence was transferred to humans from cows.
D. Prehistoric milk did not contain lactose.

[1]

19M.1A.HL.TZ1.33

The image shows part of a section through the stem of a non-woody plant.



[Source: © Ross Koning. Image used with the kind permission of the author. http://plantphys.info.]

Which feature distinguishes the transport of materials in the tissue labelled I from that in the tissue labelled II?
A. In II, active transport is used.
B. In II, products of photosynthesis are transported.
C. In I, movement of materials is the result of transpiration.
D. In I, there is a higher solute concentration.

[1]

SPM.1A.HL.TZ0.31

Female grasshoppers have XX sex chromosomes and males have XO, signifying a single X chromosome. An X chromosome will be present in only half of the male gametes. A recessive mutation is induced by radiation in the X chromosome of a male. In which generation will the effect of this radiation appear?

A. F1 females
B. F1 males
C. F2 females
D. F2 males

[1]

19M.1A.HL.TZ2.28

Which is the hierarchy of taxa in order of increasing numbers of species? [1]
A. genus, family, order, class
B. class, order, genus, family
C. genus, family, class, order
D. class, order, family, genus

21M.1A.HL.TZ1.21

Which process results in the exchange of gases across the membrane of pneumocytes?
A. Active transport
B. Simple diffusion
C. Facilitated diffusion
D. Mass flow

[1]

19M.1A.HL.TZ2.25

What causes the atrioventricular valves to close during a heartbeat? [1]
A. Pressure in the atria is higher than in the ventricles.
B. Pressure in the atria is lower than in the ventricles.
C. Pressure in the arteries is higher than in the ventricles.
D. Pressure in the arteries is lower than in the ventricles.

23M.1A.HL.TZ2.39

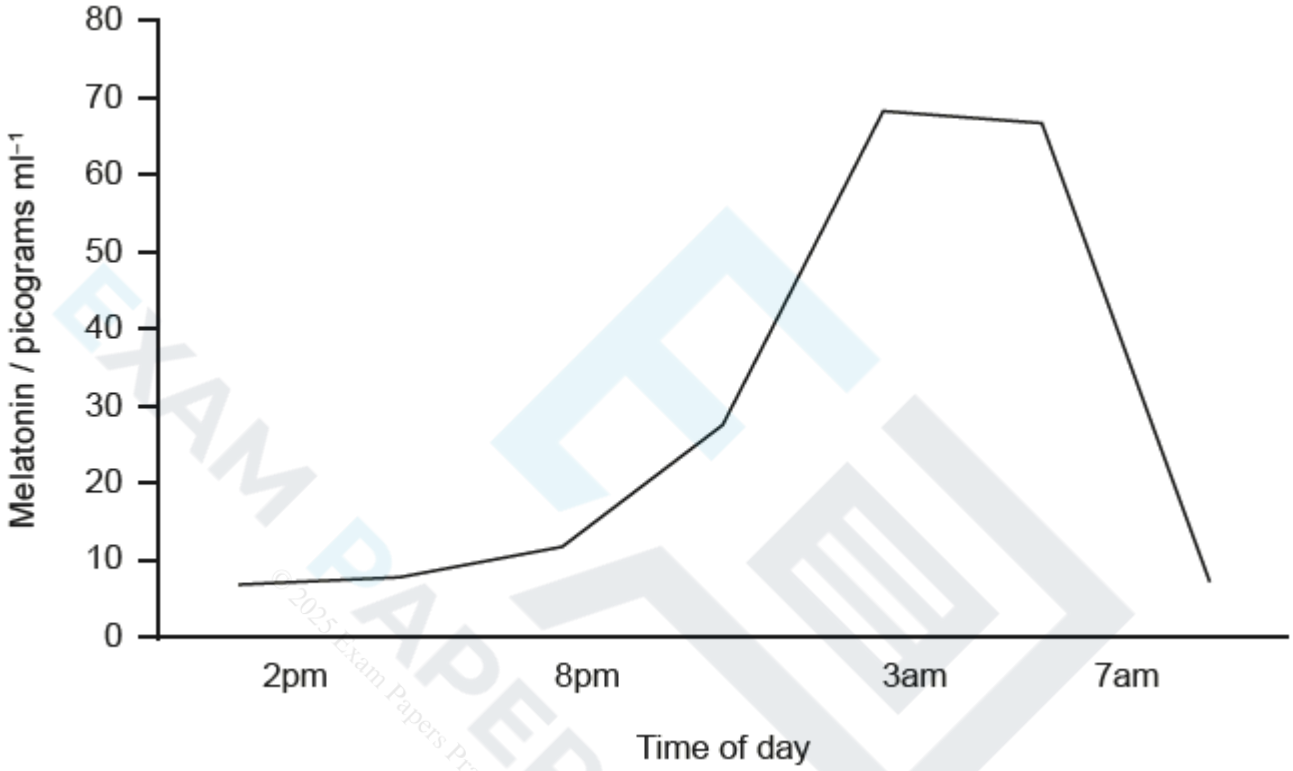
At what stage of spermatogenesis does the first division of meiosis occur? [1]

A. Spermatogonium to primary spermatocyte
B. Primary spermatocyte to secondary spermatocyte

C. Secondary spermatocyte to spermatid
D. Spermatid to mature sperm cell

22N.1A.HL.TZ0.25

Melatonin controls circadian rhythms and is involved in the sleep-wake cycle. The pineal gland, which secretes melatonin, is inhibited by light. The graph shows a normal cycle where bedtime is around 10pm.



Using data from the graph, what might be the effect(s) of screen light from a laptop, tablet or phone at bedtime?

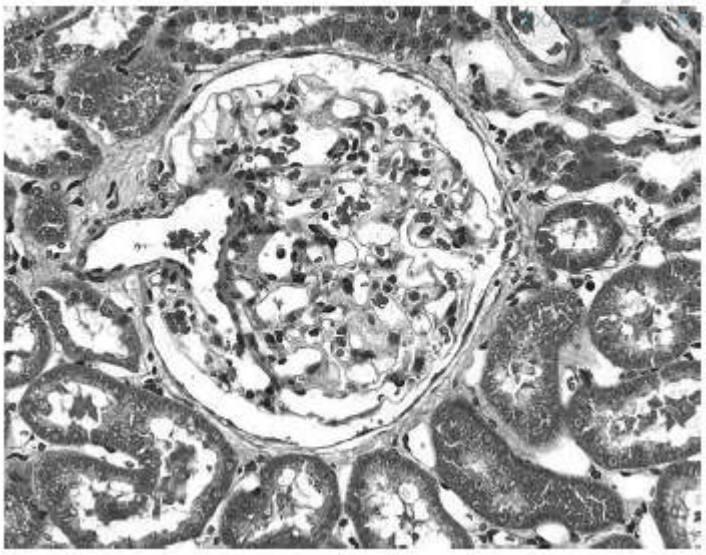
I. Delay in melatonin production
II. Lower peak concentration of melatonin
III. Peak of melatonin earlier in the evening

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

[1]

22M.1A.HL.TZ2.39

The micrograph shows a glomerulus and Bowman's capsule, where ultrafiltration takes place in the kidney.



[Source: MICROSCAPE/SCIENCE PHOTO LIBRARY.]

What facilitates the formation of glomerular filtrate?

A. Many fenestrations in walls of capillaries in the glomerulus

B. High pressure in the Bowman's capsule

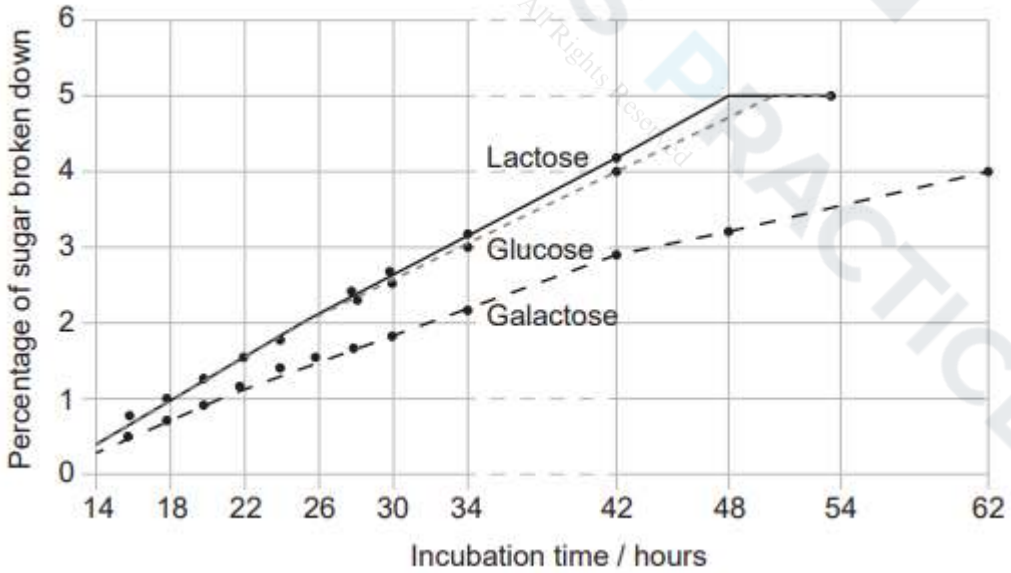
C. ADH secreted by the pituitary gland

D. Osmosis caused by a high concentration of urea in the blood

[1]

21M.1A.HL.TZ2.11

The graph shows the results of an experimental investigation that compared the rates at which lactose, glucose and galactose are broken down in the process of anaerobic cellular respiration by the yeast *Torulopsis cremoris* .



[Source: Rogosa, M., 1948 Mechanism of the Fermentation of Lactose by Yeasts. *Journal of Biological Chemistry* , 175, p.418. (CC BY 4.0) https://creativecommons.org/licenses/by/4.0/ .]

What can be concluded from these results?

A. Cellular respiration of lactose involves the production of glucose and galactose.

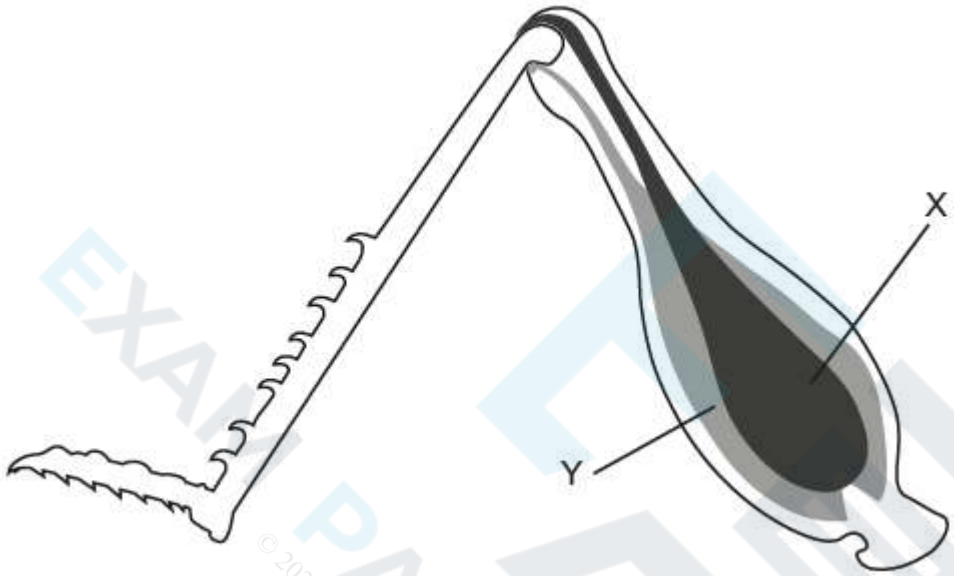
B. The breakdown of glucose and galactose occurs more slowly in the presence of lactose.

C. The rate of cellular respiration is greater for glucose than for lactose and galactose.
D. The percentage of sugar remaining after 42 hours is greater for galactose than glucose.

[1]

22N.1A.HL.TZ0.37

Movement of insects requires muscles in antagonistic pairs. The diagram shows an insect leg with muscles labelled X and Y.



[Source: Johnson, S.K., n.d. [*Insect leg*]. [diagram online] Available at: http://www.susankjohnson.com/portfolio.shtml [Accessed 26 October 2021].]

What actions in the human arm are equivalent to muscle X contracting and muscle Y relaxing?
A. triceps contracts, biceps relaxes, arm extends
B. biceps contracts, triceps relaxes, arm flexes
C. triceps contracts, biceps relaxes, arm flexes
D. biceps contracts, triceps relaxes, arm extends

[1]

19M.1A.HL.TZ2.8

Which statement correctly describes genome and proteome?
A. Only the genome but not the proteome can be analysed using gel electrophoresis.
B. The genome and the proteome are the same in all tissues in an organism.
C. In cells of different tissues, the genome is the same while the proteome varies.
D. Only mutations in the proteome but not in the genome cause any variability.

[1]

SPM.1A.HL.TZ0.18

What activates a tyrosine kinase pathway in a cell following binding to a receptor? [1]

A. Odorant molecules
B. Epinephrine
C. Taste molecules
D. Insulin

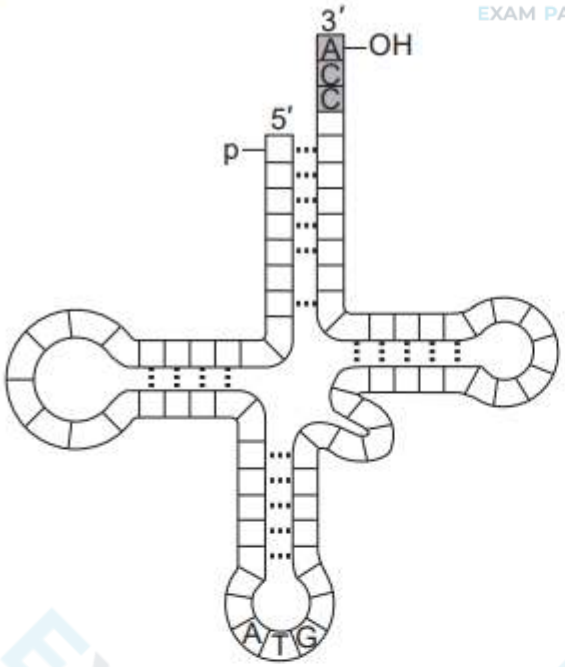
21M.1A.HL.TZ1.32

Which process does **not** take place in the stroma of chloroplasts? [1]
A. Synthesis of carbohydrates
B. Fixation of carbon
C. Reduction of NADP
D. Synthesis of ribulose bisphosphate

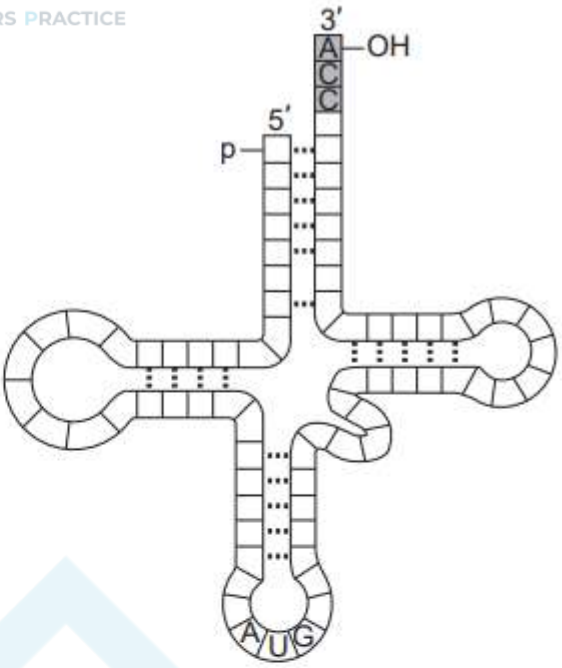
21M.1A.HL.TZ2.28

The mRNA codon UAC codes for the amino acid tyrosine. Which tRNA carries tyrosine?

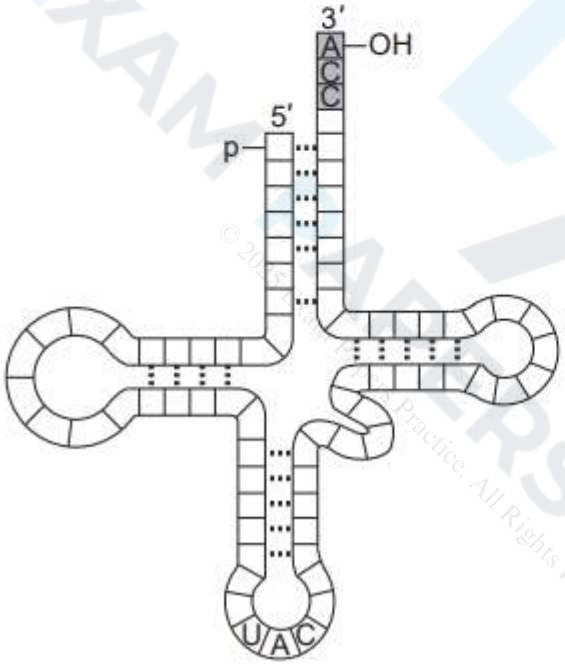
A.



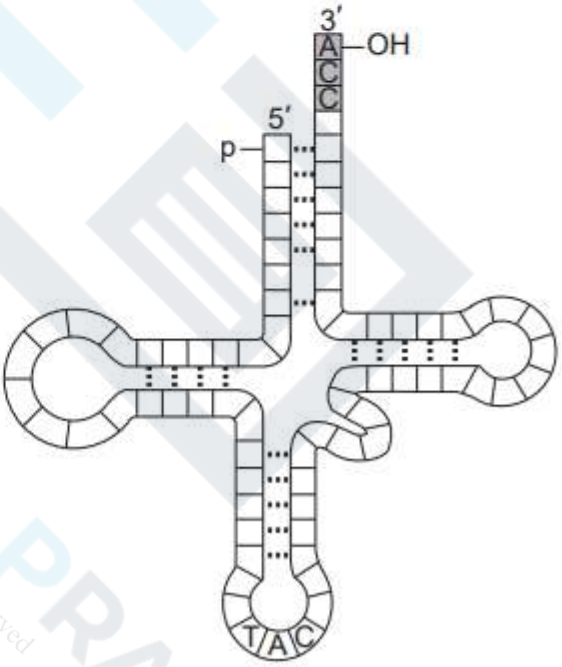
B.



C.



D.



[1]

23M.1A.HL.TZ2.8

What is the proteome of an individual?

A. The amino acids unique to an individual making up the proteins in cells
B. The way in which an individual's polypeptides are folded into a three-dimensional structure
C. The proteins synthesized as an expression of an individual's genes
D. All possible combinations of amino acids an individual contains

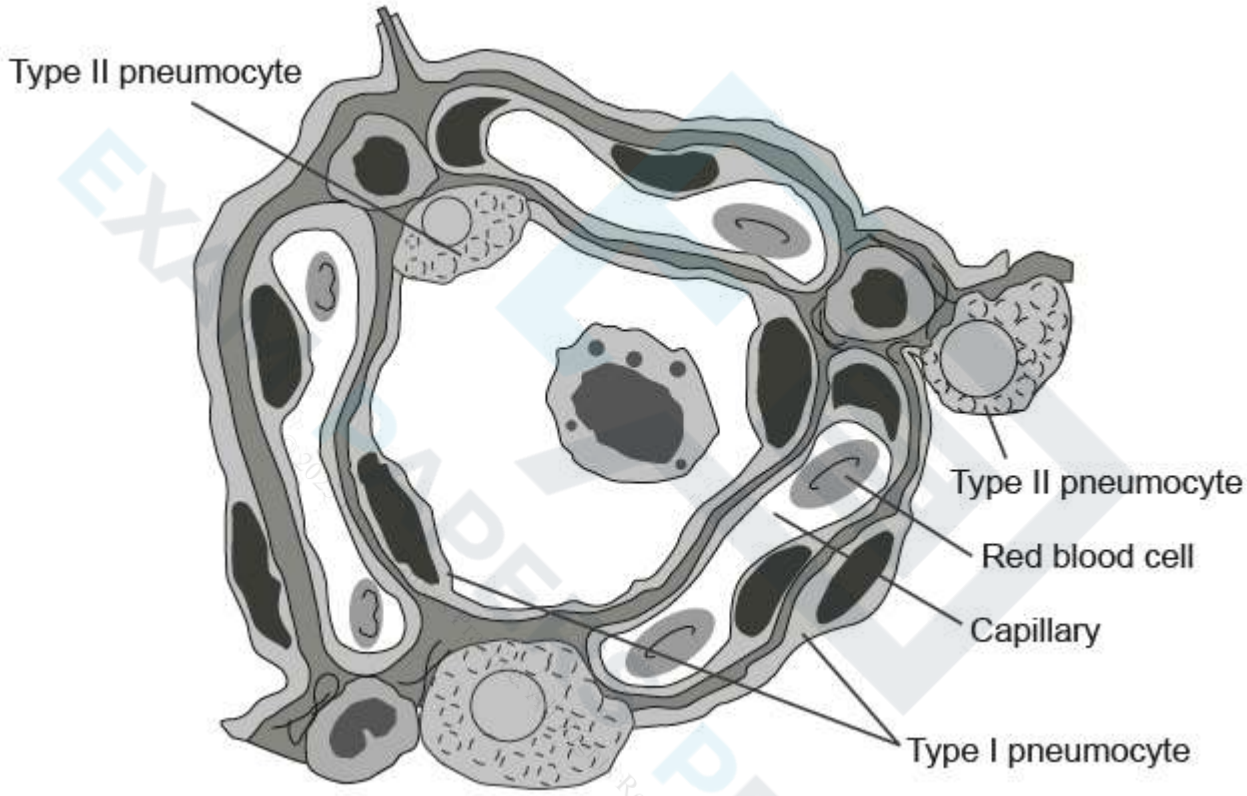
[1]

21M.1A.HL.TZ2.5

Which statement is evidence for the endosymbiotic theory? [1]
A. Chloroplasts contain 70S ribosomes.
B. Protein synthesis occurs in the cytoplasm.
C. Organic molecules can be synthesised abiotically.
D. RNA is self-replicating.

22N.1A.HL.TZ0.22

The diagram shows a section through an alveolus.



[Source: Bergman, Ronald A., Ph.D., and D'Alessandro, Michael P., M.D. Pulmonary alveoli, "Anatomy Atlases". Available online: http://www.anatomyatlases.org/ [Accessed 02/01/2023].]

What are the functions of the following labelled structures?

	Type I pneumocyte	Type II pneumocyte	Capillary
A.	Gas exchange	Produces surfactant	Transports carbon dioxide from alveolus
B.	Produces surfactant	Gas exchange	Transports oxygen to alveolus
C.	Gas exchange	Produces surfactant	Transports carbon dioxide to alveolus
D.	Produces surfactant	Gas exchange	Transports oxygen from alveolus

[1]

22N.1A.HL.TZ0.31

What occurs in the light-independent reactions of photosynthesis? [1]
A. Glycerate 3-phosphate is reduced to triose phosphate.
B. Ribulose bisphosphate is regenerated using reduced NADP.
C. Ribulose bisphosphate is oxidized to two molecules of glycerate 3-phosphate.
D. Both ATP and NADP are used to produce triose phosphate.

20N.1A.HL.TZ0.21

What happens in the heart when epinephrine is secreted into the blood? [1]
I. Pressure in the heart falls.
II. The pulmonary artery transports oxygenated blood at a faster rate.
III. The sinoatrial node increases the rate of electrical signals.
A. I only
B. I and II only
C. II and III only
D. III only

23M.1A.HL.TZ1.5

What is evidence for the endosymbiotic theory in eukaryotic cells? [1]

A. Mitochondrion with DNA
B. Golgi complex in cytoplasm
C. Single nuclear membrane
D. Ribosomes in cytoplasm

19M.1A.HL.TZ2.35

What are features of both endoskeletons of mammals and exoskeletons of insects? [1]
A. They are both made of bone.
B. They both have cartilage.
C. They are both moved by antagonistic sets of muscles.
D. Both consist of dead tissue.

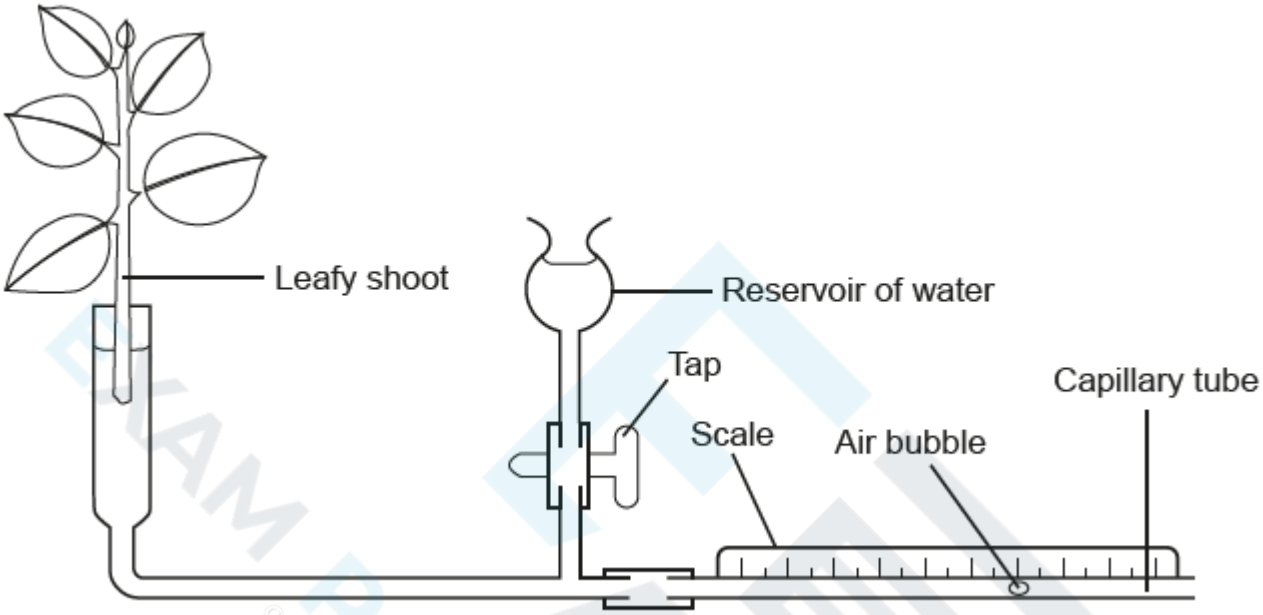
21M.1A.HL.TZ2.23

What information can be deduced from the sequence of nodes in a cladogram?
A. The geological period in which the species in the clade diverged from their common ancestor
B. The probable sequence of divergence among the species in the clade
C. The number of characteristics the species have in common
D. The number of mutations that have occurred since the species shared a common ancestor

[1]

22N.1A.HL.TZ0.32

The apparatus is set up to measure the rate of transpiration. As transpiration occurs from the leafy shoot, water is drawn through the apparatus and is measured by timing the movement of the air bubble along the capillary tube.



Which variable(s) must be controlled if transpiration rates are compared in different plant species?

I. Total leaf surface area
II. Volume of water in the reservoir
III. Room temperature

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

[1]

21M.1A.HL.TZ1.22

Which statement applies to an axon at rest?
A. There is no electric potential difference between the external and internal surfaces of the plasma membrane.
B. The external surface of the plasma membrane is positive relative to the internal surface.
C. The external surface of the plasma membrane is negative relative to the internal surface.
D. The internal surface of the plasma membrane has a much higher concentration of sodium ions.

[1]