Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 1

13 May 2024

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

1 hour

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The maximum mark for this examination paper is **[40 marks]**.

2224 – 6007

25 pages

1. Scientists are investigating the potential use of embryonic stem cells to repair spinal cord injuries in humans. What would be an advantage of using embryonic rather than adult stem cells?

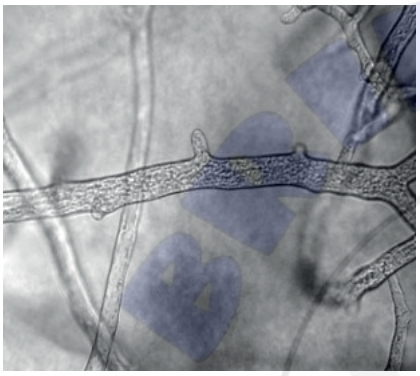
A. More cell types can be obtained.

B. Possibilities of rejection are lower.

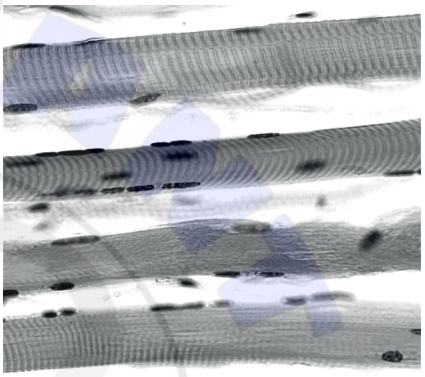
C. The risk of stem cells forming malignant tumours is lower.

D. Unlimited numbers of cells can be extracted from the umbilical cord.

2. The micrographs show two examples of atypical cells.



Aseptate fungal hyphae



Striated muscle fibres

Which feature shared by both types of cells makes them atypical?

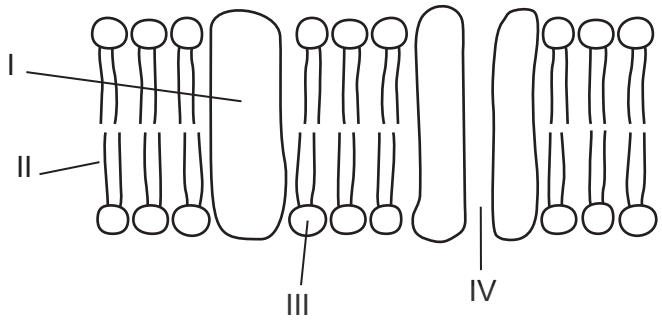
A. Both have cell walls.

B. Both have several nuclei.

C. Both lack membrane-bound organelles.

D. Both are divided into compartments.

3. The diagram shows the fluid mosaic model of cell membranes. Which labelled regions are hydrophilic?



A. I and II

B. I and III

C. II and IV

D. III and IV

4. What explains the movement of glucose molecules down a concentration gradient across the cell surface membrane?

A. They can diffuse between phospholipids due to their flexibility.

B. They are actively transported by protein pumps due to their size.

C. They move through hydrophilic channels because they are polar.

D. They dissolve in the phospholipid bilayer because they are not charged.

5. How does the endosymbiotic theory explain the origin of mitochondria in eukaryotes?

A. Autotrophic eukaryotes fused with photosynthetic bacteria.

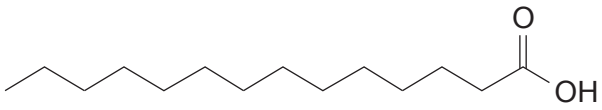
B. Small aerobic bacteria survived inside anaerobic prokaryotes.

C. Anaerobic prokaryotes were engulfed by small aerobic bacteria.

D. Invaginations occurred in large prokaryotes to increase surface area for gas exchange.

6. The diagrams show the molecular structure of carbon compounds found in living organisms. Which one is found in phospholipids?

A.



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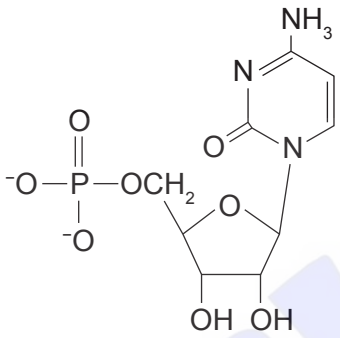
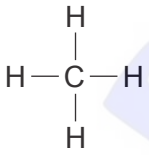
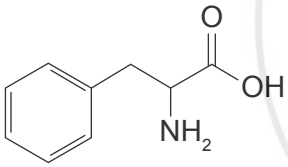


C.



D.



7. The graph shows mean air and water temperatures recorded at the same time of day at different distances downstream from the city of Asunción on the Lower Paraguay river over an 8-day period.

Removed for copyright reasons

What explains the differences between water and air temperatures shown in the graph?

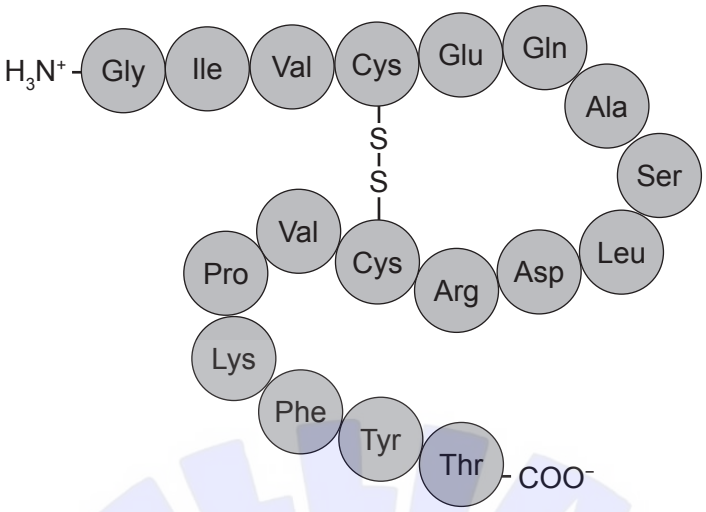
A. Evaporation of surface water causes an increase in the temperature of surface water.

B. Adhesion between water molecules prevents heat absorption, so its temperature remains lower.

C. Heat is rapidly lost from water due to breakage of covalent bonds.

D. Breakage of hydrogen bonds in water requires much heat energy.

8. The diagram shows the structure of a peptide.



How many bases would be present in the length of an mRNA molecule coding for this peptide?

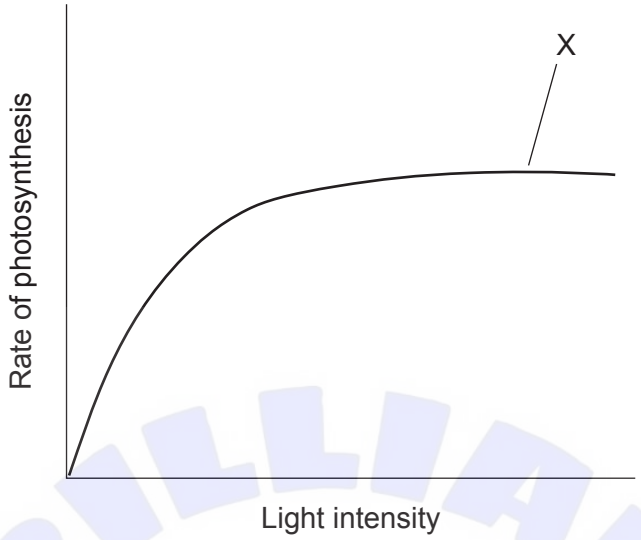
A. 18

B. 36

C. 54

D. 72

9. The graph shows the effect of increasing light intensity on the rate of photosynthesis during an experiment carried out at optimum temperature and normal atmospheric CO_2 concentration.



Which factor could be limiting photosynthesis at point X on the graph?

A. Light intensity

B. Carbon dioxide concentration

C. Temperature

D. Nutrient availability

10. Polypeptides are made of twenty different types of amino acids. What makes amino acids different from each other?

A. The number of unsaturated carbons

B. The position of the carboxyl group

C. The composition of the side chains

D. The position of the amino group

11. The Human Genome Project completed the sequencing of the human genome by the year 2003.

Which could have been a source of the entire genome in humans?

A. The contents of a red blood cell

B. The nucleus and mitochondria of a skin cell

C. The nucleus and acrosome of a sperm cell

D. The nucleus and ribosomes of any somatic cell

12. The image shows a pair of homologous chromosomes from a human cell.

What is **always** found at the same loci of homologous chromosomes?

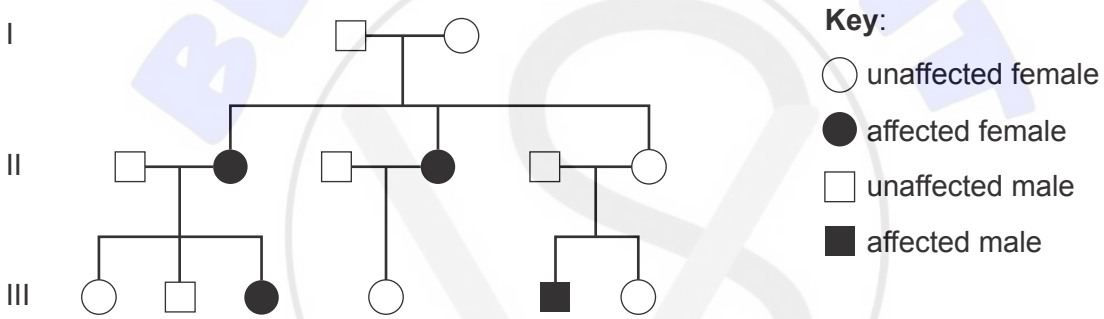
A. Alleles with the same function

B. Alleles with identical base sequences

C. Genes with identical base pairs

D. Genes with the same mutations

13. Nonsyndromic Hearing Loss and Deafness (DFNB1) is an inherited cause of deafness in humans. The pedigree chart shows the inheritance of DFNB1 in a family.



Where is the DFNB1 allele found in family members with this condition?

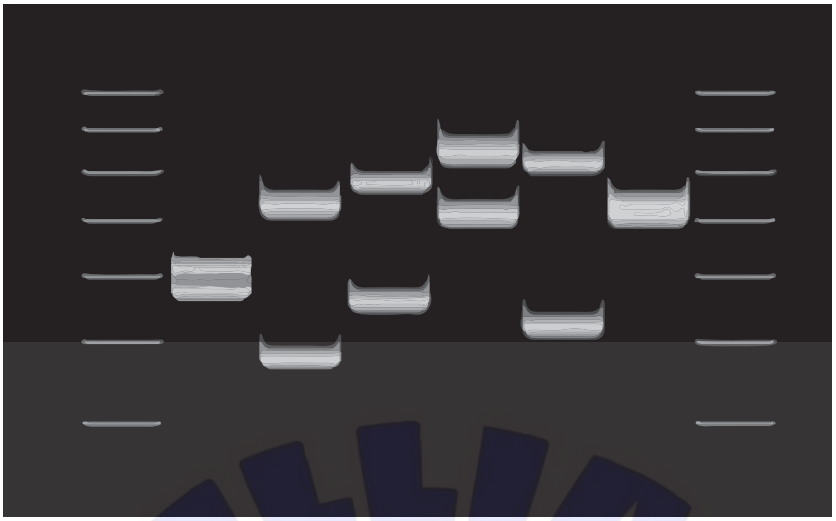
A. On the Y chromosome

B. On the X chromosome

C. On one autosome only

D. On a pair of autosomes

14. The image shows a DNA profile obtained by gel electrophoresis.



What could be found in each band?

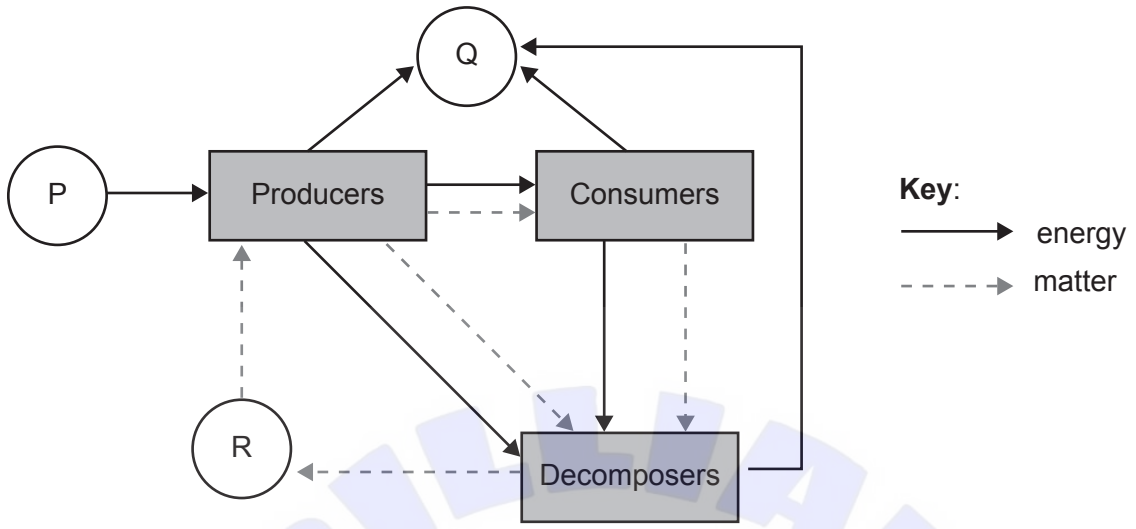
A. DNA fragments with the same number of base pairs

B. Several complete DNA molecules of different lengths

C. A complete DNA molecule with a specific charge

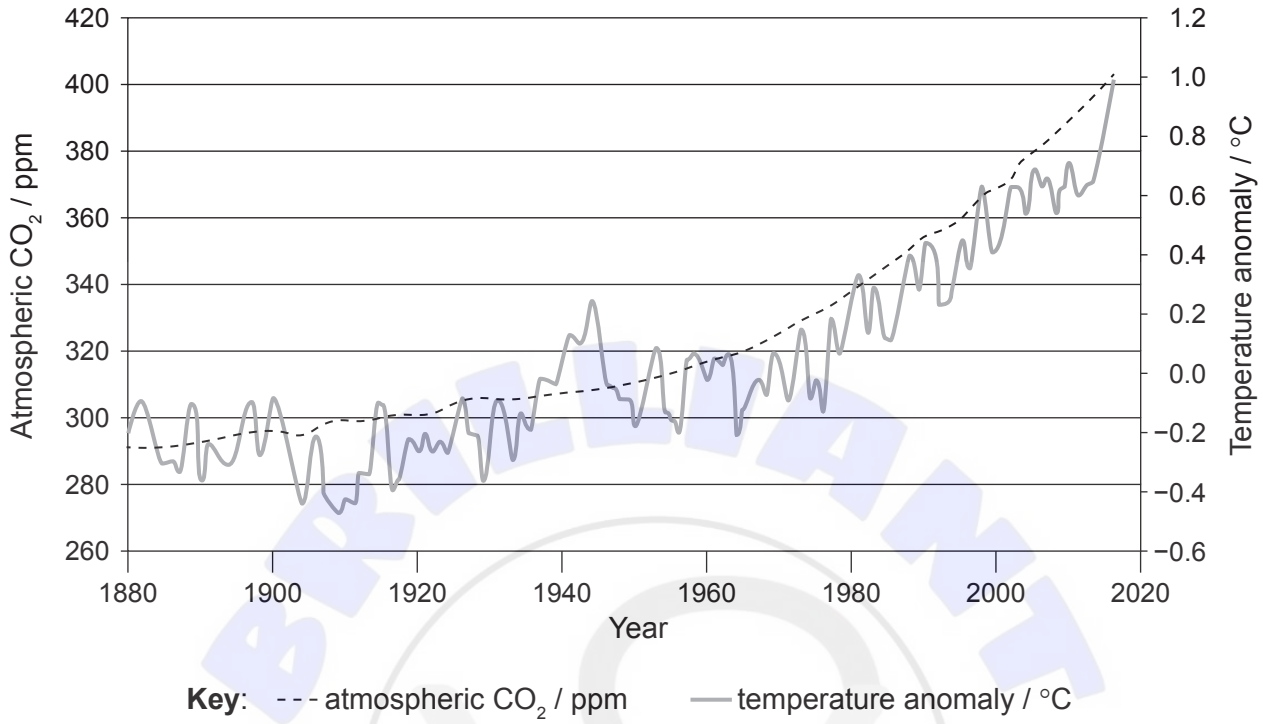
D. One DNA strand with a particular base sequence

15. The diagram shows flows of energy and matter in an ecosystem. What do the letters P, Q and R represent?



	P	Q	R
A.	light	water vapour	nitrates
B.	chemical energy	heat	carbon dioxide
C.	light	heat	inorganic nutrients
D.	chemical energy	carbon dioxide	glucose

16. The graph shows the correlation between atmospheric carbon dioxide concentration and global temperature anomalies (deviations from mean global temperatures) since the industrial revolution to the year 2017.



Which statement explains the correlation between atmospheric carbon dioxide concentration and temperature shown in the graph?

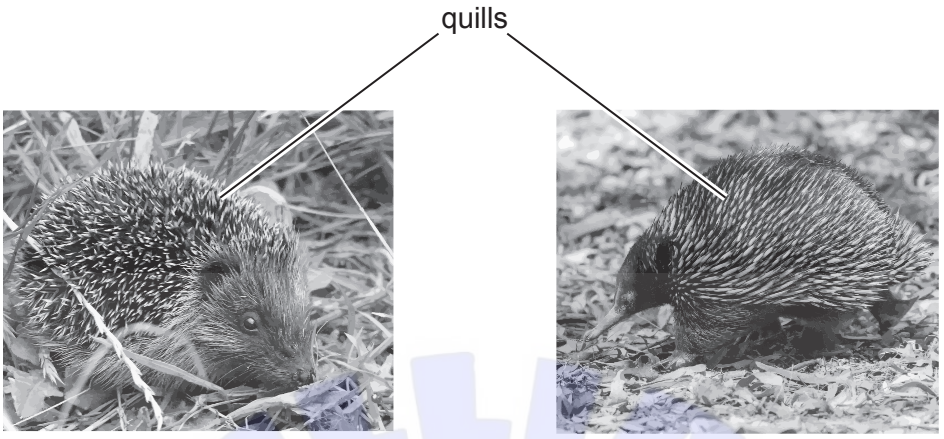
A. Carbon dioxide heats up the surface of the Earth.

B. More short wave radiation bounces back to space, causing warmer seasons.

C. Less long wave radiation can escape the atmosphere, heating up the Earth.

D. Less radiation is emitted by the Earth's surface, increasing seasonal fluctuations.

17. Modified hairs (quills) cover the bodies of hedgehogs (*Erinaceus europaeus*) and short-beaked echidnas (*Tachyglossus aculeatus*). However, these structures do not have the same evolutionary origin.



Hedgehog
(*Erinaceus europaeus*)

Short-beaked echidna
(*Tachyglossus aculeatus*)

What is a possible explanation for the presence of quills in both species?

A. Both species diverged gradually, but quills were conserved for successful survival.

B. Quills developed in response to similar environmental pressures.

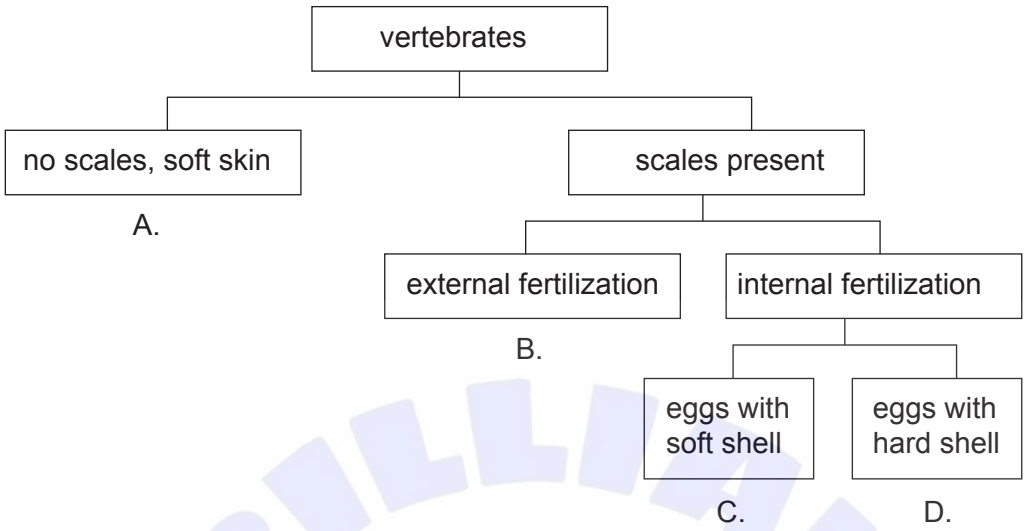
C. Quills are homologous structures that result from adaptation to a similar predator.

D. They developed by adaptive radiation to survive in slightly different habitats.

18. Variation may result in a favourable characteristic in a species. What could be a cause of this variation and the likely effect on the frequency of other alleles for this characteristic?

	Cause of variation	**Effect on frequency of other alleles**
A.	different combinations of alleles	increases
B.	sexual reproduction	increases
C.	successful acquired characteristics	decreases
D.	high mutation rates	decreases

19. The dichotomous key shows general features of four vertebrate classes. Which letter identifies most fish?



20. Which substances are absorbed by villi in the small intestine?

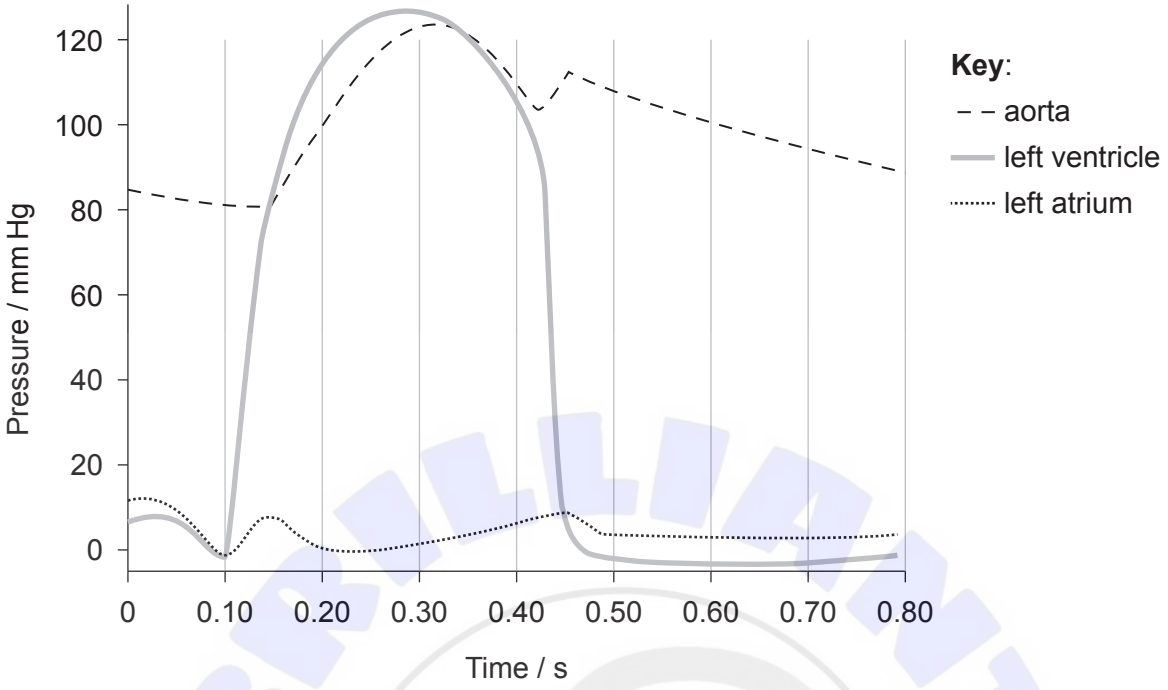
A. Glucose, lactose and amino acids

B. Vitamins, polypeptides and fructose

C. Glycerol, fructose and phosphate

D. Fatty acids, maltose and fructose

21. The graph shows pressure changes in the left side of the heart during one cardiac cycle.



How long does the atrioventricular valve remain open during one cardiac cycle?

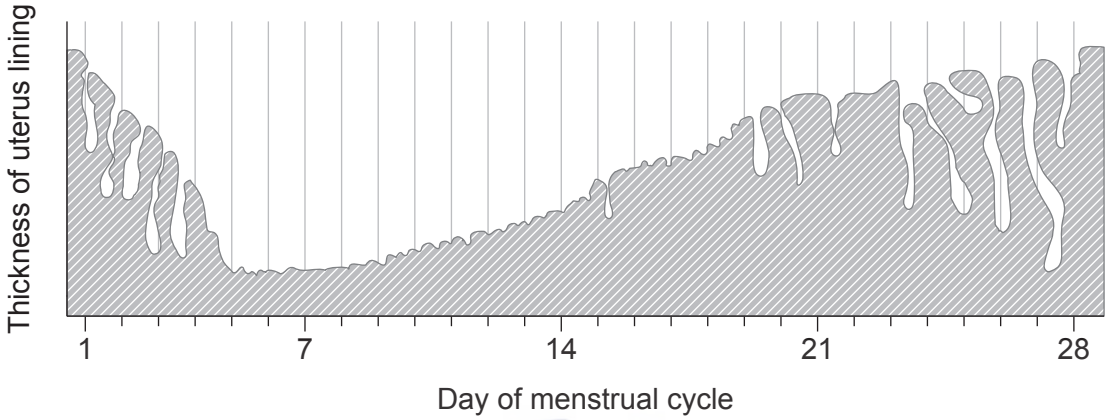
A. 0.10 seconds

B. 0.20 seconds

C. 0.35 seconds

D. 0.45 seconds

22. The diagram shows changes in the uterus lining of a woman throughout her menstrual cycle.



Between which days is she likely to be fertile?

A. 1–6

B. 7–10

C. 11–16

D. 17–21

23. What causes the expansion of the thorax during inspiration?

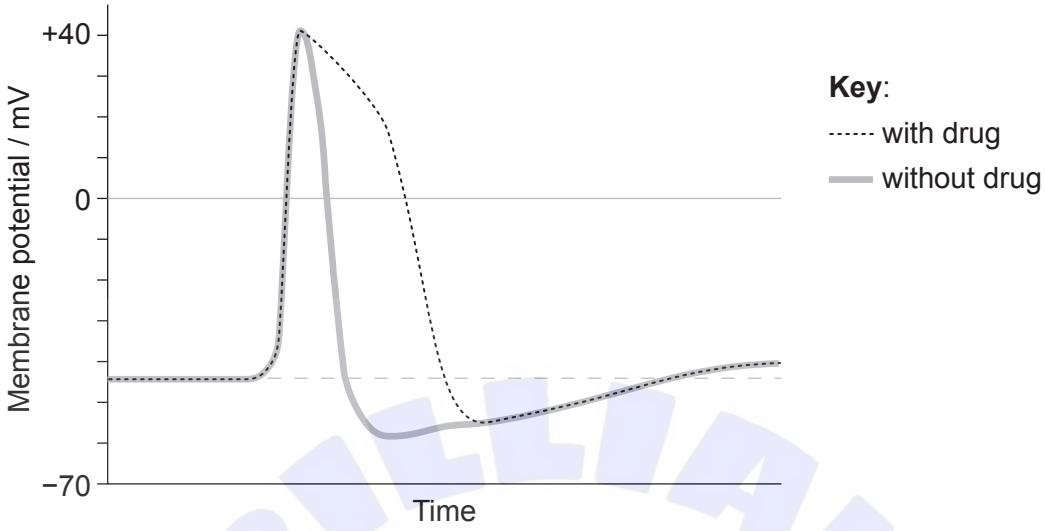
A. Air entering the lungs

B. An increase in tidal volume

C. An increase in pressure inside the lungs

D. The contraction of the diaphragm and external intercostal muscles

24. Doctors often use drugs to restore normal action potentials. The oscilloscope trace shows the effect of one of these drugs, which acts on potassium (K) ion channels of cell membranes.



From the graph, what can be concluded about the effect of this drug on membrane potentials?

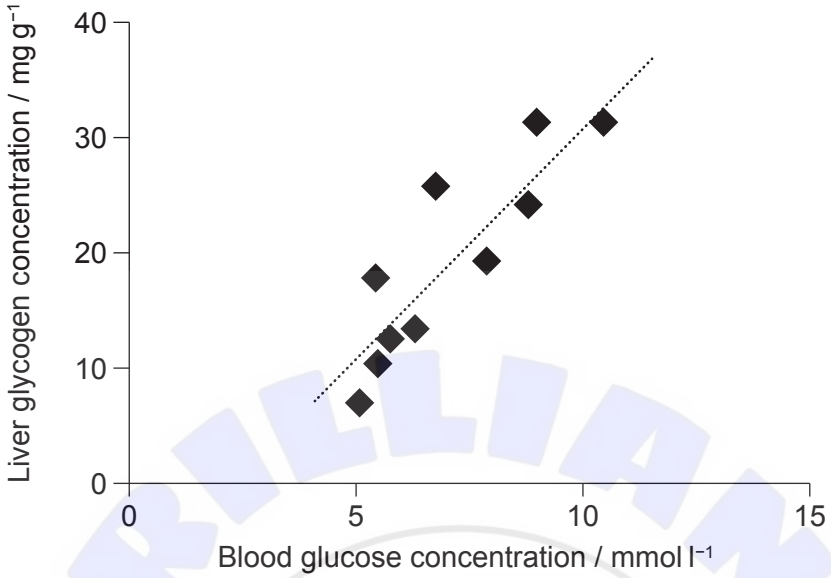
A. It delays repolarization by preventing the influx of K ions towards the cytoplasm.

B. It delays depolarization due to a build-up of K ions outside the neuron.

C. It lengthens the resting potential as membrane permeability to K ions is decreased.

D. It lengthens the action potential by reducing the rate of K ions released from the cytoplasm.

25. The graph shows the correlation between blood glucose and liver glycogen concentrations in animals after receiving different glucose meals.



Which statement explains the correlation shown in the graph?

A. Liver cells store excess blood glucose as glycogen in response to glucagon.

B. Glucagon increases the release of glucose by liver cells to restore concentrations.

C. Insulin decreases respiration rates in liver cells for storage of excess blood glucose.

D. Liver cells respond to insulin by speeding up the conversion of blood glucose into glycogen.

26. What is a role of DNA polymerase I during replication of DNA?

A. Form replication forks

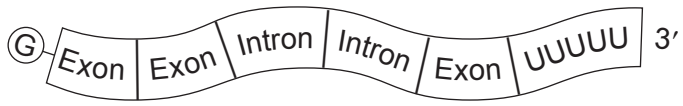
B. Remove RNA primers

C. Add short length of RNA to template strand of DNA

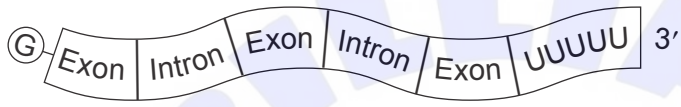
D. Add DNA nucleotides to the 5′ end of the new strand

27. Which diagram shows modified mRNA after transcription?

A. 

B. 

C. 

D. 

28. What is the role of tRNA-activating enzymes in protein synthesis?

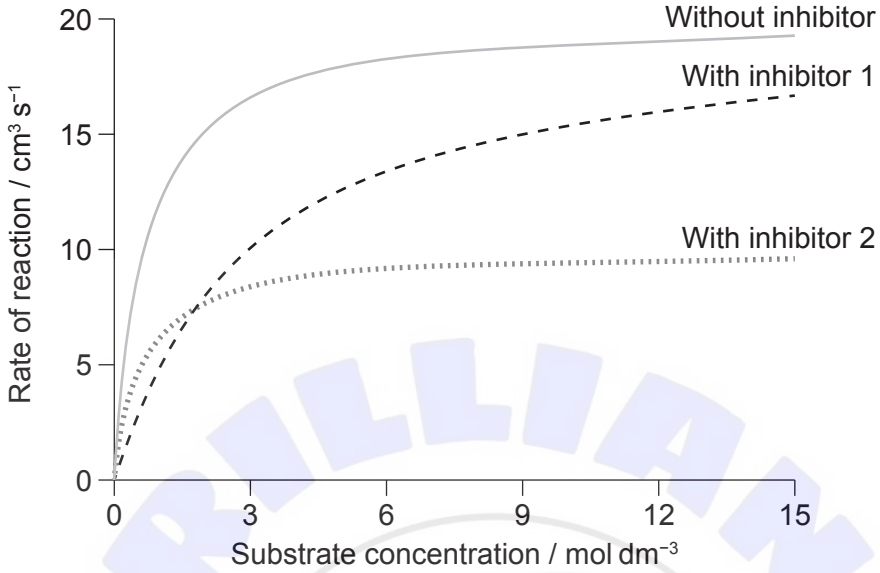
A. They attach amino acids to tRNA molecules using ATP.

B. They activate tRNA and amino acids during transcription.

C. They synthesise ATP and bind it to specific tRNA molecules.

D. They allow the formation of H bonds between tRNA anticodons and specific amino acids.

29. A group of students investigated the effect of increasing substrate concentration on the rate of an enzyme-catalysed reaction in the presence of two inhibitory substances. The results are shown in the graph.



What can be deduced from these results?

A. At all substrate concentrations, both inhibitors compete for the enzyme's active site.

B. Both inhibitors are specific for this enzyme-catalysed reaction.

C. At very low substrate concentrations, inhibitor 2 shows a higher inhibitory effect.

D. Inhibitor 1 and substrate have similar shapes.

30. Which molecules are reactants and products during glycolysis?

	Reactants	**Products**
A.	pyruvate and ATP	acetyl coenzyme A, carbon dioxide and NAD
B.	glucose and oxygen	pyruvate, carbon dioxide and ATP
C.	glucose and ATP	pyruvate, reduced NAD and ATP
D.	pyruvate and oxygen	ATP and reduced NAD

31. Which of the following processes require(s) ATP during photosynthesis?

I. The splitting of water molecules

II. The regeneration of ribulose bisphosphate (RuBP)

III. The maintenance of a proton gradient between the thylakoid space and the stroma

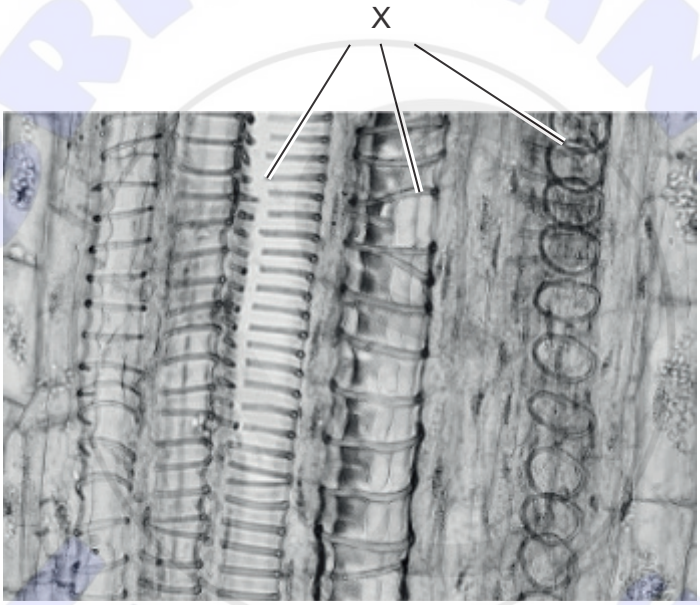
A. I only

B. II only

C. I and II

D. II and III

32. The micrograph shows xylem vessels in the longitudinal section of a plant stem.



How do the structures labelled X contribute to the transport of water up the stem?

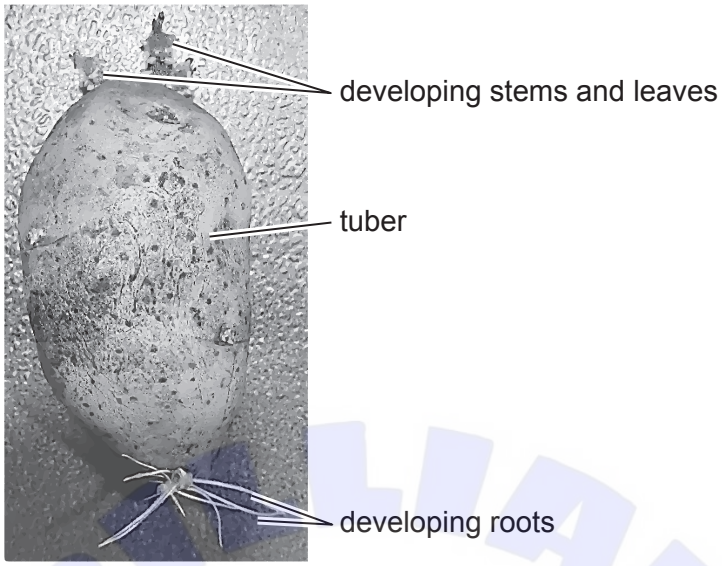
A. They make xylem walls more permeable to water.

B. They develop cohesive forces with water molecules.

C. They allow xylem vessels to withstand low pressures.

D. They increase adhesion between neighbouring xylem vessels.

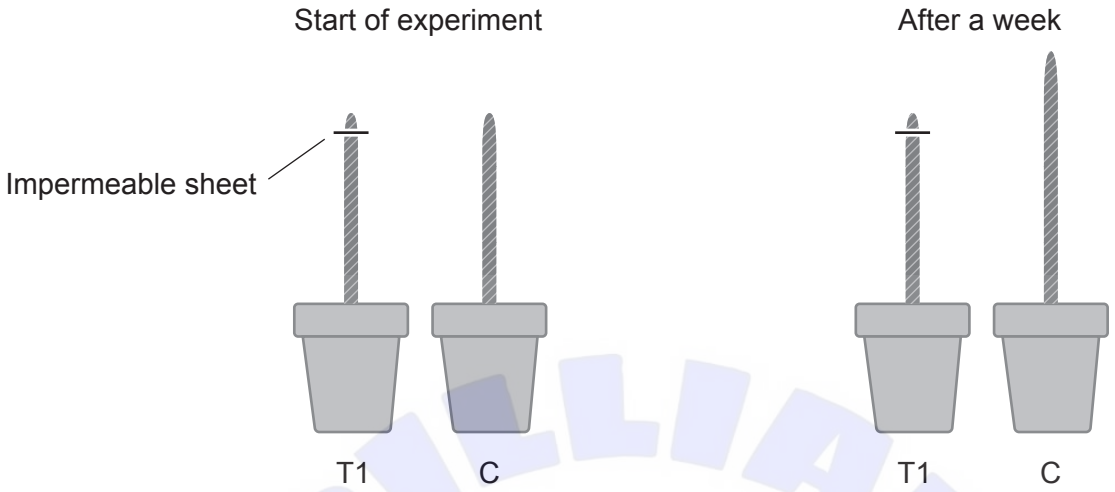
33. The image shows a potato (*Solanum tuberosum*) plant at the beginning of the growing season.



Which visible structures are sources and sinks?

	Sources	**Sinks**
A.	developing leaves	tuber
B.	developing roots	developing leaves
C.	tuber	developing stems
D.	developing stems	developing roots

34. A group of students investigated the effect of auxins on shoots subjected to different treatments. The diagrams show one of these treatments (T1) and the control (C) at the start of the experiment and after a week. Light was provided from all directions during the experiment.



What could be an explanation for the results obtained for T1 after a week?

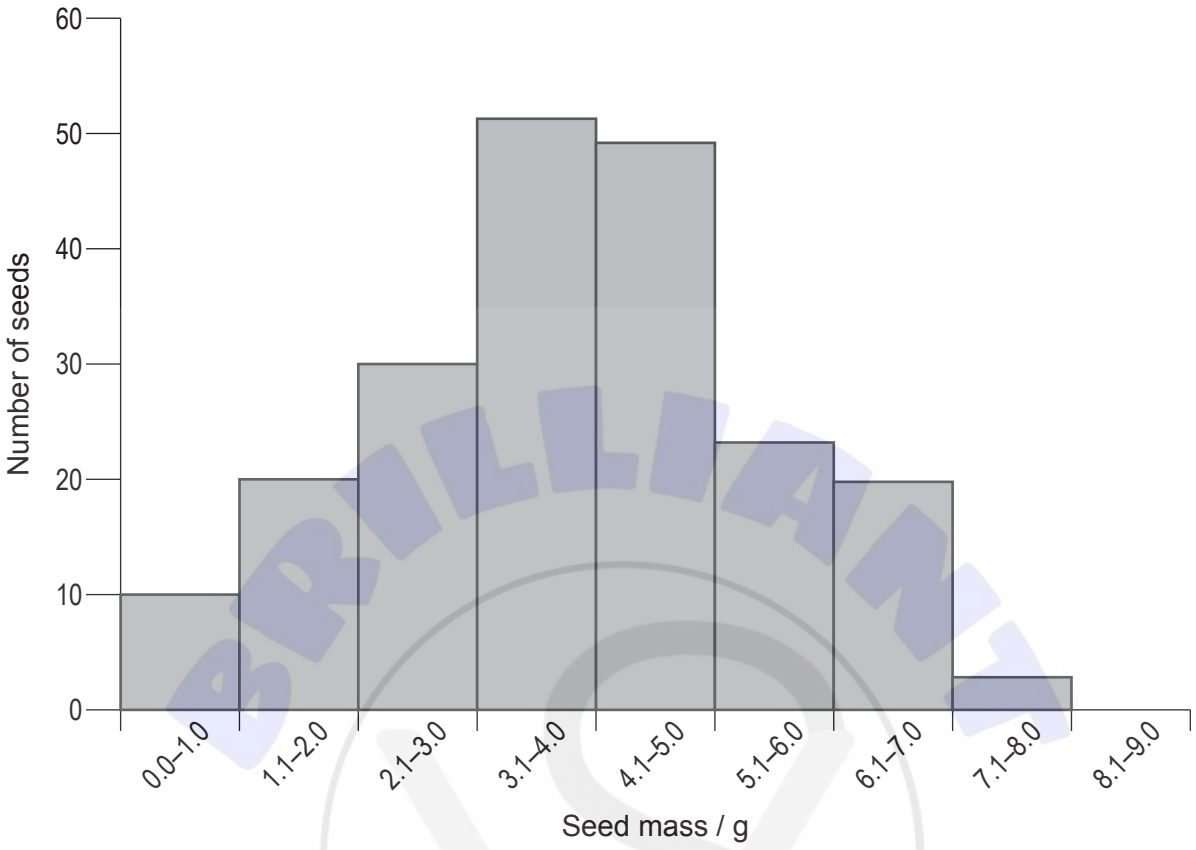
A. Cell division along the shoot was inhibited due to a lack of auxins.

B. Mitosis stopped in the apical meristem due to a low auxin concentration.

C. Cell elongation did not occur as auxins could not diffuse downwards.

D. Cell differentiation slowed down as auxins were not synthesised in apical meristems.

35. A farmer was interested in the yield produced by his crop. The graph shows the number of seeds of different masses in the crop yield.



Which statement could explain the inheritance of this characteristic?

A. Inheritance of seed mass follows Mendel's laws for a monohybrid cross.

B. This is an example of discontinuous variation.

C. Two linked genes are responsible for seed mass in this plant.

D. Polygenic inheritance results in subtle phenotypic differences.

36. Clutch size is the number of eggs produced by a female bird at one time. Clutch size varies within a population of American robins (*Turdus migratorius*). It is a phenotypic trait that correlates with the number of successful hatches and shows stabilizing selection.

What can be deduced about the frequency of different clutch sizes in American robin populations?

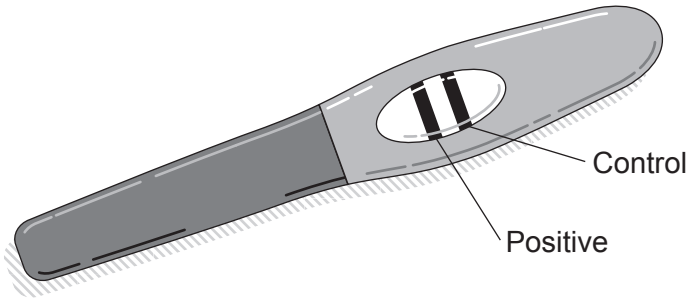
A. Only larger clutches are common.

B. Only smaller clutches are favoured.

C. Medium-sized clutches are less frequent.

D. Smaller and larger clutches are rarely found.

37. The image of a pregnancy test shows a positive result. The band that indicates pregnancy develops when molecules that are present in the strip are immobilized after binding to the female hormone HCG.



What are the molecules that bind to HCG?

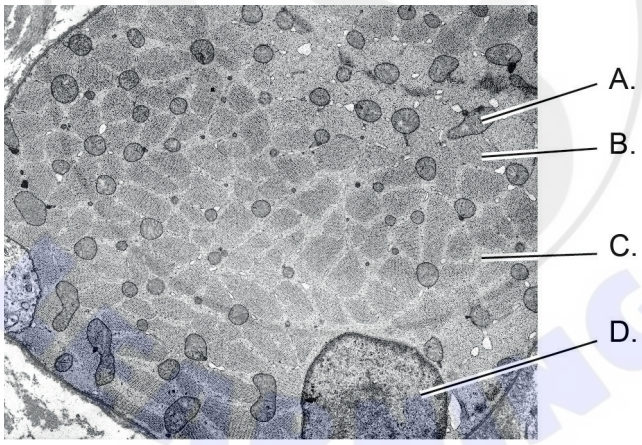
A. HCG antigens obtained from human plasma

B. HCG antibodies synthesised by human lymphocytes

C. HCG antibodies made by modified plasma cells of small mammals

D. HCG antigens extracted from myeloma cells of mice

38. The electron micrograph shows the transverse section of a skeletal muscle fibre. Where is the specialized endoplasmic reticulum (sarcoplasmic reticulum) likely to be found?



39. ADH is involved in osmoregulation. The pituitary gland secretes ADH when the solute concentration in blood is higher than normal.

Which statement explains how ADH helps to reduce the solute concentration of blood?

A. It increases ultrafiltration of solutes in the glomerulus, so blood becomes more diluted.

B. It increases reabsorption of sodium ions in the loop of Henle, so less water is excreted.

C. It causes selective reabsorption of some solutes in the distal convoluted tubule.

D. It changes the collecting duct's permeability to water to produce more concentrated urine.

40. Globozoospermia is an inherited condition that causes infertility in males due to the production of abnormal sperm. The diagram shows a normal sperm cell and a sperm cell produced by a man with globozoospermia.

Normal sperm cell

Sperm cell from male with globozoospermia

Why are sperm from males with this condition unable to fertilize eggs?

A. They lack enzymes to digest the follicle cells.

B. They have less genetic material.

C. They have no energy to swim through the oviducts.

D. They fail to reach the plasma membrane of the egg.

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References:

2. Left: Clayton, Michael W., n.d., University of Wisconsin Libraries. Coenocytic hyphae of Rhizopus. [image online] Available at: https://search.library.wisc.edu/digital/APHT7CUN235E5D8M#dci-item-details [Accessed 31 May 2024]. Source adapted.

Right: Berkshire Community College Bioscience Image Library. [image online] Available at: https://commons.wikimedia.org/wiki/File:Muscle_Tissue_Skeletal_Muscle_Fibers_(40153601630).jpg. Licensed under the CC0 1.0 Universal Public Domain Dedication (https://creativecommons.org/publicdomain/zero/1.0/deed.en) [Accessed 1 September 2022]. Source adapted.

12. National Human Genome Research Institute. [image online] Available at: https://commons.wikimedia.org/wiki/File:NHGRI_human_male_karyotype.png?uselang=en#Licensing. Licensed under the CC Public Domain as a work of the U.S. federal government. [Accessed 1 September 2022]. Source adapted.

14. PaleWhaleGail, 2008. https://commons.wikimedia.org/wiki/File:D1S80Demo.png. Licensed under the CC BY-SA 3.0 Deed: https://creativecommons.org/licenses/by-sa/3.0/deed.en. Source adapted.

16. Stable Climate, n.d. Atmospheric CO_2 vs temperature anomalies. [online] Available at: https://www.stableclimate.org/graphs [Accessed 1 September 2022]. Source adapted.

17. Left: Wills, T., 2009. https://commons.wikimedia.org/wiki/File:Young_hedgehog.jpg. Licensed under the CC BY-SA 3.0 Deed: https://creativecommons.org/licenses/by-sa/3.0/deed.en.

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