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Biology

Higher level

Paper 1

17 May 2023

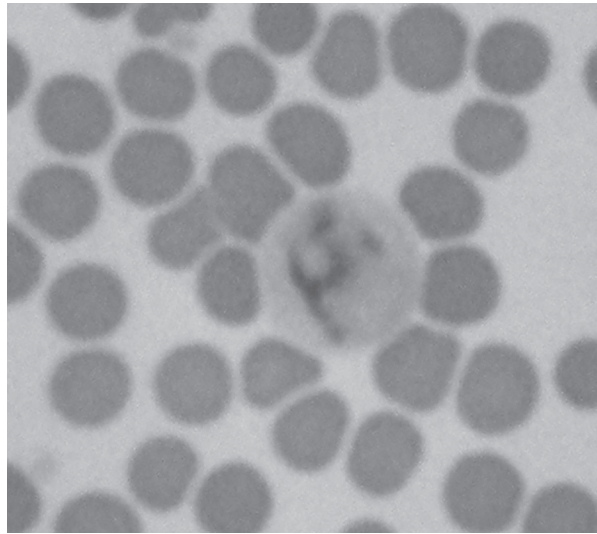
Zone A afternoon | **Zone B** morning | **Zone C** afternoon

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]**.

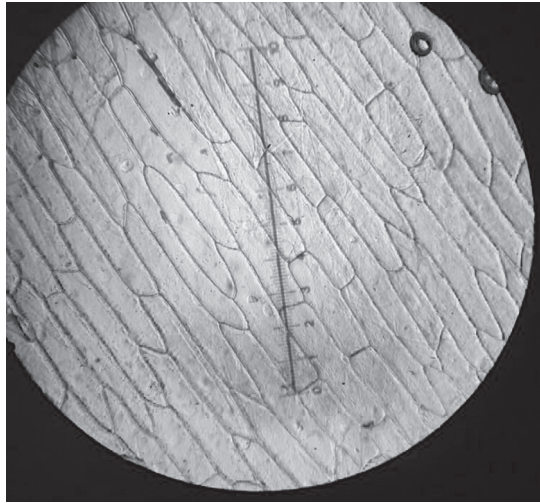
1. The micrograph shows two types of blood cell.



What determines the differences between the two types of cell?

- A. Different number of mitotic cycles
 - B. Different expression of some genes
 - C. Reaction to oxygen of red blood cells
 - D. Reaction to antigens of white blood cells
2. What is a difference between eukaryotic and prokaryotic cells?
- A. Cell walls are found only in prokaryotes.
 - B. Naked DNA with histones is found only in prokaryotes.
 - C. Compartmentalization is found only in eukaryotes.
 - D. Cilia and flagella are found only in prokaryotes.

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



- What would happen to these cells if they were transferred to a hypertonic solution?
- A. Cells would gain mass.
 - B. Cells would take in water by osmosis and swell.
 - C. Cells would burst open, releasing their content.
 - D. Cell membranes would detach from walls at some points.
4. What is evidence for the endosymbiotic theory in eukaryotic cells?
- A. Mitochondrion with DNA
 - B. Golgi complex in cytoplasm
 - C. Single nuclear membrane
 - D. Ribosomes in cytoplasm
5. What is an example of anabolism?
- A. Formation of peptides after protein digestion
 - B. Formation of glucose and fructose from sucrose
 - C. Formation of maltose from two glucose molecules
 - D. Formation of glycerol and fatty acids from triglycerides

6. What is the body mass index (BMI) of a man whose height is 2 m and mass is 80 kg?
- A. 40
 - B. 30
 - C. 20
 - D. 10
7. The table shows the approximate energy stores in a man with an average mass.

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

What can be concluded from the data?

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

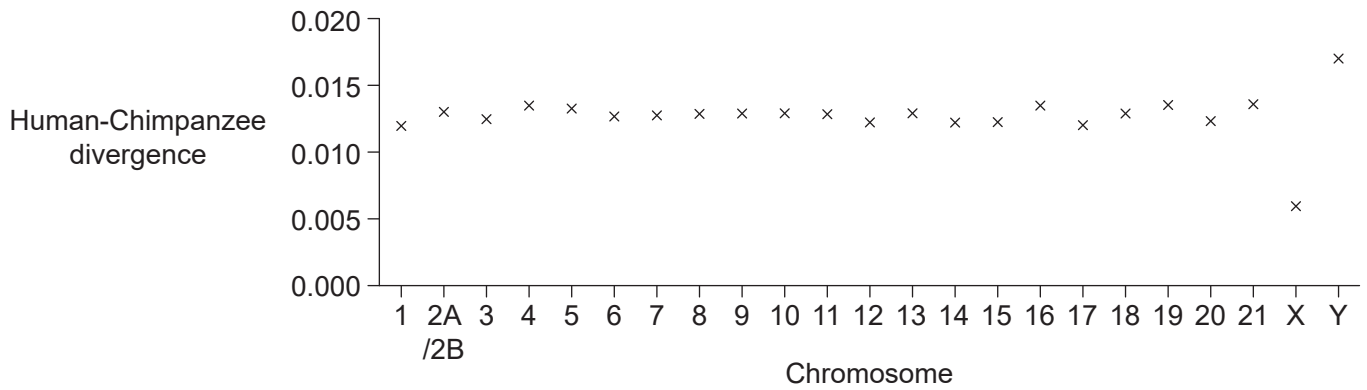
8. The effect of substitution mutations in a salamander gene was studied. Some mutations have no observable effect on the phenotype and are called silent mutations.

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What conclusion about the position of the mutation in the codon can be drawn from this graph?

- A. Most changes in this gene are silent.
 - B. A change in any position of the codon will always cause a change in the protein.
 - C. More phenotype changes occur due to a mutation in the second position.
 - D. There is a 50% chance that a change in the third position will not affect the phenotype.
9. What is a consequence of anaerobic cell respiration in muscles?
- A. Large yield of readily available ATP and ethanol production
 - B. Small yield of readily available ATP and lactate accumulation
 - C. Large yield of ATP and production of carbon dioxide and lactic acid
 - D. Small yield of ATP that is not readily available and carbon dioxide production

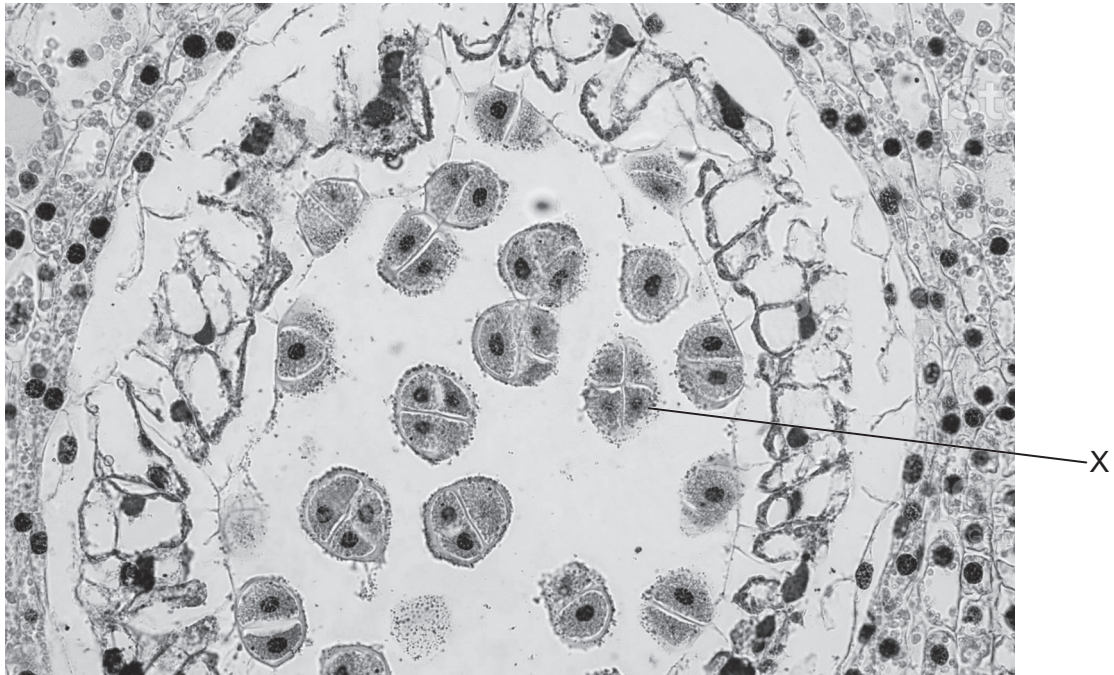
10. Scientists sequenced the genes in each chromosome of chimpanzees (*Pan troglodytes*) and humans (*Homo sapiens*). The graph shows the mean divergence between the genes of these species by chromosome.



What can be deduced from this data?

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

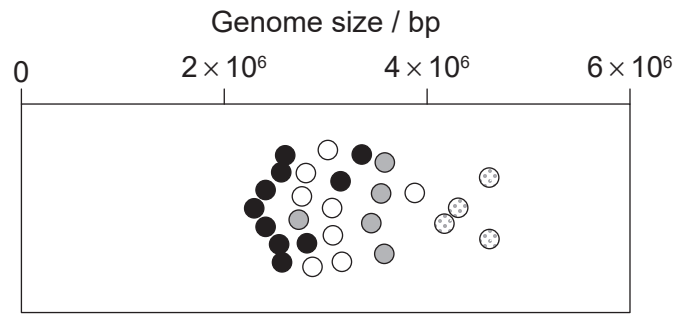
11. The micrograph shows a cross section of a lily (*Lilium longiflorum*) anther.



What can be found in X?

- A. Haploid nuclei produced by meiosis
- B. Diploid nuclei produced by fertilization
- C. Haploid nuclei produced by mitosis
- D. Diploid nuclei produced by pollination

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

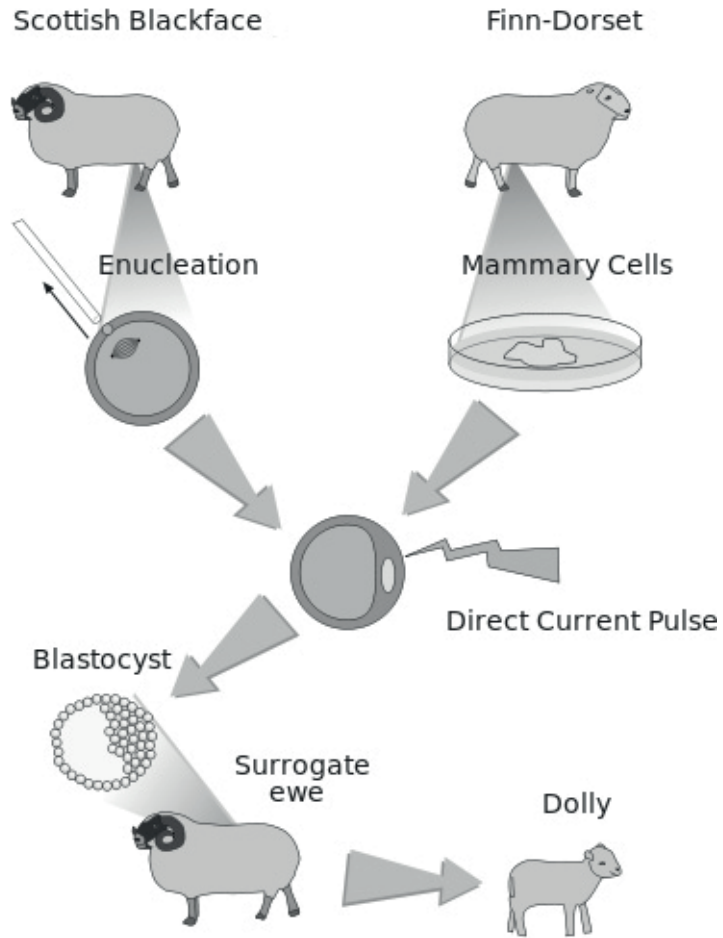


Key: ● *E. columbae*
○ *E. faecium*
● *E. faecalis*
⊕ *E. pallens*

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

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

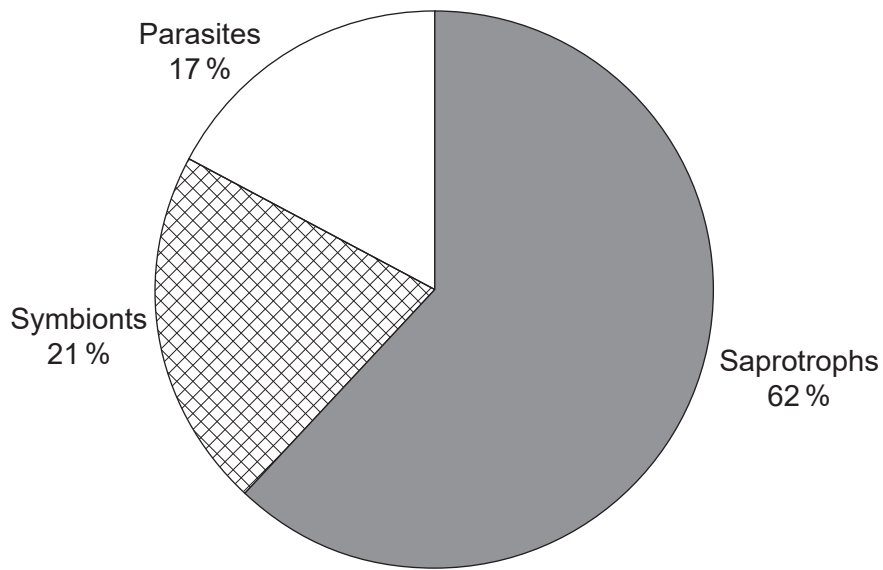
13. Dolly the sheep was the first mammal to be cloned from an adult somatic cell.



Which DNA did Dolly inherit?

- A. Nuclear and mitochondrial DNA from the surrogate ewe
- B. Nuclear and mitochondrial DNA from the Finn-Dorset
- C. Mitochondrial DNA from the Scottish Blackface and nuclear DNA from the Finn-Dorset
- D. Mitochondrial DNA from the Scottish Blackface and nuclear DNA from the surrogate ewe

14. The pie chart shows the modes of nutrition of fungi in Huahu Lake wetland in China.



What is the most common mode of nutrition of fungi in this wetland?

- A. Heterotrophic fungi that feed on living organisms by ingestion
- B. Autotrophic fungi that obtain organic nutrients from detritus by internal digestion
- C. Fungi that have either an autotrophic or heterotrophic method of nutrition
- D. Heterotrophic fungi obtaining nutrients from dead organisms by external digestion

15.

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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.

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.

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

What can be concluded from the data?

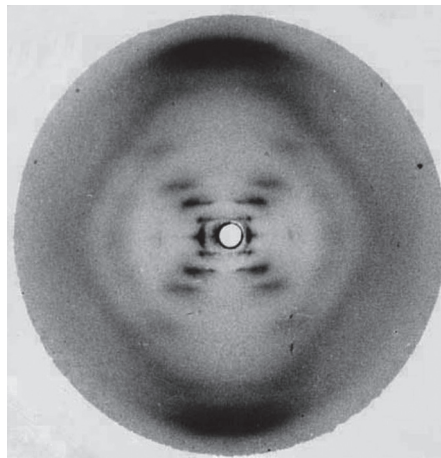
- A. *L. minor* and *E. coli* are both eubacteria.
 - B. *S. cerevisiae* and *M. barkeri* are in the same domain.
 - C. *M. ruminantium* is an archaean, therefore so is *B. firmus*.
 - D. *E. coli* and *B. firmus* are in the same domain.
- 18.

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19. What is secreted by the pancreas for digestion in the small intestine?
- A. Lipase to break bond between phosphate and fatty acid
 - B. Insulin to digest glycogen to glucose
 - C. Amylopectin to digest starch to maltose
 - D. Endopeptidase to digest proteins to peptides
20. Which characteristic of the subclavian vein distinguishes it from the subclavian artery?
- A. Larger lumen
 - B. Absence of valves
 - C. Presence of pores
 - D. Two layers of muscle
21. What happens during blood clotting?
- A. A chain reaction causes platelets to release antibodies to avoid infections.
 - B. Thrombin is converted into fibrinogen after a series of chemical reactions.
 - C. Sealing of wounds by fibrinogen makes platelets release antibodies for clotting.
 - D. Chemical reactions cause wounds to seal after platelets release clotting factors.
22. What are functions of type I and type II alveolar pneumocytes?

	Type I	Type II
A.	Produce surfactant	Exchange CO ₂
B.	Exchange CO ₂	Exchange O ₂
C.	Phagocytic cells	Protective epithelial cells
D.	Carry out gas exchange	Produce surfactant

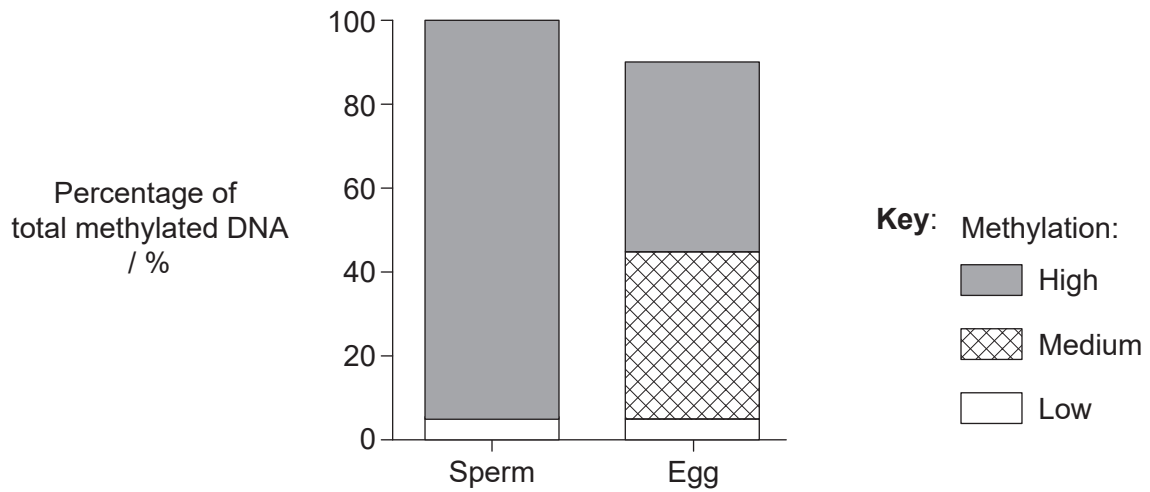
23. What occurs during the establishment of a resting membrane potential of a neuron?
- A. Both sodium and potassium ions are pumped outside the neuron.
 - B. Sodium ions are pumped out while potassium ions are pumped into the neuron.
 - C. Both sodium and potassium ions are at rest inside the membrane of the neuron.
 - D. Sodium ions leave by diffusion and potassium ions enter the neuron by active transport.
24. What causes gonads to develop as testes in humans?
- A. Effect of placental hormones
 - B. Initiation of testosterone secretion in puberty
 - C. Development of secondary sexual characteristics
 - D. Activation and transcription of a gene on the Y chromosome
25. The image of the X-ray diffraction of calf thymus DNA was obtained by R. Franklin and R. Gosling in 1953.



What does this image show about the structure of DNA?

- A. It is associated with histones.
- B. It has a helical shape.
- C. It contains deoxyribose.
- D. It contains four nitrogenous bases.

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.

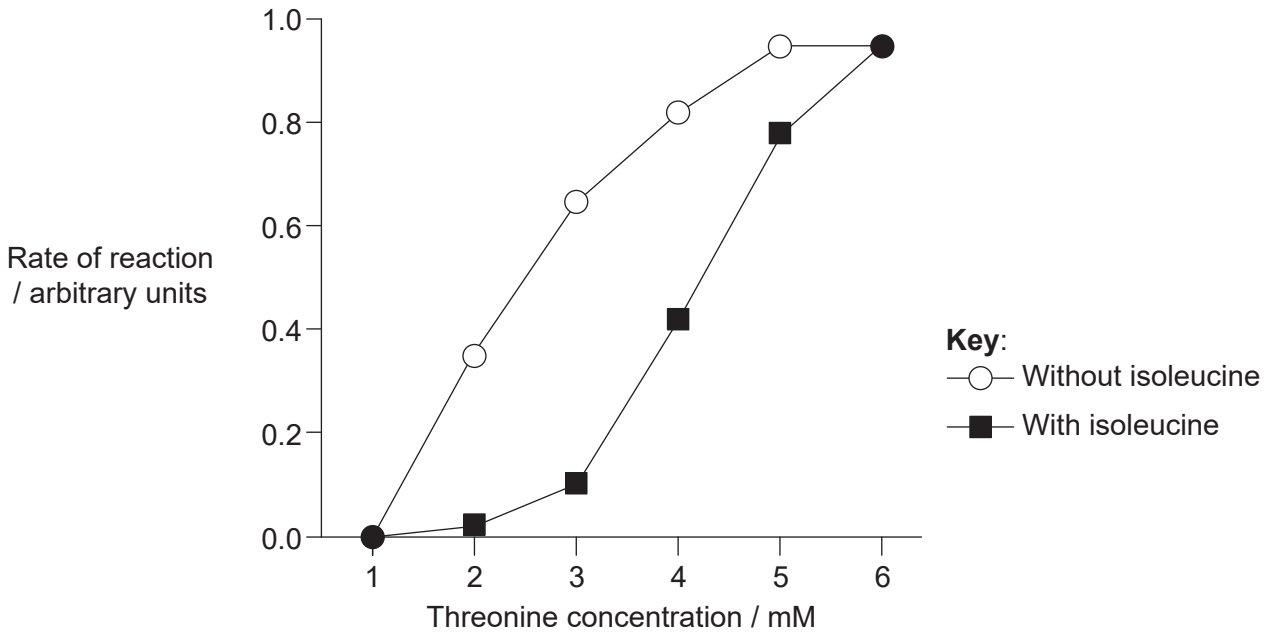
27. The image shows leucyl-tRNA synthetase from *Thermus thermophilus* complexed with a tRNA. This tRNA-activating enzyme joins the amino acid leucine to tRNA using ATP.



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

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

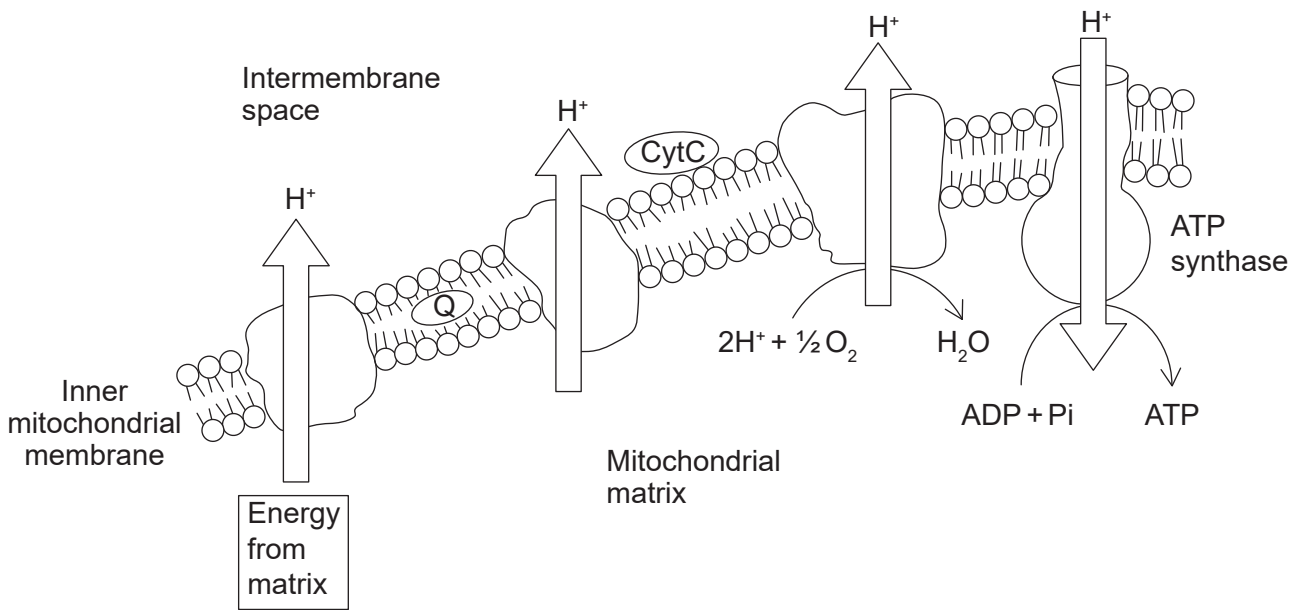
28. Through a series of enzymatic reactions, the amino acid threonine is converted to isoleucine. The graph shows the rate of reaction of threonine deaminase according to the concentration of its substrate threonine, with and without the presence of isoleucine.



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.

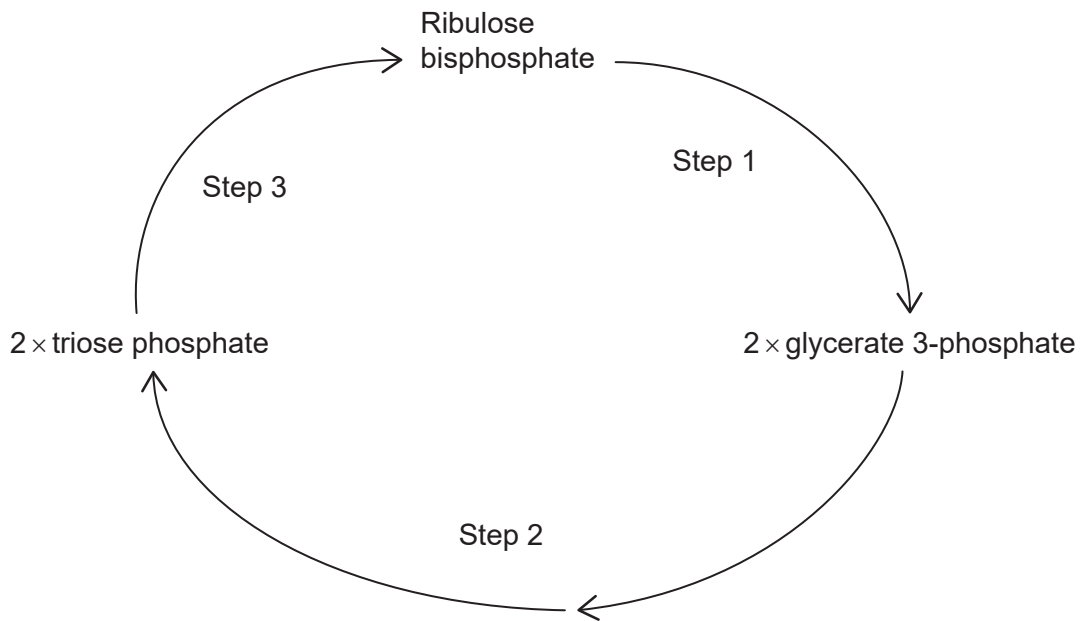
29. The diagram shows some reactions occurring during respiration in the mitochondrion.



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

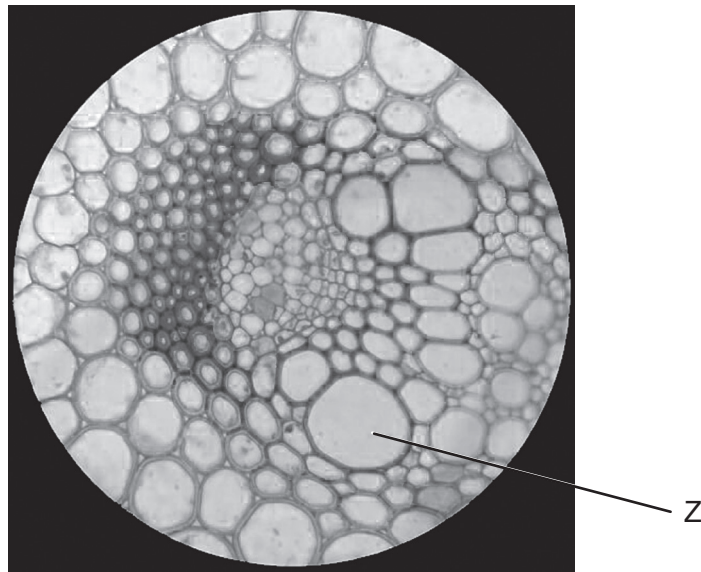
30. The cycle shows part of the light-independent reactions in photosynthesis.



What occurs in Step 1?

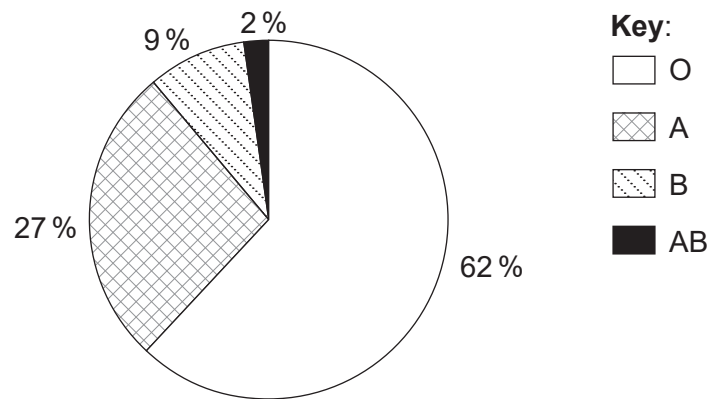
- A. ATP is formed for Step 2.
 - B. Rubisco catalyses the hydrolysis of ribulose biphosphate.
 - C. A carboxylase catalyses the carboxylation of ribulose biphosphate.
 - D. NADP is converted to reduced NADP.
31. Which adaptation would allow plants to live in saline irrigated soil?
- A. Small, shallow 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
32. What is always needed for seed germination?
- A. Light
 - B. Oxygen
 - C. Carbon dioxide
 - D. Fertilizer

33. The micrograph shows tissues in a plant stem.



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

- A. Xylem vessels are formed from dead lignified cells.
 - B. Staining of cells destroys their nucleus.
 - C. Phloem companion cells lack a nucleus.
 - D. The nucleus is too small to be seen in a light microscope slide preparation.
34. A total of 271 164 people were tested for blood groups in Mexico. The pie chart summarizes the ABO blood group distribution.



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

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

35. Pterosaurs were flying reptiles that appeared 220 million years ago and became extinct 65 million years ago.

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What type of selection could account for the increase in wingspan in pterosaurs?

- A. Directional
 - B. Stabilizing
 - C. Artificial
 - D. Disruptive
36. What happens in the first division of meiosis?
- A. Formation of chiasmata where two sister chromatids join
 - B. Exchange of chromatids between homologous chromosomes
 - C. Exchange of DNA between non-sister chromatids of homologous chromosomes
 - D. Formation of chiasmata between non-homologous chromosomes

37. What is used in a pregnancy test kit?
- 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
38. What is contained in skeletal muscle?
- 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
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
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.
-

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