Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 1

17 May 2023

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

45 minutes

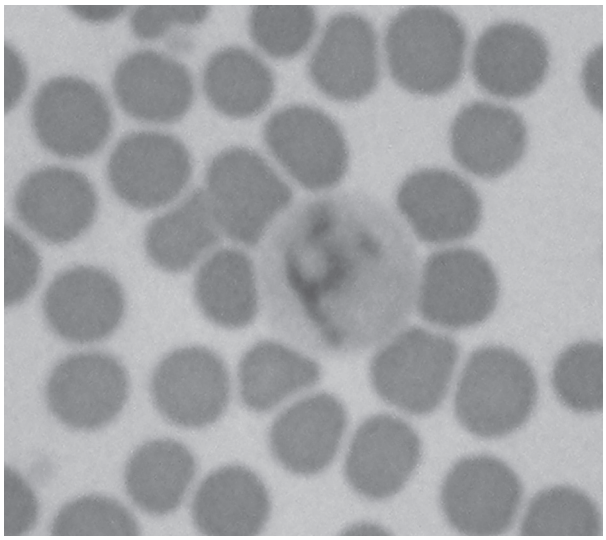
Instructions to candidates

- 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 **[30 marks]**.

2223 – 6010

15 pages

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. Cytochrome reductase is a transmembrane protein which acts as a H^+ channel in respiration. Which characteristic allows cytochrome reductase to be a transmembrane protein?

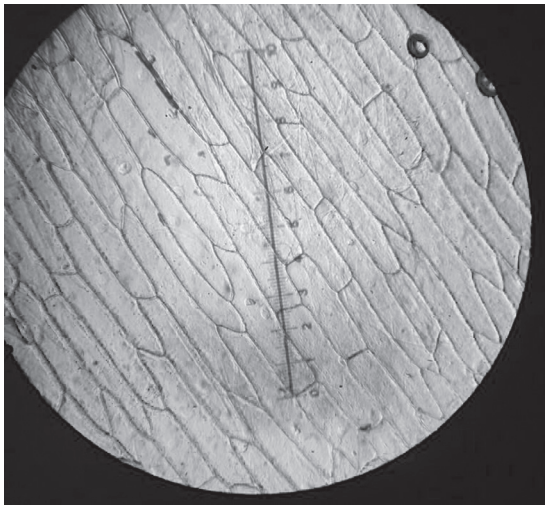
A. It is hydrophilic except for the central core which is a hydrophobic channel.

B. It has hydrophobic regions embedded in the membrane and hydrophilic regions exposed on both sides of the membrane.

C. It has a hydrophobic central core acting as a channel and a hydrophilic region embedded in the membrane.

D. It is hydrophobic except for the part in contact with the phospholipid membrane.

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



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

A. Cells would gain mass.

B. Cells would take in water by osmosis and swell.

C. Cells would burst open, releasing their content.

D. Cell membranes would detach from walls at some points.

5. 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

6. What is an example of catabolism?

A. Maltose produced from glucose molecules

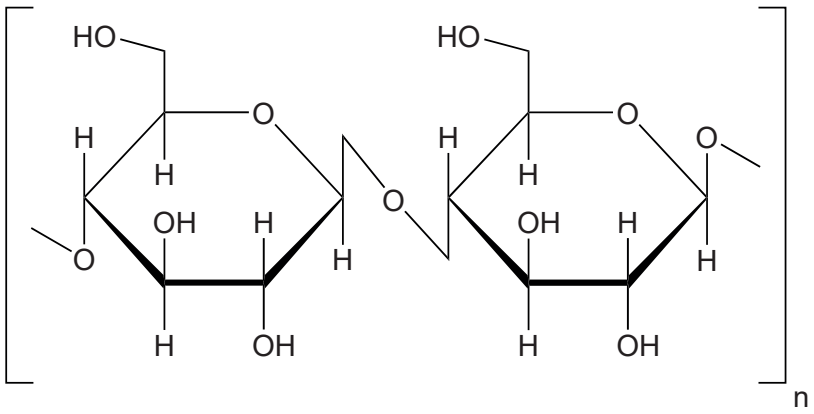
B. Starch produced from monosaccharides

C. Peptides produced by protein digestion

D. Ethanol and fatty acids produced by triglyceride digestion

7. Which molecular diagram shows part of a cellulose molecule?

A.



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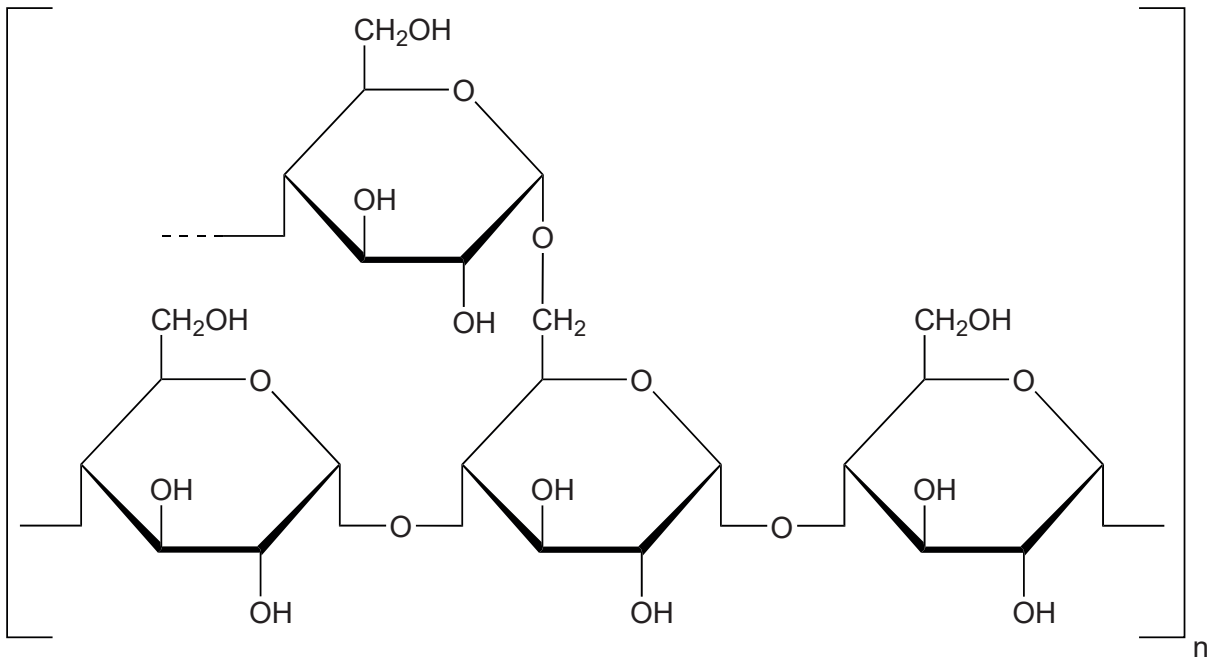

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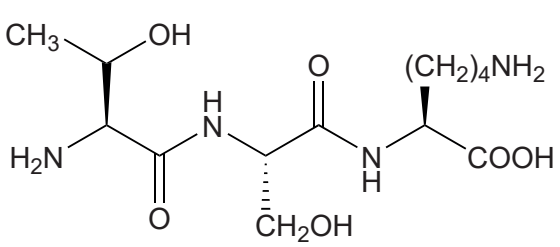

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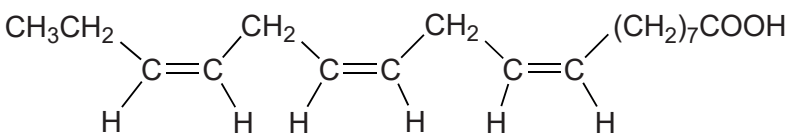


8. The table shows the approximate energy stores in a man with an average mass.

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

What can be concluded from the data?

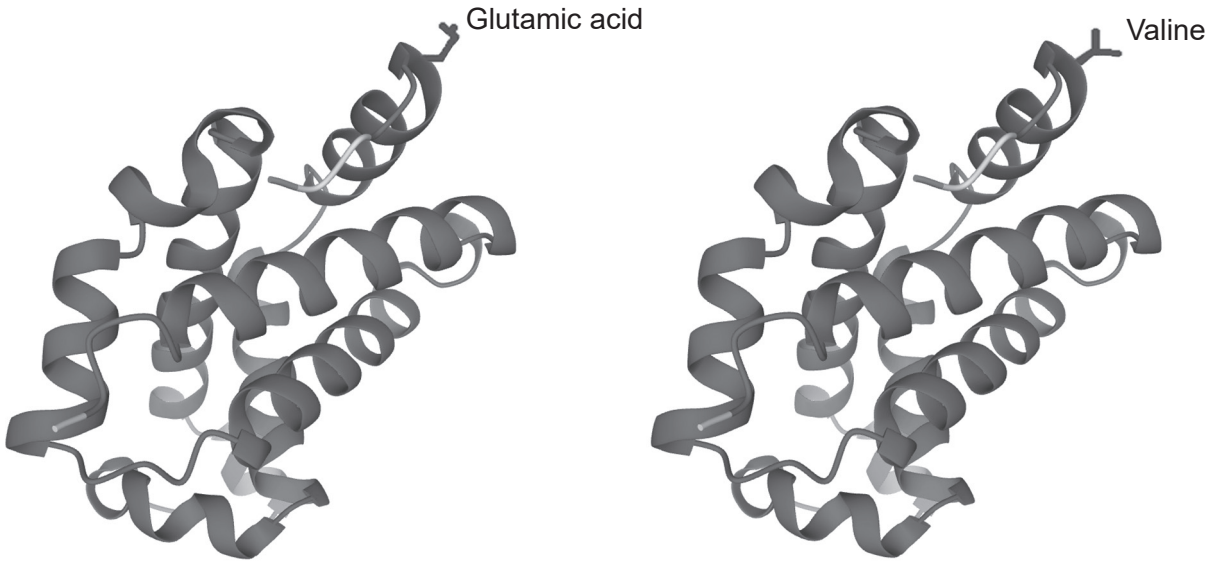
A. The brain contains no short-term stored energy.

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.

9. Hemoglobin is a protein made up of two alpha and two beta polypeptide chains. In sickle cell anemia, a mutation causes one glutamic acid in each beta chain to be replaced by valine, as shown in the image.



Normal beta chain

Sickle beta chain

How does this mutation in hemoglobin cause sickle cell anemia?

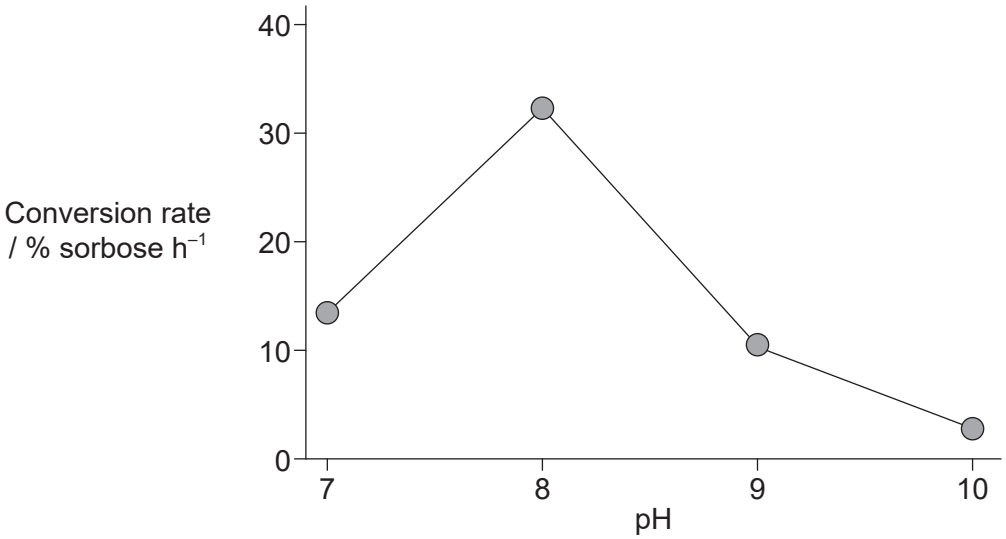
A. It prevents the beta chains from forming a protein.

B. It replaces an amino acid with a fatty acid in the beta chain.

C. It changes the three-dimensional conformation of hemoglobin.

D. The polypeptide produced in sickle hemoglobin is shorter than in normal hemoglobin.

10. Sorbitol is oxidized to sorbose by the enzyme sorbitol dehydrogenase. The conversion rate was measured by monitoring sorbose concentrations. The graph shows the activity of sorbitol dehydrogenase at different pH values.



What can be deduced from these results?

A. There is no conversion of sorbitol to sorbose at a pH of 10.

B. At least 10 % of the product is transformed to substrate at a pH of 9.

C. The pH affects the rate of activity of the enzyme sorbitol dehydrogenase.

D. The amount of sorbose produced is not affected by the substrate concentration.

11. How do DNA and messenger RNA (mRNA) molecules differ in eukaryotes?

A. mRNA is twice the size of DNA and is formed from four different bases.

B. DNA contains ribose while mRNA contains deoxyribose.

C. mRNA has the same bases as DNA but contains ribose.

D. DNA has two strands while mRNA has only one.

12. 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.

13. What is a consequence of anaerobic cell respiration in muscles?

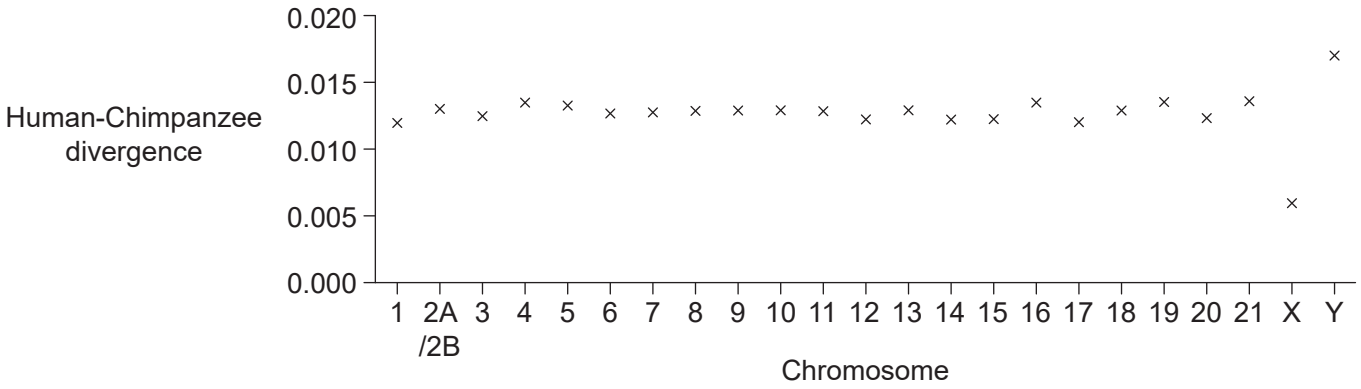
A. Large yield of readily available ATP and ethanol production

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

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



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.

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

A. It increases greatly with maternal age after 30 years.

B. Chromosome 21 always suffers non-disjunction.

C. Very young mothers have no chance of non-disjunction.

D. There is no relation between age and the probability of non-disjunction.

16. For what reason do gametes contain only one allele of each gene?

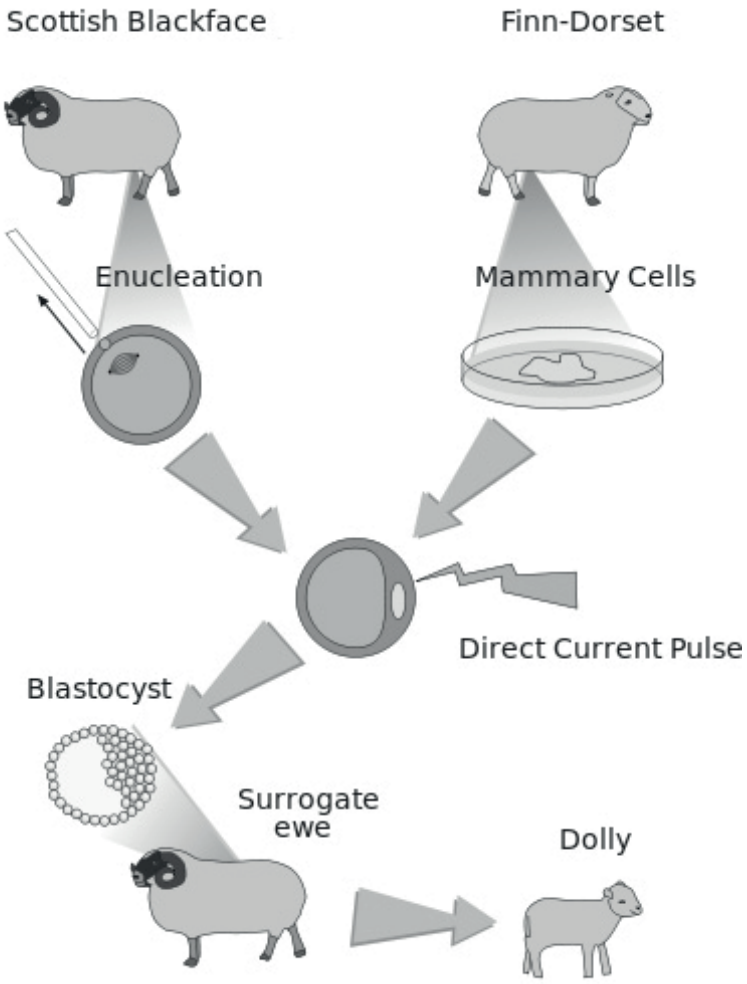
A. To prevent inbreeding in a population

B. Haploid cells contain only one set of chromosomes

C. The two alleles of a gene are separated during mitosis

D. Crossing over will always produce one allele of a gene

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



Which DNA did Dolly inherit?

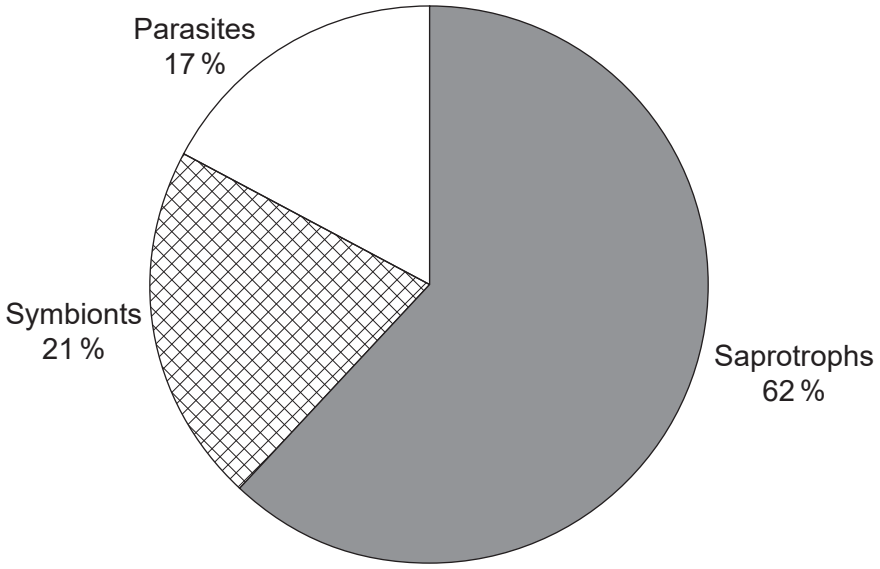
A. Nuclear and mitochondrial DNA from the surrogate ewe

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

18. 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

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

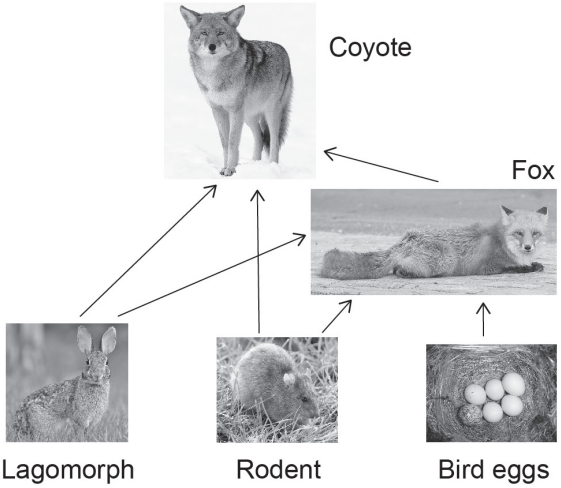
A. Absorbing long wave radiation, therefore retaining atmospheric heat

B. Converting long wave radiation to short wave radiation

C. Producing a hole in the ozone layer, therefore allowing more heat into atmosphere

D. Reflecting short wave radiation, therefore increasing the atmospheric temperature

20. Humans have persecuted predators such as coyotes (*Canis latrans*), causing severe reduction in the number of large carnivores throughout the world. The diagram represents part of a food web in Texas, USA.



What is a possible outcome for the lagomorph population in this ecosystem if coyote numbers were controlled by killing them to reduce losses of domestic livestock?

A. Decrease because there are fewer predators

B. Increase because there are fewer foxes to eat them

C. Decrease because there are more rodents for foxes to eat

D. Increase because, although there are more foxes, there are also more rodents

21. 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.

22. The photograph shows a scorpion (*Pandinus imperator*).

What recognition features indicate that it is an arthropod?

A. Exoskeleton and articulated legs

B. Segmented body and endoskeleton

C. Soft body covered by calcium exoskeleton

D. Body divided into three parts and radial symmetry

23.

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24. What occurs in the human small intestine during digestion?

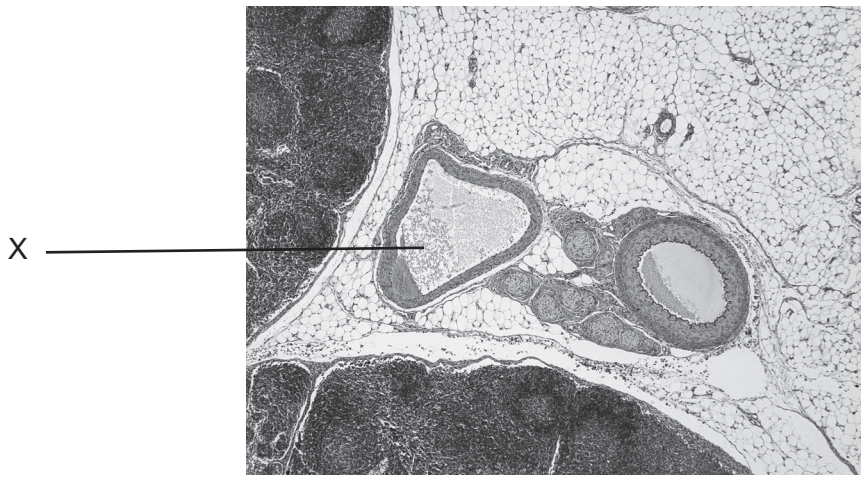
A. Cellulose is digested to maltose.

B. Starch is digested to amylose and amylopectin.

C. Lipids are digested by amylase.

D. Proteins are digested by endopeptidases.

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



Which blood vessel is shown by X?

A. A vein

B. An artery

C. An arteriole

D. A capillary

26. What happens during blood clotting?

A. A chain reaction causes platelets to release antibodies to avoid infections.

B. Thrombin is converted into fibrinogen after a series of chemical reactions.

C. Sealing of wounds by fibrinogen makes platelets release antibodies for clotting.

D. Chemical reactions cause wounds to seal after platelets release clotting factors.

27. What is the effect of antibiotics on viruses?

A. Antibiotics have no direct effect on viruses.

B. Antibiotics affect the metabolism of viruses.

C. Viruses will evolve to present resistance to the antibiotic.

D. Antibiotics directly prevent viruses from reproducing.

28. 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

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

A. Both sodium and potassium ions are pumped outside the neuron.

B. Sodium ions are pumped out while potassium ions are pumped into the neuron.

C. Both sodium and potassium ions are at rest inside the membrane of the neuron.

D. Sodium ions leave by diffusion and potassium ions enter the neuron by active transport.

30. Which hormone helps control levels of glucose in blood?

A. Insulin secreted by the liver cells

B. Thyroxin secreted by the thyroid gland

C. Glucagon secreted by the α cells of the pancreas

D. Melatonin secreted by the β cells of the pancreas

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References:

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9. AlphaFold Protein Structure Database, n.d. [image online] Available at: https://alphafold.ebi.ac.uk/entry/P68871 [Accessed 14 March 2022]. Public domain.

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17. Squidonius, Public domain, via Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Dolly_clone.svg.

18. Fei Xie, Anzhou Ma, Hanchang Zhou, Yu Liang, Jun Yin, Ke Ma, Xuliang Zhuang and Guoqiang Zhuang, 2020. Revealing Fungal Communities in Alpine Wetlands through Species Diversity, Functional Diversity and Ecological Network Diversity. *Microorganisms*, 8, p. 632. Open Access.

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Fox: https://commons.wikimedia.org/wiki/File:Foxes_of_Island_Beach_State_Park_New_Jersey_(16324545492).jpg. CC-Attribution 2.0; Anthony Quintano, Jan. 2015, Foxes of Island Beach State Park New Jersey.

Rodent/Brown Rat: https://commons.wikimedia.org/wiki/File:Rattus_norvegicus_-_Brown_rat_02.jpg. CC-BY-SA-4.0 Zeynel Cebeci, May 2020; Brown Rat, Adana, Turkey.

Lagomorph: https://commons.wikimedia.org/wiki/File:Eastern_Cottontail.JPG. CC 3.0. Taken by Gareth Rasberry, Huntington Beach State Park, Murrells Inlet, South Carolina, USA.

Nest Eggs: https://commons.wikimedia.org/wiki/File:Eastern_Phoebe-nest-Brown-headed-Cowbird-egg.jpg. CC 3.0. Galawebdesign, June 2007, Eastern Phoebe (Sayornis phoebe) nest with one Brown-headed Cowbird (*Molothrus ater*) egg.

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