Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 1

Wednesday 19 May 2021 (morning)

1 hour

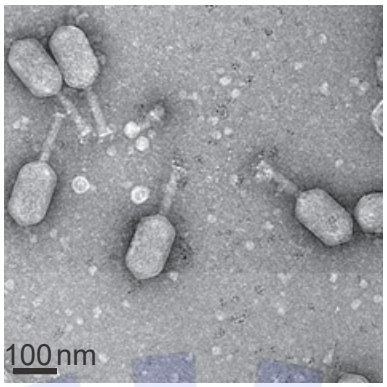
Instructions to candidates

- 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]**.

2221 – 6013

20 pages

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.



What does a virus have in common with a living cell?

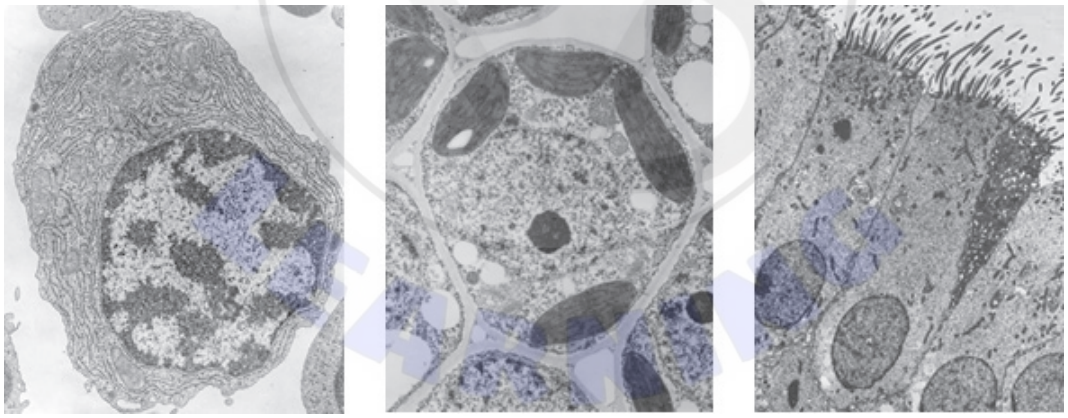
A. 70S ribosomes

B. Genetic material

C. Reproduction by binary fission

D. Anaerobic respiration

2. Three cell types are shown in the micrographs.



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

A. Mitochondria

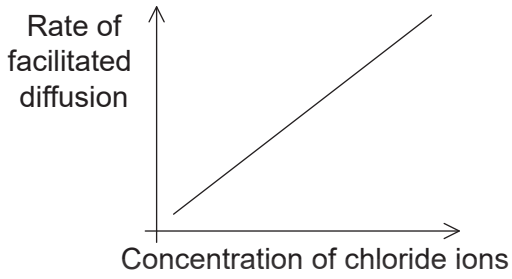
B. Nucleoid regions

C. Multinucleate structure

D. Membrane-bound organelles

3. Which graph best represents the relationship between the concentration of chloride ions in the external environment of a cell and the rate at which the chloride ions move by facilitated diffusion into the cytoplasm of the cell?

A.



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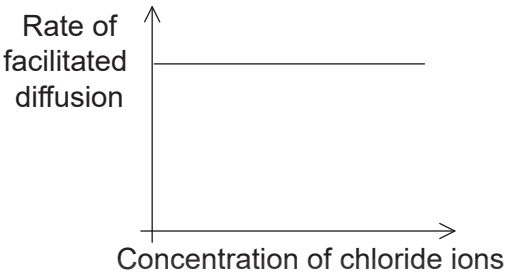

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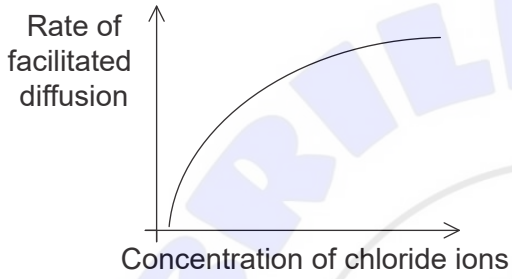
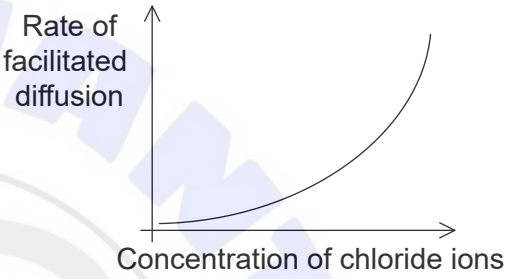


D.



4. When does DNA replication occur?

A. S phase of interphase

B. Early prophase

C. G phase of interphase

D. Late prophase

5. Which process is an example of catabolism?

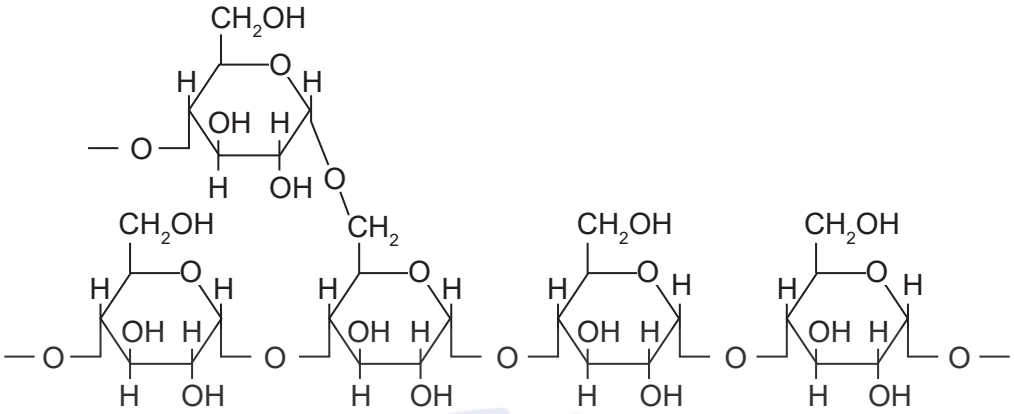
A. Translation of mRNA

B. Replication of DNA

C. Hydrolysis of protein

D. Synthesis of a disaccharide

6. The diagram shows part of a molecule.



What is the molecule?

A. Amylose

B. Cellulose

C. Collagen

D. Amylopectin

7. Which organic molecules may contain the element sulphur?

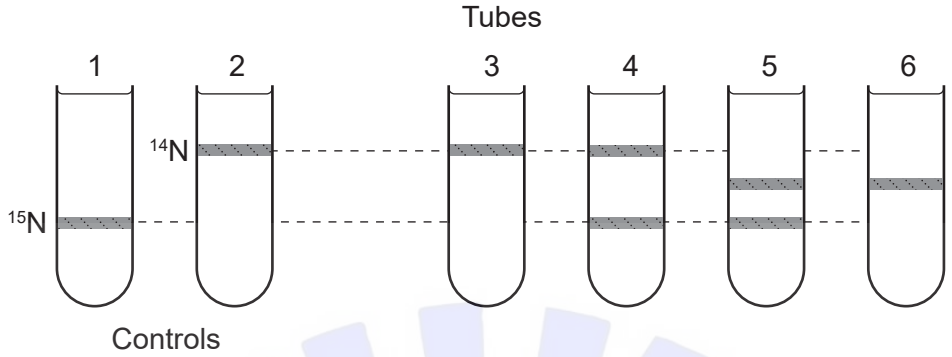
A. Proteins

B. Carbohydrates

C. Phospholipids

D. Nucleic acids

8. Bacteria cultured in a medium containing only ^{15}N were transferred to a medium containing only ^{14}N and allowed to complete one round of replication. The DNA in bacteria produced as a result of replication on the ^{14}N medium was extracted and subjected to caesium chloride centrifugation which separates DNA molecules according to their density.



Which centrifuge tube shows the arrangement of bands observed after one round of replication?

A. Tube 3

B. Tube 4

C. Tube 5

D. Tube 6

9. What does the R_f value in thin layer chromatography represent?

A. The distance travelled by the pigment front in a fixed time period

B. The distance from the origin to the solvent front at the end of the experiment

C. The ratio of distances travelled by the pigment and solvent fronts

D. The concentration of the pigment applied to the chromatography plate

10. What is a feature of the human genome?

A. Plasmids

B. Messenger RNA

C. Transfer RNA

D. Mitochondrial DNA

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

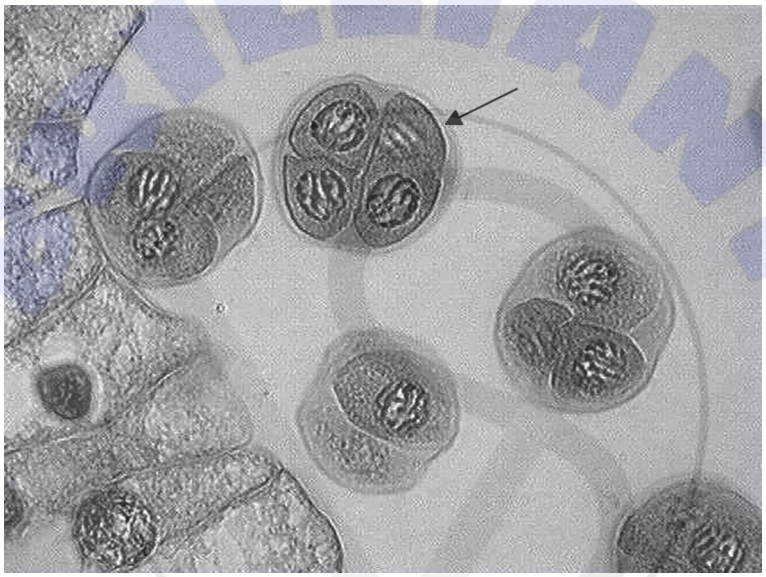
A. Histone proteins

B. Circular DNA

C. Double-stranded DNA molecules

D. Multiple genes along the length of each chromosome

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



What is the diploid number of the plant?

A. 12

B. 24

C. 48

D. 96

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

A. 0.75

B. 0.50

C. 0.25

D. 0.00

14. Which organism would be classified as a saprotroph?

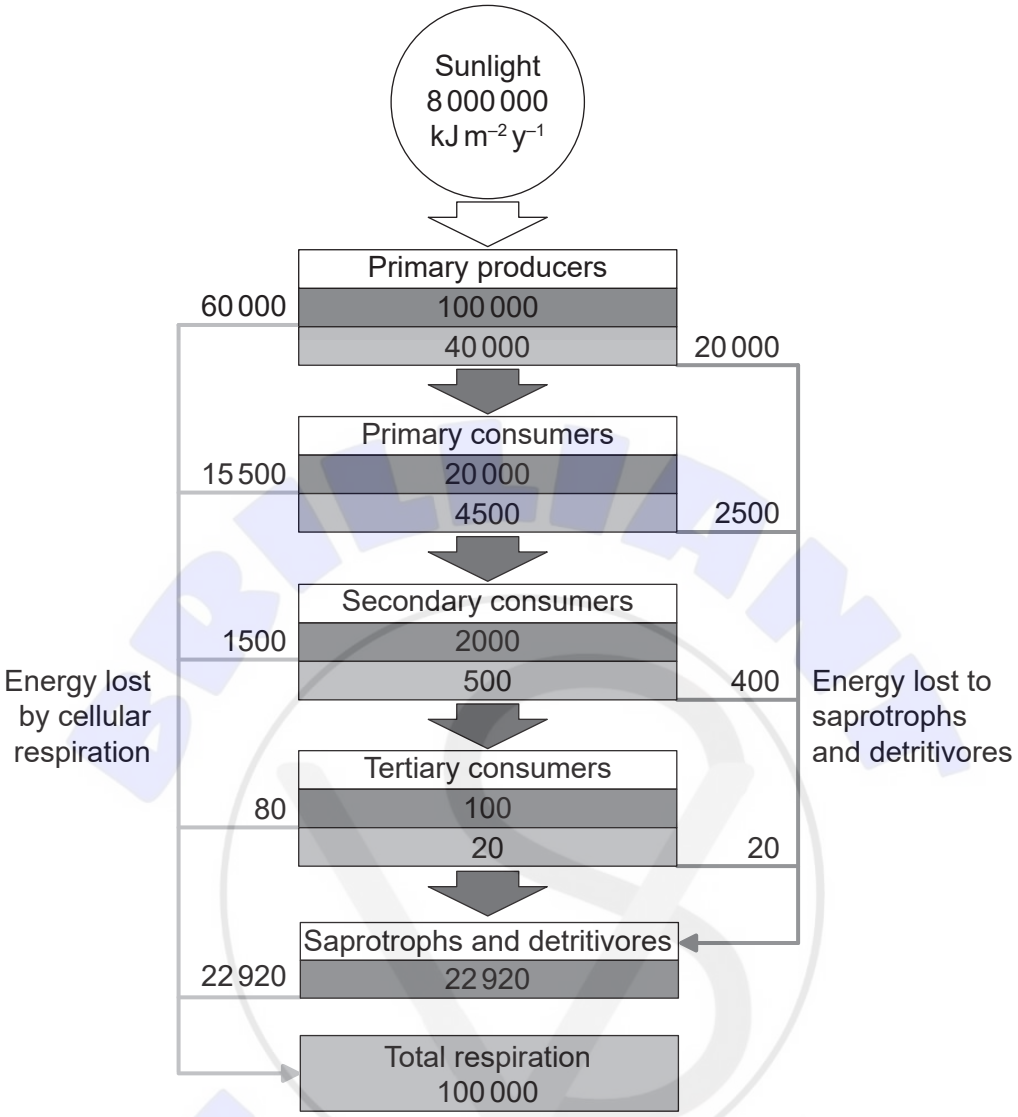
A. A single-celled eukaryote that obtains its carbon compounds by photosynthesis and ingestion of other single-celled organisms

B. A jellyfish that uses the stinging cells in its tentacles to paralyse its prey, which is passed to an internal gastric cavity through a single opening

C. A fungus that feeds by secretion of digestive enzymes onto its food and absorption of digested material

D. A dung beetle that feeds on the fecal material left behind by other animals

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



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

A. 0.001 %

B. 0.08 %

C. 0.2 %

D. 0.4 %

16. Which gases have made the most significant contributions to global warming?

A. Water and carbon dioxide

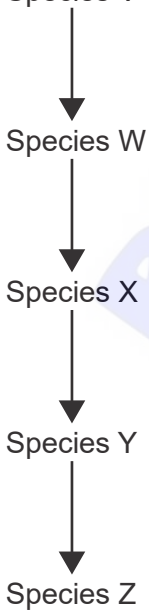
B. Carbon dioxide and methane

C. Methane and nitrous oxide

D. Carbon dioxide and ozone

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

A.



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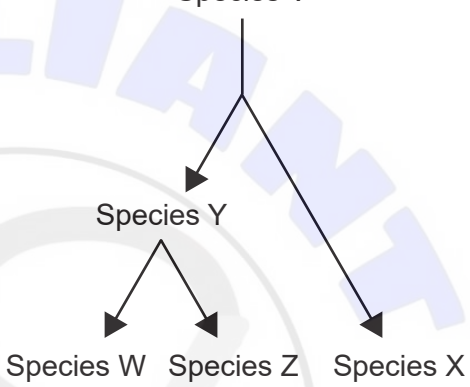

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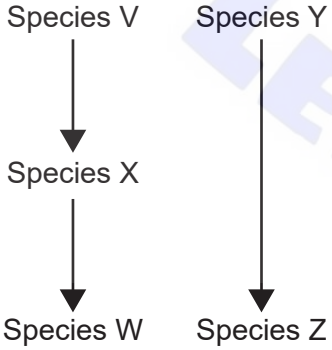


D.

18. The images show a structure found on members of a phylum of green plants.

Whole structure

Structure sectioned longitudinally

What is the name of the phylum to which the organisms belong?

A. Coniferophyta

B. Angiospermophyta

C. Filicinophyta

D. Bryophyta

19. What information can be deduced from the sequence of nodes in a cladogram?

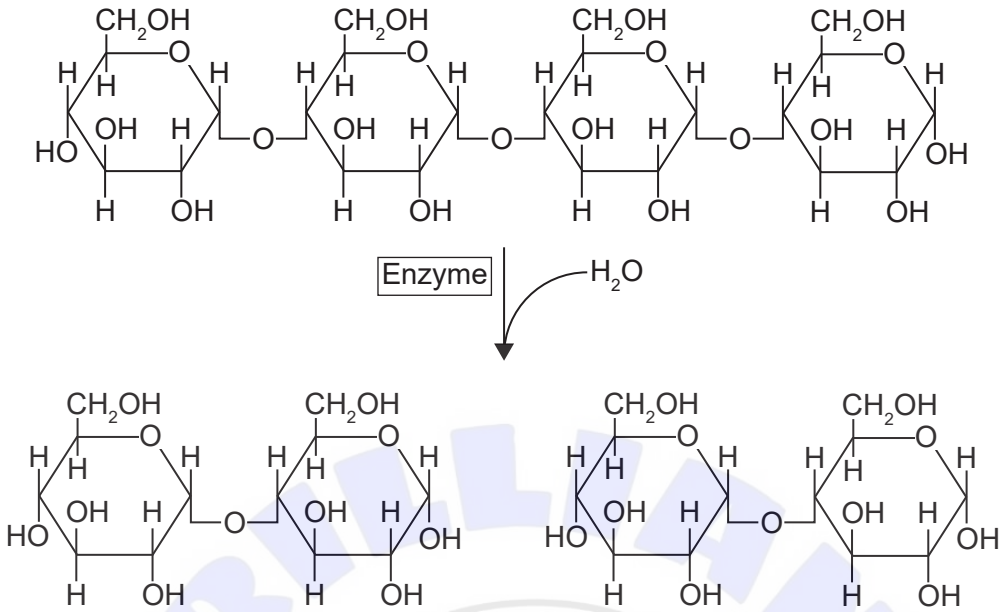
A. The geological period in which the species in the clade diverged from their common ancestor

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

20. What is the name of the enzyme in the diagram?



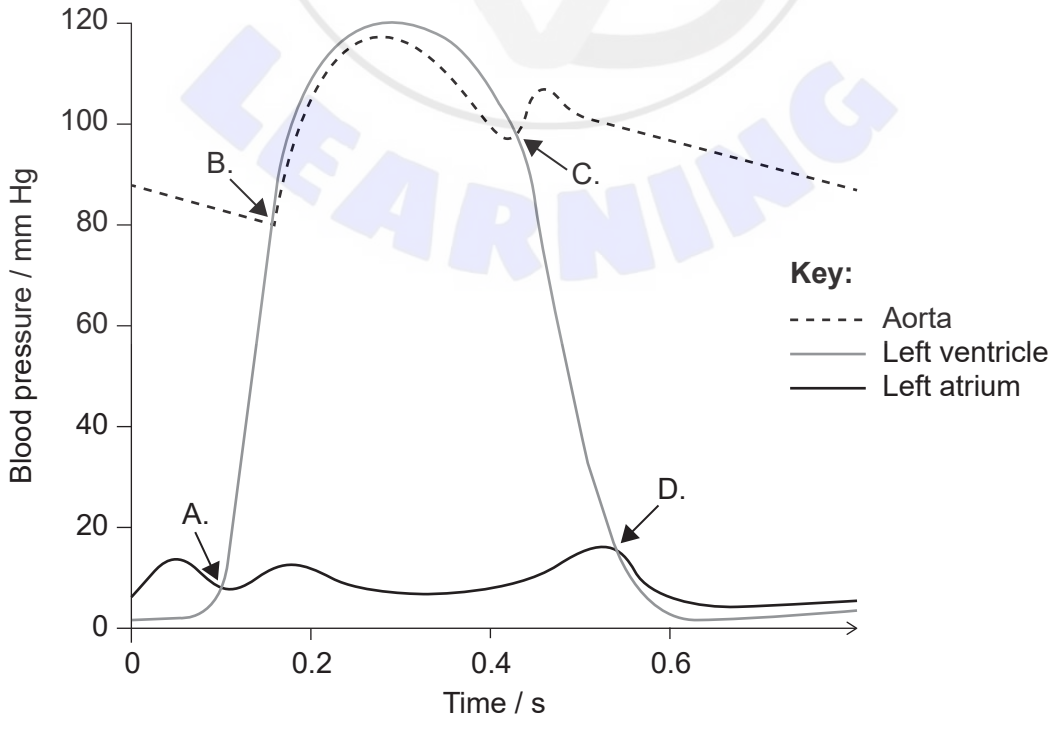
A. Amylase

B. Maltase

C. Glucosidase

D. Sucrase

21. 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?



22. What is the role of antibiotics produced by fungi?

A. Destruction of viral particles

B. Inhibition of the growth of prokaryotes

C. Digestion of food molecules

D. Stimulation of antibody production

23. Where in the body are type I pneumocytes found?

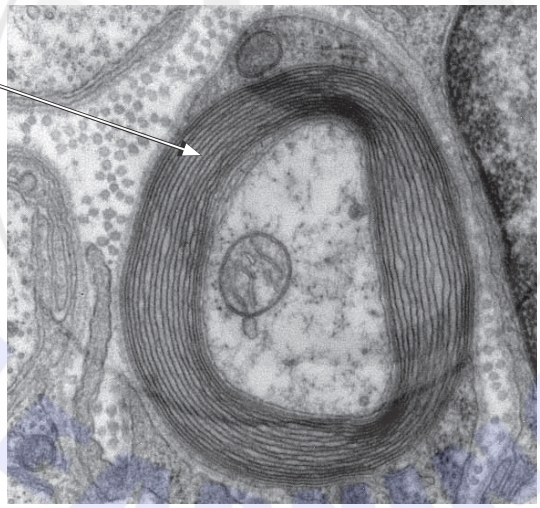
A. Alveoli

B. Nephrons

C. Capillaries

D. Trachea

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



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

A. Repolarization of the nerve cell membrane

B. Generation of an action potential

C. Saltatory conduction

D. Synaptic transmission

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

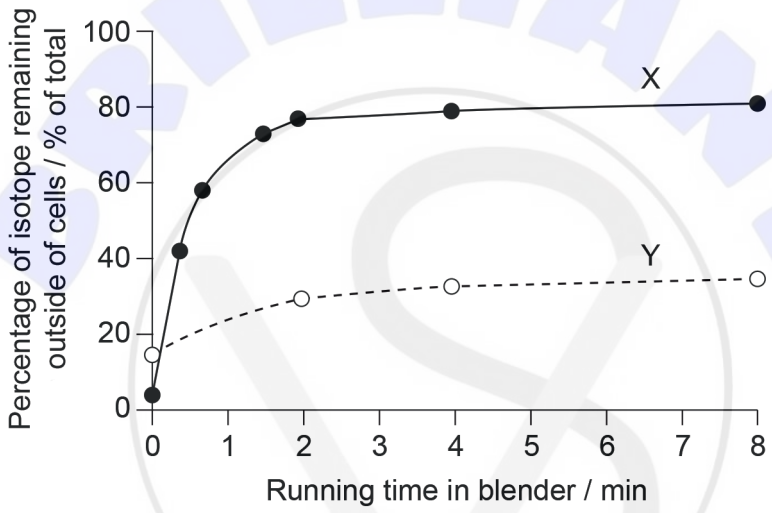
A. They produce gametes throughout the life of the individual.

B. They secrete hormones into the blood stream.

C. Their development is controlled by a gene on the Y chromosome.

D. They release products to the outside of the body directly through the urethra.

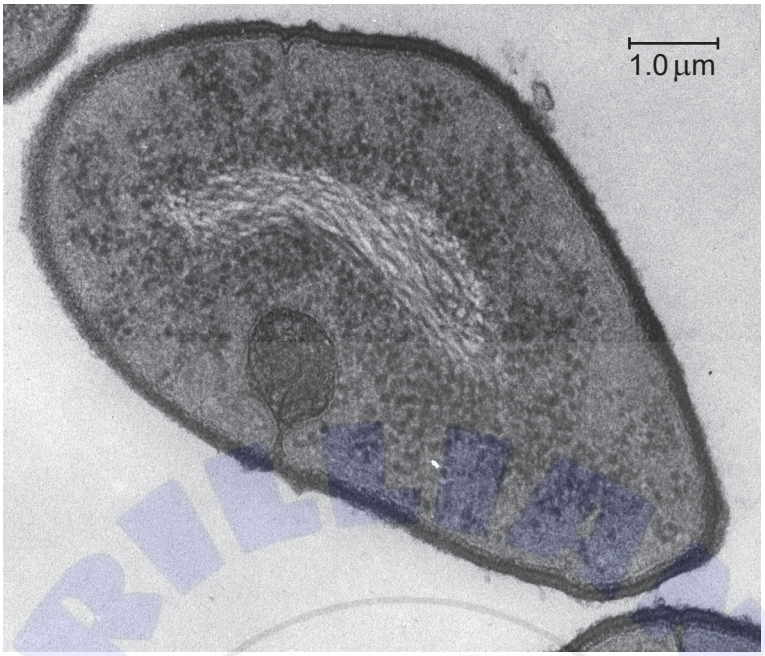
26. The graph shows results of an experiment by Hershey and Chase in 1952 in which bacteria were infected with a mixture of virus particles labelled with either ^{32}P or ^{35}S. A suspension of the infected bacteria was agitated with a blender, and samples collected from the suspension were centrifuged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



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

27. What is a feature of transcription in the single-celled organism shown in the electron micrograph?



A. mRNA splicing

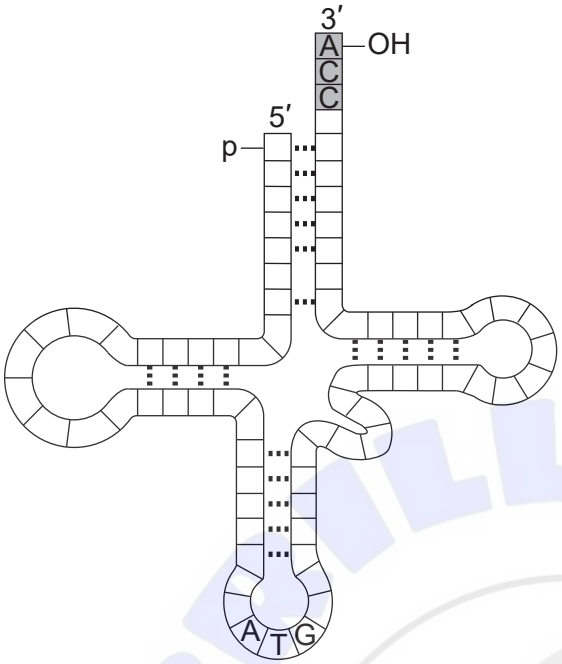
B. Removal of introns

C. Codon-anticodon binding

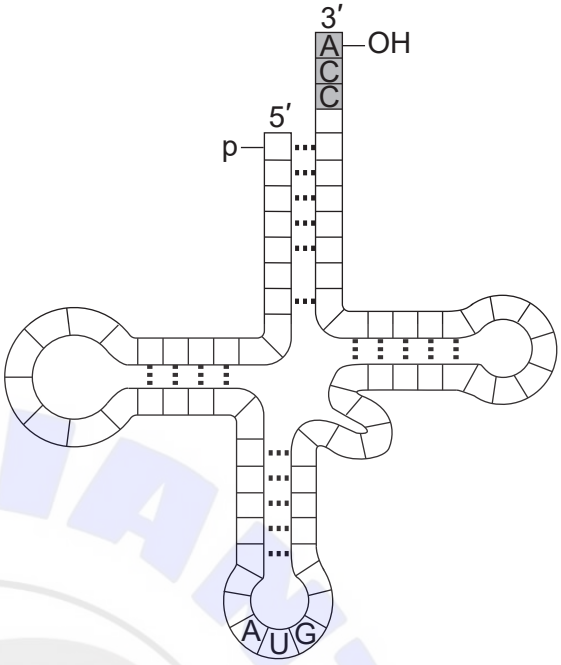
D. Synthesis of RNA in a 5′ to 3′ direction

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

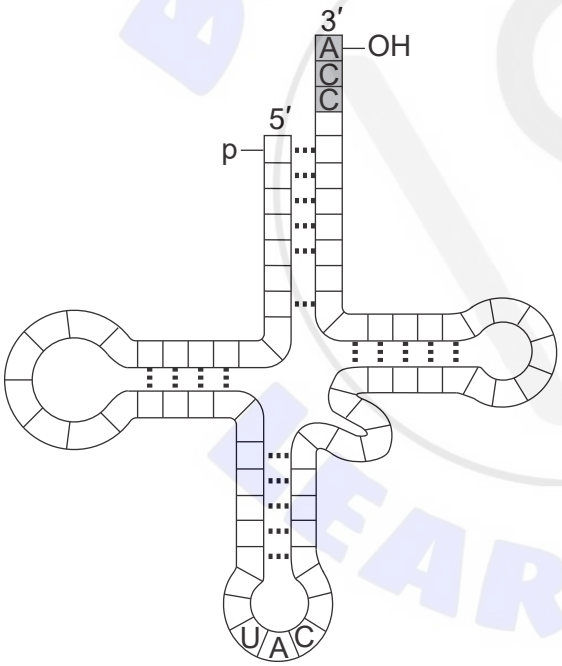
A.



B.



C.



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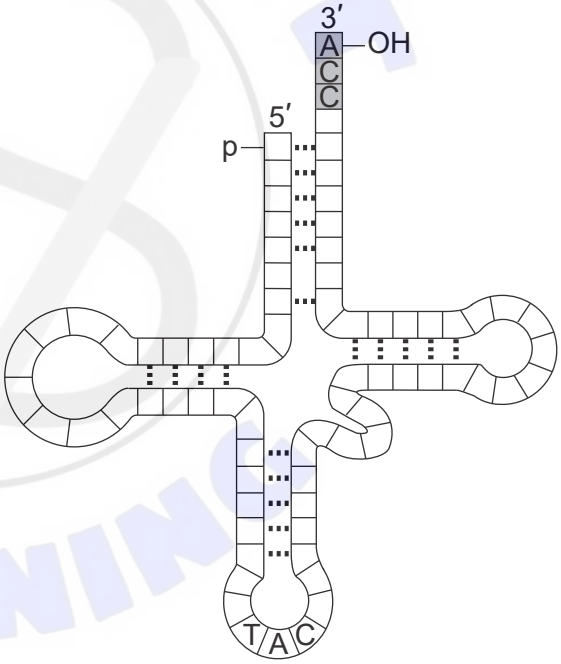
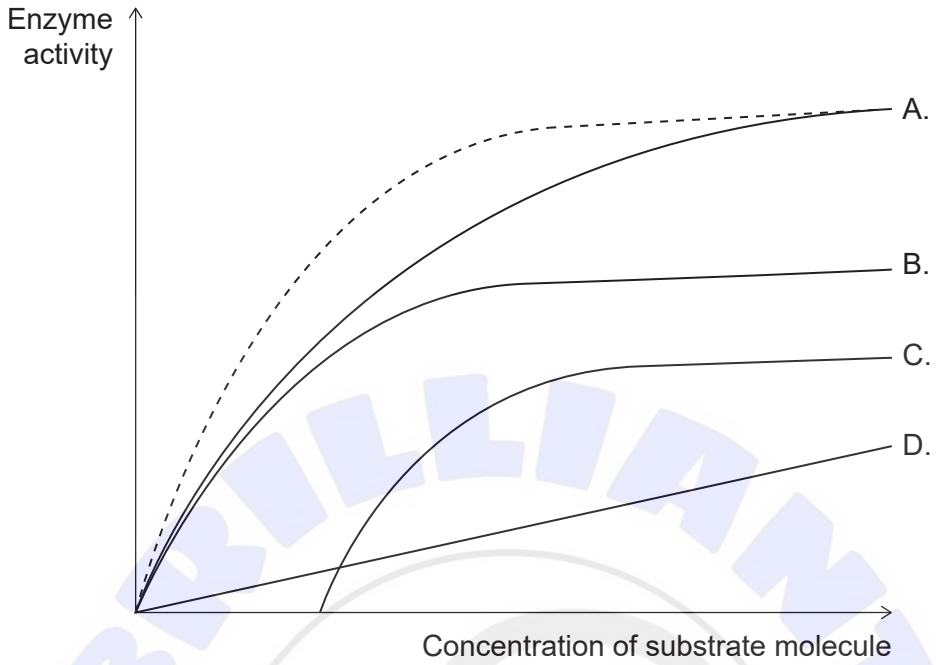


29. The dashed line shows the relationship between the activity of an enzyme and the concentration of its substrate. Which curve shows the effect of a non-competitive inhibitor on this relationship?



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

31. The Hill reaction occurs when isolated chloroplasts are exposed to sunlight in the presence of DCPIP. DCPIP replaces NADP as the final electron acceptor for the light-dependent reactions of photosynthesis. What are products of the Hill reaction?

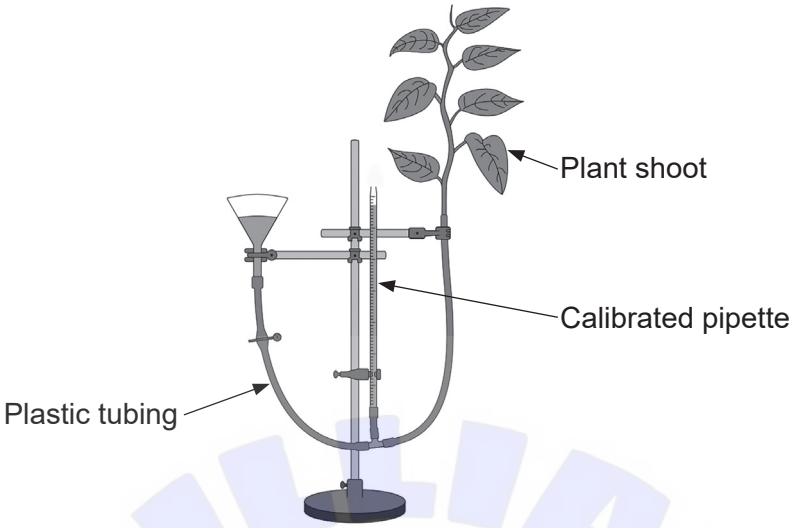
A. H_2O and ATP

B. ATP and CO_2

C. O_2 and ATP

D. $C_6H_{12}O_6$ and O_2

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



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

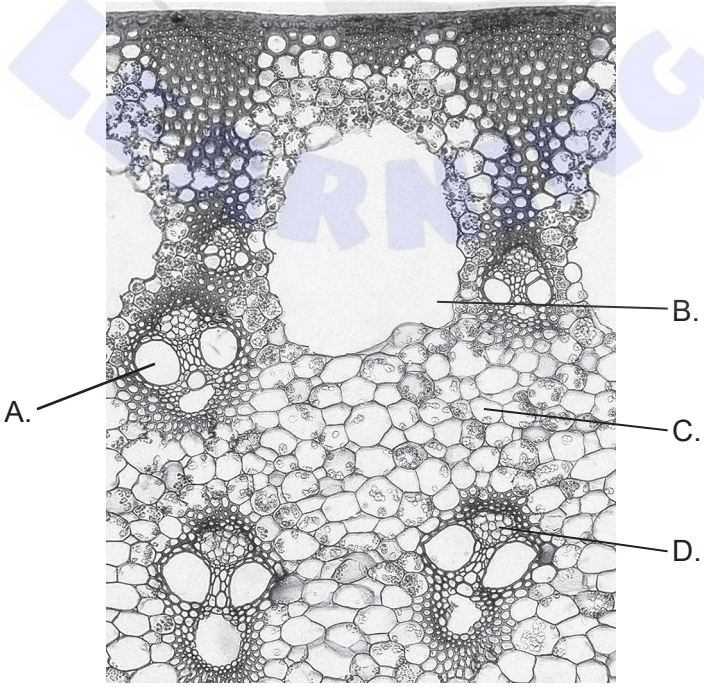
A. The opening and closing of stomata

B. The intensity of light striking the plant

C. The height of the water in the reservoir

D. The evaporation of water from the leaves

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



34. How does auxin contribute to phototropism?

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.

35. What process occurs in both mitosis and meiosis?

A. Formation of chiasmata

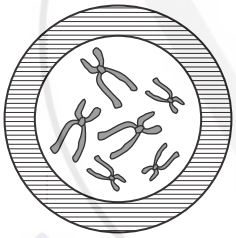
B. Reduction division

C. Separation of chromatids

D. Exchange of alleles between non-sister chromatids

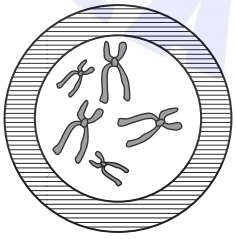
36. Which cell is a polyploid zygote produced by fusion of one haploid and one diploid gamete?

A.



B.

C.



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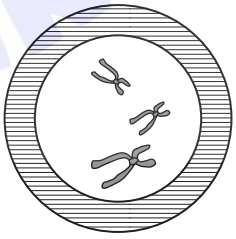
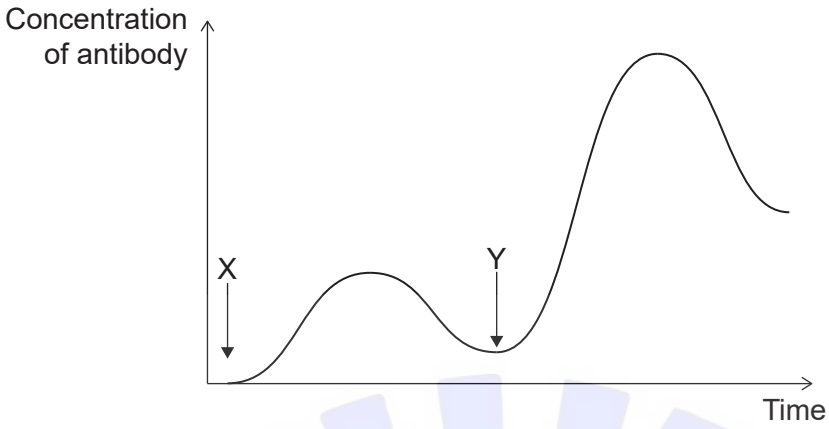


37. The graph shows changes in the concentration of an antibody in the blood of an individual subjected to two separate infections at time X and time Y.



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

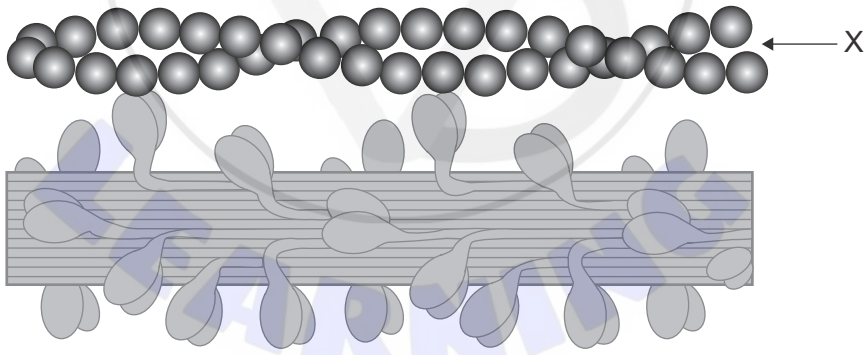
A. The individual was infected with different pathogens at X and Y.

B. Memory B cells are involved in antibody production at Y but not at X.

C. There is no clonal selection involved.

D. There are no T lymphocytes involved.

38. The diagram shows structures involved in contraction of a sarcomere.



What is X?

A. Myosin filament

B. Sarcomere

C. Actin filament

D. Myofibril

39. What sequence shows the route taken by nitrogenous wastes in insects from their production in body cells to their removal from the insect's body?

A. Hemolymph → Malpighian tubule → hindgut → rectum

B. Hindgut → hemolymph → kidney tubule → bladder

C. Malpighian corpuscle → nephron → ureter → bladder

D. Neonicotinoid → rectum → antagonistic muscles → anus

40. What function is maintained as a result of the release of HCG?

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

References:

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

2. left: UCSF School of Medicine, Courtesy of Prof. D Schmucker.

middle: Professor Roger Meicenheimer, Miami University, Department of Botany.

right: Courtesy of visualhistology.com.

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

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

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24. Transmission electron micrograph of a myelinated axon. https://commons.wikimedia.org/wiki/File:Myelinated_neuron.jpg. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license (https://creativecommons.org/licenses/by-sa/3.0/deed.en).

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