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

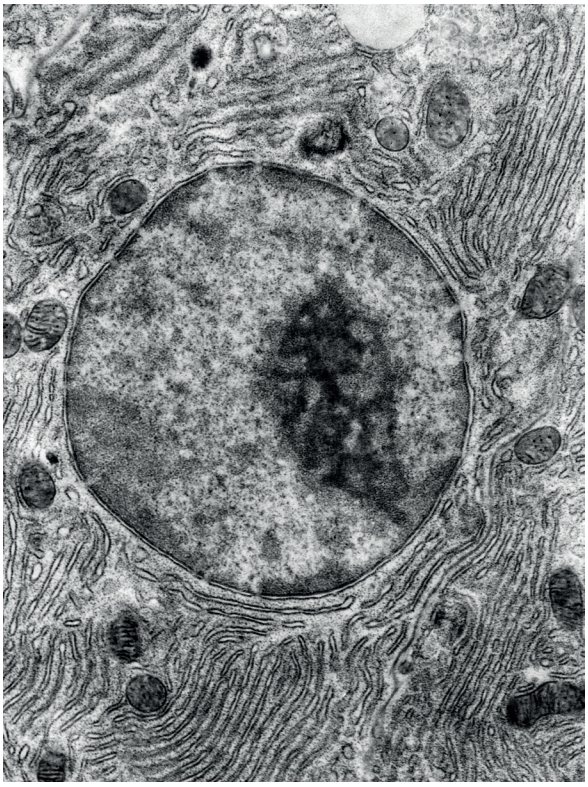
Instructions to candidates

- 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 – 6001

20 pages

1. The image shows the nucleus of a cell from the pancreas that is surrounded by endoplasmic reticulum.



What describes this nucleus?

A. It is composed of highly folded internal membranes and a liquid matrix.

B. It contains ribosomes and is the main site of protein synthesis in a cell.

C. It contains membrane-bound organelles.

D. It contains chromatin and is surrounded by a double membrane.

2. The image shows a single *Paramecium* with food vacuoles that contain ingested cells of the unicellular green alga *Chlorella*.

What can be deduced about *Paramecium*?

A. It is an autotroph.

B. It cannot perform all of the functions of life.

C. It carries out heterotrophic nutrition.

D. It is a prokaryote.

3. What distinguishes simple diffusion from facilitated diffusion?

A. Simple diffusion occurs in both prokaryotes and eukaryotes, while facilitated diffusion only occurs in eukaryotes.

B. Energy is not required for simple diffusion, while facilitated diffusion requires ATP.

C. The rate of facilitated diffusion depends on the number of transport proteins in the membrane, while simple diffusion does not.

D. Simple diffusion can only move substances along the concentration gradient, while facilitated diffusion can move substances along or against the concentration gradient.

4. The electron micrograph shows the detailed structure of a prokaryotic cell.

Removed for copyright reasons

How is this cell different from a eukaryotic cell?

A. Eukaryotic cells are compartmentalized, whereas this cell is not.

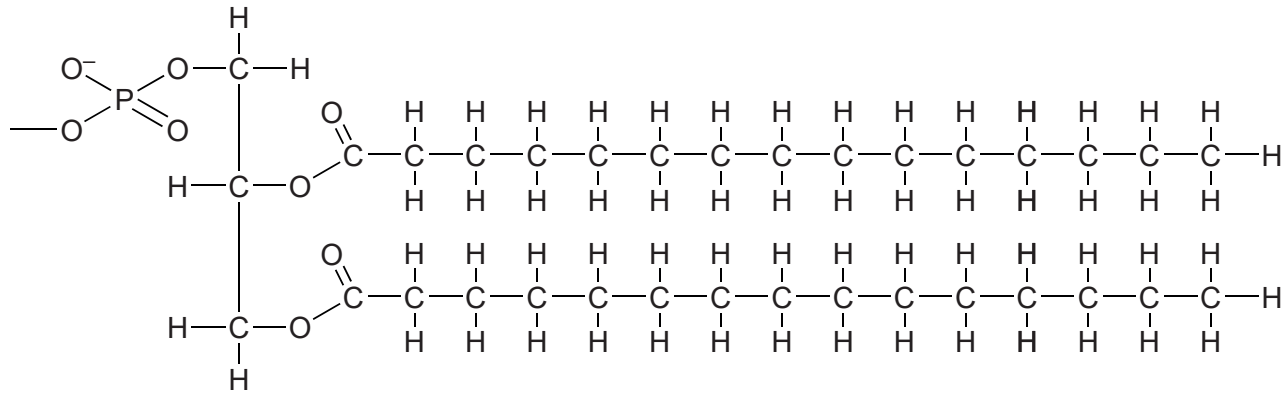
B. This cell contains ribosomes, whereas eukaryotic cells do not.

C. Eukaryotic cells contain DNA, whereas this cell does not.

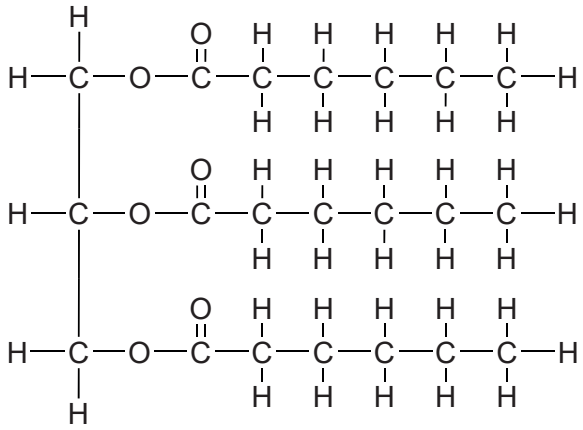
D. This cell has a cell wall, whereas eukaryotic cells do not.

5. Which molecule can have cis and trans isomers?

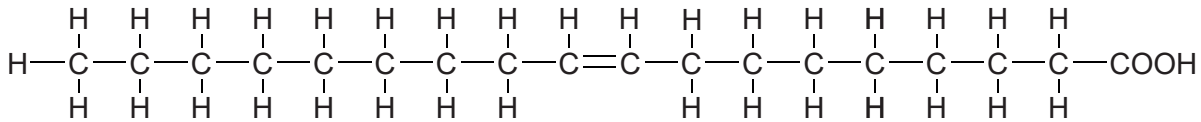
A.



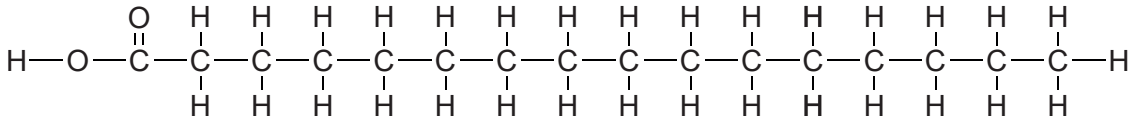
B.



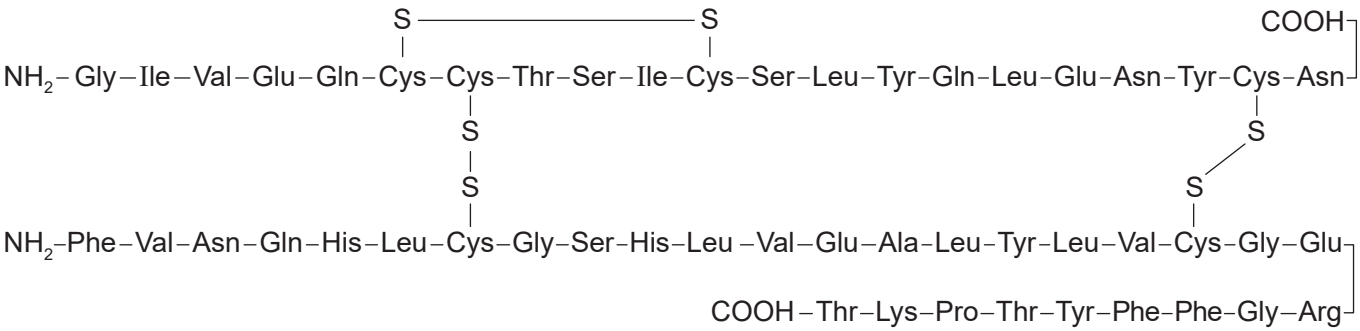
C.



D.



6. This diagram shows the amino acids present in a molecule of insulin, using three-letter abbreviations.



What describes the structure of insulin?

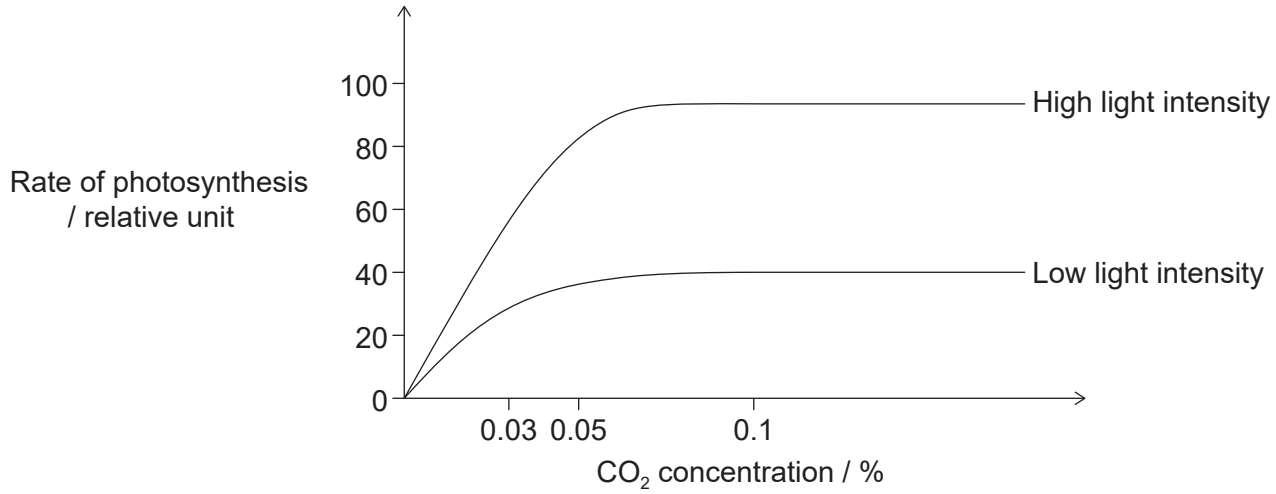
A. Insulin is a fibrous protein, since the amino acids are arranged in a linear pattern.

B. Insulin consists of a single continuous polypeptide chain with one free amino terminal and one free acid terminal.

C. Insulin has three disulphide bridges giving it tertiary structure and two polypeptide chains giving it quaternary structure.

D. Insulin has primary and secondary structure only, as there is no evidence of a three-dimensional shape in the diagram.

7. The graph shows the effect of limiting factors on the rate of photosynthesis.



What can be concluded from this graph?

A. At a CO_2 concentration of 0.1 % and a low light intensity, temperature is the only limiting factor.

B. At a CO_2 concentration of 0.1 % and a low light intensity, light intensity is the only limiting factor.

C. At a CO_2 concentration of 0.03 % and a low light intensity, both CO_2 concentration and temperature are limiting factors.

D. At a CO_2 concentration above 0.1 %, there are no limiting factors.

8. How do human muscle cells respond to intense exercise?

A. They stop using oxygen and replace glycolysis with lactic fermentation.

B. They produce smaller amounts of ATP in order to reduce the need for oxygen.

C. They produce lactate in order to quickly supply the energy for muscle contraction.

D. They produce ethanol and carbon dioxide as waste products.

9. Watson and Crick worked out the three-dimensional structure of DNA. What did the model they built show for the first time?

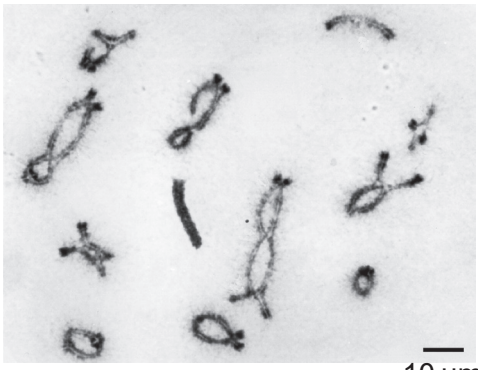
A. DNA is a polynucleotide.

B. DNA contains equal quantities of adenine and thymine.

C. DNA molecules have a helical shape.

D. DNA is a double helix with antiparallel sugar–phosphate backbones.

10. The image shows details of a cell from a male locust *Schistocerca gregaria*.



What can be deduced from this image?

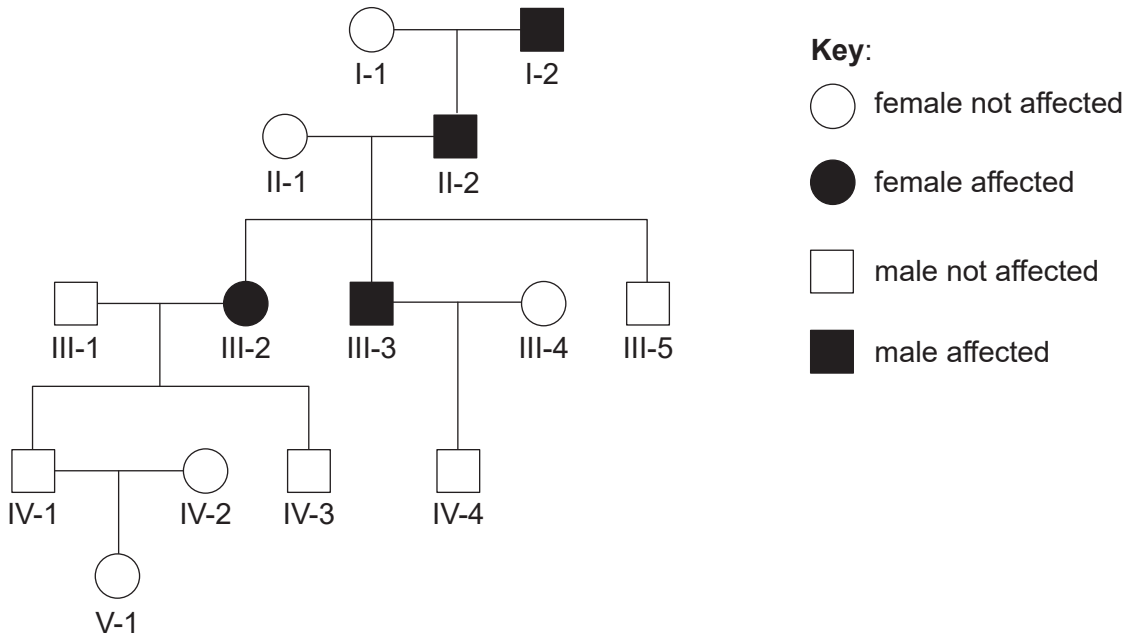
A. It is in prophase of mitosis.

B. It is in prophase II of meiosis.

C. It contains circular chromosomes.

D. It contains chiasmata as crossing over is taking place.

11. Huntington's disease is a neurodegenerative genetic disorder caused by a dominant allele. The pedigree chart for a family shows the inheritance of Huntington's disease.



What can be concluded from this pedigree chart?

A. Huntington's disease is sex-linked, since most affected individuals are male.

B. Huntington's disease is not sex-linked, since individuals IV-1 and IV-3 are not affected.

C. Huntington's disease is not sex-linked, since individual III-3 is affected.

D. Individual IV-1 is a carrier, since individual III-2 is affected.

12. How are target genes transferred to a bacterial cell?

A. Taq polymerase is used to cut the target gene, and ligase is used to attach it to a plasmid.

B. The target gene is amplified using PCR and then transferred to the bacterial cell using gel electrophoresis.

C. A nucleus containing the target gene is cloned and transferred into the bacterial cell.

D. The target gene and a plasmid are cut with the same restriction endonuclease and are attached using ligase.

13. Sickle cell anemia is a genetic disease caused by a single base substitution mutation. Two parents, both heterozygous for sickle cell anemia, have one unaffected child and one child with a mild form of the disease. What are the chances that their next child will be unaffected?

A. 0 %

B. 25 %

C. 75 %

D. 100 %

14. Which gas is the main contributor to the greenhouse effect?

A. Ozone

B. Methane

C. Nitrogen oxide

D. Water vapour

15. In a stable natural ecosystem, how is the supply of nutrients and energy maintained?

A. Nutrients and energy are efficiently cycled within the ecosystem.

B. Energy from the Sun is cycled through the food chains, while nutrients are constantly lost.

C. Nutrients are efficiently cycled within the ecosystem, while there is a constant flow of energy.

D. Energy is cycled through photosynthesis and respiration, while food chains ensure that nutrients flow through the ecosystem.

16. How do autotrophs living in an aquatic ecosystem obtain carbon?

A. By diffusion of dissolved carbon dioxide and hydrogen carbonate ions

B. By feeding on heterotrophs and obtaining carbon from carbohydrates

C. By active transport of carbon dioxide directly from the atmosphere

D. By ingesting organisms with carbonate shells

17. In a natural classification, what do all members of a genus have in common?

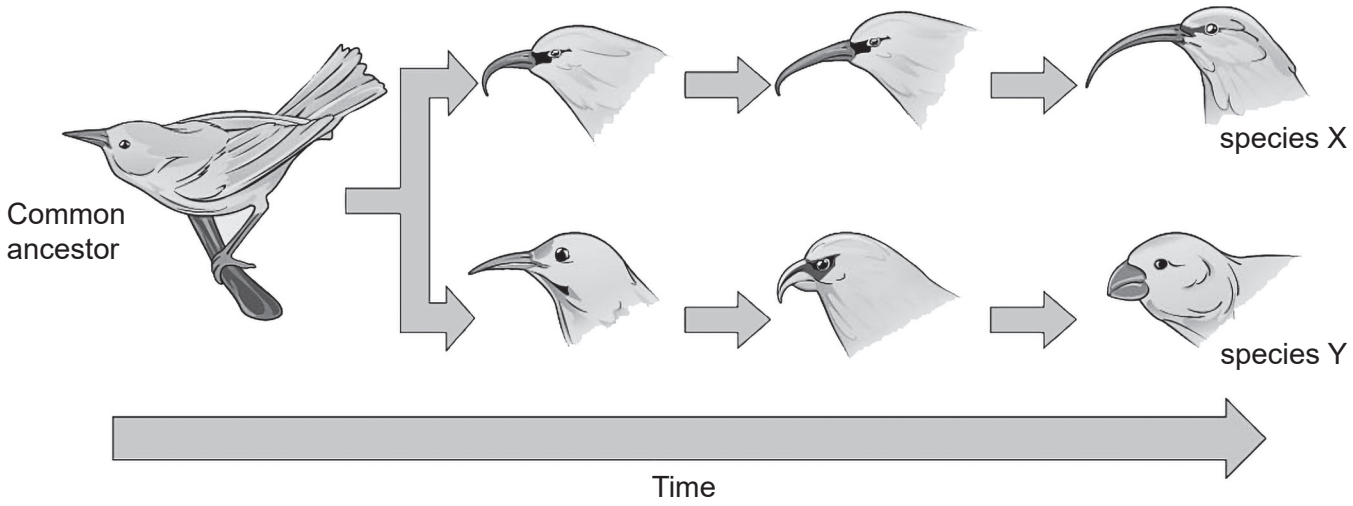
A. They all have the same binomial name.

B. They all belong to the same species.

C. They can freely interbreed to produce fertile offspring.

D. They have all evolved from the same common ancestor.

18. A central idea in the theory of evolution is that species may evolve gradually over time from a common ancestor.



Which statement(s) explain(s) the pattern of evolution seen in the diagram?

I. Beak shape shows genetic variability in the common ancestor.

II. Changes in beak shape that occur during the lifetime of an individual bird are passed on to the next generation.

III. Changes in beak shape are heritable and make each species better adapted to its environment.

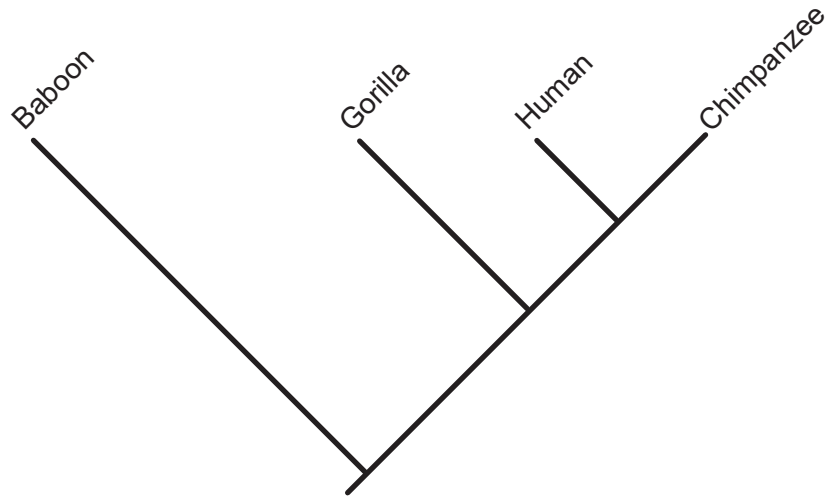
A. II only

B. I and II only

C. I and III only

D. I, II and III

19. What can be deduced from this cladogram?



A. Baboons do not share a common ancestor with gorillas, humans and chimpanzees.

B. Humans and chimpanzees are more closely related to each other than to gorillas and baboons.

C. The common ancestor for all four groups is the baboon.

D. The splitting events which separated the four groups took place at equal time intervals.

20. What is a function of the pancreas?

A. To control the rate of metabolism by releasing thyroxine when metabolic rate is low

B. To release glucagon when blood glucose levels are low

C. To release insulin when blood glucose levels are low

D. To secrete an endopeptidase which lowers the blood glucose levels

21. What occurs during the transmission of an impulse at a synapse?

I. Acetylcholine is released into the synaptic cleft by exocytosis when calcium ions enter the presynaptic neuron.

II. Acetylcholine diffuses across the synaptic cleft and binds to receptors on the postsynaptic membrane.

III. Acetylcholine is broken down by cholinesterase and resorbed into the presynaptic neuron once an impulse has been initiated on the postsynaptic membrane.

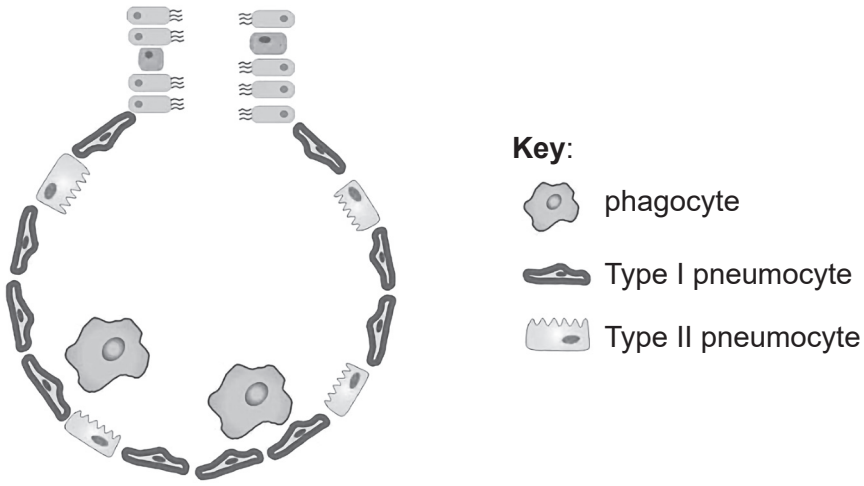
A. I and II only

B. II and III only

C. I and III only

D. I, II and III

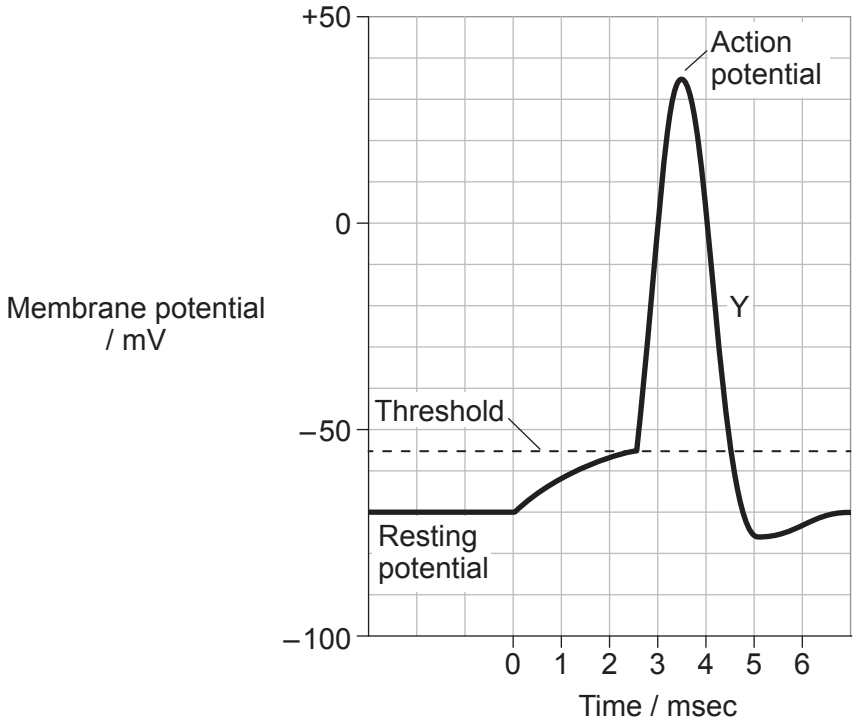
22. The diagram shows an alveolus from a healthy human lung with type I and II pneumocytes and phagocytes.



What are the main functions of these cells?

	Type I pneumocyte	Type II pneumocyte	Phagocyte
A.	Production of surfactant	Gas exchange	Production of antibodies
B.	Gas exchange	Production of surfactant	Production of antibodies
C.	Production of surfactant	Gas exchange	Ingestion of pathogens
D.	Gas exchange	Production of surfactant	Ingestion of pathogens

23. Changes in membrane potential during nerve transmission along an axon involve the movement of sodium and potassium ions across the axon membrane.



What explains the membrane potential at Y in the trace?

A. Potassium channels open and allow potassium ions to move to the outside of the axon membrane.

B. Potassium channels allow potassium ions to enter the axon.

C. When the threshold voltage is reached, the sodium pump begins to pump sodium ions to the outside of the axon membrane.

D. Potassium and sodium channels are closed, so there is no movement of ions across the axon membrane.

24. Amylose, amylopectin and glycogen are polysaccharides that are components of human nutrition. Which molecules are products of the digestion of these molecules?

	Amylose	**Amylopectin**	**Glycogen**
A.	Alpha glucose	Alpha glucose	Alpha glucose
B.	Beta glucose	Beta glucose	Alpha glucose
C.	Alpha glucose	Alpha glucose	Beta glucose
D.	Beta glucose	Beta glucose	Beta glucose

25. What is the role of the sinoatrial (SA) node?

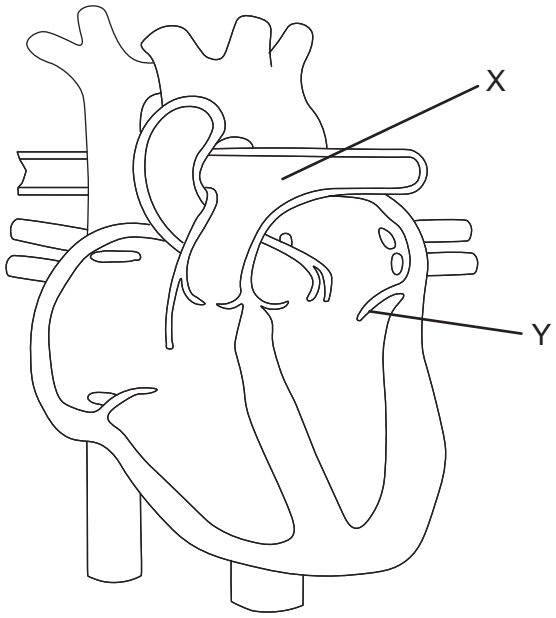
A. To produce epinephrine in response to vigorous activity

B. To stimulate the contraction of the walls of the atria

C. To send signals from the ventricles to the atria

D. To ensure that the heart rate does not respond to signals from the medulla

26. The diagram shows a section through a human heart with the chambers, valves and main blood vessels.



What are the functions of X and Y?

	X	**Y**
A.	To carry oxygenated blood to the head and body	To prevent backflow into the aorta when the ventricle relaxes
B.	To carry oxygenated blood to the head and body	To prevent backflow into the aorta when the atrium relaxes
C.	To carry deoxygenated blood to the lungs	To prevent backflow into the atrium when the ventricle contracts
D.	To carry deoxygenated blood to the lungs	To prevent backflow into the atrium when the ventricle relaxes

27. What is the function of DNA polymerase I in DNA replication?

A. It forms primers by adding short lengths of RNA to the template strand.

B. It removes RNA primers and replaces them with DNA.

C. It builds the leading strand by adding DNA nucleotides continuously.

D. It forms Okazaki fragments by adding DNA nucleotides on the lagging strand.

28. The sequence of bases on a short section of the antisense strand of a gene undergoing transcription is shown:

5′ CATG 3′

What is the sequence of bases on the resulting mRNA?

A. 3′ CATG 5′

B. 5′ GUAC 3′

C. 3′ GUAC 5′

D. 3′ GTAC 5′

29. Which statement distinguishes between the roles of free and bound ribosomes?

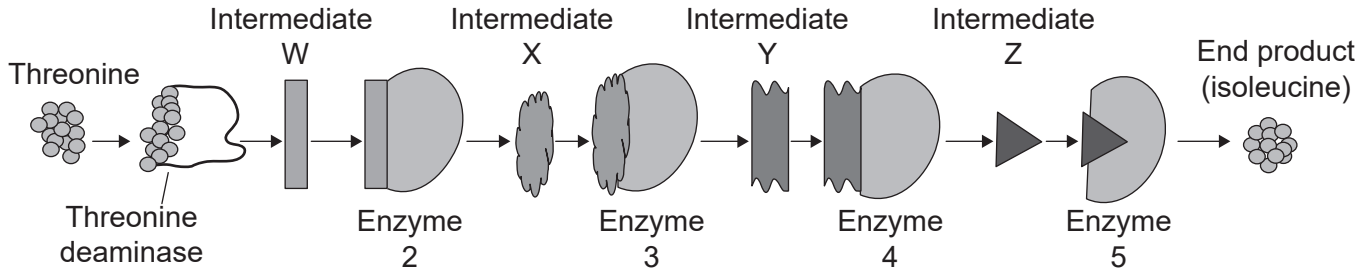
A. Free ribosomes synthesize proteins for use inside the cell, whereas bound ribosomes synthesize proteins mainly for export.

B. Free ribosomes synthesize proteins mainly for export, whereas bound ribosomes synthesize proteins for use inside the cell.

C. Free ribosomes synthesize proteins, whereas bound ribosomes do not.

D. Bound ribosomes synthesize proteins, whereas free ribosomes do not.

30. The production of isoleucine from threonine is summarized in the diagram. This process involves several steps and is regulated by feedback inhibition.



What occurs during isoleucine production?

A. Isoleucine inhibits the conversion of intermediate W to intermediate X.

B. Isoleucine inhibits the conversion of intermediate Y to intermediate Z.

C. Threonine inhibits threonine deaminase activity.

D. Isoleucine inhibits threonine deaminase activity.

31. What feature is common to both the Krebs cycle and the Calvin cycle?

A. They are forms of catabolism.

B. They are forms of anabolism.

C. They involve reduction reactions.

D. They produce large amounts of ATP.

32. What applies to chemiosmosis?

A. It takes place in both cristae and thylakoid membranes.

B. It involves the movement of water across a semipermeable membrane.

C. It only takes place in the presence of sunlight and oxygen gas.

D. It uses ATP to pump hydrogen ions against the concentration gradient.

33. Phloem transports organic molecules from the leaves to other parts of the plant. How are phloem sieve tubes adapted for this function?

I. Sieve tubes have porous endplates that allow the cytoplasm to move freely between adjacent cells.

II. Each sieve tube cell contains a nucleus that controls the production of energy and materials.

III. Sieve tubes have thickened walls to allow the cells to resist the high osmotic pressure that exists throughout the phloem tissue.

A. I only

B. I and II only

C. II and III only

D. I, II and III

34. How does auxin cause plants to respond to changes in the environment?

A. It prevents plant cell walls from elongating.

B. It controls plant growth in the shoot apical meristem.

C. It causes shoots to grow away from light.

D. It ensures that plants are unaffected by changes in the environment.

35. Chrysanthemums are short-day flowering plants that are often grown in greenhouses and sold commercially. Which conditions would ensure that they produce flowers at all times of year?

A. Continuous long periods of uninterrupted darkness

B. Mainly dark conditions but with several short bursts of light over a 24-hour period

C. Continuous long periods of uninterrupted light

D. Alternating short periods of light and dark

36. Research into eye colour in humans shows a range from very light blue or grey to dark brown or black. In Europe eye colour shows a strong correlation with latitude, with lighter colours being more frequent in northern latitudes and darker eyes more frequent in the south. What do these facts suggest about the genetic basis for eye colour in humans?

A. It shows discrete variation and is determined by a pair of alleles.

B. It is a polygenic trait controlled by multiple genes.

C. It is environmentally determined and is not controlled by genes.

D. It shows discrete variation and is independent of environmental factors.

37. What is the role of calcium ions in muscle contraction?

A. They release energy, causing myosin to bind to actin.

B. They prevent cross bridges from forming between actin and myosin.

C. They cause myosin heads to bend, resulting in contraction.

D. They unblock myosin binding sites on actin.

38. What is the response of the immune system to first-time exposure to a pathogen?

A. Antibodies already present in the blood attack and destroy the pathogen.

B. Antigens on the surface of the pathogen stimulate B lymphocytes to produce plasma cells that in turn produce antibodies.

C. The immune system will only respond to an infection if memory cells are present.

D. Antigens on the surface of the pathogen stimulate the production of monoclonal antibodies.

39. Which statement describes the function of the Malpighian tubules in insects?

A. They are the main organs of gas exchange in insects.

B. They act as channels through which excess nutrients and ammonia are excreted.

C. They carry out osmoregulation and excrete nitrogenous waste mainly as uric acid.

D. They excrete large volumes of dilute urine containing urea as the main nitrogenous waste.

40. What is a function of human chorionic gonadotropin (HCG)?

A. To stimulate the corpus luteum to produce progesterone during early pregnancy

B. To stimulate contraction of uterine muscles at the onset of birth

C. To inhibit the production of progesterone and prevent menstruation during pregnancy

D. To prevent polyspermy during fertilization in the fallopian tubes

---

References:

1. Fawcett, D.W., n.d. [*Micrograph of Myotis lucifugus*]. Available at: https://www.sciencephoto.com/media/214818/view/pancreatic-cell-nucleus-tem [Accessed 27 May 2024].

2. Summerer, M., Sonntag, B. and Sommaruga, R., 2007. An experimental test of the symbiosis specificity between the ciliate *Paramecium bursaria* and strains of the unicellular green alga *Chlorella*. *Environ Microbiol*. 9(8), 2117–22. [e-journal] Available at: https://pubmed.ncbi.nlm.nih.gov/17635555/ [Accessed 11 April 2023]. Source adapted.

10. Jones, G.H. and Franklin, F.C.H., 2006. *Cell* 126(2), pp. 246–248. [e-journal] Available at: https://pubmed.ncbi.nlm.nih.gov/16873056/ [Accessed 11 April 2023]. Source adapted.

11. Barahona Corrêa, B., Xavier, M. and Guimarães, J., 2006. Association of Huntington's disease and schizophrenia-like psychosis in a Huntington's disease pedigree. *Clinical Practice and Epidemiology in Mental Health* 2(1) [e-journal] Available at: https://cpementalhealth.biomedcentral.com/articles/10.1186/1745-0179-2-1 [Accessed 11 April 2023]. Source adapted.

18. [*Visual connection*], n.d. [image online] Available at: https://openstax.org/books/biology-2e/pages/18-3-reconnection-and-speciation-rates [Accessed 16 May 2023]. Source adapted.

19. © University of California Museum of Paleontology. Available at: https://ucmp.berkeley.edu/education/events/carlson2.html [Accessed 13 April 2023]. Source adapted.

22. Huang, B., 2021. *Cellular & Molecular Immunology* 18, pp.1823–25. [e-journal] Available at: https://www.nature.com/articles/s41423-021-00714-8#Fig1 [Accessed 12 April 2023]. Source adapted.

30. Isogai, S., et al., 2022. High-Level Production of Isoleucine and Fusel Alcohol by Expression of the Feedback Inhibition. *Applied and environmental microbiology* 88(5), e0213021. [e-journal] Available at: https://journals.asm.org/doi/10.1128/aem.02130-21 [Accessed 12 April 2023]. Source adapted.