

© International Baccalaureate Organization 2023

All rights reserved. No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without the prior written permission from the IB. Additionally, the license tied with this product prohibits use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, whether fee-covered or not, is prohibited and is a criminal offense.

More information on how to request written permission in the form of a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organisation du Baccalauréat International 2023

Tous droits réservés. Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite préalable de l'IB. De plus, la licence associée à ce produit interdit toute utilisation de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, moyennant paiement ou non, est interdite et constitue une infraction pénale.

Pour plus d'informations sur la procédure à suivre pour obtenir une autorisation écrite sous la forme d'une licence, rendez-vous à l'adresse <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organización del Bachillerato Internacional, 2023

Todos los derechos reservados. No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin la previa autorización por escrito del IB. Además, la licencia vinculada a este producto prohíbe el uso de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales—, ya sea incluido en tasas o no, está prohibido y constituye un delito.

En este enlace encontrará más información sobre cómo solicitar una autorización por escrito en forma de licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Biology

Standard level

Paper 1

8 November 2023

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

45 minutes

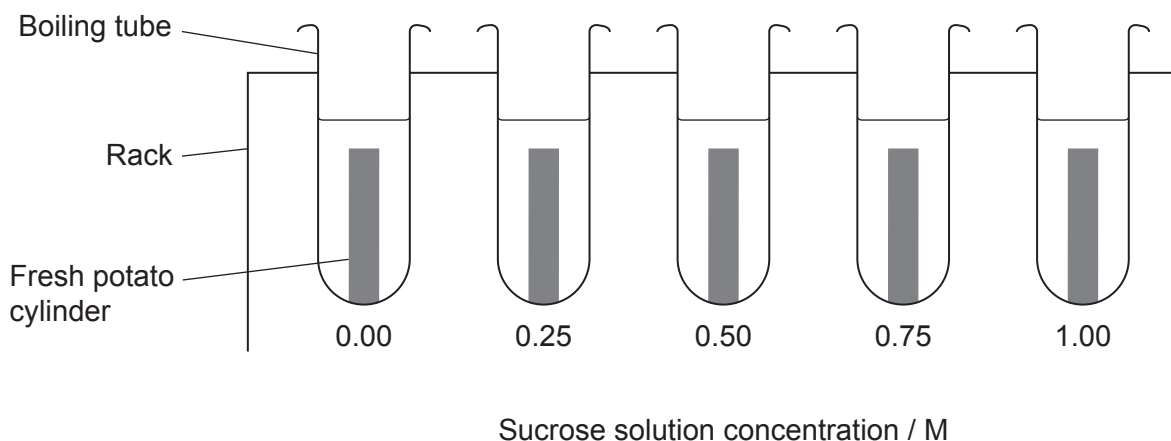
Instructions to candidates

- 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]**.

1. Stargardt's is an inherited disease caused by the mutation of a gene associated with vitamin A processing in the eye. It results in degeneration of receptor cells and loss of vision. For what reason are stem cells suitable to treat this disease?
 - A. They can be taken from the eye of an embryo and transplanted into a patient.
 - B. They can produce vitamin A in newborn babies.
 - C. They can develop into receptor cells and prevent blindness.
 - D. They can be removed from an embryo to detect early onset of the disease.

2. What was observed by electron microscopy that led to the falsification of the Davson–Danielli model and acceptance of the Singer–Nicolson model for cell membranes?
 - A. Peripheral proteins on the membrane surface
 - B. A phospholipid bilayer
 - C. The outward orientation of the hydrophilic phospholipid heads
 - D. The presence of transmembrane proteins

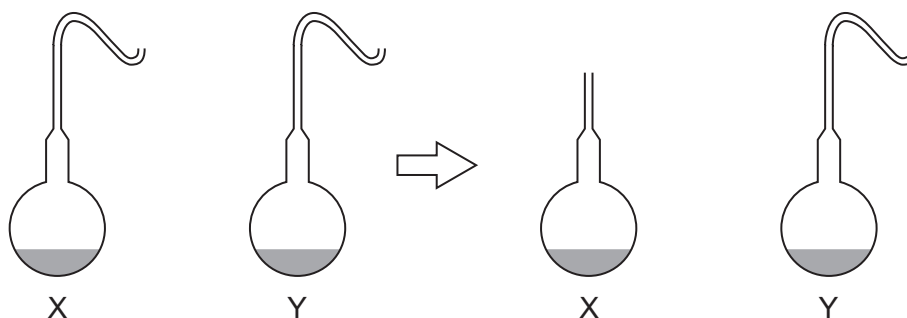
3. In an experiment, a student placed five fresh potato cylinders of equal size in solutions of varying sucrose concentrations.



On completion of the experiment, the student concluded that the concentration of sucrose isotonic with the potato was 0.30 M. In how many of the solutions did the potato cylinders lose mass?

- A. 1
- B. 2
- C. 3
- D. 4

4. Pasteur boiled broth in swan-necked flasks. He then broke the neck of one flask (X) and left another one (Y) unbroken.



What observations did he make about the broth in the flasks with broken and unbroken necks that led him to conclude that spontaneous generation does not occur?

	X	Y
A.	Cloudy	Cloudy
B.	Cloudy	Not cloudy
C.	Not cloudy	Cloudy
D.	Not cloudy	Not cloudy

5. A microscope slide of an onion (*Allium cepa*) root tip shows the number of cells in different stages of mitosis.

Stage of mitosis	Number of cells
Interphase	30
Prophase	10
Metaphase	3
Anaphase	5
Telophase	2

What is the mitotic index?

- A. 0.2
B. 0.3
C. 0.4
D. 0.6

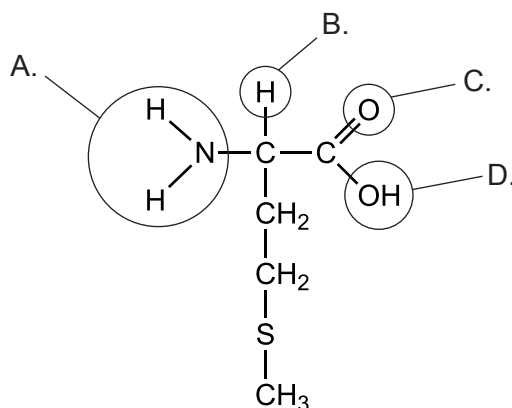
6. What distinguishes alpha-D-glucose from beta-D-glucose molecules?
- A. The number of carbon atoms in the ring
 - B. The number of OH groups present
 - C. The orientation of OH groups
 - D. The position of the CH₂OH group
7. Water striders of the Gerridae family of insects have areas of their legs covered with a hydrophobic substance.



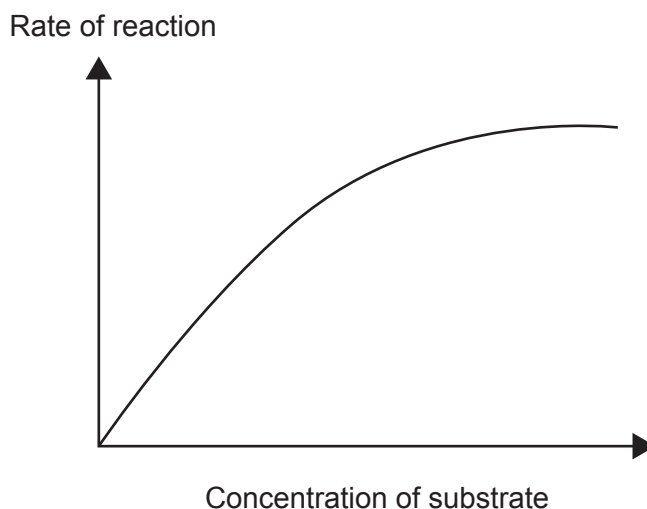
What property of water makes it possible for them to walk on its surface?

- A. Adhesion of water molecules
 - B. Cohesion of water molecules
 - C. High specific heat capacity
 - D. High density
8. In what units would body mass index (BMI) be measured?
- A. kg m^{-2}
 - B. kg m^2
 - C. m kg^2
 - D. m kg^{-2}

9. The diagram shows the structure of the amino acid methionine with some atoms labelled. Which atom(s) would be removed when two molecules of methionine join to form a dipeptide?



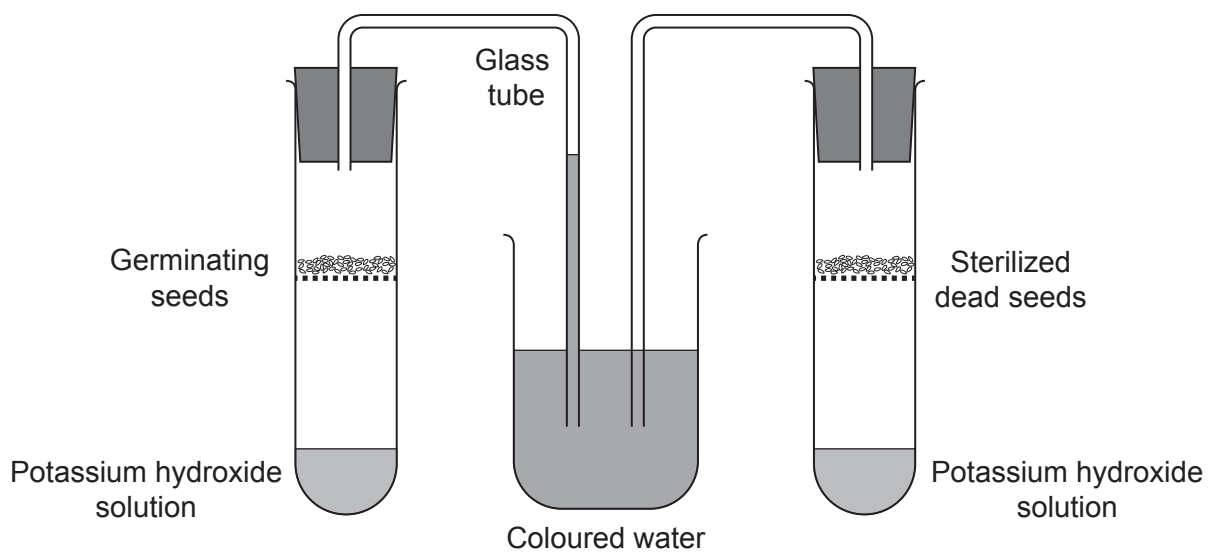
10. Pancreatic amylase is an enzyme that breaks down starch into maltose. The graph shows how the rate of reaction of pancreatic amylase changes as the concentration of substrate increases.



What causes the rate of reaction to level off?

- A. Maltose is reducing the activity of the enzyme.
- B. The concentration of starch is too low.
- C. All the pancreatic amylase has been consumed in the reaction.
- D. The active sites of pancreatic amylase are saturated.

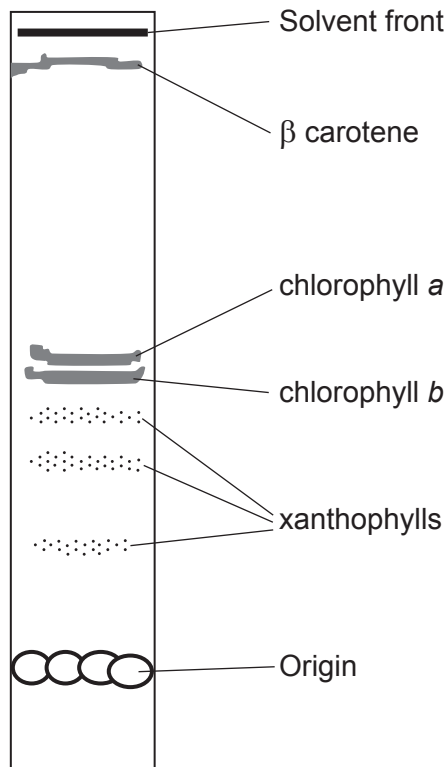
11. Which subunits would be connected by hydrogen bonds in a DNA molecule?
- A. Phosphate to deoxyribose sugar
 - B. Thymine to deoxyribose sugar
 - C. Cytosine to guanine
 - D. Adenine to uracil
12. The diagram shows the arrangement of the apparatus used to carry out an experiment with germinating seeds. The levels of coloured water in the glass tubes show the results at the end of the experiment. Initially, the levels of coloured water in the glass tubes were equal.



What does the experiment show?

- A. Potassium hydroxide has absorbed the oxygen produced by photosynthesis.
- B. Anaerobic respiration takes place during seed germination.
- C. Oxygen has been absorbed by the seeds in aerobic respiration.
- D. Heat is produced by germinating seeds during respiration.

13. The image shows the separation of photosynthetic pigments in a spinach leaf by thin layer chromatography and the colours that appear on a chromatogram.



Key:

Pigment

β carotene

Chlorophyll *a*

Chlorophyll *b*

Xanthophylls

Colour

Orange

Blue-green

Yellow-green

Yellow

What colour is the pigment with R_f value 0.2?

- A. Yellow
- B. Yellow-green
- C. Blue-green
- D. Orange

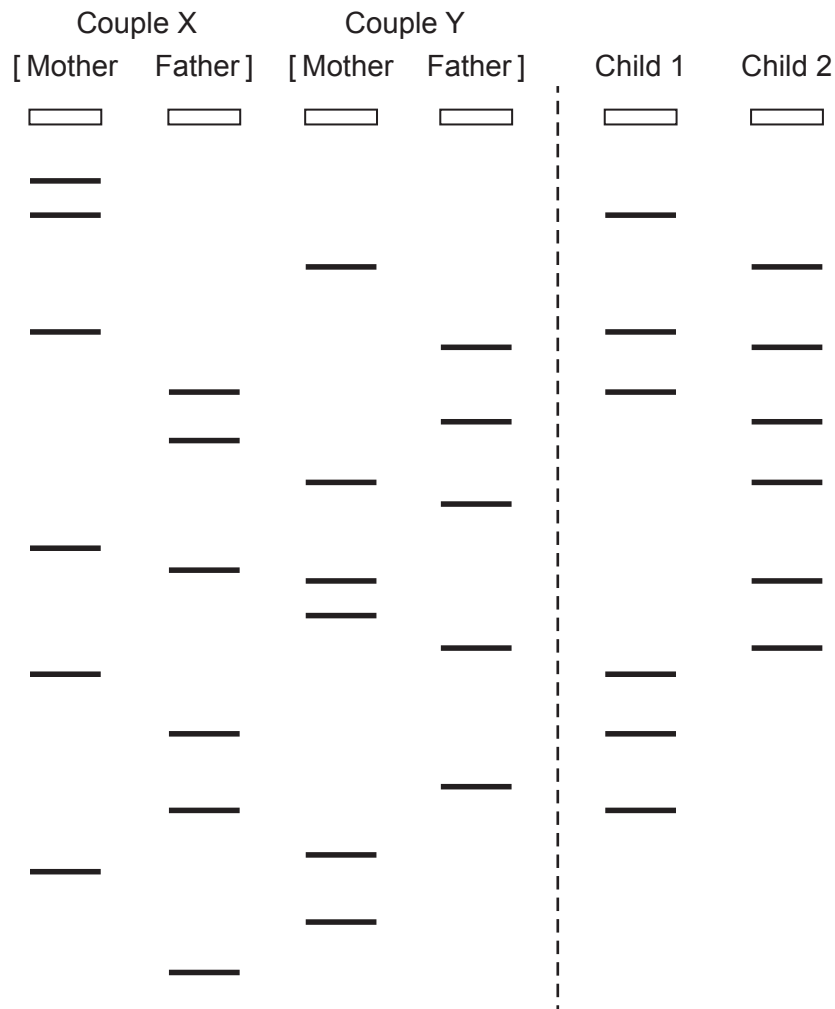
14. The table shows the approximate genome size of four species of organisms.

Species	Type of organism	Genome size / bp $\times 10^6$
<i>Escherichia coli</i>	Bacterium	5
<i>Drosophila melanogaster</i>	Insect	140
<i>Homo sapiens</i>	Mammal	3000
<i>Paris japonica</i>	Plant	150 000

What can be deduced from this information?

- A. Plants have more chromosomes than humans.
 - B. The genetic code is universal.
 - C. The amount of functional DNA varies between organisms.
 - D. The genome size does not always indicate the complexity of the organism.
15. What occurs during the first division of meiosis?
- A. Replication of DNA
 - B. Separation of chromatids
 - C. Halving of the chromosome number
 - D. Production of two identical cells
16. Cystic fibrosis is a genetic disorder that leads to lung damage. Two parents both have a recessive allele of the gene for cystic fibrosis and have no signs or symptoms of the disease. Their first child has cystic fibrosis. What is the probability that their second child will have the disease?
- A. 0 %
 - B. 25 %
 - C. 50 %
 - D. 100 %

17. The diagram shows the DNA profile of two couples and two children.



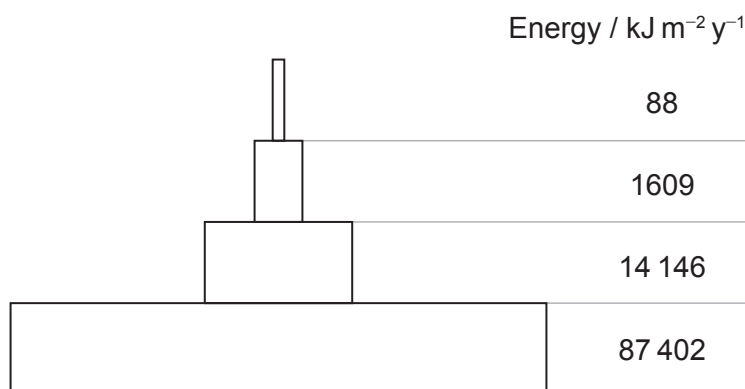
What is the most probable relationship between them?

- A. Couple X are the parents of child 1 and couple Y are the parents of child 2.
- B. Couple X are the parents of child 2 and couple Y are the parents of child 1.
- C. Couple X are the parents of both children.
- D. Couple Y are the parents of both children.

18. Which factor(s) would be expected to vary in a closed terrestrial mesocosm?

- I. Carbon content
 - II. Temperature
 - III. Biomass
- A. I only
 - B. I and II only
 - C. II and III only
 - D. I, II and III

19. The pyramid of energy shows the annual gross productivity for each trophic level in the Silver Springs ecosystem in Florida.



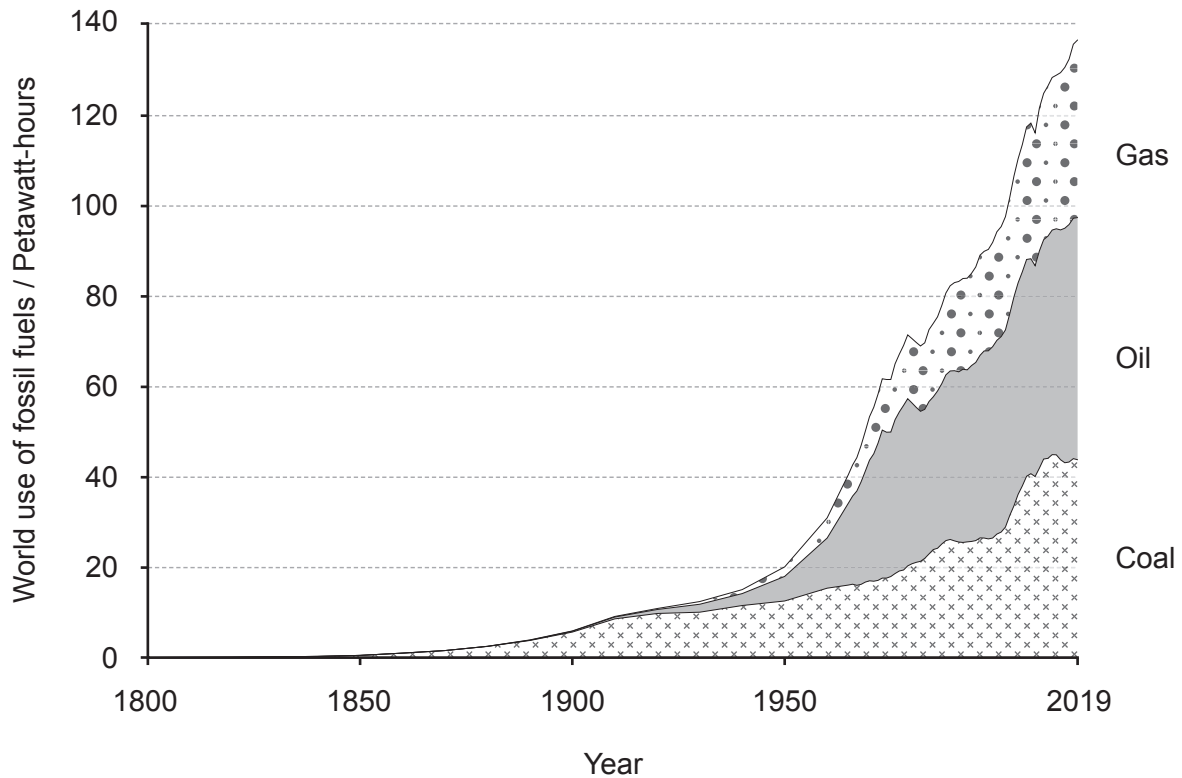
What does the pyramid show?

- A. Most energy is lost by the autotrophs.
- B. There are a larger number of herbivores than carnivores.
- C. The biggest loss of energy is when sunlight reflects from plants.
- D. The energy in the trophic levels is affected by seasonal changes.

20. What conditions favour peat formation?

A.	acidic	aerobic
B.	acidic	anaerobic
C.	alkaline	aerobic
D.	alkaline	anaerobic

21. The graph shows how the worldwide use of fossil fuels has increased from 1800 to 2019.



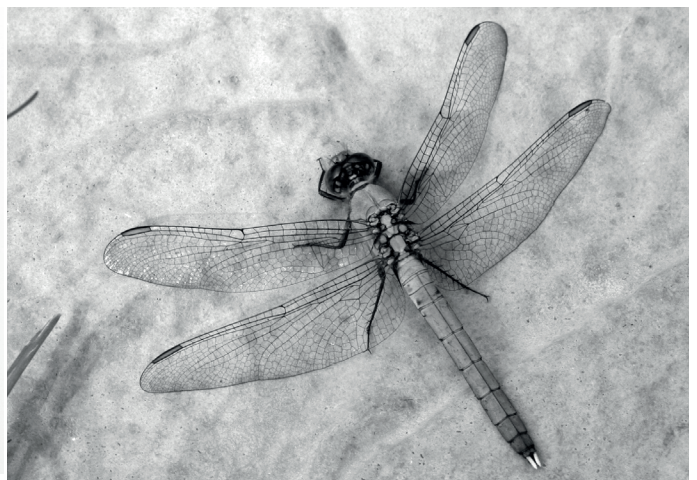
How has the increased combustion of fossil fuels contributed significantly to global warming?

- A. The heat released raises the temperature of the air.
 - B. Combustion causes ozone depletion, which enhances the greenhouse effect.
 - C. Carbon dioxide produced by combustion prevents radiation from the Sun reaching Earth.
 - D. The products of combustion absorb long wave radiation.
22. What is a result of natural selection?
- A. Variation among members of a species
 - B. Heritable mutations occurring in the gametes
 - C. A decrease in the frequency of certain characteristics
 - D. Production of more offspring than survive to reproductive age

23. The starry thyme-moss (*Mnium stellare*) and the badge moss (*Plagiomnium insignne*) are both bryophytes in the order Bryales. What must they have in common?
- A. They are classified into the same class.
 - B. They are classified into the same genus.
 - C. They have vascular tissue to transport water.
 - D. They reproduce by producing seeds.
24. The wings of bats and insects have both evolved for flight. The bats have bones to strengthen their wings and the insects have veins.



Bat wing

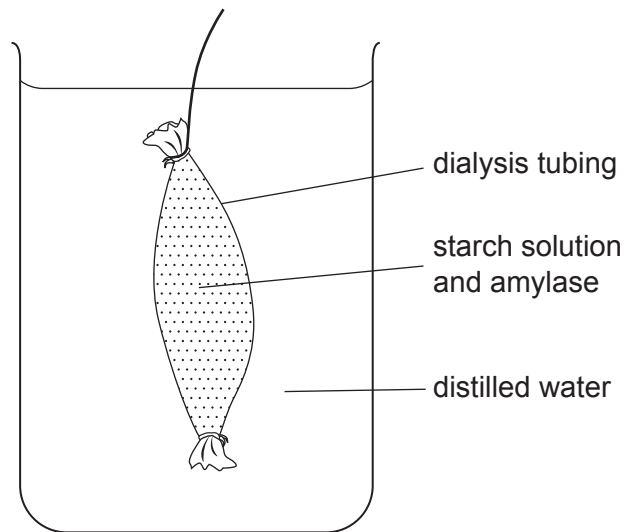


Insect wing

What is a valid comparison of bat and insect wings?

- A. They are homologous structures formed by adaptive radiation.
- B. They are analogous structures evolving from a common ancestor.
- C. They are homologous structures as both have strengthened wings.
- D. They are analogous structures as both allow flight.

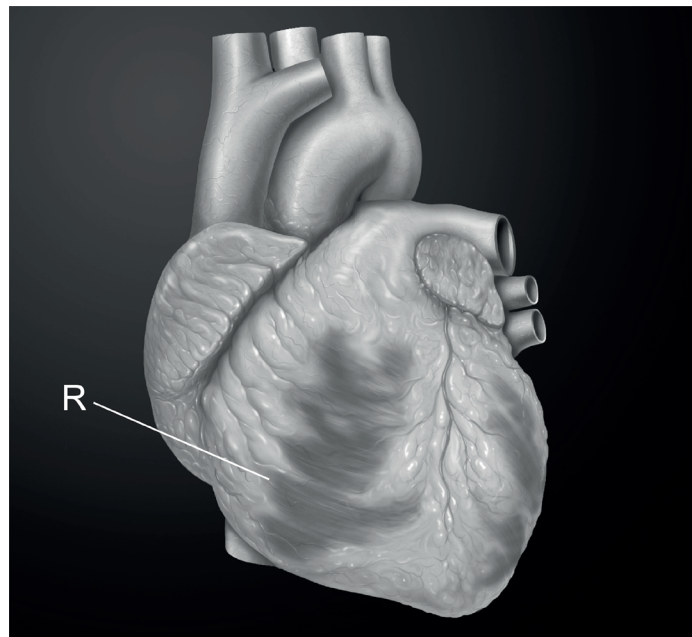
25. A mixture of starch solution and amylase was placed in dialysis tubing in a beaker of water to simulate digestion and absorption.



What changes would be expected in the concentrations of sugar and starch in the distilled water and inside the dialysis tubing after one hour?

	Starch in distilled water	Sugar in dialysis tubing	Sugar in distilled water
A.	increased	unchanged	unchanged
B.	unchanged	increased	decreased
C.	unchanged	increased	increased
D.	unchanged	unchanged	increased

26. The image shows a model of a human heart with one chamber labelled R.



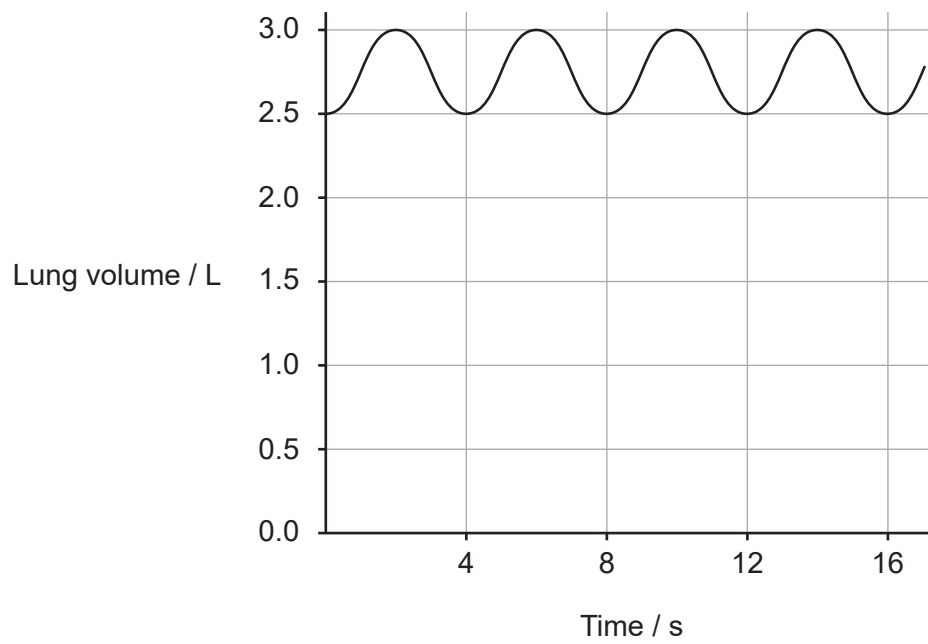
Which statement is most accurate?

- A. When the pressure in R increases the semilunar valve closes.
 - B. R contains the sinoatrial node, which initiates heartbeat.
 - C. Blood passes from R into the pulmonary artery.
 - D. Deoxygenated blood in the vena cava flows directly into R.
27. The body has developed various methods to fight against infectious disease.
- I. Fibrinogen is converted to fibrin, which prevents the entry of bacteria and loss of blood.
 - II. Phagocytic white blood cells recognize pathogens and ingest and destroy them.
 - III. Lymphocytes produce antibodies in response to pathogens in the blood.

Which provides specific immunity to disease?

- A. I and II only
- B. II and III only
- C. III only
- D. I, II and III

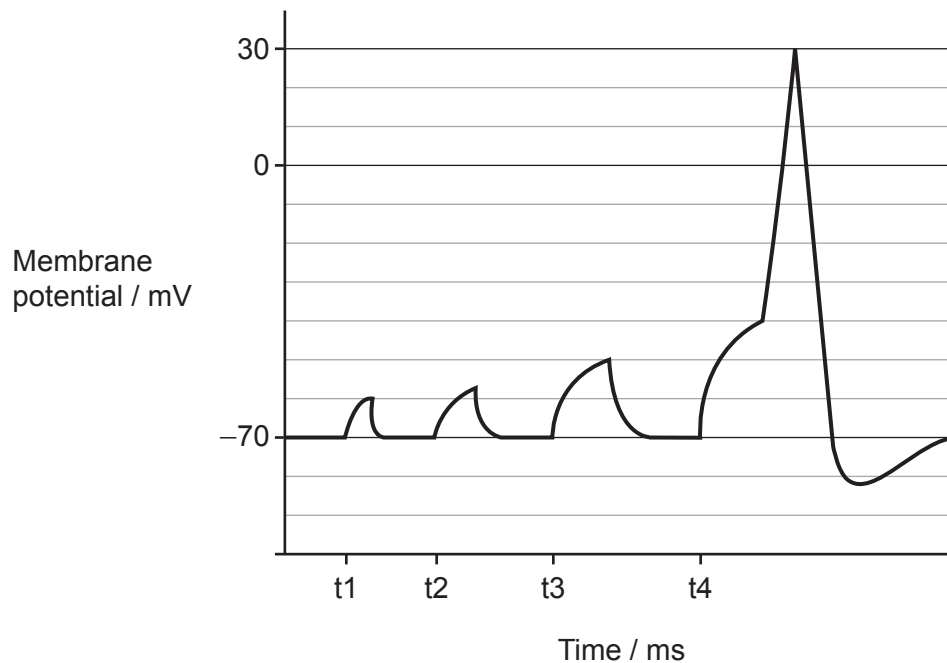
28. The spirometer reading shows the change of volume of the lungs during normal breathing.



What are the tidal volume and the ventilation rate?

	Tidal volume / L	Ventilation rate / breaths min ⁻¹
A.	3.0	4
B.	3.0	15
C.	0.5	4
D.	0.5	15

29. Four electrical stimuli of increasing size are applied to a neuron at times t_1 to t_4 . The graph shows the effects of each electrical stimulus on the membrane potential of the neuron at the point where the stimulus is applied.



What can be concluded from the graph?

- A. The stronger the stimulus, the greater the action potential.
- B. Only the stimulus at t_4 causes a change in membrane potential.
- C. The stimulus at t_4 caused a total increase of membrane potential of 30 mV.
- D. The threshold potential is approximately -40 mV.

30. The hormone leptin has been tested on patients with clinical obesity to try to treat the disease. From where is leptin secreted, where does it act and what is its function?

	Secreted from	Acts on	Function
A.	adipose tissue	hypothalamus	inhibits appetite
B.	hypothalamus	adipose tissue	inhibits appetite
C.	hypothalamus	small intestine	inhibits absorption
D.	adipose tissue	small intestine	inhibits absorption

Disclaimer:

Content used in IB assessments is taken from authentic, third-party sources. The views expressed within them belong to their individual authors and/or publishers and do not necessarily reflect the views of the IB.

References:

7. Pérez, Nicolás. https://commons.wikimedia.org/wiki/File:02_Villaverde_de_Pontones_Rio_Aguanaz_Gerris_lacustris_Ni.jpg. Licensed under CC BY-SA 4.0 DEED <https://creativecommons.org/licenses/by-sa/4.0/deed.en>. Image adapted.
13. Motten, AF, 1995. *Diversity of photosynthetic pigments*. [PDF online] Available at: <https://www.ableweb.org/biologylabs/wp-content/uploads/volumes/vol-16/6-motten.pdf> [Accessed 31 August 2022]. Source adapted.
17. Barral, M, 2020. *The Birth of Genetic Fingerprinting, an Invaluable Tool for CSI*. [online] Available at: <https://www.bbvaopenmind.com/en/science/scientific-insights/the-birth-of-genetic-fingerprinting-an-invaluable-tool-for-csi/> [Accessed 1 September 2022]. Source adapted.
21. Hannah Ritchie and Pablo Rosado (2017) – “Fossil Fuels” Published online at OurWorldInData.org. Retrieved from: <https://ourworldindata.org/fossil-fuels> [Online Resource]. Data source: Energy Institute Statistical Review of World Energy (2023).
24. Bat image: Mike's Birds from Riverside, CA, US. Flying Fox, Cairns, Queensland, Australia, Jan. 6, 2017. Accessed at: [https://commons.wikimedia.org/wiki/File:Fruit_Bat_\(31871913674\).jpg](https://commons.wikimedia.org/wiki/File:Fruit_Bat_(31871913674).jpg).
Dragonfly image: Nonenmacher, RA. https://commons.wikimedia.org/wiki/File:Dragonfly_ran-103.jpg. Licensed under CC BY-SA 3.0 DEED: <https://creativecommons.org/licenses/by-sa/3.0/deed.en>.
26. Patrick J Lynch; illustrator; C Carl Jaffe; MD; cardiologist Yale University Center for Advanced Instructional Media Medical Illustrations by Patrick Lynch, generated for multimedia teaching projects by the Yale University School of Medicine, Center for Advanced Instructional Media, 1987–2000. Accessed at: https://commons.wikimedia.org/wiki/File:Heart_anterior_exterior_view.jpg Licensed under CC BY 2.5 DEED: <https://creativecommons.org/licenses/by/2.5/>. Image adapted.