Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 1

8 November 2023

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

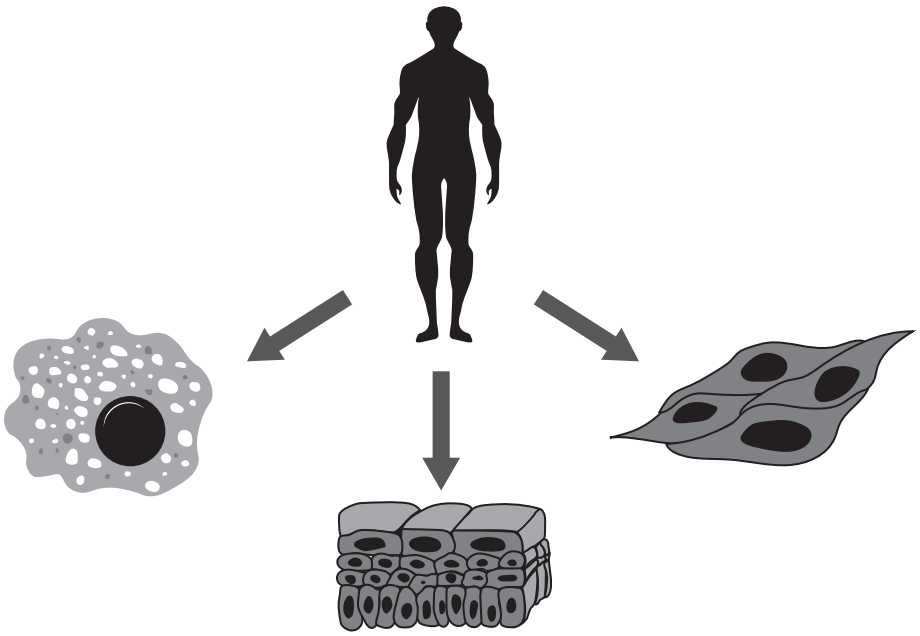
45 minutes

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]**.

8823 – 6010

1. Undifferentiated cells can become specialized to perform specific functions in a multicellular organism.



What accounts for the differences in these cells?

A. Their chromosome number differs.

B. Their proteomes are different.

C. They have slightly different genomes.

D. They express different chromosomes.

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?

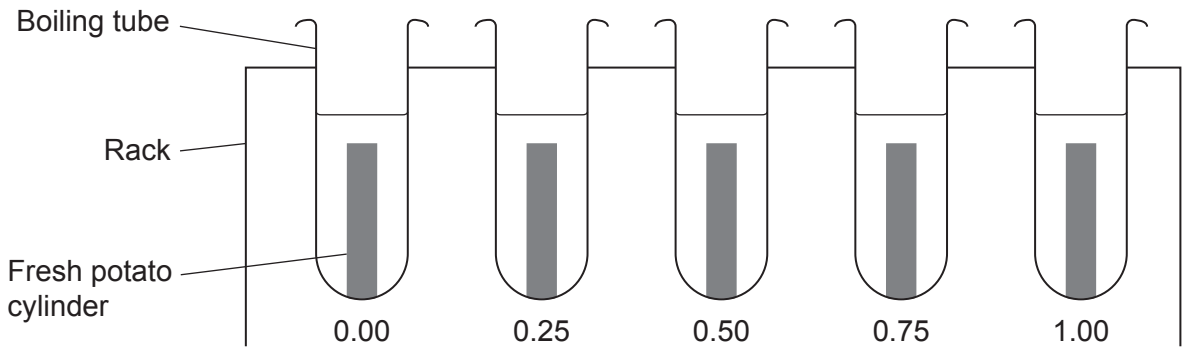
A. Peripheral proteins on the membrane surface

B. A phospholipid bilayer

C. The presence of transmembrane proteins

D. The outward orientation of the hydrophilic phospholipid heads

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?

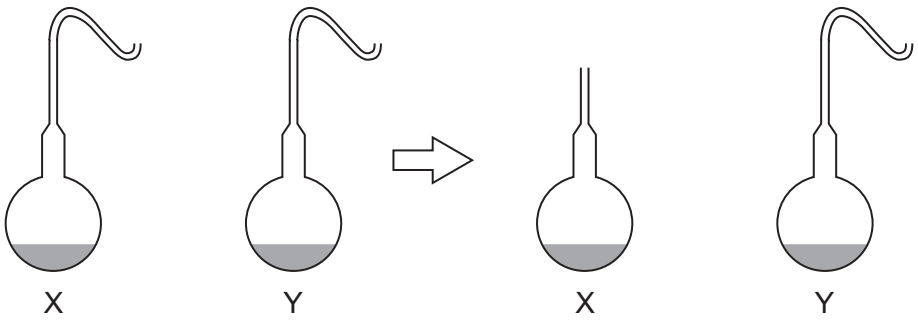
A. 1

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?

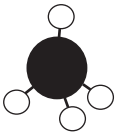
A. The orientation of OH groups

B. The number of OH groups present

C. The number of carbon atoms in the ring

D. The position of the CH_2OH group

7. Water and methane molecules have different thermal properties despite similarities in mass.

Properties	**water** 	**methane** 
Density / $g\,cm^{3\,-1}$	1.00	0.46
Boiling point / °C	100.00	–161.00
Freezing point / °C	0.00	–182.00
Specific heat capacity / $J\,g^{-1}\,°C^{-1}$	4.19	2.20

Key: carbon oxygen hydrogen

What is a reason water remains in a liquid state over a larger range of temperature than methane?

A. Water molecules are non-polar.

B. Water molecules occupy less space.

C. There are fewer covalent bonds within water molecules.

D. There are stronger attractions between water molecules.

8. In what units would body mass index (BMI) be measured?

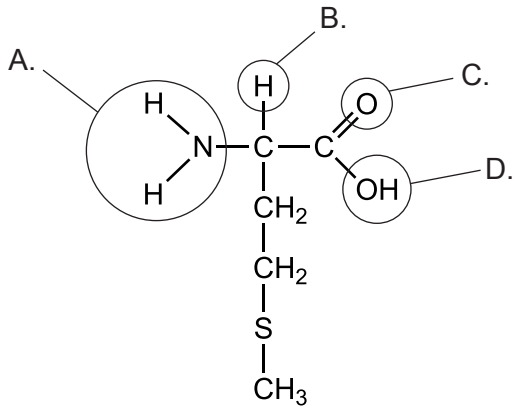
A. $kg\,m^2$

B. $kg\,m^{-2}$

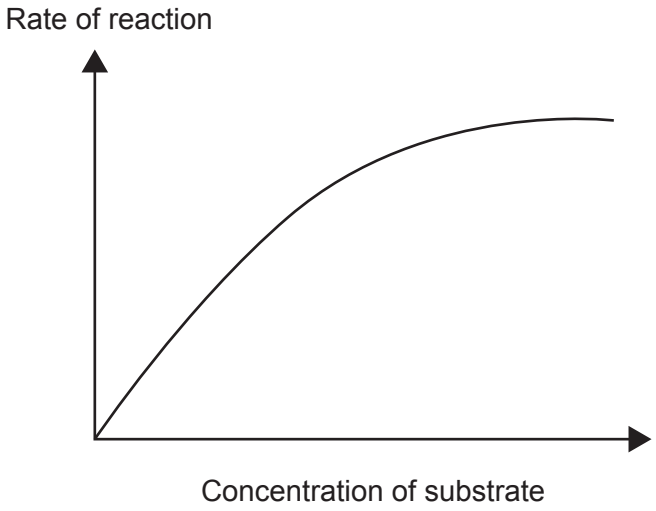
C. $m\,kg^2$

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. The active sites of pancreatic amylase are saturated.

D. All the pancreatic amylase has been consumed in the reaction.

11. Which subunits would be connected by hydrogen bonds in a DNA molecule?

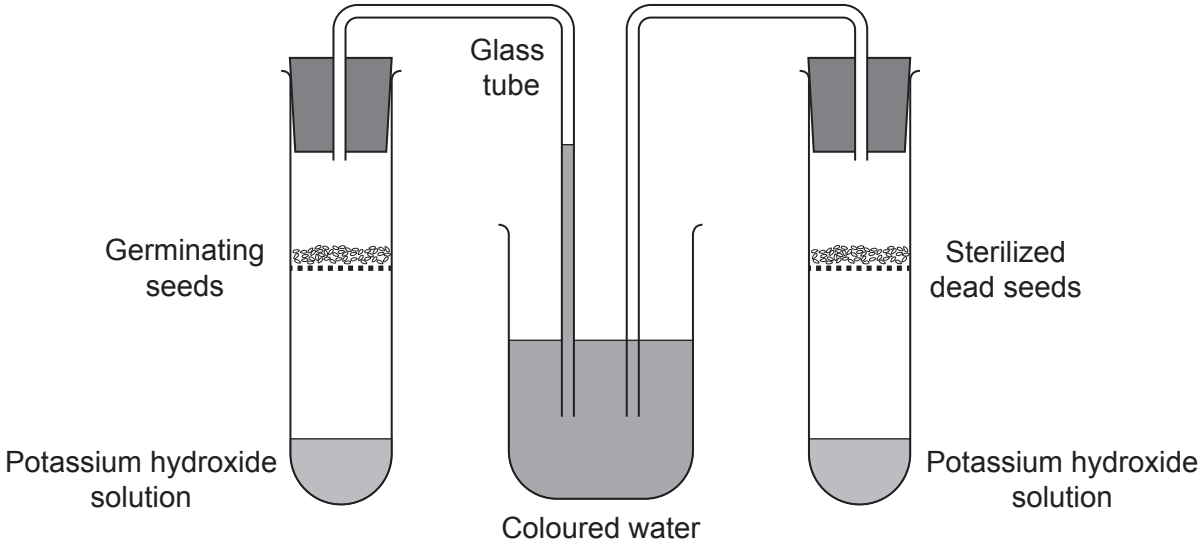
A. Phosphate to deoxyribose sugar

B. Thymine to deoxyribose sugar

C. Adenine to uracil

D. Cytosine to guanine

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?

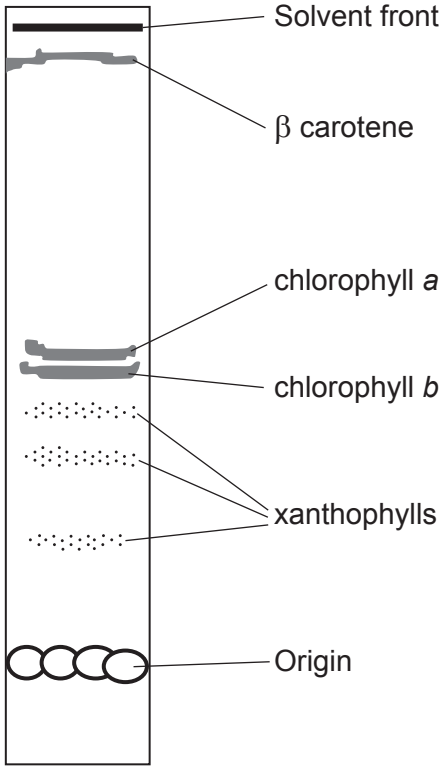
A. Potassium hydroxide has absorbed the oxygen produced by photosynthesis.

B. Oxygen has been absorbed by the seeds in aerobic respiration.

C. Anaerobic respiration takes place during seed germination.

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	**Colour**
β carotene	Orange
Chlorophyll *a*	Blue-green
Chlorophyll *b*	Yellow-green
Xanthophylls	Yellow

What colour is the pigment with Rf value 0.2?

A. Yellow

B. Yellow-green

C. Blue-green

D. Orange

14. All chromosomes present in a bacterial cell and a unicellular fungus were extracted and their structure analyzed.

What would be a common feature of chromosomes found in both types of cells?

A. They form pairs.

B. They are bound to histone proteins.

C. They contain the same bases.

D. They have centromeres.

15. What occurs during the first division of meiosis?

A. Replication of DNA

B. Separation of chromatids

C. Production of two identical cells

D. Halving of the chromosome number

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?

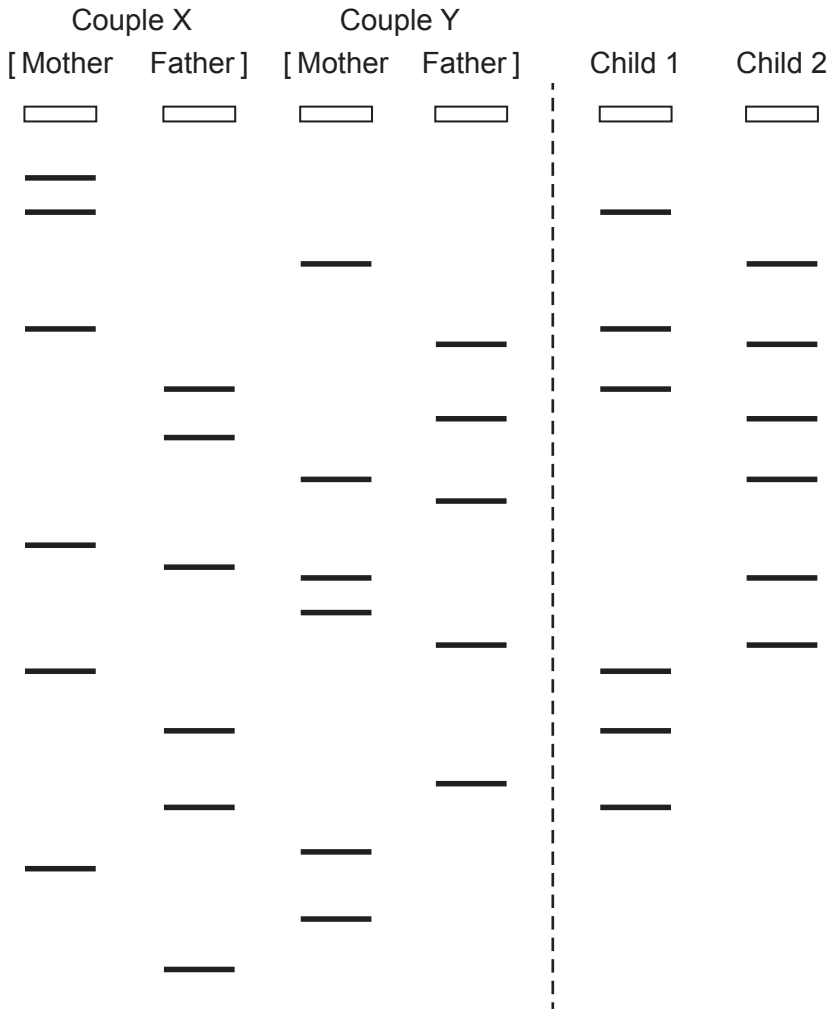
A. 0 %

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 both children.

B. Couple Y are the parents of both children.

C. Couple X are the parents of child 1 and couple Y are the parents of child 2.

D. Couple X are the parents of child 2 and couple Y are the parents of child 1.

18. *Mycena interrupta* lives in small colonies on moist, rotting dead wood in rainforests. It feeds on this plant material by breaking it down with enzymes before ingestion.

What best describes the mode of nutrition of this species?

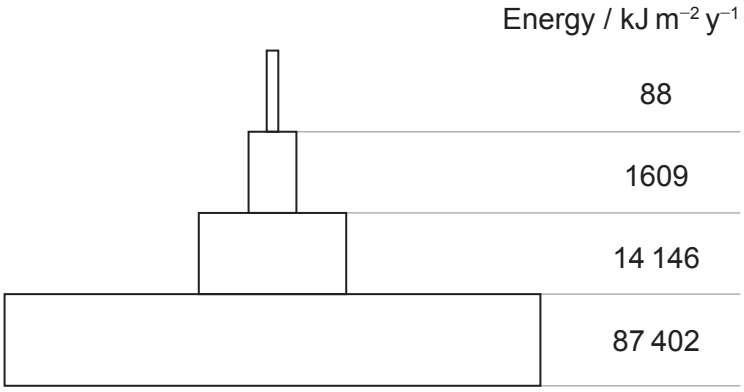
A. Detritivore

B. Saprotroph

C. Consumer

D. Herbivore

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.

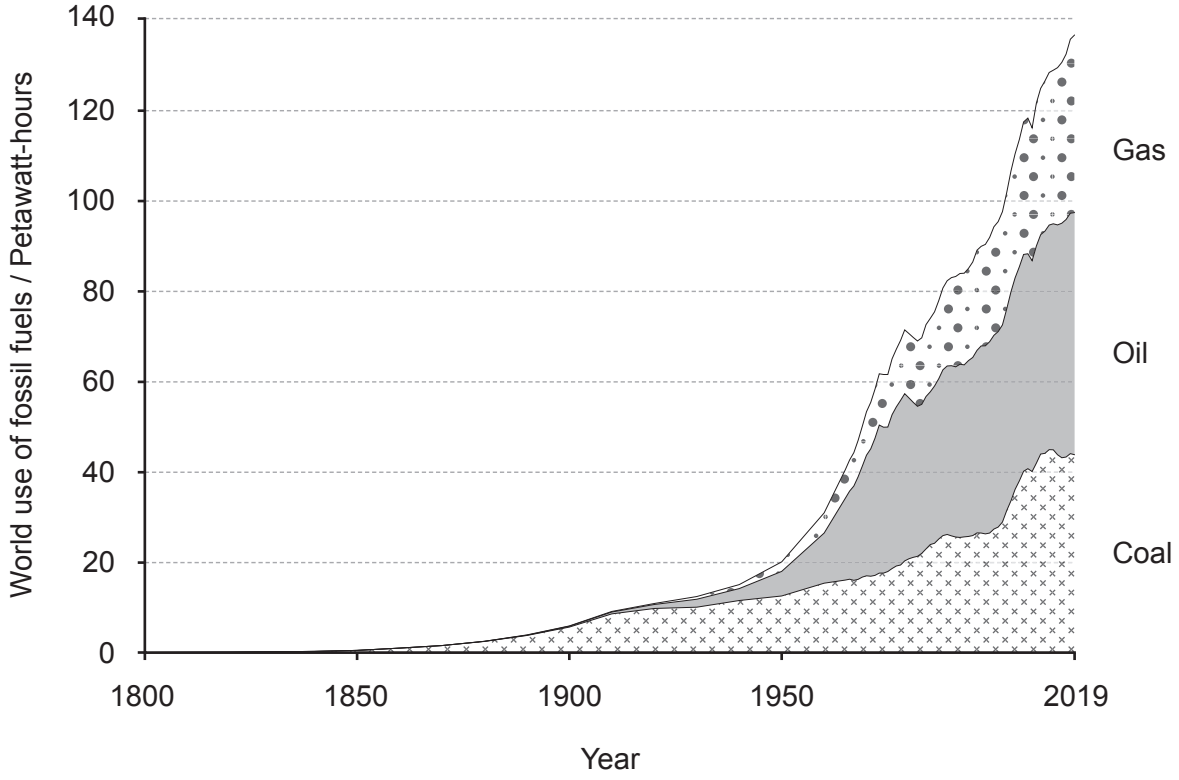
C. The biggest loss of energy is when sunlight reflects from plants.

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. The products of combustion absorb long wave radiation.

C. Carbon dioxide produced by combustion prevents radiation from the Sun reaching Earth.

D. Combustion causes ozone depletion, which enhances the greenhouse effect.

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 insigne*) are both bryophytes in the order Bryales. What must they have in common?

A. They have vascular tissue to transport water.

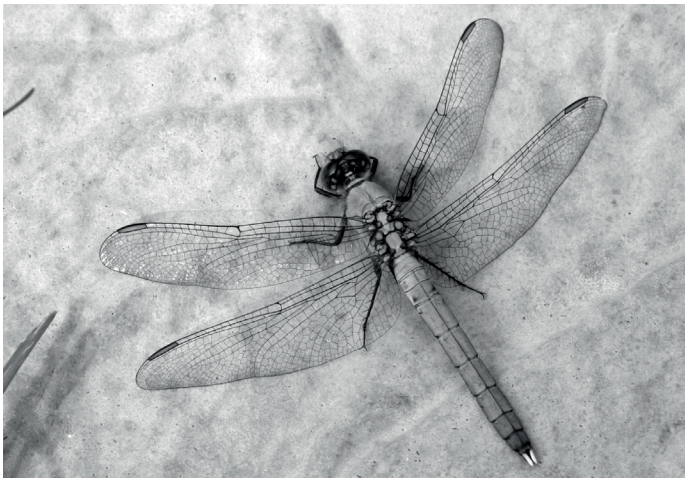
B. They reproduce by producing seeds.

C. They are classified into the same class.

D. They are classified into the same genus.

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?

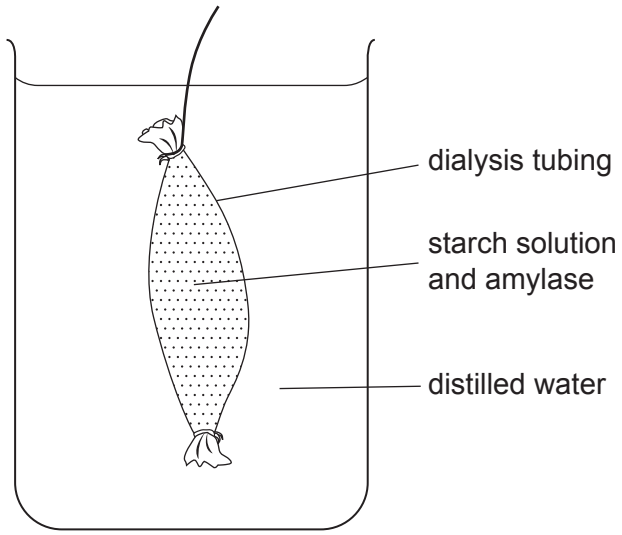
A. They are homologous structures formed by adaptive radiation.

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. What is a reason antibiotics are not used to treat the strains of viruses that cause influenza?

A. Influenza is caused by many different strains of virus.

B. Viruses have become resistant to antibiotics.

C. Viruses lack a metabolism.

D. Antigens of viruses have a high rate of mutation.

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?

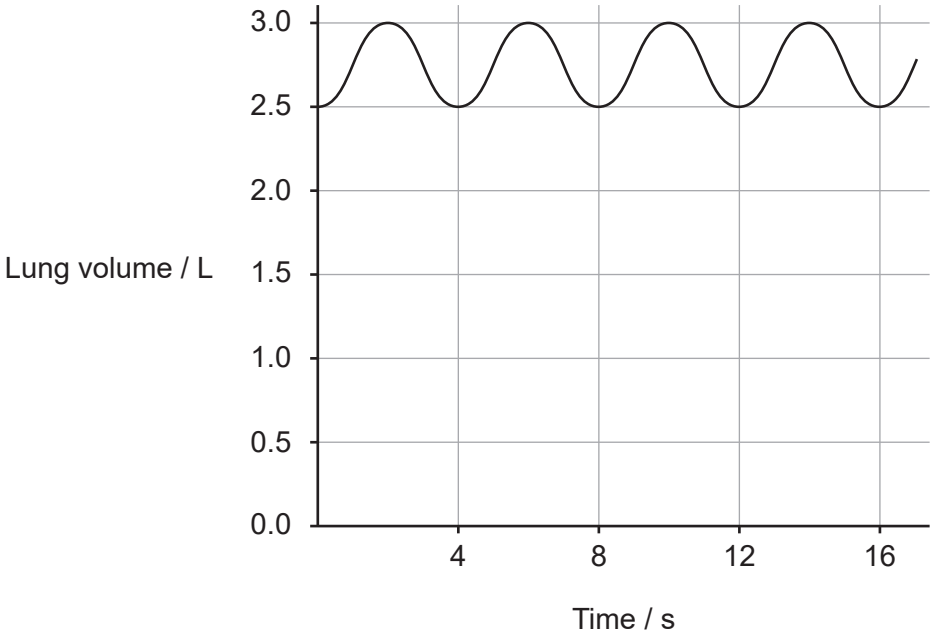
A. I and II only

B. II and III only

C. I, II and III

D. III only

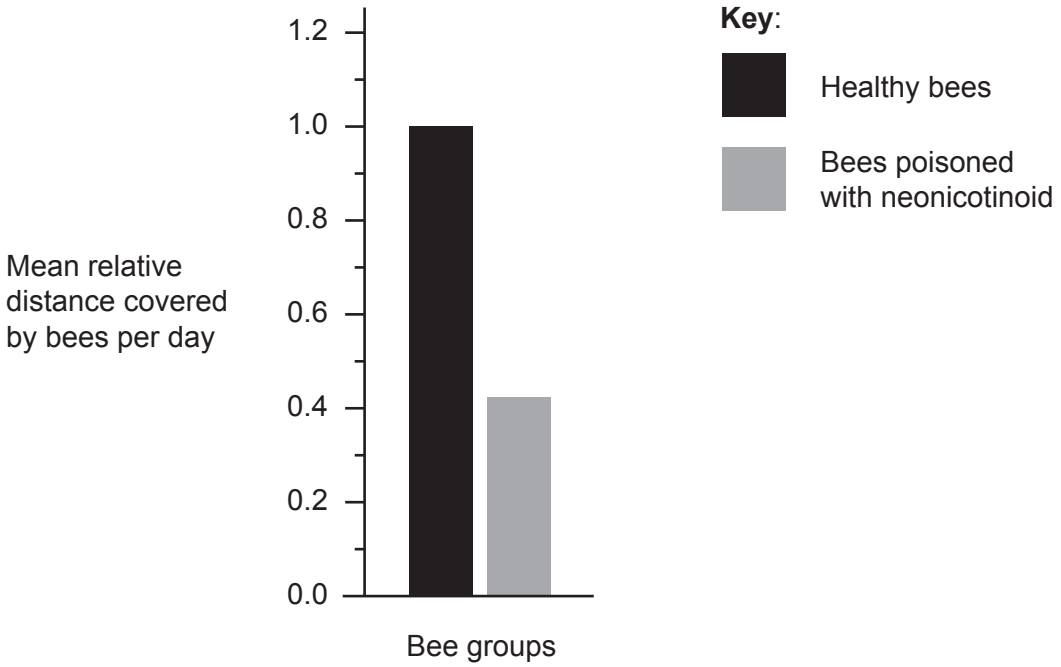
28. The spirometer reading shows the change of volume of the lungs during normal breathing.



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. The use of neonicotinoid pesticides in agriculture has been restricted because they reduce the survival of useful insect populations such as bees. A study compared the distance moved in one day by bees poisoned with neonicotinoid and healthy bees.



What explains the results obtained for the bees poisoned with neonicotinoids?

A. Muscle stimulation decreased because acetylcholine secretion was blocked.

B. Muscles were overstimulated as acetylcholine accumulated in synaptic clefts.

C. Muscle paralysis resulted from acetylcholine denaturation.

D. Muscle contraction decreased as less acetylcholine could bind to receptors.

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

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References:

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.

Dragonfly image: Nonenmacher, R. A. 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.

29. Charreton M, et al, 2015. A Locomotor Deficit Induced by Sublethal Doses of Pyrethroid and Neonicotinoid Insecticides in the Honeybee *Apis mellifera*. *PLoS ONE* 10(12): e0144879. https://doi.org/10.1371/journal.pone.0144879. Licensed under https://creativecommons.org/licenses/by/4.0/.