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GCE AS / A LEVEL – BIOLOGY UNIT 2 QUESTION PACK

1072-01 (Legacy BY2) · New spec Unit 2 Topic 5 · AS unit, first sat 2016, 80 marks, 1h 30min paper

REVISE

.wales

BIOLOGY – UNIT 2 · GAS EXCHANGE & ANIMALS (FISH, INSECTS, SINGLE-CELLED)

BY2.2.4 Adaptations for gas exchange – single-celled organisms, fish gills and insect tracheae

Surface area: volume relationships in single-celled organisms, counter-current exchange in fish gills, the insect tracheal system and the transition from aquatic to terrestrial respiration across vertebrates.

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~2 h 10 min

Derived from the legacy BY2 paper's pace of ~1.1 min/mark, padded for long-prose answers (81 marks over 8 questions).

You are advised to **not** attempt to complete all of this in one sitting.

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC BY2 papers (2008 modular spec, 2011–2017) that maps onto new-spec AS Unit 2 Topic 5 (2.4).

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – quality of written communication will affect marks. A calculator is allowed. Diagrams included in answers must be fully annotated.

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Q	Source	Max	Mark	Q	Source	Max	Mark
1	Jun 12 Q5	8		5	Jun 14 Q4	13	
2	Jan 12 Q5	15		6	Jun 16 Q2	7	
3	Jan 13 Q2	11		7	Jan 14 Q6	9	
4	Jan 13 Q4	10		8	Jun 17 Q2	8	
Total						81	

Gas Exchange – Animals (Fish, Insects, Single-Celled) – what the new spec asks

WJEC GCE AS / A Level Biology (from 2015) · Unit 2: Biodiversity & Physiology of Body Systems · Topic 2.4.

Single-celled organisms

- Large SA:V; short diffusion distance.
- Direct diffusion across cell membrane.
- Examples: *Amoeba*, *Paramecium*.

Insects – tracheal system

- Spiracles → tracheae → tracheoles → tissue.
- Air-filled tubes deliver oxygen directly to cells.
- Ventilation by abdominal muscle pumping in active insects.

Fish gills – counter-current

- Filaments and lamellae give huge SA.
- Counter-current flow: blood and water move in opposite directions.
- Maintains diffusion gradient along the whole lamella.

Vertebrate comparison

- Fish (gills) → amphibians (lungs + skin) → reptiles, birds, mammals (lungs).
- Move from aquatic to terrestrial ⇒ need to limit water loss.
- Earthworms gas exchange across moist skin – only viable in damp habitats.

Gas Exchange – Animals (Fish, Insects, Single-Celled) in one page

Quick-reference notes – revisit before each question.

Why size matters

Small organism: high SA:V \Rightarrow direct diffusion is enough.

Large multicellular: low SA:V \Rightarrow needs specialised surface + transport.

Insect tracheae

Spiracles (valved openings) \rightarrow tracheae (chitin-rings) \rightarrow tracheoles \rightarrow cell.

Air-filled – gas diffuses directly to tissues.

Abdominal muscle pumping ventilates in active insects.

Fish gills

4 pairs of gills under operculum.

Each has filaments; each filament has lamellae.

Counter-current flow keeps diffusion gradient along whole lamella.

Aquatic vs terrestrial

Water: low O₂ concentration; viscous; oxygen extracted from water.

Air: 21% O₂; less dense; but evaporation risk.

Terrestrial animals develop internal lungs to limit water loss.

Earthworm & amphibians

Earthworm gas exchanges across moist skin – only in damp soil.

Amphibians: lungs + skin + buccal cavity.

Lugworm & Planaria

Flatworms (e.g. *Planaria*): flat shape gives high SA:V.

Lugworm: external gill projections increase SA in burrows.

5. The photograph below shows a scanning electron micrograph of fish gills.

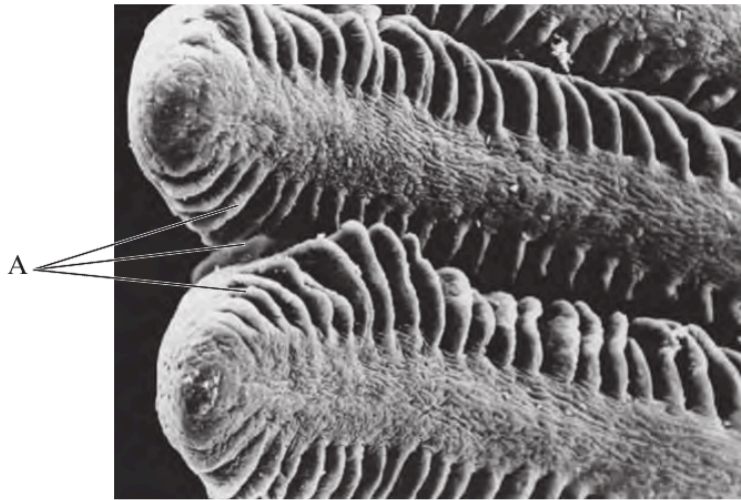


Photo courtesy of Electron Microscopy Unit, Royal Holloway University of London

(a) Identify structures A. [1]

(b) Using the photograph above and your own knowledge, describe **three** features of fish gills which allow them to achieve efficient gas exchange. [3]

- 1.
- 2.
- 3.

(c) Water is a dense medium with a low oxygen content. Explain how bony fish have overcome the problems of oxygen uptake in water. [4]

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(Total 8 marks)

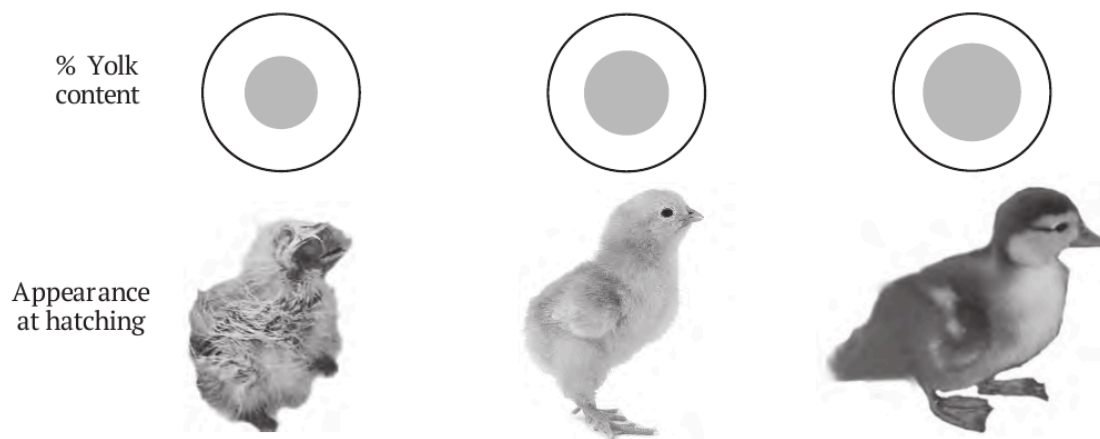


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5. (a) The different classes of vertebrates show a gradual change from an aquatic to a terrestrial existence. Tick (✓) the boxes in the table below, to show the class or classes of vertebrates to which each statement refers. [4]

Statement	Fish	Amphibia	Reptiles	Birds	Mammals
Fertilisation is always internal					
Eggs are laid in an aquatic environment					
The embryo is surrounded by a membrane called the amnion					
Both fertilisation and embryo development are always internal					

- (b) The diagram shows the percentage of yolk found in the eggs of three different species of birds and the appearance of the chicks at hatching.



- (i) Explain why the chick hatched from the egg with 20% yolk would need the greatest level of parental care after hatching. [2]

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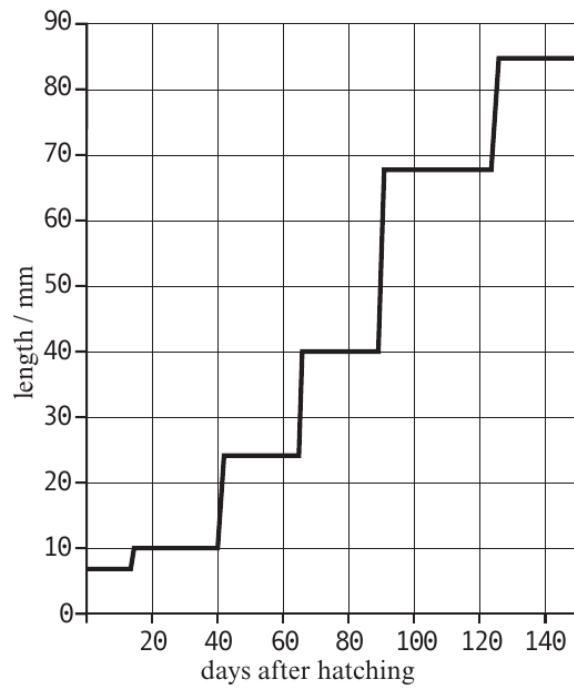
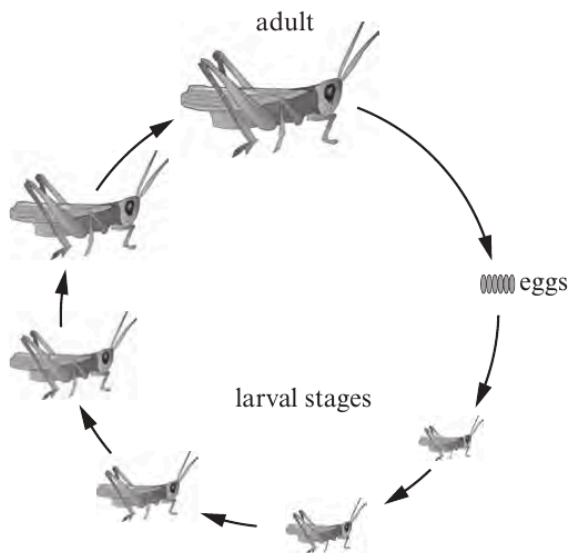
- (ii) Suggest a reason why organisms that provide a high level of parental care to their young often produce fewer offspring. [2]

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(c) Insects are a group of organisms adapted to a terrestrial way of life.

The diagrams below show the stages in the life cycle of a locust and the length of the insect at different times following hatching.



(i) Name the type of insect life cycle shown by the locust. [1]

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(ii) What name is given to the different larval stages shown in the diagram? [1]

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(iii) Use your knowledge and understanding of this type of insect life cycle to explain the changes in length of the insect following hatching. [3]

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(d) As an adaptation to life on land, insects have evolved a different system of gaseous exchange to vertebrates.

Complete the following sentences, about gaseous exchange, by inserting the most appropriate words to fill in the blanks. [2]

Insects have a system of tubes, called, instead of lungs. These transport oxygen directly to the cells. Air enters these tubes through pores called

(Total 15 marks)

Examiner
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2. In animals gas exchange occurs across respiratory surfaces.

(a) Describe **three** properties that all respiratory surfaces must possess and explain why they must have them. [3]

Property

Reason

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Property

Reason

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Property

Reason

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(b) The Flat-headed Frog, *Barbourula kalimantanensis*, is found in fast-flowing mountain streams and is the only known lungless frog.

(i) Suggest how this frog carries out gas exchange without lungs. [1]

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(ii) How do the conditions in the mountain stream aid gas exchange? [2]

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(iii) Give **two** reasons why gills do not function effectively on land. [2]

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(c) Define counter-current flow as seen in the gills of bony fish, and explain why counter current flow makes gas exchange more efficient. [3]

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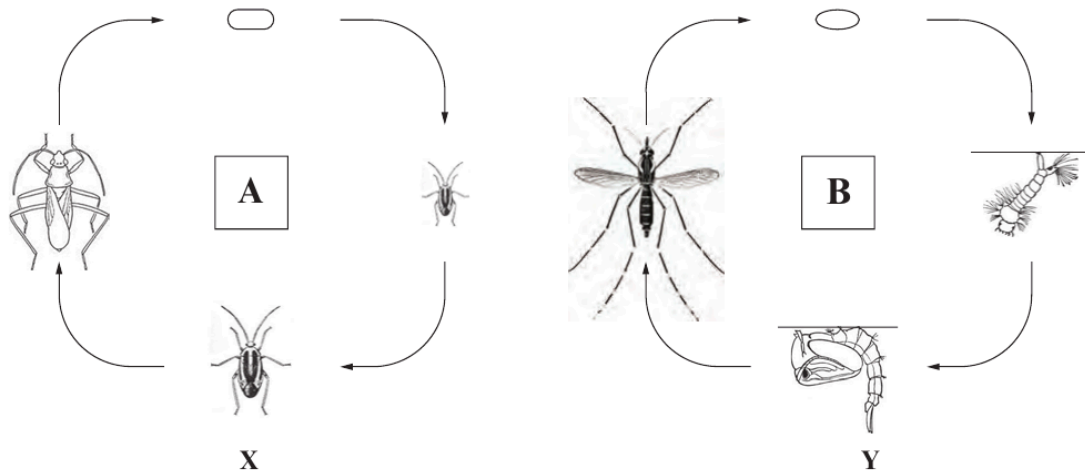
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4. Insects are amongst the animals best adapted to life on land. Their exoskeleton provides a protective waterproof covering, however it creates a problem for growth. The diagrams below show how insects' reproductive strategies help to overcome this problem.



(a) (i) Name the types of life cycle shown above. [1]

A B

(ii) Name the stages X and Y shown in the life cycles above. [1]

X Y

(b) State why having an exoskeleton is a problem for growth and explain how the problem of growing with an exoskeleton is overcome in life cycle A. [3]

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(c) Reptiles and birds are adapted to reproduce on land by producing amniote eggs. Describe **two** features of an amniote egg. [2]

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(d) The development of embryos takes place internally in mammals. List **three** ways in which this is an advantage over externally laid eggs. [3]

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4. (a) Bony fish rely on gills and gill filaments for gaseous exchange. Explain how the presence of gill filaments is an adaptation to gaseous exchange. [2]

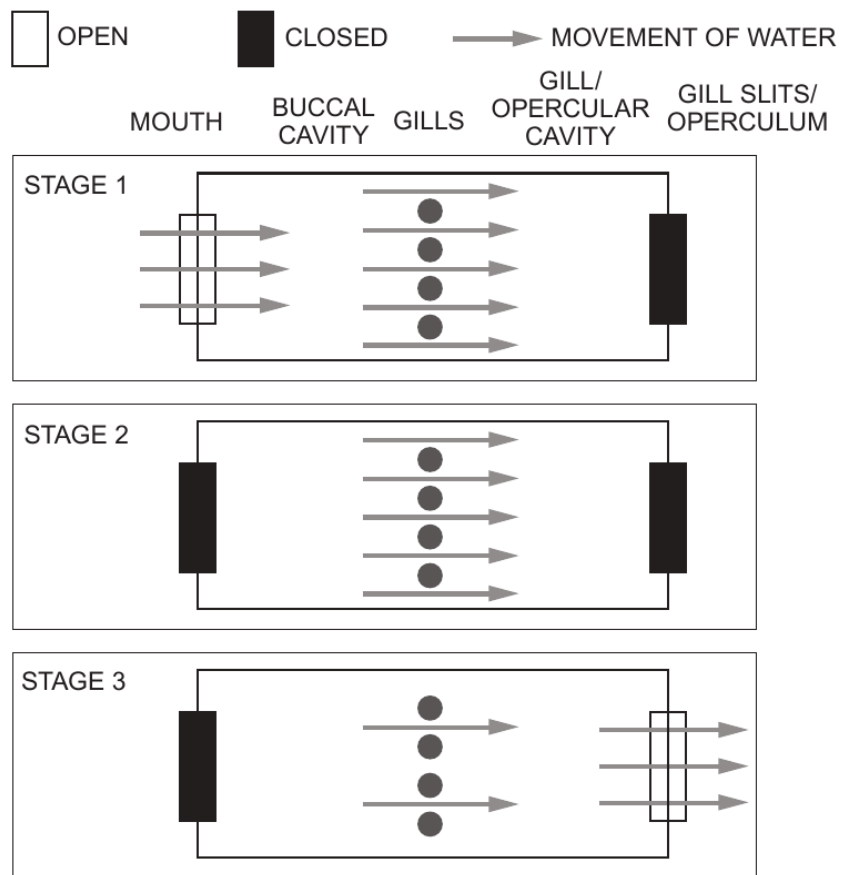
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- (b) The system of ventilation in a bony fish enables water to be passed continuously over its gills whilst the fish is at rest. The diagrams below show three stages in the process of ventilation.



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- (i) Ventilation of the gills is achieved by pressure changes in the buccal and gill/ opercular cavities. Using information from the diagram opposite and your own knowledge describe the process of ventilation in a bony fish. [4]

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- (ii) In order to further increase the efficiency of gas exchange, bony fish use a counter current flow. State what is meant by *counter current flow* and explain how this increases the efficiency of gas exchange in the bony fish. [3]

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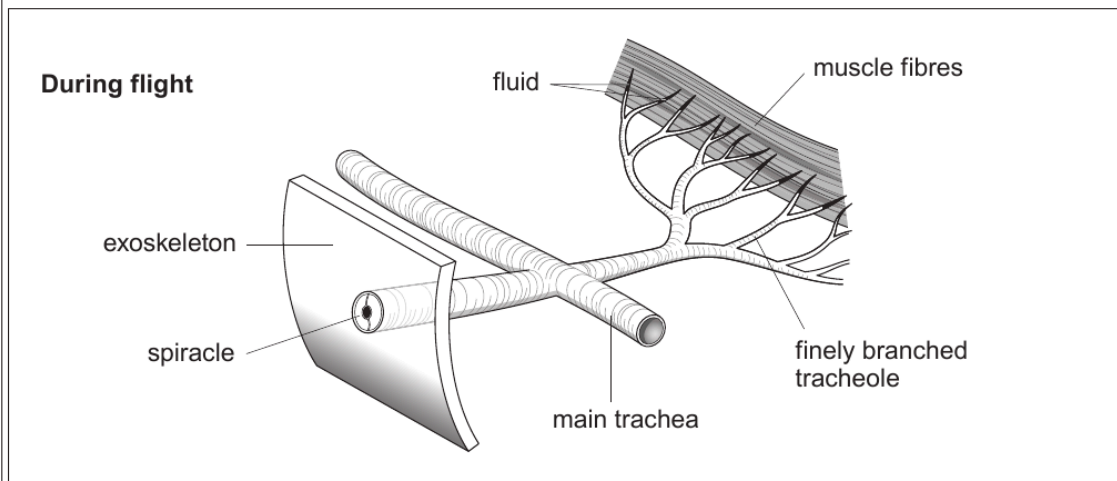
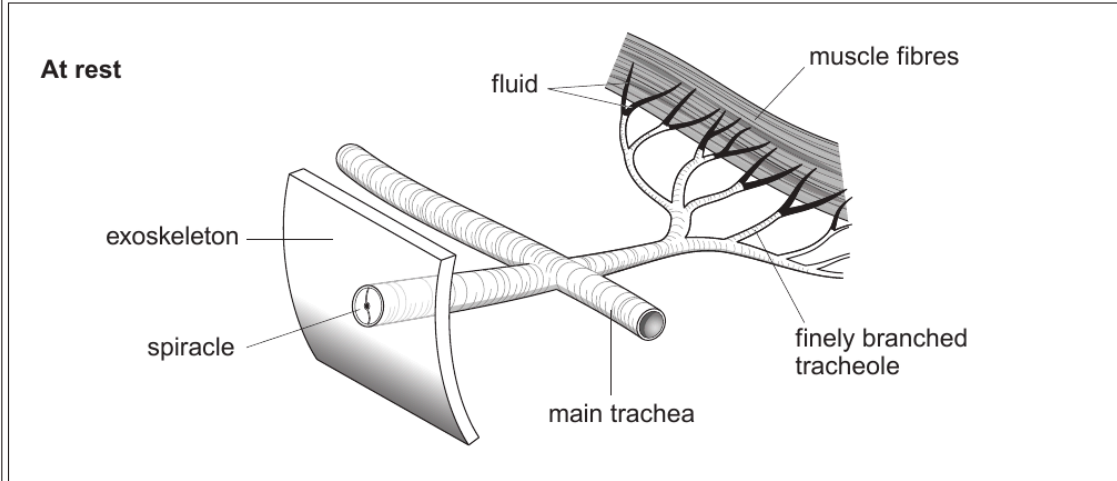
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(c) The diagrams below show insect tracheoles supplying muscle fibres at rest and during flight.



(i) The tracheoles are found on the outside of the muscle fibres. Suggest why the maximum diameter of a muscle fibre never exceeds 20 μm in diameter. [2]

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(ii) Describe the change in fluid level in the tracheoles during flight. Suggest how this change benefits gaseous exchange during flight. [2]

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2. (a) Below is a photograph of the dragonfly, *Aeshna caerulea*, which inhabits wetland areas of Scotland.

Examiner only



- (i) State the name of the phylum to which it belongs. [1]

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- (ii) State **two** characteristics, shown by the dragonfly, which could be used to place it into its phylum. [2]

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- (iii) What is meant by the term *genus*? [1]

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- (iv) State the genus to which this dragonfly belongs. [1]

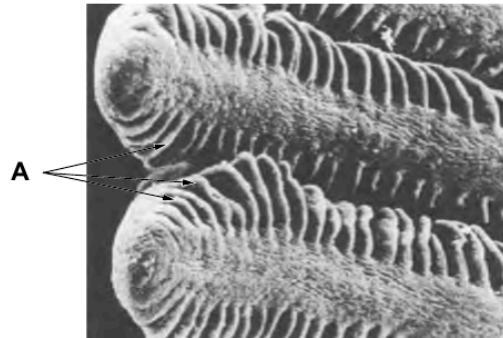
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- (b) Both dragonflies and birds have wings that enable them to fly, but are placed in different taxonomic groups. What conclusions can be drawn about the evolution of these structures? [2]

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6. The photograph below shows a scanning electron micrograph of fish gills.



<http://ars.els-cdn.com/content/image>

Examiner
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(a) Name the structures labelled **A** in the photograph above. [1]

(b) Describe how a bony fish ventilates its gills and absorbs oxygen from water. [4]

(c) Using the photograph above and your own knowledge, describe **four** similarities in the adaptations of the gill for gaseous exchange and a mammalian villus for the absorption of digested products. [4]

2. (a) Define the term *diffusion*.

[1]

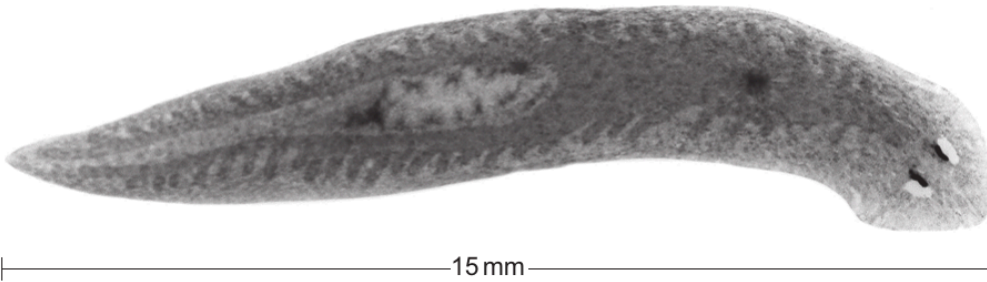
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(b) The image below is of a *Planaria*, a multicellular flatworm.



Although it is a multicellular organism, simple diffusion provides adequate gaseous exchange between the organism and the environment. Explain why simple diffusion is adequate in this case. [2]

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(c) The phylum Annelida contains both the earthworm (*Lumbricus terrestris*) and the lugworm (*Arenicola marina*).

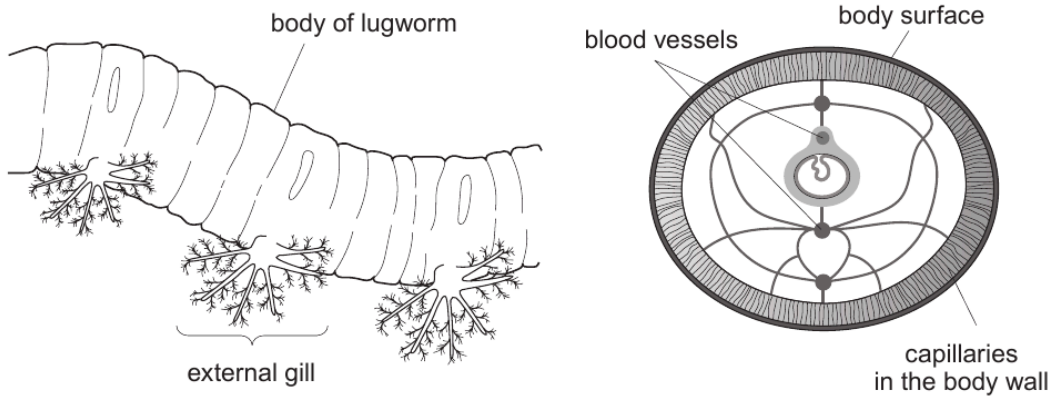
(i) State where gas exchange occurs in an earthworm.

[1]

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- (ii) A fully grown lugworm can reach a length of 23cm with a diameter of 1 cm. The images below show the external appearance and a transverse section through the body.



Explain how the structural adaptations shown by the lugworm have enabled it to grow to such a large size. [4]

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END OF QUESTION PACK

8 questions · 81 marks · ~2 h 10 min

Source: WJEC BY2 (2008 modular spec, 2011–2017)

Curated for WJEC Biology 2015 spec AS Unit 2 – Topic 5 (2.4)

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