Name	Date started	Target end date

GCE A LEVEL — BIOLOGY UNIT 3 QUESTION PACK

1074 (Legacy BY4) + 1075 (Legacy BY5) · New spec Unit 3 Topic 11 · A2 unit, first sat 2017, 90 marks, 2h paper

REVISE
.wales

BIOLOGY — UNIT 3 · NERVOUS SYSTEM — SYNAPSES, REFLEX ARCS & CNS

3.6 The nervous system — synaptic transmission, the reflex arc and CNS organisation

Structure of a cholinergic synapse, the cascade from action potential to vesicle fusion, neurotransmitter release, postsynaptic depolarisation and acetylcholinesterase clean-up; the three-neurone reflex arc through the spinal cord (sensory→relay→motor), and the broad organisation of the central and peripheral nervous systems.

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~1 h 17 min

Derived from the legacy BY4 / BY5 papers' pace of ~1.3 min/mark, padded for long-prose answers (48 marks over 5 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 BY4 (and BY5, where relevant) papers (2008 modular spec, 2011–2017) that maps onto new-spec A2 Unit 3 Topic 11 (3.6).

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.

For Examiner's use only

Q	Source	Max	Mark
1	BY4 Jun 12 Q2	10	
2	BY4 Jun 13 Q1	3	
3	BY4 Jun 14 Q3	14	
4	BY4 Jun 15 Q7	9	
5	BY4 Jun 17 Q6	12	
	Total	**48**	

Nervous System — Synapses, Reflex Arcs & CNS — what the new spec asks

WJEC GCE A Level Biology (from 2015) · Unit 3: Energy, Homeostasis & the Environment · Topic 3.6.

Synapse structure

- Presynaptic knob, vesicles of neurotransmitter, mitochondria.
- Synaptic cleft ~20 nm wide.
- Postsynaptic membrane with receptor proteins.

Cholinergic synapse cascade

- AP → Ca^{2+} influx via voltage-gated channels.
- Vesicles fuse with presynaptic membrane → ACh into cleft.
- ACh binds postsynaptic receptors ⇒ Na^{+} influx ⇒ new AP.

ACh clean-up

- Acetylcholinesterase in the cleft hydrolyses ACh to acetate + choline.
- Stops continuous postsynaptic firing.
- Choline taken back into presynaptic knob, recycled.

Synapse properties

- Unidirectional — receptors only on postsynaptic side.
- Summation: temporal or spatial sub-threshold signals add up.
- Inhibitory synapses (e.g. GABA) hyperpolarise postsynaptic membrane.

Reflex arc

- Three neurones: sensory → relay (spinal cord) → motor.
- By-passes the brain ⇒ rapid, automatic response.
- Examples: knee-jerk, withdrawal of hand from hot object.

Spinal cord

- Grey matter centrally (cell bodies); white matter outside (myelinated axons).
- Dorsal root carries sensory fibres in; ventral root carries motor fibres out.
- Relay neurones in grey matter integrate the reflex circuit.

Crib sheet »

Nervous System — Synapses, Reflex Arcs & CNS in one page

Quick-reference notes — revisit before each question.

Synapse parts

Presynaptic knob with vesicles & mitochondria.

Synaptic cleft ~20 nm.

Postsynaptic membrane with receptor proteins.

ACh release

AP → Ca^{2+} influx via voltage-gated channels.

Vesicles fuse with presynaptic membrane.

ACh exocytosed into cleft.

Postsynaptic response

ACh binds receptor → Na^{+} channels open.

Depolarisation → new AP (if threshold).

Excitatory or inhibitory depending on receptor.

ACh clearance

Acetylcholinesterase (AChE) hydrolyses ACh.

Acetate + choline recycled.

Allows postsynaptic membrane to repolarise.

Unidirectional

Receptors only on postsynaptic side.

Vesicles only on presynaptic side.

One-way signal flow.

Summation

Temporal: rapid repeats sum.

Spatial: multiple synapses sum.

Sub-threshold becomes threshold.

Reflex arc

Sensory neurone → relay (cord grey matter) → motor neurone.

Bypasses brain; fast protective response.

Examples: knee-jerk, withdrawal from heat.

Spinal cord

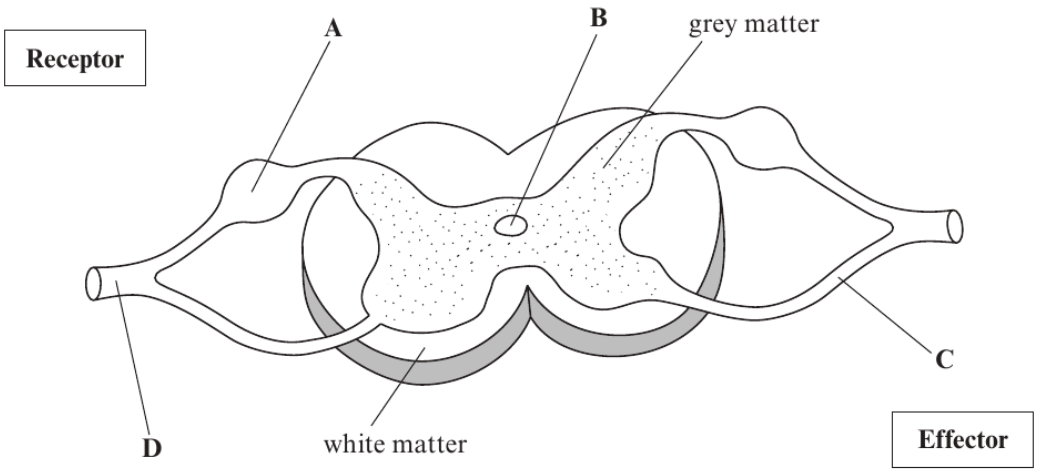
Grey matter inside (cell bodies); white outside (myelinated tracts).

Dorsal root: sensory in; ventral root: motor out.

Relay neurones link the arc.

Examiner only

2. A diagram of a section of the spinal cord is shown.



(a) (i) Identify structures **A-D**. [4]

A .....

B .....

C .....

D .....

(ii) Explain why the white matter is white and the grey matter is grey. [2]

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(b) (i) On the diagram above, draw a **sensory neurone**, a **relay neurone** and a **motor neurone**. The sensory neurone should enter at one side of the spinal cord and the motor neurone should exit on the other side. The neurones should link the **receptor** to the **effector**. **Label** each neurone. [3]

(ii) What is the difference in **function** between an axon and a dendrite? [1]

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(Total 10 marks)

Examiner only

1. *(a)* State the general role of muscles and glands in simple reflexes. [1]

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(b) The phylum Cnidaria includes animals with a relatively simple body plan such as sea anemones, jellyfish and hydra. They respond to stimuli but these responses are slower than in humans. Suggest a reason for the slower speed of response. [1]

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(c) Name the substance that plants use to detect day and night length. [1]

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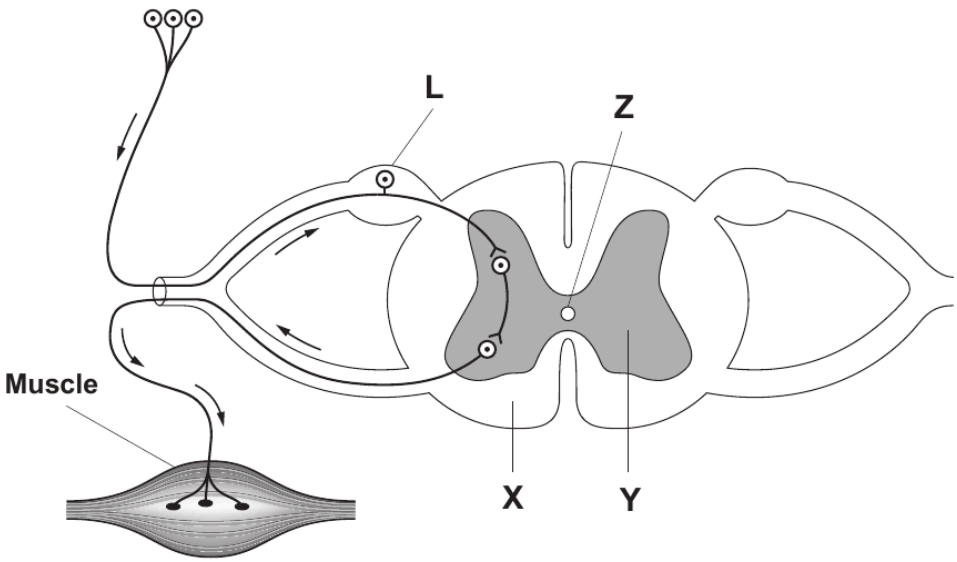
2. The red kite *(Milvus milvus)* was at one time a common bird of prey in Britain, but by the end of the 19th century it had been driven almost to extinction and just three pairs survived in mid-Wales. As a result of conservation efforts, numbers rose during the 20th century. The table below shows numbers of breeding pairs for years when accurate counts or estimates are available.

Year	Number of breeding pairs
1933	4
1962	15
1976	34
1986	48
1995	100
2009	1000

Examiner only

3. The diagram below shows a transverse section of spinal cord and an associated reflex arc.



(a) (i) Identify **X** and **Y** shown on the diagram above and explain why there is a difference in colour in these two areas. [2]

X .....

Y .....

Explanation

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(ii) Identify **L** and **Z** shown on the diagram above. [2]

L .....

Z .....

Examiner only

(b) (i) What is the name given to: [2]

I the cells which partially cover neurons

.....

II the material which the cells produce to cover the axon

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(ii) What is the function of this material in the conduction of an action potential? [2]

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(iii) Multiple sclerosis is a progressive, degenerative disease of the nervous system in which the material referred to in *(b)*(i) is destroyed. Symptoms include increasing muscle weakness and loss of vision. Suggest an explanation for these symptoms. [2]

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(iv) Suggest a possible medical treatment for multiple sclerosis. [1]

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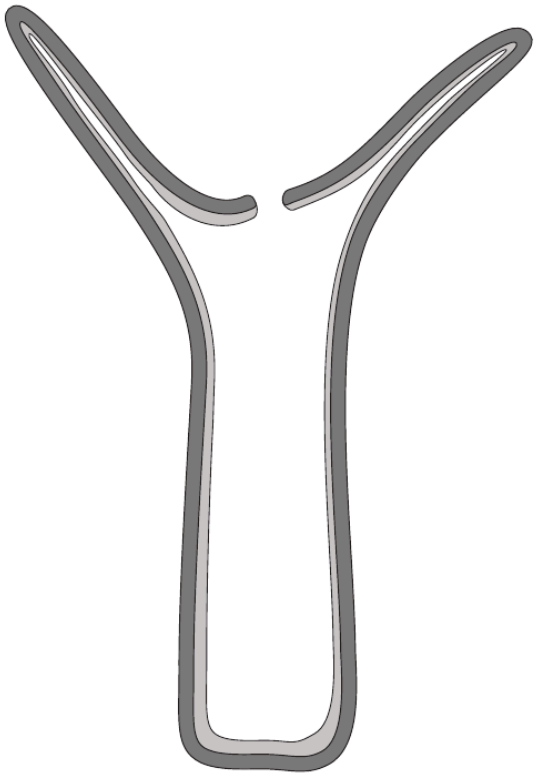
Examiner only

(c) Nerve nets are common in some animal groups.

(i) Complete the diagram below to show a nerve net as would be seen in *Hydra*. [1]



(ii) Give **two** ways in which the nerve net, as seen in *Hydra*, differs from that of the nervous system of a vertebrate. [2]

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Examiner only

7. Acetyl cholinesterase is one of many enzymes needed for the functioning of the nervous systems of vertebrates and insects. Certain chemical classes of pesticides, such as organophosphates, work against pests by inhibiting cholinesterase. While the effects of cholinesterase-inhibiting products are intended for insect pests, these chemicals can also be toxic to humans.
In severe cases of exposure to organophosphates, symptoms include uncontrollable muscular tremors, breathing difficulty and possible death.

(a) Explain the toxic effects of the organophosphates. [5]

(b) Psychoactive drugs can affect synaptic transmission in a number of different ways.
Suggest some different mechanisms by which psychoactive drugs could decrease the rate of synaptic transmission. [4]

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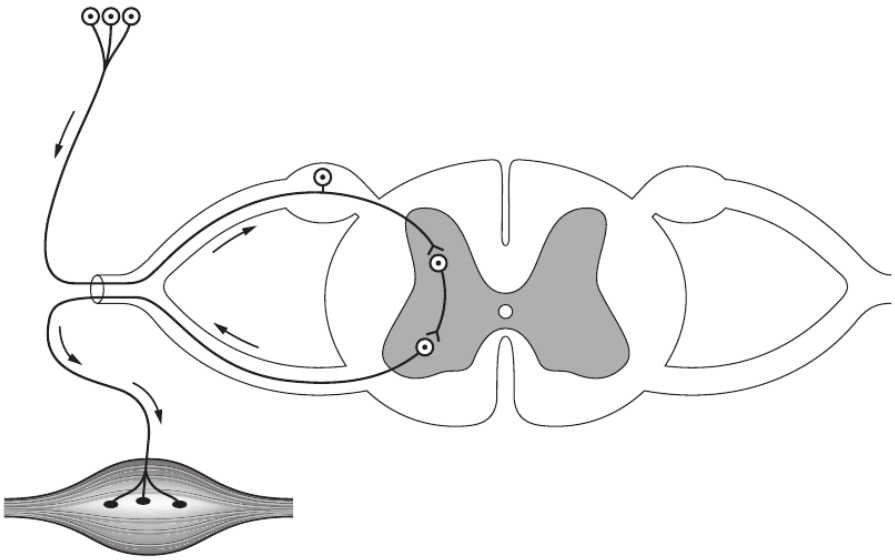
Examiner only

6. The diagram below shows a transverse section of the spinal cord.



(a) **Label the position** of a cell body of a motor neurone on the diagram above. [1]

Spinal polio results from viral invasion of the motor neurones of the spinal column. This causes inflammation of the nerves, finally resulting in the destruction of motor neurones. The muscles formerly supplied by the now-dead neurones become weak, floppy and poorly controlled, and finally completely paralysed.

(b) (i) Explain how the virus causes muscles to become weak and finally paralysed. [3]

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Examiner only

(ii) The paralysis can be asymmetrical with any limb or any combination of limbs affected. Suggest why. [2]

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Action potentials are transmitted from neurone to neurone by means of neurotransmitters at synapses.

(c) (i) Describe the sequence of events which would lead to the release of the neurotransmitter. [3]

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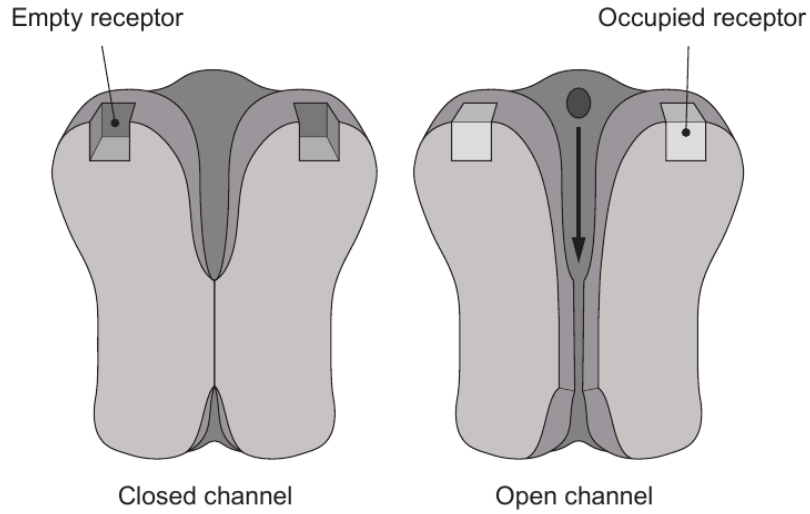
Examiner only

The diagrams below show a closed and open receptor on the post synaptic membrane.



(ii) Describe how the neurotransmitter causes the channel to change from the closed to open position and the consequence of opening the channel. [3]

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END OF QUESTION PACK

5 questions · 48 marks · ~1 h 17 min
Source: WJEC BY4 + BY5 (2008 modular spec, 2011–2017)
Curated for WJEC Biology 2015 spec A2 Unit 3 — Topic 11 (3.6)