Unit 21 · Nervous System

ANSWER KEY · FOR TEACHERS

Full marks 32

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

K · 4

1. pia mater
2. choroid plexuses
3. subarachnoid space
4. nodes of Ranvier
5. saltatory
6. acetylcholinesterase
7. GABA
8. thoracolumbar

Each carries 0.5 mark.

2 Label the diagram

K · 3

1. corpus callosum
2. hypothalamus
3. midbrain
4. pons
5. thalamus
6. medulla oblongata

Each carries 0.5 mark.

3 Multiple choice

i. **c.** vagus — K · 1

The **vagus** (CN X), the "wanderer", runs from the medulla down through the neck to the chest and abdomen. The trigeminal is the **largest** (thickest), not the longest.

ii. **c.** most sympathetic postganglionic fibers — U · 1

Adrenergic fibers are most **sympathetic postganglionic** fibers. All preganglionic fibers, parasympathetic postganglionic fibers and somatic motor neurons are **cholinergic**: they release acetylcholine.

iii. **b.** voltage-gated sodium channels open and Na^+ diffuses in — U · 1

At threshold the **voltage-gated Na^+ channels** open and Na^+ ions **diffuse in**, down their concentration gradient, making the inside positive. The pump always moves Na^+ **out**; K^+ flowing **out** (not in) is what repolarizes the membrane afterwards.

iv. **a.** Broca's area, in the frontal lobe — A · 1

Broca's area plans the movements of speaking. Damage to **Wernicke's area** does the opposite: the person speaks fluently but makes little sense and cannot understand speech.

v. **b.** cerebellum — A · 1

Clumsy, badly timed movements and poor balance, with thinking intact, point to the **cerebellum**, the coordinator of movement and balance. Damage to the medulla would threaten breathing and heartbeat; the hypothalamus, temperature and hunger; the occipital lobe, vision.

4 Short answers

a. MARKING SCHEME — K · 2

- ✓ The law: no impulse below threshold, the same-sized impulse at or above it.
- ✓ A stronger stimulus gives more impulses a second and excites more neurons.

b. MARKING SCHEME — U · 2

- ✓ Along the axon: the patch behind is refractory.
- ✓ At the synapse: vesicles on one side, receptors only on the other.

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c. MARKING SCHEME A · 2

✓ Acetylcholine is not broken down and builds up in the cleft.
✓ The muscles are overstimulated (twitching), then can't respond (paralysis).

d. MARKING SCHEME U · 3

✓ Na^+ high outside; K^+ and negative proteins high inside.
✓ The Na^+/K^+ pump uses ATP: 3 Na^+ out, 2 K^+ in.
✓ K^+ leaks out through open channels, leaving the inside at about −70 mV.

5 Long answers

a. ANSWER U · 4

- **Resting (polarized):** about **−70 mV**, inside negative.
- **Depolarization:** a stimulus brings the membrane to **threshold (about −55 mV)**; **voltage-gated Na^+ channels** open and Na^+ **diffuses in**, opening more channels (positive feedback); the inside reaches about **+30 to +40 mV**: the action potential.
- **Repolarization:** at the peak the Na^+ channels **close and lock**, and the slower **voltage-gated K^+ channels** open; K^+ flows **out** and the inside turns negative again (absolute refractory period).
- **Hyperpolarization:** the K^+ channels close slowly, so the inside falls to about **−80 to −90 mV** (relative refractory period), then settles at −70 mV; the **pump** slowly restores the ions.

MARKING SCHEME

✓ Resting −70 mV; threshold about −55 mV.
✓ Na^+ channels open, Na^+ diffuses in, inside +30 to +40 mV.
✓ Na^+ channels close, K^+ flows out: repolarization.
✓ Undershoot to −80 to −90 mV, then rest; the pump restores the ions.

b. ANSWER A · 4

	Sympathetic	Parasympathetic
Outflow	thoracolumbar (T1–L2)	craniosacral (CN III, VII, IX, X; S2–S4)
Fibers	short preganglionic, long postganglionic; ganglia in a chain near the cord	long preganglionic, short postganglionic; ganglia near or in the organs
Transmitter at the organ	noradrenaline (adrenergic)	acetylcholine (cholinergic)
Effects	"fight or flight": faster heart, wider pupils and airways, glucose released, less digestion	"rest and digest": slower heart, narrower pupils and airways, more saliva and digestion, bladder emptied

MARKING SCHEME

✓ Outflow: thoracolumbar against craniosacral.
✓ Short against long preganglionic fibers, and where the ganglia are.
✓ Noradrenaline against acetylcholine at the organ.
✓ Opposite effects, with two examples (heart, pupil, airways, digestion).

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6 Think

ANSWER HA · 3

In a myelinated fiber the **ion channels are crowded at the nodes** and the myelin insulates the membrane between them, so the impulse **leaps from node to node** (saltatory conduction), fast.
Where the myelin is lost, the current from one node **leaks out** through the bare membrane before it reaches the next.
That stretch has **few sodium channels** to fire on its own, so the impulse slows or **dies out**.

MARKING SCHEME

- ✓ Myelin insulates; channels at the nodes give fast saltatory conduction.
- ✓ Without myelin the local current leaks away before the next node.
- ✓ The bare stretch has too few Na^+ channels to fire, so the impulse slows or fails.

7 Activity: Catch the ruler

(not marked)

WHAT STUDENTS SHOULD FIND

Most students catch it after about **10–25 cm** (a reaction time of about 0.15–0.25 s; time = $\sqrt{(2 \times \text{distance} \div 9.8)}$). The impulse must go from the **eye (or ear)** along the sensory nerve to the **brain**, be processed in the cortex, and travel down the **motor neurons** to the hand muscles, crossing several **synapses**, each with a short delay. This is a voluntary action, not a spinal reflex, so it takes longer.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	10	11	8	3	**32**

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