5.10 The brain, imaging and brain chemistry

Name: _____ Class: _____ Date: _____ **Total: 18 marks**

KEY WORDS cerebral hemisphere • cerebellum • pituitary • dopamine • blood-brain barrier

Objective

Practise statements 8.13-8.16: nervous and hormonal coordination, the brain's regions and functions, the four imaging methods, and neurotransmitter imbalances with their drug treatments.

1 Key knowledge and worked examples

Two coordination systems, one organism

Nervous: fast, electrical, precise targets, short-lived. Hormonal: slower, chemical, broadcast by blood, longer-lasting. Many responses - fight or flight, exercise, stress - use both.

The brain's landmarks

Cerebral hemispheres : voluntary movement, sensation, thought. **Cerebellum** : balance, coordination of movement. **Hypothalamus** : thermoregulation, osmoregulation. **Pituitary** : the hormone master gland below the hypothalamus. **Medulla oblongata** : heart rate, breathing, swallowing.

Seeing the brain

MRI - strong magnetic field and radio waves; detailed structure. **fMRI** - tracks oxygenated blood flow; shows ACTIVE regions. **CT** - rotating X-ray; fast structural images, less detail than MRI. **PET** - radioactive tracer (e.g. FDG); metabolism, active areas, tumours.

Chemistry first

Parkinson's disease: **dopamine** -secreting neurones die in the substantia nigra; tremor, stiffness, slow movement. Treatment: **L-Dopa** - crosses the blood-brain barrier and is converted to dopamine inside the brain (dopamine itself cannot cross). Depression: low **serotonin** 5- - treated with SSRIs that block its re-uptake.

Worked example: choosing a scan

"Evidence of a stroke bleed within the hour": CT (fast, shows fresh blood). "Find which region controls memory during a task": fMRI (activity, not just structure). Matching the method to the question is the exam pattern.

2 Practice

2.1 Name the region of the brain that controls balance and coordination. [1]

2.2 State which imaging method shows brain ACTIVITY rather than structure. [1]

2.3 Name the neurotransmitter lacking in Parkinson's disease. [1]

3 Exam-style questions

3.1 The table lists five brain regions. Complete it by matching each region to its function, and state which two regions work together in osmoregulation.

Region	Function
Cerebral hemisphere	?
Cerebellum	?
Hypothalamus	?
Pituitary	?
Medulla oblongata	?

[6]

3.2 Explain why L-Dopa relieves the symptoms of Parkinson's disease while injected dopamine does not, naming the barrier involved and the conversion that occurs. [4]

3.3 A researcher wants to identify which brain areas are active when a person performs a memory task. Compare the suitability of MRI, fMRI and PET for this investigation, choosing one and justifying the choice. [5]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 The cerebellum.

2.2 fMRI (accept PET).

2.3 Dopamine.

3.1 Cerebral hemispheres - voluntary movement, sensation, thought; cerebellum - balance and coordination of movement; hypothalamus - thermoregulation and osmoregulation (monitors water potential); pituitary - secretes hormones under hypothalamic control (e.g. ADH); medulla - heart rate and breathing centres. Osmoregulation: hypothalamus detects, pituitary releases ADH.

3.2 Dopamine cannot cross the blood-brain barrier - it is a charged, polar molecule; L-Dopa is an amino-acid derivative transported across by carrier proteins; inside the brain, DOPA decarboxylase converts L-Dopa to dopamine, restoring transmission in the surviving pathways.

3.3 MRI shows structure only - it cannot show which regions are active. fMRI records oxygenated-blood flow to active regions in real time, and the task can be switched on and off to compare states. PET also shows activity via tracer uptake and could work, but requires injecting a radioactive tracer and gives lower spatial resolution. Choice: fMRI - non-invasive activity mapping with good resolution.