9.1 Neurons, synapses and neurotransmitters

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS synapse • reuptake

Objective

Predict drug and toxin effects from the six steps of transmission.

1 Key knowledge and worked examples

■ **The six steps**

AP → Ca^{2+} entry → SNARE fusion → cleft → receptor → reuptake or degradation ✓. One vesicle at the NMJ carries ~5,000–10,000 ACh molecules; ~50–300 vesicles sum to fire.

■ **Worked example: site predicts sign**

Botulinum cuts SNAREs (pre) and curare blocks the receptor (post) → flaccid; tetanus blocks inhibitory release → spastic ✓.

2 Practice

2.1 Name the ion that triggers vesicle fusion, and the protein machinery. [3]

2.2 Which is faster, an ionotropic or a metabotropic response – and by roughly how much? [3]

2.3 GABA on GABA-A inhibits while glutamate on AMPA excites. What decides the sign? [3]

3 Exam-style questions

3.1 A fictional patient given a teaching-set toxin develops flaccid paralysis; a second develops spastic paralysis.

For each toxin site (pre-synaptic release machinery, post-synaptic receptor, inhibitory interneuron release), predict the sign and justify from the six steps. Explain why weakness appears only when most end-plate receptors are occupied (the safety factor). [7]

3.2 A fictional drug blocks the serotonin transporter (an SSRI).

State which of the six steps it acts on (termination by reuptake). Predict the immediate effect on the cleft (more transmitter, longer presence). Explain why it does not change synthesis. [7]

Solutions

2.1

- Ca^{2+} through voltage-gated channels; SNARE proteins fuse the vesicle ✓.

2.2

- Ionotropic: channel opens in milliseconds; metabotropic works via G-proteins in seconds ✓.

2.3

- The receptor's channel – GABA-A passes Cl^{-} (inhibition), AMPA passes Na^{+} (excitation) ✓.

3.1

- Botulinum: no vesicle fusion → no release → flaccid ✓.
- Curare: release normal, receptor blocked → flaccid ✓.
- Tetanus: inhibitory release blocked → unopposed excitation → spastic ✓.
- The NMJ safety factor (~50–300 vesicles to threshold) means weakness needs most receptors occupied ✓.

3.2

- Step six – termination by reuptake is blocked ✓.
- Cleft serotonin persists longer and at higher concentration ✓.
- Synthesis (step three's loading of vesicles) is untouched – the drug acts after release ✓.
- Effect builds as clearance, not packing, is inhibited.

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