1.

(1) Please explain the change of ionic permeability of the membrane during the course of an action potential. (6%)

(2) What will happen if there is a tenfold change in the K+ concentration outside the neuron? Explain the rationales of your answer. (6%)

2.

Dopamine is an important neurotransmitter. For a neurotransmitter, there are some criteria: 1) the presence of its synthesizing enzyme in the neuron; 2) It can be released upon stimulation and function as exogenous ligands after activating postsynaptic receptors; 3) there is the way of elimination in the synapse. Based on these, can you justify why dopamine is a neurotransmitter? Please elaborate every point, especially for point #2, including the receptor subtypes and the downstream signaling. Besides, please also name three dopaminergic circuits in the brain and their associated functions. (12%)

3.

How much do you know about "long-term potentiation"? (8%)

4.

In the 1920s, American psychologist Karl Lashley conducted experiments to study the effects of brain lesions on learning and memory in rats. In a typical experiment, he trained a rat to run through a maze to get a food reward. The rat was given brain lesions in the rat's cortex before or after the rat learned the task. Lashley was investigating how rat's performance on this task was affected by lesions in the rat's cortex. Lashley found that the severity of the behavioral deficits caused by the lesions correlated with the size but was unrelated to the location of the lesion within the cortex. Thus Lashley speculated all cortical areas contribute equally to learning and memory.

(1) Please state and explain your comments on Lashley's studies. (6%)

(2) What might be the significance of Lashley's studies? (6%)

5.

Please explain below terms.

(1) Electroencephalogram (EEG) (4%)

(2) Epilepsy (4%)

(3) Sleep cycle (4%)

(4) Circadian rhythm (4%)

(5) Suprachiasmatic nucleus (4%)

6.

The common quality of the drugs heroin, nicotine, amphetamine and cocaine is explained by the fact they all act on the brain circuitry that motivates drug-seeing behaviors. State what you know about the underlying mechanism. (12%)

7.

(1) Why is dopa used to treat Parkinson's disease? How does it act to alleviate the symptoms? (6%)

(2) Masao Ito and his colleagues at the University of Tokyo discovered cerebellar long-term depression (LTD) in the Purkinje cell. Please briefly state what you know about it. (6%)

8.

Please explain the principles for "the diffuse modulatory systems" and list at least two examples. (12%)

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