PERIPHERAL NERVOUS SYSTEM AND SYMPATHETIC PHARMACOLOGY
PHA-2TJ1

Time allowed: 2 hours

Part ONE
Answer ALL questions. For each question, there is ONE correct answer. Use the answer grid provided for ALL your answers.

Part TWO
Answer THREE of the FOUR questions.
Use a SEPARATE answer book for EACH question in Part TWO.

The mark allocation for the paper is:
- Part ONE carries 40% of the total mark.
- Part TWO carries 60% of the total mark.

This paper consists of 10 pages in total.

The following is provided: Multiple choice answer grid.

Dictionaries are not permitted in this examination.
Notes are not permitted in this examination.
Do not take this question paper out of the examinations room.
Do not turn over until you are told to do so by the invigilator.
PART ONE

Answer ALL questions. For each question, there is ONE correct answer. Use the answer grid provided for ALL your answers.

1. Which ONE of the following parts of the neuron is responsible for synthesis of non-peptide neurotransmitters?
   (A) The axon hillock
   (B) The dendrites
   (C) The synaptic terminal
   (D) The nucleus
   (E) The axon

2. Which ONE of the following statements is INCORRECT regarding the vagus nerve?
   (A) Stimulation causes a decrease in heart rate
   (B) It is a cranial nerve
   (C) Its neurons release acetylcholine
   (D) It contains sympathetic pre-ganglionic neurons
   (E) It plays an important role in maintenance of homeostasis

3. At the resting membrane potential, the membrane is most permeable to which ONE of the following ions?
   (A) Na^+
   (B) Ca^{2+}
   (C) Cu^{2+}
   (D) K^+
   (E) Mg^{2+}

4. The exocytosis of synaptic vesicles is mediated by which ONE of the following?
   (A) Closing of Na^+ channels
   (B) Hyperpolarization of the membrane potential
   (C) Closing of K^+ channels
   (D) Increase in Ca^{2+} in the synaptic terminal
   (E) Repolarization of the membrane potential
5. Which **ONE** of the following is **CORRECT** regarding temporal summation?

(A) Inhibitory post-synaptic potentials (IPSPs) add together to depolarize the post-synaptic membrane
(B) Excitatory post-synaptic potentials (EPSPs) from the same pre-synaptic input add together to depolarize the post-synaptic membrane
(C) Excitatory post-synaptic potentials (EPSPs) and inhibitory post-synaptic potentials (IPSPs) arrive at the same time and cancel each other out
(D) Excitatory post-synaptic potentials (EPSPs) from different synaptic inputs add together to depolarize the post-synaptic membrane
(E) Excitatory post-synaptic potentials (EPSPs) add together to hyperpolarize the post-synaptic membrane

6. Which **ONE** of the following statements is **CORRECT** regarding tonic receptors?

(A) They have a transient receptor potential
(B) They frequently exhibit an off-response
(C) They adapt rapidly
(D) They are important in detecting sustained stimuli
(E) They show no adaption

7. Which **ONE** of the following statements is **INCORRECT** regarding the receptor potential?

(A) Sustained stimuli result in adaption
(B) It is a graded potential
(C) Its size is dependent on the size of the stimulus
(D) It results from a change in membrane permeability
(E) It is self-propagating

8. Glutamate receptors mediate signal transduction in taste receptors of which **ONE** of the following taste sub-modalities?

(A) Salty
(B) Sour
(C) Sweet
(D) Bitter
(E) Umami
9. Which **ONE** of the following statements concerning skeletal muscle contraction is **INCORRECT**?

(A) An increase in Ca\(^{2+}\) initiates contraction  
(B) The sarcomere shortens  
(C) As thin filaments slide inward they pull the Z-lines closer together  
(D) ATP undergoes hydrolysis  
(E) The A-band becomes shorter

10. Which **ONE** of the following statements is **INCORRECT** regarding visceral smooth muscle?

(A) It contracts as a single unit  
(B) It is self-excitable  
(C) It is striated  
(D) Cells are electrically linked by gap junctions  
(E) It is found in the walls of hollow organs

11. Which **ONE** of the following statements is **CORRECT** regarding the sympathetic nervous system?

(A) It decreases the rate of contraction of the heart  
(B) It causes vasoconstriction in skeletal muscles  
(C) It causes bronchodilation  
(D) It increases motility in the gut  
(E) It constricts the pupil

12. Pre-ganglionic parasympathetic neurons have their cell bodies in which regions of the spinal cord?

A) Cranial and lumbar  
B) Cranial and thoracic  
C) Thoracic and sacral  
D) Thoracic and lumbar  
E) Cranial and sacral

13. The actions of the parasympathetic system on glands are mediated predominantly by which **ONE** of the following receptors?

(A) M\(_1\)  
(B) M\(_2\)  
(C) M\(_3\)  
(D) M\(_4\)  
(E) M\(_5\)
14. Transmission at autonomic ganglia is mediated primarily by which neurotransmitter acting at which ONE of the following receptor?

(A) Acetylcholine acting at β-adrenoreceptors
(B) Noradrenaline acting at α-adrenoreceptors
(C) Acetylcholine acting at muscarinic receptors
(D) Noradrenaline acting at muscarinic receptors
(E) Acetylcholine acting at nicotinic receptors

15. Which ONE of the following is INCORRECT regarding acetylcholine?

(A) It is synthesized by choline acetyltransferase
(B) It is released by Ca\(^{2+}\) triggered exocytosis
(C) It is taken into non-neuronal cells by the uptake 2 transporter
(D) It is taken into vesicles by a specific transporter
(E) It is broken down by acetylcholinesterase

16. Which ONE of the following statements is CORRECT about the muscarinic receptor?

(A) It is a G protein-coupled receptor
(B) It is a ligand-gated ion channel
(C) It is a tyrosine kinase-coupled receptor
(D) It is an enzyme
(E) It is a nuclear receptor

17. Which ONE of the following statements is INCORRECT about nicotine?

(A) It is a naturally occurring alkaloid
(B) It causes skeletal muscle contraction
(C) It acts at nicotinic receptors
(D) It acts at ligand-gated ion channels
(E) Its action is inhibited by atropine

18. Drugs that induce a depolarising block of the neuromuscular junction are best described as which ONE of the following?

(A) Agonists at nicotinic receptors
(B) Antagonists at nicotinic receptors
(C) Agonists at muscarinic receptors
(D) Antagonists at muscarinic receptors
(E) Inhibitors of voltage-gated sodium channels
19. Which **ONE** of the following is **NOT** a potential side effect of drugs with anti-muscarinic actions?

(A) Dry mouth  
(B) Constipation  
(C) Dry skin  
(D) Bradycardia  
(E) Blurred vision

20. The uptake of choline into pre-synaptic terminal is driven by a gradient of which **ONE** of the following?

(A) $H^+$  
(B) $Na^+$  
(C) $Ca^{2+}$  
(D) $K^+$  
(E) ATP

21. Isoproterenol (isoprenaline) > adrenaline > noradrenaline is the potency order at which **ONE** of the following receptor types?

(A) $\alpha_1$-adrenoceptors  
(B) $\beta_1$-adrenoceptors  
(C) $\alpha_2$-adrenoceptors  
(D) $\beta_2$-adrenoceptors  
(E) $\beta_3$-adrenoceptors

22. Which **ONE** of the following describes the mechanism of action of the sympathomimetic drug ephedrine?

(A) Inhibition of uptake 2  
(B) Inhibition of catechol-O-methyl transferase  
(C) $\alpha_2$-adrenoceptor antagonist  
(D) Displacement of noradrenaline from the synaptic vesicles  
(E) Inhibition of monoamine oxidase

23. Which **ONE** of the following statements is **CORRECT** regarding botulinum toxin?

(A) It acts as a parasympathomimetic  
(B) It inhibits the release of acetylcholine from nerve terminals  
(C) It enhances the release of noradrenaline from nerve terminals  
(D) It blocks voltage-gated $Na^+$ channels  
(E) It has effects only at the neuromuscular junction
24. Which **ONE** of the following statements is **CORRECT** regarding pre-junctional $\alpha_2$-adrenoceptors?

(A) Stimulation decreases the uptake of noradrenaline (uptake 1) into the nerve
(B) Stimulation decreases the extra-neuronal uptake of noradrenaline (uptake 2)
(C) Stimulation increases noradrenaline release from the nerve
(D) Stimulation decreases noradrenaline release from the nerve
(E) Stimulation decreases uptake of noradrenaline (uptake 1 and uptake 2)

25. Pilocarpine, used in the treatment of glaucoma, is an example of which **ONE** of the following?

(A) A muscarinic agonist
(B) A muscarinic antagonist
(C) A $\beta$-adrenoceptor agonist
(D) An $\alpha$-adrenoceptor agonist
(E) An $\alpha$-adrenoceptor antagonist

26. Which **ONE** of the following statements is **CORRECT** regarding eye drops containing a $\beta$-blocker, such as timolol?

(A) They cause an increase in aqueous humour production
(B) They cause mydriasis
(C) They should be avoided in asthmatic patients
(D) They should be avoided in patients with glaucoma
(E) They do not affect intraocular pressure

27. Which **ONE** of the following is **NOT** classified as a NANC transmitter?

(A) Nitric oxide
(B) Neuropeptide Y
(C) Noradrenaline
(D) ATP
(E) 5-HT

28. P2X receptors are which **ONE** of the following?

(A) Ligand-gated cation channels
(B) Nuclear receptors
(C) Tyrosine kinase-coupled receptors
(D) Ligand-gated anion channels
(E) G protein-coupled receptors
29. Which **ONE** of the following statements is **INCORRECT** regarding peptide neurotransmitters?

(A) Their action is terminated by proteases in the synaptic cleft  
(B) They are synthesized in the cell body of the neuron  
(C) They act at specific receptors  
(D) They are stored in synaptic vesicles  
(E) They are found in both the sympathetic and the parasympathetic nervous systems

30. Which **ONE** of the following statements is **INCORRECT** regarding local anaesthetics?

(A) The lead compound for the development of local anaesthetics was cocaine  
(B) Local anaesthetics are weak bases  
(C) Local anaesthetics are mainly ionised at physiological pH  
(D) The basic side chain in local anaesthetics is usually a secondary or tertiary amine  
(E) The duration of action of local anaesthetics is unaffected by the degree of lipid solubility

**END OF PART ONE**
PART TWO

Answer THREE of the FOUR questions. Use a SEPARATE answer book for EACH question.

31. Answer BOTH parts.
   (a) Describe the three activation states of the voltage-gated Na⁺ channel. [40%]
   
   (b) Explain how these properties of the voltage-gated Na⁺ channel enable the following:
       (i) The absolute and relative refractory periods
       (ii) The propagation of the action potential. [60%]

32. Answer BOTH parts.
   (a) Relating to the function of photoreceptors, discuss similarities and differences between the rods and the cones. [50%]
   
   (b) Describe the mechanism in the photoreceptor by which phototransduction occurs. [50%]

33. Answer ALL parts (a) to (c).
   (a) Discussing the reason, predict the effects that a muscarinic agonist would have on the following:
       (i) The cardiovascular system
       (ii) Bronchial smooth muscle
       (iii) The gastrointestinal tract
       (iv) Glandular secretions [80%]
   
   (b) List TWO clinical uses of muscarinic agonist. [10%]
   
   (c) List TWO contraindications for muscarinic agonists. [10%]
34. Answer BOTH parts.

(a) Describe the anatomy and physiology of the sympathetic nervous system including discussion of the receptors mediating the physiological responses. [60%]

(b) Using named examples describe ONE therapeutic use of drugs acting at each of the following processes in the sympathetic nervous system. Describe details of their mechanisms of action.

(i) Release of noradrenaline

(ii) Agonism at $\beta_2$-adrenoceptors [40%]

END OF PAPER