Part 1: Multiple Choice. Choose the BEST answer.

1. The structure labelled X is a(n)
   A. node.
   B. axon.
   C. synapse.
   D. Dendrite

2. The structure labelled X is the
   A. axon.
   B. dendrite.
   C. cell body.
   D. myelin sheath.

3. If molecule X causes depolarization at Y, what could X be?
   A. sodium ions
   B. calcium ions
   C. acetylcholine
   D. acetylcholinesterase

4. In an excitatory neuron, the molecules labelled X function to
   A. open sodium ion gates.
   B. speed up the transmission of impulses.
   C. provide an energy source for the resting potential.
   D. tell the brain the kind of stimulus that is being received.

5. The structure above carries impulses
   A. from a receptor.
   B. to a muscle or a gland.
   C. away from the central nervous system.
   D. solely within the central nervous system.
6. Which of the following is a characteristic of a resting potential?
   A. secretion of calcium ions
   B. neurotransmitters move into the axon
   C. depolarization of the post-synaptic membrane
   D. a net negative charge on the inside of the axon

7. If a neuron is severed at point X,
   A. sensory impulses still reach the brain.
   B. increased amounts of neurotransmitters are secreted.
   C. a message is sent to the sensory receptors, inhibiting them.
   D. another interneuron moves into place to complete the reflex arc.

8. If the structure above is part of a reflex arc, the part labelled X would receive
   messages directly from
   A. a receptor.
   B. an interneuron.
   C. a motor neuron.
   D. a muscle or gland.

9. The part of a sensory neuron that transmits nerve impulses from a receptor to the
   cell body is the
   A. axon.
   B. synapse.
   C. dendrite.
   D. neurotransmitter.

10. In which of the following is ATP required?
    A. initiation of the nerve impulse
    B. establishment of the resting potential
    C. repolarization of the neural membrane
    D. depolarization of the neural membrane

11. During which of the following times is the membrane’s permeability to sodium
    ions increasing?
    A. 0 to 1 milliseconds
    B. 1 to 3 milliseconds
    C. 3 to 4 milliseconds
    D. 4 to 5 milliseconds

12. The space between two neurons in a reflex arc is the
    A. synaptic cleft.
    B. terminal knob.
    C. node of Ranvier.
    D. post-synaptic membrane.

13. The bacterial toxin that causes botulism prevents the release of acetylcholine
    from pre-synaptic membranes. Which event in the transmission of a nerve
    impulse would be affected first by this poison?
    A. the depolarization of an effector
    B. the opening of sodium gates in dendrites
    C. the production of an action potential at the nodes of Ranvier
    D. the operation of the sodium-potassium pump in the neuron membrane

14. Which of the following is characterized by a short axon and long dendrites?
    A. interneuron
    B. synaptic cleft
    C. motor neuron
    D. sensory neuron
15. Considering the direction of the nerve impulse, what is structure X?
   A. cell body
   B. myelin sheath
   C. synaptic ending
   D. post-synaptic membrane

16. When a doctor taps below the kneecap and the lower leg jerks forward involuntarily, the pathway that the nerve impulse travels is
   A. Effector, sensory neuron, interneuron, motor neuron, receptor.
   B. Effector, motor neuron, interneuron, sensory neuron, receptor.
   C. Receptor, sensory neuron, interneuron, motor neuron, effector.
   D. Receptor, motor neuron, interneuron, sensory neuron, effector.

17. In a synaptic cleft, neurotransmitters move to the receptor sites by
   A. osmosis.
   B. diffusion.
   C. active transport.
   D. facilitated transport.

18. Movement of which of the following ions causes depolarization?
   A. sodium
   B. calcium
   C. hydrogen
   D. potassium

19. Which substance causes the microfilaments to contract and pull the synaptic vesicles to the presynaptic membrane?
   A. sodium ions
   B. calcium ions
   C. noradrenalin
   D. acetylcholine

20. Which of the following events is causing the change within the neuron between time X and time Y?
   A. Sodium ions are moving into the axon.
   B. Sodium ions are moving out of the axon.
   C. Potassium ions are moving out of the axon.
   D. Large, organic, negative ions are moving into the axon.

21. Which of the following is a function of structure X?
   A. to produce neurotransmitters
   B. to speed conduction of the nerve impulse
   C. to provide energy for nerve impulse conduction
   D. to receive stimulation for production of the nerve impulse
22. What would occur in Area X when the event shown there later occurs in Area Y?
   A. depolarization
   B. K+ would enter the axon
   C. generation of a new impulse
   D. the membrane potential would approach –65 mV

23. Which of the following events causes the polarity to change from –65mV to +40mV across the membrane of the axon?
   A. the diffusion of sodium ions into the axon
   B. the diffusion of potassium ions into the axon
   C. the active transport of sodium ions out of the axon
   D. the active transport of potassium ions out of the axon

24. What is the function of hydrolytic enzymes in the synaptic cleft?
   A. to increase the threshold level
   B. to break down neurotransmitters
   C. to stimulate contractile proteins in the synaptic ending
   D. to increase the permeability of the presynaptic membrane to calcium ions

25. Which of the following refers to the “threshold” of nerve transmission?
   A. the frequency of action potentials which occur down a neuron
   B. the action potential created when potassium ions leave the neuron
   C. the total polarity change across the membrane during an action potential
   D. the minimum level of stimulus necessary for an action potential to occur

26. What is the advantage of reflex arcs?
   A. They stop the sensation of pain in the brain.
   B. They provide a quick response to a stimulus.
   C. They take place independently of any nerve function.
   D. They allow us to think about an appropriate response to a stimulus.

27. The graph illustrates changes in membrane potential during the transmission of an action potential. What point on the graph corresponds to the time when repolarization begins?
   A. W
   B. X
   C. Y
   D. Z

28. Where in the myelinated axon would an action potential occur?
   A. W
   B. X
   C. Y
   D. Z
Part B Written Response - Write in complete sentences, using concise, detailed writing with the appropriate vocabulary to receive full marks. You may use a diagram to help explain your answer.

1. Describe the upswing and downswing of an action potential with respect to membrane polarity and movement of ions. (4 marks: 2 marks each)
   a) upswing:
   Depolarization of neuron as sodium channels open and sodium moves down its concentration gradient into the neuron.

   ![Diagram of Action Potential]

   b) downswing:
   Sodium gates close, potassium gates open and potassium moves down its concentration gradient out of the neuron, repolarizing the neuron.

2. What is the “All or None Law”? (2 marks)

   An action potential either fires or it does not. There is no 'half action potential' or 'weak' or 'small'. It either happens and happens completely, or it doesn't happen at all.

3. Explain synaptic integration. (2 marks)

   A neuron can receive thousands of impulses from other neurons at synapses. These impulses can be excitatory (depolarizes neuron towards threshold potential -55mV) or inhibitory (hyperpolarizes neuron away from threshold potential). The cell body integrates all these impulses and sums them up. If the sum of all the excitatory and inhibitory impulses is enough to reach threshold, an action potential will fire from the axon hillock along the axon. If the sum does not reach threshold, no action potential will form at the axon hillock.

4. Explain how an excitatory signal is transmitted from one neuron to another. (6 marks)

   ![Diagram of Excitatory Signal Transmission]

   Bonus: What is the name of the enzyme which breaks down noradrenalin?

   **Monoamine oxidase**