This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 04

27MAR2023

Do NOT write in this box. Your MARK will be placed here.

Subject :	Biology	
Class :	12E	
Teacher :	Christine Khalil	
Duration :	1 hour	
Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

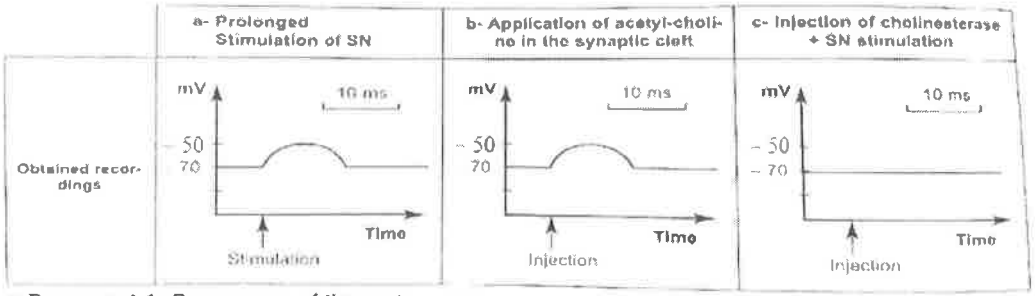
- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

Acetylcholine is one of the well-known neurotransmitters of the body. It is the neurotransmitter of motor end plate (neuro-muscular junction), ganglia of autonomic nervous system as well as its role in the spinal cord and brain.

During a study that aims to clarify the different aspects of its action, a synapse between a sensory neuron (SN) and a motor neuron (mN) of the spinal cord is isolated. The following experiments are done:

a. We apply an effective stimulation on the SN.
b. We inject acetylcholine in the synaptic cleft.
c. We stimulate the SN and in the same time we inject acetylcholinesterase in the synaptic cleft.

The electric activity of the cell body of mN is shown in document 1.

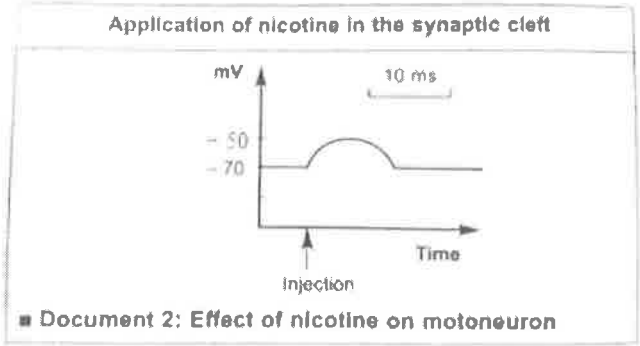


■ Document 1: Responses of the motoneuron

1. Interpret the results of document 1. What can you deduce? (3)

Nicotine is a substance of plant origin. We inject nicotine in the preceding synaptic cleft without any applied stimulation.

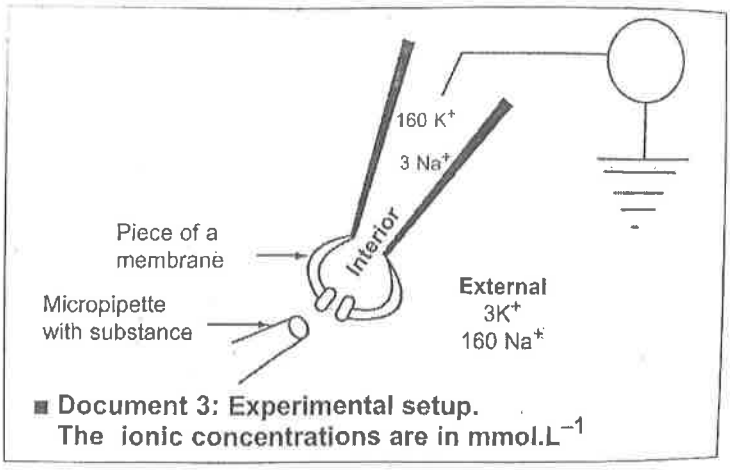
The electric activity of the cell body of mN is represented in document 2.



■ Document 2: Effect of nicotine on motoneuron

2. What is the effect of nicotine on the muscle connected to mN? (1)
3. Suggest 2 possible modes of action of nicotine at the level of this synapse. (2)

To discover the real mode of action of nicotine at the level of this synapse, we isolate a piece of the postsynaptic membrane of mN that has only ionic channels with its external side exposed towards the exterior (document 3).



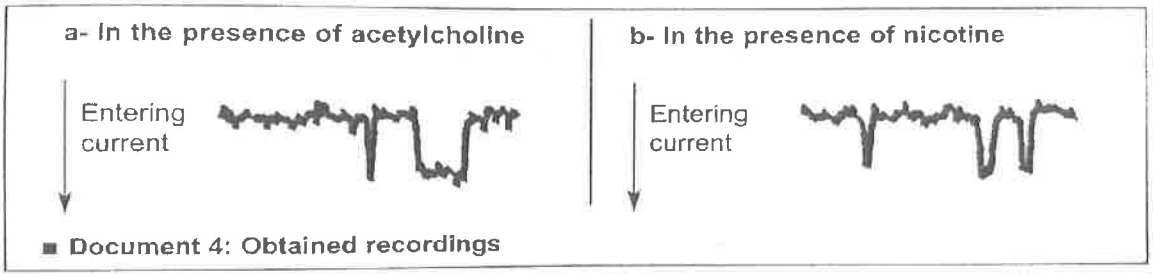
■ **Document 3: Experimental setup. The ionic concentrations are in mmol.L^{-1}**

4. What is the direction of passage followed by each of the ions found in the medium at rest? Justify your answer. (2.5)

Experiment 1: Using the micropipette, a drop of acetylcholine is added on the membrane.

Experiment 2: Using the micropipette, a drop of nicotine is added on the membrane.

Following each of these two experiments, the current (flow) of ions across the membrane at the level of the post-synaptic receptors is measured using an appropriate device and the results are presented in document 4.



■ **Document 4: Obtained recordings**

5. a. What is the ion responsible for the current observed in document 4 in each case? Justify your answer. (1)
   b. Specify the mode of action of each of acetylcholine and nicotine on the post-synaptic membrane receptors. (2)
   c. Draw out the role of nicotine. (1)

Other acetylcholine receptors at the level of the autonomic nervous system were successfully isolated. Application of nicotine on these receptors has no effect.

6. What can you deduce? (1.5)

Marking Scheme for SE04 12E

1. The stimulation of NS and the injection of acetylcholine in the synaptic cleft have the same effect: a hypopolarization that changes the membrane potential from -70 to -50 mV. (1) This indicates that this synapse is excitatory with acetylcholine as a neurotransmitter. (0.5)
   The injection of acetylcholinesterase followed by a stimulation of NS has no effect on the membrane potential which remains at -70 mV. (0.5) This indicates that NS doesn't produce any other neurotransmitter at the level of this synapse. (0.5)
   Hence, acetylcholine is the only excitatory neurotransmitter at the level of this synapse. (0.5)
2. Nicotine creates an EPSP in the post-synaptic membrane; (0.5) it hence stimulates the effects of acetylcholine. The EPSP appearing in mN is translated according to the threshold by an action potential at the level of the axon of mN. These action potentials stimulate the muscle connected to mN and provoke its contraction. (0.5)
3. 1. Nicotine acts at the level of the pre-synaptic neuron by stimulating the release of acetylcholine. (1)
   2. Nicotine can bind to acetylcholine receptors and activate them. (1)
4. Ions diffuse according to their concentration gradient, from high to low concentration. (0.5) The exterior medium is richer in Na^+ ions (160 $mmol.L^{-1}$ compared to 3 in the interior medium). This ion will diffuse towards the inside. (1) On the contrary, the interior medium is richer in K^+ ions (160 $mmol.L^{-1}$ compared to 3 in the exterior). This ion will diffuse towards the exterior. (1)
5. a. The document shows an entering current in presence of acetylcholine or nicotine. This current corresponds only to Na^+ ions which alone can enter under the conditions of this experiment. (1)
   b. The presence of acetylcholine leads to an entering current of Na^+ ions. Hence acetylcholine allows the opening of Na^+ channels justifying its excitatory role proven earlier. (0.5) Nicotine has the same effect as acetylcholine at the level of the receptors. (0.5) Hence, it binds to the post-synaptic receptors of acetylcholine and activates them. (1)
   c. Nicotine is an agonist for acetylcholine. (1)
6. Application of nicotine has no effect on acetylcholine receptors of the autonomic nervous system. (0.5) Hence, nicotine couldn't bind to this type of receptors (0.5) indicating it's a different type of ionic channel than the one in the spinal cord. (0.5)