

مسابقة في الثقافة العلمية

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الرقم:

المدة: ساعة واحدة

Answer the following exercises :

Exercise 1 (5 points)

CFTR Protein

Cystic fibrosis is a genetic disease that affects the lining cells of the respiratory tract and sweat glands by altering their secretions (mucus, sweat ...). At the level of the respiratory system, the mucus produced by the lining cells of the bronchi is thicker than normal, and flows with difficulty. This retained mucus provides a favourable environment for the multiplication of germs that cause infections.

Cystic fibrosis is due to a mutation (modification) of a gene which codes for the production of CFTR protein. This protein regulates the transportation of chloride ions across the cell membrane which is needed for the normal secretion of mucus. Mutations in this gene can cause the CFTR protein to be either absent or abnormal.

Document 1

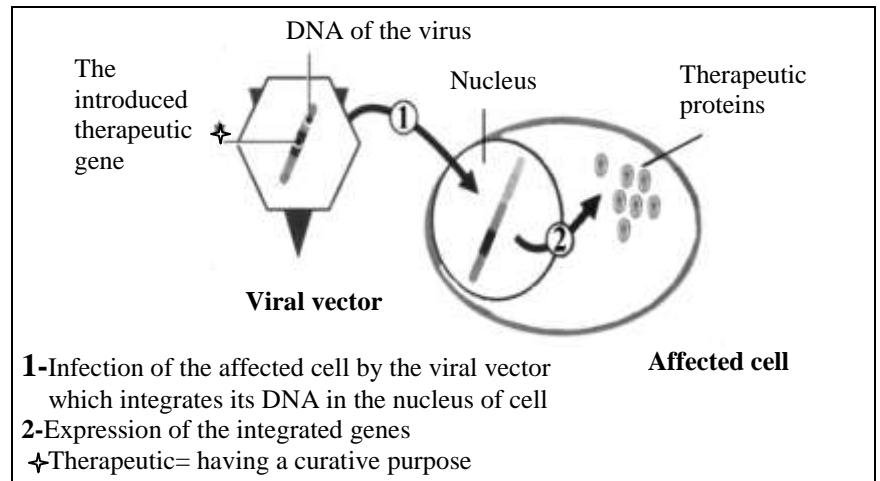
1- Pick out from document 1:

- 1.1- The cells affected by the disease;
- 1.2- The origin of this genetic disease.

Researches are performed to develop a therapy for this disease. Document 2 shows the principle of one treatment for this disease.

2- Describe, in a short text, the technique illustrated in document 2.

3 - Determine, referring to documents 1 and 2, how this therapy solves the respiratory problem of individuals affected with cystic fibrosis.



Document 2

Exercise 2 (5 points)

Thrill

Thrill (shivering) occurs involuntarily when a person moves from a warm place to another of lower temperature without being covered. Thrill begins by affecting the jaw muscles and later every other body muscle, without causing significant movement. To determine the anatomical structures involved in this reflex act, the following observations and experiment have been performed.

Observation 1: A person shivers more intensely when a larger skin surface area which contains nerve endings sensitive to cold is exposed to low atmospheric temperature.

Observation 2: Clinical observation of some wounded persons shows the effect of complete sectioning of the spinal cord. One of the observed symptoms is the disappearance of thrill in the body parts which are located below the sectioned part of the spinal cord, regardless of the level of this section.

Experiment: In an animal, the destruction of the hypothalamus eliminates completely the appearance of shivering in response to cooling.

- 1- Pick out the stimulus and the effectors of thrill.
- 2- Interpret each of the above observations and the experiment.
- 3- Schematize, using the provided information, a functional diagram showing the anatomical elements involved in the thrill reflex.

Exercise 3 (5 points)

Alzheimer: Disease of the century

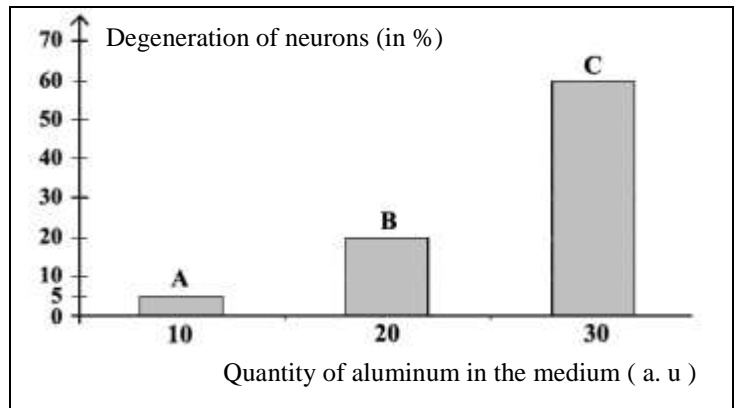
Alzheimer's disease, the disease of the century, is an enormous public health problem. It encompasses dementia and cerebral lesions (loss of neurons) that begin in the innermost region of the temporal lobe of the cerebrum which is involved in memory processing. This disease is manifested by a set of symptoms which includes loss of short-term memory, behavioral modifications and loss of judgmental abilities and reasoning. Yet, little is known about the cause of the progressive destruction of neurons responsible for the loss of cognitive functions. Several risk factors including environmental and genetic factors are currently under study.

Document 1

1-Pick out from document 1:

- 1.1-The symptoms of the disease.
- 1.2- The region presenting cerebral lesions.

An experiment was performed to determine the cause of this disease: different neurons were placed in three media A, B and C containing increasing concentrations of aluminum. We measured the percentages of damaged neurons; the results are shown in document 2.



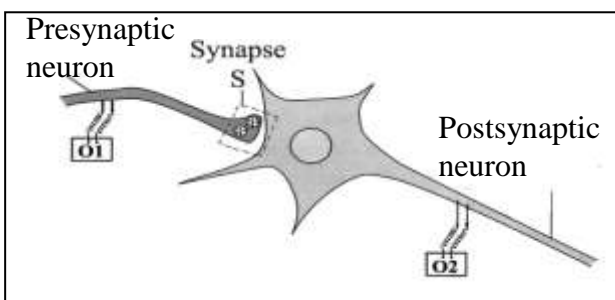
Document 2

- 2 - Construct a table that translates the obtained results.
- 3 - Indicate which risk factor, environmental or genetic, is validated by the results of document 2. Justify the answer.
- 4 - Name the neurotransmitter whose deficiency is at the origin of the disease.

Exercise 4 (5 points)

Synaptic functioning

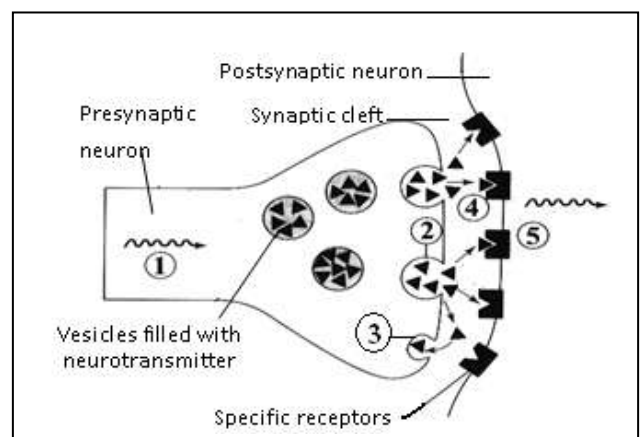
We apply two effective stimulations of increasing intensities I_1 and I_2 on a sensory receptor. We record, by the help of two oscilloscopes O_1 and O_2 , the electrical activities of the pre-and post-synaptic neurons during time t (document 1). Results are shown in document 2.



Intensities	Recording by O_1	Recording by O_2
I_1	action potential (single spike)	[burst of spikes]
I_2	[burst of spikes]	[burst of spikes]

Document 2

- 1 – Specify whether the studied synapse is excitatory or inhibitory. Justify the answer.
 - 2 - Analyze the recordings obtained at the level of the pre-synaptic neuron (in O_1) and draw out the type of coding of nerve message.
- Document 3 reveals a detailed diagram of area (S) shown in document 1.
- 3 – Name the steps of the synaptic functioning numbered 1-2-3-4-5.



Document 3

مسابقة في الثقافة العلمية
مادة علوم الحياة
اسس التصحيح

Part of Ex	Exercise 1 (5 points)	Mark
1		
1.1	Cystic fibrosis affects the cells lining the respiratory tract and sweat glands by altering their secretions (mucus, sweat ...).	0.5
1.2	Origin: mutation of a gene which codes for the production of CFTR protein.	0.5
2	We introduce the therapeutic gene into the DNA of the virus which is the viral vector. We infect the affected cell by the viral vector that integrates its DNA into the nucleus of the affected cell. The integrated genes are expressed by the secretion of therapeutic proteins.	1.5
3	Cystic fibrosis is caused by a mutated gene encoding an abnormal protein that disturbs the transport of chloride ions across the cell membrane needed for the secretion of mucus. Using this therapy, we introduce the gene that encodes the therapeutic normal protein that once integrated, it restores the normal secretion of mucus and thus solve the problem of the respiratory tract of individuals with cystic fibrosis.	1.5

Part Of Ex	Exercise 2 (5 points)	Mark
1	Stimulus: The drop in temperature or cold. Effectors: Muscles of the jaw and all other body muscles.	1
2	Observation 1 indicates that thrill is even bigger in large area of skin where nerve endings have been cooled. Thus, the skin constitutes a sensory receptor. Observation 2 shows that the thrill doesn't occur if the cooled region of the body is located below the sectioned part of the spinal cord. This shows that the spinal cord is not the nerve center responsible for thrill. The experiment shows that thrill is eliminated in response to cooling following the destruction of the hypothalamus, thus the hypothalamus is the centre responsible for thrill.	2
3	<p>Functional diagram illustrating the anatomical elements intervening in thrill reflex</p> <pre> graph TD Stimulus[Stimulus: drop in temperature] -- jagged arrow --> Skin[Skin: capture coldness or sensory receptor] Skin --> SpinalCord[Spinal cord] SpinalCord --> Hypothalamus[Hypothalamus] Hypothalamus --> SpinalCord Hypothalamus --> Muscles[muscles: effector organs] Muscles --> Thrill[Thrill] </pre>	2

Part of Ex	Exercise 3 (5 points)	Mark												
1														
1.1	Loss of short-term memory, behavioral modifications and loss of judgmental abilities and reasoning.	1												
1.2	Innermost region of the temporal lobe of the cerebrum which is involved in memory processing.	0.5												
2	<p>The variation of the percentages of neuron degeneration as a function of aluminum quantity in the three media: A, B and C.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Medium</th> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>Quantity of Aluminium (in au)</td> <td>10</td> <td>20</td> <td>30</td> </tr> <tr> <td>Degeneration of neurons (in%)</td> <td>5</td> <td>20</td> <td>60</td> </tr> </tbody> </table>	Medium	A	B	C	Quantity of Aluminium (in au)	10	20	30	Degeneration of neurons (in%)	5	20	60	
Medium	A	B	C											
Quantity of Aluminium (in au)	10	20	30											
Degeneration of neurons (in%)	5	20	60											
3	The validated risk factor of Alzheimer's disease is the environmental factor because the histogram shows that the percentage of the degeneration of neurons increases from 5% (medium A) to 60% (medium C) with the increase in the quantity of aluminum from 10 a.u (medium A) to 30 a.u. (medium C). Thus, aluminum seems to be an environmental factor that favors the destruction of neurons and consequently it represents a risk factor for Alzheimer's.	1.5												
4	Acetylcholine	0.5												

Part of Ex	Exercise 4 (5 points)	Mark
1	<p>The synapse is excitatory because for intensity I_1, 4 AP / t are recorded by oscilloscope O_1 connected to the pre-synaptic neuron and a train of 14 AP/t are recorded by oscilloscope O_2 which is connected to the post-synaptic neuron.</p> <p>OR</p> <p>For intensity I_2, 8 AP / t are recorded by oscilloscope O_1 connected to the pre-synaptic neuron and a train of 24 AP/t are recorded by oscilloscope O_2 which is connected to the post-synaptic neuron.</p>	1.5
2	The frequency of nerve message recorded by O_1 increases from 4 AP / t to 8 AP / t of the same amplitude when the intensity of stimulation increases from I_1 to I_2 , thus, the nerve message along a nerve fiber is coded by modulation of frequency of AP and not by amplitude.	1
3	<ol style="list-style-type: none"> 1. Arrival of action potentials to the pre-synaptic terminal buds. 2. Release of the neurotransmitter into the synaptic cleft, or exocytosis . 3. Recapturing of the neurotransmitter. 4. Fixation of neurotransmitter on specific receptors on the post-synaptic membrane. 5. Generation of action potential by the post-synaptic neuron. 	2.5