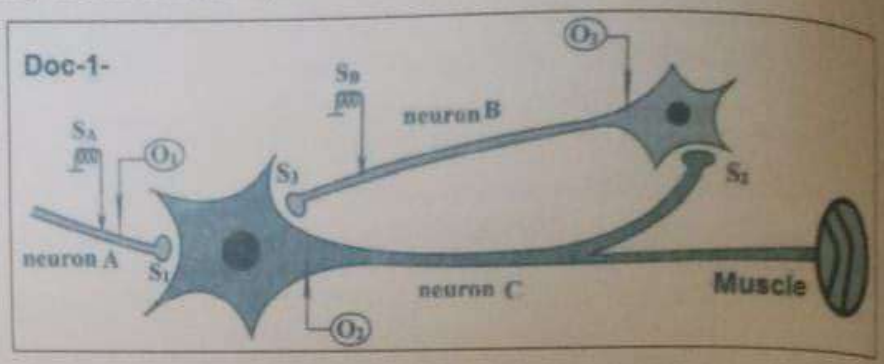
Question 12: Synaptic transmission

Muscle fatigue, is the decline in ability of a muscle to generate force. It can be a result of vigorous exercise There are two main causes of muscle fatigue - limitations of nerve's ability to generate a sustained signal and the reduced ability of calcium (Ca^{2+}) to stimulate contraction.

Motor neurons are responsible for controlling the contraction of muscles, after a period of maximum contraction, the nerve's signal reduces in frequency and the force generated by the contraction diminishes.

Given aside the neuronic chain innervating a skeletal muscle through which the nervous message is transmitted (Doc.1).

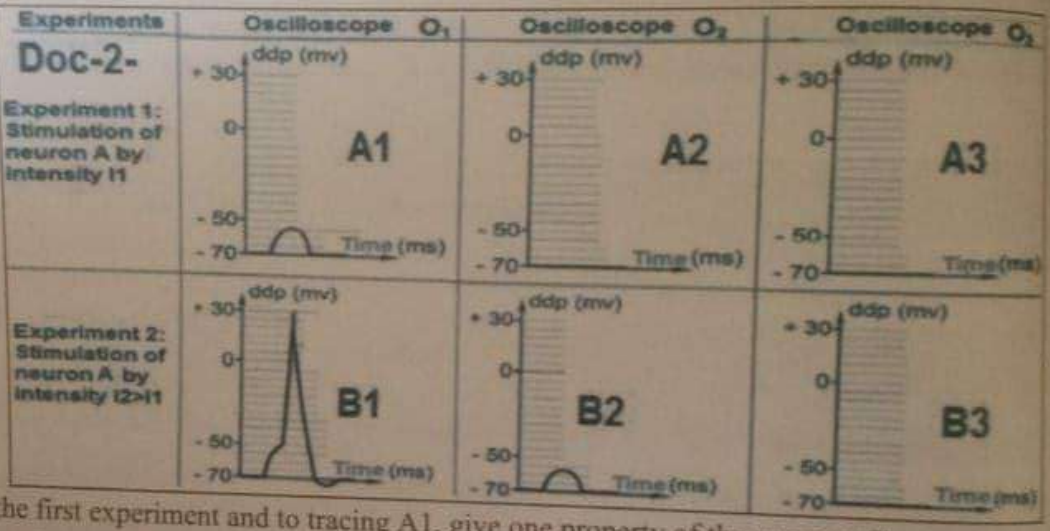
Doc-1-



We realize a series of experiments by stimulating the three neurons A, B, and C.

Document 2 represents the results of such stimulations recorded by the oscilloscopes O1,O2, & O3.

Doc-2-

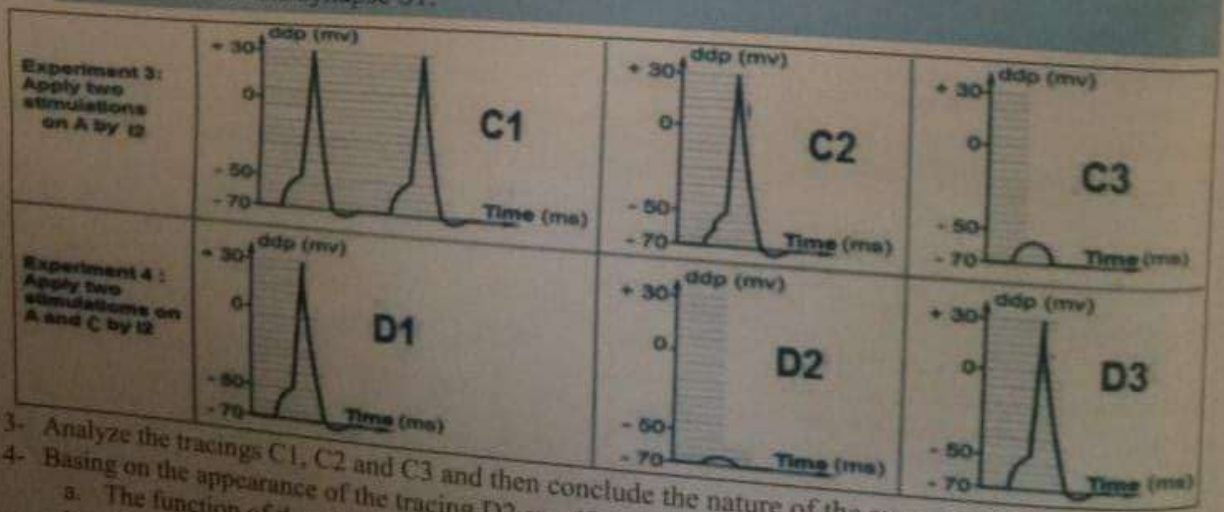


1- Referring to the first experiment and to tracing A1, give one property of the nervous fiber.

2- Analyze the results of the experiments 1 and 2 and then deduce:

a. Second property of the nervous fiber.

b. The nature of the synapse S1.



3- Analyze the tracings C1, C2 and C3 and then conclude the nature of the synapse S2.

4- Basing on the appearance of the tracing D2 specify:

a. The function of the neuron C.

b. The nature of the synapse S3.

5- Referring to your acquired knowledge and basing on the results of the preceding experiments, explain the appearance of the tracing D2 & D3.

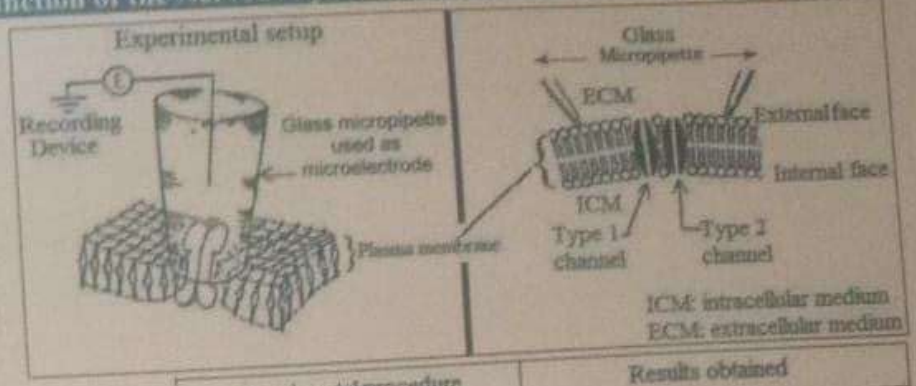
Question -13-

Patch clamp technique allows us, with the help of a micropipette, to isolate very thin fragments of the membrane of a neuron, containing many ionic channels.

The micropipette, interfaced with an electronic device, allows us to impose a variation of membrane potential difference & to measure simultaneously the intensity of the weak currents which can then appear at one or more channels.

A fragment of the membrane is isolated with the help of a micropipette; its external face is oriented to the exterior. This membrane fragment contains 2 types of channels: K+ channel & Na+ channel.

With the help of the experimental setup, a series of experiments is realized on a mammal's neuron. The results are shown in doc-1→



	Experimental procedure	Results obtained
Experiment A	The extracellular medium contains few mmol.L⁻¹ of TTX (tetrodotoxine), substance that blocks the function of type 1 channels	0 mV, -80 mV, 0 pA, 5 ms; Imposed depolarization; ↑outgoing current ↓ingoing current; [1 pA = 1 picoampere
Experiment B	The extracellular medium contains 10 mmol.L⁻¹ of TEA (tetra ethyl ammonium), substance that blocks the function of type 2 channels	0 mV, -80 mV, 0 pA, 5 ms; Imposed depolarization; ↑outgoing current ↓ingoing current; [1 pA
Experiment C	Non modified extracellular medium	0 mV, -80 mV, 0 pA, 5 ms; Imposed depolarization; ↑outgoing current ↓ingoing current; [1 pA

1- Interpret the results obtained.

2- Compare the results shown in the table. Conclude the origin of resting potential.

Note: *Keep in mind that there is a net passive flow of ions from a medium where the concentration is high to a medium where the concentration is low.*

Doc- 2: Ionic concentration on both sides of the membrane of mammal's neuron at rest.

Ion	Concentration in mmol.L-1	
	Cytoplasm of axon	Extracellular medium
K^+	160	2.5
Na^+	14	140

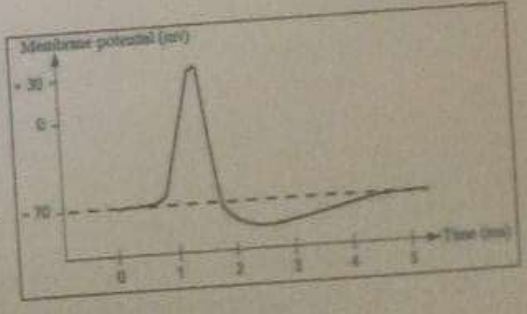
Doc-3-: The number of opened channels per surface unit is determined during an action potential. The results are shown in the following table:

No. of opened channels /µm² of membrane	Time (ms)	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Type 1 channels	0	5	40	25	5	2	0	0	0	0	0
	Type 2 channels	0	0	5	15	20	18	12	8	2	1	0

3- Translate the results shown in the table into a graph.

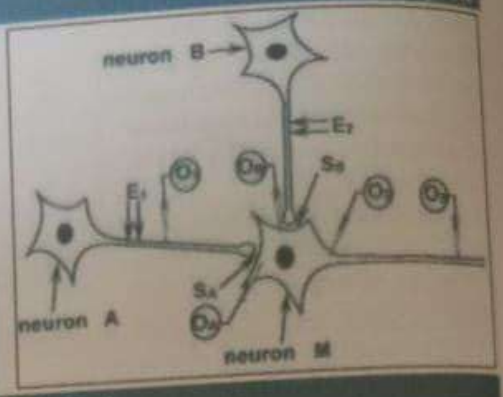
Document 4: We record the variation of the potential difference in the membrane of an axon after applying an effective stimulation. The results are shown in the given graph.

4- Referring to your acquired knowledge and the results shown in the table indicate the different phases of an action potential and determine the cause of each phase.

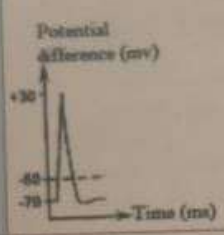
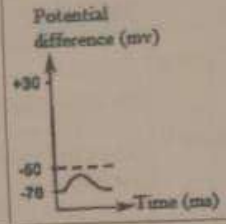
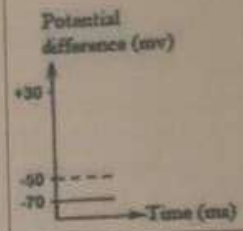
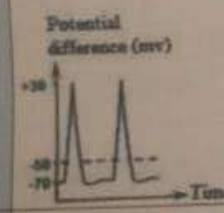
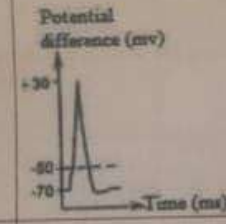
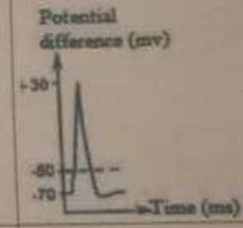
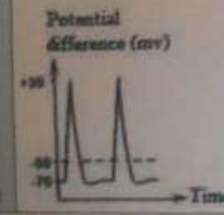
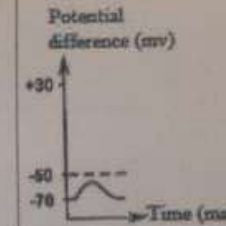
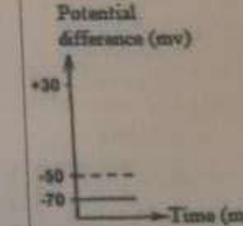


Question-14-

In the course of studying the properties of neurons in the integration and the transmission of nervous messages, we realize a series of experiments with the help of the setup shown in document 1.



The table of doc-2 presents a 1st series of experiments realized on neurons A and B & the recordings obtained at the levels of oscilloscopes O_1, O_2, and O_3.

Experiment	Recording Obtained at O_1	Recording Obtained at O_2	Recording Obtained at O_3
We apply an effective stimulation In E_1			
We apply two effective close stimulations in E_1			
We apply simultaneously - Two effective close stimulations in E_1 - an effective stimulation in E_2			

1- Interpret the results of the first experiment.

2- Explain, ionically, the recording shown on O2 in the second experiment.

3- Referring to the 2nd & 3rd experiments, explain the integration property of the motor neuron-M.

• To show the mechanism of transmission of the nervous message in synapses S_A and S_B, we realize a second series of experiments. Doc-3 shows the conditions of the experiment and the results obtained.

Experiment	1	2	3	4
Substance injected	ACH in S_A	ACH in S_B	GABA in S_A	GABA in S_B
Results: Measurement of the variation of the concentration of Na+, K+, and Cl- ions in the cell body of the motor neuron	Increase in the [Na+]	No variation in the[Na+], [K+], and [Cl-]	No variation in the [Na+], [K+], and [Cl-]	increase in the [Cl-]

4-1. What does each result reveal concerning the direction of ions flow?

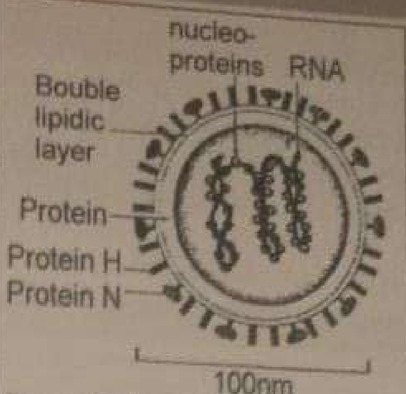
4-2. Conclude the nature of channel opened by each neurotransmitter.

5- Represent the recordings that we would obtain at the level of O_A & O_B in experiments 1 & 4.

Question-64-

In the frame work of studying how an organism fights against the flu virus and the difficulties that exist against making a vaccine, the flu virus is an RNA virus that multiplies inside the cells of the respiratory tract causing their infection. This viral RNA is formed of eight segments. H and N are proteins that play the role of two antigens.

Experiments are realized to determine how usually an organism defends itself against this virus. The reaction of the organism is facilitated by anti-viral vaccines that are obtained from inactivated viruses. The results are indicated in table (b).



Doc.a- Scheme of the virus

Case	Non-vaccinated mice infected by flu virus	Results after a certain delay
A	Mice born without thymus	Proliferation of the virus
B	Mice born without thymus having received an injection of serum of a vaccinated mouse	The virus doesn't disappear from the organism but cease its multiplication
C	Mice deprived of lymphocytes B	Appearance of the virus

1- Analyze doc- b to determine the conditions required by an organism to fight against the flu virus.
2- Deduce the effectors that intervene in this immune response.
3- Use your knowledge to explain the mechanisms used by these effectors to fight flu.

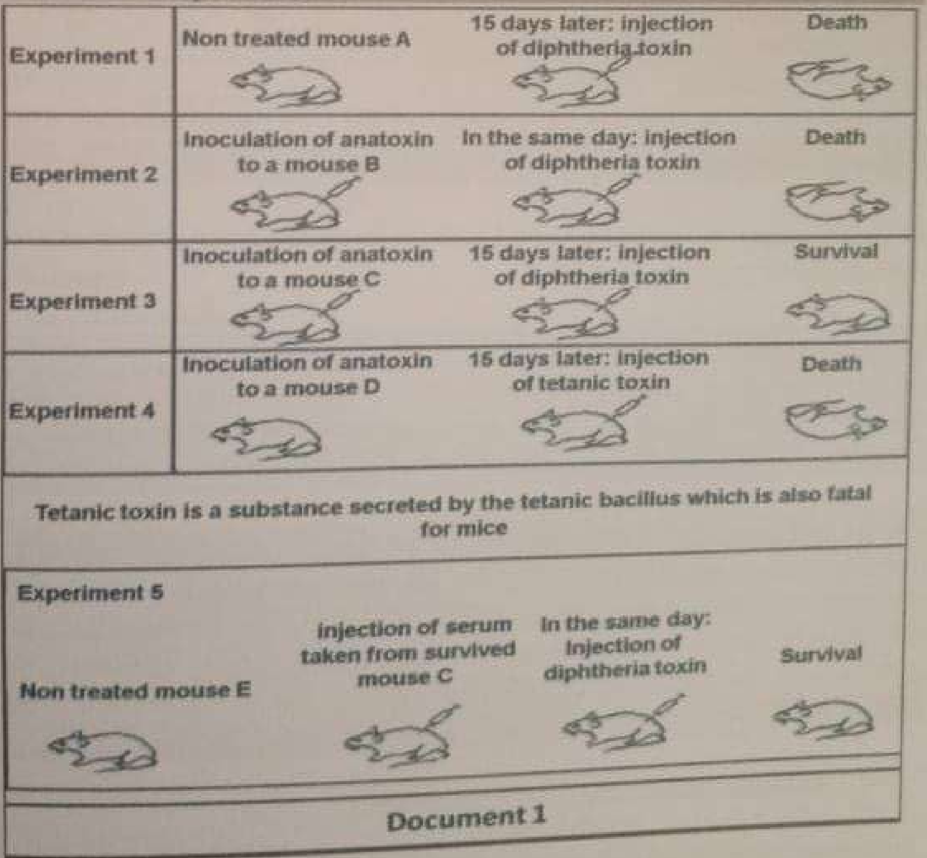
Question-65- Diphtheria

Diphtheria is a disease due to a bacillus bacterium which affects the throat but it secretes a very active exotoxin.

This toxin provokes cardiac and nerve lesions leading to the paralysis of certain muscles like respiratory muscles.

Diphtheria toxin, added to a formal solution then heated to 40 °C for one month, becomes the diphtheria anatoxin which is harmless but keeps its antigenic power.

Document 1 shows different experiments performed on mice.



Experiment 1	Non treated mouse A	15 days later: injection of diphtheria toxin	Death
Experiment 2	Inoculation of anatoxin to a mouse B	In the same day: injection of diphtheria toxin	Death
Experiment 3	Inoculation of anatoxin to a mouse C	15 days later: injection of diphtheria toxin	Survival
Experiment 4	Inoculation of anatoxin to a mouse D	15 days later: injection of tetanic toxin	Death
Tetanic toxin is a substance secreted by the tetanic bacillus which is also fatal for mice			
Experiment 5			
Non treated mouse E	injection of serum taken from survived mouse C	In the same day: Injection of diphtheria toxin	Survival

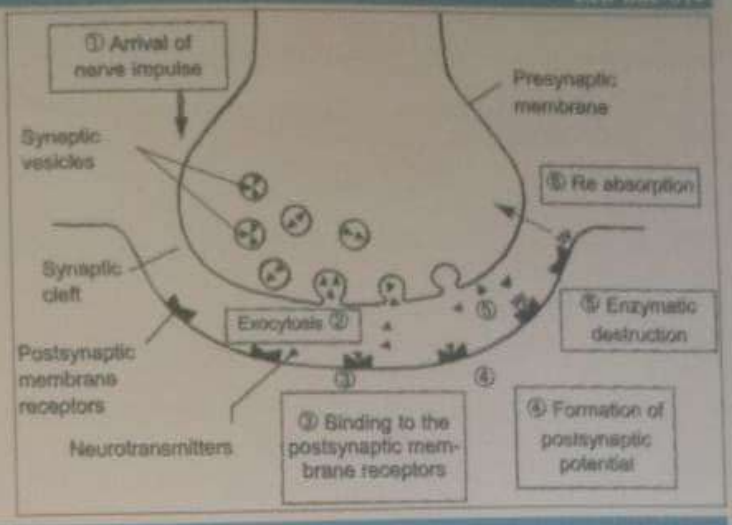
Document 1

1. Describe the experiments from 1 to 4.
2. Deduce, using the results of the experiments 1, 2, 3 & 4, the characteristics of the acquired immunity.
3. Interpret experiment 5.
4. The injection of diphtheria toxin to survived mouse E after 20 days leads to its death. Deduce the characteristics of the immunity ensured in experiment 5.
5. In humans, we perform 3 injections of diphtheria anatoxin with an interval of time 15 days, then after one year. Explain the interest of these injections.

Question-1-

Leb Bac-011

1- Write a short text summarizing the different steps of this synaptic functioning.

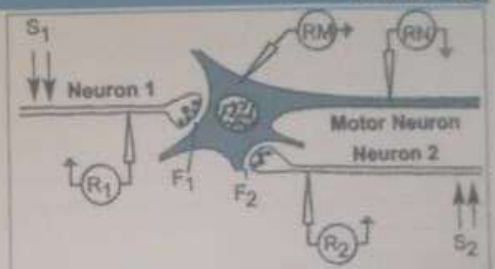


Question-2-

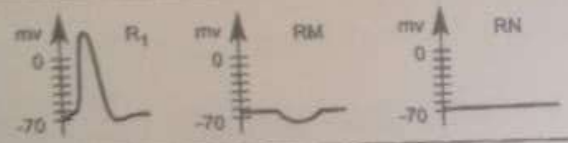
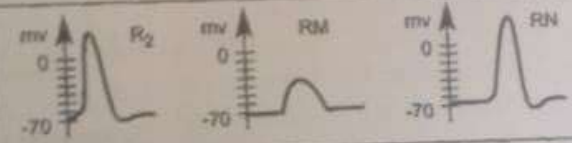
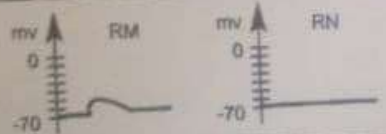
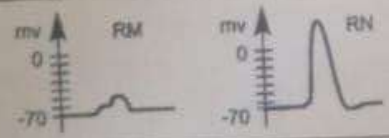
Leb Bac-021

In the spinal cord, the two neurons 1 and 2 are linked to a motor neuron by means of synapses.

Documents 1, 2 and 3 represent the experimental set-up and the recordings obtained.

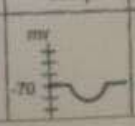
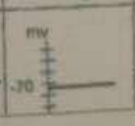
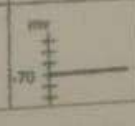
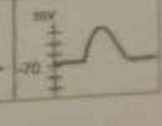


■ Document 1: Experimental set-up

Stimulation by S_1			
Stimulation by S_2			
Simultaneous Stimulation by S_1 and S_2			
Simultaneous Stimulation by S_1 and S_2 then stimulation by S_2			

1- Interpret the obtained results, and then conclude the role of the motor neuron.

2- Interpret document-3, and then conclude the neurotransmitter acting in each of the two synapses: F1 & F2.

Performed operations	Injection of GABA in F_1	Injection of GABA in F_2	Injection of acetylcholine in F_1	Injection of acetylcholine in F_2
Recordings in RM				

Research has shown that 95% of the individuals having myasthenia have antibodies, which block or destroy the membrane receptors of the acetylcholine.

e- To which type of disease does myasthenia belong?

f- Which of the two hypotheses is valid? Justify the answer.

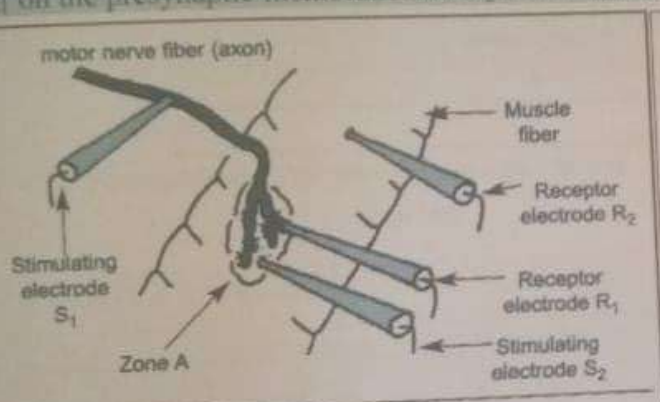
h- A pregnant woman having myasthenia, gives birth to an infant who presents, at birth, muscular paralysis, that disappears after a few weeks or a few months. How can you explain this particularity?

Question-5-

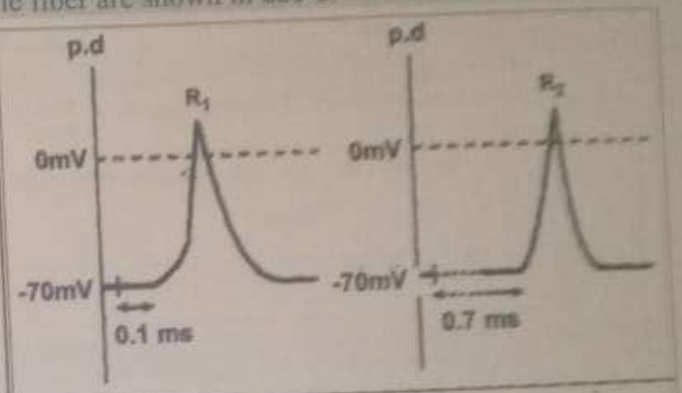
We propose to study how a nerve fiber gives order to a muscle fiber to contract. For this sake, we do an experimental study on an isolated muscle fiber connected to its motor nerve fiber, document-1.

Experiment-1:

We stimulate the motor nerve fiber with electrode S_1. The obtained recordings at the levels of electrodes R_1 on the presynaptic membrane and R_2 on the muscle fiber are shown in doc-2.



Document 1



Document 2

Experiment 2:

We stimulate the muscle fiber with electrode S_2 placed at the level of postsynaptic membrane. The muscular action potential takes 0.1 ms to reach R_2.

1- Interpret the first experiment.

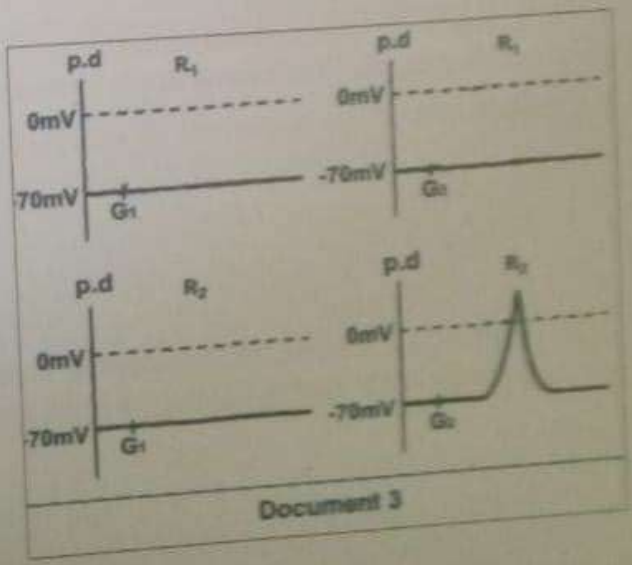
2- Determine from the two experiments the time needed by a nerve impulse to traverse the synapse.

Experiment 3:

With a micropipette, we put on the plasma membrane of the muscle fiber at the level of zone A, a small drop of acetylcholine C_1, and then we put another small drop of acetylcholine C_2, which is more concentrated than C_1.

The obtained recordings at the level of R_1 and R_2 are shown in document-3.

3- Interpret the obtained recordings.



Document 3

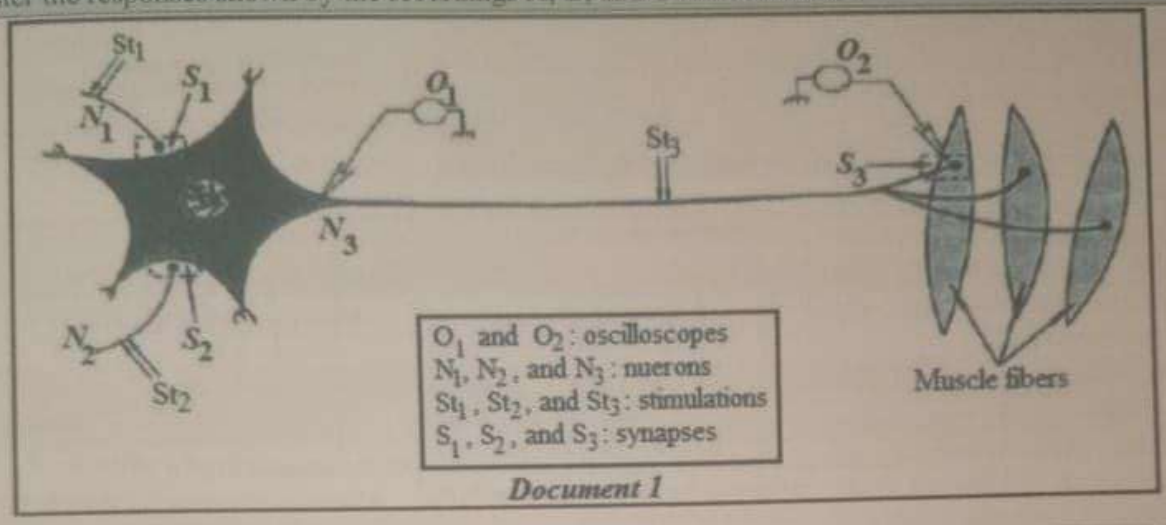
to the muscle fiber to contract.

Question -15-

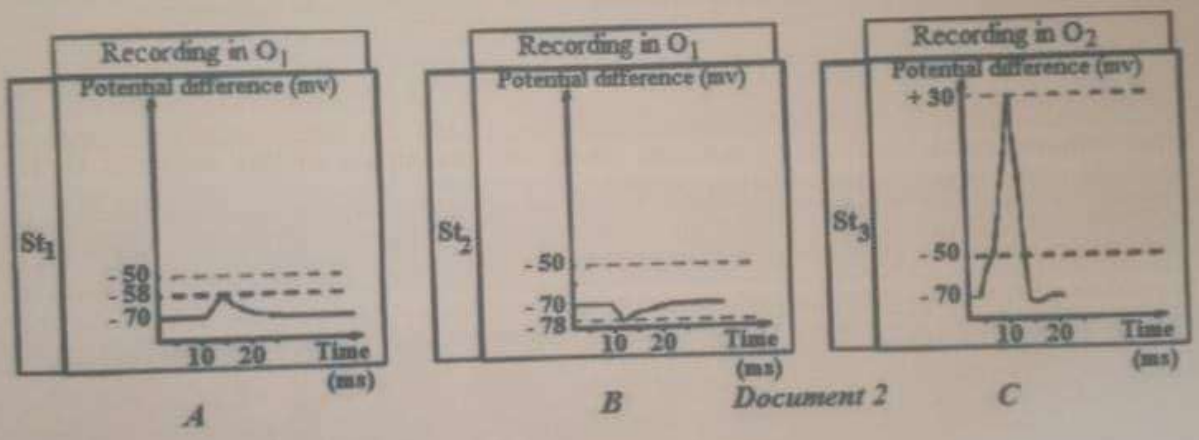
Tn Bac-update

In the course of studying the origin of the nature of postsynaptic terminal response, we apply on the structures represented in document 1 two series of experiments.

• **1st series of experiments:** We apply an effective stimulation in St1 then in St2 then in St3. We then register the responses shown by the recordings A, B, and C in document 2.



Document 1



Document 2

1- Referring to your acquired knowledge, identify the recordings A, B, and C.

2- Analyze the results obtained in document 2. Conclude the nature of the studied synapses.

• **2nd series of experiments:** The concentration of some ions is measured in neuron N3 during the application of the previous experiment. We notice:

- An increase in the intracellular concentration of Na+ ions during the transmission of the message at the level of synapse S1.
- An decrease in the intracellular concentration of K+ ions during the transmission of the message at the level of synapse S2.

3- Referring to the results obtained in the 2nd series of experiments; explain the origin of changes recorded by oscilloscope O1 in cases A and B.

9- Using all the previous results, indicate the stages of the studied synaptic transmission.

Question-17-

Σ Updated

To understand how the ionic concentration on the neuron membrane existed, we proceed with a series of measurements and experiments.

We measure the concentration of sodium ions, K^+ at the inner side and at the outer side of a giant axon of a squid; the values are indicated in the adjacent table.

Ions	Extra cellular Medium (mmol/l)	Intra cellular Medium (mmol/l)
K^+	20	400
Na^+	440	50

1- Compare the ionic composition of the intracellular medium to that of the extracellular.

A giant axon is submerged in a convenient artificial medium, containing radioactive sodium $^{24}_{Na}$ used as a tracer. After a certain time, the cytoplasm of the axon becomes radioactive.

2- Explain the obtained result.

A new measurement of ionic concentrations, at the inside and the outside of the axon, doesn't show any modification in these concentrations. (We measure the Na^+ ions and the K^+ ion to see if they are radioactive or not).

3- Formulate a hypothesis that explains the constancy of ionic concentrations.

In a second experiment:

The axon having received $^{24}_{Na}$ then placed in a medium containing only normal sodium; we notice that this medium becomes radioactive.

4- Does the obtained result confirm the preceding formulated hypothesis? Justify.

The laws of diffusion don't explain how the membrane potential is maintained, It is in fact explained by the actions of Na^+ /K^+ pumps which allows 3-Na^+ ions to leave while 2-K^+ ions enter.

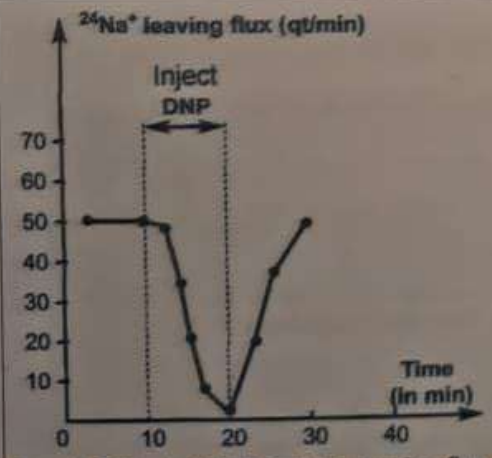
Two additional experiments enable us to determine the mechanism that took place:

First experiment:

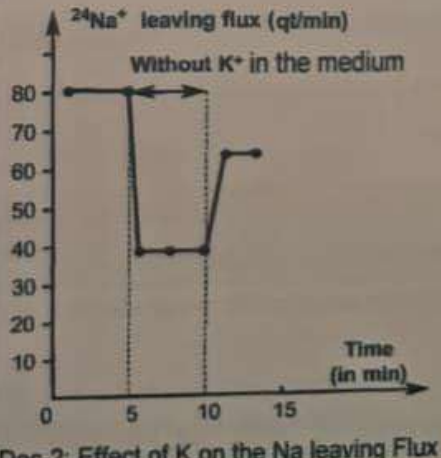
The axon marked by $24Na^+$ and is submerged, for 10-minutes, in a normal medium. We then add a 2, 4 dinitrophenol or DNP, a substance that inhibits the synthesis of the ATP (form of energy storage). The neuron is kept there for 10-minutes then placed in a normal medium. The curve of document-1 explains the obtained results.

Second experiment:

The marked axon is placed in a normal medium. Then removed and for 5-minutes kept in a medium without K^+. It is then replaced in the initial medium. We obtain the curve of doc-2.



Doc-1: Effect of DNP on Na+ leaving flux

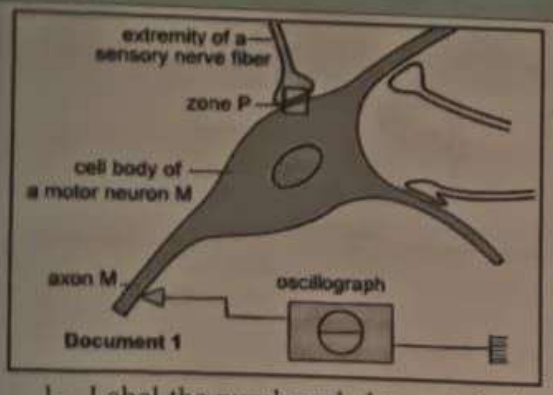


Doc-2: Effect of K on the Na leaving Flux

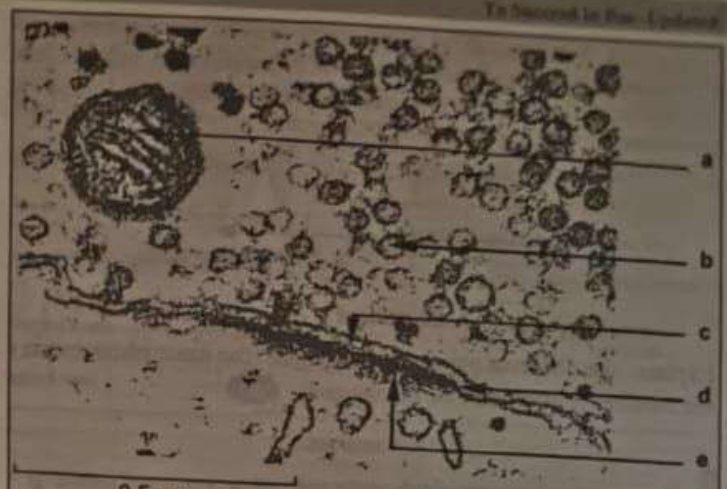
5-Interpret the two obtained curves and show that the membrane potential is maintained by the aid of transport that needs energy for the intervention of Na^+/K^+ pump.

Question -19-

Doc.2 shows an electronograph of a synapse: zone P of **doc.1**, which shows in turn a motor neuron M where a microelectrode attached to an oscilloscope is inserted.



Document 1



Document 2 : neuroneuronic synapse

1- Label the numbered elements in doc- 2.

In order to determine the role of calcium ions in the synaptic transmission, the following experiments are done:

❖ **Experiment 1:**
An efficient stimulation is applied on a sensory neuron. We observe exocytosis of elements b in document 2 that empty their contents in the space d. even more, the graph 3a is obtained on the oscilloscope.

❖ **Experiment 2:**
The terminal axon of the sensory neuron is placed in an extracellular medium deprived of Ca^{2+}. The sensory nerve fiber is stimulated, the previous observed exocytosis doesn't take place, only a membrane potential is registered on the oscillograph as shown in document 3b.

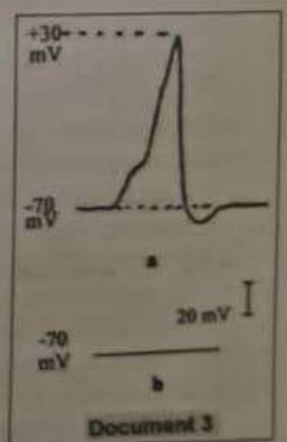
❖ **Experiment 3:**
In the absence of electric stimulation of a sensory fiber, we inject using a micropipette, Ca^{2+} ions in the cytoplasm of the terminal of this fiber. We obtain the same results as experiment 1.

2- Interpret the obtained results. What can you conclude concerning the role of the Ca^{2+} in the transmission of the nervous message at the level of the synapse?

3- Identify the type of the synapse studied in this experiment.

❖ Experiment 4:
We inject in the space d two different substances: the acetylcholine and the GABA, the results are identical respectively to that of a and b of the doc-3.

4- Interpret experiment 4. Conclude the nature of the neurotransmitter acting in the studied synapse.



Document 3

5- Explain in details the mode of action of the corresponding neurotransmitter in this synapse taking into consideration the conclusion of part 4.

6- Make a functional diagram that shows the mode of transmission of the message in this synapse.

Question 11 — Myotatic reflex — Tn-updated

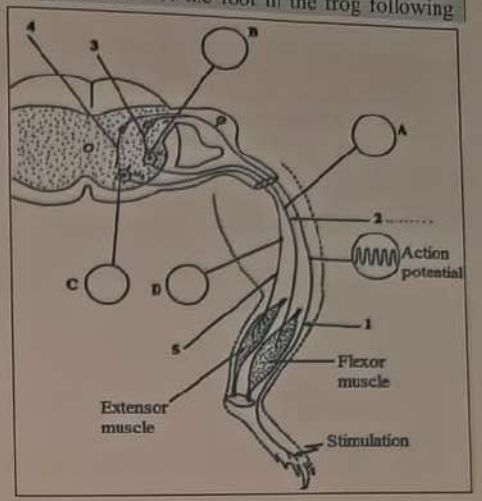
The scheme of document 5 is the reflex arc corresponding to flexion of the foot in the frog following stimulation of the skin effectively.

1- Annotate the schema according to numbers provided (from 1 to 5)

2- Indicate using numbers, letters, and arrows the direction of nerve impulses.

3- Represent in each of the circles A, B, C and D, the nerve activity (action potential or no action potential) that can be recorded using an oscilloscope following stimulation of the skin.

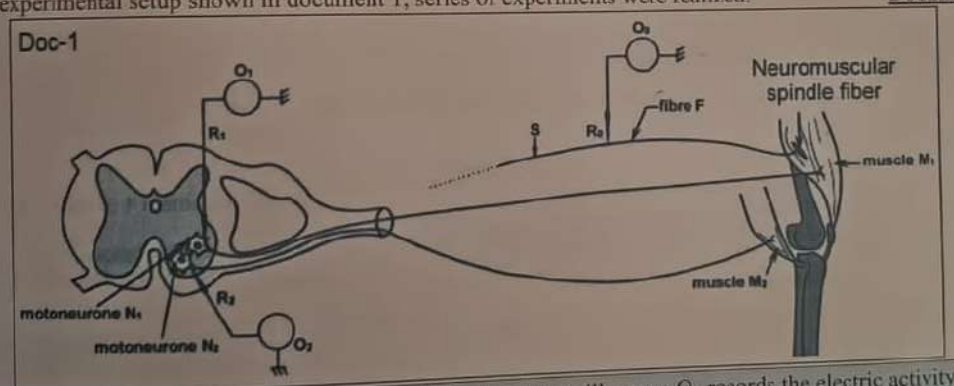
4- Explain, based on your answers to previous questions and your acquired knowledge, the relationship between the postsynaptic integration at the level of M1 and M2 and the state of activity of two antagonistic muscles.



Question 12: — Myotatic reflex — Tn-updated

We are searching for the determination of the electric circuit intervening in a myotatic reflex. Using the experimental setup shown in document 1, series of experiments were realized. **Document 1**

Doc-1



First experiment: The microelectrode R_0 linked to the oscilloscope O_0 records the electric activity of the nerve fiber F issued from the neuromuscular spindle found within the muscle M_1, in function of the intensity of stretching or elongation of the same muscle M_1.

The obtained recordings are shown in the following doc.2.

Doc-2 Recording 1	Recording 2	Recording 3	Recording 4
Absence of stretching of M1	Slight stretching of M1	Moderate stretching of M1	Strong stretching of M1

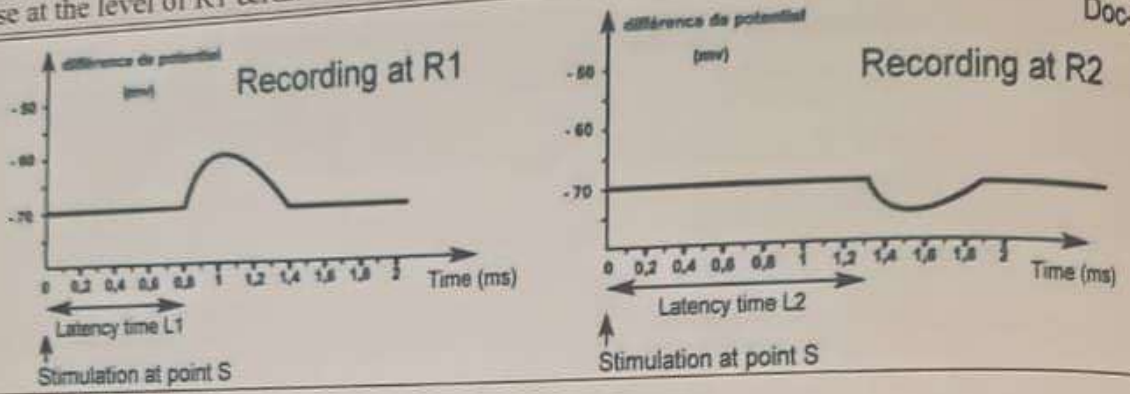
1- Analyze the obtained results to conclude:

a- A fundamental property of the nervous message.

b- The physiological role of the neuromuscular spindle in a myotatic reflex.

Second experiment: An effective stimulation was done on fiber F at the level of point S and then ... potential difference was registered by the two electrodes R1 & R2 fixed respectively on the implantat... cones of the two motor neurons N1 and N2 and linked to the two oscilloscopes O1 and O2 (document 1). Equally, we measure the elapse of time separating the instant of stimulation and the instant of appearan... of response at the level of R1 &R2. The obtained recordings are represented in doc-3: below:

Doc-3



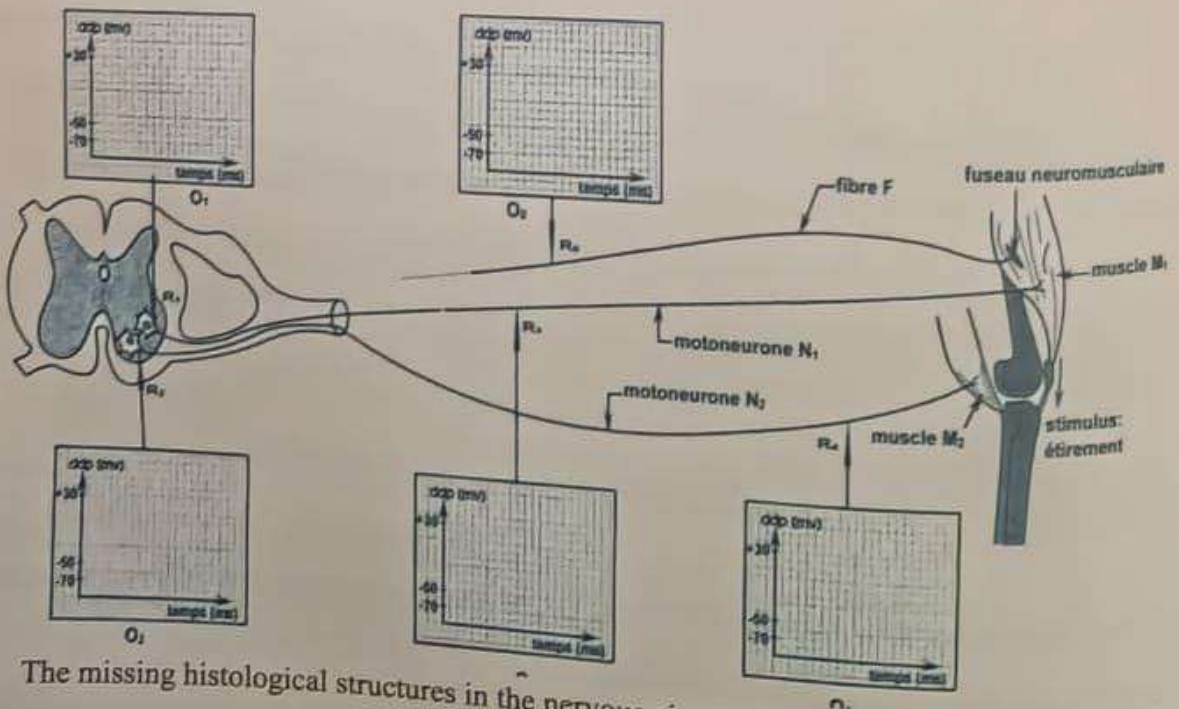
2-1. Indicate the electric recordings registered by R1 and R2.

2-2. Deduce the nature of the studied synapses at the level of the two motor neurons N1 and N2.

3- Assume that the elapse of time is 0.5 milliseconds, what can you deduce from the comparison between the two elapse of time L1 and L2?

4- Based on the given information, represent on document 4:

Document 4 (à remettre avec la copie)



a. The missing histological structures in the nervous circuit of the myotatic reflex.

b. The nervous activity recorded at the level of the receptor electrodes R_0, R_1, R_2, R_3 and R_4 linked to the oscilloscopes O_0, O_1, O_2, O_3, and O_4, after the elongation of the muscle M_1.

Question 13: Patellar reflex

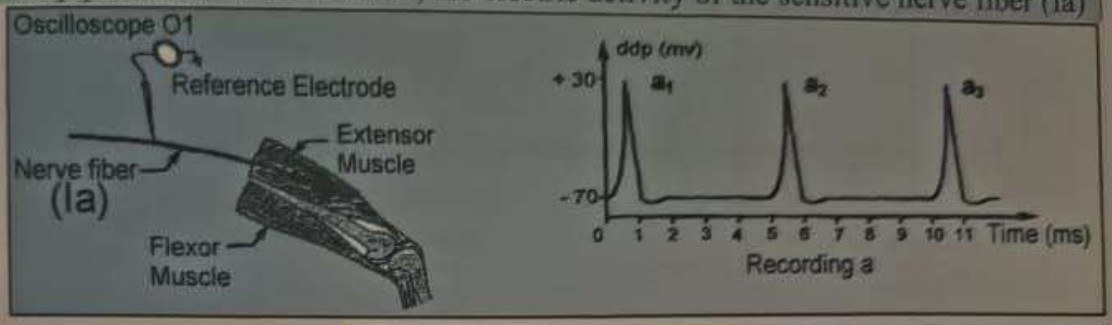
Re-updated

During myotatic reflex, patellar reflex for instance, the stretching or elongation (due to percussion or stimulation or hitting or hammering) of the extensor muscle provokes the contraction of this same muscle that tends to retain to its initial length.

The contraction of the extensor muscle is accompanied with the relaxation of the flexor muscle (antagonistic muscle). To determine the anatomic circuits that interfere in this myotatic reflex, we realize on cat series of experiments.

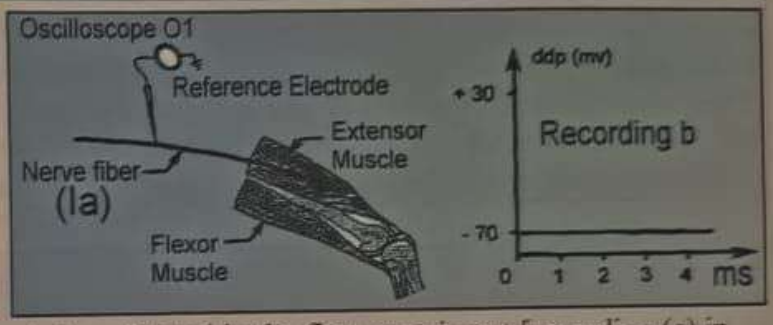
Experiment 1: The anterior muscle of the leg (extensor muscle) is kept at rest. Then, we register, by the aid of the experimental setup presented in document 1, the electric activity of the sensitive nerve fiber (Ia) issued from this muscle.

We observe by the help of the oscilloscope O1, the registration (a) shown in the same document 1. →



Experiment 2: The receptor electrodes are being kept in their place; we section the tendon of the extensor muscle as shown in the scheme document 2.

By the help of the oscilloscope O1, we observe the registration represented by the tracing (b) as shown in document 2. →



1- Identify and explain the electric phenomenon (a1) registered in the first experiment [recording (a) in document 1].

2- Using the given of the 1st and the 2nd experiment and referring to your acquired knowledge concerning myotatic reflex, indicate:

a- The origin of the electric phenomenon registered in the first experiment.

b- The effect of this phenomenon on the extensor muscle of the leg and the physiological importance of this effect.

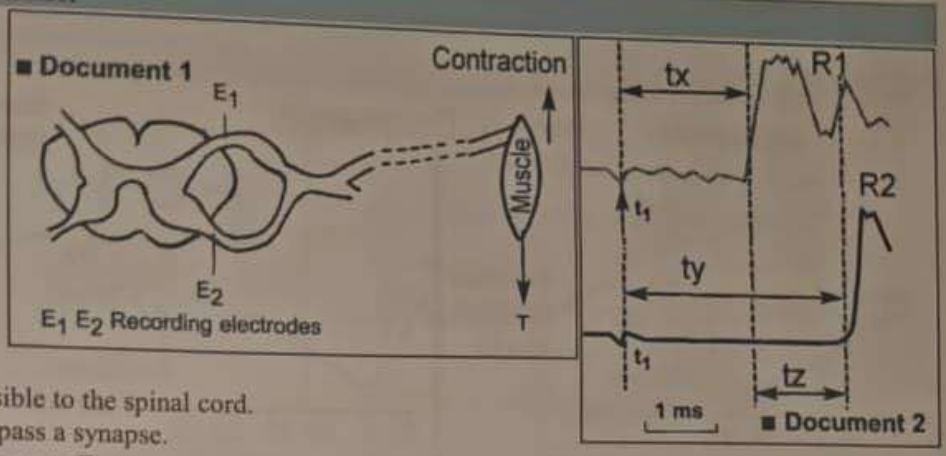
Question-14-

The response of a muscle to a stretch is a contraction that takes place in a few hundredths of a second after the beginning of stretching; this is called a reflex & usually controlled by spinal cord.
In order to study the different neuronic circuits involved in this reflex, we conduct the following experiments.

1- Name this type of reflex, pick out two statements to justify your choice.

We perform the following experiment:

We exert a slight pull Ton a muscle at time t_1, We record the electric response at the dorsal root (R_1) & that of the ventral root (R_2) of a spinal nerve innervating the same anterior thigh muscle.
Doc-1 represents the experimental set up, whereas doc-2 represents the obtained results.



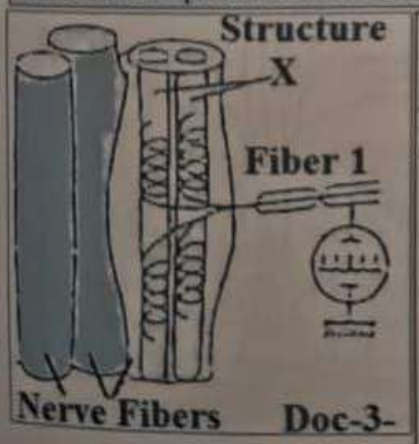
N.B. The recording is done as near as possible to the spinal cord.
The nervous message needs 1 ms to pass a synapse.

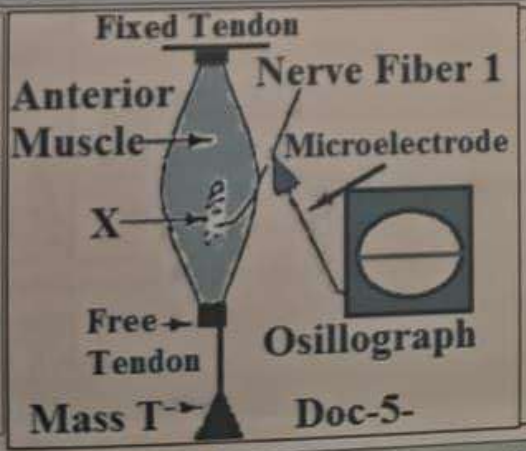
2- Explain the form of the response R_1.

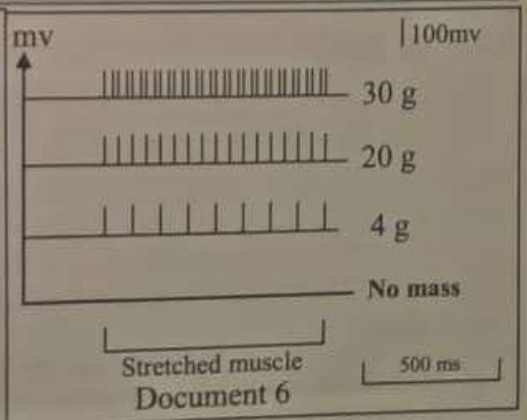
3- What do t_x, t_y and t_z represent in document-2?

4- Identify if the circuit involved is mono or poly synaptic circuit.

Doc-3 represents structure X found inside a thigh anterior muscle & connected to a nerve fiber 1.
In order to know the nature (function) of this fiber we conduct the following experiments that are summarized in the table document-4.
Doc-5 shows the experimental setup recording nervous message in one of the nervous fibers connected to this structure, as a function of different weights with increasing masses (g) attached to this muscle, the results are represented in Doc-6.







5- The nervous message at nerve fibers is coded by frequency, justify this statement.

Doc-4- Treatment		Result
Section nerve Fiber 1	Stimulating its central end	Pain feeling
	Stimulating its peripheral end	No response

6- Interpret the result of doc.4, & then derive a conclusion concerning the nature of nerve fiber 1.

7- Label structure X & indicate its function.

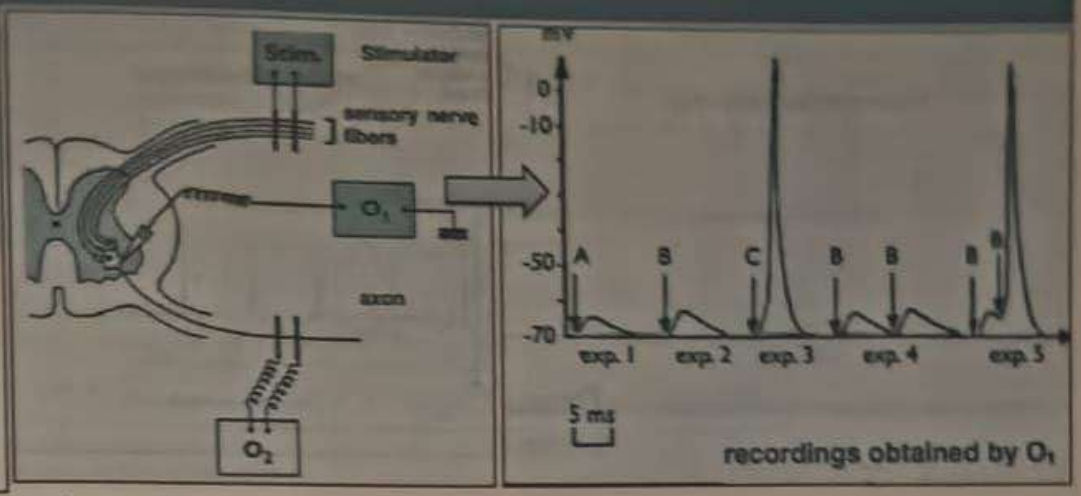
8- Indicate the law obeyed by this nervous structure, draw out the information that confirms your answer.

5-2. Formulate two hypotheses to explain the effect of each of valproic acid & picrotoxin. Justify your choice.

Question -12-:

Using the setup of the document 1, many experiments are done according to study the role of the motor neuron.

We stimulate the dorsal root by increasing intensities A, B & C. The results of the experiments are shown in the doc-2.



1- Interpret each of the given experiments.

2- Identify the results recorded on an oscilloscope connected at the level of the sensory nerve fibers of the doc-1- in response to the different excitations.

3- What can you deduce concerning the mode of action of the motor neuron?

4- In what cases of the document 2, does the corresponding muscle contract? Justify.

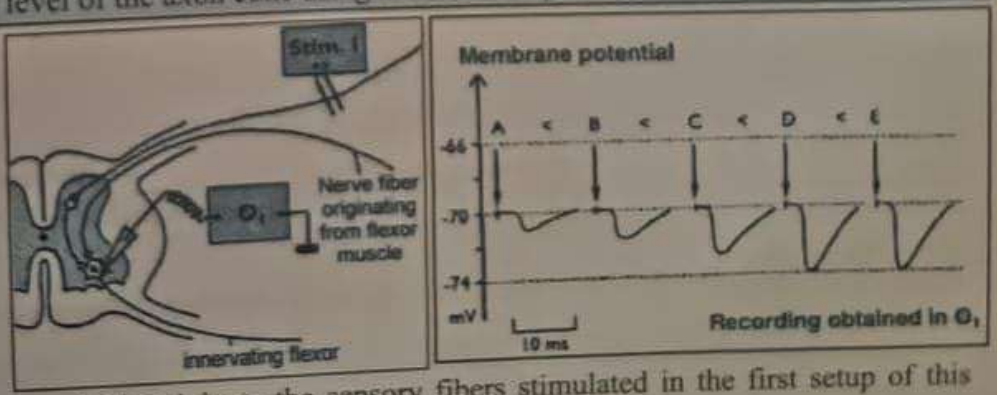
5- By what other method can we obtain a muscular contraction? Name the corresponding phenomenon.

We consider two antagonistic muscles of the arm, the biceps (flexor) and the triceps (extensor).

Sensory fibers other than that observed in the preceding question are related to the motor neurons innervating the biceps, by the intermediate of associative neurons. In the figure, we have represented only one of these fibers

We stimulate these fibers by stimulations A, B, C, D, E of increasing intensity and we observe the modification of polarity at the level of the axon cone using an oscilloscope O_1.

6- Interpret the obtained recordings and conclude the property of the interneuron of the spinal cord.



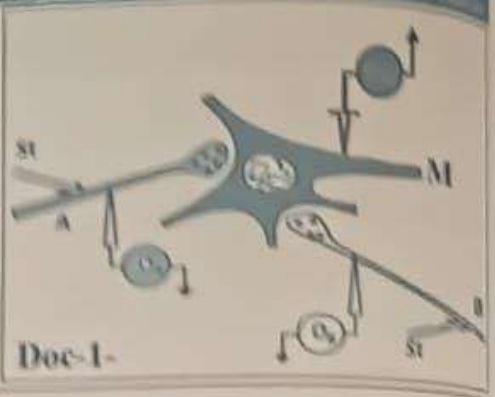
7- Determine the muscle, from which originate the sensory fibers stimulated in the first setup of this exercise, as well as the muscle, from which originate the sensory fibers of the second setup.

8- What would be the results, if experiment 5 of the 1st setup is accompanied with the excitation A of the 2nd setup? Justify & name the corresponding phenomenon.

9- Referring to the two experiments, deduce the role of the motor neuron.

Question – N°3 : Synaptic functioning & its role in the coordination of antagonistic muscles

In order to understand the synaptic functioning & its role in the coordination of the activities of antagonistic muscles during a myotatic reflex, we perform experiments on the neuronic circuit composed of a postsynaptic neuron **M** which is in relation with two presynaptic neurons **A** & **B**, indicated in the doc-1.



Doc-1-

Experiment 1:

We stimulate the presynaptic neurons **A** and **B** by an effective intensity. The evolution of the electric state of presynaptic neurons A and B and that of postsynaptic neuron **M** is indicated in document-2.

1- Identify the traces a, b & c

2- Derive a conclusion about the nature of each of synapses (A – M) & (B – M).

Electric state of presynaptic neuron A	Electric state of presynaptic neuron B	Electric state of postsynaptic neuron M	
		Following the stimulation of presynaptic neuron A	Following the stimulation of presynaptic neuron B
p.d (mV) +30 -70 ms	p.d (mV) +30 -70 ms	p.d (mV) -58 -70 ms	p.d (mV) -70 -73 ms
Trace a: (At the level of O_A)	Trace a: (At the level of O_B)	Trace b: (At the level of O_M)	Trace c: (At the level of O_M)

Experiment 2:

We make several micro-injections at different synapses, then we record the electric state of postsynaptic neuron M in absence of any stimulation of A or B. The results are shown in doc-3

Document 3	Micro-injection of GABA		Micro-injection of acetylcholine	
	In the cleft of synapse A-M	In the cleft of synapse B-M	In the cleft of synapse A-M	In the cleft of synapse B-M
Electric state of postsynaptic neuron M (Recording on O_M)	p.d (mV) -70 ms	p.d (mV) -70 -73 ms	p.d (mV) -58 -70 ms	p.d (mV) -70 ms
p.d: potential difference	Recording d			Recording d

3- Interpret the obtained results.

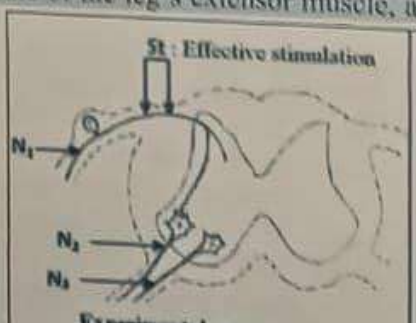
4- Formulate a hypothesis that explains each of recordings d.

5- Represent the obtained recording at the level of the oscilloscope O_M following two very close effective stimulations on the presynaptic neuron A. Justify your drawing.

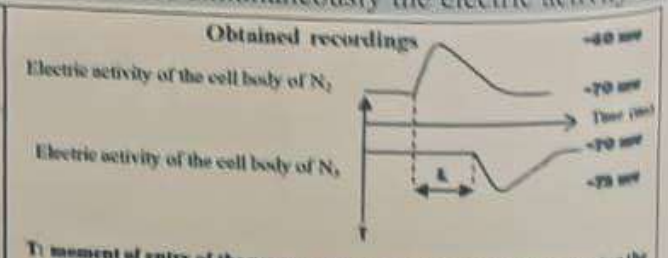
We carry an effective electric stimulation on the terminal knob of the sensitive neuron **N1** issued from the neuromuscular spindle of the leg's extensor muscle, and we record simultaneously the electric activity of the cell bodies of motor **N2** & **N3** by intracellular micro-electrodes:

-Motor **N2** innervates the leg extensor muscle.

-Motor **N3** innervates the leg flexor muscle.



Experimental setup



T: moment of entry of the nervous message in the spinal cord following the effective stimulation of the terminal arborization of sensitive neuron N1

L: latency time of 0.5 ms

Document 4

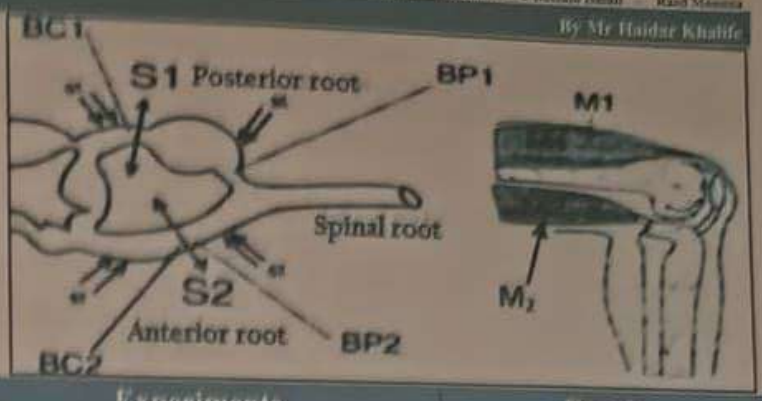
6-1. Specify the nature of the synapse N_1-N_2 & indicate its effect on the activity of the extensor muscle.

6-2. Specify the nature of the synapse N_1-N_3 and indicate its effect on the activity of the flexor muscle.

6-3. Explain, referring to all what precede, the mechanism of coordination between the antagonistic muscles (extensor & flexor) during the myotatic reflex following the stretching of the extensor muscle.

Question 21

In the frame work of studying the mechanism of myotatic reflex, a series of experiments were performed at the level of the lumbar region of the spinal cord which is responsible for controlling the patellar reflex in the right leg.

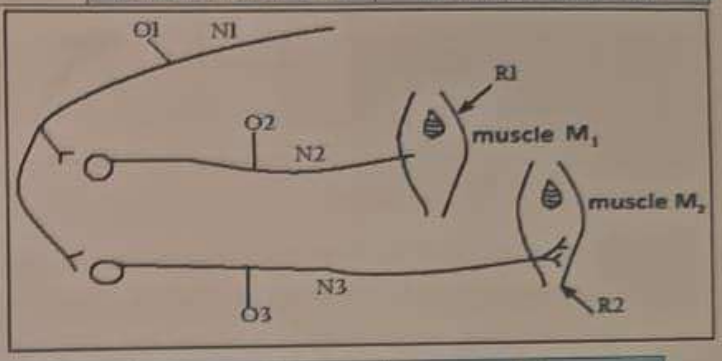


1- Interpret the results of these experiments.

no	Experiments		Results
1	Hitting of the tendon of muscle M1		Extension of the foot
2	Hitting of the tendon muscle M1, after sectioning S1 or S2		Disappearance of the reflex
3	Section S1	Stimulation of BC1	Extension of the foot
4		Stimulation of BP1	No reflex
5	Section S2	Stimulation of BC2	No reflex
6		Stimulation of BP2	Extension of the foot

2- Referring to your knowledge, and the results of experiment 1 determine the role of muscles M1 & M2.

The sensory neuron N1issued from one of these two muscles is subjected to series of stimulations, the results of these stimulations on N1, N2, and N3, in addition of the two muscles are given below:



Intensities	O1	O2	O3	R1	R2
I_1	A			70 mv (ms)	(ms)
$I_1 + I_1$				45 mv 1 ms (ms)	(ms) 95 mv

3- Interpret the results obtained and conclude the muscle from where N1 is issued.

4- Determine the number of synapses implied in each of the concerned neurons' circuits knowing that the transmission of a nerve message at the level of a synapse needs 0.5ms.

5- By referring to the results of all above given, redraw document 1 showing the neuronic circuit.

The stimulation of the neuron issued from the cerebrum by intensity I2 at the same time we excite N1 by $I_1 + I_1$ leads to the following:

Intensity	O2	O3	R1	R2
$I_1 + I_1$			80	55

6- Determine the results of the recordings that will be given if I_2 is applied alone.

7- By referring to your knowledge, indicate the area and cerebral part from where this neuron is issued.

During the stimulation by S_1 we stimulate the motor neuron N_4 that is originated from the cerebrum, the results are given below:

N4	R1	O2	R2	O3	M1	M2
Non - Stimulated	-55mv		-85mv		Contract	Relax
Stimulated	-85mv		-55mv		Relax	Contract

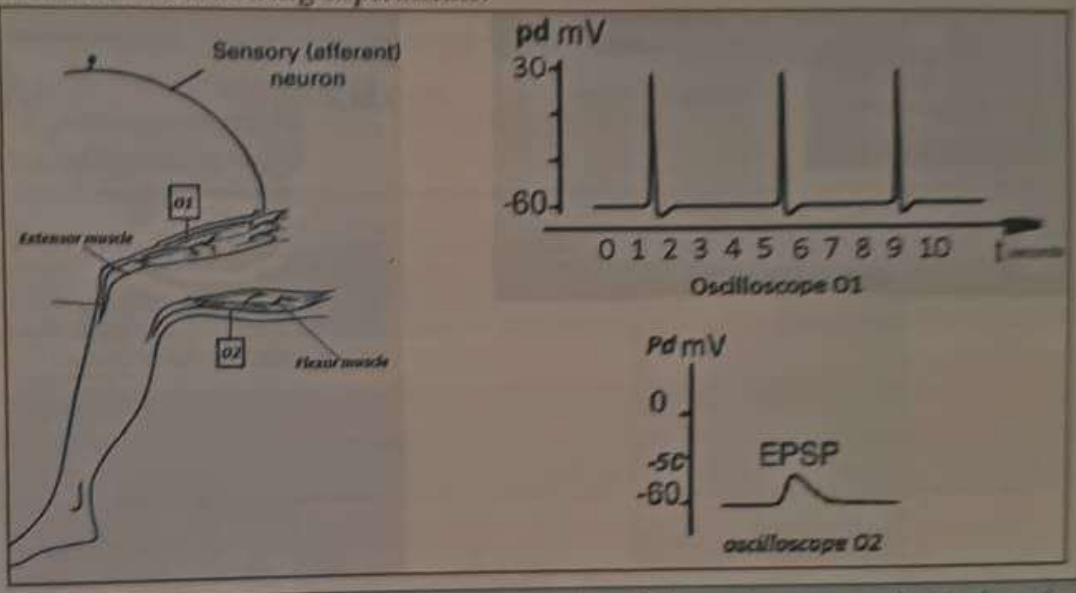
7- Compare these obtained results, and conclude the role of N4.

Question-23-

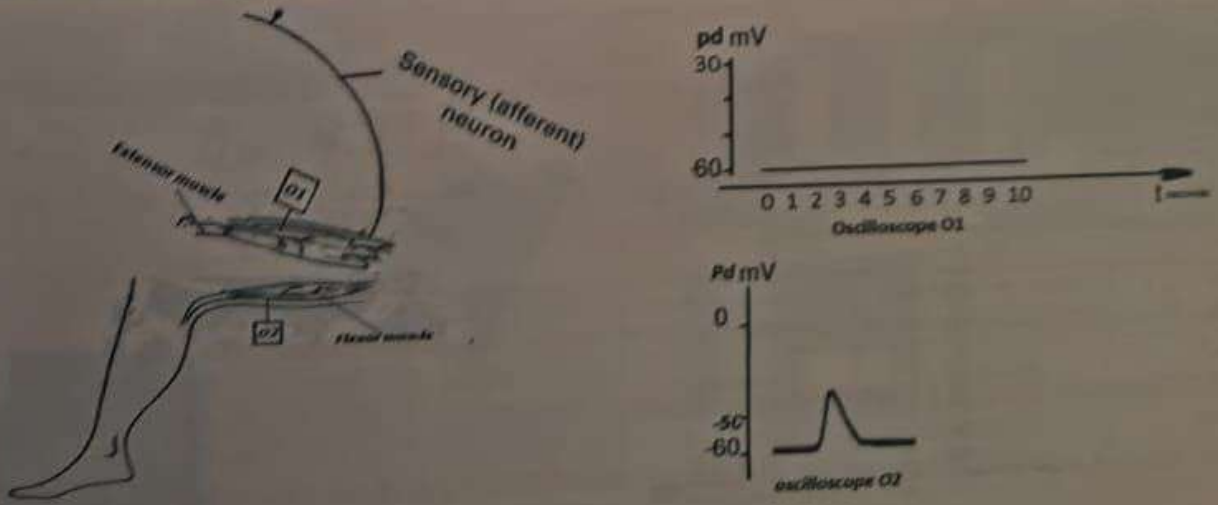
The stretching of the extensor muscle leads to its contraction in order to retain its initial length .This contraction is accompanied by the relaxation of the flexor. In order to determine the neural circuit that innervates this reflex. We realize the following experiments.

Exp1: The leg is placed as given in the document below which shows the behavior of the two studied muscles.

The electric activity of the sensory fiber issued from the extensor muscle is registered by the oscilloscope O1 and the activity of the flexor muscle is detected by O2.



Exp 2: Keeping the leg at the same position, we section the tendon of the extensor muscle as given in doc.2 we observe in the two oscilloscopes O1 and O2 the following registrations:



1- Determine the type of reflex revealed in these experiments.