وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة فرع علوم الحياة	دورة سنة 2008 االاكمالية- الاستثنائية

مسابقة في مادة "علوم الحياة" المدة : ثلاث ساعات	الاسم : الرقم :

Answer the following exercises.

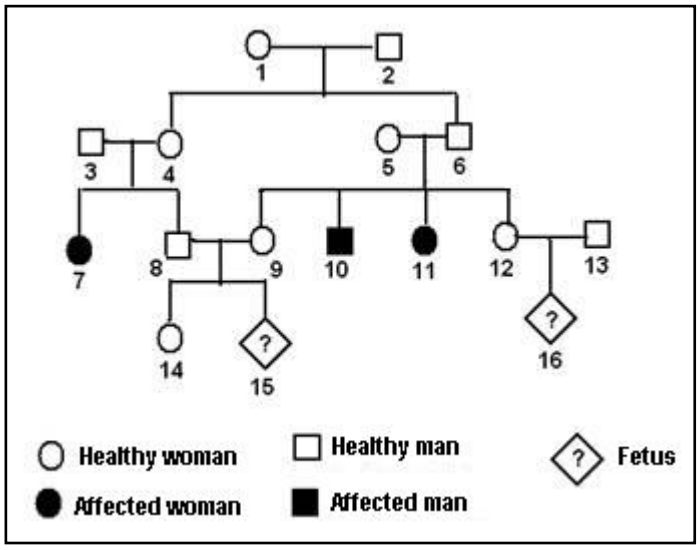
Exercise 1 (5pts)

Phenylketonuria is a recessive autosomal disease that affects 1/10,000 of newborns world wide. This disease is related to a deficiency in an enzyme called PAH. In normal conditions, this enzyme metabolizes phenylalanine into tyrosine, in the presence of a co-factor DHBP. This deficiency leads to an increase in the amount of phenylalanine in the blood accompanied with serious troubles.

A study performed on 1,200 children selected from an isolated community, showed that 30 children were heterozygous for PAH.

1. Calculate the proportion of heterozygous children in this community; and then determine the genetic risk for a child to be affected with phenylketonuria.
2. Compare the genetic risk obtained to the world wide risk. Formulate a hypothesis that explains the difference between these two risks.

In order to verify the formulated hypothesis, a study was carried out on a family of this community, which pedigree is shown in the adjacent document.



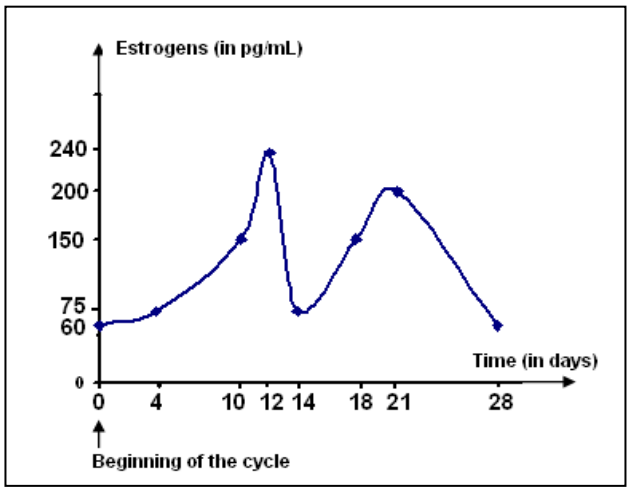
3. By referring to the pedigree, justify that the disease is recessive and autosomal.
4. Determine, for each of the fetuses 15 and 16, the risk to be affected.
5. Do the obtained results confirm the formulated hypothesis? Justify the answer.

Daughter 7 marries an affected man. Their first child was normal. All the tests performed confirm that the child is legal, and that the husband, unlike his wife, has a normal amount of PAH.

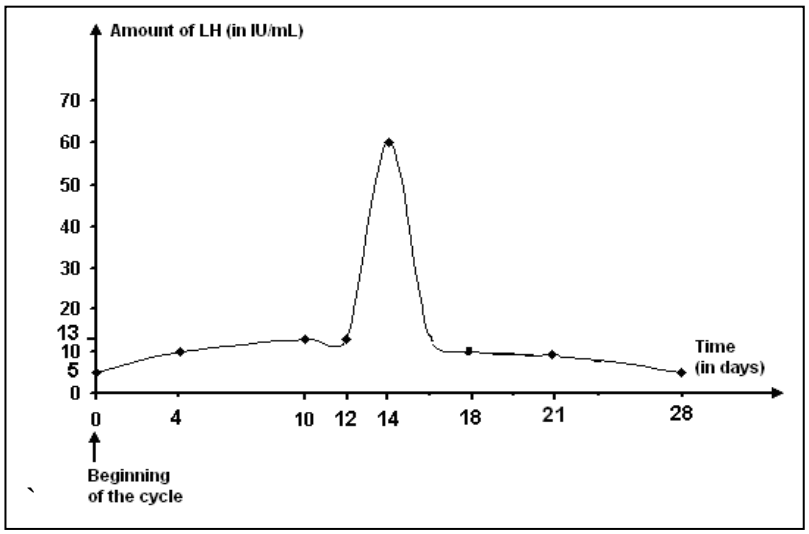
6. Determine the probable cause of the disease of the husband of daughter 7.
7. Justify, genetically, the birth of a normal child by this couple.

Exercise 2 (5pts)

In order to determine the reason of sterility in a 30 years old woman, a gynecologist prescribed the determination of estrogens and LH hormones levels in the course of a sexual cycle. The obtained results are shown in documents 1 and 2.



Document 1



Document 2

1. Draw up in the same table, the variations of the plasma amount of estrogens and LH in this woman.

Advanced analysis showed a production of normal gametes. The doctor affirms that the results show an absence of disturbances in the functioning of the hypothalamus, pituitary, and ovaries and that the anomaly is mainly in the genital ducts.

2. By referring to documents 1 and 2 and to acquired knowledge, justify the doctor's affirmation.
3. Name the technique that allows treating this woman's sterility.

Document 3 reveals the amount of estrogens and LH in another woman of the same age, who also suffers from sterility.

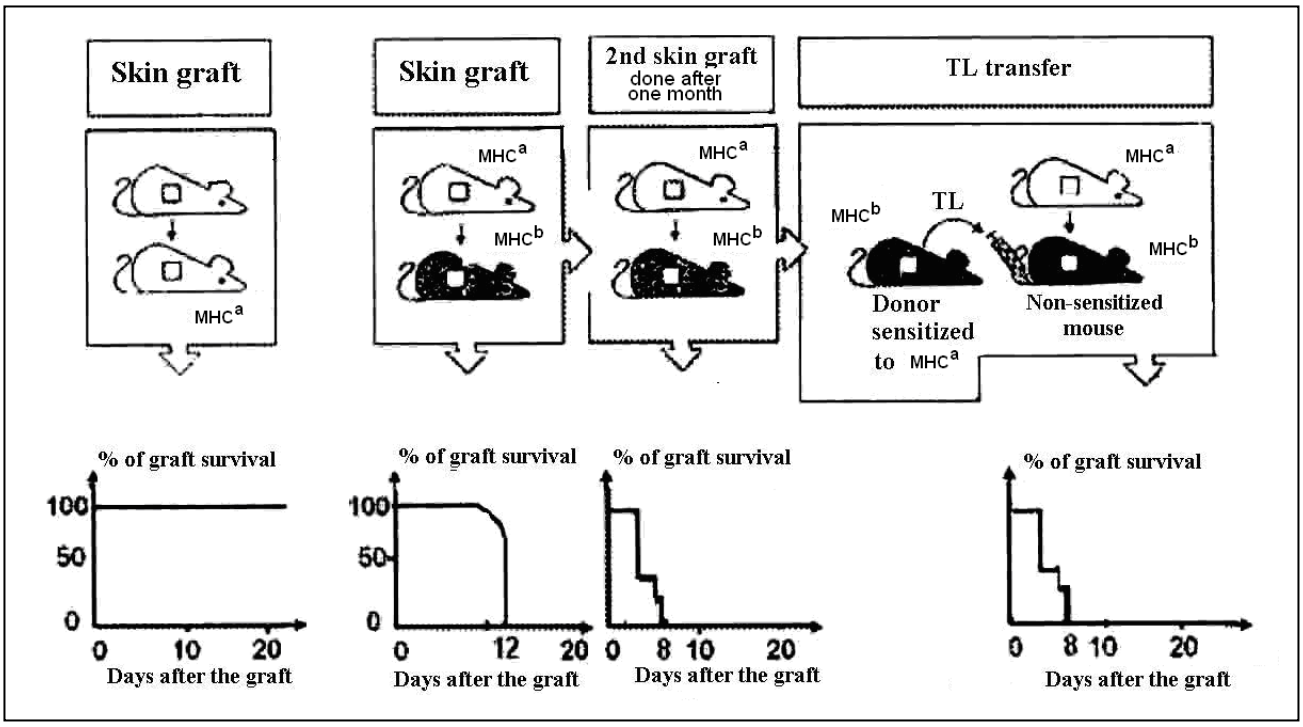
Days after the beginning of menstruation	**0**	**4**	**10**	**12**	**14**	**18**	**24**	**28**
Amount of estrogens (pg/mL)	**29.1**	**0**	**30.4**	**29.9**	**29.3**	**30.3**	**30**	**30.3**
Amount of LH (mIU/mL)	**5.3**	**6.8**	**6.3**	**7**	**6.2**	**6**	**7.3**	**6.5**

Document 3

4. Interpret the obtained results.
5. Explain the probable origin of this woman's sterility.
6. Propose a treatment that may solve the problem of sterility in this woman.

Exercise 3 (5 pts)

In order to know the mechanisms responsible for rejecting or accepting grafts, experiments on mice of the same line or different line are done. The experiments and their results are shown in document 1



Document 1

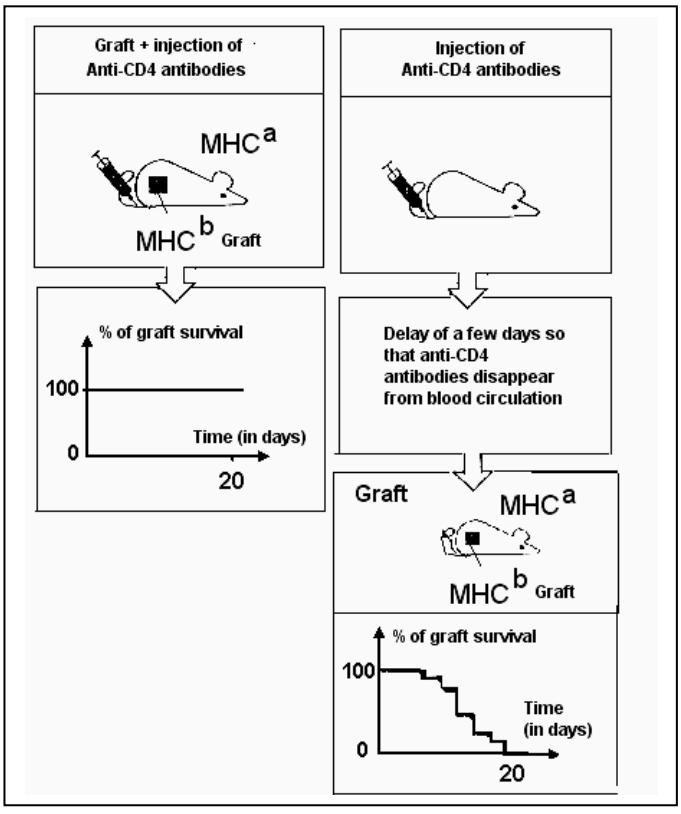
1. Interpret these experiments. Draw out the conditions of a graft rejection.

Two types of T-lymphocytes (TL) are recognized: TL4 with a CD4 receptor and TL8 with CD8 receptor. The experiments revealed in document 2 are carried out in order to determine the role of TL involved in graft rejection.

2. Interpret the obtained results. What can be deduced?

3. Justify that these experiments are not sufficient to assure, which of the two types of TL is involved in graft rejection.
   Suggest an experiment that allows solving this problem.

4. Explain how the anti-CD4 antibodies intervene in accepting grafts. Draw out a practical medical application.

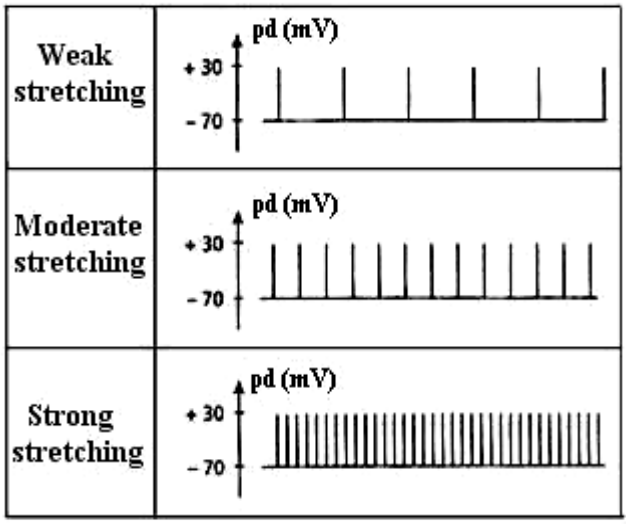


Document 2

Exercise 4 (5pts)

Myotatic reflex is a muscle response triggered by a stimulus whose receptor is the neuromuscular spindle.

Tapping the Achillean tendon provokes the stretching of the foot's extensor muscle into variable lengths. Simultaneously, we record the nerve message transmitted all along a nerve fiber issued from the neuromuscular spindle of this muscle. The results are shown in document 1.

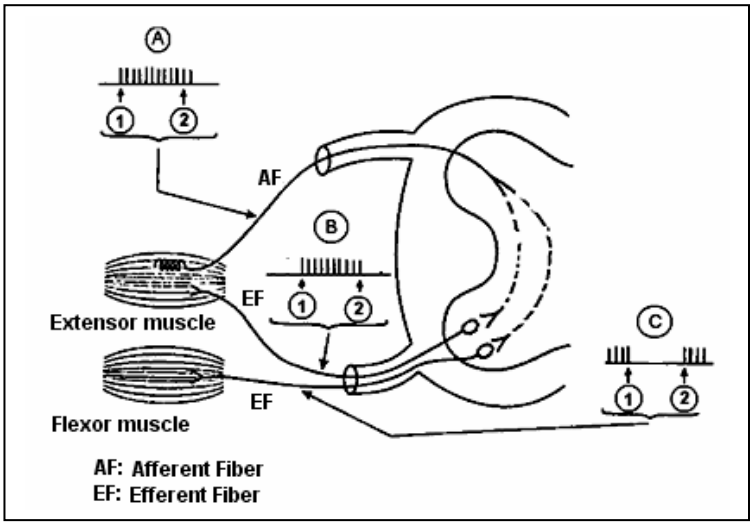


Document 1

1. Interpret the recordings obtained. What can be deduced?

The nerve fibers issued from the neuromuscular spindles are connected, inside the spinal cord either directly or by means of interneurons, to the motor neurons of two muscles: one is an extensor, and the other is a flexor.

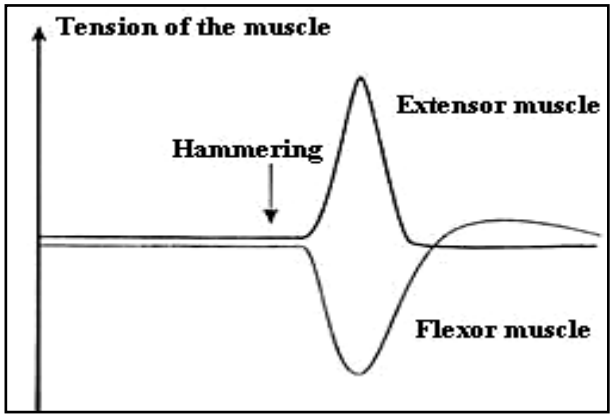
The activity of these motor neurons is recorded in response to an afferent message. The results are shown in document 2. For each recording obtained, arrow "1" corresponds to the beginning of the stimulation and arrow "2" corresponds to the end of the stimulation.



Document 2

2. Compare the four recordings obtained.
3. Explain the role of the spinal cord in the establishment of this reflex and specify the neuronic circuit implied.

The tensions of the extensor and flexor foot's muscles during this reflex were recorded as shown in document 3.



Document 3

4. Specify the movement that was done. Justify your answer based on documents 2 and 3.

5. What can these muscles be qualified as? Justify the answer.

Exercice 1 (5pts)

1- The proportion of heterozygotes: 30/1,200 = 1/40. **(0.25 pt)**
It is an autosomal transmission, for get a child of normal parents to be affected, parents must be heterozygous. The probability of each parent to be heterozygous is 1/40, the probability for heterozygous parents to have a sick child is ¼. Therefore, the risk of the birth of a child affected with phenylketonuria in this community is :1/40 x 1/40 x 1/4 =1/6400. **(0.5pt)**

2- The obtained risk 1/6400 is greater than the world wide risk 1/10,000 **(0.25pt)**
Hypothesis: A consanguineous marriage (intermarriage) in this community increases the risk of phenylketonuria.**(0.25pt)**

3- Couples (3-4) and (5-6) are normal and have affected children (7, 10 and 11). This implies that each of the parents carries the hidden allele of the disease. Thus, the allele is recessive. (m is the symbol of the abnormal allele)**. (0.25pt)**
The disease is autosomal.
- If it was sex-linked and the gene carried by the segment of Y that has no homologue with X, then all the affected individuals should be boys who must have the same phenotype as the father. Child 10 is affected while his father 6 is not, this is not the case.
- If the gene is carried by the X segment that has no homologue on Y, daughters 7 and 11 must have a genotype Xm/Xm and each of the parents transmits one Xm, this is not the case since the father of each daughter is normal.
- If the gene is carried by the homologous segment of X and Y, affected children 10 and 11 should have the genotypes Xm/Y and Xm/Xm respectively. The father must give Xm to his daughter and Ym to his son, and in this case his genotype should be Xm/Ym and he should be affected, this is not the case. **(0.75pt)**

4- Fetus 15: The two parents of this fetus is normal, however, the grand parents of the fetuses are heterozygous. Thus, the probability for each of the fetuses' parents to be heterozygous is 2/3. The risk for both parents to be heterozygous is 2/3 x 2/3, and the risk to have an affected child is ¼. Therefore, the risk for fetus 15 to be affected is 2/3 x 2/3 x 1/4 = 1/9 **(0.5pt)**
Fetus 16: his/her mother has the same risk as his/her sister 9 to be heterozygous: 2/3. The father is a member of the community and the risk to be heterozygous is 1/40. If the parents of this fetus are heterozygous, then the probability to have an affected child is ¼. Therefore, the risk of fetus 16 to be affected is: 2/3 x 1/40 x 1/4 = 1/240. **(0.5pt)**

5- Yes, fetus 15 has a risk of 1/9 to be affected, this is greater than the risk in the case of fetus 16 (1/240). The parents of fetus 15 are cousins of the same family, which presents the disease. On the contrary, only the parents of fetus 16 do not belong to the same family. Therefore, the hypothesis is valid and the intermarriage favors the appearance of the disease. **(1pt)**

6- The husband of daughter 7 is affected and yet with a normal PAH amount. Therefore, it can be said that the disease must have an origin other than PAH. Based on the data, PAH converts phenylalanine into tyrosine in the presence of a co-factor DHBP. This makes us say that the probable cause of the disease in the husband of daughter 7 is due to an absence or a deficiency in DHBP. **(0.75 pt)**

7- A normal child inherits the normal allele of the PAH gene from the father and the normal allele of the DHBP gene from his mother. This is why he has a normal phenotype. **(0.5 pt)**

Exercise 2 (5pts)

1. **(2 pts)**

Time (days)	**0**	**4**	**10**	**12**	**14**	**18**	**21**	**28**
Amount of estrogens (pg/mL)	**60**	**75**	**150**	**240**	**75**	**150**	**200**	**60**
Amount of LH (mIU/mL)	**5**	**10**	**13**	**13**	**60**	**10**	**10**	**5**

Variations of estrogens and LH amounts in the course of a cycle of a woman

2. The woman produces normal gametes, which shows a normal state of endocrine control and ovarian functioning. In fact, the results obtained indicate an increase in the amount of estrogens between days 0 and 10 that indicates a normal development of follicles. The estrogens peak on day 12 provokes a positive feedback on the hypothalamo-pituitary axis, which is explained by LH peak on day 14 that induces ovulation. Thus, the problem is at the level of the genital ducts. **(1pt)**

3. This woman must be subjected to FIVETE technique. **(0.5pt)**

4. During 28 days the levels of estrogens and LH in this woman show remain constant. The amount of estrogens fluctuates between 29.1 and 30.4 pg/mL and the amount of LH fluctuates between 5.3 and 7.3 mIU/mL through out the cycle. This implies that there are no cyclic variations for the amounts of estrogens and LH in this woman.**(0.5pt)**

5. The measurements of hormone levels done in this woman reveal the absence of cyclic variations of hormones, the release of estrogens at day 12 should trigger the peak of LH, which induces ovulation. Therefore, the probable cause of sterility in this woman is the a deficiency of estrogens that blocks LH peak which leads to ovulation. This signifies that this sterility is due to disturbances in the functioning of the hypothalamus, or pituitary, or ovaries. **(0.5pt)**

6. A hormonal treatment should be given to this woman. For example, a strong dose of estrogens can be administered in order to stimulate the occurrence of LH peak, which triggers ovulation.**(0.5pt)**

Exercise 3 (5pts)

1. The skin graft from mouse MHC^a to another mouse of the same line shows a 100% survival of the graft that persists beyond 20 days. On the other hand, the graft carried out between two mice of different lines MHC^a and MHC^b survives 100% until day 10 after which the % of survival then decreases to become null, and the graft is rejected at the end of day 12. This % is even weaker when mouse MHC^b receives, after one month, a second skin graft from MHC^a and the graft is rejected on the 8^{th} day < 12^{th} day.
   The injection of TL, obtained from mouse MHC^b immunized against MHC^a, into a mouse MHC^b which receives a 1^{st} skin graft from MHC^a, led to the rejection of the graft in 8 days as in the case of the 2^{nd} graft.
   This implies that graft survival can take place when it is done between members of the same line. Graft rejection is done between individuals of different lines and is faster after a 2^{nd} contact with the same antigen and that TL are the cells that reject grafts.
   Therefore, graft rejection done between two different lines necessitates the presence of TL. **(1.5pts)**

2. Graft between different lines, done along with the injection of anti-CD4 antibodies, succeeds and the percentage of its survival is maximal. On the other hand, if the injection of anti-CD4 antibodies is carried out a few days before the graft, a time delay for these antibodies to disappear from blood circulation, the graft is rejected. This means that the anti-CD4 antibodies, when they are present, prevent graft rejection.
   Therefore, TL4 cells have a role in graft rejection. **(1pt)**

3. This experiment is not sufficient to determine which type of cells is involved in graft rejection. Question 2 reveals that the TL4 cells have a role in graft rejection but it cannot be determined whether TL8 have the same role. **(0.5 pt)**
   For that, it is necessary to repeat the experiments of document 2, and add two more mice. The 1^{st} mouse is injected with anti-CD8 antibodies and the 2^{nd} mouse with anti-CD4 and anti-CD8 antiobodies, before performing the graft between the two different lines. We follow the variation of the graft: survival or rejection in order to determine which cell is behind graft rejection, TL4 or TL8 or both. **(1pt)**

4. Antibodies specific for CD4 are simultaneously injected with the grafting. They fix to TL4 receptors to block them. The blocked TL4 are not activated and do not proliferate nor do they differentiate into cells that secrete interleukins 2. Thus, the TL8 are not activated and the graft is successful. **(0.75 pt)**
   Anti-CD4 antibodies can be used as immunosuppressor drugs during grafting. **(0.25pt)**

Exercise 4 (5pts)

1. With a weak stretching of the neuromuscular spindle, 6 AP of 100mV amplitude each, are obtained. As the stretching increases, the number of AP (34) increases while their amplitude remains constant. Therefore, as the intensity of stimulation increases the frequency of action potentials increases. Hence, the nerve message is coded by the frequency of action potentials **(1pt)**

2. Recording (A) obtained on the afferent fiber of the extensor muscle shows a frequency of AP of same amplitude. These AP start at 1 and end at 2. This recording is identical to that obtained in B at the level of the efferent fiber of the extensor muscle. On the other hand, recording (C) at the level of the efferent fiber of the flexor muscle shows the absence of AP during the period of stimulation. **(1pt)**

3. At the level of the spinal cord, the afferent fiber of the extensor muscle synapses directly with the motor neuron of the extensor muscle. This synapse is excitatory; it transmits the nerve message to the efferent fiber to the extensor muscle.Also, this afferent fiber of the extensor muscle synapses at the level of the spinal cord, with an interneuron through an excitatory synapse and the interneuron synapses with the motor neuron of the flexor muscle along an inhibitory synapse; as a result, the nerve message is inhibited. The spinal cord, via its different synapses, is able to coordinate the activity of the different motor neurons and the muscles on which these synapses depend. **(1.5 pts)**

4. Stretching (extension) movement **(0.25 pt)** Tension increase of the extensor muscle is an indication that the muscle contracts after the arrival of the nerve message through the efferent nerve fiber .
   The decrease in the tension of the flexor muscle is an indication that the muscle is relaxed and that this muscle is not receiving any nerve messages. **(0.75pt)**

5. Antagonistic muscles **(0.25pt)**. Because as one muscle contracts, the other muscle relaxes (at the same time), favoring the extension of the foot. **(0. 25pt)**