

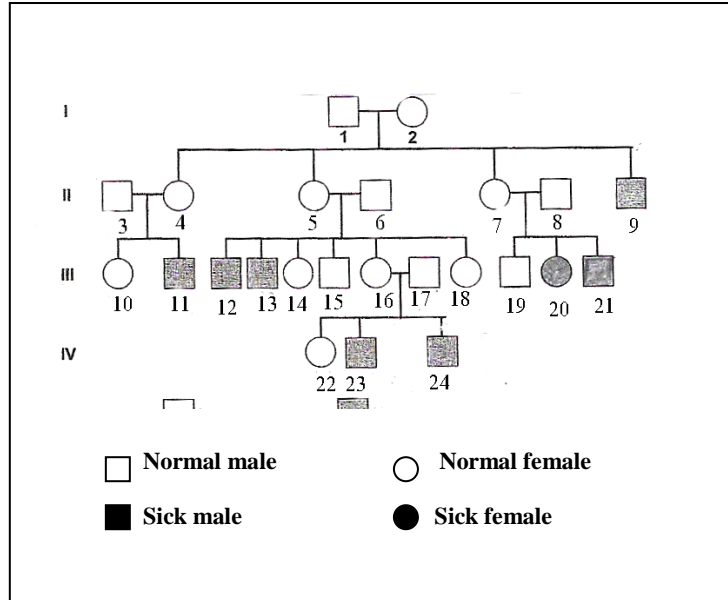
الاسم :
 الرقم :

مسابقة في "علوم الحياة"
 المدة : ثلاث ساعات

Answer the following questions

Question I (5 ½ pts)

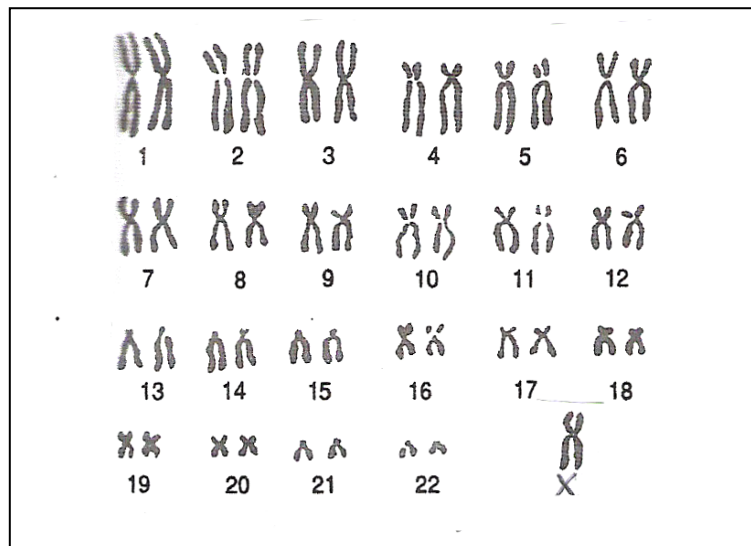
Document 1 represents the pedigree of a family with some of its members, shown in black, having a rare hereditary disease that occurs mainly in males and very rarely in females.



Document 1. Pedigree of the transmission of the disease

- a- Is the allele responsible for the disease dominant or recessive? Justify the answer.
- b- Discuss logically the chromosomal localization of the gene responsible for this disease (**without considering female 20**).

c- Illustrate, chromosomally, the genotype of each of the individuals 13 and 16. Justify the answer.



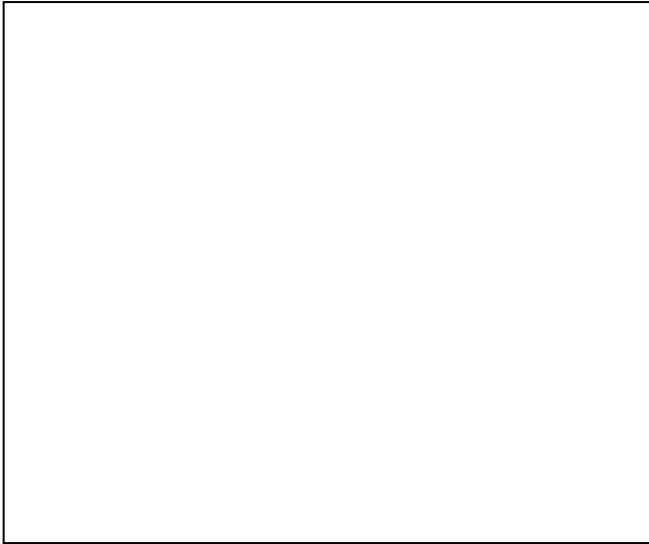
Document 2. Karyotype of female 20

Female 20 presents, besides her disease, an abnormality, which is manifested by the absence of menstruation, absence of the development of mammary glands... To identify this abnormality we perform the karyotype of female 20, document 2.

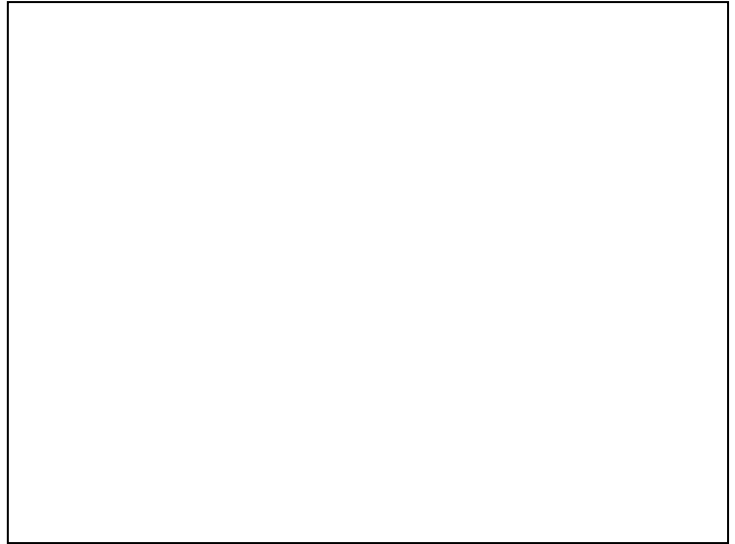
- d- Write the chromosomal formula of this female. Give the name of the abnormality revealed by the karyotype.
- e- Based on the karyotype, how can you explain the appearance of the disease in female 20?
- f- Knowing that this chromosomal abnormality results from an error in meiosis during spermatogenesis, schematize the chromosomal behavior of the concerned chromosomes only (**consider one case only**).

Question II (4 pts.)

In the framework of studying the mode of action of a chemical contraceptive, we follow up the variation of the ovarian and pituitary hormonal secretion over time in two women having normal cycles, in two different situations: woman A, who does not take a contraceptive pill, and woman B, who takes an estro-progesterone contraceptive pill. The results are presented in documents 1 and 2 for woman A, and 3 and 4 for woman B.



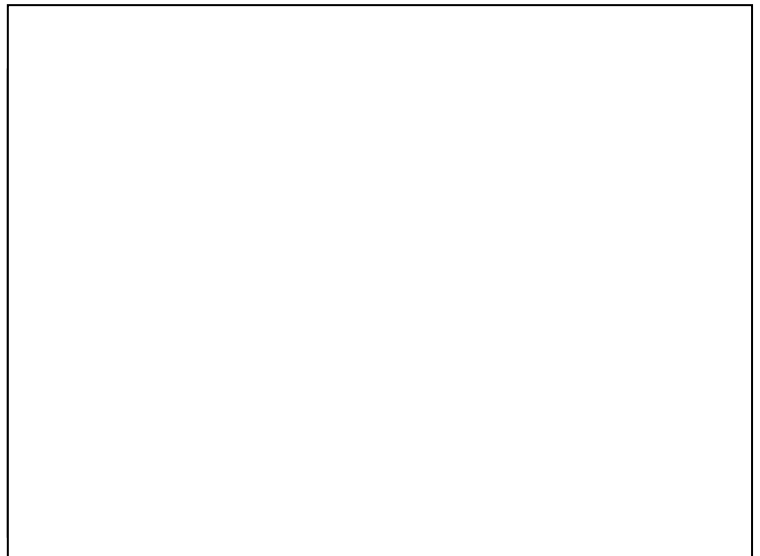
Document 1. Variation of the concentration of the secreted pituitary hormone



Document 2. Variation of the concentration of the secreted ovarian hormones



Document 3. Variation of the concentration of the secreted pituitary hormone

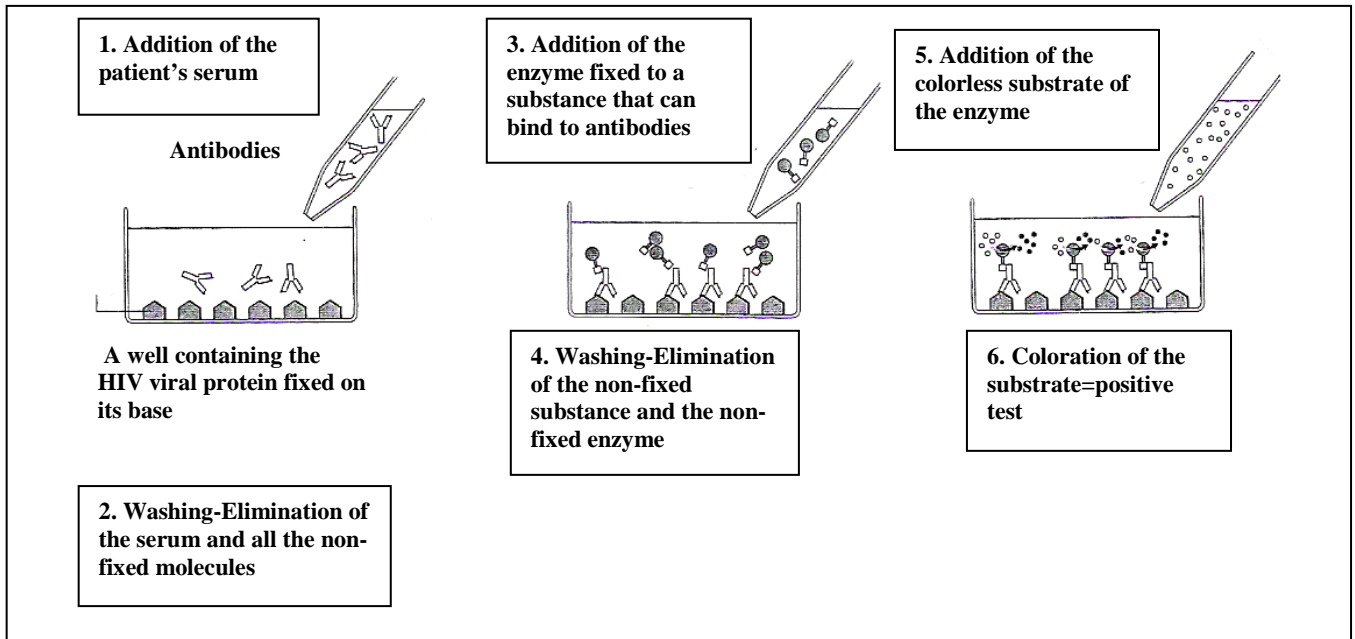


Document 4. Variation of the concentration of the secreted ovarian hormones

- a- Compare the variations of the concentration of estradiol on one hand, and the variation of the concentration of progesterone on the other hand, in the two women. Point out the effect of the pill on the ovaries.
- b- In reference to the documents and to the acquired knowledge, explain the observed differences between the given two situations.

Question III (6 pts.)

AIDS, or Acquired Immunodeficiency Syndrome is a disease due to a virus called HIV, or Human Immunodeficiency Virus. This disease affects the immune system and develops through many years, more or less rapidly depending on the individual. Individual **A** is suspected to be infected by the virus. He consulted a doctor who prescribed blood analysis and a test called ELISA test. Document 1 reveals the different steps and the obtained results of this test.



Document 1. ELISA test: steps and result

- a- Write a short text describing document 1.
- b- What does the obtained result indicate? How can you explain this result?

Document 2 reveals the amount of T4 lymphocytes, measured over time, of a patient **B** who presents severe signs of infection.

Duration in months	3	6	12	18	30	40	50	70
Amount of T4 lymphocytes/mm³ of blood	550	750	800	500	450	300	200	50

Document 2. Variation of the amount of T4 lymphocytes in function of time

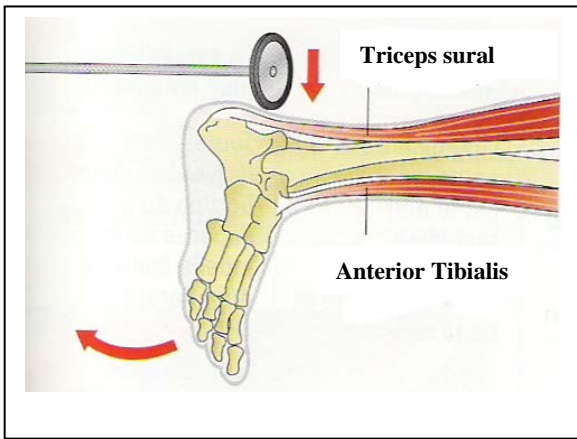
- c- Draw the curve of the variation of the amount of T4 lymphocytes in function of time.
- d- Analyze the curve, then find out the cause of the observed immune deficiency starting from the 40th month.
- e- Knowing that the blood analysis done for patient **A** shows that the amount of T4 lymphocytes is equal to 800/mm³ of blood, and in reference to document 2, find out the duration of infection in patient **A**.

Question IV (4 ½ pts)

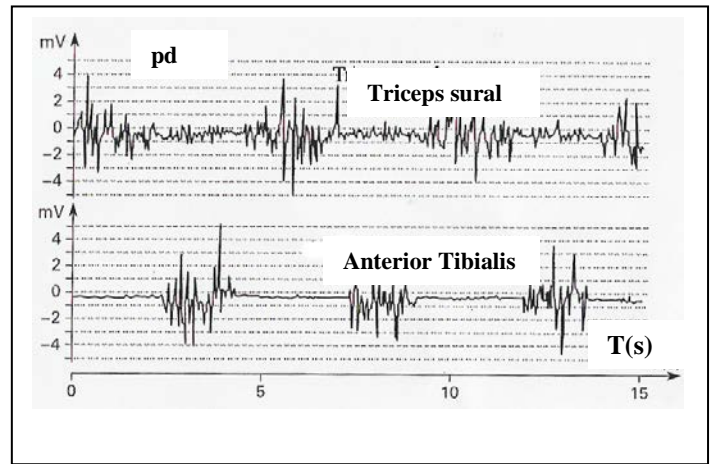
To understand the activity of the two muscles of the lower leg, the anterior tibialis and the triceps sural, during a reflex act and during their voluntary movement, the following experiments are done and the results are presented in following documents.

1st experiment: Stretching of the triceps sural by hitting the Achillian tendon, connected to the muscle, immediate extension of the foot and the contraction of the mentioned muscle is provoked, document 1.

2nd experiment: We place electrodes on the skin of a person at the level of the triceps sural and the anterior tibialis, and we ask this person to perform alternating movements of his foot: extension followed by flexion. The obtained recordings are presented in document 2.



Document 1



Document 2

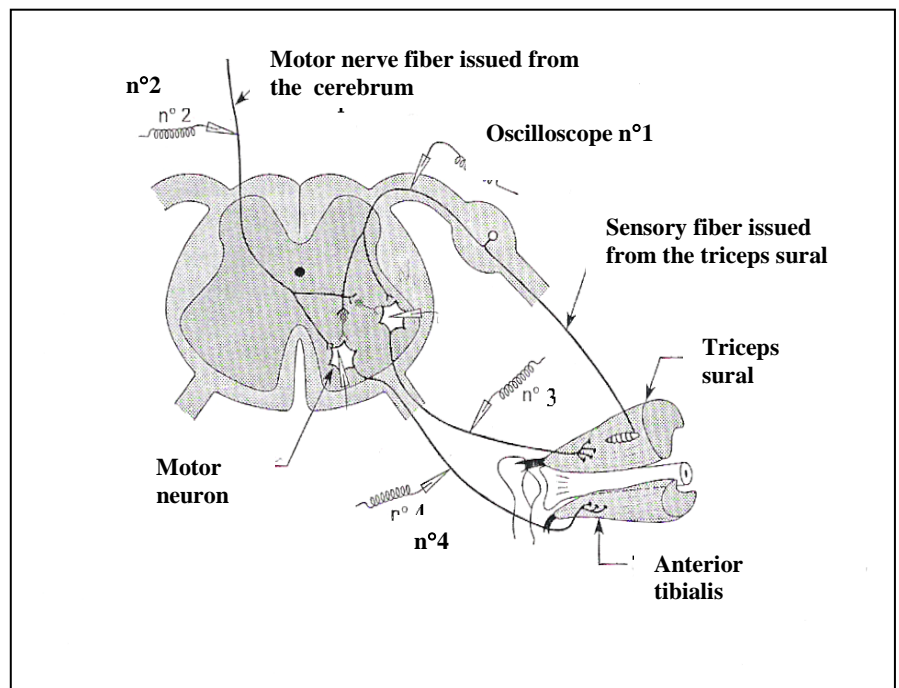
- a- What type of reflex is revealed in the first experiment? Justify the answer.
 b- Interpret the results of the second experiment. What can you deduce concerning the role of each of these two muscles?

In order to know if a person is capable to control an Achillian reflex we perform the experimental set-up shown in document 3. We record the electric activity at the level of the triceps sural, the anterior tibialis, and the corresponding network of neurons, in the following two cases:

Case A: Hitting the Achillian tendon.

Case B: Hitting the Achillian tendon during a strong voluntary contraction of the anterior tibialis.

The results are presented in document 4.



Document 3

	Obtained recordings at the level of the oscilloscopes				Muscular activity	
	n° 1	n° 2	n° 3	n° 4	Triceps sural	Anterior tibialis
Case A	+	-	+	-	Contraction	Relaxation
Case B	+	+	-	+	Relaxation	Contraction

(+) presence of action potential

(-) absence of action potential

Document 4

- c- Compare the obtained results. Deduce the role of the cerebrum in this activity.

Document 4

Question I (5 ½ pts.)

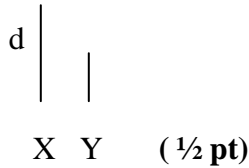
- a- The allele responsible for the disease is recessive. Individual 9, sick, his parents are healthy (couple 1-2). This individual receives the allele responsible for the disease from his parents who have the allele which is masked. (½ pt)
Let "N" be the symbol of the normal allele, and "d" the symbol of the allele of the disease.

- b- Localization of the gene:

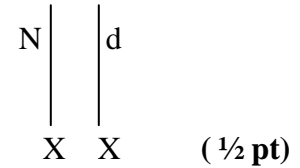
- Since the disease affects mainly the males and very rarely the females, hence the most probable hypothesis is that the gene is sex linked.
- If the gene is carried on the part of Y that has no homologue on X. the transmission should be from fathers to sons. In this case all the boys should have sick fathers. Thus, male 9 who is sick has a normal father 1, which is not the case. Hence the allele responsible for the disease is carried on the X that has no homologue on Y.

(1 pt)

- c- 13



- 16



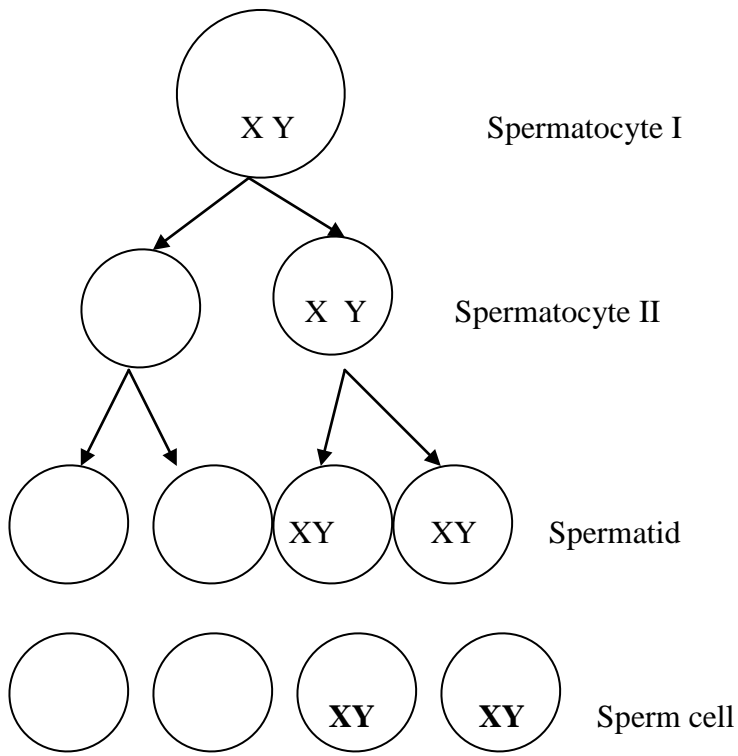
13: Since he is a sick boy, has one chromosome X, carrying the allele d. (½ pt)

16: Since she is a healthy girl and has two sick boys 23 and 24, she must be heterozygote carrying the sick allele. Thus this female must be $X^N X^d$. (½ pt)

- d- Chromosomal formula = $44 + X$ (¼ pt)
Turner syndrome (¼ pt)

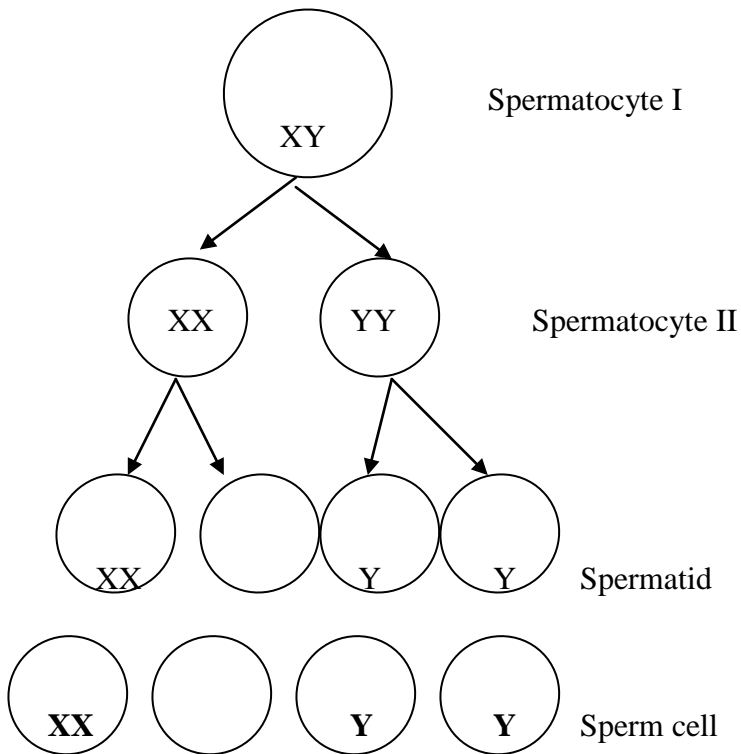
- e- This karyotype shows one chromosome X having the sick allele, and since it does not have an allele on a homologue, the disease is expressed in this female. (½ pt)

f-



Abnormality of reduction division:
Sex chromosomes do not separate

Or



Abnormality of equational division:
No separation of chromatids

(1 pt.)

Question II (4pts,)

a- The secretion of estradiol fluctuates between 5 pg/mL and 8 pg /mL all through the cycle in woman B similarly in woman A from day 0 to day 12, who shows two estradiol peak, of 20 pg/mL on day 13 and another of 15 pg/mL on day 20.

In woman A, the secretion of progesterone by the ovaries is null from day 0 to day 14. It starts increasing from day 14 to day 21 to reach 170 ng/mL then it decreases gradually until it becomes null on day 28.

Moreover, in woman B, the concentration of progesterone fluctuates around a null value through the cycle. (2 ½ pts.)

b- In woman A, not taking the pill, A peak of estradiol is observed on day 13, which is followed by an LH peak on day 14. There is a correlation between the LH peak and the secretion of estradiol: the estradiol peak triggers, by positive feedback the peaking of LH that provokes ovulation. This is not the case in woman B, who lacks an estradiol peak, which does not provoke LH peaking. The contraceptive pill inhibits the secretion of FSH and LH that inhibits the development of the follicles and decreases the secretion of estradiole. The absence of LH peak prevents ovulation. (1 ½ pt.)

Question III (6 pts)

a- We add the serum of the patient to a well containing the viral protein of HIV fixed on its base. Then we wash the well to eliminate the serum and all the non-fixed molecules. We then add an enzyme fixed to a substance capable to bind to antibodies. We wash again the well to eliminate the non-fixed substance and the enzyme. We finally add to the well a colorless substrate of the enzyme, a coloration appears indicating that the test is positive. (1 ½ pt)

b- Patient A is seropositive. The positive test indicates that the serum of patient A contains anti-HIV antibodies. This means that individual A is infected and his immune system reacts to synthesize the specific antibodies. (½ pt.)

c- (1 ½ pt.)

**Amount of T4 lymphocytes
/mm³ of blood**

T4 L/mm³ of blood

months

**Duration
(in months)**

Variation of the amount of T4 lymphocytes in function of time

- d- During the first 12 months, the amount of T4 increased from $550 / \text{mm}^3$ of blood to a maximum of $800/\text{mm}^3$ of blood. Starting from the 12th month, the amount of T4 decreased to become $50/\text{mm}^3$ of blood after 70 months. **(1 pt)**
 The total immune deficiency observed, takes place starting from the 40th month, is due to the absence of T4 (destruction). **(½ pt)**
- e- Since the number of lymphocytes is $800/\text{mm}^3$ of blood, we can say that the duration of the infection is almost 12 months. **(1 pt)**

Question IV (4 ½ pts.)

- a- Myotatic reflex. **(¼ pt)**
 because the muscle responds to its own stretching by contraction. **(¼ pt)**
- b- The recordings of document 2 during extension reveal that when the triceps sural is in action, the anterior tibialis is at rest (0 to 2.5 seconds) and during flexion the triceps sural is at rest, and the anterior tibialis is in action (2.5 to 5 seconds). This implies that the two muscles are antagonistic, thus, the triceps sural is responsible for extension and the anterior tibialis is responsible for flexion. Hence the triceps sural is an extensor muscle while the anterior tibialis is a flexor muscle. **(2 pts.)**
- c- In the Achillian reflex (Case A), the recordings reveal the action potentials by oscilloscopes 1 and 3 and no recordings by oscilloscopes 2 and 4, which leads to the contraction of triceps sural and the relaxation of anterior tibialis. On the other hand, when we ask for the voluntary activity for the contraction of the anterior tibialis while stretching of the triceps, the recordings reveal action potential in 1, 2, and 4, and no recording in 3, which leads to the relaxation of the triceps sural that should have contracted and to the contraction of the anterior tibialis that should have relaxed. This implies that when neuron 2 of the cerebrum is active, it modifies the activity of motor neurons 3 and 4, which stops the reflex act. Thus, the cerebrum controls the reflex activity. **(2 pts)**