وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة فرع علوم الحياة	دورة سنة ٢٠١٢ العادية

مسابقة في مادة علوم الحياة
المدة: ثلاث ساعات

الاسم:
الرقم:

Answer the following exercises

Exercise 1 (5 points) **Analysis of partial karyotypes**

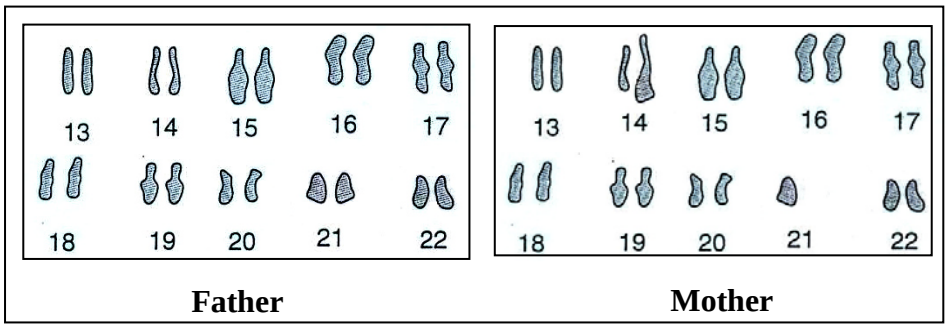
In the framework of studying human chromosomal abnormalities, we prepare the karyotypes of parents of normal phenotype (document 1) and those of their children (document 2); one of these children has trisomy 21. Only certain pairs of chromosomes, from number 13 to 22, are represented.

1- Compare the partial karyotypes of the father and the mother. What can you draw out?

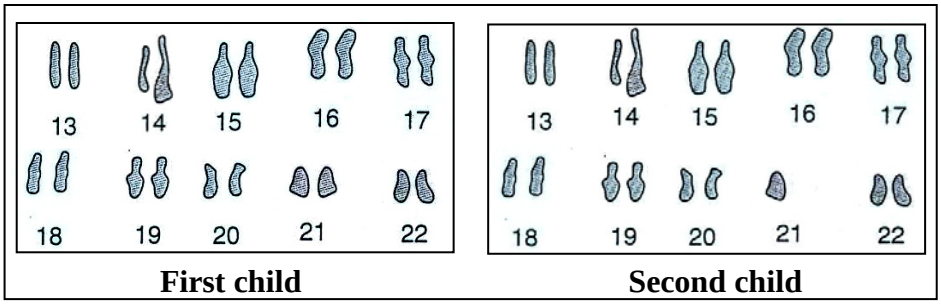
2- Explain why the first child is affected with trisomy 21 and the second presents normal phenotype.

3- Schematize, for the mother, the phase of meiosis that is at the origin of trisomy 21 in the first child. (Limit your answer to chromosomes 14 and 21)

4- Make a chromosomal analysis considering only chromosomes 14 and 21in order to determine the proportions of normal and abnormal children of this couple.



Document 1



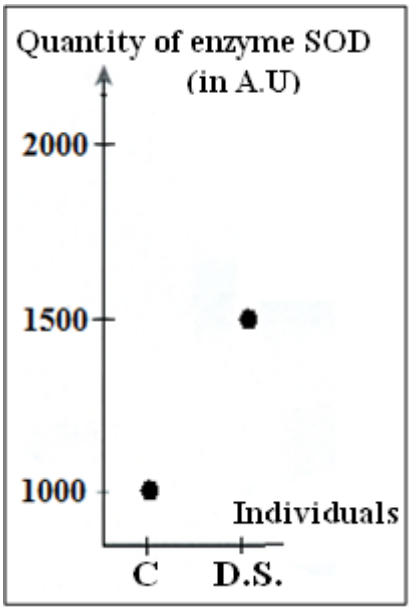
Document 2

One of the manifestations of Down syndrome (trisomy 21) is mental retardation. Biochemical analyses relate this manifestation to an abnormally high level of a protein "P" in the brain of individuals with this syndrome. This protein is coded by a gene located on chromosome 21.

5- Propose an explanation concerning the presence of protein "P" in quantities greater than normal in the brain of individuals with Down syndrome.

On the other hand, we measured the level of an enzyme, superoxide dismutase (SOD), in the red blood cells of unaffected control individuals(C) and in those of others with Down syndrome (D.S). This enzyme is coded by a single gene and is involved in the synthesis of protein "P". Document 3 shows the results of SOD measurement.

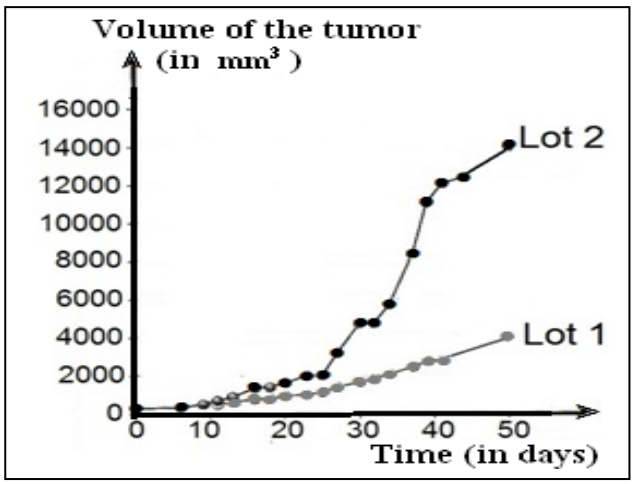
6- Determine, with reference to document 3, the probable chromosomal location of the gene coding for the enzyme SOD.



Document 3

Exercise 2 (5 points) **Tetrahydrocannabinol and immune response**

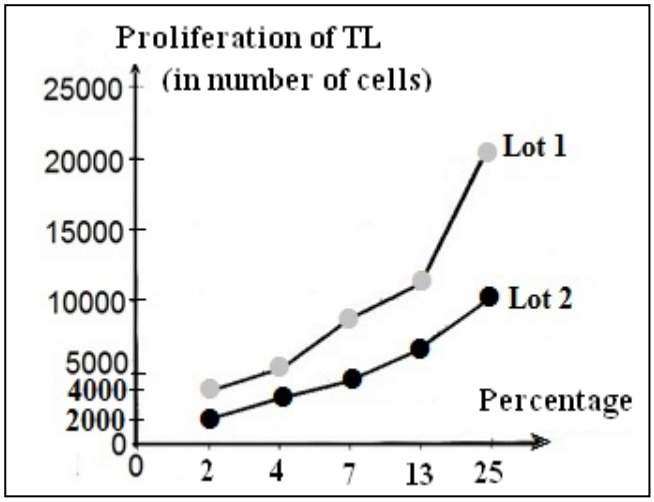
A recent experimental study was performed on mice to demonstrate the action of tetrahydrocannabinol (THC) on the immune system. THC is an active ingredient of cannabis (drug) that is suspected to modify the immune response against cancer cells. In order to study the tumor development and the immune response in the presence of THC, the following experiments were performed.



Document 1

Experiment 1: We take two lots of non-immunized healthy mice, to which we implant cancer cells having the same strain as that of the mice: Lot 1 did not receive any injection of THC; Lot 2 was subjected to four injections of THC per week before and after the implantation of cancer cells. The results of the two lots are presented in documents 1 and 2.

Document 1 represents the variation of the tumor volume as a function of time after implantation. Document 2 shows the proliferation of T lymphocytes as a function of the percentage of the cancer cells implanted relative to the number of T lymphocytes before proliferation.



Document 2

1- Interpret the results of each of the documents 1 and 2.

Experiment 2: The level of interleukins secreted in the mice of experiment 1 was measured at the level of the tumor and the spleen. These values are presented in document 3.

2- Determine, with reference to document 3 and to acquired knowledge, the target cells of THC.

3- Draw out referring to all what preceded, the action of THC on the immune response against the tumor.

In the framework of studying the effect of THC on the secondary immune response, we perform experiment 3.

	Interleukins secreted at the level of the tumor ($pg.mL^{-1}$ for 500 mg of tumor)	**Interleukins secreted at the level of the spleen ($pg.mL^{-1}$ for 10^6 cells)**
Lot 1	190	37
Lot 2	73	21

Document 3

Experiment 3: New mice belonging to the same lots are immunized against this tumor before being subjected to implantation of cancer cells. From each lot, eight mice were subjected to the implantation of a variable number of cancer cells and the percentage of mice rejecting the tumor was calculated (Document 4).

Number of live implanted tumor cells		**1×10^5**	**2×10^5**	**3×10^5**
Percentage of mice rejecting the tumor	Lot 1	100%	100%	100%
	Lot 2	100%	60%	50%

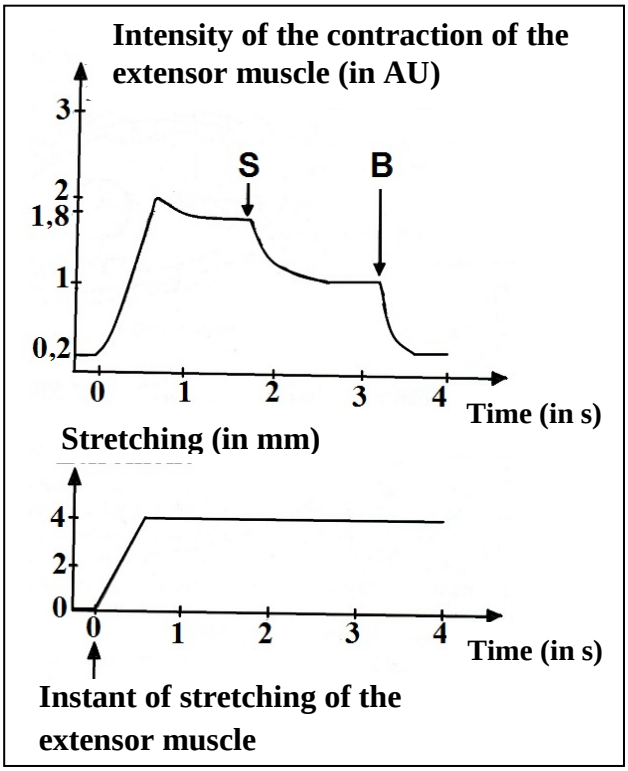
Document 4

4- Construct a histogram that translates the results of document 4.

5- Analyze the results of experiment 3. What can you draw out?

Exercise 3 (5points) **Activity of antagonistic muscles**

In order to study the coordinated behavior of the flexor and the extensor muscles of the leg during a reflex action in mammals, we record in a spinal animal (an animal whose spinal cord was sectioned), the variations in the intensity of the contraction of the quadriceps,the extensor muscle of the leg, under the effect of stretching starting from time 0. Keeping the extensor muscle stretched ,at moment S, we stretch muscle X and at moment B we stretch simultaneously both muscles X and Y of the thigh. Document 1 shows the obtained recordings.

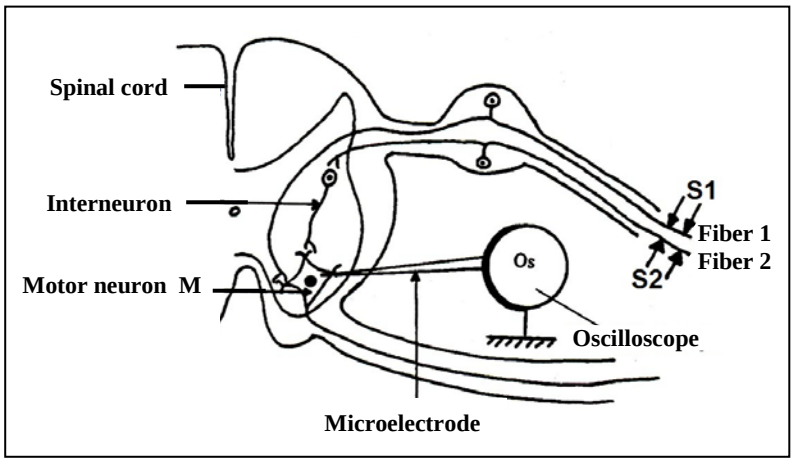


Document 1

1- Name the type of reflex occurring between 0s and 1s. Justify the answer.

2- Interpret the obtained results.

To better understand the role of the spinal cord in this reflex, we performed effective stimulations S1 and S2 respectively on each of the afferent fibers 1 and 2 issued from the above mentioned muscles. Document 2 represents the neural circuits in the spinal cord and the experimental set up.



Document 2

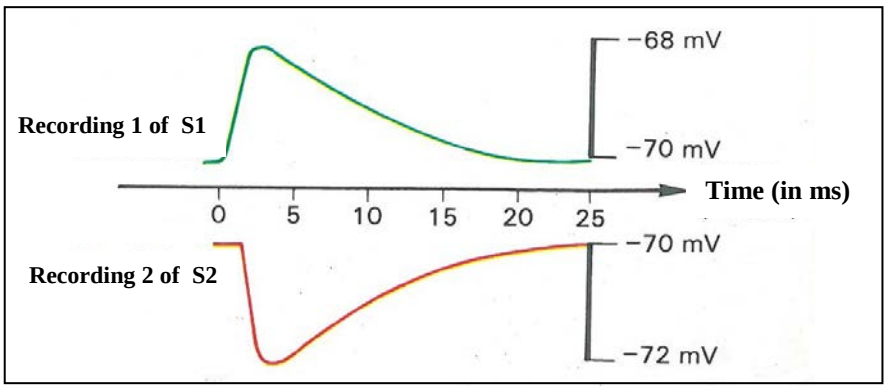
Document 3 shows the recording obtained at the motor neuron M of the extensor muscle for each of the performed stimulations.

3- Match each of the two afferent fibers 1 and 2 to its corresponding muscle involved in this reflex (extensor, muscle X or muscle Y).
Justify the answer by specifying the type of each involved synapse (documents 2 and 3).

4- Explain, on what was preceded, the role of the motor neuron M at moment S.

.

.



Document 3

Exercise 4 (5 points) **Functional relationships between ovaries and uterus**

In the frame work of studying the functional relationships between the ovaries and the uterus, many experiments are performed on female mammals.

Experiment 1: We inject increasing amounts of estradiol, to lots of ovariectomized mice at puberty; the results are shown in document 1.

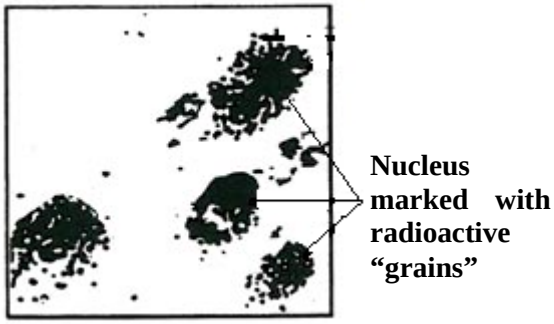
Lots of mice	1 (control)	2	3	4
Amount of injected estradiol (in µg)	0	0.005	0.01	0.1
Average mass of the uterus (mg)	12	20	40	100

Document 1

Experiment 2: We inject only physiological doses of progesterone to an ovariectomized female mouse. No significant changes were observed at the level of the uterus.
In another ovariectomized female, 0.01 µg of estradiol is injected followed by an injection of the same previous doses of progesterone. We observe more amplified results than those represented in document 1.

1- Interpret each of the above experiments.

Experiment 3: We perform autoradiography on a cross-section of the uterine mucosa taken from an ovariectomized female after 1 to 2 hours of being injected with estradiol marked by tritium (radioactive isotope of hydrogen) as shown in document 2.

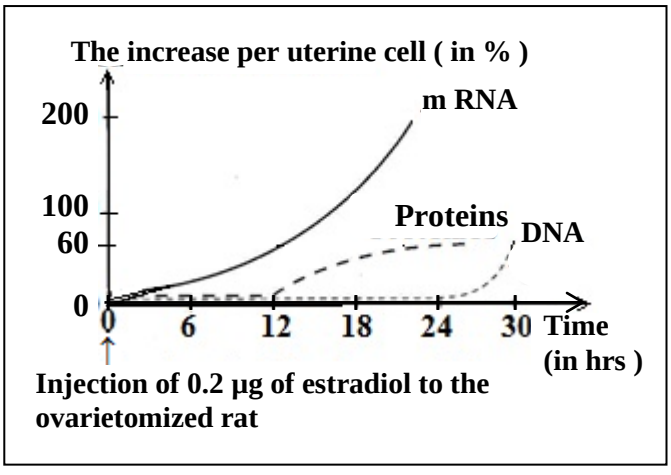


Remark: The membrane of the cell and its cytoplasm are not distinguished.

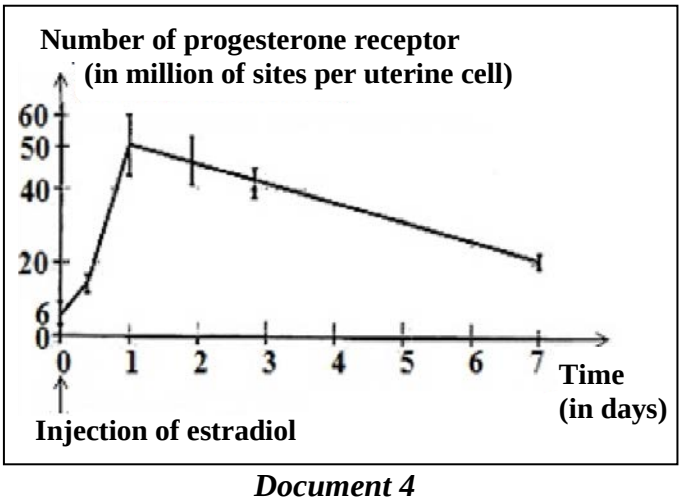
Document 2

2- What can you draw out of document 2? Justify the answer.

Experiment 4: We inject estradiol to an ovariectomized rat at time 0. Then we measure the rate of certain constituents of the uterine mucosa cells. The results are represented in documents 3 and 4.



Document 3

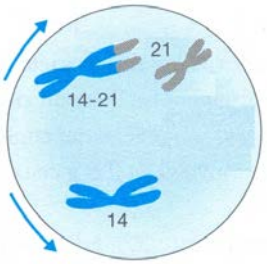


Document 4

3- Knowing that the development of the uterine mucosa is related to mitosis, determine, using document 3 and the acquired knowledge, the mode of action of estradiol on the uterus.

4- Explain,based on document 4, the results of experiment 2.

وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة فرع علوم الحياة اسس التصحيح	دورة سنة ٢٠١٢ العادية

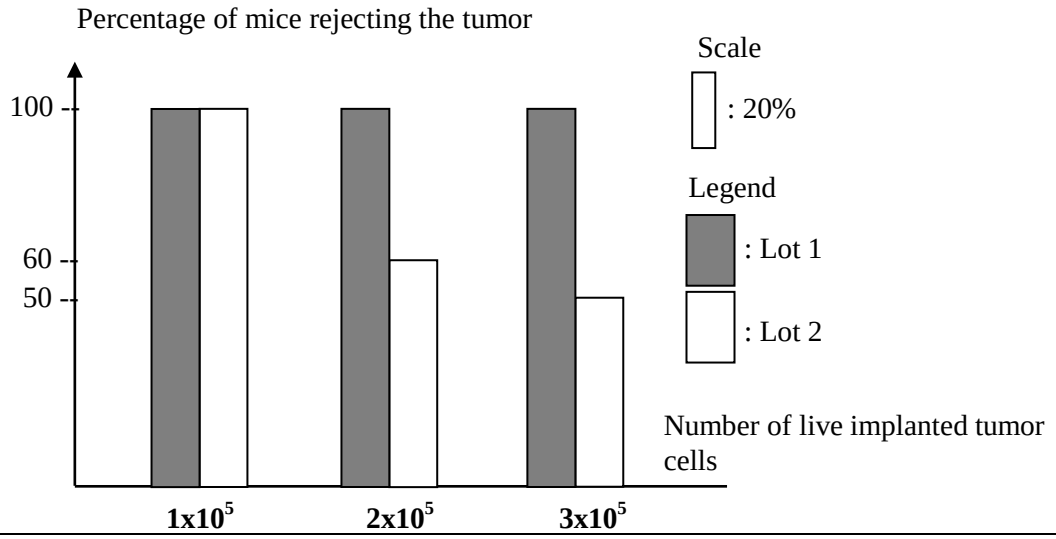
Part of ex.	Answer	Grade
	Exercice 1	
1	All chromosome pairs are similar in the father and the mother with the exception of pairs 14 and 21 **(1/4pt)** Concerning the pair14: the two chromosomes of this pair are of the same size in the father while in the mother, one of them has the same size as those of the father while the second is longer than the others. **(1/4pt)** Concerning the pair21: there are two chromosomes of the same size in the father while in the mother a single chromosome 21 is found and has same size as those of the father. **(1/4pt)** The number of chromosomes in the given partial karyotype of the father is 20, higher than that of the mother, 19 chromosomes. Thus, the karyotype of the father is normal while that of the mother of normal phenotype shows a chromosomal abnormality for pairs 21 and 14 where there is translocation of a complete chromosome 21 on chromosome 14. **(1/2pt)**	**1 1/4**
2	The first child has trisomy 21 because he has three chromosomes 21, two free chromosomes 21 (pair 21) and one chromosome 21 translocated on a chromosome 14 (14^{21}) **(1/2pt)** The second child has normal phenotype because he has 2 chromosomes 14 and two chromosomes 21, one is free and the other is translocated on chromosome 14, so the genetic material is conserved. **(1/2pt)**	**1**
3	Scheme of chromosomal behavior  Anaphase I	**1/2**
4	**Chromosomic analysis** Phenotypes normal mother x normal father Chromosomes 14^{21} //14 21/ x 14//14 21//21 Gametes 14 21 : ¼ 14^{21} : ¼ 14. 21 : 1 and their proportions 14^{21} 21 : ¼ 14 : ¼ Table of cross	**1**

Gametes ♀ / ♂	14 21 ¼	14^{21} ¼	14^{21} 21 ¼	14 ¼
14 21 1	14//14 21//21 ¼	14^{21} //14 21/ ¼	14^{21} //14 21//21 ¼	14//14 21/ ¼

Phenotypes and proportions :
Children with trisomy 21 : ¼
Children with monosomy 21: ¼
Children with normal phenotype: ½

	The proportion of getting normal children is ½ and that of abnormal children is ½.	
5	The individual with Down syndrome has three copies of chromosome 21 instead of 2. Since the gene coding for protein P is located on chromosome 21, the affected individuals have three alleles of this gene that will code for this protein and this explains the high level of protein P.	**1/2**
6	In the RBCs of control individuals the amount of enzyme SOD is equal to 1000 au, while it is higher (1500a.u.) in the RBCs of the individuals with Down syndrome. Then individuals with Down syndrome synthesize 1500/1000 or 1.5 times more enzyme SOD than healthy individuals. Since 1000 corresponds to the presence of 2 chromosomes 21 in a normal individual and 1500 corresponds to the presence of 3 chromosomes 21 in the case of trisomy 21, then one can say that the gene coding for the enzyme SOD is located on chromosome 21.	**3/4**

Part of ex.	**Answer**	**Grade**
	Exercise 2	
1	Document 1: The volume of the tumor (VT) is constant between day 0 and day 10 in both lots. On the other hand, this volume increases to 4000mm^3 between day 10 and day 50 in lot 1. Similarly, in lot 2 which received THC injection VT increases slightly to 2000 mm^3 from day 10 till day 25 followed by a sharp increase to a much higher value than lot 1 (14000 mm3) between day 25 and day 50. This shows that THC favors the development of the tumor after 10 days**(1/2 pt)** Document 2: The number of T cells in the mice of lot 1 increases from 4000 cells to 20000 cells when the percentage of implanted tumor cells relative to the number of lymphocytes before proliferation increases from 2 % to 25%. Similarly, in lot 2 which received THC, the number of TL increases but slightly from 2000(< 4000) to 10000(< 20000). This shows that the proliferation of TL varies in the same direction as the quantity of cancer cells and THC reduces this rate of proliferation against tumor cells. **(1/2 pt)**	**1**
2	The level of IL secreted at the level of the tumor in lot 2 is 73 pg / mL for 500 mg of tumor which is less than 190 pg / mL for Lot 1.Similarly, in lot 2 the level of IL secreted at the level of the spleen is 21 pg / mL for 10^6 cells which is less than that secreted at the level of the spleen of Lot 1 (37 pg / mL for 10^6cells). Thus THC decreases the secretion of interleukins and since interlukins are secreted by T4 cells then the target cells of THC are the T4cells.	**1**
3	THC acts on T4 lymphocytes secreting IL indispensible for the activation of the specific immune response (humoral mediated and cell mediated). Thus a decrease in the quantity of IL provokes a decrease in the proliferation of T lymphocytes leading to a decrease in the immune response. Hence the tumor develops.	**3/4**

4	Histogram: percentage of mice rejecting the tumor as a function of number of live implanted tumor cells.  	**1 1/2**
5	Document 4 shows that the percentage of mice rejecting the tumor in lot 1 is constant 100 percent regardless of the number of implanted tumor cells while in lot 2 receiving injections of THC, it decreases from 100 % to 50% when the number of implanted tumor cells increases from $1x10^5$ to $3x10^5$. **(1/2)** In mice immunized against this tumor, the rejection of the tumor corresponds to a secondary immune response. Hence THC weakens the secondary immune response. **(1/4pt)**	**3/4**

Part of ex.	**Answer**	**grade**
	Exercice 3	
1	Myotatic reflex **(1/4pt)** because the muscle responds by a contraction due to its own stretching. **(1/2pt)**	**3/4**
2	The intensity of the contraction of the extensor muscle increases from 0.2 AU to 2 AU between 0 s and 0.6 s, then it drops slightly to 1.8 AU at 1.8 s as long as the extensor muscle is stretched. This shows that the muscle contracts due to its own stretching. However, this intensity decreases from 1.8 AU to 1AU between1.8 s and 3.2 s following a simultaneous stretching of the extensor muscle and muscle X (moment S). This shows that the extensor muscles and muscle X are antagonists **Or** the activity of muscle X attenuates that of the extensor muscle. Similarly, there was a greater decrease in the intensity of the contraction from 1 AU to 0.2 AU, following the simultaneous stretching of the two preceding muscles and muscle Y (moment B). This means that muscle Y is also antagonist to the extensor muscle and agonistic to muscle X **or** the activity of muscle Y attenuates that of the extensor muscle.	**1 ½**
3	Fiber 1 is the afferent fiber of the extensor muscle because it is connected directly to the motor neuron of the extensor muscle M (monosynaptic circuit). Similarly, the recording 1 shows a hypo polarization (EPSP) of amplitude 2mV which means that the synapse is an excitatory synapse **(1pt).** Fiber 2 is the afferent fiber of muscle X or Y is connected via an interneuron to motor neuron M (polysynaptic circuit) which has an inhibitory role in this reflex. Also the	**2**

	recording 2 shows a hyperpolarization (IPSP) of amplitude 2 mV, which means that the synapse is inhibitory. **(1pt).**	
4	At moment S, the motor neuron M receives an excitatory message from the afferent fiber 1 and at the same time, an inhibitory message from the interneuron attached to the sensory fiber 2. This motor neuron M integrates the two messages in a spatial summation (or spatial-temporal summation + frequency of AP). The resultant is an attenuated efferent nerve message which leads to a decrease in the intensity of the contraction of the extensor muscle.	**3/4**

Part of ex.	**Answer**	**grade**
	Exercice 4	
1	**Experiment 1**: The average mass of the uterus of the ovariectomized mice without injection of estradiol is 12 mg. This mass increases from 20 mg to 100 mg when the dose of the injected estradiol increases from 0.005 mg to 0.1 mg.Thus estradiol stimulates the development of the uterus. **(3/4pt)** Experiment 2: No significant changes were observed at the level of the uterus after the injection of progesterone only, however the development is more intense compared to document 1 (above 40 mg) after the injection 0.01 µg of estradiol followed by progesterone. This means that progesterone alone has no effect on the uterus, but it enhances the development of the uterus in the presence of estradiol in an ovariectomized female. **(3/4pt)**	**1 ½**
2	We can draw out that estradiol has as targets the nuclei of uterine cells. (1/4pt) since document 2 shows the "grains" of radioactive estradiol in the nuclei of uterine cells after the injection of the tritium-labeled estradiol. (1/2pt)	**3/4**
3	After the injection of 0.2 µg of estradiol to ovariectomized rats, the increase of mRNA per uterine cell elevates from zero to 200%. (This corresponds to the phase of DNA transcription into mRNA), and the increase of proteins per uterine cell elevates from zero to 60% after a delay of 12 hours. (This corresponds to the translation phase which follows the phase transcription). So, estradiol stimulates the expression of certain genes for protein synthesis. **(3/4pt)** Also, This injection elevates the increase of DNA per uterine cell from 0 to 60% after a more delay of 24 h, indicating the replication of DNA molecules, which precedes cell division that corresponds to cellular proliferation. **(3/4pt)**	**1 ½**
4	Document 4 shows an increase in progesterone receptors in thousands of sites per uterine cell from 6 to 50 between 0 to1day after the injection of estradiol. This shows that estradiol favors the production of progesterone receptors. Therefore, when injecting progesterone alone (experiment 2) there was few progesterone receptors in uterine cells and therefore this hormone has no effect on these cells, but after the injection of estradiol, the number of progesterone receptors increases and the fixation of progesterone on the receptors also increases thus modifying the cellular function and favoring protein synthesis which explains the increase in the mass of the uterus.	**1 ¼**