وزارة التربية والتعليم العالي
المديرية العامة للتربية
دائرة الامتحانات

امتحانات الشهادة الثانوية العامة
الفرع : علوم الحياة

دورة سنة 2009 الإكمالية الاستثنائية

مسابقة في مادة علوم الحياة
المدة ثلاث ساعات

الاسم:
الرقم:

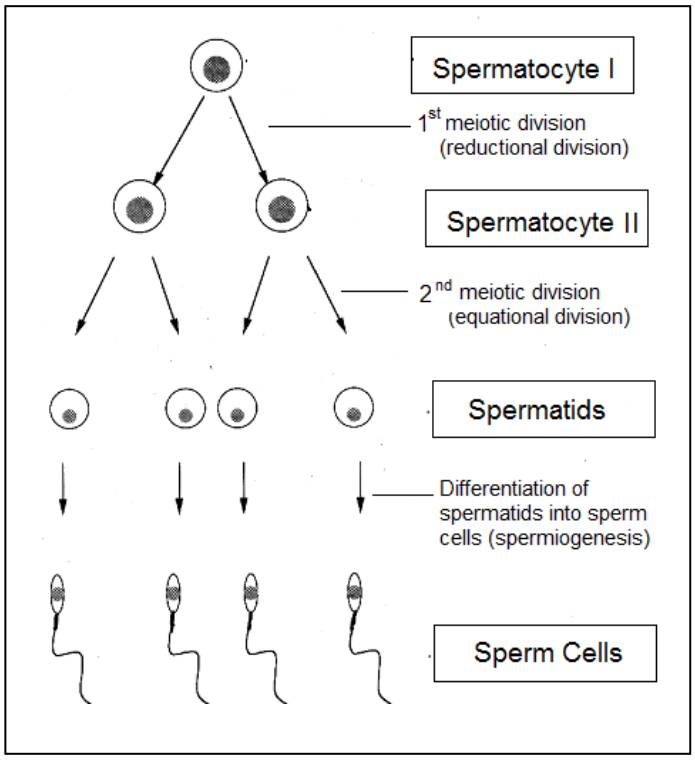
Answer the following exercises.

Exercise 1 (5 Pts)

Mr. X and Mr. Y are two adult sterile men. We perform different tests to specify the origin of this defect.

Document 1 shows certain stages of spermatogenesis. The germ cells, whose names are framed in boxes, are found in the wall of the seminiferous tubules.

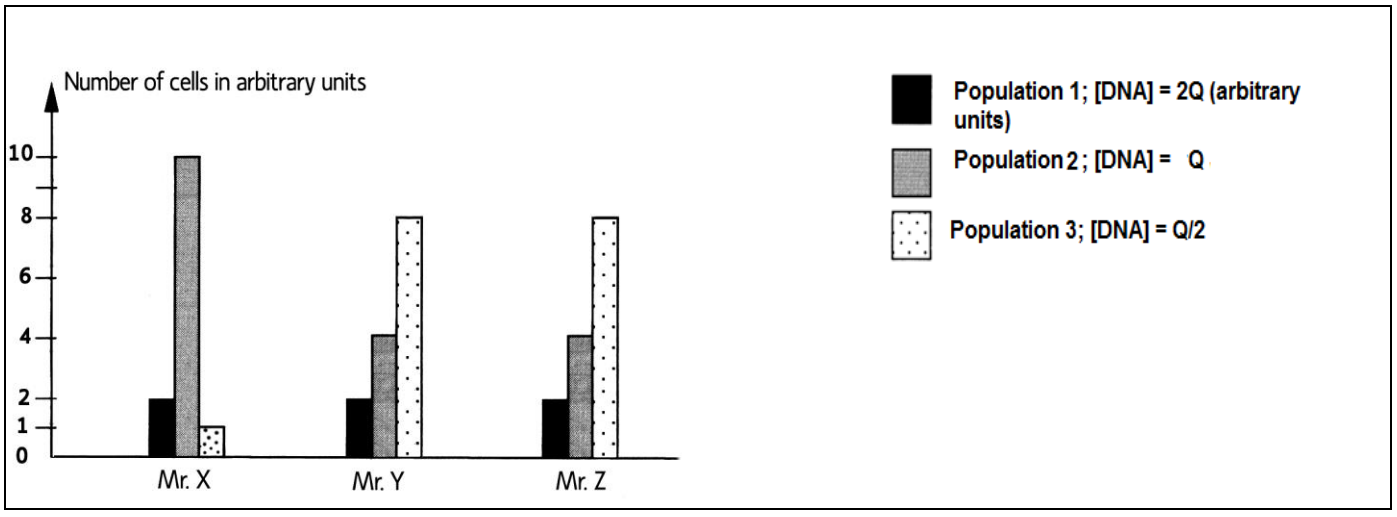
1- Describe the different stages of spermatogenesis represented in document 1.



Document 1

We perform a quantitative study for the amount of DNA of the germ cells extracted directly, by biopsy, from a fragment of the testicles of these two sterile men and that of a fertile man Mr. Z. Three different populations of germ cells are obtained. The number of each cell population, as well as the amount of DNA in each of them are shown in document 2.

2- Indicate the germ cells corresponding to each of the three populations shown in document 2. Justify the answer.

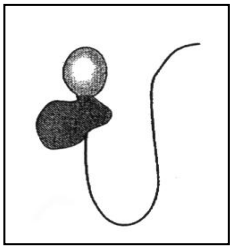


Document 2

3- Explain the variation of the number of germ cells of the three populations in the fertile man Mr. Z.

4- Determine, by referring to document 2, the cause of sterility of Mr. X.

Microscopic observations of the semen of Mr. Y showed sperm cells, where the majority of these cells showed an aspect identical to that schematized in document 3.



Document 3

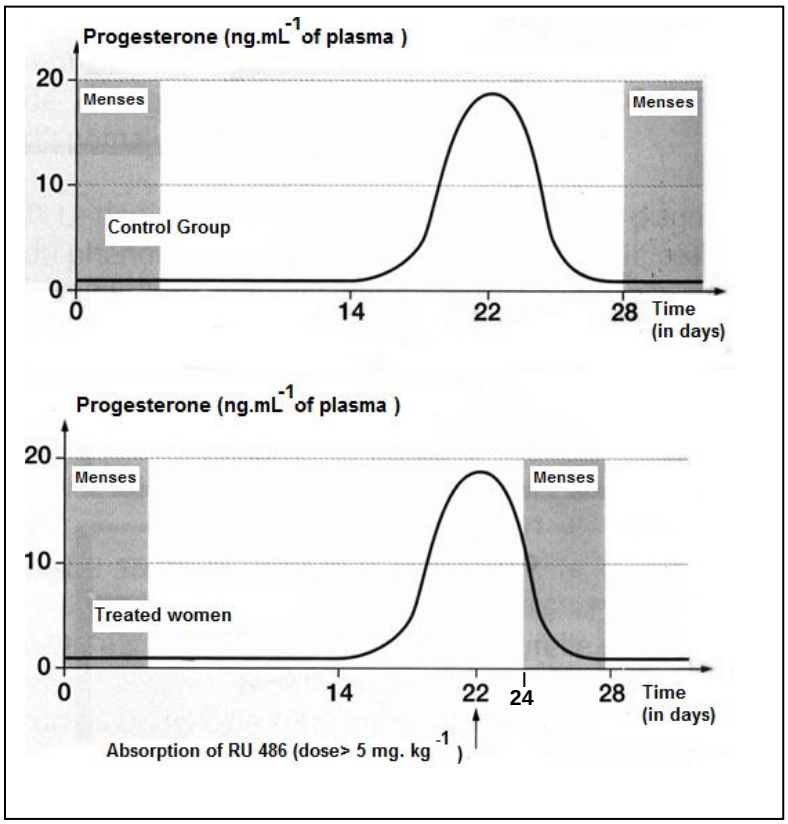
5- Explain the origin of the sterility of Mr.Y.

Exercise 2 (5 pts.)

RU 486 (mifepristone) is a molecule that has a contragestive action .It prevents the implantation of the embryo, and terminates early gestation.

Document 1 presents the time of the appearance of menses and the variation of the amount of progesterone in a control group of women and in women having absorbed RU 486.

1- Determine, from document 1, the effect of RU 486 on the secretion of progesterone and on the appearance of menses.



Document 1

We inject three lots of female rats with the same quantity of different molecules labeled with a radioactive element called tritium (^{3}H). Fifteen minutes following the injection, we remove the uterus of these female rats. Autoradiography was done on thin sections of the uterine mucosa. We count the silver grains that became black by radioactive emission and which reveal the concentration of radioactive molecules present in the nuclei of the uterine mucosa cells.

Document 2 shows the results obtained on 300 uterine mucosa cells.

Lots	**1**	**2**	**3**
Injections done	RU486 labeled with tritium	Progesterone labeled with tritium	Equal quantities of non-labeled RU486 and progesterone labeled with tritium
Average number of silver grains (grains/per cell)	8	8	2

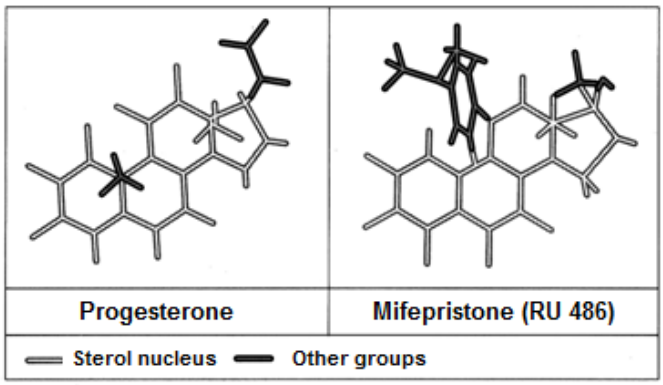
Document 2

2- Construct a histogram that translates the data of document 2.

3- Interpret document 2 and deduce the mode of action of RU 486.

Document 3 reveals the structure of RU 486 and that of progesterone molecules.

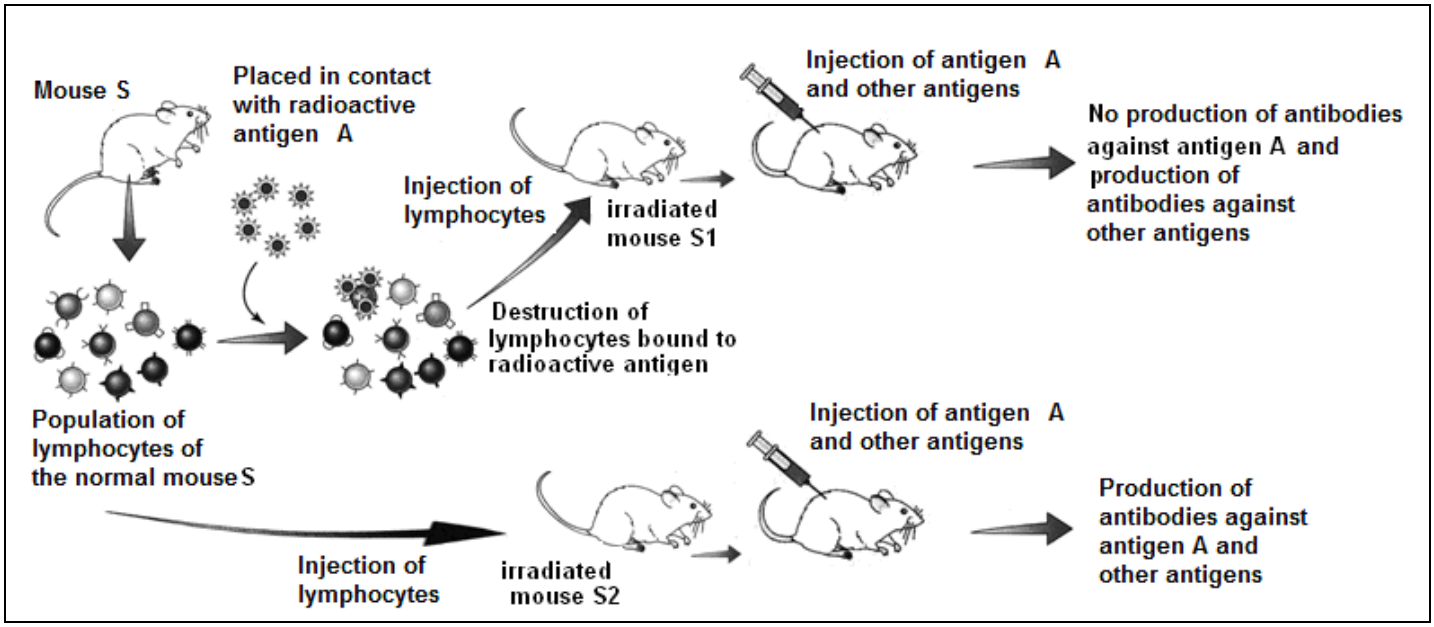
4- Explain, by referring to the information derived from documents 2 and 3 and to the acquired knowledge, the results obtained in the treated women (document 1).



Document 3

Exercise 3 (5 pts.)

In the framework of studying clonal selection of B lymphocytes which are at the origin of antibodies, we perform several experiments on mice of line S that are not immunized against an antigen A (document 1). According to the theory of clonal selection, each lymphocytes acquires during its development the ability to react with a specific antigen, even without being previously exposed to it.



Document 1

N.B. irradiation leads to the destruction of immune cells.

1- Refer to document 1 to show that:

1-1 B lymphocytes are ready to respond to an antigen before encountering it;

1-2 B lymphocytes possess a surface receptor;

1-3 The immune response is specific.

To determine the phenomenon responsible for the secretion of the most effective antibodies, researchers performed the following experiment. They injected mice with a chemical substance recognized by the immune system as a foreign antigen. This antigen is characterized by having several antigenic determinants.

Time since the injection of the antigen (in days)	Aspect of the lymphatic ganglia	Number of the different detectable B lymphocytes clones	Efficiency of the immune response
5	Beginning of swelling	10	Average
10	Strong swelling	1 or 2	Very high

Document 2

At different times following the injection, researchers sacrificed the mice and dissected their lymphatic ganglia to detect the B lymphocytes which recognize the injected antigen. Document 2 shows the results of this experiment.

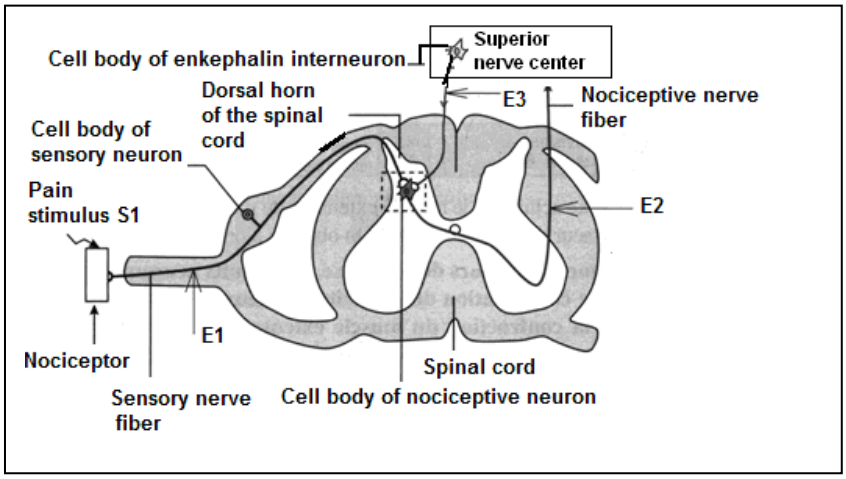
2- Explain the swelling of the lymphatic ganglia mentioned in document 2.

3- To what can we attribute the number of B Lymphocytes clones 5 days following the injection of the antigen?

4- Formulate a hypothesis that explains the decrease in the number of B lymphocytes clones detected 10 days following the injection of the antigen.

Exercise 4 (5 pts.)

Pain sensation necessitates the intervention of several neuronic circuits. Document 1 represents the structures implicated in pain sensation and in its modulation.

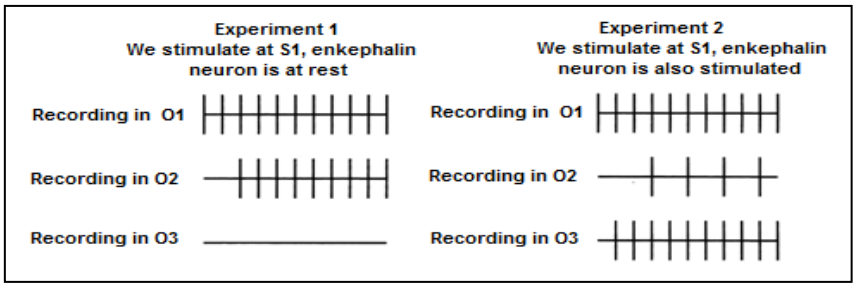


Document 1

We study certain mechanisms which control the transmission of nociceptive message or pain message, in an attempt to show the mode of action of enkephalin and morphine.

In two different experiments 1 and 2, we stimulate at S1 the nociceptors of the skin using the same effective intensity and we record the electric activity of three nerve fibers:

- Sensory nerve fiber by an electrode E1 connected to oscilloscope O1;
- Nociceptive medullary nerve fiber by an electrode E2 connected to oscilloscope O2; and
- Nerve fiber of enkephalin inter-neuron by an electrode E3 connected to oscilloscope O3.



Document 2 ***N.B. Each vertical line corresponds to an action potential (A.P)***

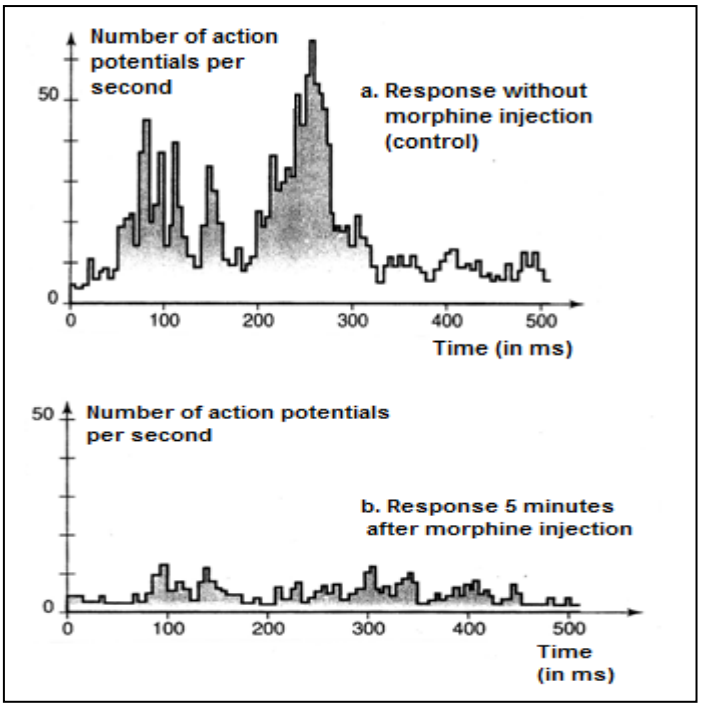
The conditions and the obtained results are shown in document 2.

1- Draw out, in reference to document 2, the role of enkephalin. Justify the answer.

2- Explain how the results recorded by O2 in experiment 2 put in evidence the integrative role of the nociceptive neuron.

In the framework of studying the action of morphine on the medullary nociceptive neuron, we perform experiments 3 and 4.

Experiment 3: By the help of a microelectrode, we record the activity of the medullary nociceptive neuron at the level of the dorsal horn after an intense electric stimulation of the sensory fibers.



Document 3

Experiment 4: Under the same conditions of experiment 3, we also record the activity of the medullary interneuron after the injection of a morphine dose by a micropipette at the level of the dorsal horn. Document 3 shows the obtained results.

3- Determine, from document 3, the role of morphine.

4- Morphine and enkephaline are agonist substances. Justify this statement.

اسس تصحيح مادة علوم الحياة

Exercise 1 (5 Pts)

1- During the first meiotic division (reductional division), spermatocyte I produces two spermatocytes II that are subjected to the second meiotic division (equational division) , each producing two spermatids. Then, the spermatids differentiate into sperm cells (spermiogenesis). **(1/2 pt)**

2- Population 1 corresponds to spermatocytes I because the quantity Q is duplicated during the S phase of interphase and becomes 2Q in spermatocyte I that has 2n chromosomes of 2 chromatids each**.(½ pt)**
Population 2 corresponds to spermatocytes II because after the reductional division of meiosis we obtain spermatocytes II that have n chromosomes each of 2 chromatids corresponding to the quantity Q of DNA**.(½ pt)**
Population 3 corresponds to spermatids or sperm cells because after the equational division of meiosis, we obtain 4 cells (spermatids) each having n chromosomes of one chromatid each corresponding to the quantity Q/2 of DNA. This same quantity remains constant after spermiogenesis that gives sperm cells. **(½ pt.)**

3- In the fertile man, the number of germ cells is doubled from 2 to 4 then to 8 passing from population 1 to population 3 because the number of cells is doubled after each meiotic division. Each spermatocyte I produces 2 spermatocytes II and each spermatocyte II produces 2 spermatids (1-2-4) **(1/2 pt)**

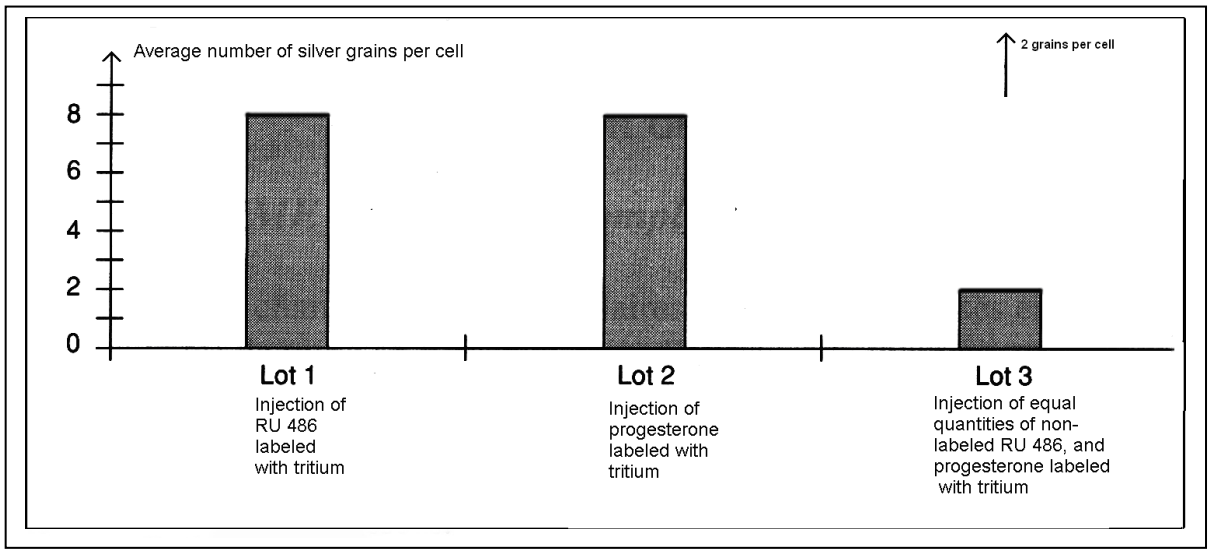
4- In the sterile man X, the number of spermatocytes I is the same as in the fertile man (2 a.u.), but the number of spermatocytes II in the sterile man is much higher than that in the fertile man (10 a.u >4 a.u) . On the other hand, the number of spermatids or sperm cells in the sterile man is abnormally lower than that in the fertile man (1 AU < 8 AU). Therefore, not all spermatocytes II had divided into spermatids during meiosis. Hence, the cause of sterility in man X is an abnormal meiosis, which is blocked at the stage of spermatocytes II leading to an insufficient number of sperm cells (oligospermy) **(1 pt)**

5- Document 2 reveals that in the sterile man Y, the number of cells of the three populations is the same as in the fertile man Z; this indicates that meiosis took place normally in man Y, that is why he has a normal number of spermatids and sperm cells, therefore, oligospermy did not happen . **(1/2 pt)** On the other hand, document 3 reveals one type of sperm cell that has a normal flagellum and a normal head, but the middle piece is larger than in the normal sperm cell. This is due to the non elimination of residual cytoplasm **.(½ pt)** Hence, the origin of sterility of man Y is the abnormal spermiogenesis **(1/2 pt)**

Exercise 2 (5 Pts)

1- RU 486 has no effect on the secretion of progesterone because in the control and treated women we observe an increase in the amount of progesterone from almost null level to about 18 ng/mL of plasma from day 14 till day 22. Then, this amount of progesterone decreases progressively until it reaches the initial value(almost null) on day 26 and remains constant at this value until day 28**.(½ pt)**
RU 486 leads to the early appearance of menses because we observe the appearance of menses on day 24 in the treated women 4 days before the appearance of menses in the control group which occurs on day 28**.(½ pt).**

2-



Histogram showing the average number of the silver grains per cell in function of the injections done in 3 lots (2 pts)

3- The average number of silver grains per cell is the same (8 grains/ cell) for the two lots 1 and 2 injected by RU 486 labeled with tritium and progesterone labeled with tritium respectively. This signifies that progesterone and RU 486 fix in the same manner at the level of the nucleus of the uterine mucosa cell. On the other hand, this number decreases to 2 grains/cell in lot 3 injected with non-labeled RU 486 and progesterone labeled with tritium. This indicates that RU 486 prevents the fixation of a large quantity of progesterone (75%) in the nucleus of endometrial cells. Therefore, RU 486 is a competitive substance to progesterone. **(1 pt)**

4- The two molecules, progesterone and RU 486, have a similar structure at the level of sterol nucleus (doc .3). This allows RU 486 to fix on the progesterone nuclear receptors, and since RU 486 fixes more efficiently than progesterone by occupying almost 75% of the progesterone receptors , it prevents progesterone from performing its action.(Lot 3, doc. 2). This inhibits protein synthesis leading to the sloughing off of the surface layer of the endometrium and to the early appearance of menstruation **(1 pt).**

Exercise 3 (5 Pts)

1-1 B lymphocytes are ready to respond to an antigen before encountering it, because we observe anti-A antibodies production in mouse S2 which received all lymphocytes. On the contrary, there is no production of anti-A antibodies in mouse S1 which received all lymphocytes except the lymphocytes that can recognize antigen A (already destroyed by radioactivity after the fixation on the radioactive antigen A). This indicates that the lymphocytes that recognized antigen A were present before any contact with this antigen. **(1 pt)**

1-2 The experiment shows that the radioactive antigen is fixed on plasma membrane of the B lymphocytes that recognized this antigen. This implies the presence of a membrane receptor capable of the fixation of this antigen. **(1 pt)**

1-3 The immune response is specific to this antigen because we observe the production of antibodies against all antigens except anti-A antibodies in mouse S1 that received all lymphocytes except the lymphocytes that can recognize antigen A**.(1 pt).**

2- The swelling started after 5^{th} day and the strong swelling observed on the 10^{th} day correspond to the activation of lymphocytes(T4 and BL) and to their rapid and important proliferation on day 10 leading to the formation B lymphocytes clones that recognize the antigen. **(1 pt)**

3- The 10 clones of BL 5 days following the injection is attributed to the presence of 10 different antigenic determinants at the level of the antigen**.(½ pt)**

4- Hypothesis: There is an important clonal selection of B lymphocytes where only lymphocytes that can recognize the most effective antigenic determinant are kept. **(1/2 pt)**

Or

There is an important clonal selection of B lymphocytes where only lymphocytes that can recognize the most frequent antigenic determinant are kept.

Exercise 4 (5 pts)

1- The role of enkephalin is to decrease pain sensation **(½ p**t), because we observe in O2 a pain message of 4 AP after the stimulation of the sensory nerve fiber and the enkephalin interneuron (experiment 2), which is lower than the message recorded in O2(9 AP) after the stimulation of the sensory nerve fiber only (experiment 1). This shows that the enkephalin liberated after the stimulation of the interneuron inhibited partially the transmission of the pain message. **(1 pt)**

2- The nociceptive neuron has an integrating role. It performs spatial summation for two nerve messages coming from the presynaptic fibers, the first is an EPSP caused by the sensory neuron (11 AP in O1) and the second is an IPSP caused by enkephalin neuron (10 AP in O3). The result of this summation is a message of weaker frequency (4 AP in O2). **(1 1/2 pt)**

3- The frequency of action potentials at the level of the medullary neuron is high, it varies from 5 AP/s till a maximum of 65 AP/s after the stimulation of the sensory nerve fiber in the absence of morphine (doc. 3a). On the other hand, this frequency decreases sharply and fluctuates between 2 and 12 AP/s after the stimulation of the sensory nerve fiber with the injection of morphine (doc. 3b). This indicates that morphine inhibits the activity of the nociceptive neuron by decreasing the frequency of AP that leads to the decrease in pain sensation. **(1 1/2 pt)**

4- They are agonists because morphine and enkephaline have the same effect of decreasing pain sensation at the level of the nociceptive medullary neuron. **(1/2 pt).**