وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات الرسميّة	امتحانات الشهادة الثانوية العامة فرع علوم الحياة	دورة العام ٢٠١٦ الاستثنائية السبت ٦ آب ٢٠١٦

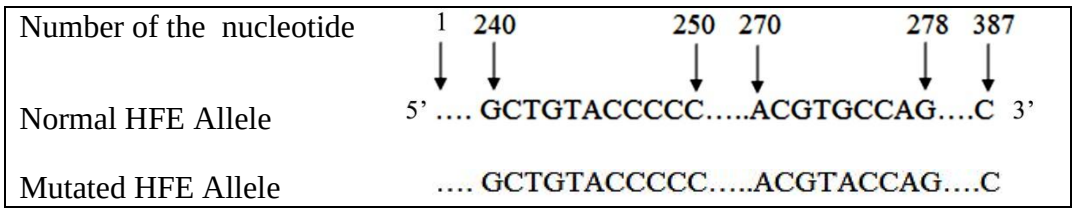
مسابقة في مادة علوم الحياة المدة: ثلاث ساعات	الاسم: الرقم:

Exercise 1 (5 points)

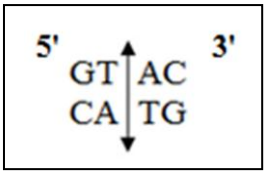
Hemochromatosis

Hemochromatosis appears after the age of 40 years and is characterized by the accumulation of iron in the body. It is a recessive disease linked to the HFE gene which is located on chromosome 6. This gene has two alleles: the normal allele which codes for a membrane protein that regulates the entry of iron into the cells, and the mutated allele which codes for an abnormal protein that favors the accumulation of iron inside the cells.

Document 1 presents the partial sequence of nucleotides of the two alleles, the normal and the mutated ones.
Document 2 presents the restriction site of a restriction enzyme Rsa1.



Document 1

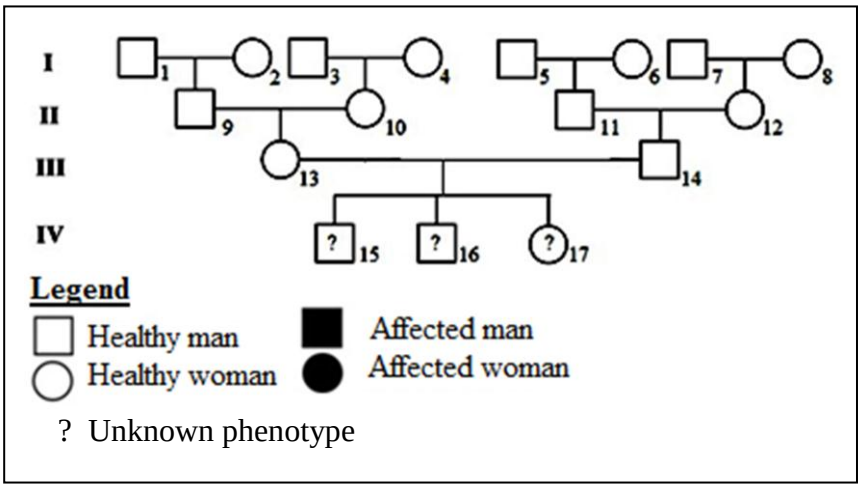


Document 2

1- Specify, by referring to document 1, the origin of hemochromatosis.
2- Determine for each of the two alleles, the number and the length of the restriction fragments obtained after cutting by Rsa1 enzyme.

The frequency of heterozygotes in a certain population is 1/10.

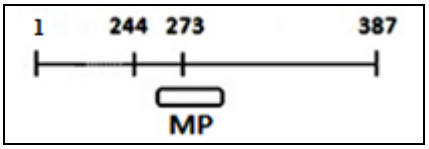
A healthy couple, older than 40 years, belongs to this population. This couple would like to know if their three children, who appear healthy, have a risk to develop the disease. That's why they consult a doctor who, as a first step, establishes for this family a pedigree which is shown in document 3.



Document 3

3- Calculate the risk for this couple, III13 and III14, to have an affected child.

As a second step, the doctor performs DNA analysis by applying the southern blot technique using the restriction enzyme Rsa1 and a radioactive molecular probe (MP) which is complementary to a specific sequence of HFE gene. This probe can fix to the whole or to a part of the recognized sequence as shown in document 4.
Document 5 shows the results obtained by this technique for certain members of this family.



Document 4

4- Explain the absence of the 244 bp fragment in the electrophoregram presented in document 5.
5- Establish the diagnosis for each of the children in document 5.

Size of DNA fragments (bp)	III13	III14	IV15	IV16	IV17
29	▬	▬		▬	▬
114	▬	▬		▬	▬
143	▬	▬	▬	▬	

Document 5

Exercise 2 (5 points) **Conditions of LT8 Action**

The Choriomeningitic leukemia virus (CML) is slightly pathogenic and infects nervous cells. In the framework of studying the immune response against the infection by this virus, two experiments were performed.

Experiment 1: different viruses are injected into mice of different strains, Y and Z. The experimental conditions as well as the obtained results are shown in document 1.

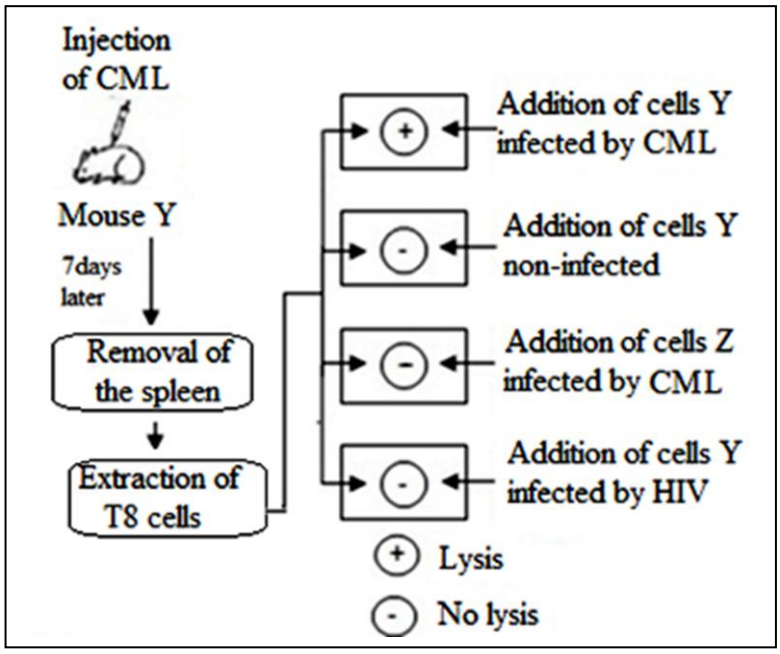
1- Name the specific immune response triggered against a virus and that triggered against a bacterium.
2- Interpret the results of experiment 1.

Experiment 2: T4 cells are cultured in the presence of macrophages and CML. The experimental conditions as well as the results are shown in document 2.

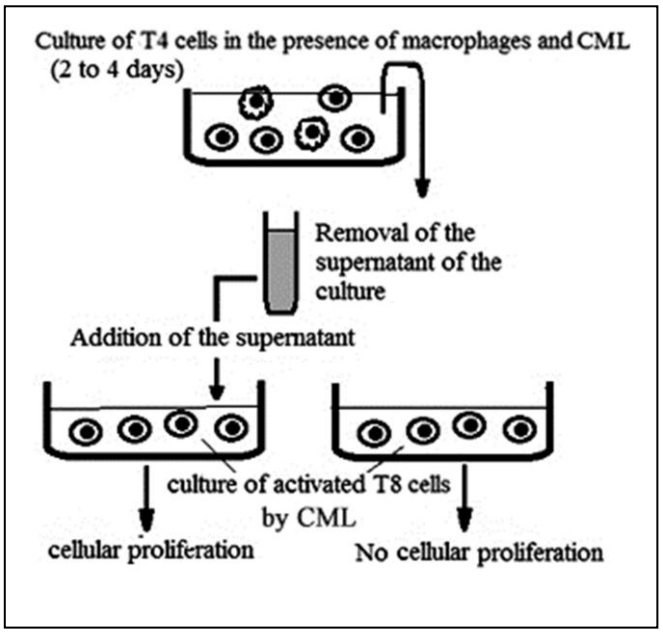
3- Determine the role and the mode of action of T4 cells as revealed in experiment 2.
4- Explain the role of macrophages in the culture of T4 cells in experiment 2.

Document 3 shows two electronographs, made at two successive times, of a target cell infected by CML in the presence of an activated T8 cell taken from experiment 2.

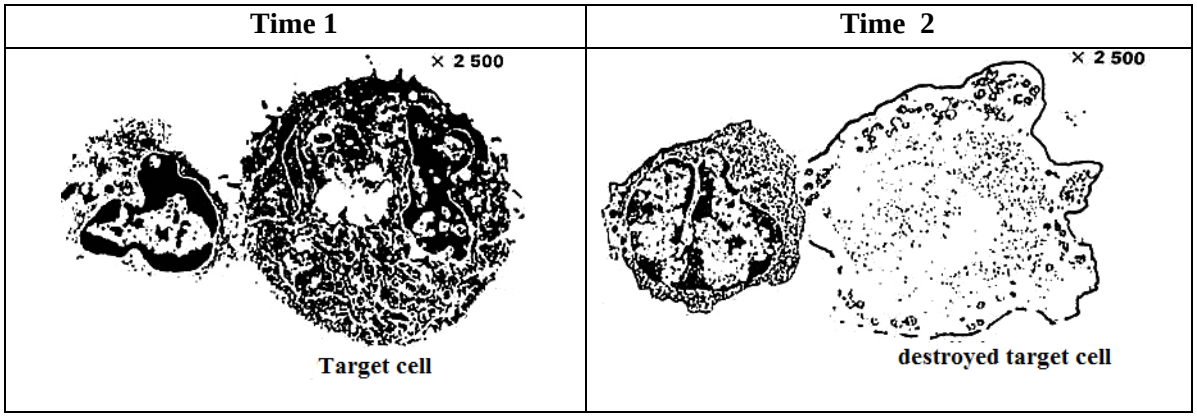
5- Draw a scheme showing the molecules involved in the recognition taking place between the activated T8 cell and the target cell.
6- Explain the mechanism shown in document 3.



Document 1



Document 2

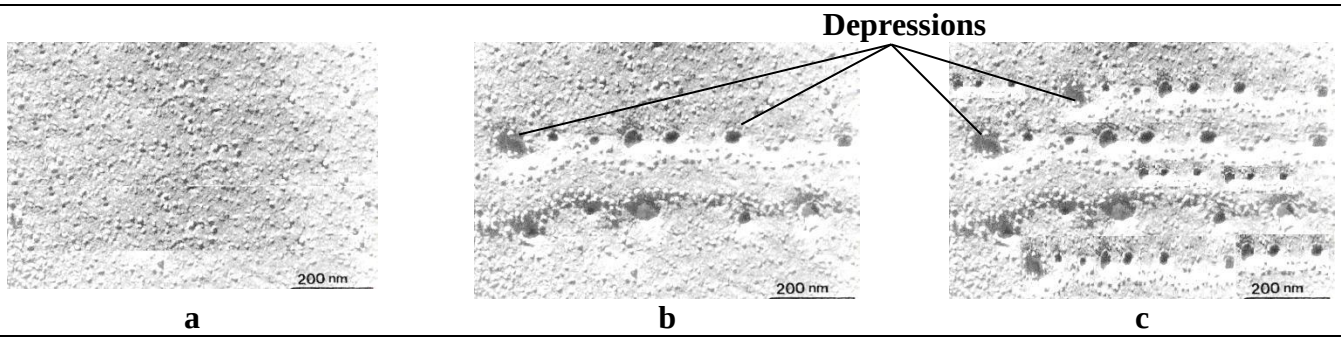


Document 3

Exercise 3 (5 points) **Synaptic Transmission**

Nervous messages are transmitted along the nerve fibers and traverse synapses.
In order to study the mechanisms of the synaptic transmission and the effect of certain exogenous substances, Norcuron and TEPP, the following studies were performed.

Study 1: electronographs of the external side of the presynaptic membrane were performed in different cases: case "a" where the presynaptic neuron is not stimulated, and cases "b" and "c" where this neuron is stimulated respectively with increasing intensities I_1 and I_2 which are above the threshold. The results are shown in document 1. The depressions represent the fusion of the vesicles with the presynaptic membrane.



Document 1

1- Justify, based on document 1, that the exocytosis of neurotransmitters at the level of a synapse is amplified with the increase of the intensity of stimulation.

Study 2: an experimental set up is used to measure the quantity of acetylcholine released in the synaptic cleft of a neuromuscular synapse as well as the amplitudes of the muscular contractions in the three cases "a", "b" and "c" of study 1. The obtained recordings are shown in document 2.

2- Draw a histogram showing the variation of the quantity of acetylcholine and that of the amplitude of the muscle contraction in the three cases "a", "b" and "c".

3- Indicate the type of coding of the nervous message at the level of a synapse. Justify the answer by referring to document 2.

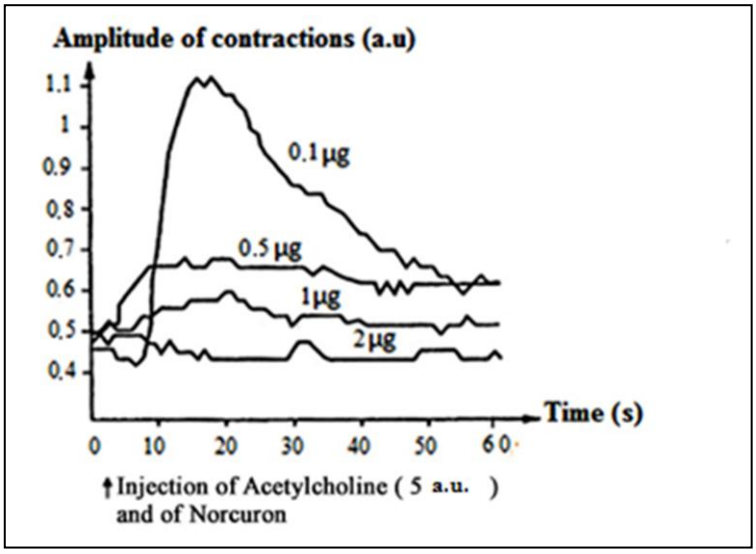
Case	a	b	c
Quantity of Acetylcholine (a.u)	1	3	5
Amplitude of the contraction (a.u)	0.1	0.5	1.5

Document 2

Study 3: in the synaptic cleft, 5 a.u. of acetylcholine are injected simultaneously with increasing amounts (from 0.1µg to 2µg) of Norcuron, a substance that has similar molecular structure to that of acetylcholine. Document 3 shows the recordings of muscular contractions obtained for each amount of Norcuron.

4- What can be deduced from the results of document 3?

Study 4: TEPP is injected in insects. Symptoms characterized by a period of convulsions followed by permanent contraction of muscles are observed.



Document 3

5- Determine whether each of the substances TEPP and Norcuron is agonist or antagonist relative to acetylcholine.

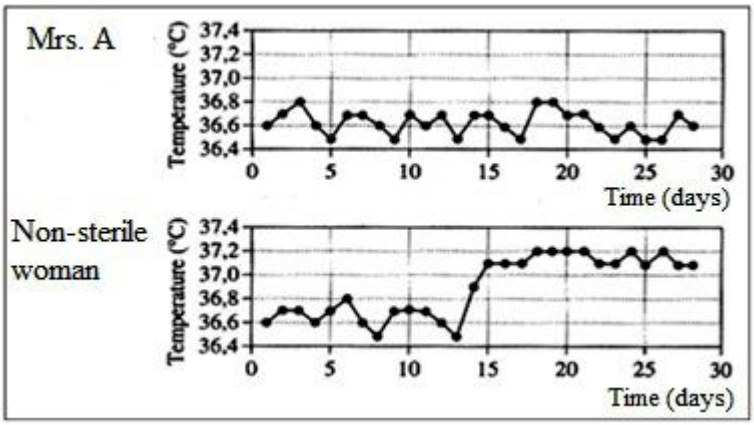
Exercise 4 (5 points) **Infertility in a Woman**

Many factors lead to sterility in women. Most of them are irreversible, but some can sometimes be solved. Mrs. A consults her doctor for a sterility problem. He asks her to measure her body temperature for a certain period of time. The obtained results of Mrs. A as well as those of a normal woman are shown in document 1.

1- Determine the cause of sterility of Mrs. A.

The gynecologist supposes that the sterility of Mrs. A is due, either to a lack of stimulation of the ovaries by the pituitary gland (hypothesis 1) or to the insensitivity of the ovaries to the pituitary gland secretions (hypothesis 2).

2- Justify the two hypotheses that are formulated by the doctor.



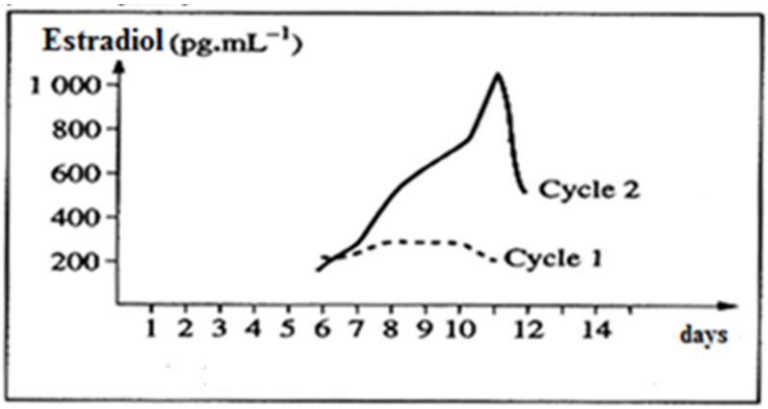
Document 1

The doctor requests Mrs. A to perform an echography accompanied by ovarian biopsies as well as hormonal measurements.
The echography reveals two ovaries of normal size while the multiple performed biopsies show only primary follicles.
The results of the hormonal measurements of Mrs. A concerning the pituitary hormones (LH and FSH) and the ovarian hormones (estradiol and progesterone), show concentrations that are obviously lower than that of a non-sterile woman during a normal cycle.

3- Show that the above obtained results are insufficient to validate hypothesis 2.

The doctor then performs a treatment that consists of injecting a mixture of LH and FSH followed by LH. Estradiol measurements are performed during cycle 1 before treatment and during cycle 2 with treatment. The obtained results are shown in document 2.

4- Specify which of the two hypotheses that are formulated by the doctor is validated by the above obtained results.



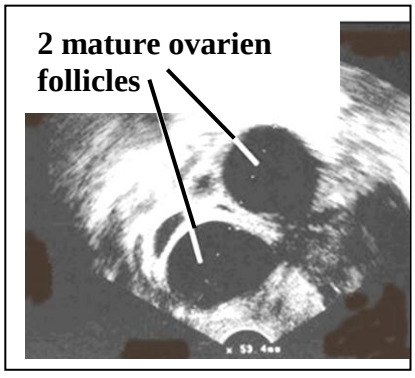
Document 2

Following this treatment, the regular follow up of the development of the ovarian follicles gives the result presented in document 3.

5- Did this treatment solve the sterility problem of Mrs. A? Justify the answer.

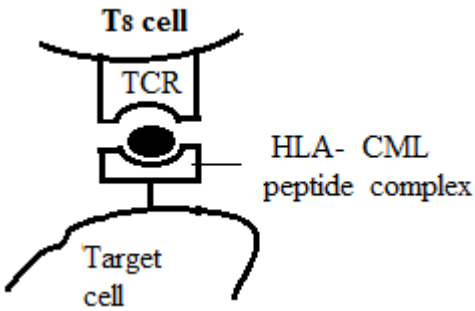
The doctor announces to Mrs. A that she may have fraternal twins.

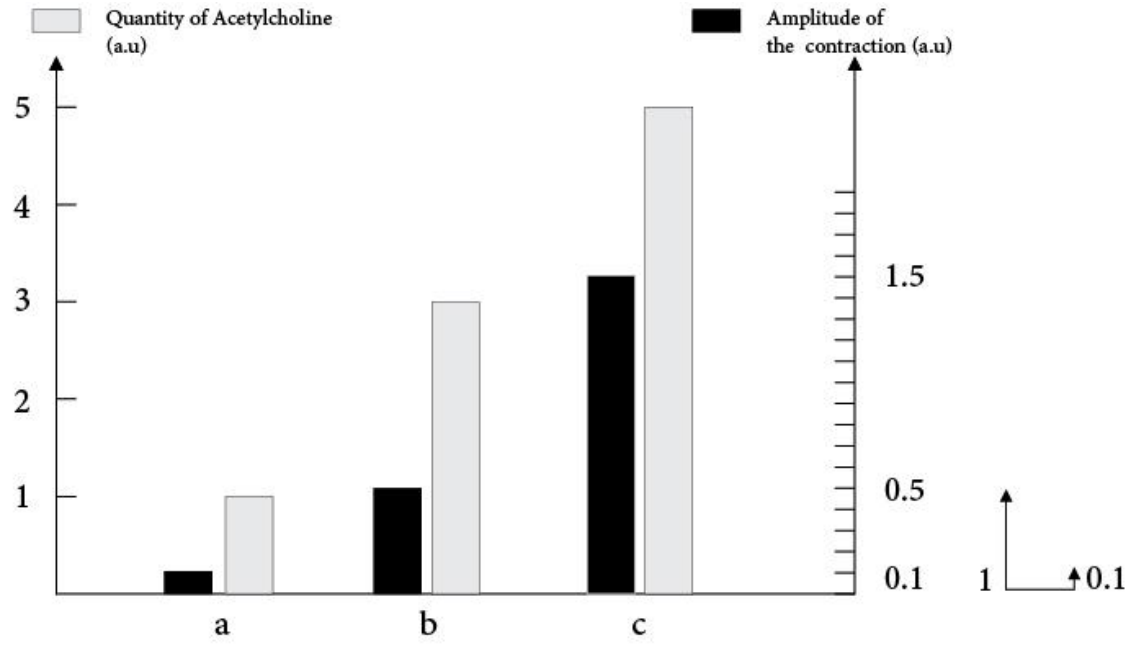
6- Justify this announcement concerning the possible birth of fraternal twins.



Document 3

Q.	Exercise 1 (5 points)	Grade
1	The origin of hemochromatosis is a mutation by substitution at the level of the HFE gene, Since the nucleotides of the normal allele HFE, presented in document 1, are identical to those of the mutated allele except for the nucleotide 274 where G in the normal allele is replaced by A in the mutated one. This mutation leads to the synthesis of an abnormal protein.	**3/4**
2	When treated by the restriction enzyme Rsa1, the normal allele which presents only one recognirtion site GTAC at the level of nucleotides 243 – 246 is cut once between T in position 244 and A in position 245, thus we obtain 2 fragments the first is of 244 bp length and the second of 387-244= 143pb length (3/4 pt) When treated by the restriction enzyme Rsa1, the normal allele which presents 2 recognition sites GTAC at the level of nucleotides 243-246 and at the level of nucleotides 272-275 is cut twice: - between T in position 244 and A in position 245, giving the first fragment of 244 pb length, - between T in position 273 and A in position 274 which gives the second fragment 273 – 244 = 29 bp length and the third fragment of 387 – 273= 114 bp length. Therefore three fragments are obtained (3/4 pt)	**11/2**
3	Since each of the two parents has no family history for hemochromatosis, the frequency for each of them to be heterozygous is 1/10 (frequency in the considered population). Thus the risk for both of them to be heterozygotes is 1/10 x 1/10 = 1/100 Since the allele responsible for the disease is recessive, the risk for a heterozygous couple to have an affected child is 1/4. Hence the risk for this couple to have an affected child is 1/100 x 1/4=1/400	**1/2**
4	The electrophoregram shows only the fragments to which the radioactive molecular probe is hybridized. Since the recognized sequence to which the MP gets fixed is localized only at the level of nucleotide 273, thus the 244 bp fragment is not hybridized and doesn't appear in the electrophoregram.	**3/4**
5	The electrophoregram shows 3 bands: band 143 bp characterizing the normal allele and bands 29bp and 114 bp characterizing the mutated one. The electrophoregram of child IV15 shows one thick band at the level of 143 bp corresponding to the normal allele. Hence he is healthy homozygote. (1/2 pt) The electrophoregram of child IV16 shows the 3 bands. Thus he is heterozygote and since the allele of the disease is recessive, he is healthy. (1/2pt) The electrophoregram of child IV17 shows two thick bands, 29 bp and 114 bp corresponding to the mutated allele. Thus she is recessive homozygote. She will be sick after the age of 40 years. Hence, among the three children, only the girl 17 will be sick after the age of 40 years. (1/2pt)	**11/2**

Part of the Ex	Exercise 2 (5 points)	Grade
1	The response triggered against a virus is a specific cell mediated immune response. The response triggered against a bacterium is a specific humoral mediated immune response.	**1/2**
2	Cells Y infected by CML undergo lysis by T8 cells which are taken from mice of the same strain Y injected by CML. Whereas, cells of the same strain Y that are not infected don't undergo lysis. This shows that T8 cells destroy only infected cells. On the other hand, T8 cells which are taken from mice of strain Y injected by CML lyse the cells of same stain that are infected by CML, but they don't lyse cells of a different strain Z infected by the same virus CML. This implies that T8 cells lyse only infected cells that belong to the same strain. Cells Y infected by CML undergo lysis by T8 cells which are taken from mice of the same strain Y injected by CML . On the contrary, cells of same strain Y which are infected by another virus, HIV, are not lysed. This implies that T8 cells destroy only the cells infected by the same virus that activated them	**11/2**
3	There's only proliferation of T8 cells when we add the supernatant taken from a culture of T4 cells which are activated by CML in the presence of macrophages. Thus activated T4 cells stimulate the multiplication of T8 cells that recognized the same antigen, by secreting a substance, chemical messengers.	**3/4**
4	The macrophage phagocytes and digests the CML virus, the obtained peptides get associated to HLA class II molecules and expressed at the cell surface. The macrophage becomes an antigen presenting cell APC. The APC fixes to T4 cells having specific receptors to the HLA- CML peptide complex thus activating the T4 cells leading to the formation of TH cells that secrete IL-2.	**3/4**
5	Scheme of the recognition site between T8 cells and the target cell  	**3/4**
6	The T8 cell performs the double recognition by fixing to the HLA- CML peptide complex of the target cell (time 1). It secretes perforine molecules that form a channel through the plasma membraneof the target cell; then it releases granzymes that penetrate the target cell through the polyperforin channel leading to the degradation of its DNA and consequently to its lysis (time 2).	**3/4**

Part of the Ex	Exercise 3 (5 points)	grade
1	The depressions observed at the level of the presynaptic membrane correspond to the fusion of vesicles with the membrane, exocytosis. Since the number of depressions increases between cases b and c as the intensity of stimulation increases from I1 to I2, thus the number of vesicles undergoing exocytosis increases with the intensity of stimulation. This justifies that the exocytosis of neurotransmitters at the level of a synapse is amplified with the increase of the intensity of stimulation.	**3/4**
2	Variation of the amplitude of the muscle contraction as a function of Acetylcholine dose.  	**1 3/4**
3	The nervous message at the level of the synapse is coded in concentration of neurotransmitters. Since the amplitude of the muscle contraction increases from 0.5 to 1.5 a.u. when the amount of acetylcholine increases from 3 a.u up to 5 a.u. which corresponds to an increase in the intensity of stimulation from I1 to I2.	**3/4**
4	The amplitude of the contraction increases to a maximum of 1.1 a.u within 15 s in the presence of 0.1µg of Norcuron and 5 au of acetylcholine. On the contrary, this amplitude decreases and become almost constant at 0.45 a.u when we increase the amount of injected Norcuron up to 2µg with the same injection of 5 au of acetylcholine. Thus, Norcuron inhibits the action of acetylcholine and decreases the amplitude of the muscle contractions and its action varies in parallel to its concentration.	**3/4**
5	Since Norcuron reduces the muscle contraction while acetylcholine provokes the muscle contraction. Thus Norcuron has an opposite (reverse) effect to acetylcholine. Hence they are antagonistic substances. TEPP provokes the permanent contraction of muscles like acetylcholine. Thus it has the same effect as acetylcholine on the muscle. They are agonistic substances.	**1**

Part of the ex.	Exercise 4 (5 points)	Grade
1	The temperature fluctuates in the 2 women around a value of 36.6°C, from day zero till day 14 of the cycle. This temperature increases abruptly on the 14th day up to 37.1°C in the non-sterile woman indicating ovulation and remains high around 37.2°C for the rest of the cycle. On the contrary in Mrs. A, and throughout the whole cycle, the temperature undergoes variations which stay always slight around a value of 36.6 °C indicating the absence of ovulation in Mrs. A what causes her sterility.	**1**
2	The pituitary gland secretes two horomones FSH and LH: FSH triggers the follicle development and LH triggers ovulation. In case where one of these two hormones is deficient, there will be no ovulation, nor formation of corpus luteum and thus no secretion of progesterone which is responsible for the increase of temperature to above 37°C. This justifies the first hypothesis. Similarly, if the pituitary gland secretes hormones that cannot fix on the follicular cells due to the absence of receptors, we obtain the same results in the first case. This justifies the 2nd hypothesis.	**1**
3	The echography shows ovaries whose size is normal and containing primary follicles. Thus maybe these follicles can develop in the presence of pituitary hormones if they exist or maybe these follicles are not sensitive to these hormones. The results of hormone measurement show low concentrations of pituitary and ovarian hormones. Thus, maybe there's no control of the pituitary gland on the ovaries or maybe there is no positive feedback of ovarian hormones on the pituitary gland what maintains the low level of pituitary hormones.	**3/4**
4	Hypothesis 2 is validated by the results of document 2 since following the injections of FSH and LH followed by LH, the level of estradiol increases from 200 pg/ml to around 1000 pg/ml indicating follicular development. Thus the ovaries are sensitive to the pituitary secretions and hence it is the levels of FSH and LH in Mrs. A that are insufficient to stimulate the ovaries. What allows the rejection of hypothesis 2 and the validation of hypothesis 1.	**1**
5	Yes, the treatment has solved the problem of Mrs.A. Since the ovaries have, starting from the primary follicles, developed into two mature ovarian follicles that may undergo ovulation releasing two oocytes II blocked at metaphase II that have the possibility to be fertilized.	**1/2**
6	The birth of fraternal results from two different zygotes formed by the fertilization of two oocytes II issued from the two mature follicles presented in document 3 by two different sperm cells.	**3/4**