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دائرة الامتحانات

امتحانات الشهادة الثانوية العامة
فرع علوم الحياة

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الخميس 22 آب 2013

مسابقة في مادة علوم الحياة
المدة: ثلاث ساعات

الاسم:
الرقم:

Answer the following exercises

Exercise 1 (5 points) **Vaccine against AIDS**

In the framework of researches concerning AIDS, scientists followed up 1600 non treated persons that are infected by HIV (Human Immunodeficiency Virus). They measured, at the beginning of the infection, the viral concentration in the blood and recorded the percentage of persons reaching the phase of AIDS. The results are presented in document 1.

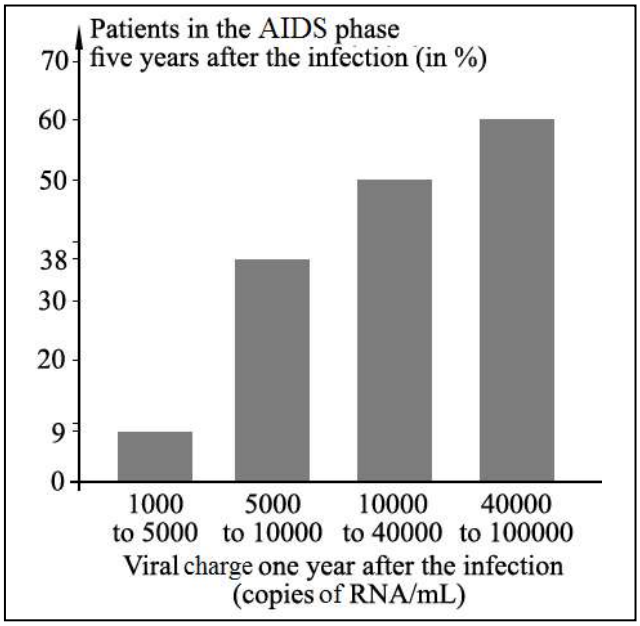
1- Justify, by referring to document 1, the following statement: "in the absence of treatment, there is a relation between the onset of the phase of AIDS and the early evolution of the viral charge".

In the case of HIV, vaccines that activate only the production of anti-HIV antibodies don't protect against all the known strains of the virus. Currently, the scientific community agrees on the fact that: to be effective, a vaccine should also stimulate the production of cytotoxic T lymphocytes directed against HIV. This allowed the elaboration of vaccines against HIV.

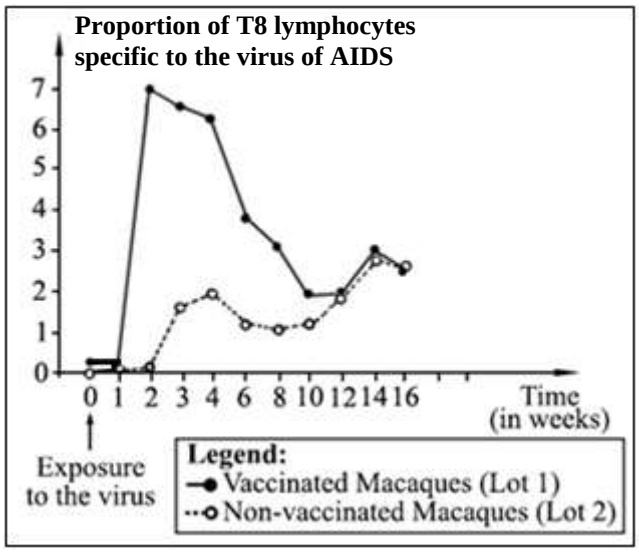
2- Indicate how vaccination protects against a given antigen.

One of these vaccines was tested on two lots of macaques monkeys that are not infected by the virus of AIDS. The monkeys of the first lot (lot1) receives a series of five vaccine injections. The monkeys of the second lot (lot 2) are not vaccinated. Then, all the monkeys are exposed to the virus. The proportion of T8 lymphocytes specific to the AIDS virus is then evaluated in the blood of the monkeys (document 2). The viral charge is measured in the two lots of monkeys at the 8^{th} and at the 24^{th} week following the exposure to the virus (document 3).

3- Show, by referring to document 2, that the immune response of the vaccinated monkeys is more rapid and more amplified then that of the non-vaccinated monkeys during the first 3 months of the infection.
4- Determine if the immune response triggered in lot 1 is durable.
5- Interpret the results of document 3.
6- Show, by referring to what precedes, that the tested vaccine has a limited efficiency and doesn't allow the eradication of the disease.



Document 1



Document 2

Time after exposure to the virus.	Viral charge (number of viral RNA copies / ml of plasma)	
	Lot 1	Lot 2
8^{th} week	5.10^4	25.10^4
24^{th} week	5.10^4	50.10^4

Document 3

Exercise 2 (5 points) **Origins of Phenylketonuria**

In hepatic cells, the enzyme phenylalanine hydroxylase, PAH, is responsible for the transformation of phenylalanine into tyrosine. Its absence or its inactivity results in the accumulation (increase in the amount) of phenylalanine in the blood which becomes toxic at a dose exceeding 20mg/dL which leads to the destruction of the nerve cells in individuals affected with phenylketonuria. This disease has different origins and is manifested by irreversible mental retardation.

1- Pick out the consequence of the high amount of phenylalanine in the blood.

Document 2 represents a part of the gene coding for the enzyme PAH of a healthy individual and that of the equivalent fragment of an individual suffering from phenylketonuria.

Nucleotides position 1	Nucleotides position 2: U	C	A	G	Nucleotides position 3
U	UUU, UUC: phenylalanine; UUA, UUG: leucine	UCU, UCC, UCA, UCG: serine	UAU, UAC: tyrosine; UAA, UAG: non-sens	UGU, UGC: cysteine; UGA: non-sens; UGG: tryptophane	U C A G
C	CUU, CUC, CUA, CUG: leucine	CCU, CCC, CCA, CCG: proline	CAU, CAC: histidine; CAA, CAG: glutamine	CGU, CGC, CGA, CGG: arginine	U C A G
A	AUU, AUC, AUA: isoleucine; AUG: methionine	ACU, ACC, ACA, ACG: threonine	AAU, AAC: asparagine; AAA, AAG: lysine	AGU, AGC: serine; AGA, AGG: arginine	U C A G
G	GUU, GUC, GUA, GUG: valine	GCU, GCC, GCA, GCG: alanine	GAU, GAC: aspartic acid; GAA, GAG: glutamic acid	GGU, GGC, GGA, GGG: glycine	U C A G

A : Adenine U : Uracil G : Guanine C : Cytosine.

Document 1

2- Determine, using the genetic code table (document 1), the sequence of amino acids of the part of the enzyme PAH coded by each of these two alleles.

3- Explain how the modification in the nucleotide sequence of the allele leads to the appearance of phenylketonuria.

Alleles	Nucleotide sequence of the non-transcribed strand of DNA from codon 277 to codon 283
Normal	TAT ACC CCC GAA CCT GAC ATC
Diseased	TAT ACC CCC AAA CCT GAC ATC

Document 2

Two normal couples had two newborns with high plasma concentration of phenylalanine that exceeds 20mg/dL.

4- Indicate if the allele of the disease is dominant or recessive. Justify the answer.

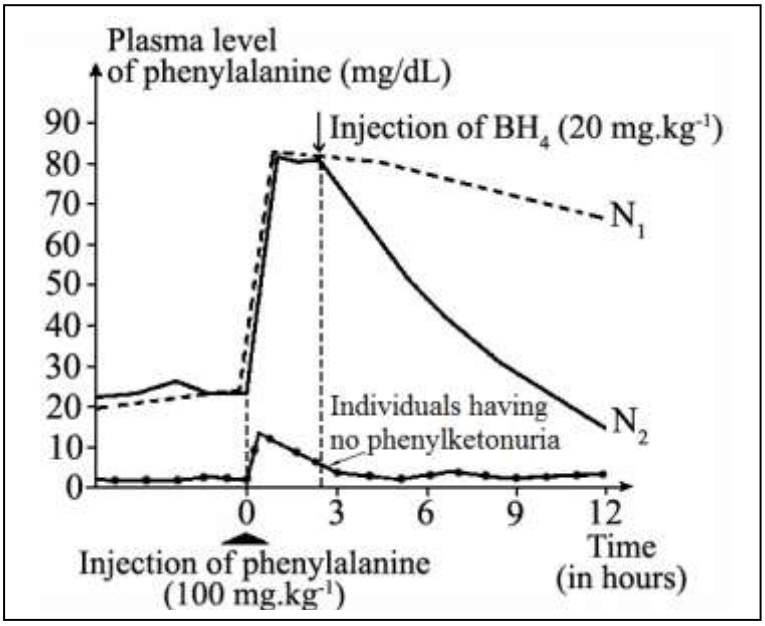
Alleles	F_1	M_1	N_1		F_2	M_2	N_2
Normal	▬	▬			▬	▬	▬
Diseased	▬	▬	▬		▬	▬	

F: Father M: Mother N: Newborn

Document 3

In order to determine the origin of the disease in these two newborns, N_1 and N_2, these couples consulted a doctor who recommended DNA analysis for all the family members. The obtained results are presented in document 3.

Moreover, the doctor proposed another test, where he injected the newborns with phenylalanine followed by injection of BH_4, an organic substance normally present in the organism and that is indispensable for the normal activity of PAH. The obtained results are presented in document 4.



Document 4

5- Indicate the possible origin of the disease in the case of the newborn (N1). Justify the answer by referring to documents 3 and 4.

6- Determine, by referring to documents 3 and 4, the possible origin of the disease in the case of the newborn (N2).

Exercise 3 (5 points)

LSD and Hallucinations

Albert Hofmann is best known for discovering a powerful synthetic drug, the LSD. In one of his books, he described his sensations after he voluntarily took this drug in the frame work of experimental automedication.

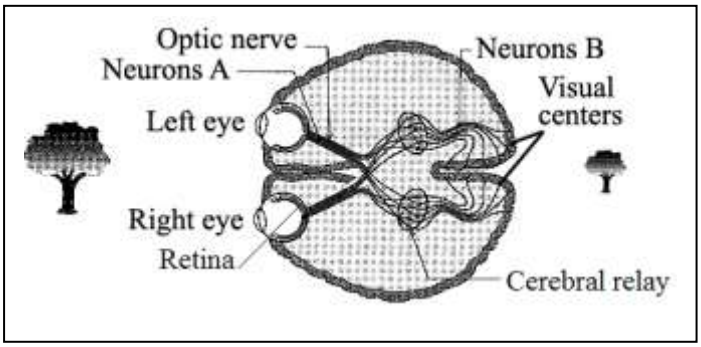
> « Everything in my field of vision was oscillating and distorted as if seen in a curved mirror. I also had the sensation that the bike was not moving even though my assistant told me later that we have been moving fast. When I arrived home, dizziness and weakness sensation were more serious in a way that I couldn't stand up and was obliged to lie down on a sofa-bed.
> Later, I noticed that the way all acoustic perceptions, such as the sound of a door handle or that of a car passing by the house, were transformed into visual perceptions. Every sound generated a corresponding animated image with a particular form and color. »

Document 1

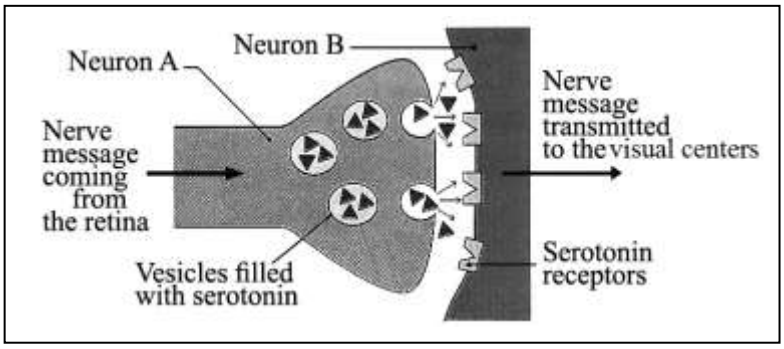
1- Knowing that hallucination is defined as «perception without any object to perceive», show that the LSD is a powerful hallucinogen.

2- Justify that the LSD doesn't modify only the visual perceptions of the individual.

To better understand the action of LSD and its effects, the following studies are performed.
Stimulations applied on neurons A produce visual perceptions. Document 2 shows the encephalic visual pathways involved in these types of perceptions.
Document 3 represents the scheme of the synapse between the two types of neurons A and B at the level of the cerebral relay.



Document 2



Document 3

Effective stimulations of increasing intensities (I1< I2< I3) are applied on neuron A. The amount of serotonin in the synaptic cleft is measured and the nervous message at the level of neurons A and B are recorded. The results are shown in document 4

Intensity	Frequency of AP at the level of the neuron A	Amount of serotonin (in AU)	Frequency of AP at the level of the neuron B
I1	5	1.5	8
I2	9	2.5	13
I3	12	3	18

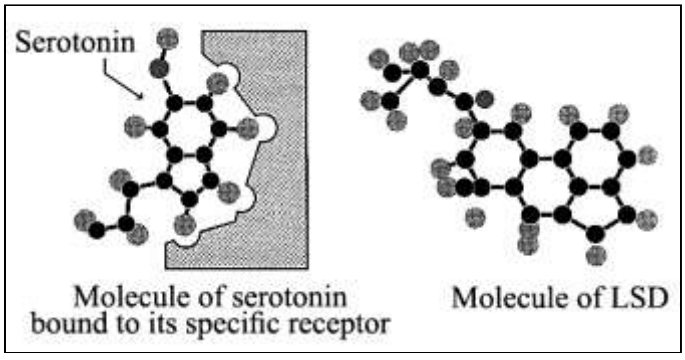
Document 4

3- Explain the steps of synaptic transmission of the nervous message coming from the retina via neurons of type A before reaching the visual centers.

4- Draw a histogram showing the variation of the amount of serotonin as a function of the intensity of stimulation.

5- Analyze the obtained results. Draw out the form in which the nervous message is coded at the level of the neuron as well as that at the level of the synapse.

Document 5 shows the molecular structure of serotonin and that of LSD.



Document 5

6- Suggest, referring to all what precedes, an explanation of the mode of action of LSD in the genesis of visual hallucinations.

Exercise 4 (5 points)

Ovaries and Sexual Cycles

Ovaries are active from puberty till menopause.

In order to understand the endocrine role of ovaries on the genital activity, the following experiments are performed.

Groups	Conditions	Observed Results	
		Mass of the uterus	Uterine cycles
1	Control	710 mg	Cyclic variation
2	Ablation of two ovaries	120 mg	No variation
3	Bilateral ovariectomy + continuous and identical injections of ovarian extracts	705 mg	No cyclic variation

Document 1

Experiment 1:

Two lots of female rats which did not reach puberty, 2 and 3, are subjected to ovariectomy with or without injection of ovarian extracts: estradiol and progesterone. The conditions and the results of the experiment are presented in document 1.

1- Draw out the roles of ovaries and their mode of action as revealed in this experiment.

Experiment 2:

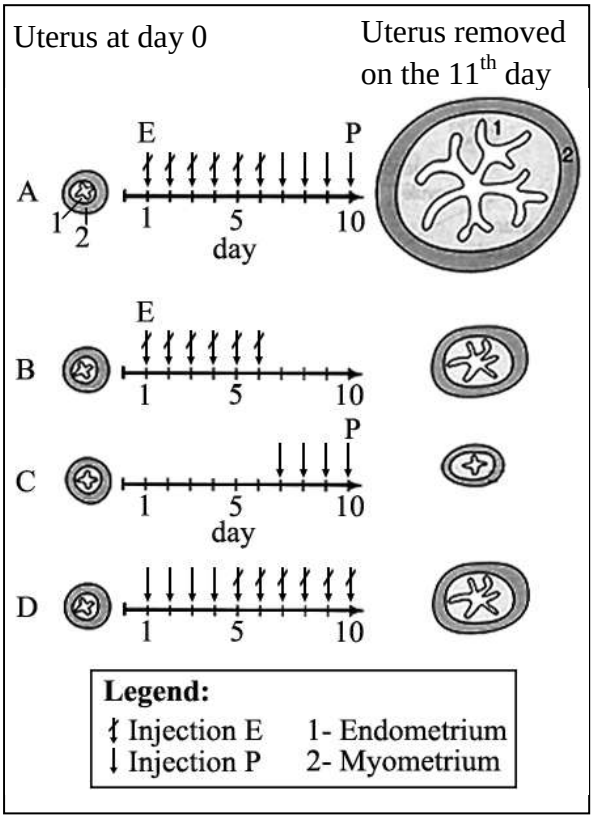
Four lots (A, B, C and D) of female rabbits that did not reach puberty receive daily injections of 5 µg of estradiol (E) and/or 200 µg of progesterone (P) during several days. Then, transverse sections of their uterus are prepared at the end of the experiment, at day 11. Document 2 presents the experimental conditions as well as the obtained results.

2- Interpret the results of document 2.

Experiment 3:

Protein receptors for progesterone were revealed at the level of endometrium cells. The injection of estradiol provokes an increase in the number of progesterone receptors in the day following the injection.

3- Explain the obtained results of lot A in experiment 2.

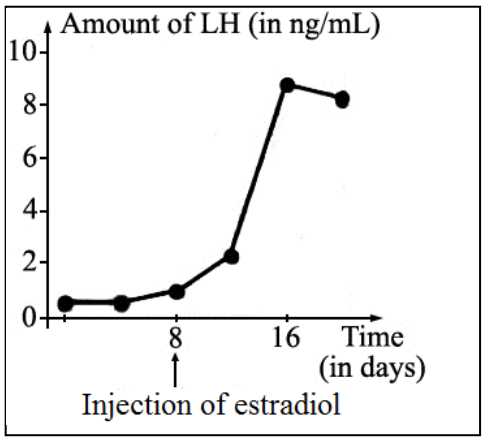


Document 2

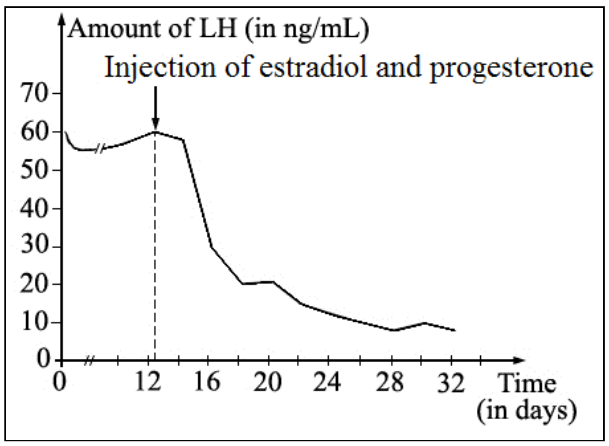
Experiment 4:

A lot of ovariectomized female mammals are subjected to injections of high amounts of estradiol with or without progesterone.

The evolution of the plasmatic concentration of the pituitary hormone LH is measure and the obtained results are shown in documents 3 and 4.



Document 3



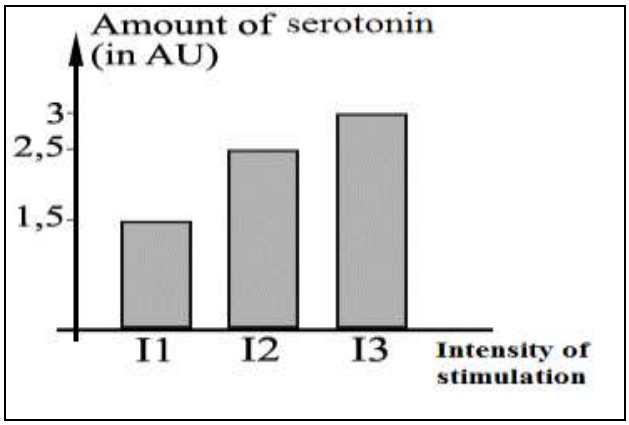
Document 4

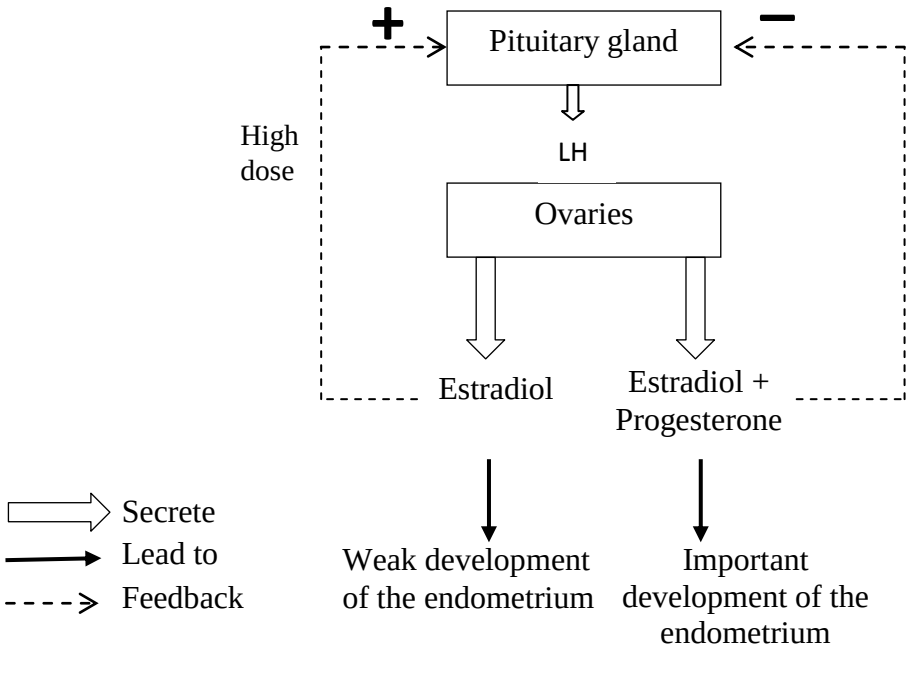
4- Show, by referring to documents 3 and 4, that "the activity of the pituitary gland is under the control of ovarian hormones".

5- Establish, by referring to all what precedes, a functional diagram showing the relations existing between the ovaries and the two other organs: the pituitary gland and the uterus.

Part	Answer	Grade
	Exercise 1	
1	The percentage of untreated patients in the AIDS phase five years after the infection increases from 9% to 60% when the viral charge one year after the infection increases from 1000 up to 10000 copies of mRNA/mL. This shows that the onset of the AIDS phase and the early evolution of the viral charge vary in parallel to each other.	**1**
2	Vaccines immunize the organism against a specific antigen by inducing a durable immunological memory. Or Vaccines protect the organism by sensitizing the immune system against the pathogens in order to recognize and destroy them in a more rapid and more efficient manner upon a second contact with the same pathogen.	**0,5**
3	In vaccinated monkeys, the proportion of T8 lymphocytes increases from 0 to 6.5 greater than that of non-vaccinated monkeys which is 2. This shows that the response triggered in vaccinated monkeys is more amplified. **(0,5 pt)** After the exposure to the virus, the increase of the proportion of T8 lymphocytes in vaccinated monkey begins after a latency time of one week, less than that in the vaccinated monkeys which is 2 weeks. This shows that the response in vaccinated monkeys is more rapid than that of the non-vaccinated ones. **(0,5 pt)**	**1**
4	Between the fourth and the 12^{th} week, the proportion of T8 lymphocytes, in both lots 1 and 2 decreases while remaining higher in vaccinated monkeys and reach the same value of 2 at week 12. After the 12^{th} week, the variations of these proportions remain identical. This shows that the immune response triggered by the vaccine is not durable, it does not last except for 12 weeks.	**0,5**
5	Document 3 shows that the viral charge at the 8th week in vaccinated macaques is 5. 10^4viral RNA copies/ml inferior to that of the non-vaccinated ones 25. 10^4viral RNA copies/ml . At the 24^{th} week it increases (doubles) to 50.10^4viral RNA copies/ml in the non-vaccinated macaques while it remains constant at 5.10^4viral RNA copies/ml in vaccinated macaques value that is 10 times smaller than 50.10^4viral RNA copies/ml. This shows that vaccine maintains the viral charge weak and constant at the beginning of the infection.	**1**
6	The chance of reaching the phase of AIDS diminishes in the case where the viral charge is weak at the beginning of the infection (doc.1). The vaccine maintains the viral charge low at the beginning of the infection (doc.3). This diminishes the evolutions of the disease toward the phase of AIDS thus extending the asymptomatic phase. Therefore there is a greater chance to prolong the life of seropositive individuals. From this point the vaccine is efficient. The vaccine amplifies the specific cell mediated immune response the first three months after infection (doc.2) however this amplification is not durable thus the efficiency is limited. In addition the vaccine doesn't ensure a total recovery and the disease is not eradicated.	**1**

Part of the ex.	Answer	Grade
	Exercise 2	
1	It is toxic, leads to the destruction of the nerve cells and is manifested by irreversible mental retardation.	**0,5**
2	Portion of the amino acids sequence of the enzyme: We establish the mRNA sequence by replacing T by U Normal mRNA: UAU ACC CCC GAA CCU GAC AUC Amino acids sequence : Tyr-Thr-Pro-Glu-Pro-Asp-Ile Diseased m RNA: UAU ACC CCC AAA CCU GAC AUC Amino acids sequence : Tyr-Thr-Pro-Lys-Pro-Asp-Ile	**1**
3	The mutation by substitution at the level of the first nucleotide of the 280th codon of the DNA where G is replaced by A is transcribed at the level of mRNA by a new codon which is translated into a new amino acid, lysine instead of the glutamic acid. This new amino acid sequence affects the tridimensional structure of the enzyme PAH which becomes inactive (nonfunctional). Since this enzyme is responsible for the transformation of phenylalanine into tyrosine. This transformation doesn't occur any more leading thus to the accumulation of phenylalanine which in high amount becomes toxic and causes phenylketonuria.	**1**
4	The allele of the disease is recessive with respect to the normal allele. Since normal parents gave birth to an affected child, thus they carry the allele of the disease that is masked in the parents. Let N be the symbol of the normal allele. Let m be the symbol of the allele coding for the disease.	**0,5**
5	The origin of the disease in the case of N1 is a mutation that leads to the synthesis of an inactive PAH (non-functional). Document 3 shows that affected N1 is homozygous of genotype m//m. And document 4 shows that a slight decrease in the plasma level of phenylalanine in N1 from 80 to 70 mg/dL after the injection of 20 mg/Kg of BH4. This implies that even in the presence of functional BH4, the PAH remains nonfunctional.	**1**
6	Document 3 shows that the affected newborn N2 is homozygous of genotype N//N. His allele codes for a normal PAH. Document 4 shows that in N2, the constant plasma level of phenylalanine of 80 mg/dL decreases after the injection of 20 mg/Kg of BH4to 15 mg/dL value that is inferior to the reference level of 20 mg/dL. Thus BH4 acts in N2 by decreasing the plasma level of phenylalanine toward its normal value. The PAH in the newborn N2 is functional but needs the presence of BH4 to be activated. Hence, his disease in N2 can be due to the absence of BH4 or to the presence of non-functional BH4.	**1**

Part	Answer	Grade
	Exercise 3	
1	"Every sound generated a corresponding animated image". The "acoustic perceptions such as the sound of a door handle or a passing automobile became transformed into optical perceptions". Sounds are generating visual perceptions. Thus LSD is a powerful hallucinogen since it provokes perceptions without objects to perceive.	**0,5**
2	LSD doesn't modify only the visual sensations, but it also causes general disturbance. Hoffmann didn't realize that the bike was moving, he felt dizzy and weak he couldn't stand up and was forced to lie down on a sofa bed.	**0,5**
3	The nerve message coming from the retina towards the extremity of the axon of presynaptic neuron A, leads to the influx of calcium in the terminal knob, this causes vesicles filled with neurotransmitters, serotonin, to migrate to the cell's surface and to release their contents of serotonin into the synaptic cleft by exocytosis. Then, serotonin fixes on specific receptors of the membrane of the postsynaptic neuron B. the binding of the neurotransmitter to its specific receptor generates an EPSP in the postsynaptic neuron inducing the birth of a nerve message that is transmitted by neuron B towards the nerve centers.	**1**
4	Histogram : variation of the amount of serotonin as a function of the intensity of stimulation 	**1,25**
5	The frequency of AP at the level of the neuron A and at the level of neuron B increases respectively from 5 to 12 AP and from 8 to 18 AP as the intensitiy of stimulation increases from I1 to I3. Meanwhile, the amount of serotonin increases from 1.5 to 3 au. Thus the nerve message at the level of neuron is modulated by frequency of AP and at the level of the synapse by the amount of neurotransmitter.	**0,75**
6	the molecule of serotonin and that of LSD have an identical part in their molecular structures, and this common part allows the serotonin to fix on its specific receptor. We can suggest that molecules of LSD fix on serotonin receptors due to their complementary form. Being agonist to serotonin, the LSD fixation on serotonin receptors generates an EPSP at the level of neuron B in absence of any message at the level of the presynaptic neuron A, and consequently the induced nerve message propagates towards the visual centers even though eyes don't detect any object. This explains the visual hallucinations described by Hoffmann.	**1**

Part	Answer	Grade
	Exercise 4	
1	Ovaries are responsible for the development of the uterus and the cyclic variation of the uterine cycle. Ovaries act by secreting estradiol and progesterone in the blood in a variable or cyclic manner.	**0.75**
2	There is development in the endometrium of the uterus following the injection of estradiol for 6 days followed by an injection of progesterone for 4 days (lot A). However this development is less important following the injection of estradiol for 6 days alone (lot B). Thus estradiol stimulates the development of the endometrium and progesterone amplifies this action. While there is no development of the endometrium following the injection of progesterone alone from day 7 till day 10 (lot C). Hence, progesterone alone doesn't have any effect on the endometrium. On the other hand the endometrium shows a weak development less important than that in lot A following the injection of progesterone for 4 days followed by an injection of estradiol for 6days. Thus progesterone does not act on the endometrium unless it is preceded by estradiol.	**2**
3	In lot A, the injection of estradiol at the beginning of the cycle ensures slight development of the endometrium and increases the number of progesterone specific receptors. This increases the concentration of the progesterone bound to its receptors in the nucleus of target cells. this increases the synthesis of proteins and ensures the thickening of the endometrium, leading to the important development of the endometrium in lot A.	**0.75**
4	The amount of LH increases from 0.5ng/mL to 9ng/mL between the days 8 and16 following the injection of estradiol alone on day8. This shows that estradiol exerts a positive feedback on the pituitary gland. On the contrary, the amount of LH decreases from 60ng/mL to 10ng/mL between day 12 and 28 after the injection of estradiol and progesterone at day 12. This shows that estradiol with progesterone exert a negative feedback on the pituitary gland. This shows that the activity of the pituitary gland is under the control of ovarian hormones.	**0.75**
5	Functional diagram showing the relations existing between the ovaries and the two other organs: the pituitary gland and the uterus  	**0.75**