

الاسم:  
الرقم:

مسابقة في مادة علوم الحياة  
المدة: ثلاث ساعات

### Exercise 1 (5 points)

### Genetics and Cancer

Billions of cells of the organism, having a limited lifespan, are continuously renewed due to cellular divisions controlled by a system of regulation. The dysfunction of this system of regulation can produce a clone of cells, thus forming a tumor. This latter, is benign as long as it is controlled but it can evolve into malignant tumor: cancer.

The cancerous cells lose their contact with their neighboring cells; they tend to migrate and colonize in other tissues: this is metastasis.

1- Pick out from the text :

1-1- The cause of the appearance of tumor.

1-2- The definition of metastasis.

In order to better understand the origin of this type of cancer, several studies have been carried out on the gene p53 coding for the protein p53. This protein intervenes in the regulation of the cell divisions.

#### Study 1:

The development of this type of cancer is studied in three lots of mice as a function of their genotypes concerning the gene p53. Two alleles of this gene, p53+ (normal) and p53- (mutated) are only considered. The results of this study are shown in document 1.

2- Interpret the obtained results shown in document 1.

Document 2 shows the nucleotides sequence of the non-transcribed strand of each of the two alleles involved in this study.

3- Specify the type of mutation at the origin of this cancer.

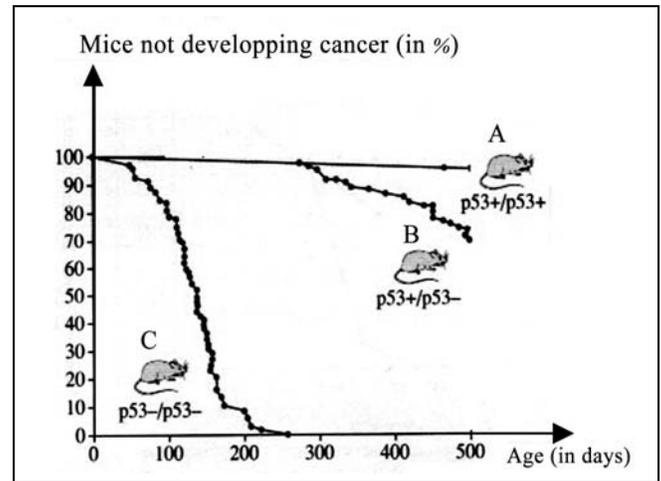
4- Explain how the modification in the nucleotide sequence leads to the appearance of this type of cancer.

#### Study 2:

Researchers have studied the mutations detected in three groups of individuals: individuals of group 1 are non-smokers and non-alcohol consumers, those of group 2 are smokers but non-alcohol consumers and those in group 3 are smokers and alcohol consumers. The results are shown in document 3.

5- Show that the consumption of tobacco is a risk factor for cancer.

6- Justify the high number of individuals affected by cancer in the case of the simultaneous consumption of alcohol and tobacco.



Document 1

Gene p53	Sequence of the nucleotides of the non-transcribed DNA strand
N° of codon	↓244 <span style="float: right;">↓250</span>
Allele p53+	GGC GGC ATG AAC CGG AGG CCC
Allele p53-	GGC GGC ATG AAC CGG AGT CCC

Document 2

		Group 1	Group 2	Group 3
Mutations detected at the level of gene p53	Number	3	5	7
	Type	Substitution	Substitution	Substitution, deletion and insertion
Result : Number of individuals affected by cancer		Low	Moderate	High

Document 3

## Exercise 2 (5 points)

## Roles of Macrophage

The monocytes circulate in the blood and can migrate to the tissues where they become macrophages.

1- Indicate the origin of monocytes.

In order to study the mode of action of macrophages and their cooperation with certain cells of the immune system, the following experiments are performed.

### Experiment 1 :

Cells are extracted from the ganglia of a guinea pig which is immunized against antigen X. T4 lymphocytes and macrophages are isolated and placed in different culture media. The experimental conditions and the results are shown in document 1.

2- Determine the conditions indispensable for the proliferation of T4 lymphocytes.

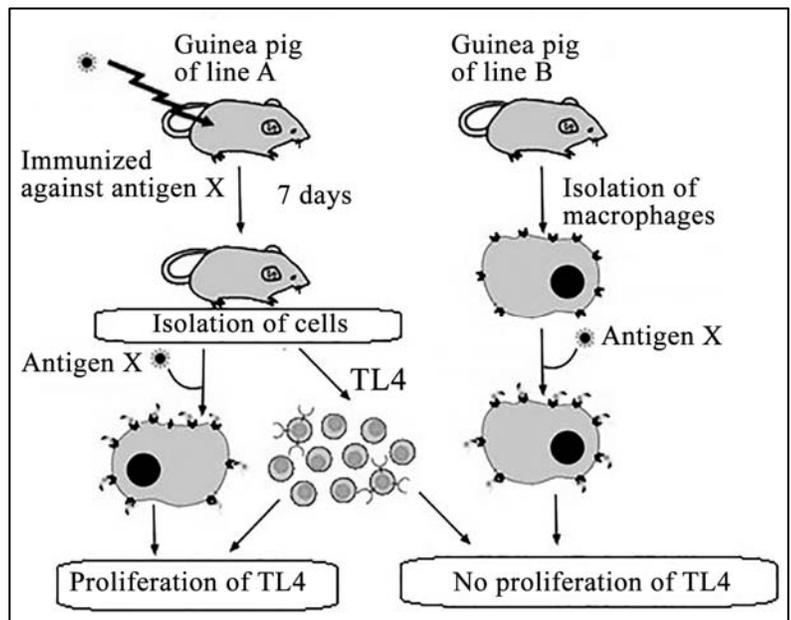
Culture medium	Conditions of the culture	Results
1	T4 lymphocytes and antigen X	No proliferation of T4 lymphocytes
2	T4 lymphocytes and macrophages	No proliferation of T4 lymphocytes
3	T4 lymphocytes, macrophages and antigen X	Proliferation of T4 lymphocytes
4	T4 lymphocytes	No proliferation of T4 lymphocytes

Document 1

### Experiment 2 :

An experiment is performed on two different strains of guinea pigs, A and B. The experimental conditions as well as the results are shown in document 2.

3- Indicate the condition indispensable for the proliferation of T4 lymphocytes shown in this experiment. Justify the answer.



Document 2

### Experiment 3:

Macrophages are incubated with the same antigen X labeled with radioactive  $^{131}\text{I}$  Iodine isotope. At phase I, radioactivity is detected inside the macrophage, and in phase II a rapid degradation of antigen X is noticed. After some time 80% of radioactivity is detected in the culture medium in the form of  $^{131}\text{I}$  Iodine isotope linked to peptides, while the remaining 20% are found attached to the cell surface.

4- Draw out the role of macrophages shown at phase I of experiment 3.

5- Explain the results obtained at phase II in experiment 3.

6- Explain the mode of action of the macrophages that permits the proliferation of T4 lymphocytes.

7- Specify the consequence of the absence of the macrophages on the specific immune responses.

**Exercise 3 (5 points)**

**Reflex Control**

In order to understand how the myotatic reflex can be controlled, many studies are carried out on different fibers, the sensory fibers and motor fibers involved in this reflex.

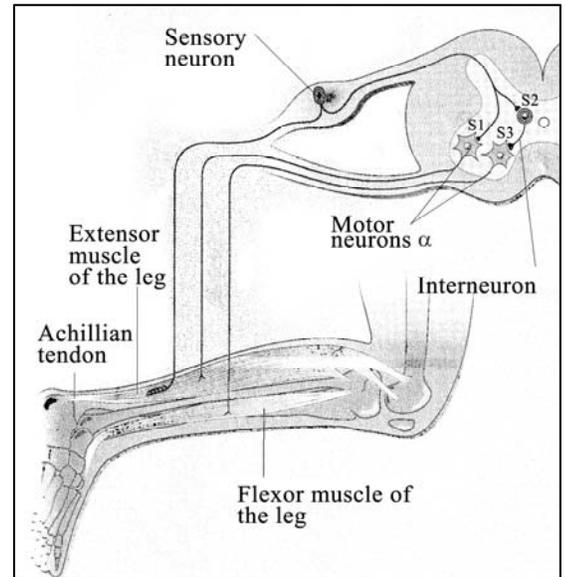
1- Define the myotatic reflex.

**Study 1:**

The extensor muscle is stretched and the sensory and the motor messages are recorded in two different situations: in the first situation the flexor muscle is at rest, and in the second situation the flexor muscle is strongly stretched.

Document 1 shows the concerned muscles with their nervous connections.

Document 2 shows the experimental conditions as well as the obtained recordings during the same duration in the two situations.



**Document 1**

2- Compare the neuron circuits innervating these antagonistic muscles involved in this reflex.

		Situation 1 Flexor muscle at rest	Situation 2 Flexor muscle strongly stretched
Electrical recordings	Fiber issued from the neuromuscular spindle of the extensor muscle		
	Fiber issued from the motor neuron alpha innervating the extensor muscle		
	Fiber issued from the motor neuron alpha innervating the flexor muscle		

**Document 2**

3- Determine, based on the results of the first situation (doc 2), the contracted muscle and the relaxed one.

4- Indicate the role of the interneuron.

5- Explain the role of the motor neuron alpha of the extensor muscle in the second situation.

**Study 2**

The extensor muscle is stretched and the activities of the sensory fiber and the motor fiber of this muscle are recorded with or without the voluntary contraction of the flexor muscle. The results are presented in document 3.

		Stretching of the extensor muscle	
		Flexor muscle at rest	Voluntarily contracted flexor muscle
Electrical recordings	Fiber issued from the neuromuscular spindle of the extensor muscle		
	Fiber issued from the motor neuron alpha innervating the extensor muscle		

**Document 3**

6- Deduce the action of the superior nerve centers on the studied reflex.

**Exercise 4 (5 points)****Determination of Ovulation**

The first phase of the menstrual cycle is marked by important development of the follicles. Out of these follicles, only one becomes mature and ready for ovulation. In order to better understand the factors and the mechanisms that cause ovulation to occur, the following studies are performed.

**Study 1:** the variation of the level of estradiol, an ovarian hormone, is monitored during a sexual cycle. The results are shown in document 1.

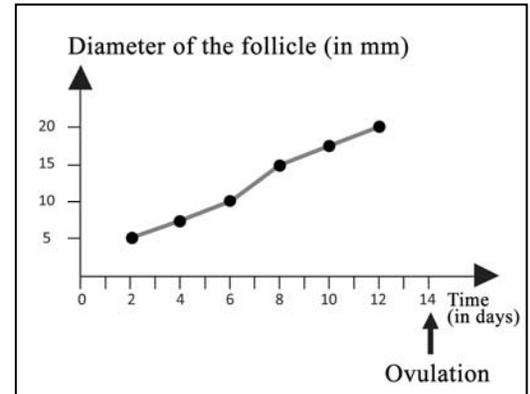
Time(days)	0	4	10	12	14	18	21	28
Level of estradiol (pg/mL)	60	75	150	240	75	100	150	60

**Document 1**

- 1- Draw the curve which represents the variation of the level of estradiol as a function of time.

Document 2 shows the variation of the diameter of a cavitory follicle during maturation until ovulation. Note that the diameter of the follicle is proportional to the number of follicular cells.

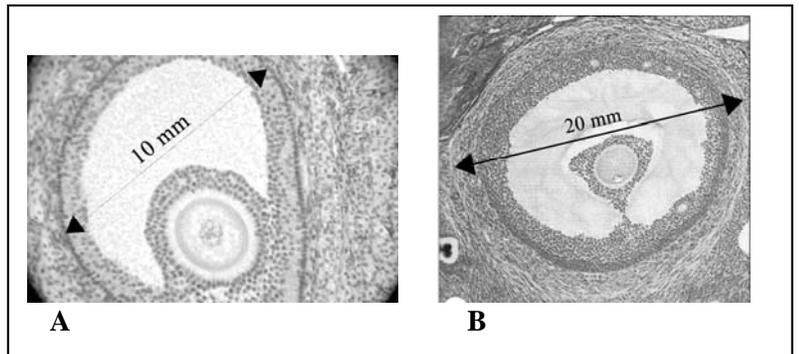
- 2- Define ovulation  
 3- Explain how the transformation of the follicle (doc 2) leads to the variation of the level of estradiol during the follicular phase (doc 1).  
 Document 3 shows a follicle at two different stages of the development in the ovary during a sexual cycle.

**Document 2**

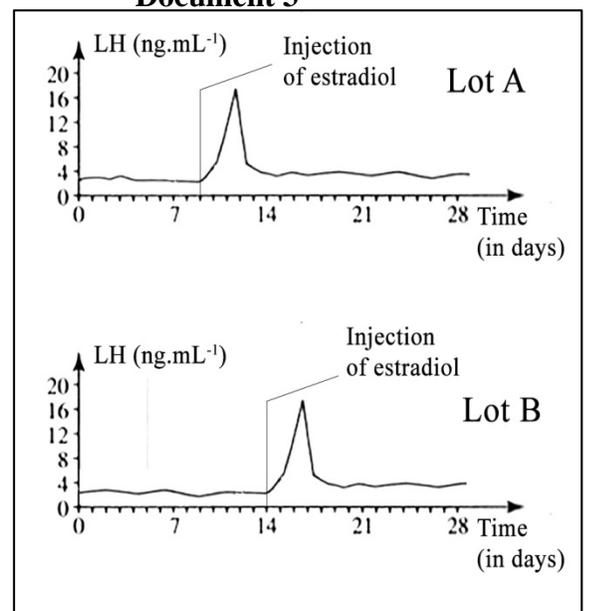
- 4- Name the follicle represented in each of the photos A and B. Justify, by referring to document 2, the answer.

**Study 2**

Two lots A and B of female monkeys which are subjected to the ablation of their ovaries, receive a continuous injection of moderate level of estradiol, which keeps LH at a low level. The monkeys of each lot receive later a unique injection of a high dose of estradiol, on a specific day. The variation of the LH level is monitored in these monkeys. The results are represented in document 4.

**Document 3**

- 5- Interpret the results in document 4.  
 6- Explain that the stimulus leading to ovulation is given by the ovarian follicle.

**Document 4**

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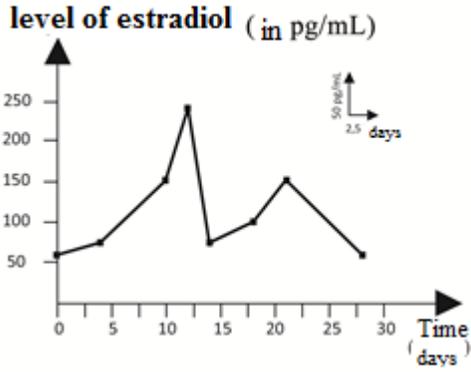
Q.	Exercise 1 Genetics and Cancer	mark
1-1	The dysfunction of this system of regulation can produce a clone of cells, thus forming a tumor.	1/4
1-2	The cancerous cells lose their contact with their neighboring cells; they tend to migrate and colonize in other tissues: this is metastasis.	1/4
2	In lot A of genotype p53+//p53+, the percentage of mice that don't develop cancer stays constant at 100% during 500 days. However, the percentage decreases from 100% to 70% in mice of lot B of genotype p53+//p53- between day 280 and day 500. This shows that the allele p53- favors the development of cancer when it's present in one copy. However, in lot C having the genotype p53-//p53-, the percentage of mice not developing cancer begins to diminish from 100% on day 50 to null on day 250 days which is less than day 280 corresponding to the appearance of cancer in lot B. Therefore, the allele p53- accelerates the appearance of cancer and its action is amplified when it exists in 2 copies.	1
3	The origin of cancer is a mutation by substitution of gene p53. Since the nucleotides of alleles are identical except at the level of the 3rd nucleotide of codon 249 where the G nucleotide in the allele p53+ is substituted by the nucleotide T in the allele p53-.	1
4	The mutation by substitution at the level of codon 249 leads to an amino acid different than that translated by the normal allele. This modification of amino acid has as a consequence the synthesis of an abnormal and non-functional protein. As a consequence, the regulatory system of cellular divisions becomes nonfunctional and the cells divide in an uncontrollable manner, producing thus a clone of cells forming tumors.	1
5	Document 3 shows that in the smokers, the number of mutation by substitution is 5 and the number of individuals affected by cancer is moderate; whereas, the non-smokers present 3 (3<5) mutations by substitution that limits the development of cancer in them. This shows that tobacco is a risk factor for cancer.	3/4
6	In the smokers and consumers of alcohol, the number of mutation is 7, a value greater than 5, which is the number of mutation in the smokers (and also greater than 3, in non-smokers and non-alcohol consumers). In addition to the increase in number, the mutations exit in different types: deletions and insertions in addition to substitutions, the only type mutations revealed in the two groups 1 and 2. Since the mutations at the level of gene p53 is at the origin of tumors, the increase in the number of mutations as well as the occurrence of new types of mutations, favor the appearance of cancer and therefore justifies the high number in individuals affected by cancer which are smokers and alcohol consumers.	3/4

Q	Exercise 2(5 Points)	Role of Macrophages	Mark
1-	Bone marrow		1/4
2-	Proliferation of T4 lymphocytes takes place only in culture of medium 3 in the presence of T4, macrophages and antigen X. Hence the proliferation of T4 lymphocytes necessitate the association or cooperation between T4 and macrophages in the presence of antigen X.		1
3-	The macrophages and the T4 cells must descend from the same strain. Since there is no proliferation of T4 lymphocytes when T4 cells of strain A are incubated with macrophages from another strain B.  However proliferation takes place when T4 cells and macrophages previously in contact with an antigen X that descend from the same strain A.		1
4-	Phagocytosis		1/2
5-	At phase II of the experiment, 20% of radioactivity is detected on the surface of the cell, because a part (80%) of the degraded radioactive protein is eliminated out of the cell; The remaining 20% is degraded into peptides that are associated with MHC II on the surface of macrophages.		1/2
6-	The macrophages that are transformed into APC present the non-self-peptide associated with MHC II on its surface. So TCR of T4 lymphocytes bind to this complex and the T4 becomes activated.		3/4
7-	The induction of specific immune response ceases because the activation of T4 lymphocytes necessitate its binding to APC. So in the absence of activated T4 lymphocytes, no more secretion of interleukin 2 takes place which is responsible for launching the specific cell mediated immune response. Moreover, no interleukin 4 secretion takes place which is responsible for launching of the specific humoral immune response.		1

Q	Exercise 3 (5 points)	Control of Reflex	Mark
1	The myotatic reflex is the contraction of the muscle due to its own stretching		1/2
2	The two circuits posses the same sensory neuron . Each of the two circuit have a unique motor neuron $\alpha$ . The circuit of the flexor muscle possesses an interneuron between its sensory neuron and its motor neuron $\alpha$ . However the circuit of the extensor muscle does not have interneuron .  The number of synapses in the extensor muscle(1) circuit is less than that in the circuit of the flexor muscle (2).		1

3	<p>The muscle which receives the excitatory nerve message, contracts. Since the fiber issued from the motor neuron <math>\alpha</math> which innervates the extensor muscle shows the propagation of the nerve message of frequency equals to 15 A.Ps. Hence the muscle which contracted is the extensor muscle.</p> <p>The muscle which does not receive any nerve message does not contract. Since the fiber issued from the <math>\alpha</math> motor neuron and which innervates the flexor muscle shows resting potential ( or absence of action potential). Hence this muscle stays at rest.</p>	1
4	The interneuron plays an inhibitory role on the $\alpha$ motor neuron of flexor muscle.	1/2
5	The recordings at the level of the fibers issued from the motor neuron of the extensor muscle shows disappearance of the frequency of action potential (previously shows recording at the level of the same fiber in the absence of contraction of the flexor muscle).Although there exists sensory nerve message of frequency of 8 APs at the level of the sensory neuron, and this is explain by the spatio-temporal summation of an excitatory nerve message coming from sensory neuron and an inhibitory message coming from the flexor muscle resulting in the disappearance of the recording ( algebraic sum).	1
6	<p>Only the frequency of APs of the fiber issued from the motor neuron innervating the extensor muscle decreases from 15 to 3 APs after the voluntary contraction of flexor muscle. (On the contrary, sensory nerve message stays at the same frequency of 8 Aps in the two cases with and without voluntary contraction of flexor muscle) .</p> <p>Thus the superior nerve center inhibits only the motor nerve message at the level of the motor neuron innervating the extensor muscle. This results in decreasing the stimulation of the muscle consequently its contraction and attenuates the myotatic reflex. .</p>	1

<b>Q.</b>	<b>Exercise 4 (5 Points)</b>	<b>Determining Ovulation</b>	<b>Mark</b>
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1	<p style="text-align: center;"><b>level of estradiol (in pg/mL)</b></p>  <p style="text-align: center;">Variation of the level of estradiol as a function of time</p>	11/2
2	Ovulation is the liberation or release of oocyte II from the mature ruptured graafian follicle into the pavilion duct.	1/4
3	The increase in the diameter of the follicle from 5mm at day 2 of the follicular phase into 20 mm at day 12 of the same phase is followed by an increase in the number of follicular cells. Knowing that these cells are responsible for estradiol secretion, as the number of these cells increases, the estradiol level increases from 60 pg/ml into 240 pg/ml between day 0 and 12 of the follicular phase (as shown in document 1)	3/4
4	<p>A= cavitary (tertiary) follicle. Since the diameter is 10 mm which corresponds to a follicle at day 6 of the cycle during its development.</p> <p>B= Graafian follicle. Since the diameter is 20 mm which corresponds to a follicle at day 12 of a follicular phase that's a mature follicle tends to ovulate.</p>	1
5	In both ovariectomized female monkeys of lot A and B a peak of LH of 16 ng/ml at day 12 and day 17 for the females that are subjected respectively at day 9 (lot A) and day 14 (lot B) to a unique injection of high dose of estradiol. However this level of LH is constantly maintained about 3 ng/ml following the injection of a continuous moderate level of estradiol. This shows that a high quantity of estradiol favors the peak of LH.	3/4
6	The ovary secretes a high concentration of estradiol (at the level of threshold) that stimulates by positive feedback the pituitary gland. Hence the peak of LH is responsible for ovulation. Moreover the follicle undergoing mature emits a stimulus, high dose of estradiol that favors its rapturing corresponding to ovulation.	3\4