

الاسم:
الرقم:مسابقة في مادة علوم الحياة
المدة: ثلاث ساعات**Exercise 1 (5 points)****Cystic Fibrosis**

Certain mutations which are at the origin of genetic diseases may protect against other diseases. In order to clarify this observation, the following studies are performed.

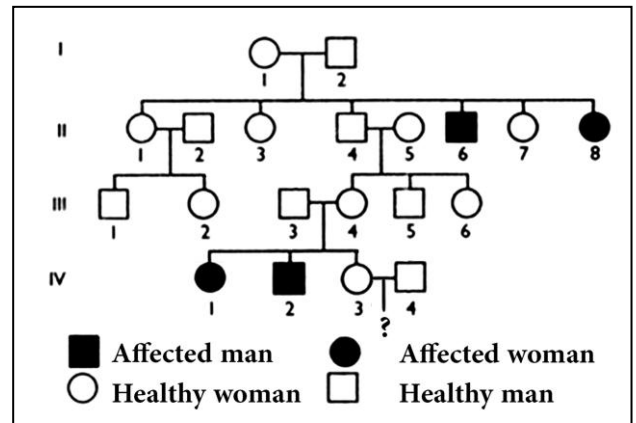
Study 1:

Cystic fibrosis is a severe disease manifested by respiratory and digestive troubles.

The origin of the disease is a mutation of the gene coding for the protein CFTR leading to the modification of amino acid 508.

The protein CFTR is present in the plasma membrane of the cells. It allows the exchange of Cl^- ions and therefore, the exchange of water. The alteration of this protein blocks the passage of the Cl^- ions and water leading to an increase in the viscosity of the mucus, particularly at the level of the lungs and the digestive tract. In a well-defined population, 1 out of 20 persons are heterozygous.

Document 1 shows the pedigree of a family whose some members are affected by cystic fibrosis.

**Document 1****1- Pick out:****1-1** The origin of cystic fibrosis.**1-2** The consequences of the mutation at the cellular level.**2-** Indicate if the allele responsible for the disease is dominant or recessive. Justify the answer.**3-** Determine the chromosomal localization of the gene responsible for cystic fibrosis.**4-** Specify the genotype of each of the individuals II8, III3, IV2 and IV3.**5-** Determine the risk for couple IV3 and IV4 to have a child affected by cystic fibrosis.**Study 2:**

Three lots of mice are genetically modified by integrating the human gene coding for CFTR protein in their genome. The mice of lot 1 are homozygous for the normal allele, the mice of lot 2 are homozygous for the mutated allele, and the mice of lot 3 are heterozygous.

Salmonella typhi bacteria have been ingested by the mice of the three lots. The number of intestinal cells infected by *Salmonella typhi* is estimated. The results are shown in document 2.

The infection by this bacterium leads to Typhoid fever which is manifested by a very serious inflammation of the digestive tract leading to death in the absence of any antibiotic treatment.

6- Justify, referring to what precedes, that some mutations which are at the origin of genetic diseases may protect against other diseases.

	Lot 1	Lot 2	Lot 3
Mice	Homozygous for the normal allele	Homozygous for the mutated allele	Heterozygous for this gene
Results	Numerous infected intestinal cells	No infected intestinal cells	Few infected intestinal cells

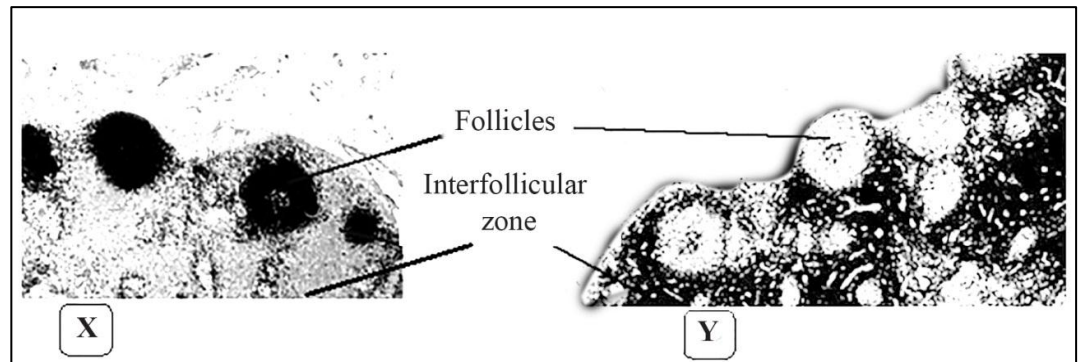
Document 2

Exercise 2 (4 points)

Hypertrophy of Lymph Nodes

A temporary hypertrophy (swelling) of the lymph nodes is observed in an individual infected by an antigen like the tetanus toxin. In order to better understand the mechanisms involved in this hypertrophy, the following experiments are performed.

Experiment 1: The constituents of the lymph nodes of this individual are studied by using radioactive markers. Microradiographs are then performed. The radioactive labeled zones appear in black on the microradiographs.



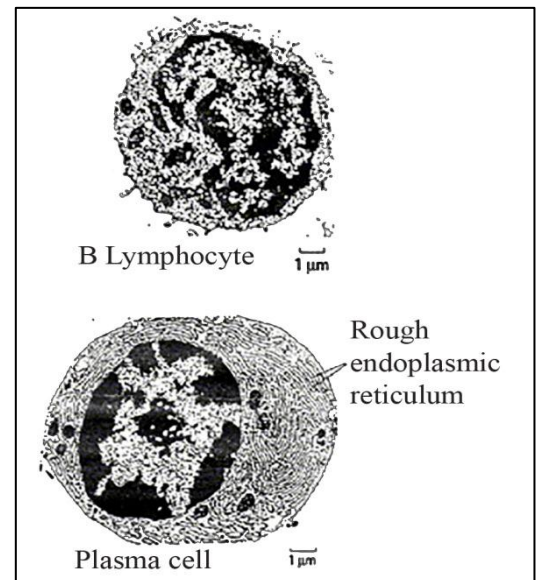
Document 1

Document 1 shows the results of labeled radioactive B lymphocytes (X) and of labeled radioactive T lymphocytes (Y).

- 1- Deduce the localization of each lymphocyte population at the level of lymph nodes.

Document 2 shows microphotographs of the cells identified in the lymph nodes of the individual who is infected with tetanus toxin.

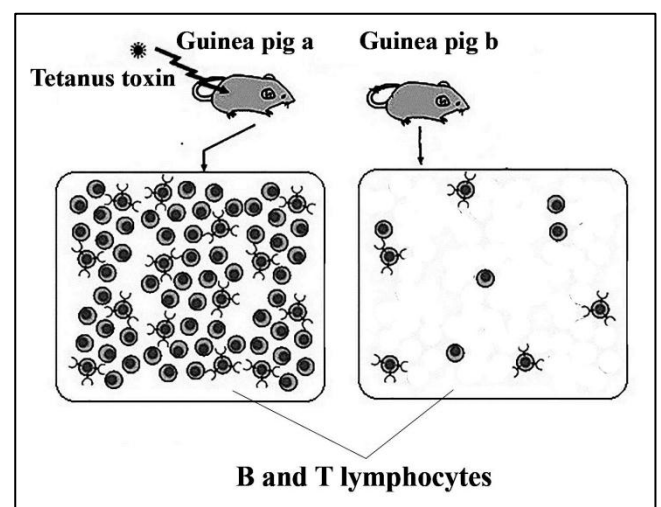
- 2- Specify the type of the immune response triggered against this antigen and revealed in document 2.
- 3- 3-1- Name the molecules secreted by this plasma cell.
3-2- Explain how the plasma cell is a cell adapted to the secretion of these molecules.



Document 2

Experiment 2: cells are extracted from the lymph nodes of a guinea-pig (a) which is injected with tetanus toxin and from the lymph nodes of a healthy guinea pig (b). They are then purified to obtain only B and T lymphocytes. The results are schematized in document 3.

- 4- Interpret the results presented in doc 3.
- 5- Justify, referring to what precedes, the temporary hypertrophy of the lymph nodes observed in this individual.
- 6- Explain the role of TL involved in the immune response revealed in document 2.



Document 3

Exercise 3 (5 points)

Effect of An Insecticide

Farmers use organophosphorous insecticides to kill insects. Some of these insecticides such as pyrethrum alter the function of the nervous system thus blocking respiration leading to death by asphyxia. In fact, the respiratory movements are ensured by contractions followed by relaxations of the respiratory muscles. In order to better understand the mode of action of pyrethrum, the following experiments are performed.

Experiment 1: the gastrocnemius muscle of a frog and the nerve connected to it are immersed in a physiological medium. An effective stimulation of intensity I is applied on this nerve in the presence and absence of pyrethrum. For each stimulation, the amplitude and the duration of the muscle contraction are recorded. The results are presented in document 1.

- 1- Represent in a table the results of document 1.
- 2- 2-1- compare the obtained results.
2-2- what can you conclude?
- 3- Formulate two hypotheses explaining the mode of action of pyrethrum.

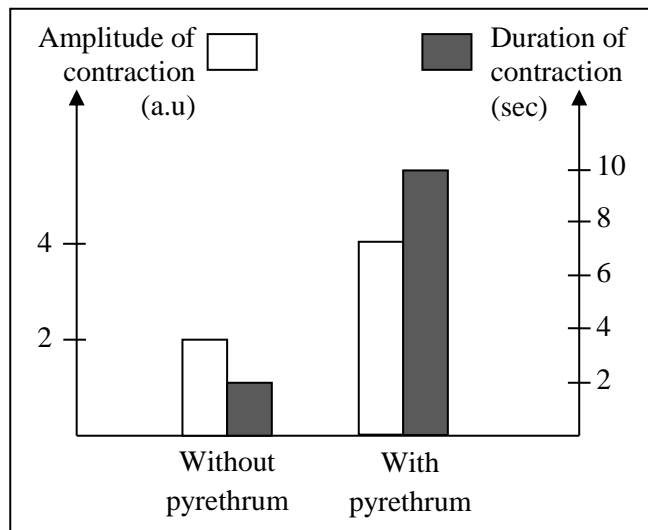
Document 2 shows the ultrastructure of the neuromuscular synapse.

- 4- Identify, which of the structures 1, 2, or 3 corresponds to the presynaptic neuron.

Experiment 2: a micro-drop of pyrethrum marked by radioactive phosphorus is injected at the level of the neuromuscular synapse. Concentrated radioactivity is observed at the level of the synaptic cleft.

Profound analyses show that the pyrethrum molecules are associated with acetylcholinesterase, an enzyme that degrades acetylcholine molecules that are fixed on the receptors of the postsynaptic membrane.

- 5- Explain, referring to what precedes, how can pyrethrum lead to death by asphyxia.



Document 1



Document 2

Exercise 4 (6 points)

What Determines the LH Peak?

The secretion of the hormone LH by the pituitary gland varies in a cyclic manner. In a woman having a 28-days cycle, the LH peak on the 13th day of the cycle triggers the ovulation of the oocyte II blocked at metaphase II. Searching for the factors that determine the LH peak, different experiments are performed on female mammals.

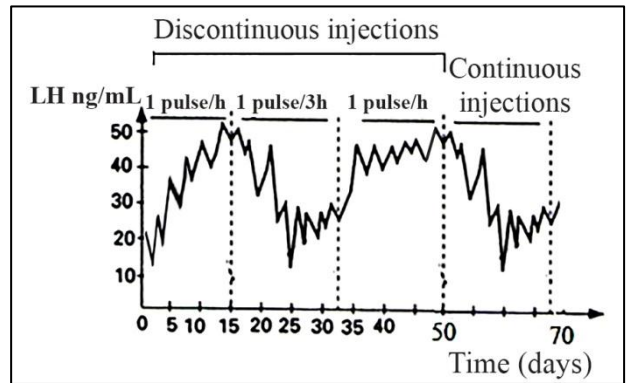
Series of experiments 1: different treatments are performed on 4 lots of adult female rats, then the level of the secreted LH is measured.

Lot 1: the female rats are not subjected to any treatment. There is secretion of LH.

Lot 2: the female rats are subjected to the lesion of the hypothalamus. There is no secretion of LH.

Lot 3: the female rats are subjected to ablation of the pituitary gland followed by the graft of the pituitary gland in the anterior chamber of the eye. There is no secretion of LH.

Lot 4: the female rats are subjected to ablation of the pituitary gland followed by the graft of this gland in an area connected to the pituitary duct. There is secretion of LH.



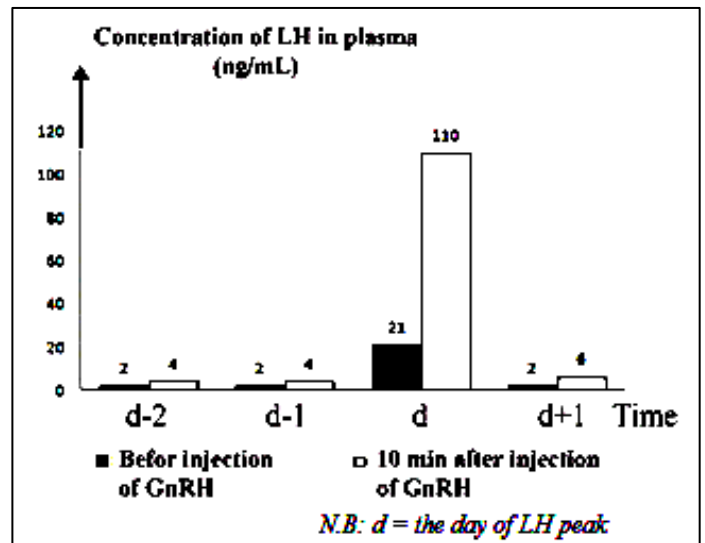
Document 1

1- Interpret the results of the series of experiments 1.

Experiment 2: In a female macaque, the arched nucleus of the hypothalamus has been destroyed and the secretions of FSH and especially of LH have dropped. This female is injected by GnRH (substance extracted from the hypothalamus) in a continuous manner and in a pulsatile manner at two different frequencies using an automatic micropump. The obtained results are represented in document 1.

2- Specify the mode of action of the hypothalamus on the pituitary gland as revealed in this experiment.

Experiment 3: female rats are injected on daily basis of the cycle at 16:00 o'clock with the same quantity of GnRH. The plasma level of LH is measured immediately before the injection and ten minutes after the injection of GnRH. The results are presented in document 2.



Document 2

3- What can you deduce concerning the sensitivity of the pituitary gland to GnRH?

Experiment 4: the same number of pituitary LH secreting cells extracted from female rats in the morning of day (d-1) is incubated in vitro. At the end of the incubation, the quantity of LH in the medium is measured. The experimental conditions as well as the results are presented in document 3.

		Pituitary cells with estradiol	Pituitary cells without estradiol
Quantity of LH (µg)	With GnRH	3.3	0.7
	Without GnRH	< 0.2	< 0.2

Document 3

- 4- Name the structures that secrete estradiol during the sexual cycle.
- 5- 5-1- Analyze the results of document 3.
5-2- What can you conclude?
- 6- Explain how the peak of LH is triggered.