

Answer the following exercises:

Exercise 1 (5 points)

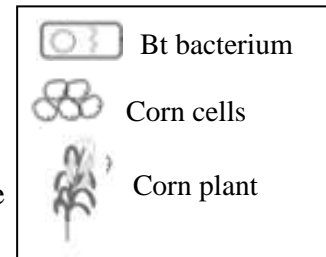
Every year, corn cultures are being attacked by a moth whose caterpillar feeds on the internal part of the corn stem and destroys it. Insecticides which are harmful to the environment are used to fight against this caterpillar. To avoid the use of these insecticides, studies were done in order to obtain a transgenic corn plant that is able to produce by itself an insecticide molecule. The technique of this production as well as its consequences on the environment is described in the adjacent document.

GMO, Solution or Problem?

In order to manufacture transgenic corn plants, a soil bacterium, *Bacillus thuringiensis* (Bt) that naturally produces an insecticide protein has been used. The gene coding for this protein has been isolated from this bacterium and introduced into the genome of corn cells. The obtained cells are able to produce the insecticide protein. The obtained corn plants, called Bt 176, resist the caterpillar attack and do not require any more the use of insecticides.

Other laboratory studies in corn fields have been carried on a non harmful caterpillar: the Monarch caterpillar. These studies have shown a slowdown in the growth of these caterpillars as function of their exposure to the pollen grains of Bt 176.

- 1- Pick out from the text the benefit of the corn Bt 176 production.
- 2- Schematize the steps of the technique of transgenic corn plants production as described in the given document using the adjacent legends.
- 3- Explain why this technique is qualified as transgenesis.
- 4- Draw out one advantage and one disadvantage of Bt 176 corn culture on the environment.



Exercise 2 (5 points)

Regulation of Calcemia

Calcium is an essential bone component that ensures its rigidity. Calcemia or the concentration of Ca^{2+} in blood maintains a constant value.

In order to understand the regulation of calcemia, the following experiments are performed.

Experiment 1

Dog A is subjected to the ablation of parathyroid glands at t_1 followed by an intravenous injection of parathyroid extracts at t_2 . The obtained results are represented in document 1.

Experiment 2

Dog B is subjected to the ablation of the thyroid gland at t_1 followed by an intravenous injection of thyroid extracts at t_2 . The obtained results are presented in document 2.

1.1- Analyze the results of each experiment.

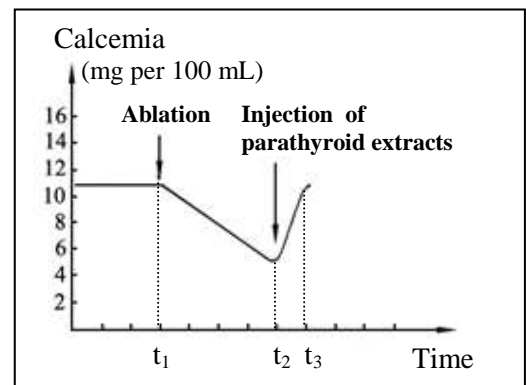
1.2- What can you conclude?

Experiment 3

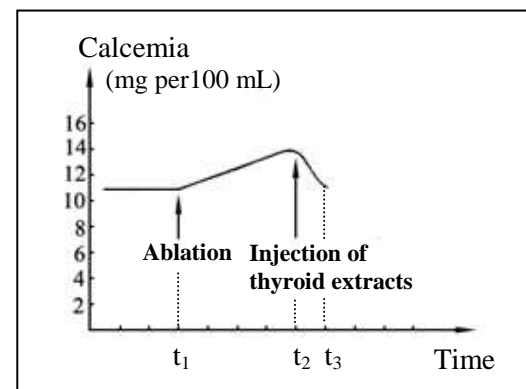
A fasting dog receives repeated injections of high quantities of parathyroid extracts; it shows an abnormal increase in calcemia followed, after a certain time, by bone fragility (decalcification) accompanied by spontaneous fractures.

2- Determine, by referring to experiment 3, the probable origin of calcium in the blood.

3- Name the thyroid hormone and indicate another role of it.



Document 1



Document 2

Exercise 3 (5 points)

Dangers of Tobacco

A statistical study performed in a certain country has shown that every year tens of thousands of individuals die from tobacco. Approximately, two thirds of these deaths occur due to cancer. Such cases of cancer provoked by tobacco occur at the level of the lungs and the higher respiratory tracts (mouth, pharynx, larynx), as well as at the level of other organs such as the urinary bladder and the pancreas. Tobacco smoke (cigarettes and narghile...) contains many carcinogenic compounds such as tar, nicotine derivatives...

Also, non-carcinogenic respiratory troubles related to tobacco consumption are the cause of thousands of supplementary deaths.

Moreover, tobacco is a major risk factor for cardiovascular diseases and is responsible for 11000 deaths per year due to these diseases. Document 1 and document 2 show the percentages of tobacco smokers as a function of age intervals and gender.

Age interval	Percentage of smokers
14-15 years	20%
16-17 years	50%
18-24 years	65%
25-34 years	50%
35-44 years	40%

Document 1

Percentage of smoker by gender	
Adult men	46%
Adult women	35%

Document 2

- Draw out from the text :
 - Two carcinogenic compounds contained in the tobacco smoke.
 - Two consequences of tobacco smoking on health other than cancer.
- Draw a histogram showing the variation of the percentage of smokers as a function of age intervals.
- Justify, by referring to documents 1 and 2, the following statement: "Heavy smokers are young adult males".
- Suggest 2 measures to be adopted by a country to fight against smoking.

Exercise 4 (5 points)

Botox and Expression Wrinkles

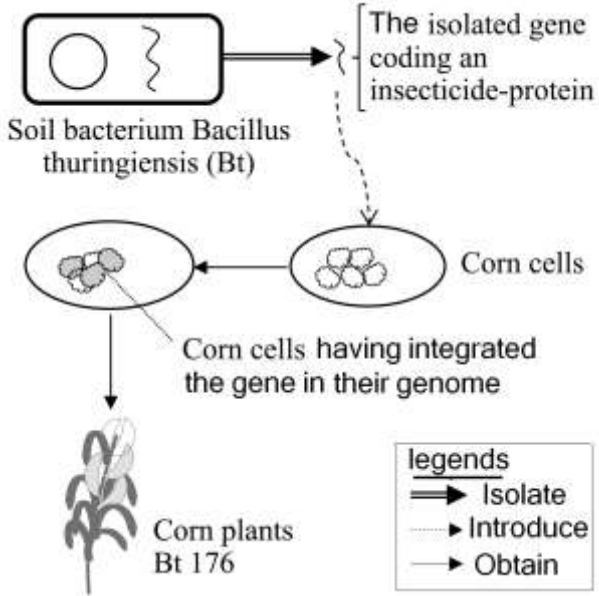
Botox is a protein extracted from *Clostridium botulinum*, a bacterium that provokes severe food intoxication which is often deadly. It is used to attenuate the expression wrinkles which are caused by muscular contraction.

When Botox is administered in very small quantities to certain facial muscles, these muscles stop receiving nervous messages that command their contraction and thus relax.

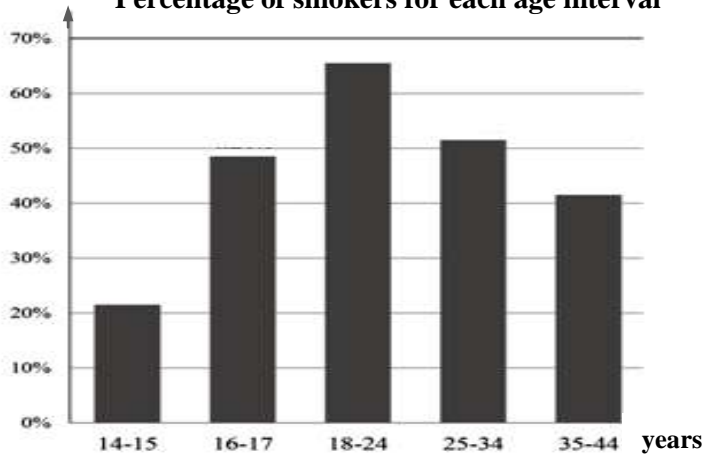
In order to determine the mode of action of Botox at the level of a neuro-muscular synapse, an effective stimulation is applied on the presynaptic neuron with or without Botox injection. The results are shown in the document below.

	Stimulation without Botox	Stimulation with Botox
Recording at the level of the neuron (E1)	AP +30 mV -70 mV 	AP +30 mV -70 mV
Response of the muscle	Contraction	No contraction
Synaptic function		

- Pick out from the text:
 - The aim of Botox use.
 - The origin of Botox.
 - The cause of expression wrinkles.
- Indicate whether this neuro-muscular synapse is excitatory or inhibitory. Justify the answer.
- List the steps of the synaptic transmission.
- Indicate the step of synaptic transmission at the level of which Botox act.
- Determine how Botox attenuates expression wrinkles.

Part	Answer key	Mark
Exercise 1		
1	The obtained cells are able to produce the insecticide protein. Or The obtained corn plants, called Bt 176, resist the caterpillar attack and do not require any more the use of insecticides.	0,5
2	Scheme of the technique used in the production of corn.  <p>The diagram illustrates the production of Bt 176 corn. It starts with a soil bacterium, <i>Bacillus thuringiensis</i> (Bt), which is isolated. From this bacterium, a gene coding for an insecticide protein is isolated. This gene is then introduced into corn cells. The corn cells that have integrated the gene into their genome are used to produce corn plants, labeled as Bt 176. A legend indicates that a solid arrow represents 'Isolate', a dashed arrow represents 'Introduce', and a solid arrow represents 'Obtain'.</p>	1,5
3	This technique is qualified as transgenesis since it consists of transferring a gene of a bacterium to another organism the corn that integrates it into its genome.	1
4	Advantage: reducing the use of insecticides that are harmful to the environment. Disadvantage: slowing down the growth of another living organism.	2

Part	Answer key	Mark
Exercise 2		
1	Calcemia decreases from 11 to 6 mg/100mL after the ablation of parathyroid. However, it increases back to its initial value after the injection of parathyroid extracts. (1 pt) Calcemia increases from 11 to 14 mg/100 mL after the ablation of the thyroid. However it decreases back to its initial value after the injection of thyroid extracts. (1 pt).	2
2	The parathyroids secrete directly into blood a substance that provokes hypercalcemia. The thyroid secretes directly into blood a substance that provokes hypocalcemia.	1
3	The parathyroids secrete into the blood substances that act on the bones provoking their decalcification and increasing the amount of calcium in the blood. Thus calcium in the blood may have an endogenous origin, calcium from bones.	1
4	Thyroxin Increases cellular oxidation or cellular metabolism.	1

Part	Answer key	Mark
	Exercise 3	
1	Two carcinogenic compounds: tar and nicotine derivatives.	0,5
2	Respiratory troubles (0.25pt). Cardiovascular diseases (0.25pt).	0,5
3	<p style="text-align: center;">Percentage of smokers for each age interval</p>  <p style="text-align: center;">Histogram showing the variation of smoker's percentages as a function of age intervals.</p>	1,5
4	The highest smoker's percentage (65%) corresponds to the age interval of 18-24 years, which means that young adults are the heavy smokers. (0.75pt) The percentage of adult male smokers 46% is higher than that of adult female smokers 35%, which means that adults' males are the heavy smokers. (0.75pt) Therefore "Heavy smokers are young adult males".	1,5
5	Launch an awareness campaign about the risks associated to smoking (0.5pt) Implement the laws that forbid smoking in public areas (0.5pt) Raise the price of cigarettes...	1

Part	Answer key	Mark
	Exercise 4	
1	1-1- It is used to attenuate the expression wrinkles (0,5 pt)	1.5
	1-2- Botox is a protein extracted from <i>Clostridium botulinum</i> (0,5pt)	
	1-3- Muscular contraction. (0,5)	
2	It's an excitatory synapse since it transmits the nervous message from the presynaptic neuron to the muscle provoking its contraction.	1
3	<ul style="list-style-type: none"> - Arrival of the nervous message through the presynaptic neuron. - Exocytosis of synaptic vesicles containing neurotransmitters. - Release of neurotransmitters into the synaptic cleft. - Binding of neurotransmitters to postsynaptic membrane receptors. - Generation of a PSP at the level of postsynaptic structure. 	1.5
4	exocytosis of synaptic vesicles containing neurotransmitters.	0.5
5	Botox blocks the transmission of the nervous message at the level of the synapse. This provokes muscular relaxation and thus attenuates the wrinkles that are due to muscular contraction.	0.5