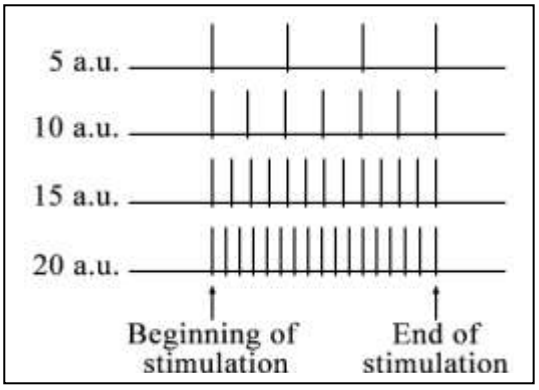
وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة فرع علوم الحياة	دورة سنة 2015 العادية الأربعاء 10 حزيران 2015

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

Answer the following exercises:

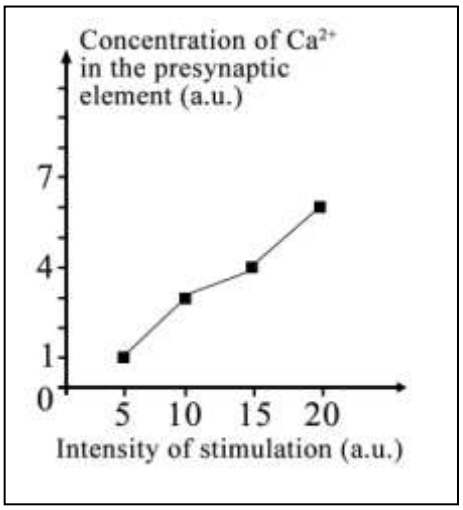
Exercise 1 (5 points) **Mode of Action of Botox**

Botulinum toxinsare at the origin of a serious disease called Botulism. This disease affects all the muscles and may lead to paralysis of the respiratory muscles thus causing death. However, these toxins are frequently used by all men and women who want to eliminate the signs of aging (anti-wrinkles treatment).This is realized by injecting these toxins "Botox" every 6 months.
In order to determine the mode of action of Botox, the following experiments are performed.



Document 1

Experiment 1: In a physiological culture medium, using an appropriate experimental set up, four effective stimulations of increasing intensities are applied on a motor neuron that innervates a skeletal muscle.
For each of the applied stimulations, a muscular contraction is observed. The frequency of action potentials at the level of the presynaptic motor neuron (doc.1), the concentration of calcium in the presynaptic terminal bud (doc.2), and the quantity of acetylcholine released in the synaptic cleft (doc.3) are measured for each of the applied stimulations.



Document 2

1- Interpret the obtained results in document 1.
2- Draw the curve that showsthe variation of the quantity of acetylcholine as a function of the intensity of stimulation.
3- Specify the type of coding ofthe nervous message that is revealed by each of the documents 2 and 3.

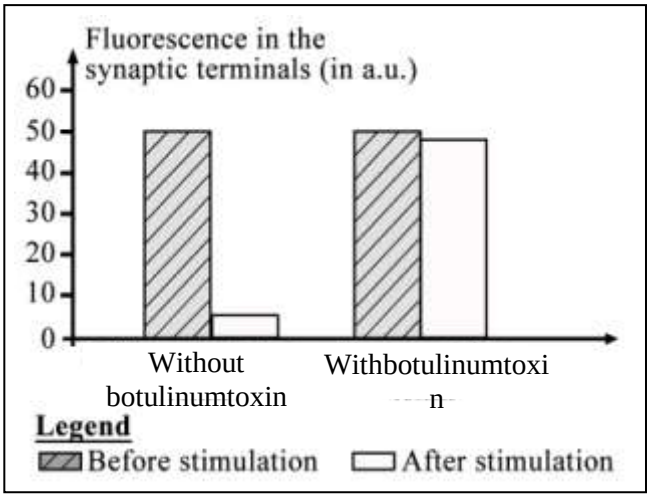
Experiment 2: Botox is added to the culture medium of the experimental set up of experiment 1. The same stimulations as well as the same measurements are repeated. Same results as those of experiment 1 are obtained except for the quantity of the released acetylcholine. In addition, no muscular contraction is observed for the 4 intensities of stimulation.

Intensity of stimulation (a.u.)	Quantity of released acetylcholine (a.u.)
5	30
10	40
15	50
20	60

Document 3

4- Formulate a hypothesis explaining the mode of action of Botox on the transmission of the nervous message.

Experiment 3: The presynaptic vesicles of the motor neuron of a frog are labeledby a fluorescent dye. This neuron is placed in a medium with or without botulinum toxin. The intensity of fluorescence inside the presynaptic bud is measured before and after stimulating this neuron. The results are presented in document 4.



Document 4

5- Determine, referring to experiment 3, the quantity of acetylcholine that should be released in experiment 2.
6- Explain how Botox eliminates the signs of aging without causing death by intoxication.

Exercise 2(5 points) **Role of the Liver in GlycemiaRegulation**

Glycemia is a physiological constancy. To better understand how it isregulated, the following studies arecarried out.

↓ ingestion of glucose

Time (in min)	0	60	90	120
Glycemia (in g/L) of individual X	0.8	1.7	1.3	0.9

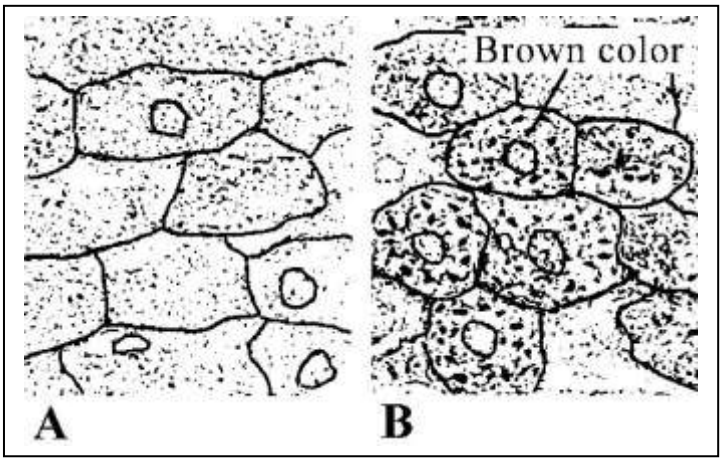
Document 1

Time	T0	T1	T2	T3
Glycemia (in g/L) of individual Y	1	0.9	0.7	0.8

Document 2

Clinical observations: Glycemiais measured as function of time in two healthy individuals X and Y. Individual X who was fastingingests 50 g of glucose at time 0 minute; his glycemiais then monitored during the two hours that follow the ingestion (document 1).
The glycemia of individual Y is monitored starting from the beginning of his fast at T0 and during the two days that follow (document2).

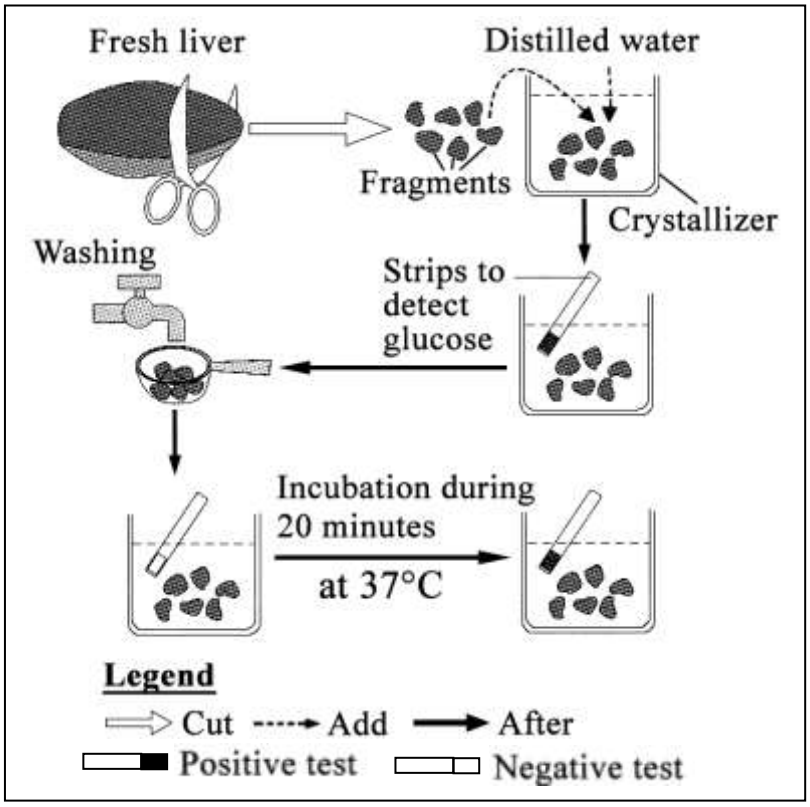
1- **1-1-** Analyze the results of each of the documents 1 and 2.
1-2- What can you conclude?



Document 3

Histological observations: Document 3 shows histological sections (x1000) of the liver of an animal at two different times. They are colored by adye that gives a brown color in the presence of glycogen. Section A was done on the liver of an animal fasting since 48h. Section B was done on the liver of the same animal after being fed recently with a meal rich in glucose.

2- Determine the role of the liver revealed by the histological sections.



Document 4

Experiment 1: An experiment inspired by the historical experiment of the washed liver is performed.The experimental procedureand the obtained results are presented in document 4.

3- Describe the experiment illustrated in document 4.

Experiment 2: Experiment 1 is repeated with a final incubationin distilled water containing traces of insulin. The result of the glucose detection test remains negative.

Experiment 3: Experiment 1 is repeated with a final incubationin distilled water containing traces ofglucagon. After only five minutes,the result of the glucose detection test becomes positive.

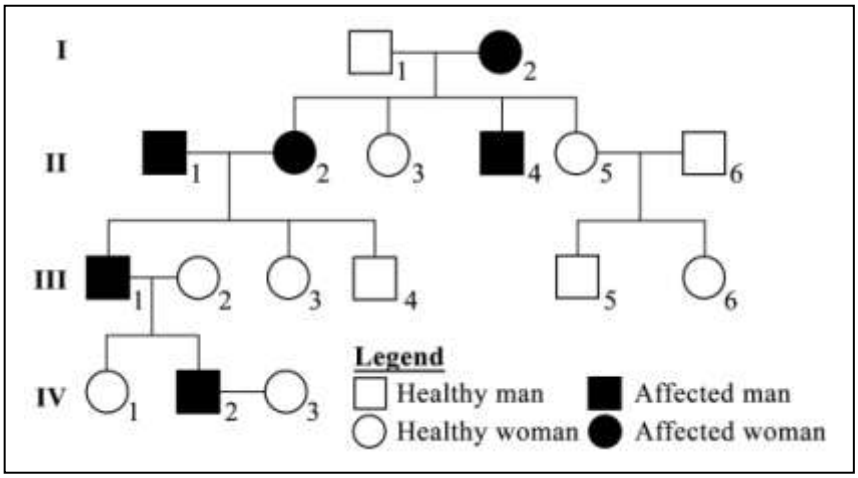
4- Show, by referring to the 3 experiments, that glycogenolysis is modulated by the action of hormones.

5- Explain, taking into considerationall what preceded, the results obtained in documents 1 and 2.

Exercise 3 (5 points) **Huntington Chorea**

Huntington Chorea is a serious neurodegenerative hereditary disease. Its first symptoms appear in adults starting fromthe age of 25 years.
We seek to determine the mode of transmission of this disease as well as its origin.

Document 1 shows the pedigree of a family whose certain members are affected by this disease.



Document 1

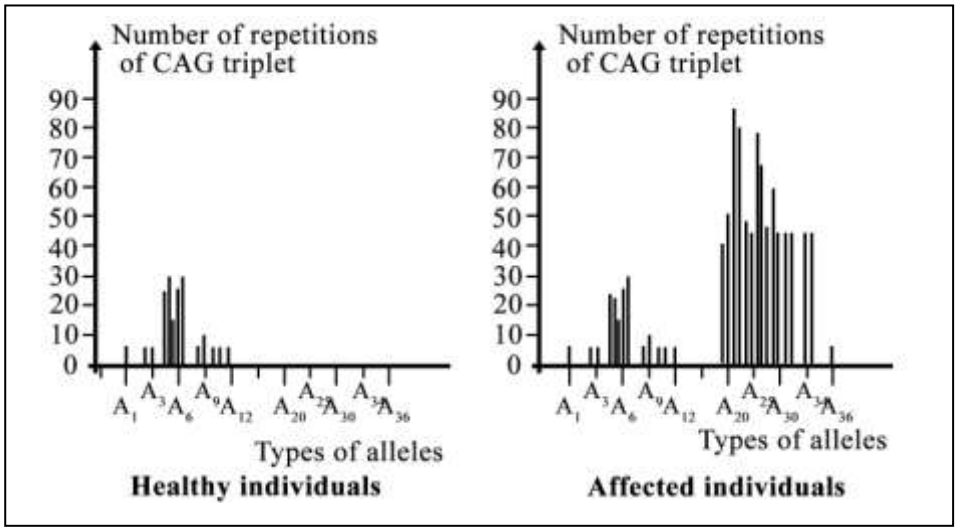
1- Indicate whether the allele determining this disease is dominant or recessive. Justify the answer.

2- Determine the localizationof the gene responsible for this disease.

All the members of this family are over 25 years oldexcept individuals III3 and III5. The latter are willing to get married but are afraid of being affected by this disease.

3- Determine the risk for each of individuals III3 and III5 to be affected by this disease.

Studies have shown that the gene coding for the functional protein, huntingtin, exists in many allelic forms that differ by the number of CAGtriplets. The number of repetitions of CAG triplet in each allele is studied in healthy individuals as well as in affected ones. The obtained results are presented in document 2.



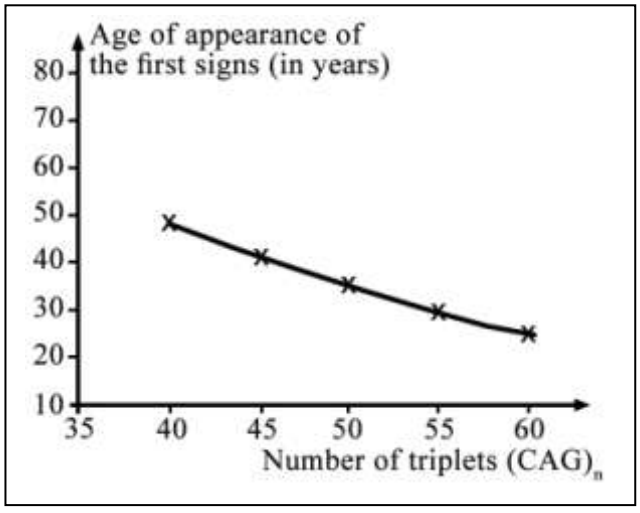
Document 2

4- Deduce,based on the statistical results of document 2, the origin of this disease.

The analysis of the genein woman III3 has revealed that she possesses two alleles.The number of repetitions of CAG in one of them is 10 andin the other it is 15.

5- Specify the real genotype of this woman.

A statistical studyhas been performed concerning the age of appearance of this disease in function of the number of CAGtriplets. The obtained results are shown in document 3.



Document 3

6- 6-1-Analyze the obtained results.
6-2- Conclude the factor that determines the age of appearance of this disease.

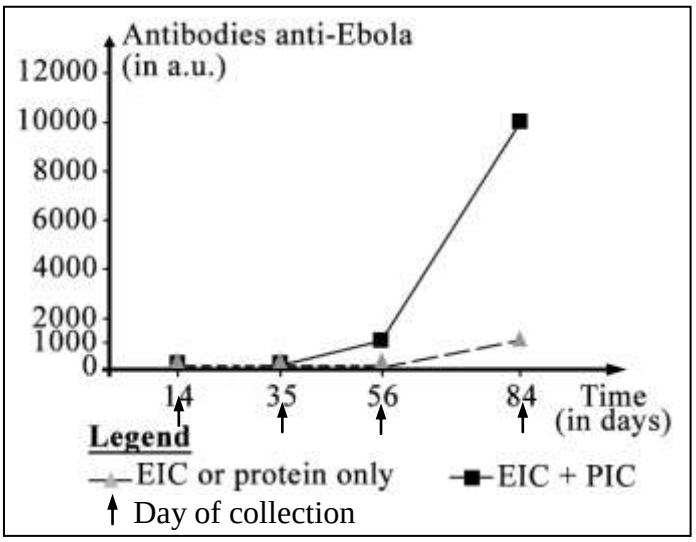
Exercise 4 (5 points) **Fight Against Ebola**

Ebola isa very contagious and fatal virus that causes hemorrhagic fever. It is transmitted through blood, saliva,feces as well as through sexual contacts.
Infected individuals who survived, show firsta high amount of specific anti-Ebolaantibodies, followed by the disappearance of the virus with an important increase in specific cytotoxic TL (TcL).

1- Identify the immune response(s) triggered against Ebola.

In order to develop fighting or therapeutic modalities against this disease, researchers performedexperiments that are described below.

- In December 2011, researchers developed a vaccine. They isolated a surface protein of the virus and injected it to a first lot of mice. To a second lot, they injected the same protein in the form of immune complexes called EIC (Ebola Immune Complexes). To a third lot they injected the EIC anda substance,the PIC. The injections are repeated four times for each lot. Two weeks after each injection, serum is collected from the mice and the antibodies amounts were measured. The obtained results are presented in document 1.



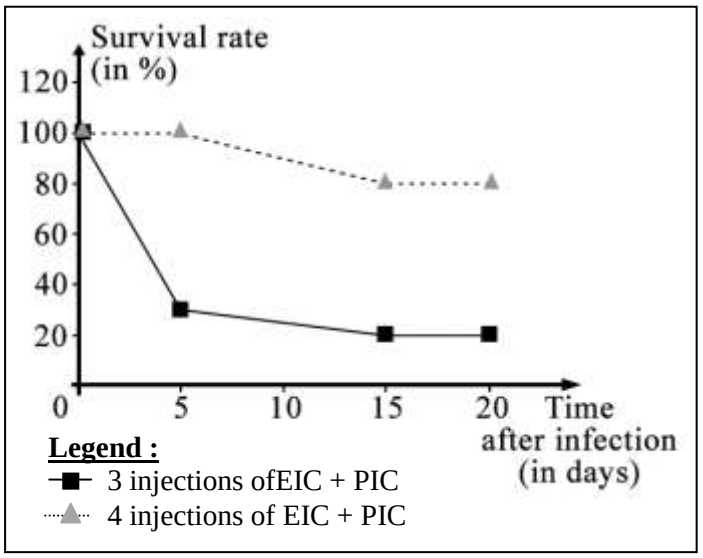
Document 1

2- Determine the most efficient vaccine against Ebola.

The molecule PIC is agonist to proteins that are indispensable for phagocytosis.

3- Indicate the roles and the moments wheremacrophages intervene in the specific immune response triggered against Ebola.

Two lots of micehave beenvaccinated using the mixture EIC+PIC, the first lot received three boosters for the vaccine and the second received four boosters. After that both lots were contaminated by Ebola virus. The results concerning the survival of the mice are presented in document 2.



Document 2

4- Deduce one condition for the vaccination against Ebola to be successful.

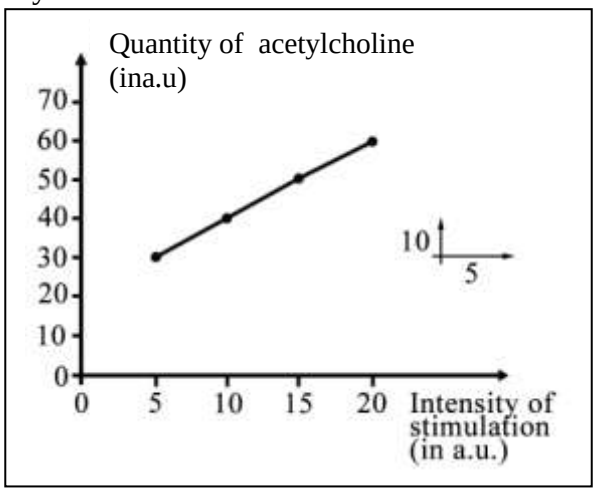
- In June 2012, Canadian researchers performed the following experiment: two lots of monkeys, infected by the Ebola virus, received a mixture of three antibodies specific to particular epitopes of the virus. The obtained results are presented in document 3.

Lots of monkeys	Performed treatment	Number of monkeys	Number of surviving monkeys
A	Infection by the virus then injection of antibodies 24 hours after infection	4	4
B	Infection by the virus then injection of antibodies 48 hours after infection	4	2

Document 3

5- Explain theobtained results.

6- Distinguish serotherapy from vaccination concerning: the nature of the injected substance, the latency period and the duration of the protection established against Ebola.

Part of the ex	Exercise 1 **Mode of Action of Botox**	Grade 5 pts
1	The recording obtained at the level of the axon of the presynaptic neuron of document 1shows APsof same amplitude. However, the frequency of AP increases from 4 APs to 17 when the intensity of the stimulation increases from 5 a.u.to 20 a.u. This shows that the response of the axon is modulated by the frequency of APas function of the intensity of stimulation.	**1/2**
2	Curve showing the variation of the quantity of acetylcholine as a function of the intensity of stimulation.  	**1**
3	At the level of the presynaptic neuron, the nervous message is modulated by the concentration of calcium as function of the intensity of stimulation, since document 2 shows that the concentration of calcium in the presynaptic element increases from 1 a.u. to 6 a.u when the intensity of stimulation increases from 5 a.uto 20 a.u. At the level of the synapse, the nervous message is modulated by the concentration of the releasedacetylcholine as function of the intensity of stimulation, since document 3 shows that the quantity of acetylcholine released increases from 30 a.u to 60 a.u when the stimulation intensity increases from 5a.u to 20 a.u.	**1**
4	Hypothesis: Botox inhibits the synthesis of Acetylcholine. Botox inhibits the exocytosis of Acetylcholine. Botox neutralizes Acetylcholine. Botox blocks the postsynaptic receptors.	**1/2**
5	The fluorescence in the presynaptic bud decreases from 50 a.u before stimulation to 5 a.u after stimulationin a medium without Botulinum toxin. However, in a medium containing Botulinum toxin, it remains almost constant at 50 a.u before and after stimulation. Thus, Botox blocks the release of neurotransmitters by exocytosis of the the presynaptic vesicles. Hence, in medium containingBotox, thequantity of releasedacetylcholine should be null.	**1**
6	Botox blocks the transmission of the nervous message at the level of neuromuscular synapses by blocking the release of acetylcholine. Thus preventing the permanent muscular contractions that are responsible for the signs of aging. WhenBotox is injected in small doses,its action will belimited on the treated zone.However, when it is used in high doses, its action is generalized on other muscles especially respiratory oneswhich will be permanently relaxed leading to death by asphyxia.	½ ½

Part of the exercise	Exercise 2 **Role of the Liver in Glycemia Regulation**	Grade 5 pts
1.1	In individual X who was fasting, glycemia increases, following the ingestion of 50g of glucose, from 0.8 g/L at t= 0 min to 1.7 g/L at t= 60 min, while it decreases to0.9 g/L between60min and 120 min. In individual Y who is fasting, glycemia decreases from 1 g/L to 0.7 g/l between from T0 and T2 while it increases slightly to 0.8 g/l atT3.	¼ ¼
1.2	The body is provided with a system of regulation able to correct hypoglycemia or hyperglycemia.	**1/2**
2	We observe brown color indicating the presence of glycogen only in section B done on the liver aftera meal rich in glucose. This shows that the liver stores glucose in the form of glycogen.	**1/2**
3	The fresh liver is cut into fragments, and then added into a crystallizer containing distilled water. After that a strip to detect glucose is introduced, the test is positive. After that the liver fragments are washed. After that the washed fragments are put in in a crystallizer and a strip to detect glucose is introduced, the test is negative. After incubation during 20 minutes at 37°C, a strip to detect glucose is introduced, the test is positive.	**1**
4	The glucose test becomes positive after the incubation of the washed liver fragments for 20 minutes. This shows that the liver releases glucose. On the contrary, the test remains negative when incubation is performed with insulin. This shows that insulin blocks the release of glucose byinhibitingglycogenolysis. The test becomes positive when incubation is performed withglucagon and this occurs only within 5 minutes, time that is less than the 20 minutes necessary to obtain a positive test in the medium containing only distilled water. This shows that glucagon accelerates the release of glucose; hence, it promotesglycogenolysis. So, glycogenolysis which is performed by the liver and which ensures the release of glucose is inhibited by insulin and promoted by glucagon. Knowing that insulin and glucagon are two hormones, soglycogenolysis is modulated by the action of these hormones, insulin and glucagon.	½ ½ ½
5	Document 1 shows that the ingestion of glucose provokes hyperglycemia between t=0 min and t= 60 min. Which stimulates the secretion of insulin by ß cells of the islets of Langerhans of the pancreas. This hormone stimulates hepatic glycogenesis (storage of glucose in the form of glycogen) and inhibits glycogenolysis leading to a decrease in glycemiaat t=120min Fasting doesn't allow anyexogeneous supply of glucose while glucose is constantly used by the body cells. Thus, glycemia decreases between T0 and T1 (document 1). This decrease stimulates the αcells of the islet of Langerhans to secrete glucagon. The latter stimulates hepaticglycogenolysis(releaseof glucose from the stored glycogen). This maintains a normal almost constant level of glycemia close to its initial value starting from T3.	½ ½

Part of the exercise	Exercise 3 Huntington Chorea	Grade 5 pts
1	The allele of the disease is dominant with respect to the healthy allele, since normal children III3 and III4 have affected parents II1 and II2. Thus the normal allele is carried at least by one of the parents and masked by the allele of the disease. Let H be the symbol of the dominant allele of the disease and nthe symbol of the recessive normal allele.	**1/2**
2	If the allele is carried on the non-homologous segment of the chromosome Y, the disease would be transmitted from father to son, but the affected son II4 has a healthy father I1. Thus the gene is not carried on the non-homologous segment of the chromosome Y. If the gene is carried by the non-homologous segment of the chromosome X, the healthy girl IV1 must be homozygous of genotype Xn//Xn; she should have inherited thenormal allele from her father III1who should be healthy of genotype Xn//Y . But her father is affected. Thus the gene is not carried by non-homologous segment of X. If the gene is carried by the homologous segments of X and Y, healthy girl III3should have inheritedXn from her father II1; the healthy boy III4 should have inherited Yn from his father II1. Father II 1 should be healthy of genotype XnYn which is not the case (II1 is affected) . thus the gene is not carried by the homologous segments of X and Y. Therefore, the gene is carried by an autosome.	¼ ¼ ¼ ¼
3	The mother II2 is affected by the disease and is heterozygous since she inherited the allele H from her mother and the allele n from her homozygous healthy father who produces only one type of gametes having the allele n. Thus she produces two types of gametes of equal probabilities: ½ H and ½ n. The affected father II1is heterozygous since he already has a healthy homozygous son III4 to whom he must have transmitted the recessive allele n. Thus he produces two types of gametes equal probabilities: ½ H and ½ n. Since the affected allele of the disease is dominant; it is sufficient for III3 to have at least one allele of the disease in order to be affected . The genotype of III3 can be either H//H ¼ or H//n ½ . Thus the risk for III3 to be affected is 3/4 of the children. Couple II5- II6 is healthy and recessivity is a criterion of purity. These parents produce only one type of gametes carrying the normal allele n. Thus all their children will be healthy. Therefore the risk for III5vto be affected is null.	½ ½
4	In healthy individuals, the number of repetitions of CAG varies between 8 and 30 for the types of alleles A1 till A12. Thus these alleles are associated to the normal phenotype.However, affected individuals present two groups of alleles: the first is identical to that present in healthy individuals with a number of repetitions of CAG between 8 and 30. The second group corresponds to alleles having a number of repetitions of CAG between 39 and 70. Thus these alleles which have a number of repetitions of CAG higher than 39 are associated to the disease. The origin of the disease is the high number of repetitions of CAG greater than 39	**1**
5	The real genotype of III3 is n//n or A_6//A_9. Since she has two alleles with a number of repetitions CAG that is respectively 10 and 15 which is less than 30 repetitions and thus correspond to the group of alleles of healthy individuals. These two alleles are among the ones that determine the normal phenotype.	¾
6-1	The average age of appearance of the disease decreases from 49 years to 25 years, when the number of repetitions of CAG triplet increases from 40 to 60.	½
6-2	The factor determining the age of appearance of the disease is the high number of repetitions per allele(>40).	¼

Part of the exercise	Exercise4 **Fight against Ebola**	Grade 5 pts
1	A humoral specific immune response is triggered, since in case of Ebola the surviving individuals have a high amount of anti-Ebolaantibodies that are released by plasma cells that are the effectors of humoral specific immune response. A cell- mediated specific immune response is triggered, since the surviving individualsshow an important increase in the specific TcL which are the effectors of the cell mediated specific immune response.	½ ½
2	The amount of anti-Ebola antibodies is nil and remains constant on the 14th and 35th day, after the first and the second injection of the three types of vaccine. After the 3rd injection of vaccine, this amount increases to 1000 a.u on the 56th day in individuals having received EIC + PIC, while its remains constant and nil in individuals having received the vaccine EIC or only the protein. This amount of antibodies increases in the three lots to reach 10000 a.u on the 84th dayin individuals having received the vaccine EIC+PIC which is 10 times higher than the 1000a.u obtained when only the vaccine EIC or only the protein is administrated. This shows that the vaccine EIC+PIC is the most effective.	**3/4**
3	At the beginning of the specific immune response, macrophages act as antigen presenting cells which induce the specific immune response. At the end of the specific humoral immune response, they perform phagocytosis of the immune complex in order to eliminate antigens.	**1**
4	Between day 0 and day 20, the percentage of survival decreases from 100% to 80% in the lot receiving 4 injections.This decrease is 4 times more significant than that obtained in the lot receiving only 3 injections which reaches 20 %. Thus, the condition for the vaccination against Ebola to be successful is to give 4 boosters.	**1/2**
5	The antibodies injected after 24 hours neutralize the antigen and slow down efficiently the propagation of virus which allows the body defenses to react and protect allthe monkeys (4/4) which remain alive. However, when the injection is delayed to 48 hours, the viruses multiply more rapidly than the lymphocytes involved in the specific immune response and infect a great number of cells before being neutralized by the specific injected antibodies. This reduces the efficiency of the body defense and sometimes renders it insufficient. This explains the death of two out of the four infected monkeys.	**1**
6	In serotherapy, the injected substances are the specific antibodies while in vaccination, the injected substances are viral or antigenic proteins. In serotherapy, the latency time is null while in vaccination, the latency time is 2 weeks In serotherapy, the duration of protection time is short while in vaccination, the protection is more durable.	¼ ¼ ¼