وزارة التربية والتعليم العالي
المديرية العامة للتربية
دائرة الامتحانات

امتحانات الشهادة الثانوية العامة
فرع علوم الحياة

دورة سنة ٢٠٠٦ الاكمالية الاستثنائية

مسابقة في "علوم الحياة"
المدة : ثلاث ساعات

الاسم :
الرقم :

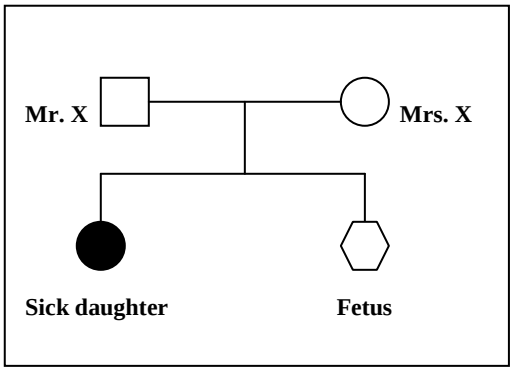
Answer the following questions.

Question I (5 pts)

Mr. and Mrs. X have a daughter suffering from sickle cell anemia, document 1. This hereditary sickness, whose mode of transmission is autosomal recessive, is characterized by an abnormality in the β-globin molecule which leads to the deformation of the red blood cells. Mrs. X is pregnant and the couple demand prenatal diagnosis to know if their second child will be affected by sickle cell anemia.

a- Indicate the genotype of Mr. and Mrs. X and that of their daughter. Justify the answer.

b- Based on logical reasoning, find the probability for this couple to have an affected child.



Document 1

Document 2 reveals the sequences of parts of the non-transcribed strands of the β-globin alleles: HbA is the normal allele while HbS is the mutant allele of the β-globin gene responsible for sickle cell anemia. A direct diagnostic method by radioactive probe is done for this family. Many copies of the parts of the β-globin gene can be obtained from the DNA of each person by this technique. These copies are separated in two lots, and each lot is placed in the presence of a different radioactive probe, document 3; each probe is capable to bind with either allele HbA or HbS. The results of autoradiography are shown in document 4.

Position of the nucleotide	**1 10 20**
HbA	**CTCCTGAGGAGAAGTCTGCC**
HbS	**CTCCTGTGGAGAAGTCTGCC**

Document 2

Probe n°1	**GAGGACACCTCTTCAGACGG**
Probe n°2	**GAGGACTCCTCTTCAGACGG**

***Document* 3**

	Mr. X	**Mrs. X**	**Daughter**	**Fetus**
Probe n°1				
Probe n°2	[redacted]	[redacted]	[redacted]	

Document 4

[redacted] [redacted] [redacted]

c- Specify, based on document 2, the location of the mutation and its type. Justify the answer.

d- Determine, in reference to documents 2 and 3, which allele corresponds to each probe used.

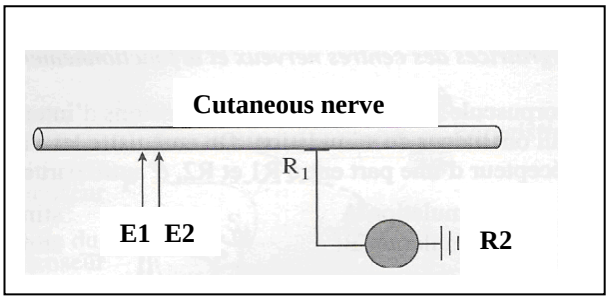
e- Do the results of document 4 confirm the genotypes you have indicated in question a? Justify the answer. Draw out the genotype and the phenotype of the fetus.

f- Justify why prenatal diagnosis is more accurate than a pedigree in detecting a genetic disease.

Question II (3 ½ pts)

In the framework of studying the electric activity of a mammalian nerve, we establish the experimental set-up shown in document 1. E1 and E2 are stimulating electrodes while R1 and R2, which are placed far from E1 and E2, are recording electrodes. R1 is placed on the surface of the nerve and R2 is connected to a fixed potential.

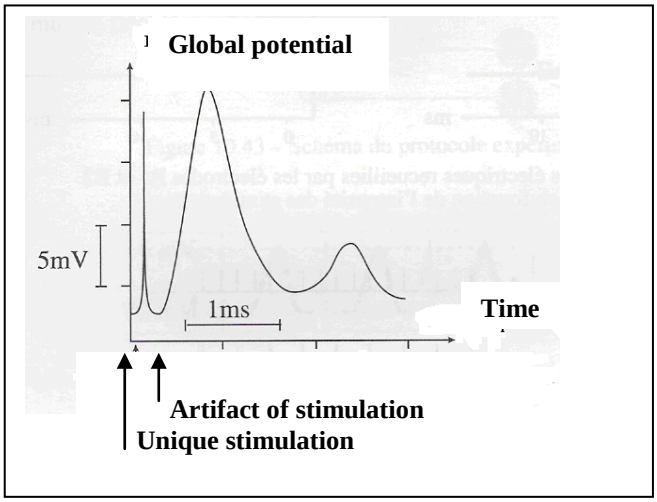
By the help of E1 and E2, we apply a unique stimulus on the nerve, of intensity above threshold. The response of the nerve to this stimulus is shown in document 2, where the curve shows two successive global potentials instead of one global potential.



Document 1

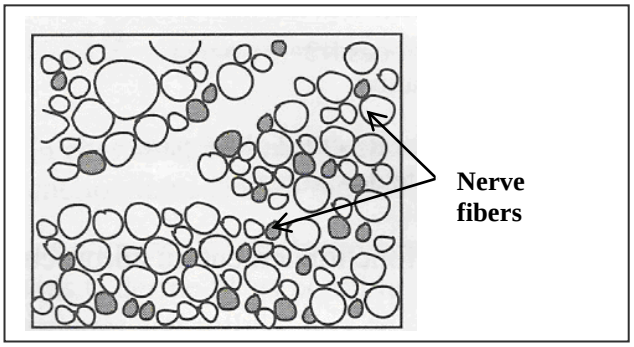
a- Draw out the problem, which arises in this study.

b- Formulate a hypothesis that explains the obtained recording.

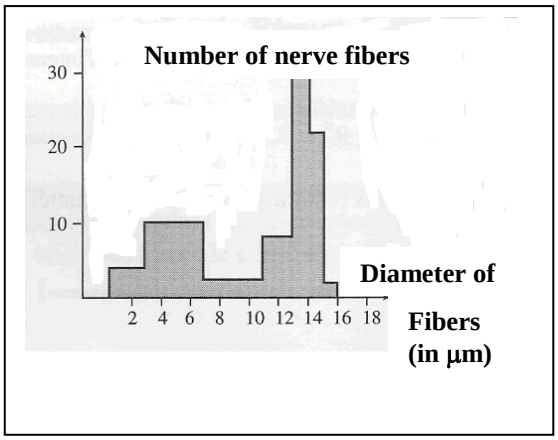


Document 2

To verify the formulated hypothesis, studies are done on this nerve whose results are shown in documents 3, 4, and 5.



Document 3: Transverse section done at the level of the nerve



Document 4: Distribution of the nerve fibers according to their diameters

The speed of propagation of the action potential is 50 meters per second in the nerve fibers having a diameter around 14 µm; and is10 meters per second in the nerve fibers having a diameter around 4µm.

Document 5

c- Is the hypothesis that you have formulated validated? Justify the answer in reference to documents 3, 4, and 5.

d- To what can you attribute the difference in the amplitude between the two global potentials obtained?

Question III (4 pts)

For determining the relation between the T4 lymphocytes and the T8 lymphocytes, also called cytotoxic T lymphocytes (Tc), we perform the following experiments:

• We remove from the spleen of a mouse, immune cells and we culture them in different mediums, document 1. We add to the culture mediums infected cells taken from an infected mouse of the same species. We detect cytotoxicity from the infected cells that are destroyed by the immune cells present in the mediums, document 2.

Medium 1	**Immune cells in serum**
Medium 2	**Immune cells in a medium that leads to the elimination of T4 lymphocytes**
Medium 3	**Immune cells in a medium that leads to the elimination of T8 lymphocytes**

Document 1

Experiment 1	**Immune cells removed from medium 1 + infected cells from a mouse of the same species**	**Presence of cytotoxicity**
Experiment 2	**Immune cells removed from medium 2 + infected cells of a mouse of the same species**	**Absence of cytotoxicity**
Experiment 3	**Immune cells removed from medium 3 + infected cells from a mouse of the same species**	**Absence of cytotoxicity**
Experiment 4	**Immune cells removed from mediums 2 and 3 + infected cells from a mouse of the same species**	**Presence of cytotoxicity**

Document 2

a- Interpret the experiments done. What can you deduce concerning the condition for the appearance of cytotoxicity in a medium?

• The following microscopic observations reveal the mode of action of Tc lymphocytes in the presence of infected cells.

1st observation: In the presence of infected cells, the Tc lymphocytes that are rich in granules containing perforin, come in contact with these cells, document 3.

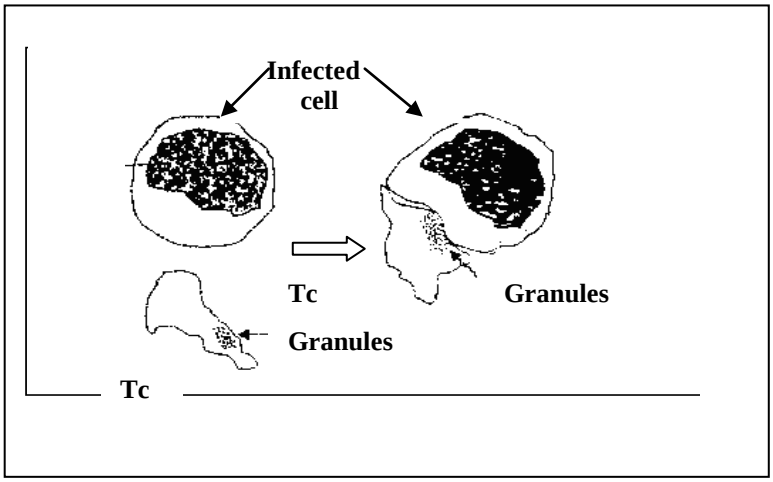
2nd observation: In the presence of non-infected cells, the Tc lymphocytes do not reveal granules containing perforin in their cytoplasm, and do not come in contact with these cells.

3rd observation: The membrane of the infected cells shows many pores in the region of contact with the Tc lymphocytes.

4th observation: In some mutant mice the Tc lymphocytes present a deficiency in perforin. No pores are observed at the level of the membrane of the infected cells in the region of contact with Tc lymphocytes, and the consequence is the non-destruction of the infected cells**.**

b- Draw out from the analysis of the microscopic observations the role of perforin in the destruction of infected cells.

c- From what has been preceded and based on the acquired knowledge, explain how the T8 lymphocytes become active cytotoxic T lymphocytes and how do they destroy the target cells.



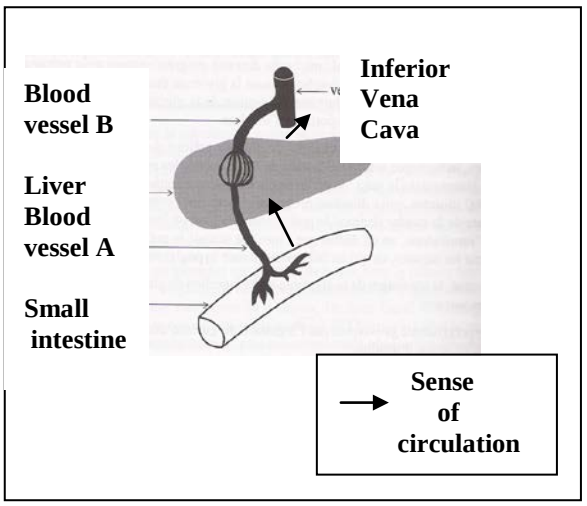
Document 3

Question IV (7 ½ pts)

In the framework of studying the regulation of glycemia in the human body, we measure the amount of glucose in the blood of two blood vessels A and B before and after a meal given at 12 O'clock. The results are shown in document 1.

Document 2 reveals the connection between the small intestine and the liver. The two blood vessels A and B, and the sense of blood circulation at this level are also shown in the document.

Document 1



Document 2

a- Construct one table that includes the different values shown in document 1.
b- Interpret the obtained results. Deduce the role of the liver.
c- Name, each of the two blood vessels A and B.

We measure the variation of glycemia and the concentrations of pancreatic hormones: insulin and glucagon in the blood of 10 persons during fasting for 3 days. We start measuring the amounts one day before fasting. The results are shown in document 3.

	24 hrs. before fasting	Beginning of fasting	24 hrs.	48 hrs.	72 hrs.
Glycemia (in $mg.dL^{-1}$)	**89**	**86**	**78**	**72**	**70**
Glucagon (in $mU.mL^{-1}$)	**126**	**126**	**157**	**189**	**190**
Insulin (in $pg.mL^{-1}$)	**9**	**10**	**5**	**4**	**3**

Document 3

d- Construct, on the same graph, the two curves that represent the variations of the concentrations of glucagon and insulin secreted as a function of time.
e- Interpret the results shown in document 3. What can you deduce concerning the hormonal secretion of the pancreas?
f- From what has been preceded, explain how glycemia regulation takes place after intestinal absorption of nutrients and during fasting.

مسابقة في "علوم الحياة"
أسس التصحيح

الاسم :
الرقم :

Question I (5 pts)

a- **N** is the symbol of Normal and **s** is the symbol of the sickled.
Mr, and Mrs. X: N//s **(¼ pt).** They have normal phenotype but have a sick child, the parents carry the allele of the sickness which is masked.**(¼ pt)**
The daughter: ss **(¼ pt)** having sickle cell anemia, a recessive sickness cannot appear unless when it is pure. **(¼ pt)**

b- Both parents are heterozygotes, since half of their gametes have the sick allele s
The probability for this couple to have sick children is 1/2 x 1/2 = 1/4 **(½ pt)**

c- The mutation is located on position 7. It is a mutation by substitution because the two alleles of the β-globin gene have the same sequence of nucleotides but differ at position 7 where adenine is replaced by thymine. **(1 pt)**

d- The radioactive probe binds to the part of the alleles by complementing with the nitrogenous bases.

Probe n°1: **GAGGACACCTCTTCAGACGG**
Complementary DNA : **CTCCTGTGGAGAAGTCTGCC**

This DNA is that of HbS, thus, probe 1 permits visualizing the mutant allele while probe 2 permits visualizing the normal allele **(1 pt)**

e- Yes, in the two parents the two probes are visualized, which confirms that the parents are heterozygotes of a genotype Ns **(¼ pt).** With respect to the daughter we visualize only probe 1 that corresponds to the mutant allele, which confirms that she has the genotype ss **(¼ pt).** The DNA of the fetus does not permit to visualize except probe 2, which corresponds to the allele N, thus, the fetus has the genotype NN and he has a normal phenotype **(½ pt)**.

f- Prenatal diagnosis is more accurate because it depends on the gene itself and gives the real genotype of the concerned person. On the other hand, the pedigree permits to detect the phenotype and the possible genotype **(½ pt)**

Question II (3 ½ pts)

a- Why does the recording present two global potentials in response to a unique stimulus? **(½ pt)**

b- Hypothesis: The nerve is constituted of two lots of nerve fibers of different diameters. **(½ pt)**
Or : The nerve is constituted of two lots of nerve fibers of different nature.

c- Yes (or no). Document 3 reveals that the nerve is constituted of many nerve fibers and that these nerve fibers are of different diameters. Document 4, confirms the information of document 3 and reveals the presence of two lots of nerve fibers in the nerve. Document 5 indicates that nerve fibers of big diameters favor a more rapid propagation of action potential which leads to the appearance of two global potentials spaced by around 1 ms. **(1 ½ pt)**

d- The amplitude of the response of the nerve depends on the number of the stimulated nerve fibers, since the number of the nerve fibers of 14 μm in diameter (30) is greater than the number of the nerve fibers of 4 μm in diameter (10), then the first global potential recorded is the result of the activity of all the nerve fibers of diameter 14 μm and the second global potential recorded corresponds to the nerve fibers of 4 μm in diameter. **(1pt)**

Question III (4 pts)

a- In experiment 1 where cytotoxicity is observed, all the immune cells are present. On the other hand, cytotoxicity does not appear in absence of T4 (experiment 2) inspite of the presence of T8 and neither in absence of T8 (experiment 3) although T4 is present, which is confirmed by experiment 4 where cytotoxicity is observed where the immune cells taken from mediums 2 and 3 are placed together with the infected cells. This indicates that T4 only or T8 only are incapable to provoke cytotoxicity, thus, the presence of both is obligatory **(1 pt).** Hence, the appearance of cytotoxicity necessitates the cooperation between T4 and T8. **(½ pt)**

b- The microscopic observations reveal that in the presence of infected cells a contact takes place between Tc rich in perforin and these cells (1st observation) while in the presence of non-infected cells, the Tc do not show perforin and are not in contact with these cells (2nd observation). On the other hand, there is the appearance of pores in the region of contact between Tc and the infected cells (3rd observation) and these pores do not appear in the case of a deficiency in perforin (4th observation), Tc are thus, incapable to provoke the destruction of infected cells. From what has preceded, we can say that perforin is necessary when there is a contact between immune cells and infected cells, which is responsible for the formation of pores at the level of the membrane of the infected cells, followed by their destruction. **(1 ½ pt)**

c- After recognizing the antigen, the activated T4 multiply and differentiate into cells that secrete interleukins. Interleukin 2 acts on certain T8 lymphocytes provoking their multiplication and their differentiation into effector cells: Tc lymphocytes. Tc binds to infected cells and secretes perforin that provokes the appearance of pores on the membrane of the infected cells. These pores permit the passage of granzymes that attack the DNA of the infected cells leading to their destruction.
(1 pt)

Question IV (7 ½ pts)

a- (1pt)

Time (in hours) / Amount of glucose (in $g.L^{-1}$)	11:30	12	12:30	13	13:30	14	14:30	15	15:30	16
Blood vessel A	0.8	0.8	3	1	0.8	0.8	0.8	0.7	0.7	0.6
Blood vessel B	0.9	0.9	1.2	1	0.9	0.9	1	1	1	1

Food intake

Variation of the amount of glucose in blood vessels A and B as a function of time

b- Before food intake, the amount of glucose in the blood vessel A is 0.8 gL^{-1} and in vessel B is 0.9 gL^{-1}. After food intake the amount of glucose in blood vessel A increases rapidly to become 3 gL^{-1} at 12:30, while it increases slightly in blood vessel B to become 1.2 gL^{-1}. 30 minutes later a rapid decrease in the amount of glucose is observed in blood vessel A (1 gL^{-1}) and continues to decrease to become 0.6 gL^{-1} at hour 16. On the other hand, the amount of glucose in blood vessel B remains constant through out the experiment and fluctuates around 1 gL^{-1} . This indicates that the food provokes the great fluctuation in the amount of glucose in blood vessel A that enters the liver but slight fluctuation in blood vessel B coming out of the liver. **(1 pt)**
Hence, the liver stores the excess of glucose **(½ pt)**

c- Blood vessel A: Portal vein **(¼)**
Blood vessel B: sub hepatic vein **(¼ pt)**

d- (2 pts)

Variation of the concentration of insulin and glucagon secreted as a function of time

e- 24 hours before fasting glycemia was 89 mg dL^{-1}, the concentration of glucagon was 126 mU mL^{-1} and the concentration of insulin was 9 pg L^{-1} .This concentration remains constant at the beginning of fasting, but only glycemia decreases slightly (86 mg dL^{-1}). At the beginning of fasting until 72 hours glycemia continues to decrease to reach 70 mg mL^{-1} and also the amount of insulin decreases to reach 3 $pg.mL^{-1}$ while the concentration of glucagon increases to become 190 mU L^{-1} . This indicates that fasting decreases the amount of glucose in the blood and as glycemia decreases the secretion of insulin decreases while the secretion of glucagon increases. Therefore, the secretion of pancreatic hormones depends on the amount of glucose in the blood. **(2 pts)**

f- After intestinal absorption, the amount of glucose in the blood increases and also the concentration of insulin, which lead to the storage of the excess of glucose in the liver. During fasting, glycemia and the concentration of insulin decrease but the secretion of glucagon increases to return glucose to the blood and maintain a normal glycemia. **(½ pt)**