وزارة التربية والتعليم العالي
المديرية العامة للتربية
دائرة الامتحانات

امتحانات الشهادة الثانوية العامة
فرع علوم الحياة

دورة سنة 2012 الاستثنائية

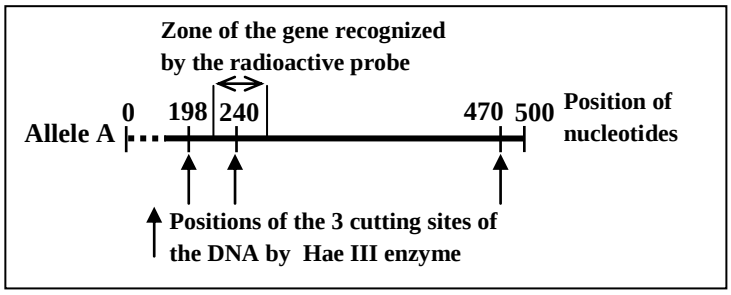
مسابقة في مادة علوم الحياة
المدة: ثلاث ساعات

الاسم:
الرقم:

Answer the following exercises

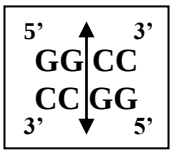
Exercise 1 (5 points) **Transmission of Albinism**

Albinism is a hereditary deficiency characterized by the absence of skin, eyes and hair pigmentation due to the absence of a black pigment: melanin. Tyrosinase is an enzyme involved in the biosynthesis of this pigment. The gene coding for tyrosinase exists in many forms of alleles and is carried by an autosome. Only two alleles are taken into consideration: allele A which codes for an active tyrosinase that is responsible for the synthesis of melanin and allele B that codes for an inactive tyrosinase that does not permit the synthesis of melanin.



Document 1

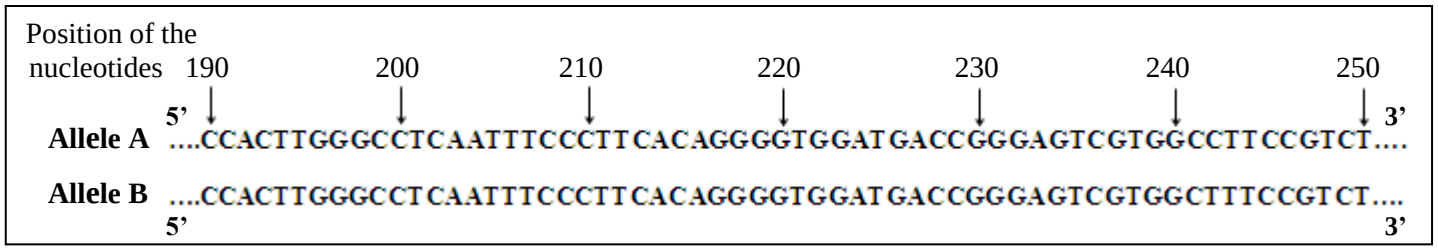
Document 1 represents the map of the restriction sites recognized by Hae III enzyme in a portion of 500 base pairs (bp) of the allele A of tyrosinase gene.



Document 2

1- Determine the number and the length of the restriction fragments obtained as a result of cutting allele A by Hae III enzyme.

Document 2 shows the restriction site of Hae III enzyme.
Document 3 reveals a partial single-stranded sequence of the two alleles A and B of tyrosinase gene.

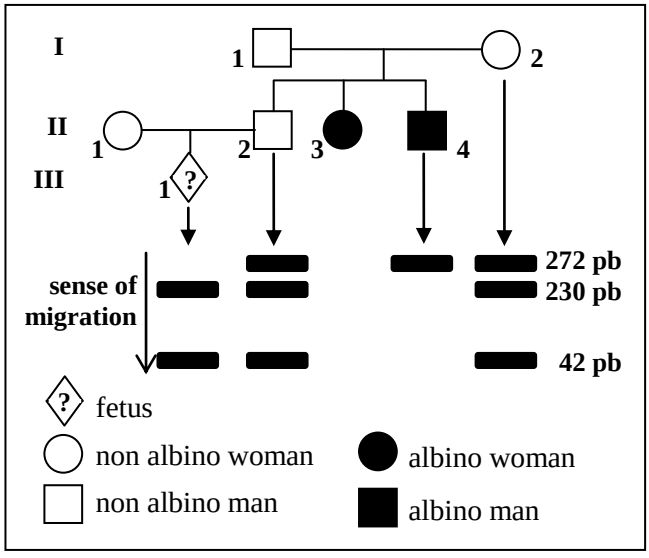


Document 3

2- Compare these two sequences. Draw out the position and the type of mutation that took place.

3- Determine the consequence of this mutation on the produced restriction fragments upon using Hae III enzyme on allele B.

Document 4 represents the pedigree of a family whose some members show albinism. It also shows the results of the electrophoresis of the restriction fragments obtained following the action of Hae III enzyme on a portion of the tyrosinase gene. These fragments are obtained by the Southern blot technique for four members of the family.



Document 4

4- Specify the respective alleles of individuals I_2 and II_4. Justify the answer by referring to the results of electrophoresis.

5- Indicate, referring to document 4, whether the allele of albinism is dominant or recessive. Justify the answer.

6- Establish a prenatal diagnosis of albinism for the fetus III_1.

Exercise 2 (5 points) **Cellular Cooperation and Production of Antibodies**

In the framework of determining the conditions of the production of antibodies during the immune response, we perform a series of experiments on mice of the same strain.

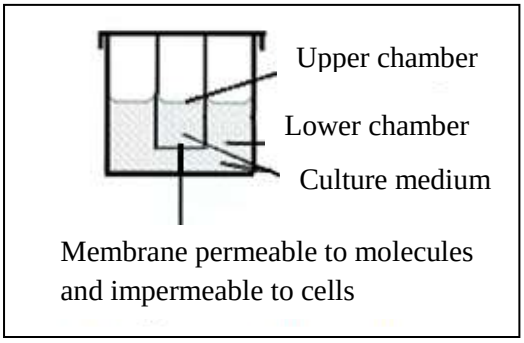
Experiment 1: Mice are subjected to the ablation of the thymus followed by irradiation that destroys all cells of the immune system. These mice are then divided into 4 lots and treated as shown in document 1.

	Ablation of the thymus then irradiation of the mice			
	Lot 1	**Lot 2**	**Lot 3**	**Lot 4**
Injection of lymphocytes removed from mice of the same strain	T	B and T	B and T	B
Injection of an antigen: SRBC (sheep red blood cells)	Yes	Yes	No	Yes
One week later, removal of serum from the mice and addition of SRBC to the serum				
Results : agglutination of SRBC	absence	presence	absence	absence

Document 1

1- Interpret the experimental results of experiment 1.

2- Specify the aim of destroying the cells of the immune system before starting the experiment.



Document 2

Experiment 2: A mouse receives an injection of sheep red blood cells (SRBC). Three days later, we extract lymphocytes from its spleen. These lymphocytes are distributed into 4 identical lots then cultured in Marbrook chamber (document 2) according to the procedure described in document 3.

Few days later, the culture medium is filtered and the collected liquid is added to SRBC. The results are shown in document 3.

Culture medium	**1**	**2**	**3**	**4**
Lymphocytes placed in the upper chamber	none	T	none	none
Lymphocytes placed in the lower chamber	T and B	B	B	T
Results : agglutination of SRBC	Strong	Strong	Null	Null

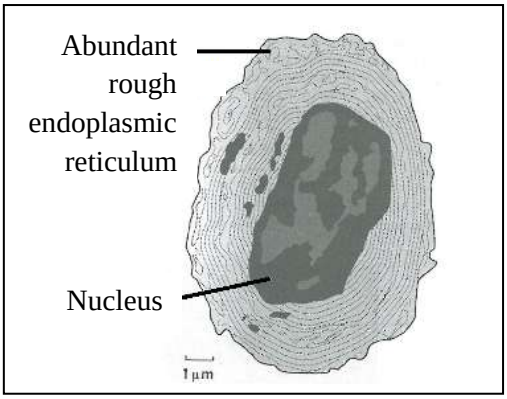
Document 3

3- Analyze the results of media 1 and 2.What can you draw out?

Document 4 illustrates an electronography of an antibody secreting cell that is found in large quantities, in media 1 and 2 of document 3 and absent in media 3 and 4.

4- Name this cell. Justify the answer.

5- Explain the variation in the quantity of this type of cells in the four media of experiment 2.



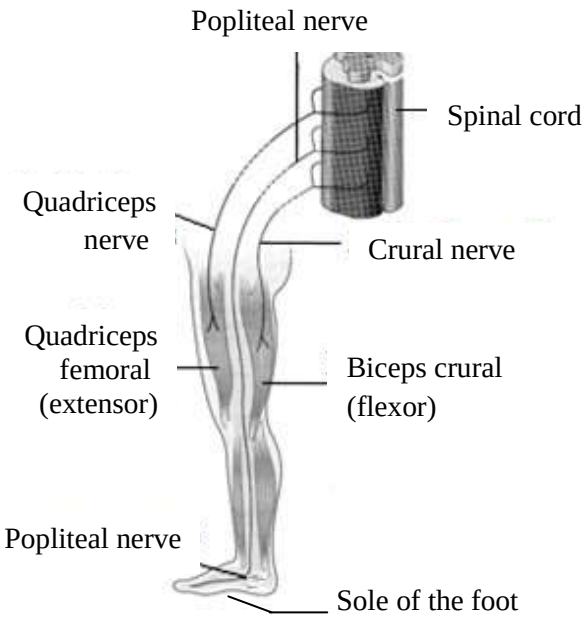
Document 4

Exercise 3 (5 points)

Protection Reflex

In a man who has been accidentally subjected to a section in the upper level of his spinal cord, the contact of a hot object with the skin of the sole of the foot causes systematically a protection reflex that is manifested by the flexion of the corresponding lower limb. We aim to study the mechanisms implicated in such a response.

Document 1 shows the muscles and the nerves involved in such a protection reflex. Document 2 represents the results of an experimental study performed on a spinal animal (cat) having only the spinal cord as a nervous center. The muscle structure and the innervation of this animal are similar to those of humans.



Document 1

Experiments	Popliteal nerve	Crural nerve	Nerve of the quadriceps
Sectioning of the nerve	disappearance of the flexion of the lower limb	disappearance of the contraction of the biceps crural	disappearance of the contraction of the quadriceps femoral
Excitation of the central end*	flexion of the lower limb	No reaction	No reaction
Excitation of the peripheral end *	No reaction	contraction of the biceps crural	contraction of the quadriceps femoral

* At the level of the sectioning of a nerve, the end that is still attached to the nervous center is called the central end whereas the end that is still attached to the peripheral organs (muscle or skin) is called the peripheral end.

Document 2

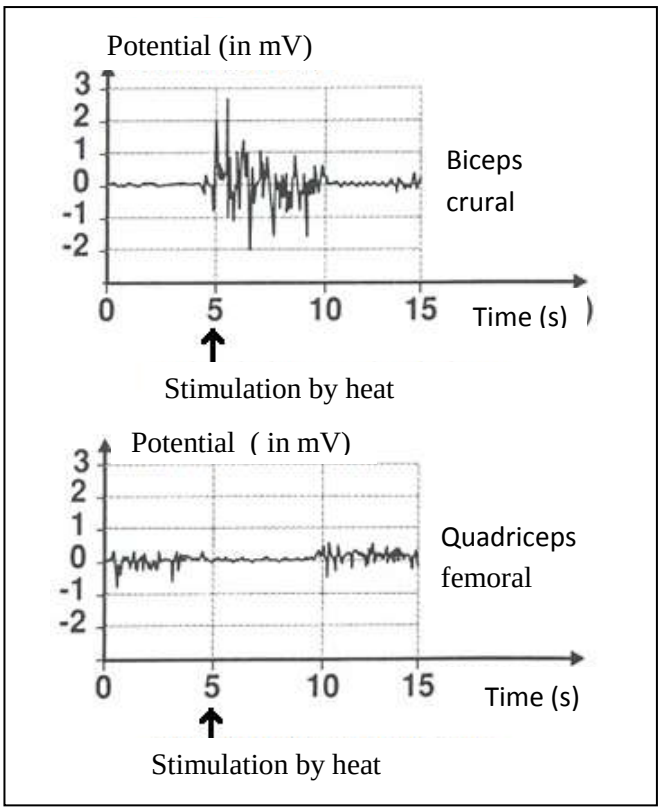
1- Specify, based on the experimental results, and for each nerve, whether it plays an afferent / sensory role or an efferent / motor role in this reflex. Justify the answer.

Document 3 represents the electromyograms recorded at the level of the biceps crural and the quadriceps femoral before and after stimulation by heat at time 5 seconds.

2- Compare these electromyograms. What can you draw out?

3- Draw a functional diagram relating the structures involved in this protection reflex.

4- Give one difference between the protection reflex and the myotatic reflex.



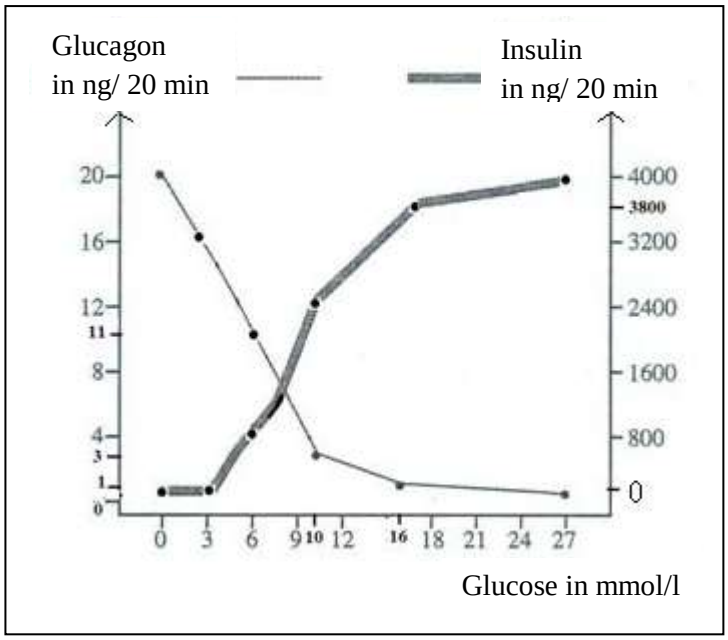
Document 3

Exercise 4 (5 points) **Role of Liver and Pancreas in the Regulation of Glycemia**

In order to show the relation between glycemia, liver and the secretion of pancreatic cells, we perform the following experiments on a rat and a dog.

Experiment 1:
We isolate the pancreas of a rat and we perfuse it with glucose solution of increasing concentrations. Each test lasts for 20 minutes. For each glucose concentration, we measure the level of insulin and that of glucagon in the liquid leaving the pancreas. The results are represented in document 1.

1- Tabulate the variation of glucagon and that of insulin levels as a function of glucose concentration.
2- Analyze the results of document 1. What can you draw out concerning the role of pancreatic cells?



Document 1

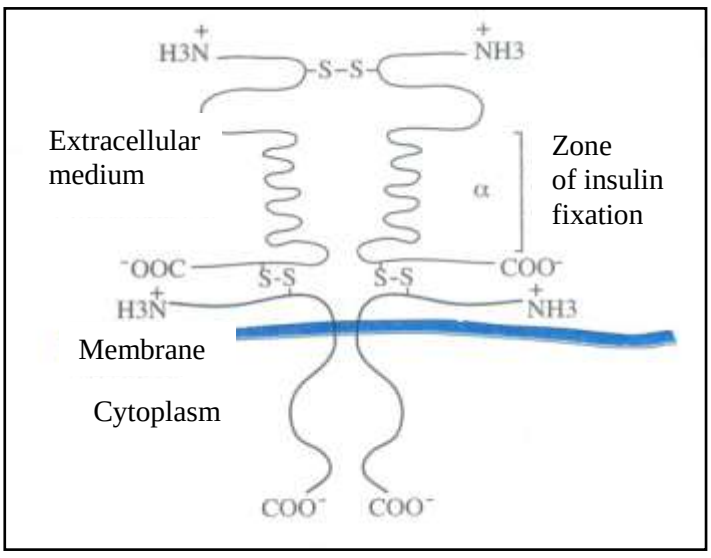
Experiment 2:
An injection of insulin provokes, in a normal fasting dog, a rapid drop in the "hepatic balance" .This balance corresponds to the difference between the concentration of glucose leaving the liver and that of glucose entering the liver. This balance drops, within less than an hour, from 42 mg / minute to approximately 0, following the injection of 1800 mg of insulin.
In a control dog, that is not subjected to insulin injection, the hepatic balance remains close to 42 mg/minute during the same period.

Experiment 3:
An injection of glucagon to a normal animal provokes hyperglycemia. This latter does not occur in an animal which liver was removed.

3- Interpret experiments 2 and 3. What can you deduce about maintaining normal glycemia in the body?

Document 2 shows a schematic representation of insulin membranous receptor of a hepatic cell.

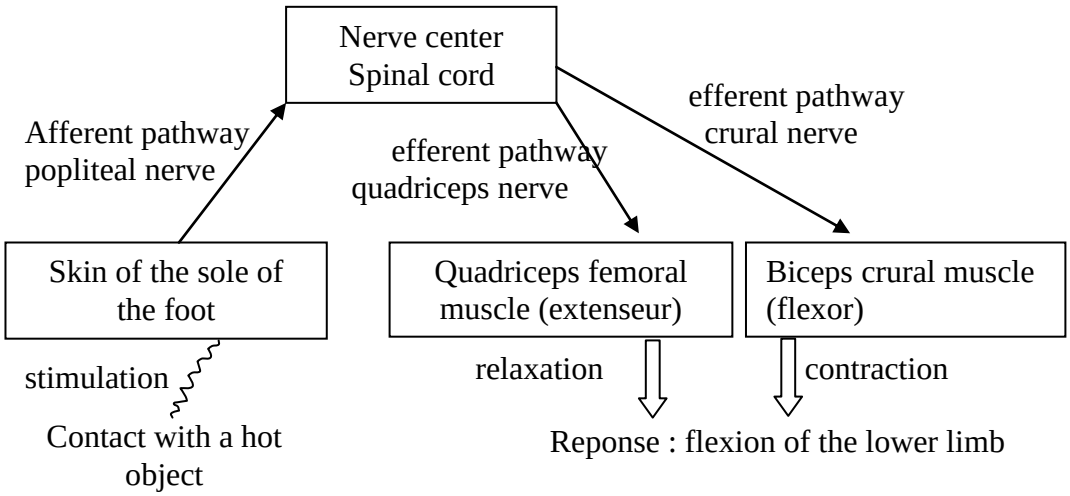
4- Explain, referring to document 2, the mode of action of insulin on the hepatic cells.



Document 2

Part of ex	Answer key	Note
	Exercise 1 (5 points)	
1	Allele A has 3 restriction sites of enzyme Hae III at the level of the nucleotide numbers 198, 240 and 470. Therefore, the enzyme cuts the allele into 4 fragments (**1/4 pt)**. The lenghth of each fragment is: a fragment of 198 base pairs (bp) (before the site 198), a fragment of 42 bp (between sites of 198 and 240), a fragment of 230 pb (between the sites of 240 and 470) and a fourth fragment which length is 30 bp (beyond the site 470) (**1/2 pt)**.	**3/4**
2	The nucleotide sequences of the portions of the two alleles are identical except at the level of the nucleotide number 242 where nucleotide C in allele A is replaced by the nucleotide T in allele B(**1/2 pt)**. It is a mutation by substitution (**1/4 pt)** at the level of nucleotide 242(**1/4 pt)**.	**1**
3	Hae III enzyme cuts the DNA when encountering the sequence GGCC. The cutting is done between GG and CC (document 2). Document 3 shows that the restriction site at the level of the nucleotide 240 does no longer exist for allele B due to the mutation by substitution. Instead of the GGCC sequence for allele A there is a GGCT sequence for allele B. As a result, the enzymatic treatment of allele B will give: a fragment of 198 base pairs (bp) (before the site 198), a fragment of 272 bp instead of the two fragments (42 and 230 bp) a third fragment which length is 30 bp (beyond the site 470).	**3/4**
4	Document 4 gives the disposition of the fragments revealed by autoradiography for the four family member. Individual I_2 has two alleles A and B (**1/4 pt)** because the electrophoresis results show three fragments: 272 pb that corresponds to allele B and 42 and 230 pb that correspond to allele A(**1/4 pt)**. Individual II_4 has two alleles B (**1/4 pt)** because the electrophoresis results show only the fragment of 272 pb that corresponds to allele B (**1/4 pt)**.	**1**
5	Albinism allele is recessive with respect to the normal allele (**1/4 pt)** because individual I2 having the two alleles A and B is of normal phenotype. Therefore allele A alone is expressed and allele B is masked (**1/2 pt)**. Or Because II3 and II4 children with albinism arise from normal parents I1 and I2, then the allele of albinism is masked in the parents. Therefore allele B determining albinism is recessive with respect to the dominant allele A.	**3/4**
6	The fetus III1 possesses only the fragments of 230 and 42 pb that correspond to the allele A. So, the fetus III1 does not have except the allele A and he will not be albino but of normal phenotype.	**3/4**

Part of ex	Answer key	Note
	Exercise 2 (5 points)	
1	There is agglutination of SRBC in lot 2 where there was an injection of lymphocytes B and T and SRBC at the same time whereas there is no agglutination in lot 1 where there were only injection of lymphocytes T with SRBC and in lot 4 where there are only injection of B lymphocytes with SRBC; This shows that the agglutination requires the cooperation of TL and BL or the presence of the TL and BL at the same time. There is agglutination of SRBC in lot 2 where there was an injection of lymphocytes B and T and SRBC at the same time however there is no agglutination in lot 3 where there were injection of lymphocytes B and T without SRBC. This shows that the contact with the antigen a week in advance is necessary to get agglutination.	**1 1/2**
2	This will ensure that the immune response triggered by the mice is due only to the injected cells.	**1/2**
3	There is strong agglutination of SRBC in the media 1 and 2 where B and T lymphocytes are found together whether they are in the same medium (medium 1) or separated by a membrane that is impermeable to cells but permeable to molecules (medium 2). **(1/2 pt)** Therefore, the agglutination of SRBC that is due to the production of anti-SRBC antibodies requires the cooperation of B and T lymphocytes via molecules and not by direct contact. **(1/2 pt)**	**1**
4	Plasmocyte **(1/2 pt)** because this cell has a voluminous cytoplasm that is rich in rough endoplasmic reticulum, cytoplasmic organelle that is indispensable for the synthesis of proteins such as antibodies. **(1/2 pt)**	**1**
5	Plasmocytes are derived from the differentiation of lymphocytes B which are absent in medium 4 where there is only TL, hence plasmocytes are absent in this medium. The differentiation of LB into plasmocytes is stimulated by IL 4 that is secreted by TL that are absent in medium 3, hence plasmocytes are absent in this medium. However B and T cells are present in media 1 and 2. IL 4 stimulates directly the B cells in the lower chamber (medium 1) or crosses the permeable membrane and stimulates B cells (medium 2). Hence the abundance of plasmocytes in these two media.	**1**

Part of ex	Answer key	Note
	Exercise 3 (5 points)	
1	The popliteal nerve is afferent (sensitive).(**1/4pt**) because the flexion of the lower limb disappears following the sectioning of popliteal nerve and the stimulation of its peripheral end however the flexion appears following the stimulation of its central end; This shows that the nervous message is transmitted by this nerve from the periphery to spinal cord (centripetal direction). **(1/2pt)** The crural nerve is efferent. (**1/4 pt**)because there is no more contraction of the biceps crural following the sectioning of the crural nerve and the stimulation of its central end while the biceps crural contracts following the stimulation of its peripheral end; This shows that crural nerve transmits the nervous message from the spinal cord toward the biceps crural. **(1/2pt)** The nerve of the quadriceps is efferent**. (1/4pt)** because there is no more contraction of the quadriceps femoral following the sectioning of the quadriceps nerve and the stimulation of its central end while the quadriceps femoral contracts following the stimulation of the peripheral end of this nerve; This shows that quadriceps nerve transmits the nervous message from the spinal cord toward the quadriceps femoral. **(1/2pt)**	**2 ¼**
2	From 0 to 5 and from 10 to 15 s, the electromyogram of the quadriceps femoral has a amplitude that fluctuates between -1 and 1mv greater than that of the electromyogram of the biceps crural that is almost null. From 5 to 10 mv, the electromyogram of the biceps crural has as amplitude that fluctuates between-2 and 2.5 mv greater than that of the electromyogram of the quadriceps femoral which is almost null. **(1/2pt)** Thus, the flexion of the lower limb is due to the activity of the biceps crural and the relaxation of the quadriceps femoral and that these two muscles are antagonistic. **(1/2pt)**	**1**
3	 Functional diagram of the structures implicated in the protection reflex	**11/4**
4	In the protection reflex, the receptor is the skin and the effector organ is the muscle, while in the myotatic reflex, the stretched muscle is, at the same time, the receptor organ and the effector organ.	**1/2**

<table>
<tr><th>Part of ex</th><th>Answer key</th><th>Note</th></tr>
<tr><td></td><td>Exercise 4 (5 points)</td><td></td></tr>
<tr><td>1</td><td>Variation of glucagon and insulin levels as a function of the glucose concentration.

<table>
<tr><td>Glucose (in mmol/l)</td><td>0</td><td>3</td><td>6</td><td>10</td><td>16</td><td>27</td></tr>
<tr><td>Glucagon (in ng/20 min)</td><td>20</td><td>16</td><td>11</td><td>3</td><td>1</td><td>0</td></tr>
<tr><td>Insulin (in ng/20 min)</td><td>0</td><td>0</td><td>800</td><td>2400</td><td>3800</td><td>4000</td></tr>
</table></td><td>11/2</td></tr>
<tr><td>2</td><td>Glucagon levels decreases rapidly from 20 ng / 20 min till 16 ng / 20 min while the insulin level remains constant at 0 ng / 20 min when the concentration of glucose in the perfused liquid increases from 0 till 3 mmol/l. The glucagon levels continue to decrease to 1ng/20min however insulin level increases from 1 to 3800 ng / 20 min when the glucose concentration continues to increase to 16 mmol/l. The glucagon levels continue to decrease but less rapidly to 0ng/20min while insulin level continues to increase weakly to 4000 ng / 20 min when the glucose concentration continues to increase to 27mmol/l (1 pt)

This shows that The pancreatic cells secrete insulin and glucagon, the insulin secretion varies in the same direction as the glucose concentration starting from 3 mmol/l while the glucagon secretion varies in opposite direction to the concentration of glucose. The pancreatic cells detect the variation of glucose and their sensibility varies according to the glucose concentration.(1/2pt)</td><td>11/2</td></tr>
<tr><td>3</td><td>The hepatic balance decreases from 42 mg/min to a value close to 0 mg/min, following the injection of 1800 mg of insulin opposite to what is noticed in the control dog without insulin injection where its hepatic balance remains constant of 42 mg/min. This shows that insulin decreases the liberation of glucose by the liver (facilitates the storage of glucose in the liver).(1/2pt)
Hyperglycemia is observed following the injection of glucagon in a normal dog however this hyperglycemia does not occur after the same injection of glucagon in a dog that his liver was removed. This means that glucagon, a hyperglycemic hormone, acts on the liver to increase the liberation of glucose in the blood. (1/2pt)
Therefore, insulin and glucagon act on the same target organ, the liver, in opposite manner (antagonist). The insulin promotes the storage of glucose while the glucagon favors his liberation which maintains the level of glucose normal. (1/2pt)</td><td>11/2</td></tr>
<tr><td>4</td><td>A hormone does not act except on its target cells that have receptors for this hormone. And since a part of the membranous receptor of the hepatic cells constitute the zone of fixation of insulin, thus insulin binds to its membrane protein receptor triggering the change in activity of hepatic target cell. This reduces the release of glucose into blood (or increases the storage of glucose in the liver).</td><td>1/2</td></tr>
</table>