مسابقة في مادة علوم الحياة
المدة: ساعتا ن ونصف

الاسم:
الرقم:

يتكون هذا الامتحان من ستة تمارين، موزعة على ست صفحات. يجب اختيار **أربعة تمارين فقط**.

إقرأ الأسئلة كلها بشكل عام وشامل، ومن ثم حدّد اختيارك.

ملاحظة: في حال الإجابة عن أكثر من أربعة تمارين، عليك شطب الإجابات المتعلقة بالتمارين التي لم تعد من ضمن اختيارك،لان التصحيح يقتصر على إجابات التمارين ،الأربع الأولى غير المشطوبة، بحسب ترتيبها على ورقة الإجابة.

Answer 4 exercises out of 6 exercises

Exercise 1 (5 points) Immunological Memory against a Virus

To study the characteristics of the immune memory against a virus, the following experiment is carried out:

A rabbit is injected with virus X. Six months later, the same rabbit is injected with the same virus X. The level of anti-X antibodies produced and liberated in the plasma after each injection is measured. Document 1 represents the obtained results.

Time (weeks)		0	1	2	3
Level of anti-X antibodies (a.u)	After the 1st injection	0	5	10	5
	After the 2nd injection	5	30	25	25

Document 1

1- Specify the nature of the immune response revealed in document 1.

2- Justify, referring to document 1, the following statements:

2.1- The secondary immune response is more amplified than the primary immune response.

2.2- The secondary immune response is more durable than the primary immune response.

3.1- Name two cells involved in the immune response revealed by document 1.

3.2- Indicate the role of each of these cells.

4- Schematize the immune complex resulting from the reaction between virus X and anti-X antibodies.

5- Specify whether this involved immune response is capable to eliminate the cells infected by virus X.

Exercise 2 (5 points) **Roles of Macrophages**

Macrophages are immune cells that play a central role in the protection of the organism against infections and damaged tissues, as well as in the regulation of the immune response.

In the framework of studying the roles of macrophages, the following experiments are carried out.

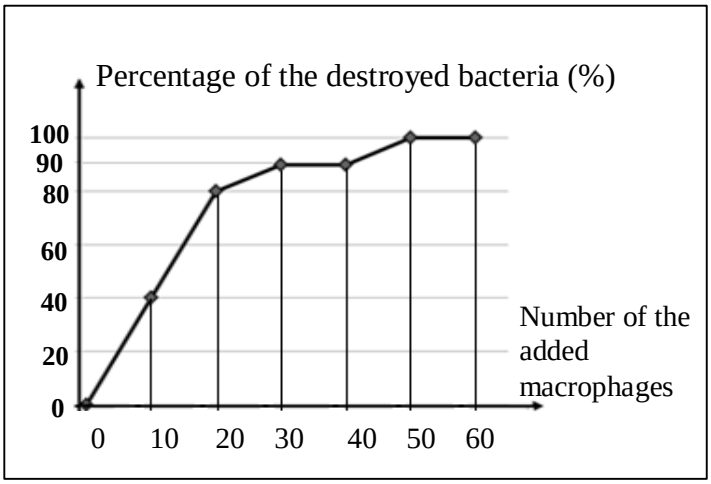
Experiment 1:
A container consists of two compartments, A and B, separated by a perforated filter. Macrophages are placed in compartment A and the plasma taken from inflamed tissue is placed in compartment B.
Few hours later, the macrophages are found in compartment B.

1- Name the substance present in the plasma taken from the inflamed tissues that attracts the macrophages.

Experiment 2: Bacteria are placed in a culture medium to which macrophages are added.

Document 1 represents the evolution of the destroyed bacteria as a function of the number of the added macrophages.

2- Construct a table that represents the obtained results in document 1.
3- Interpret the obtained results.



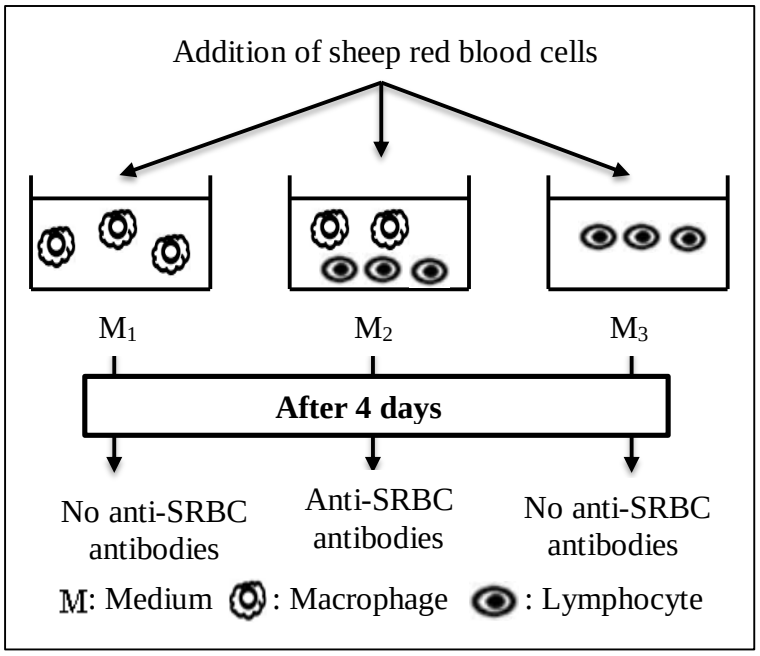
Document 1

Experiment 3: Macrophages and lymphocytes are taken from the spleen of a mouse and placed in three culture media: M1, M2, and M3.

Document 2 represents the experimental conditions as well as the obtained results.

4.1- Analyze the obtained results.
4.2- What can you conclude?

5- Indicate, referring to experiment 2 and experiment 3, the two roles of macrophage.



Document 2

Exercise 3 (5 points) **Spermatogenesis**

Spermatogenesis is the process by which the seminiferous tubules of the testicles produce sperm cells. It lasts approximately 74 days and occurs continuously starting from puberty. It has four successive phases: multiplication, growth, maturation, and spermiogenesis. Spermatogenesis ensures male fertility and contributes directly to the genetic transmission of the offspring.

Document 1

1- Pick out from document 1:

1.1- The phases of spermatogenesis.
1.2- The duration of spermatogenesis.
1.3- The role of spermatogenesis.

The microscopic observation of a section of testicles shows the presence of Leydig cells between the seminiferous tubules and Sertoli cells in these tubules.

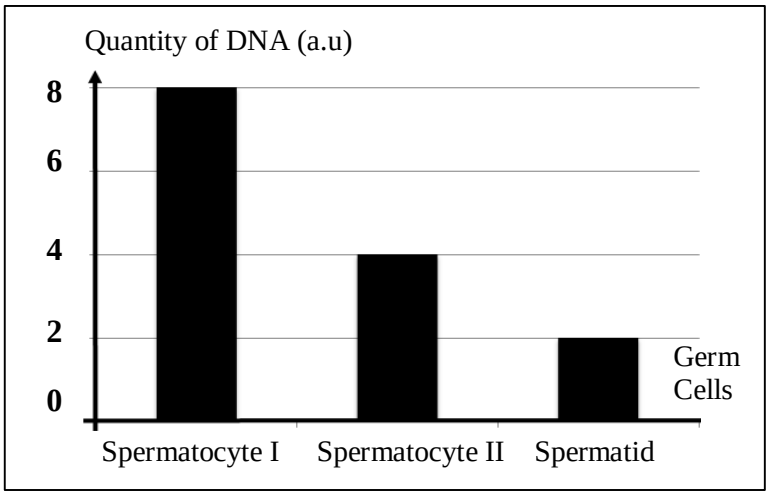
2- Indicate the role of each of these two types of cells.

Document 2 represents the quantity of DNA in different germ cells extracted directly, by biopsy, from a fragment of the testicles of a fertile man.

3- Represent in a table the results shown in document 2.

4.1- Compare the quantity of the DNA contained in the spermatocyte I to that in the spermatid.

4.2- Name the phase of spermatogenesis responsible for this variation.



Document 2

The number of chromosomes in a spermatocyte I is represented by 2n.

5- Indicate the number of chromosomes and the number of chromatids per chromosome in a spermatocyte II and in a spermatid.

A man suffers from sterility. The biopsy of his testicles shows a high number of spermatocytes II with a low number of spermatids.

6- Formulate a hypothesis explaining the origin of the sterility of this man.

Exercise 4 (5 points) **Transmission of an Autosomal Disease**

Document 1 shows the genealogical tree (pedigree) of a family in which some members shown in black are affected by an autosomal disease. The studied disease is due to a mutation of a gene for which two alleles have been identified: the normal allele A_1 and the mutated allele A_2.

1- Specify whether the allele responsible for the disease is dominant or recessive.

2- Choose the correct answer. Justify the choice.

2.1- The genotype of II_3 is:

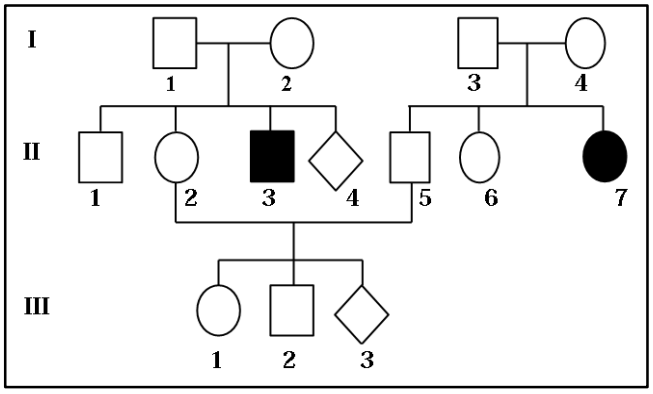
a. $A_1 A_1$ b. $A_1 A_2$ c. $A_2 A_2$.

2.2- The risk for the fetus II_4 to be affected by the disease is:

a. 1/3 b. 1/4 c. 1/9 d. 1/12

2.3- The risk for the fetus III_3 to be affected by the disease is:

a.1/3 b. 1/4 c. 1/9 d. 1/12.

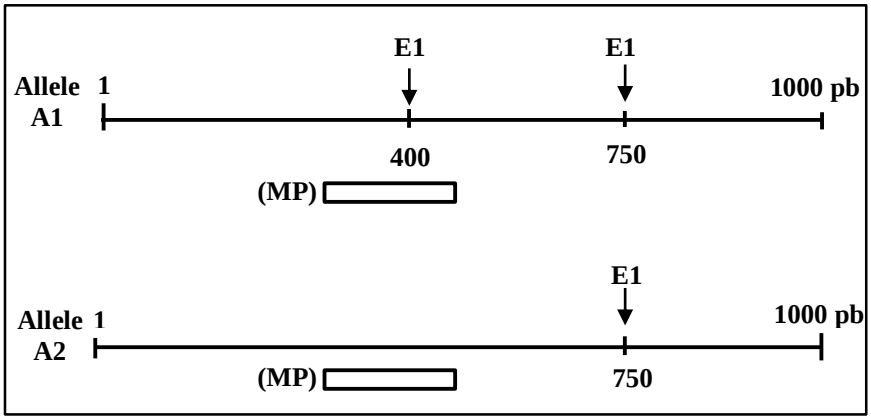


Document 1

A restriction enzyme E_1 is used to cut a segment of DNA that corresponds to the studied alleles. Document 2 represents the studied alleles and the restriction sites of the enzyme E_1.

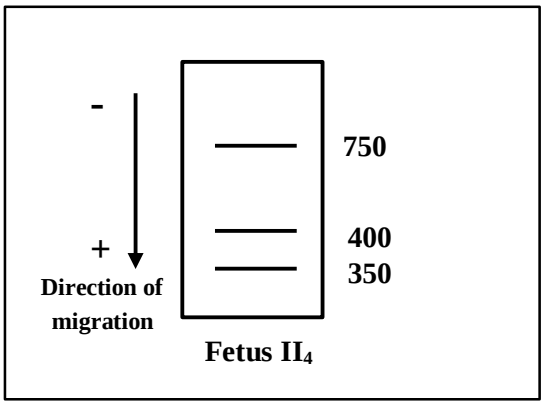
MP is a radioactive molecular probe complementary to a specific sequence of DNA of the studied gene.

3- Determine, by referring to document 2, the number and the size of the restriction fragments obtained for each allele using the enzyme E1.

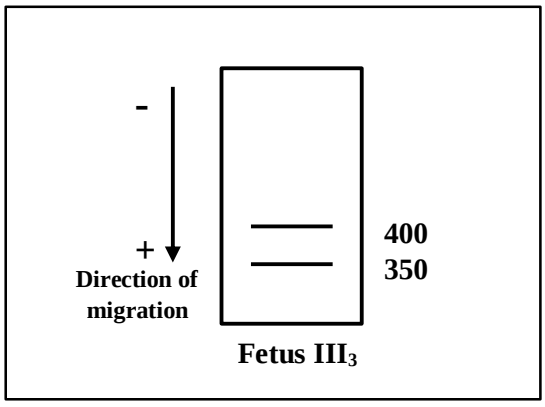


Document 2

Documents 3 and 4 represent the electrophoregrams obtained after the action of the restriction enzyme E_1 and the molecular probe MP on the studied gene, for the two fetuses of this family.



Document 3



Document 4

4- Explain the absence of the fragment of size 250 bp in the obtained electropherograms.

5- Establish the diagnosis for each fetus.

Exercise 5 (5 points) **Sickle Cell Anemia**

Sickle cell disease is a hereditary disease affecting hemoglobin, a molecule found in red blood cells and responsible for transporting oxygen in the body. The production of hemoglobin is controlled by a gene located on chromosome 11. This gene exists in different allelic forms, including the HbA allele, leading to the production of normal hemoglobin A, and the HbS allele, leading to the production of abnormal hemoglobin S. Only individuals carrying two HbS alleles are affected by sickle cell disease.

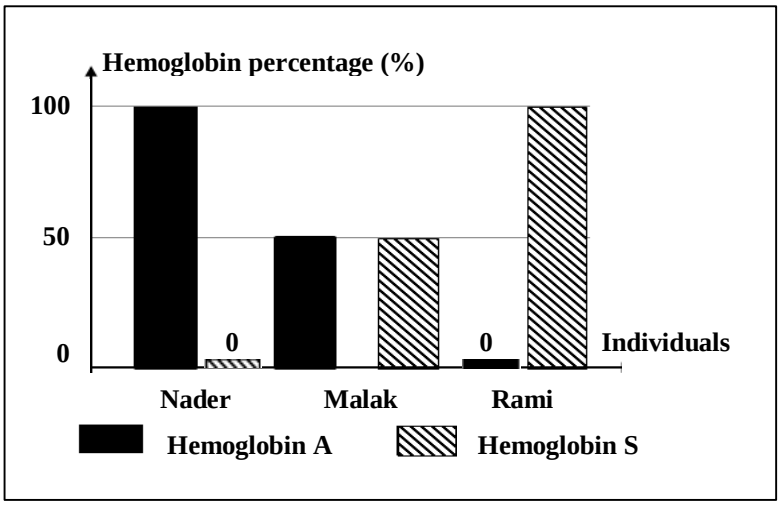
1- Pick out from the text:
- **1.1-** The allele responsible for sickle cell disease.
- **1.2-** The role of hemoglobin.

2- Show that the allele responsible for sickle cell disease is recessive.

Document 1 represents the percentage of the two kinds of hemoglobin HbA and HbS in three individuals: Nader, Rami and Malak.

3- Represent in a table the obtained results.

4- Specify the genotype of each individual.



Document 1

The couple, Malak and Nader, of normal phenotype, are expecting a child. By the help of a specific technique, the DNA analysis of the sickle cell gene of this couple and that the fetus is realized. Document 2 represents the obtained DNA fragments where the size is measured in kilobase.

Individuals / DNA fragments (kb)	Nader	Malak	Fetus
1.9 kb	———	———	———
1.4 kb		———	

Document 2

5- Determine the fragment which corresponds to the HbS allele.

6- Draw out the phenotype of the fetus.

Exercise 6 (5 points) **Cyclic Variation of the Uterus and Role of the Ovaries**

We propose to study the relationship between the ovaries and the uterus. Three experiments are carried out on adult female mammals.

Experiment 1:
Four lots of adult female mammals are subjected to ablation and grafting experiments.
Document 1 represents the experimental conditions and the obtained results.

Lots	1	2	3	4
Conditions of the experiment	Control mice (intact ovaries and uterus)	Ablation of both ovaries	Ablation of both ovaries, then grafting the ovaries under the skin	Ablation of both ovaries, then constant daily injections of ovarian extracts
Results	Cyclic development of the endometrium	No endometrial development	Cyclic development of the endometrium	Endometrial development without cyclic variation

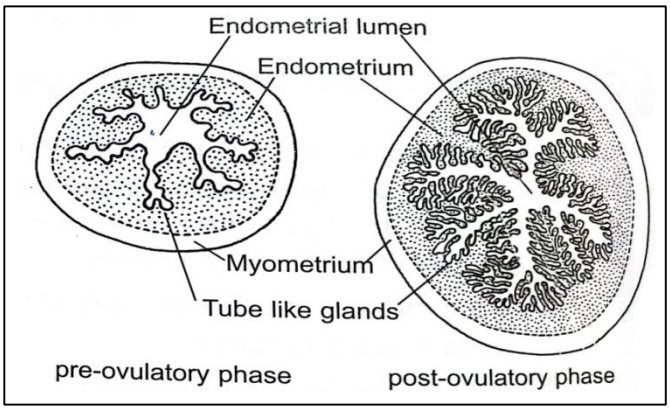
Document 1

1- Draw out the role of the ovaries.
2- Show that the ovaries are endocrine glands.

Experiment 2:
A section of the uterus is made in an adult female mammal in two different moments (pre-ovulatory phase and post-ovulatory phase).

The results are shown in document 2.

3- Compare the structure of the endometrium of the uterus in the pre and post-ovulatory phases.



Document 2

The changes observed in document 2 at the level of the uterus are under the effect of the ovarian hormones: estrogen and progesterone.

4- Name the cells that secrete these ovarian hormones in each phase of the menstrual cycle.

Experiment 3:
Increasing quantities of estrogen are injected into lots of adult female mammals previously ovariectomized.
The results are shown in document 3.

Lots	1	2	3	4
Concentration of injected estrogen (a.u)	0	0.35	0.5	0.75
Uterus mass (a.u)	$1x10^{-2}$	$1.3x10^{-2}$	$1.5\ x10^{-2}$	$1.7\ x10^{-2}$

Document 3

5.1- Analyze the obtained results.
5.2- What can you conclude?

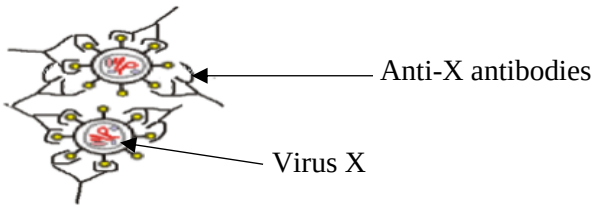
وزارة التربية والتعليم العالي
المديريّة العامّة للتربية
دائرة الامتحانات الرسميّة

امتحانات الشهادة الثانوية العامة
فرع علوم الحياة

دورة العام 2024 العادية

علوم الحياة
أسس التصحيح

الاسم:
الرقم:

Parts	Exercise 1 (5 points) Immunological Memory against a Virus	Notes
1	It is a humoral specific immune response because following the first injection of virus X, the level of anti-X antibodies increases from 0 to 10 a.u in two weeks where the antibodies are the effectors of this type of response.	0.75
2.1	The secondary immune response is more amplified because following the second injection of virus X the maximum level of the obtained anti-X antibodies is 30 a.u greater (3 times) than the maximum level obtained after the first injection of the same virus X which is 10 a.u.	0.75
2.2	The secondary immune response is more durable, since after 3 weeks following the second injection of virus X, the level of anti-X antibodies 25 a.u remains 5 times higher than that following the first injection of the same virus X (25 a. u> 5 a.u).).	0.75
3.1	Macrophage and LT4 OR Macrophage and LB OR LT4 and LB	0.5
3.2	Macrophage: Induction of the specific immune response LT4: Activation of LB. LB: Differentiation into plasma cells responsible for the secretion of antibodies.	1
4	Scheme of the immune complex:  	0.75
5	The humoral immune response does not eliminate the infected cells, because the antibodies involved in this response cannot recognize the infected cells. They can recognize and neutralize, only free antigens such as viruses that are found in the extracellular medium.	0.5

Parts	Exercise 2 (5 points) Roles of Macrophages	Notes
1	Cytokines	0.5
2	<table><tr><td>Number of the added macrophages</td><td>0</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td></tr><tr><td>Percentage of the destroyed bacteria (%)</td><td>0</td><td>40</td><td>80</td><td>90</td><td>90</td><td>100</td><td>100</td></tr></table>Variation of the percentage of destroyed bacteria (%) as a function of the number of added macrophages	1
3	The percentage of the destroyed bacteria increases from 0 % to 100% when the number of added macrophages increases from 0 till 60. This indicates that the macrophage favors the destruction of the bacteria.	1
4.1	Following the addition of SRBC, no anti-SRBC antibodies are secreted in the media M1 containing only macrophages and M3 containing only lymphocytes. However, there is production of anti-SRBC antibodies in M2 where macrophages and lymphocytes are both present.	1
4.2	The production of antibodies necessitates the cooperation between macrophages and lymphocytes.	0.5
5	Experiment 2: Phagocytosis Experiment 3: Induction or cooperation with lymphocytes to produce antibodies.	1

<table>
<tr><th>Parts</th><th>Exercise 3 (5 points) Spermatogenesis</th><th>Notes</th></tr>
<tr><td>1.1</td><td>Multiplication , growth , maturation, and spermiogenesis</td><td>0.25</td></tr>
<tr><td>1.2</td><td>74 days</td><td>0.25</td></tr>
<tr><td>1.3</td><td>Spermatogenesis ensures male fertility and contributes directly to the genetic transmission of the offspring.</td><td>0.25</td></tr>
<tr><td>2</td><td>Leydig cells: secrete testosterone.
Sertoli cells: nourish and support male germ cells</td><td>1</td></tr>
<tr><td>3</td><td><table><tr><td>Germ cells</td><td>Spermatocyte I</td><td>Spermatocyte II</td><td>Spermatid</td></tr><tr><td>Quantity DNA (au)</td><td>8</td><td>4</td><td>2</td></tr></table>Variation in quantity of DNA in male germ cells</td><td>1</td></tr>
<tr><td>4.1</td><td>The quantity of DNA in the spermatocyte I is 8 a.u (4 times) greater than that in the spermatid which is 2 au.</td><td>0.5</td></tr>
<tr><td>4.2</td><td>Maturation or meiosis.</td><td>0.25</td></tr>
<tr><td>5</td><td>Spermatocyte II: n chr. Each chromosome is made up of 2 chromatids.
Spermatid: n chr. Each chromosome is made up of 1 chromatid.</td><td>1</td></tr>
<tr><td>6</td><td>Hypothesis: the origin of the sterility of the man is an abnormality in the equational division of meiosis.</td><td>0.5</td></tr>
</table>

<table>
<tr><th>Parts</th><th>Exercise 4 (5 points) Transmission of an Autosomal Disease</th><th>Notes</th></tr>
<tr><td>1</td><td>The allele responsible for the disease is recessive. Since parents I_1 and I_2 are phenotypically healthy but having a sick child II_3, so the allele responsible for the disease is hidden (masked) in the parents.</td><td>0.75</td></tr>
<tr><td>2.1</td><td>A_2 A_2. Since II_3 is affected and the allele of the disease is recessive, and the recessive phenotype is only expressed in the homozygous state (or recessivity is a criterion of purity).</td><td>0.75</td></tr>
<tr><td>2.2</td><td>¼. Since parents I-1 and I-2 have an affected child II-3 so they are heterozygous. Thus, each has the possibility of giving the allele A_2 with a probability of ½.
The risk will be = ½ x½ = ¼. (Or a table of cross)</td><td>0.75</td></tr>
<tr><td>2.3</td><td>1/9. Knowing that the disease is autosomal, and as father II-5 has an affected sister and mother II-2 has an affected brother, the risk that both parents are heterozygous = 2/3 x 2/3 = 4/9.
Both heterozygous parents have a ¼ risk to have an affected child:
The risk will be=4/9 x 1/4= 1/9.</td><td>0.75</td></tr>
<tr><td>3</td><td>Allele A_1:
E_1: Number of fragments obtained = number of restriction sites + 1 = 2+1 = 3.
Size: 400 bp, 750 – 400 = 350 bp, 1000 – 750 = 250 bp .
Allele A_2
E1: Number of fragments obtained = number of restriction sites + 1 = 1+1 = 2.
Size : 750 pb, 1000 -750 = 250 pb.</td><td>1</td></tr>
<tr><td>4</td><td>The electropherogram shows only fragments that hybridize with the radioactive molecular probe. However, the MP probe only fixes at the site around the 400^{th} nucleotide and does not hybridize with the 250 bp fragment.</td><td>0.5</td></tr>
<tr><td>5</td><td>Fetus II_4: electropherogram 1 shows 3 fragments: 350 and 400 which correspond to allele A_1 allele and 750 which corresponds to allele A_2.
Its genotype is: A_1A_2, then he is of normal phenotype.
Fetus III_3: electropherogram 1 shows 2 fragments: 350 and 400 which correspond to allele A_1.
Its genotype is : A_1A_1 , then he is of normal phenotype.</td><td>0.5</td></tr>
</table>

<table>
<tr><th>Parts</th><th>Exercise 5 (5 points) Sickle cell anemia</th><th>Notes</th></tr>
<tr><td>1.1</td><td>HBS allele is responsible for sickle cell anemia.</td><td>0.5</td></tr>
<tr><td>1.2</td><td>Hemoglobin is responsible for transporting oxygen in the body.</td><td>0.5</td></tr>
<tr><td>2</td><td>Since only individuals carrying two HbS alleles are affected by sickle cell disease which indicates that the allele is recessive.</td><td>0.5</td></tr>
<tr><td>3</td><td>
<table>
<tr><td colspan="2">Individuals</td><td>Nader</td><td>Malak</td><td>Rami</td></tr>
<tr><td rowspan="2">Hemoglobin percentage (%)</td><td>Hemoglobin A</td><td>100</td><td>50</td><td>0</td></tr>
<tr><td>Hemoglobin S</td><td>0</td><td>50</td><td>100</td></tr>
</table>
The percentage of both kinds hemoglobin (HbA and HbS) in 3 individuals .
</td><td>1</td></tr>
<tr><td>4</td><td>Genotype of Nader is HbA//HbA since he has 100 % HbA and 0% HbS.
Genotype of Malak is HbA//HbS since she has the two types of hemoglobin: HbA and HbS with equal percentage: 50 %.
Genotype of Rami is HbS//HbS since he has 100 % HbS an 0% HbA.</td><td>1.5</td></tr>
<tr><td>5</td><td>Nader presents a single fragment of 1.9 kb, and he has 100 % hemoglobin A, then 1.9 kb corresponds to the allele HbA. Then the 1.4kb fragment corresponds to the allele HbS .</td><td>0.5</td></tr>
<tr><td>6</td><td>The phenotype of the fetus is normal.</td><td>0.5</td></tr>
</table>

Parts	Exercise 6 (5 points) Cyclic variation of the Uterus and Role of the Ovaries	Notes
1	The ovaries are responsible for the development of the endometrium.	**1**
2	The ovaries are endocrine glands because the graft of the ovaries under the skin (lot 3) gives the same result as in the control lot 1. In addition, the role is restored following injections of ovarian extracts (lot 4).	**1**
3	The endometrium is thicker in the post-ovulatory phase than in the pre-ovulatory phase. Also, the tube like glands are more developed.	**0.5**
4	Estrogen is secreted by the follicular cells if the internal theca and granulosa during the pre-ovulatory phase, and by the corpus luteum cells in the post-ovulatory phase. Progesterone is only secreted during the post-ovulatory phase by the corpus luteum cells.	**1**
5.1	The uterus mass, in the absence of any injection of estrogen is $1x10^{-2}$ (a.u). This mass increases from $1x10^{-2}$ to $1.7\ x10^{-2}$ when the concentration of the injected estrogen increases from 0 to 0.75 (a.u).	**1**
5.2	Estrogen amplifies (favors, stimulates,..) the development of the uterus.	**0.5**