This is a Class 1 exam

Lebanon Evangelical School for Boys and Girls

Lebanon Evangelical School
for Boys and Girls — Loueizeh - Baabda

Stage Exam 04

20-25JUN2025

Do NOT write in this box. Your MARK will be placed here.

Subject :	Biology
Class :	12E
Teacher :	Christine Khalil
Duration :	3 hours

You are to answer the questions to this exam on : Lined paper

Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

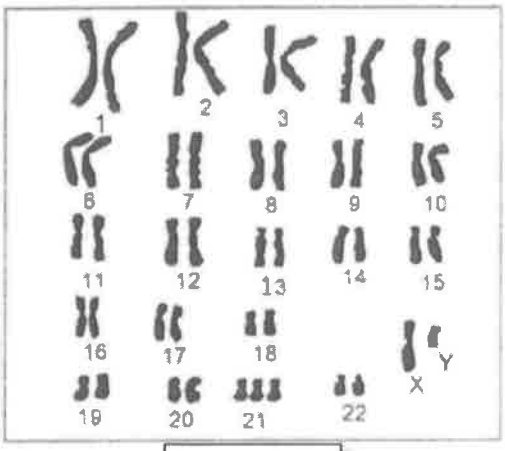
- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

Exercise 1 (7 points)

It is proposed to study the mode of transmission of a hereditary disease controlled by a couple of alleles (A1, A2), where one represents the normal allele while the other represents the mutant one. A healthy couple fears having an affected child. Their doctor makes the prenatal diagnosis. Documents 1 and 2 show the results of the diagnosis made on the fetal cells.

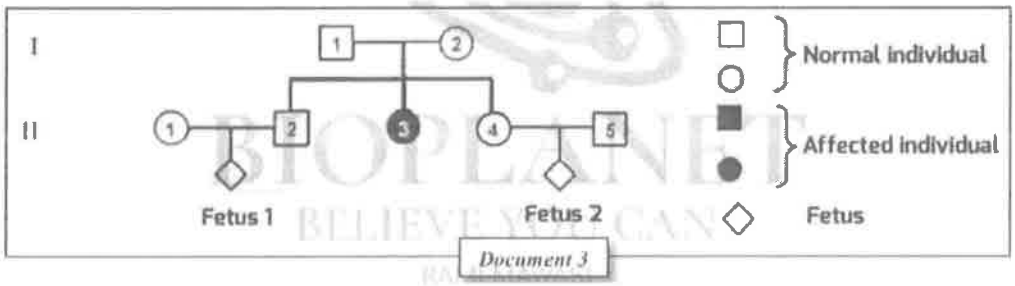
Alleles	A1	A2
Number	1	2
Alleles carried by the fetus		

Document 1



Document 2

1. Based on documents 1 and 2:
   a. Determine whether the allele of the disease is dominant or recessive. (1)
   b. Determine the location of the studied gene. (1)
2. Give a prenatal diagnosis for the fetus. (1)



Document 3

Document 3 represents the pedigree for the family of the couple in question.

Knowing that the individuals II-1 and II-4 have only the A1 allele, and that the two parental gametes at the origin of fetus 2 come from a normal gametogenesis:

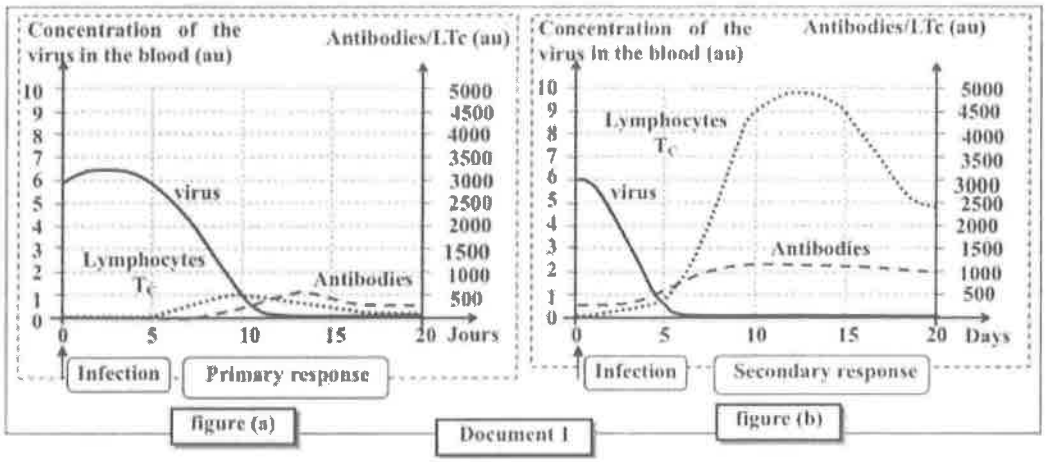
3. Specify which allele corresponds to the allele of the disease. (0.5)

4. Which couple (II-1,II-2) or (II-4,II-5) corresponds to the parents that made a prenatal diagnosis for their fetus in documents 1 and 2. Justify. (1)
5. Write the genotypes of this couple. (0.5)
6. Based on what preceded and using your knowledge, represent a figure to explain the behavior of the chromosomes during the formation of the gametes in the concerned parent, and the corresponding alleles justifying the genotype of the fetus in question. (2)

Exercise 2 (10 points)

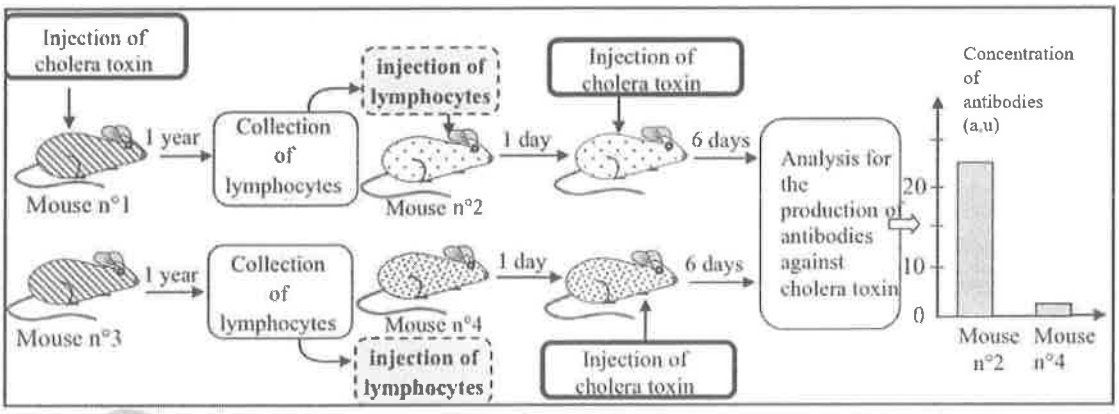
In order to specify some characteristics of the acquired immune response, the following experimental data are presented.

Document 1 presents the immune response against the influenza virus in mice infected for the first time with this virus (figure a) and in other mice infected for the second time with the same virus (figure b).



1. Show, from document 1, that:
   a. The immune response against the virus is cell-mediated and humoral. (1)
   b. The secondary immune response is faster in eliminating the virus than the primary response. (1)
   c. The immune system forms memory against previously encountered antigens. (1)

In order to study the characteristics of the immune memory, an experiment is conducted as shown in document 2. Mice number 2,3 and 4 have never been in contact with the bacterium responsible for cholera or with the toxin it produces.



Document 2

2. Referring to document 2, justify the following statement: the immune system keeps memory for a long time. (2.25)

Mouse dermal cells are cultured in vitro. Some are healthy, others have been infected with either a virus A or B. Cytotoxic lymphocytes taken from other mice of the same line, either healthy or infected with one or the other virus, are added to the medium. Document 3 presents the conditions of the experiment and the fate of the dermal cells.

		Origin of dermal cells		
		Healthy mice	**Mice infected with virus A**	**Mice infected with virus B**
Origin of cytotoxic T lymphocytes	**Healthy mice**	Absence of lysis	Absence of lysis	Absence of lysis
	Mice infected with virus A		Lysis of dermal cells	Absence of lysis
	Mice infected with virus B		Absence of lysis	Lysis of dermal cells

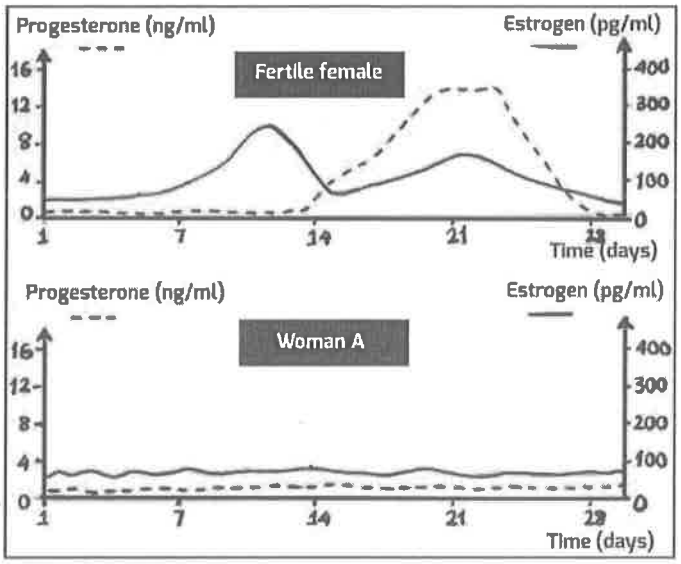
Document 3

3. Interpret the results of the above experiment. (2.25)
4. Explain the mechanism that leads to the destruction of target cells by Tc lymphocytes. (2.5)

Exercise 3 (8 points)

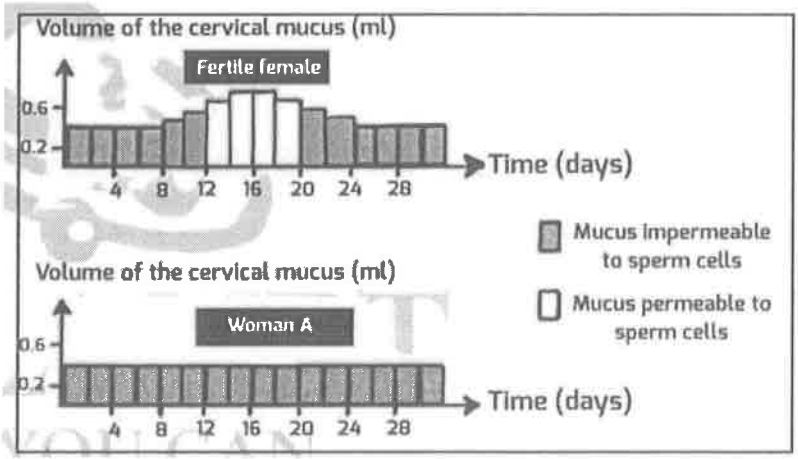
The level of ovarian hormones of a fertile woman and a woman A is measured for 28 days. The results are presented in document 1.

1. Compare the variation of the ovarian hormones in these 2 women. (2)
2. What can you draw out concerning the development of the follicles and the occurrence of ovulation in woman A? (0.5)



Document 1

The variation in the volume and sperm permeability of the cervical mucus in a fertile woman and woman A is studied. The results are presented in document 2.



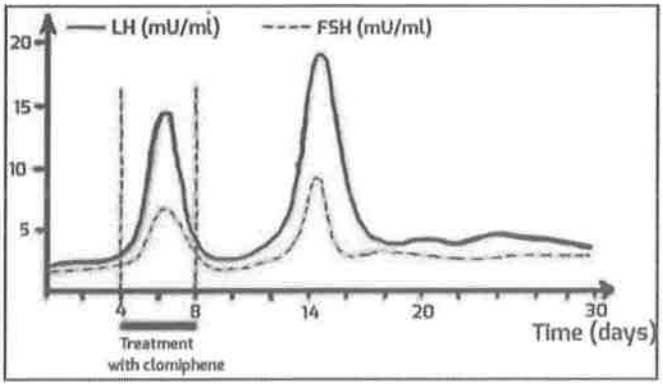
Document 2

3. Determine, based on document 2, the condition needed for the fertile woman to secrete a mucus permeable to sperm cells. (1.25)

Ultrasound of woman's A ovaries, performed during the ovulatory period, reveals many follicles without the presence of a Graafian follicle.

4. Formulate a hypothesis explaining the cause of infertility in this woman. (0.75)

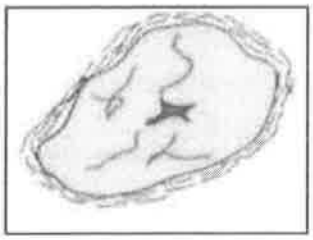
To treat this infertility, the doctor recommends to the woman to take an oral clomiphene tablet for 4 days per sexual cycle. Clomiphene blocks estrogen receptors on hypothalamic and pituitary cells. Document 3 presents the variations of LH and FSH, carried out for 30 days, in women A who underwent the treatment.



Document 3

5. Explain the variation of LH and FSH at day 14 after the treatment with clomiphene. (2.5)

Ultrasound of woman's A ovaries, carried out 15 days after the treatment with clomiphene, reveals the presence of an ovarian structure. Document 4 presents the diagram of this structure.



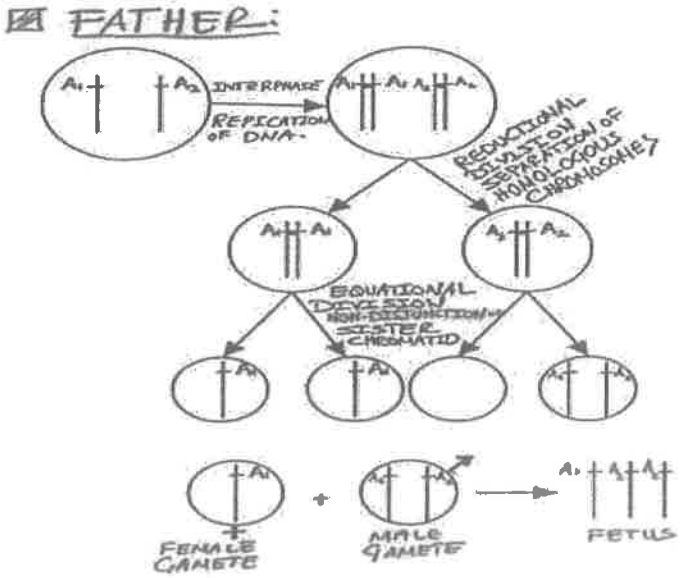
Document 4

6. Show that the treatment with clomiphene is efficient. (1)

Answer Key for Mock 12E

Exercise 1 (7 points)

1. a. Document 1 shows that the fetus has 2 types of alleles A1 and A2. One of these 2 alleles is the allele of the disease and is inherited from one of the parents. It is given that both parents are healthy. This means that the allele of the disease is masked by the normal allele. So, the allele of the disease is recessive. (1)
   b. Document 1 shows that the fetus has 3 alleles (1 A1 and 2 A2). Each allele should be carried by one chromosome or a chromosome can carry 2 alleles of the same gene in the case of a translocation. The karyotype of document 2 shows that there is no translocation and that there are 3 copies of chromosome 21. This means that the alleles are carried by chromosome 21. The studied gene is autosomal. (1)
2. The fetus is normal with respect to the genetic disease but he/she suffers from a chromosomal abnormality: Down Syndrome. (1)
3. The allele of the disease is allele A2 since the 2 individuals II-1 and II-4 are phenotypically normal and they only have allele A1. (0.5)
4. Couple II-1 and II-2 are the parents of the fetus since the fetus suffers from Down Syndrome which means that there is a chromosomal abnormality (non-disjunction) during gametogenesis but it is given that the gametes at the origin of fetus 2 come from normal gametogenesis which means that the couple II-4 and II-5 are not the parents of the studied fetus. (1)
5. II-1: A1 A1 II-2: A1 A2 (0.5)
6. (2)



Exercise 2 (10 points)

1. a. Document 1a shows that the amount of antibodies (effector molecules of the humoral immune response) starts to increase after 7 days of the infection by the virus. Moreover, the number of Tc lymphocytes (effector cells of the cell-mediated immune response) starts to increase (clonal expansion after activation) after 5 days of infection

by the virus. So, the type of immune response against the virus is humoral and cell-mediated specific immune response. (1)

b. In both the primary and the secondary immune responses, the concentration of the virus in the blood starts at 6 a.u. It takes 6 days after the secondary immune response for the virus to disappear from the blood which is a shorter duration than that taken by the primary immune response which is 12 days. So, the secondary immune response is faster in eliminating the virus than the primary response. (1)

c. The amount of secreted antibodies and the number of Tc cells after the second contact with the virus is 1000 a.u. and 5000 a.u. respectively which are greater than those secreted after the first contact with the same virus which are equal to 500 a.u. for both. This amplified response is due to the presence of memory cells. So, the immune system forms memory against previously encountered antigens. (1)

2. Lymphocytes are collected from mouse 1 after 1 year of being injected with cholera toxin and then injected into mouse 2. The same experiment is repeated in parallel but mouse 4 received lymphocytes from mouse 3 that wasn't previously injected with cholera toxin. Both mice 2 and 4 are injected with the cholera toxin after 1 day. The results show that the response is more amplified in mouse 2 where the amount of antibodies secreted is 22 a.u. which is much greater that that secreted by mouse 4 which is equal to 3 a.u. This means that the immune response in mouse 2 is considered as secondary and in mouse 4 as primary. This justifies that the immune system keeps memory for a long time. (2.25)
3. Dermal cells of healthy mice are not destroyed by the Tc lymphocytes regardless from which mice they are removed. But, dermal cells of mice infected by virus A or by virus B are only destroyed by Tc lymphocytes of mice infected by the same virus; respectively virus A or virus B. Thus, Tc only destroy infected cells, specifically those infected by the same virus that activated them. (2.25)
4. The TCR of LT8 performs double recognition by binding to the self MHC Class I-viral peptide complex on the target cell. It then secretes perforin which forms polyperforin channels on the plasma membrane of the target cell, then it releases granzymes which cross the channels and enter the target cell causing the degradation of the DNA and subsequently leading to it destruction by apoptosis. (2.5)

Exercise 3 (8 points)

1. In the fertile woman, during a period of 28 days, the estradiol level shows 2 peaks: the first peak reaches approximately 250 pg/ml around day 12, and a second peak that reaches 150 pg/ml around day 21. On the other hand, woman A shows constant variation of estradiol that fluctuates around 80 pg/ml during the same interval of time.
   In the fertile woman, during a period of 28 days, the progesterone level shows only 1 peak that reaches approximately 15 ng/ml around day 21. On the other hand, woman A shows constant variation of progesterone that fluctuates around 1 ng/ml during the same interval of time. (2)
2. There is no development of follicles and there is no ovulation. (0.5)
3. Document 2 shows that from day 1 to day 12, under the secretion of low and moderate estrogen, also from 20 till the end of the cycle (secretion of both estrogen and progesterone), the cervical mucus is always impermeable to sperm cells but starting from

day 12 and when the ovaries secrete a peak of estrogen alone, the mucus becomes permeable to sperm cells. So, the mucus permeable to sperm cells is secreted only under the effect of a peak of estrogen. (1.25)

4. Hypothesis: the pituitary gland is not secreting FSH and LH. OR the ovaries are not responding to the pituitary hormones. (0.75)
5. From day 4 to 8, the female is taking clomiphene tablets. Clomiphene blocks estrogen receptors at the level of the hypothalamo-pituitary axis. As a result, the hypothalamus and the pituitary gland won't be subjected anymore to the high suppressive effect of the moderate amount of estrogen. Therefore, FSH and LH will be secreted. This explains the increase in LH and FSH to 15 mU/ml and 5 mU/ml respectively during the treatment. Under the effect of secreted FSH, the cavitary follicle develops into a Graafian follicle accompanied by increasing estrogen secretion. The peak of estrogen exerts a positive feedback on the hypothalamo-pituitary axis to increase their secretions. The hypothalamus secretes a peak of GnRH that stimulates the pituitary gland to secrete a peak of LH (18 mU/ml) and FSH (8 mU/ml) at day 14. (2.5)
6. After treatment with clomiphene, a corpus luteum appears in the ovaries. This structure wasn't present before the treatment. Knowing that the corpus luteum appears after ovulation, the treatment was efficient. (1)