الامتحان الوطني الموحد للبكالوريا
المسالك الدولية
الدورة العادية 2020
- الموضوع –

المملكة المغربية
وزارة التربية الوطنية والتكوين المهني والتعليم العالي والبحث العلمي
المركز الوطني للتقويم والامتحانات

SSSSSSSSSSSSSSSSSS | NS 32E

المادة	علومالحياةوالأرض	مدة الإنجاز	3
الشعبةأو المسلك	شعبةالعلومالتجريبيةمسلكعلومالحياةوالأرض (خيارأنجليزية)	المعامل	7

Candidates may use non-programmable calculators

Section I: Knowledge Retrieval (5 pts)

I. Answer the following questions on your answer sheet:

a. Define genetic engineering**.** **(0.5pt)**

b. Give two examples of applications of genetic engineering**,** in the agricultural field and the medical field. **(0.5pt)**

II. For each of the propositions numbered from 1 to 4, there is only one correct suggestion in each set.

C**opy down** these pairs (1; ..), (2; ..), (3; ..), (4; ..), and **match** each number with its corresponding letter. **(2pts)**

1. The replication bubbles appear during : **a** -the prophase; **b**-the interphase; **c**- the metaphase; **d**-the telophase.	**2. The meiosis gives :** **a**- four diploid cells from a diploid mother cell; **b**- two diploid cells from a diploid mother cell; **c**- four haploid cells from a diploid mother cell; **d**- two haploid cells from a diploid mother cell.
3. A person with Down syndrome has: **a**- the chromosome 22 in one exemplar; **b**- the chromosome 21 in three exemplars; **c**- the chromosome 22 in three exemplars; **d**- the chromosome 21 in one exemplar.	**4. Chromosomal formula of a person with klinefelter syndrome is :** **a**- 2n-1= 22AA + Y; **b**- 2n-1= 22AA + X; **c**- 2n+1= 22AA + XXY; **d**- 2n+1= 22AA + XYY.

III. **Copy down** on your answer sheet the letter of each of the following propositions, and **write** whether the statements are « true » or « false »: **(1pt)**

a. Chromosomal abnormality is a modification of the number or the structure of the chromosomes.

b. The reciprocal translocation is the transfer of chromosome fragment to another chromosome.

c. Balanced chromosomal translocation changes the number of chromosome in the individual carrying anomaly.

d. Hereditary recessive disease associated to sexual chromosome X affects females more than males.

IV. Match each modification in the number and aspect of chromosomes (Group 1) to the corresponding phase during which these modifications take place (Group 2).**Copy down** these pairs (1; ..), (2; ..), (3 ;..), (4;..), and **match** each number to its corresponding letter. **(1pt)**

Group 1	Group 2
1. The pairs of homologous chromosomes forming tetrads dispersing in the cytoplasm	**a.** Metaphase I
2. The centromeres of homologous chromosomes situated on either side of cell equatorial plane	**b.** Prophase I
3. The centromeres of chromosomes are situated on cell equatorial plane	**c.** Telophase II
4. The decondensation of unreplicated chromosomes form chromatin	**d.** Metaphase II

Section II: Scientific reasoning and communication in graphic and written modes (15 pts)

Exercise 1 (5 pts)

To understand the role of skeletal muscle in the conversion of chemical energy to mechanical energy during muscle contraction, the following experimental data are proposed:

- **Data 1**

Experiment 1: Different experiments are carried out to identify certain necessary conditions for muscle contraction. Myofibrils are extracted from muscle cells and divided into three media. Document 1 presents the state of these myofibrils before and after the addition of different substances to each medium and obtained results.

1. Based on the document 1, **extract** necessary conditions to muscle contraction. **Justify** your response. **(1.5pt)**

Media	Initial state of myofibrils	Added substances	Results
1	Relaxed	Ca^{++} and ATP	Contraction
2	Relaxed	Ca^{++}, ATP and Salyrgan	No contraction
3	Relaxed	Ca^{++}, ATP and EGTA	No contraction

Document 1

NB: - the Salyrgan inhibits ATP hydrolysis.
- The Chelator EGTA fixes the Ca^{++}ions, inhibiting their action.

Experiment 2: we cultivate muscle fiber in medium containing radioactive Ca^{++} ions. We observe by autoradiography that radioactivity is localized in reticulum sarcoplasmic when muscle fibers are relaxed and in sarcoplasm when muscle fibers are contracted.

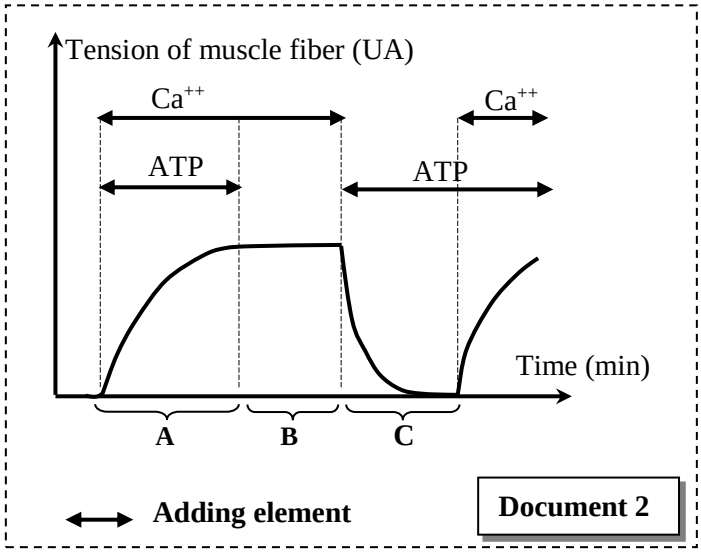
2. Based on data of experiment 2**, link** the localization of calcium to muscle fibers status. **(0.5pt)**

- **Data 2**

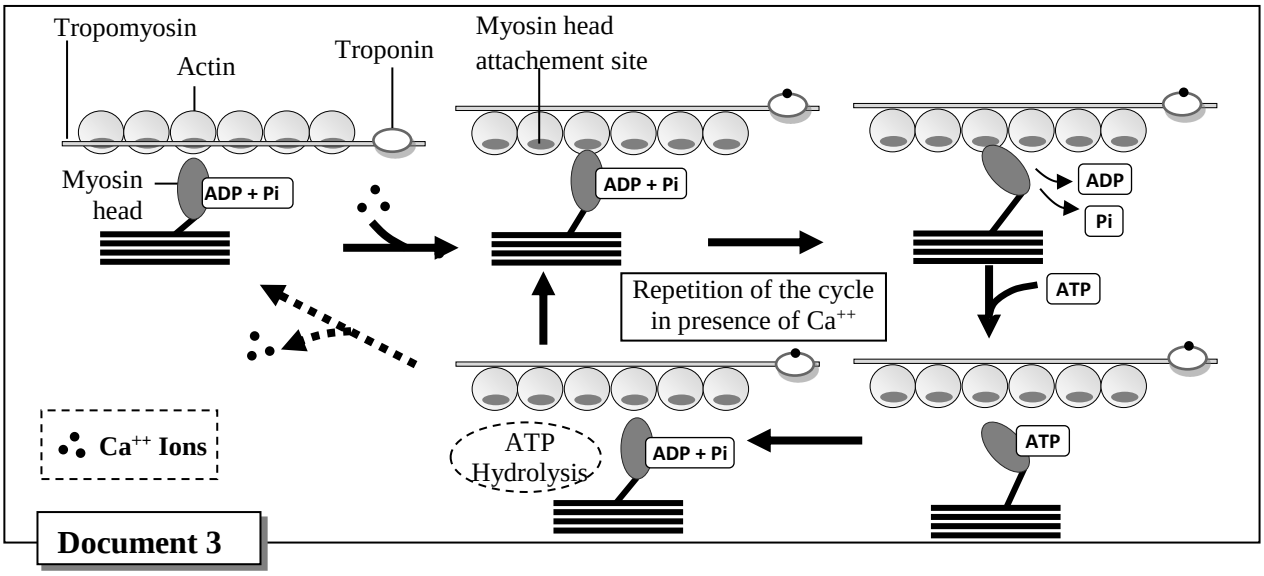
During the contraction of a muscle fiber, interactions between actin and myosin myofilaments take place. These interactions consume ATP, which is an essential source of energy for muscle contraction.

The document 2 presents the evolution of the tension of a muscle cell exposed to different experimental conditions.

The document 3 presents the interactions between myosin and actin at the origin of muscle contraction.



Document 2



Document 3

3. based on document **3**, **explain** the evolution of tension in muscle fiber observed in document **2** during contraction phase (phase A) and during relaxation phase (phase C). **(2pts)**

- **Data 3:**

Rigor mortis is the stiffening of a body after death. It's characterized by immobilization of striated skeletal muscle. It starts quickly after violent death (drowning) and disappears when putrefaction (corpse decomposition) starts. After death the cell doesn't produce ATP and its reserves of these molecules deplete quickly.

4. By exploiting the data from document **2** (phase B) and by help of document **3**, **suggest an explanation** of the phenomenon of rigor mortis. **(1pt)**

Exercise 2 (6.5 pts)

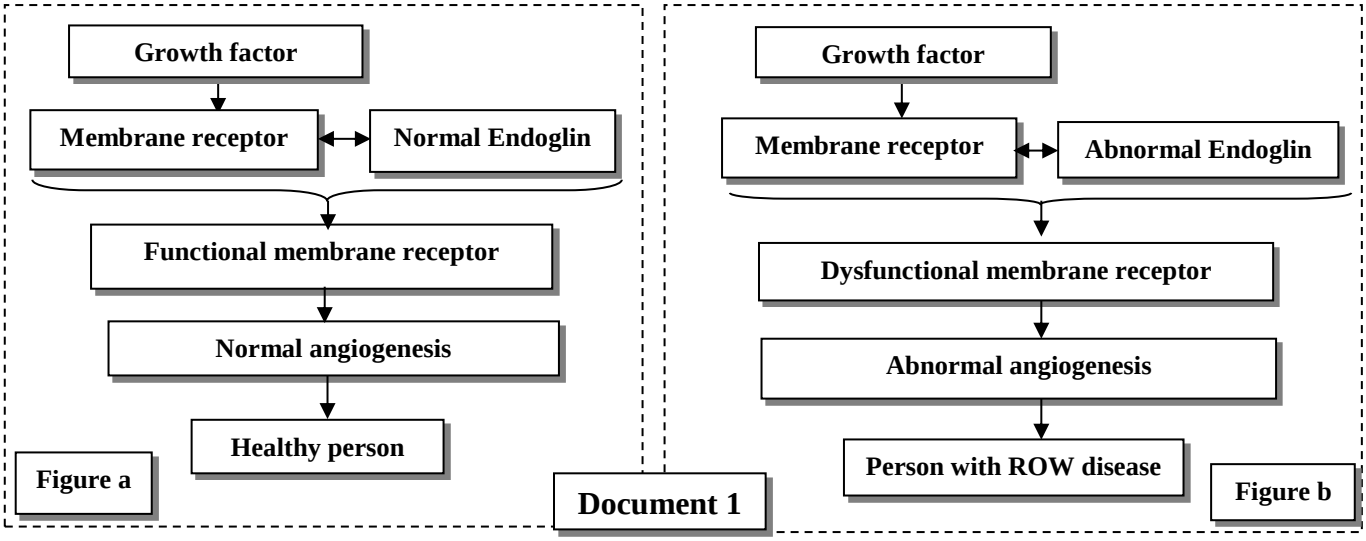
Rendu-Osler-Weber (ROW) is a hereditary disease. Some symptoms of this disease include, frequent spontaneous nosebleeds, digestive hemorrhages and liver damage. These symptoms are due to arteriovenous malformations that result in the absence of capillary networks between arteries and veins.

To determine the genetic origin of this disease, we suggest the following data:

- **Data 1**

Several growth factors interact with membrane receptors of blood vessel cells to activate angiogenesis (blood vessel proliferation). The functioning of the membrane receptors requires the intervention of a protein called "Endoglin" consisting of 633 amino acids. Research has shown the relationship between this protein and ROW disease.

The figures (a) and (b) in Document 1 represent the relationship between Endoglin and the activity of a membrane receptor that plays a part in the angiogenesis in a healthy person (figure a) and a person with ROW disease (figure b).



Document 1

1. **Use** document **1**, then **show** the protein-trait relationship. **(0.75pt)**

- **Data 2**

The synthesis of Endoglin is controlled by a gene called (Eng) which exists in two allelic forms. The document 2 presents a fragment of the normal allele (untranscribed strand) in a healthy person and a fragment of the abnormal allele (untranscribed strand) in a person with ROW disease. The document 3 presents the table of the genetic code.

				Reading direction →				
Number of triplet	1	2	3	4	5	6	7	8
Fragment of a normal allele	CCC	CAC	GTG	GAC	AGC	ATG	GAC	CGC
Fragment of an abnormal allele	CCC	CAC	ATG	GAC	AGC	ATG	GAC	CGC

Document 2

letter 1 \ letter2	U		C		A		G		Letter 3
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC		UCC		UAC		UGC		C
	UUA	Leu	UCA		**UAA**	STOP	**UGA**	STOP	A
	UUG		UCG		**UAG**		UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	Gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	Lys	AGA	Arg	A
	AUG	Met	ACG		AAG		AGG		G
G	GUU	Val	GCU	Ala	GAU	Ac.asp	GGU	Gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	Ac.glu	GGA		A
	GUG		GCG		GAG		GGG		G

Document 3

2. Based on document **1**, **2** and **3**, **give** mRNA and the amino acids sequences corresponding to two fragments of the normal allele and the abnormal allele, then **explain** the genetic origin of the disease. **(1.5pts)**

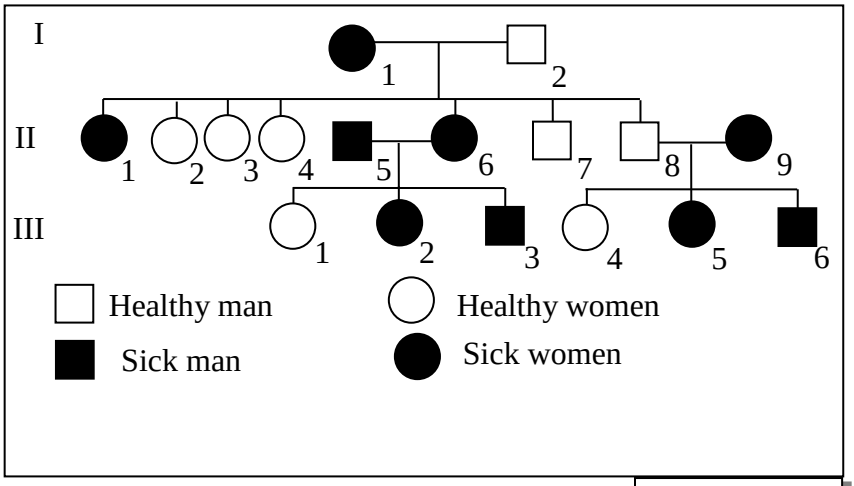
- **Data 3**

The document **4** presents a pedigree of a family whose members are affected by ROW disease.

3. Based on document **4**:

a. show that the allele responsible for the disease is dominant and the studied gene is carried by non-sexual chromosome (autosome). **(1.25pts)**

b. Use Punnett Square to **determine** the probability that couple II_8 and II_9 would give birth to a healthy child. **(1pt)**



Document 4

(Use the symbols R and r for the two alleles of the studied gene)

- **Data 4**

The ROW disease is a rare hereditary disease. In a given population it affects one person in 5000.

4. Let's suppose that this population abides by the Hardy-Weinberg equilibrium:

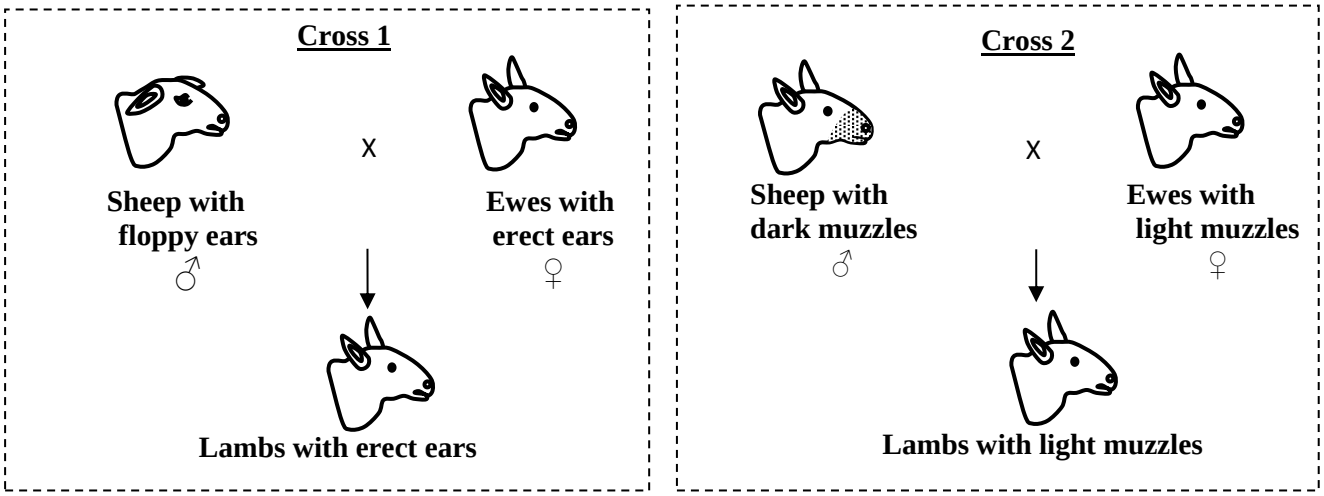
a. Calculate the frequency of the allele responsible for the disease and that of the normal allele. **(1.25pts)**

b. Calculate the frequencies of the different genotypes of the study population. **(0.75pt)**

N.B: Give only four digits after the decimal point in numerical applications.

Exercise 3 (3.5 pts)

To study the transmission of certain hereditary traits in sheep (the shape of the ears and the color of the muzzle), it is suggested to exploit the results of the following crosses:



1. What do you **deduce** from the results of the two crosses 1 and 2? **Justify** your answer. **(1pt)**

● Cross 3:

The test cross between sheep with dominant phenotype for both traits with double-recessives sheep yielded the following results:

- 45 lambs with erect ears and light muzzles;
- 38 lambs with floppy ears and dark muzzles;
- 9 lambs with erect ears and dark muzzles;
- 8 lambs with floppy ears and light muzzles.

2. Show that the two genes studied are linked and **deduce** the genotypes of the parents in the 3rd cross. **(1pt)**

3. Use Punnett square to **Interpret** the results obtained in this cross. **(1pt)**

4. Establish gene maps of the two genes studied. **(0.5pt)**

Use the following symbols: *-**D** and **d** for alleles responsible for the shape of the ears;*

*-**S** and **s** for alleles responsible for the color of the muzzle.*

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- عناصر الإجابة –

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وزارة التربية الوطنية والتكوين المهني والتعليم العالي والبحث العلمي
المركز الوطني للتقويم والامتحانات

SSSSSSSSSSSSSSSSSS | NR 32E

المادة	علوم الحياة والأرض	مدة الإنجاز	3
الشعبة أو المسلك	شعبة العلوم التجريبية مسلك علوم الحياة والأرض (خيار أنجليزية)	المعامل	7

Key and marking scale

Questions	Response elements	Scores
Section I : Knowledge Retrieval (5 pts)		
I	**a- definition** (accept any correct definitions) **Genetic engineering:** set of techniques used to modify genetic cell or organism in order to express new traits …… **b- two example of application of genetic engineering:** -in agricultural field: producing plants resistant to pests …….. -in medical field: producing human insulin……	**0.5** **0.25** **0.25**
II	(1, b) ; (2, c) ; (3, b) ; (4, c) ……	**0.5x4**
III	1- true 2- false 3- false 4- false …..……	**0.25x4**
IV	(1, b) ; (2, a) ; (3, d) ; (4, c) ……..…….……	**0.25x4**
Section II : Scientific reasoning and communication in graphic and written modes (15 pts)		
Exercise 1 (5 pts)		
1	**Necessary conditions of muscle contraction:** Presence Ca^{++} ions…… ATP hydrolysis…… **Justification** (any correct justifications is accepted) By inhibiting ATP hydrolysis of ATP (medium 2), the myofibrils don't contract... By inhibiting the action of Ca^{++} ions (medium 3) the myofibrils don't contract….	 **0.25** **0.25** **0.5** **0.5**
2	Ca^{++} ions in sarcoplasmic reticulum→ relaxed fibers …….... Ca^{++} ions in sarcoplasm → contracted fibers ……	**0.25** **0.25**
3	**Explanation of the evolution of tension of muscle fiber** **During contraction phase (phase A)**…… - fixation Ca^{++} ions on the troponin and tropomyosin displacement → exposing the binding sites to the myosin heads in actin and forming the actin-myosin complex → release the ADP and Pi → the myosin heads swiveling and sliding of myofilaments (contraction of the muscle fiber) → the actin-myosin complex is dissociated by ATP → ATP hydrolysis and myosin heads returning to their original status and resume the cycle of contraction. **During relaxation phase (phase C):** …… In the absence of Ca^{++} ions, the actin-myosin complex is not formed → relaxation of muscle fiber even though the ATP is present.	**0.25x6** **0.25x2**

4	**Explanation of the Rigor Mortis ……..……** Exhaustion and non-renewal of the ATP after death → the actin-myosin complex is not dissociated (document 3) → stop of muscle contraction cycle in contraction phase (document 3) → maintaining strong muscle tension (Phase B of document 2) causing rigor mortis.	**0.25x4**
	Exercise 2 (6.5 pts)	
1	**Protein-trait relationship:** - With normal Endoglin, the complex "membrane receptor-growth factor" is functional so a normal angiogenesis → healthy person ……..…..… - With abnormal Endoglin, the complex "membrane receptor-growth factor" is dysfunctional so an abnormal angiogenesis→ person with ROW disease…… - So any modification in the protein Endoglin causes a modification in the trait (healthy or sick person)…….……	**0.25** **0.25** **0.25**
2	**mRNA sequences corresponding to:** - the normal allele fragment **: ……..** CCC-CAC- GUG- GAC-AGC-AUG-GAC-CGC - the abnormal allele fragment **: ……..** CCC-CAC- AUG- GAC-AGC-AUG-GAC-CGC **Amino acids sequences corresponding to :** - the normal allele fragment **: ……..** Pro-His-Val-Ac.asp-Ser-Met- Ac.asp -Arg - the abnormal allele fragment**: ……..……..** Pro-His-Met- Ac.asp -Ser-Met- Ac.asp -Arg Mutation by substitution of first nucleotide **G** for **A** at the level of third triplet of un transcribed strand (DNA) → incorporation the **Met** instead of **Val** in amino acid sequence → synthesis abnormal Endoglin protein →abnormal angiogenesis (the ROW disease appear). ……..…	**0.25** **0.25** **0.25** **0.25** **0.5 pt**
3	**a. The responsible allele for disease is dominant and the studied gene is carried by an autosome:** The daughter III_1 is healthy phenotype while her parents II_5 and II_6 are sick phenotype → parents are heterozygous→ responsible allele for disease is dominant. **(Accept also the answer: any person affected must descending from affected person)**…….. -The disease is present in both sexes → the responsible allele is not carried by chromosome Y. ……..…… -The daughter III_1 is healthy, her father II_5 is sick and responsible allele for disease is dominant → the girl III_1 will inherit of her father the responsible allele for diseases so the daughter should be affected → the responsible allele for disease is not carried by chromosome X **(accept any correct answers)**…… →the responsible allele for disease is not carried by chromosome X or chromosome Y so the responsible allele for disease is carried by autosome…..… **b. the probability for that couple II_8et II_9 to give birth to healthy child:** Parents : II_8 ♂ **x** II_9♀ Phenotypes : [r] [R] Genotypes : r//r R//r Gametes : r/ 1 R/ ½ r/ ½	**0.5** **0.25** **0.25** **0.25** **0.25x2**

	Punnet square: …… Gametes ♂ / ♀ : r 1 ; R 1/2 ; r 1/2 (R//r) [R] 1/2 ; (r//r) [r] 1/2 The probability for that couple II_8et II_9 to give birth to healthy child is ½ ……	**0.25** **0.25**
4	**a. The frequency of the normal allele and abnormal allele** **we have :** f ([R])= $p^2 + 2pq = 1/5000$ **we know** $p^2 + 2pq + q^2 = 1$ **So** $q^2 = 1 - 1/5000 = 0.9998$ …… - Normal allele frequency is: f (r) = q= **0.9998**…… - Abnormal allele frequency is: f(R) = p = 1- q = **0.0002**…… **b. The frequencies of different genotypes in studied population.** f (r//r) = $q^2 \approx 0.9998$…… f (R//r)= $2pq \approx 0.0003$…… f(R//R)= $p^2 \approx 0$……	**0.25** **0.5** **0.5** **0.25** **0.25** **0.25**
	Exercise 3 (5 pts)	
1	**Deduction and justification**: -We study transmission of a hereditary trait for each cross→ monohybrid cross… -The descending of two crosses are homogenous→ the parents are for pure lineage according to Mendel's first law …….. -The descendants of the first cross have erect ears→ responsible allele for erect ears form is dominant (D) and responsible allele for floppy ears is recessive (d)… -The descendants of the first cross have light muzzle→ responsible allele for light muzzle is dominant (S) and responsible allele for dark muzzle is recessive (s)…..	**0.25** **0.25** **0.25** **0.25**
2	The test cross gives two parental phenotypes with a percentage 83% upper to percentage of recombined phenotype 17% (Mendel's third law is not verified) →The two studied genes are linked…… **Deduction** : the parental genotype The genotype of sheep with dominant phenotype : $\frac{D\ S}{d\ s}$ The genotype of double recessives sheep : $\frac{d\ s}{d\ s}$	**0.5** **0.25** **0.25**

3

Chromosomal interpretation of the third cross with Punnet square:

Phenotypes : ♀ [D,S] x [d, ه] ♂

Genotypes : $\frac{D\ S}{d\ ه}$ $\frac{d\ ه}{d\ ه}$

Gametes : 45% $\frac{D\ S}{}$ 38% $\frac{d\ ه}{}$ 9% $\frac{D\ ه}{}$ 8% $\frac{d\ S}{}$; 100% $\frac{d\ ه}{}$ **0.25x2**

Punnet square : …… **0.5**

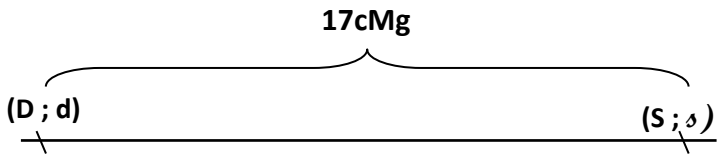
♂ \ ♀	$\frac{D\ S}{}$ 45%	$\frac{d\ ه}{}$ 38%	$\frac{D\ ه}{}$ 9%	$\frac{d\ S}{}$ 8%
$\frac{d\ ه}{}$ 100%	$\frac{D\ S}{d\ ه}$ 45% [D, S]	$\frac{d\ ه}{d\ ه}$ 38% [d, ه]	$\frac{D\ ه}{d\ ه}$ 9% [D, ه]	$\frac{d\ S}{d\ ه}$ 8% [d, S]

4

The map gene of two studied genes:

The percentage of the recombined phenotype is 17%, so the distance between two genes is 17cMg…… **0.25**

scale: 1cm → 2 cMg **(Accept any appropriate scale)**



0.25

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