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الامتحان الوطني الموحد للبكالوريا
المسالك الدولية - خيار أنجليزية
الدورة الاستدراكية 2017
- الموضوع -

RS 36E

المملكة المغربية
وزارة التربية الوطنية والتكوين المهني والتعليم العالي والبحث العلمي

المركز الوطني للتقويم والامتحانات والتوجيه

المادة	علوم الحياة والارض	مدة الإنجاز	2
الشعبة أو المسلك	مسلك العلوم الرياضية (أ) – خيار أنجليزية	المعامل	3

Candidates may use non-programmable calculators

Section I : Knowledge Retrieval (5 pts)

I –Answer the following questions:

a – **Define:** meiosis. **(0.5 pt)**

b– **State** two roles of fertilisation in the transmission of genetic information occurring through sexual reproduction. **(0 ,5 pt)**

II. For each proposition 1 and 2, **copy down** the letters (a-b-c-d) corresponding to the statements and **say** whether those statements are "**true**" or "**false**".

Proposition 1: in the case of humans affected by an autosomal hereditary disease linked to a recessive allele : (1 pt)

a	the gene responsible for this disease is located on a sex chromosome.
b	a person having a homozygous recessive allele is affected by this disease.
c	the gene responsible for this disease is located on the autosomal chromosome.
d	any individual affected by this disease is heterozygous.

Proposition 2: in the case of humans affected by a hereditary disease linked to X chromosome and controlled by a dominant allele: (1 pt)

a	any individual of female sex with the heterozygous genotype is normal.
b	any individual of male sex bearing the dominant allele is affected by this disease.
c	any individual of female sex with homozygous recessive allele is normal.
d	any individual of male sex bearing the recessive allele is affected by this disease.

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

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

1– sexual reproduction allows the genetic recombination because :
a : all reproductive cells have the same genetic information ;
b : the gametes meet randomly during fertilisation;
c : all parents' hereditary traits are preserved from one generation to the next ;
d : the male gamete and female gamete have the same alleles.

2 – human Karyotype:
a : is composed of 23 chromosomes ;
b : is all the autosomal chromosomes of an individual ;
c : allows to reveal an abnormal chromosome count in numbers ;
d : represents all chromosomes having the same size .

3 – a person affected by Down syndrome:
a: has the X chromosome in 3 homologous copies;
b : has the 21st chromosome in 3 homologeous copies;
c: has 21 homologous chromosomes ;
d: has 21 non-homologous chromosomes .

4– the chromosomal formula of an individual affected by Klinfelter syndrome is :
a : 2n = 44 A + XY ;
b : 2n +1 = 44 A + XXY ;
c: 2n – 1= 44A + X ;
d: 2 n +1 = 44 A + XYY.

Section II: Scientific Reasoning and Communication in graphic and written modes (15 pts)

Exercise1 : (5 points)

In order to establish the gene map concerning three genes located on chromosome 5 in the tomato plant (the gene responsible for the colour of branches, the gene responsible for the fruit shape and the gene responsible for the presence of hairs on branches), we suggest the study of the following data:

- **First data:** Table 1 presents the results of crosses that have dealt with transmission of colour-trait in tomato branches :

Table 1

	Parents' phenotypes		Offspring phenotypes
First cross	P_1: **Green branches**	P_2 : **Green branches**	**100% of Green branches**
Second cross	P_1: **Purple branches**	P_2 : **Green branches**	50% of **Purple branches** 50% of **Green branches**
Third cross	P_1: **Purple branches**	P_2 : **Purple branches**	75% of **Purple branches** 25% of **Green branches**

1. Using these results:

a. **Determine** the dominant allele and the recessive allele. **Justify** your answer. **(0.5 pt)**
b. **Copy down** Table 2, and **complete** it by **determining** the parents' genotype for each cross. **(0.75pt)**

NB. Use the following symbols:

*- **(G)** for the dominant allele and **(g)** for the recessive allele;*

Table 2

	Parents' genotype	
First cross	P_1:	P_2 :
Second cross	P_1:	P_2 :
Third cross	P_1:	P_2 :

- **Second data:** The gene responsible for the fruit shape has two alleles: the dominant allele (F) responsible for the phenotype « normal fruit » and the recessive allele (f) responsible for the phenotype « fasciated fruit ».

2. Based on the previous data**, determine** the possible genotypes of individuals with « purple branches and fasciated fruit » phenotype. **Justify** your answer. **(1pt)**

- **Third data:** In order to determine the genotypes of a plant with « purple branches and fasciated fruit », a cross between this plant and a plant with « green branches and fasciated fruit » has been carried out. This cross gives the followings results:
  50% of plants with « purple branches and fasciated fruit ».

50% of plants with « green branches and fasciated fruit ».

3. By exploiting the results of the third data:

a. Deduce the genotype of the plant with « purple branches and normal fruit ». **(0.25pt)**

b. Interpret and **use** Punnett square to explain the results obtained in this cross. **(0.75pt)**

In order to determine the distance between the two genes located on chromosome 5 in the tomato plant: one responsible for the colour of branches and the other responsible for the fruit shape, a test cross has been conducted between a double heterozygous plant (with purple branches and normal fruit) and a double homozygous recessive plant. The results obtained in this test cross are shown below in **Table 3**:

Table 3	Purple branches and normal fruit	Purple branches and fasciated fruit	Green branches and normal fruit	Green branches and fasciated fruit
Number of plants	385	115	115	385

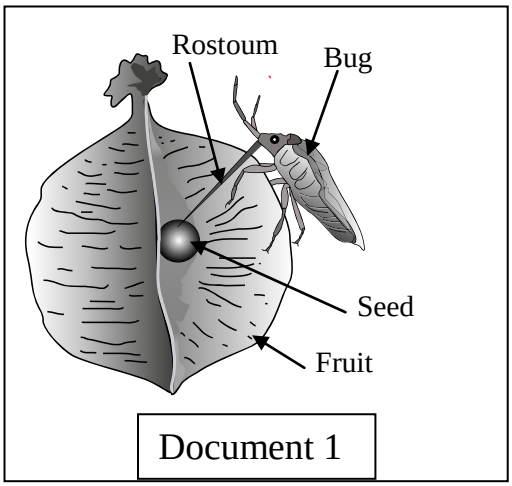
4. Calculate the distance separating the two genes on chromosome 5. **Justify** your answer. **(0.75 pt)**

- **Fourth data:** The gene with two alleles (H and h), responsible for the presence of hair on the tomato branches, is found on chromosome 5 with a distance of 18 cM with regard to the gene responsible for the colour of those branches.

5. Draw the two possible gene maps representing the relative position of the three studied genes (the gene responsible for the colour of branches, the gene responsible for the fruit shape and the gene responsible for the presence of hairs on branches) on chromosome 5. (Use 0.25cm for 1 cM). **(1 pt)**

Exercise 2 : (10 points)

To highlight the action of the variation factors on the genetic structure of a given population, genetic studies have been conducted in Florida on the populations of the soapberry bug. This insect feeds on the seeds of a species tree called *cardiospermum corindum*, but this insect can easily colonise other species of trees called *koelreuteria elegans*.



Document 1

I. The females of soapberry bugs feed on immature fruit seeds using their long and fine rostrums as a needle to pierce the seed coat (see document 1).

In the females of soapberry bugs, the distribution of the rostrum length varies according to the species of trees they feed on.

In 1988 in Florida State (USA) two populations of the soapberry bugs (P_1 and P_2) were observed:

- Population (P_1) in the center and north of Florida fed on the seeds of *koelreuteria elegans* because the *cardiospermum corundum* was absent in these regions;
- Population (P_2) in the south of Florida fed on the seeds of *cardiospermum corindum* because the *koelreuteria elegans* was absent in this region.

The table below (document 2) shows the frequency distribution of the rostrum length in females of population (P_1), and document 3 presents the histogram of frequency distribution of rostrum length and the statistical parameters ($\bar{X}$ and σ) in females of the population (P_2).

Central classes (mm)	6,125	6,375	6,625	6,875	7,125	7,375	7,625	7,875	8,125
Number of females	2	6	6	8	11	2	2	1	2

Document 2

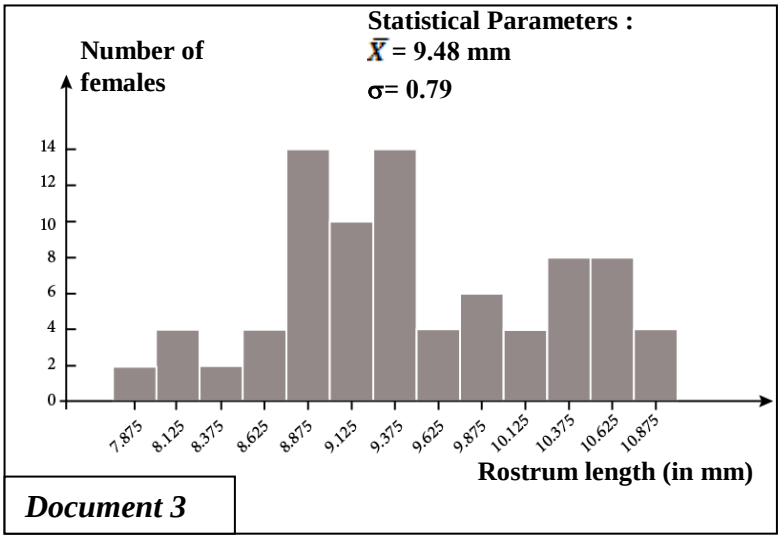
1. Draw the frequency histogram and the frequency distribution polygon of the rostrum length (in mm) in the females of population (P_1). **(1,5 pts)**

** Use 1cm for each class and 1cm for two females.*

2. Calculate the arithmetic mean and the standard deviation in the female population (P_1). **Use** the table where you set out the results to calculate these statistical parameters. **(2 pts)**

Use the following formula:

$$\bar{X} = \frac{\sum_1^i (fixi)}{n} \quad \text{and} \quad \sigma = \sqrt{\frac{\sum_1^i fi(xi-\bar{X})^2}{n}}$$



Document 3

3. Exploiting document **3** and the frequency histogram and the polygon you drew in question n°1, **compare** the distribution of rostrum length in females of the two populations (P_1 and P_2). What do you **deduce** concerning rostrum length in these two populations? **(1,5 pts)**

II. In order to determine the factor of variation responsible of the bugs' distribution according to the rostrum length, we propose the followings data:

- At the beginning of the 20th Century, the soapberry bug was only found in the regions where the *cardiospermum corindum* was largely spread: in the south of Florida and in some limited regions in the north and the center of this State;

- In the1930's, *koelreuteria elegans* was planted in all central and northern cities of Florida. These trees became very common in these cities starting from the 50's.

- ever since the plantation of the *koelreuteria elegans*, the soapberry bugs, feeding on the seeds of this tree, have been noticed and the individuals of this population have multiplied more and more.

The table below (document 4) summarises the characteristics of the bug population before and after the plantation of the *koelreuteria elegans* in the center and the north of Florida.

	Number of individuals	The average length of rostrum
Before the plantation of the *koelreuteria elegans*	low	high
After the plantation of the *koelreuteria elegans*	high	low

Document 4

4. Based on the data of document 4, **determine** the changes brought about in the bugs' population after the plantation of the *koelreuteria elegans* in the center and the north of Florida. **(1 pt)**

- The fruits of the *koelreuteria elegans* and the *cardiospermum corindum* differ in size and shape.

The table below **(document 5**) presents the comparison of some characteristics of the *koelreuteria elegans* and the *cardiospermum corindum*.

Fruit characteristics / Tree species	Distance to reach the seed from the fruit surface	Fruit shape
cardiospermum corindum	11.2 mm	allows to the long rostrum to reach the seed.
		does not allow the short rostrum to reach the seed.
koelreuteria elegans	2.82 mm	allows the short rostrum to reach the seed.
		does not allow the long rostrum to reach the seed.

Document 5

5. Describe the data in document 5, then **suggest** an explanation of the changes brought about in the bugs' population after the plantation of the *koelreuteria elegans* in the center and the north of Florida. **(1,5 pts)**

- Some studies have shown that:
  - The rostrum length in the soapberry bug is the genetic trait which is transmitted from one generation to the next;
  - The availability of the food allows the maturation of ova in the females, thus promoting their multiplication.

6. Based on the previous data, **determine** the variation factor studied, **explaining** how it can influence the genetic structure of the bugs' population in the center and the north of Florida. **(2,5 pts)**

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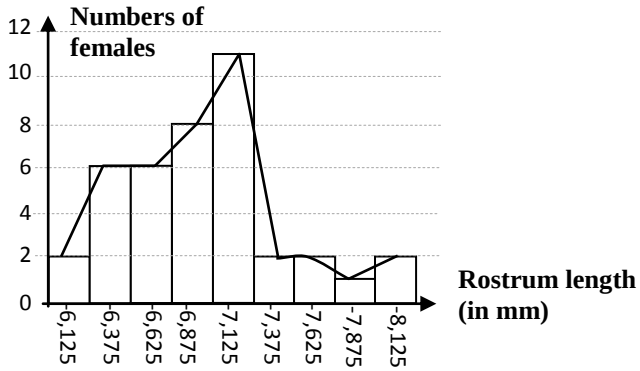
Key and Marking Scale

Section I : Knowledge Retrieval (5 pts)		
Questions		**Scores**
I	**a- Definition:** ***(Accept any appropriate answer).*** **- Meiosis** : a cell division that results in four daughter cells each with half of the number of chromosomes **(**n) (**haploid)** of the parent cell (**diploid)** (2n), as in the production of gametes and plant spores ……..….... (0.5 pt) **b- Two roles of fertilisation :** - restores the diploid numbers of chromosomes…….. (0.25 pt) - allows the genetic recombination by independent assortment via the random meeting and fusion of gametes. ……..…… ……..(0.25 pt)	**1 pt**
II	**1-** a : False ; b : True ; c : True ; d : False ……..…..0.25 x 4	**1 pt**
	2- a : False ; b : True ; c : True ; d : False ……..…..0.25 x 4	**1 pt**
III	(1 ; b) ; (2 ; c) ; (3 ; b) ; (4 ; b) ……..…… 0.5 x 4	**2pts**
Section II : Scientific reasoning and communication in graphic and written modes (15pts)		
Questions	**Exercise 1 (5 points)**	**Scores**
1	**a.** The allele responsible for the green-branch trait is recessive and the allele responsible for the purple-branch trait is dominant. ……...……(0.25 pt) **Justification:** in the 3th cross, the green-branch trait was hidden in the parents and it appeared in the offspring. ……..……..(0.25pt) **(Accept any correct justification, for example:** the purple-branch trait is in the ratio of 75% and the green-branch trait is in the ratio of 25%)	**1.25 pts**
	b. Parents' genotypes…… (0.75 pt)	
2	The two possible genotypes are : $\frac{G\ \ f}{G\ \ f}$ et $\frac{G\ \ f}{g\ \ f}$ ……..…(0.25 x 2= 0.5 pt) **Justification** : - The allele (**f**) responsible for the fascinated-fruit trait is recessive → the genotype of the « fasciated fruit » is f//f……..…….……(0.25 pt) - The allele (**G**) responsible for the purple- branch trait is dominant → the genotype of the « purple branches » is G//G or G//g……..…….. (0.25 pt)	**1 pt**
	a. The genotype of this plant is : $\frac{G\ \ f}{g\ \ f}$ ……..(0.25 pt)	

	Parents' genotypes	
First cross	**P_1: g//g**	**P_2: g//g**
Second cross	**P_1: G//g**	**P_2: g//g**
Third cross	**P_1: G//g**	**P_2: G//g**

3	**b.** Chromosomal interpretation : Phenotypes : [G , f] × [g , f] Genotypes: $\frac{G\ \ f}{g\ \ f}$ × $\frac{g\ \ f}{g\ \ f}$ Gametes: 50% G f 50% g f g f 100% ……..(0.25 pt) Punnett square: : ……..…… (0.5 pt) ♀ / ♂ | 50% G f | 50% g f 100% g f | G f / g f ½ [G,f] | g f / g f ½ [g,f] Theoretical results are: 50% [G, f] and 50% [g, f]. → the theoretical and experimental results are similar.	**1 pt**
4	Calculation of the distance between the two genes: - The rate of the recombined phenotypes in this test cross is: ((115 +115)/(115+115+385+385)) x 100 = 23%……...(0.5 pt) - The distance is: 23 cM ……(0.25 pt)	**0.75 pt**
5	The two possible gene maps are : ……..……(0.5 x 2= 1pt) 1st case: G — 18 cM — H — 23 cM — F 2nd case: H — 18 cM — G — 23 cM — F ***NB.*** *The suggested scale must be respected.*	**1 pt**
Questions	**Exercise 2 (10 points)**	**Scores**
I - 1	Give full mark for the correct frequency histogram and frequency distribution polygon.  	**1.5 pt**

I - 2 — **2 pts**

Mark just the four last columns - (0,25 pt) for each column : ……(1 pt)

central classes (xi)	frequency (fi)	$fi.xi$	$xi - \bar{X}$	$(xi - \bar{X})^2$	$fi(xi - \bar{X})^2$
6.125	2	12.25	-0.82	0.67035156	1.34070313
6.375	6	38.25	-0.57	0.32347656	1.94085938
6.625	6	39.75	-0.32	0.10160156	0.60960937
6.875	8	55	-0.07	0.00472656	0.0378125
7.125	11	78.375	0.18	0.03285156	0.36136719
7.375	2	14.75	0.43	0.18597656	0.37195313
7.625	2	15.25	0.68	0.46410156	0.92820313
7.875	1	7.875	0.93	0.86722656	0.86722656
8.125	2	16.25	1.18	1.39535156	2.79070313
Total	**40**	**277.75**			**9.2484375**

$\bar{X}$ = 277.75 /40 = 6.94 mm ..... (0.5pt)

$$\sigma = \sqrt{\frac{9{,}24844375}{40}} = 0{,}48 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (0{,}5\ pt)$$

I - 3 — **1.5pt**

In the females of population (P_1):
- the rostrum length varies between 6.125 mm and 8.125 mm .....(0.25pt)
- the arithmetic mean of the rostrum length is 6.94 mm…….....(0.25pt)

In the females of population (P_2):
- the rostrum length varies between 7.825 mm and 10.875 mm ..... (0.25pt)
- the arithmetic mean of the rostrum length is 9.48 mm…….....(0.25pt)
- Population (P_1) is more dispersed than population ($P_{2)}$ ……..(0.25 pt)

Deduction: the bugs that feed on seeds of the *koelreuteria elegans* have short rostrums whereas the bugs that feed on seeds of the *cardiospermum corindum* have long rostrums..... (0.25pt)

II - 4 — **1pt**

The changes observed in the bugs' population after the plantation of the *koelreuteria elegans* in the center and the north of Florida are:
- increase in the number of individuals in the population ……..…….... (0.5pt)
- decrease of the value of arithmetic mean of the rostrum length…….… (0.5pt)

II - 5 — **1.5pt**

The distance to reach the seed from the fruit surface is :
- short for the *koelreuteria elegans*..... (0.25pt)
- long for the *cardiospermum corindum*..... (0.25pt)
- For the *koelreuteria elegans*, the fruit shape allows only the **short rostrum bugs** to reach the seed. ……(0.25pt)
- For the *cardiospermum corindum*, the fruit shape allows only the **long rostrum bugs** to reach the seed…….(0.25pt)

Explanation :
- Due to the fruit shape, the bugs with long rostrums are not capable of feeding on the seeds of the *koelreuteria elegans* → reproduction of these insects is reduced. ……(0.25pt)

	- abundance of the *koelreuteria elegans* in the center and the north of Florida after 1950 enabled the bugs with short rostrums to easily find food in comparison with the bugs with long rostrums .So this first kind of bugs were able to reproduce and therefore their number increased. ……(0.25pt)	
II - 6	- The evolutionary factor studied is **natural selection**. .....(0.5pt) **Explanation :** →For the *koelreuteria elegans*, access to food is easier for the short rostrum bugs in comparison to the long rostrum bugs .....(0. 5pt) → maturation of the ova in this insect → boosting proliferation . …….. (0.5pt) → transmission of the allele responsible for the short rostrum to the next generations..... (0.5pt) → increase in the number of bugs with short rostrums in the center and the north of Florida where the *koelreuteria elegans* is found in abundance.....(0.5pt)	**2.5pts**

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