

الصفحة 1	الامتحان الوطني الموحد للبكالوريا المملكة المغربية الدورة العادية 2021 - الموضوع -	الجمهورية المغربية وزارة التربية والتعليم والتكوين المهني والتعليم العالي والبحث العلمي المركز الوطني للتقويم والامتحانات
6	SSSSSSSSSSSSSSSSSSSS	NS 34E

3h	مدة الإنجاز	علوم الحياة والأرض	المادة
5	المعامل	شعبة العلوم التجريبية مسلك العلوم الفيزيائية (خيار إنجليزية)	الشعبة أو المسلك

Candidates may use non-programmable calculators

Section I : Knowledge Retrieval (6 pts)

I. Define the following notions: - Pedunculated sphere - actomyosin complex (1pt)

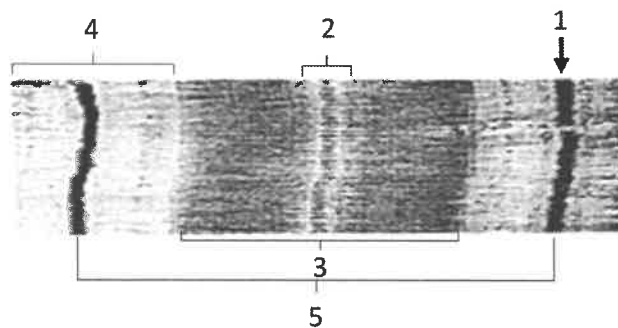
II. Copy down and complete the reaction of formation of the acetyl-CoA: (0.75 pt)



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 with its corresponding letter. (2 pts)

<p>1- The outer membrane of the mitochondria is :</p> <ul style="list-style-type: none"> a. rich in proteins of the respiratory chain ; b. similar to the plasma membrane ; c. folded to form cristae ; d. rich in ATP-Synthase. 	<p>2- The respiratory oxidation of a pyruvic acid molecule provided:</p> <ul style="list-style-type: none"> a. 2 ATP ; b. 12ATP ; c. 15ATP ; d. 36ATP.
<p>3- In a striated muscle cell, the calcium ions:</p> <ul style="list-style-type: none"> a. attach to the myosin heads during contraction; b. allow the actin filaments to bind together; c. allow myosin filaments to bind together; d. are stored in the sarcoplasmic reticulum at the end of contraction. 	<p>4- Cellular respiration takes place according to the succession of the following steps:</p> <ul style="list-style-type: none"> a. Glycolysis → Krebs cycle → acetyl CoA formation → oxidative phosphorylation; b. Glycolysis → acetyl CoA formation → Krebs cycle → oxidative phosphorylation; c. Glycolysis → acetyl CoA formation → oxidative phosphorylation → Krebs cycle; d. Glycolysis → Krebs cycle → oxidative phosphorylation → formation of acetyl CoA.

IV. The document below represents a microscopic observation of a part of a myofibril.



Name each of the structures designated by the numbers 1,2,3,4 and 5. (1.25 pt)

VI. Copy down these pairs (1 ; ..), (2 ; ..), (3 ; ..), (4 ; ..) in your separate sheet, and **match** each number of group 1 to the corresponding letter of group 2. (1pt)

Group 1

- 1- delayed heat
- 2- initial heat
- 3- Formation of gradient of proton
- 4- The production of carbon dioxide

Group 2

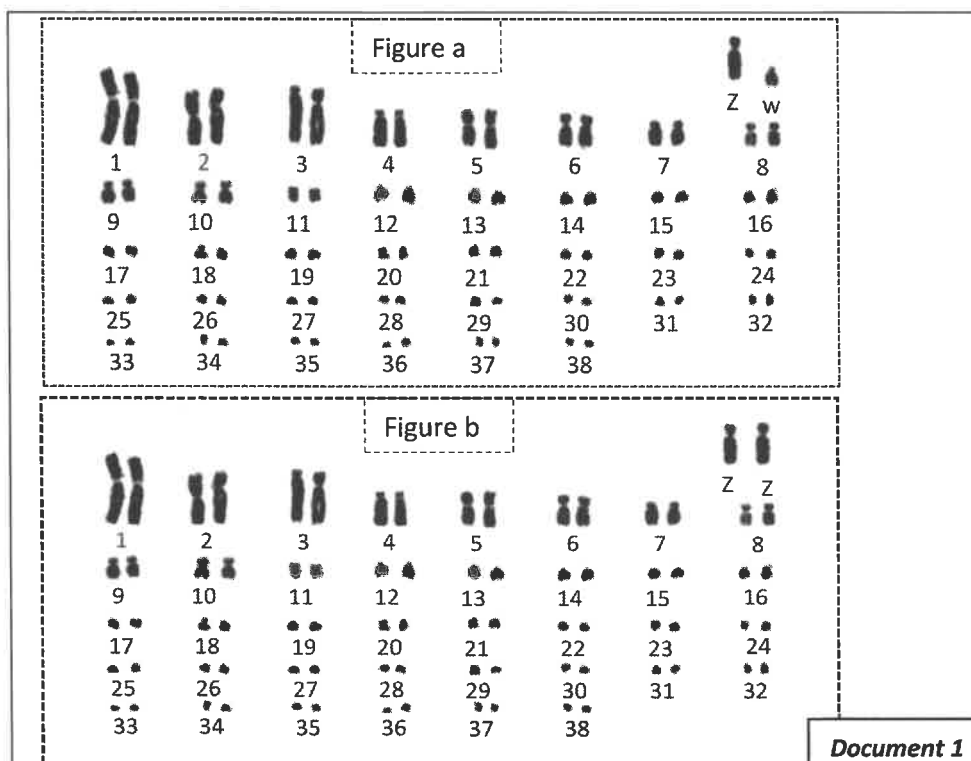
- a- Krebs cycle redox reactions.
- b- redox reactions at the level of respiratory chain.
- c- synthesis of ATP from aerobic metabolic reactions
- d- synthesis of ATP from phosphocreatine.

Section II : Scientific reasoning and communication in graphic and written modes (14pts)

Exercise 1 (4pts)

To study the mode of transmission of hereditary traits and to specify the character gene relationship, the following data are proposed:

Document 1 presents the karyotype in the chicken breed of Cuckoo Malines: figure a represents the karyotype of the hen and figure b represents the karyotype of the rooster.

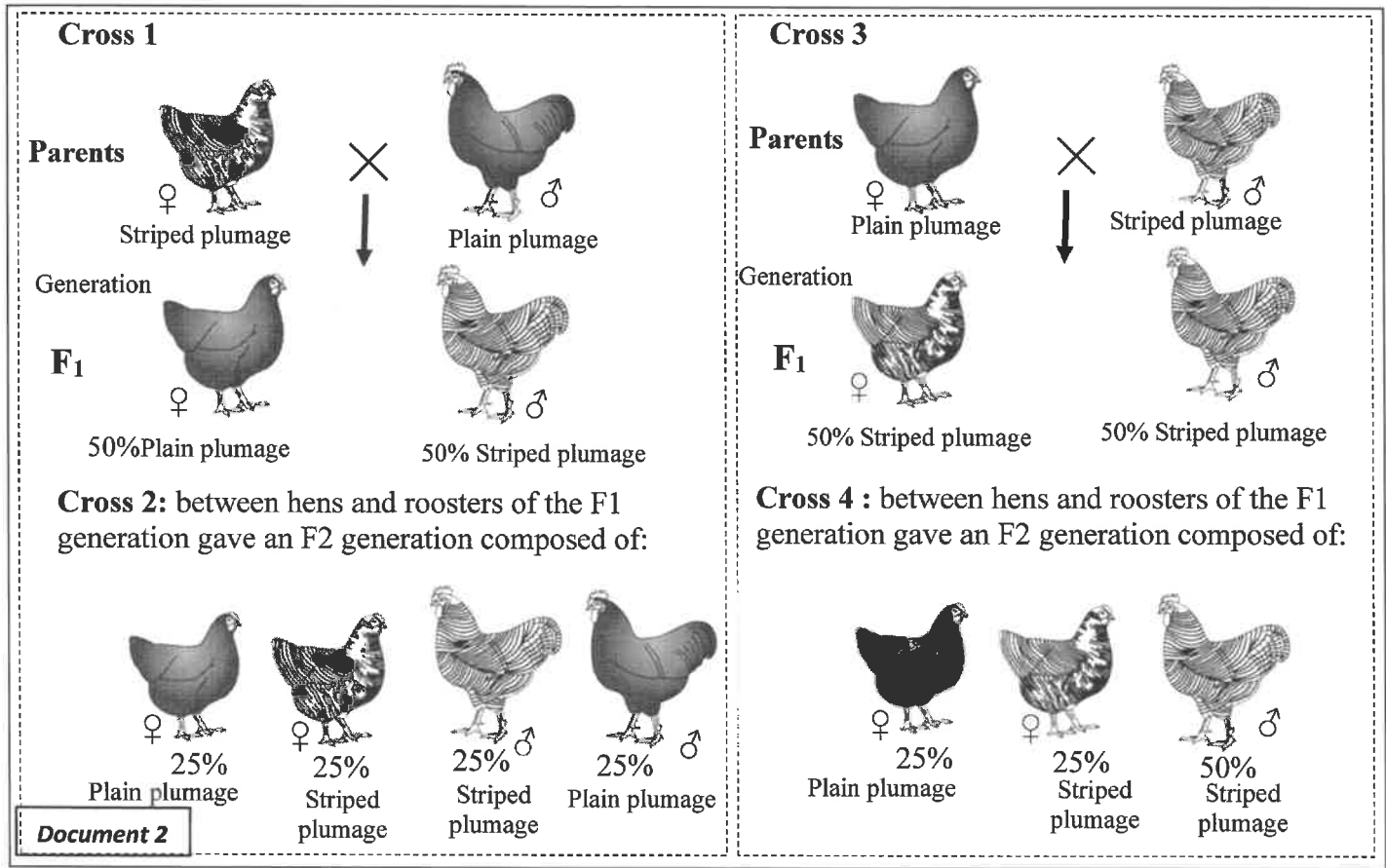


Document 1

1. **Compare** the two karyotypes from document 1 and give the chromosomal formula of the hen and the rooster. (1.5pt)

In the Cuckoo breed chicken, the plumage is either plain (homogeneous black color) or striped (black and white striped). We suppose that in this breed, a single pair of alleles located on an autosome governs the trait of the striped plumage.

To verify this hypothesis, we make a series of crosses the crosses 1 and 3 between hens and roosters of pure lineages, which differ in their plumage and crosses 2 and 4 between hens and roosters of the F1 generation. Document 2 gives the results of these crosses



1. Based on document 1, **describe** the mechanism of regulation of iron stores at the organism level and **deduce** the effect of hepcidin.(1pt)

Hepcidin synthesis in the liver is triggered by the HFE protein. This protein is encoded by the HFE gene located on chromosome 6. This gene exists in two forms:

- The wild type HFE allele encoding for normal HFE protein which allows the normal synthesis of hepcidin in a healthy person.
- The mutated HFE allele encoding for abnormal HFE protein that induce the disruption of hepcidin synthesis in a person with hemochromatosis.

Document 2 presents the nucleotide sequences encoding the two HFE alleles (the untranscribed strand of DNA) and document 3 presents the table of the genetic code.

Number of nucleotide triplets :	278	279	280	281	282	283	284
Wild HFE allele :	CAG	AGA	TAT	ACG	TGC	CAG	GTG
Mutated HFE allele :	CAG	AGA	TAT	ACG	TAC	CAG	GTG

Document 2

2nd letter 1st letter \		U		C		A		G		3rd letter
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	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	AGA	A			
	AUG	Met	ACG		AAG	Lys	AGG	Arg	G	
G	GUU	Val	GCU	Ala	GAU	Ac.asp	GGU	Gly	U	
	GUC		GCC		GAC		GGC		C	
	GUA		GCA		GAA	GGA	A			
	GUG		GCG		GAG	GGG	G			

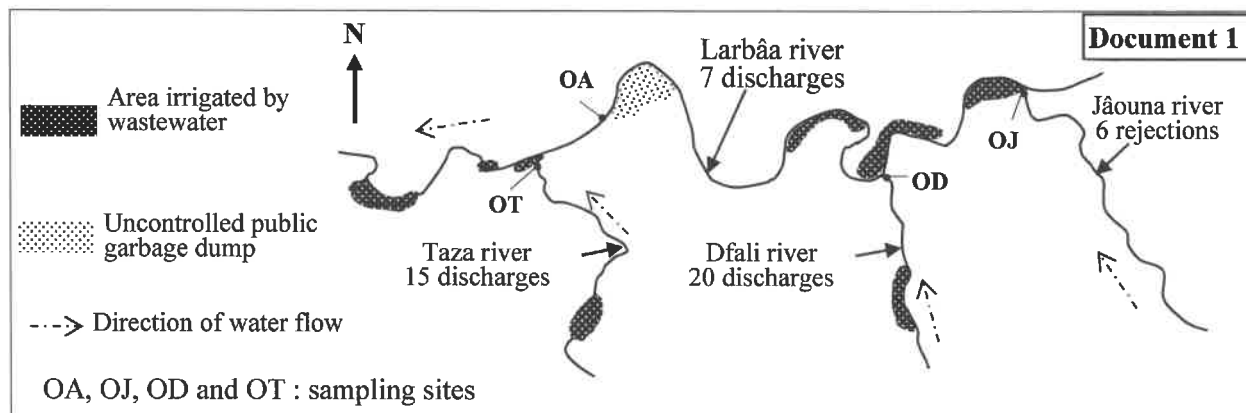
Document 3

2. Based on documents 2 and 3, **determine** the amino acid sequence of the HFE protein corresponding to the normal allele and that corresponding to the mutated allele. (1 pt)
3. Based on your previous data, **explain** the origin of hemochromatosis by **specifying** the gene-trait relationship. (2 pt)

Exercise 3 : (6 pts)

The region of Taza, located in the north-east of Morocco, has known an important agricultural development and significant demographic growth during these last decades. The public garbage dump in the Taza city is not controlled, and the wastewater is discharged directly (without any treatment) into the rivers Larbâa, Dfali, Jâouna and Taza. This water is used in the irrigation of the neighboring vegetable crops. In order to evaluate the impact of this waste on the environment, agriculture and health, the following data are proposed:

Document 1 presents a simplified map showing the location of the public landfill, wastewater discharges and areas irrigated by this water in Taza region as well as the location of the sampling sites (OA, OJ, OD and OT) at the level different rivers collecting wastewater.



Physicochemical and microbiological analyzes were carried out at 2012 on samples of irrigation water taken from the rivers collecting wastewater (document 1). The table in document 2 summarizes the results obtained.

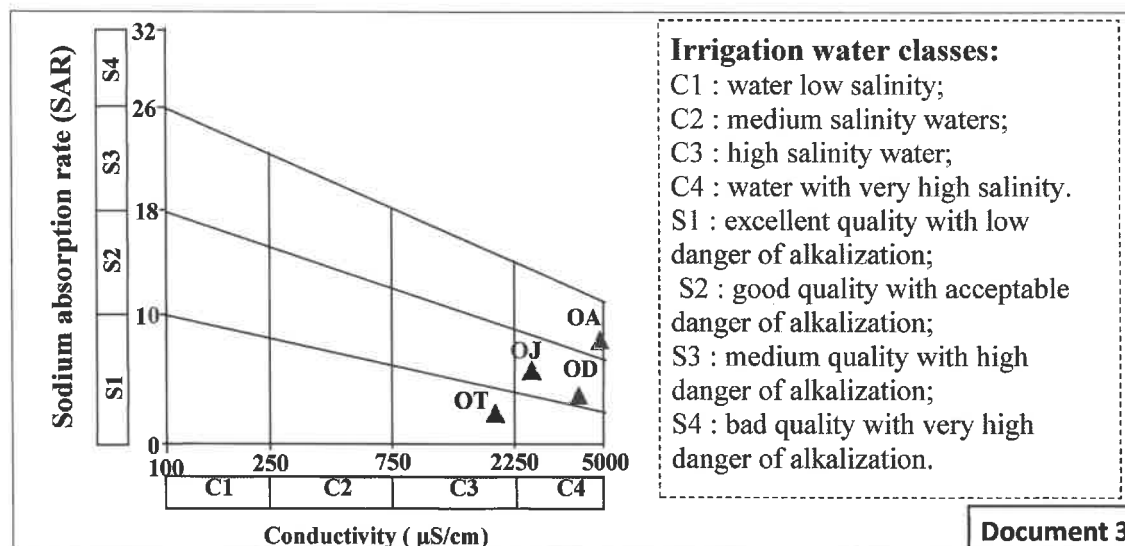
Parametres	Sites (Jâouna river)	OD (Dfali river)	OA (Larbâa river)	OT (Taza river)	Norme *
Conductivity ($\mu\text{S/cm}$)	2800	4000	5873	1200	800
BOD5 ($\text{mg O}_2/\text{L}$)	800 - 1300	800 - 1300	1300 - 1800	400 - 800	8
Iron : Fe (mg/L)	4	--	70	22	5
Fecal coliforms (germs/100mL)	5300	7500	$75 \cdot 10^7$	1600	1000

The conductivity allows assessing the quantity of salts dissolved in the water.

* Limit values of water intended for surface irrigation according to Moroccan standards.

Document 2

The Wilcox diagram classifies the water of irrigation based on its alkalinizing power (Sodium Absorption Rate or SAR) according to its electrical conductivity. Document 3 gives the Wilcox diagram of the different sampling sites of the tributaries that receive the wastewater from the Taza city.



1.a- By exploiting documents 1 and 2, **compare** the water parameters of the rivers collecting wastewater in Taza city with the standards.(1.5pt)

1.b- **Based** on document 3, **determine** the class of irrigation water taken from the different rivers of the Taza city. (1 pt)

1.c- **Explain** the water quality at the OA site. .(1 pt)

In the region of Taza city, some farmers use wastewater to irrigate their vegetable crops. To show the impact of this use of wastewater on agricultural yield and consumer health, we propose the following data.

Document 4 gives the results of studies on the yield of certain crops according to the irrigation water used (figure a) and the dosage of heavy metals and some type of bacteria in the consumable parts of lettuce irrigated by wastewater (figure b) and an inventory of water-related diseases in the province of Taza between 2001 and 2005 (figure c).

Irrigated by Cultures	Waste water	Dam water + fertilizer	Rain water	Lettuce irrigated by		
				Waste water	Dam water	
Soft wheat	57	53	8	Lead in $\mu\text{g/g}$	0.3	0.1
Alfalfa	356	285	0	Iron in $\mu\text{g/g}$	5.8	1.2
Values in quintals / ha				Fecal coliforms (germs/g)	$3.22 \cdot 10^4$	67
				Intestinal clostridium bacteria (germs / g)	$2.84 \cdot 10^3$	0

The Province of Taza was classified during the period between 2001 and 2005 among the regions at high risk for water-related diseases, mainly typhoid and hepatitis A, particularly affecting large agglomerations, partially sanitized. In addition, the irrigation of vegetable crops with wastewater around the Taza city constitute a great threat to the dissemination of these diseases.

Document 4

2. Using the figures on document 4:

a- **Show** the effect of using wastewater on yield and quality of corps.(1.5pt)

b- **Explain** the risk in terms of water-related diseases identified in Taza region.(0.5pt)

3. **Based** on your previous answers and your knowledge, **propose** two adequate solutions to deal with the problem raised in Taza city during the period between 2001 and 2005.(0.5pt)

الصفحة	<p style="text-align: center;">الامتحان الوطني الموحد للبكالوريا الممالك الحولية الدورة العادية 2021 - عناصر الإجابة -</p>		<p style="text-align: center;">  السلطة المغربية وزارة التربية الوطنية والتكوين المهني والتعليم العالي والبحث العلمي المركز الوطني للتقويم والامتحانات </p>	
1				
4				
***	SSSSSSSSSSSSSSSSSSSS	NR 34E		
3h	مدة الإنجاز	علوم الحياة والأرض		المادة
5	المعامل	شعبة العلوم التجريبية مسلك العلوم الفيزيائية (خيار إنجليزية)		الشعبة أو المسلك

Key and Marking Scale

Question	The elements of answer	Scores
Section I : Knowledge Retrieval (6pts)		
Accept any appropriate answers.		
I	- Pedunculated sphere: It is an inner mitochondrial membrane protein that catalyzes the production of ATP by phosphorylation of ADP.....	0.5 pt
	- Actomyosin complex: formed by binding actin filaments to myosin filaments and plays an important role in muscle contraction.	0.5 pt
II	$CH_3CO-COOH + NAD^+ + CoA \rightarrow CH_3CO-CoA + NADH, H^+ + CO_2$ (3x0.25pt)	0.75 pt
III	(1 ; b) ; (2 ; c) ; (3 ; d) ; (4 ; b) (4x0.5)	2 pts
IV	1 → Z disk ; 2 → Zone H ; 3 → Dark band (A); 4 → Light band (I) ; 5 →Sarcomere (5x0.25)	1.25 pt
V	(1 ; d) ; (2 ; c) ; (3 ; b) ; (4 ; a) (4x0.25)	1pt
Section II : Scientific reasoning and communication in graphic and written modes (14pts)		
Exercise 1 (4 pts)		
1	- The chicken is diploid: the chromosomes are distributed in pairs (2n = 78).....	0.25 pt
	- 38 pairs of autosomal chromosomes (each pair contains two homologous chromosomes);.....	0.25 pt
	- One pair of sex chromosomes:	
	* The hen has 2 different sex chromosomes ZW → heterogametic.....	0.25 pt
	* The rooster has 2 identical sex chromosomes ZZ → homogametic.....	0.25 pt
	- The chromosomal formula :	
	* For the hen : $2n = 38AA + ZW$	0.25 pt
	* For the rooster : $2n = 38AA + ZZ$	0.25 pt
2	- Cross 1 and cross 2 are reciprocal and do not give the same result in F1 and cross 1 between two pure lines of chickens gives a heterogeneous F1 descendants (50% ♀ with plain plumage and 50% ♂ with crossed-out plumage) → the 1st law of Mandel not verified → the gene studied is sex-linked (carried on the Z chromosome). Therefore, the hypothesis is rejected.....	0.25 pt
	- Individuals of the F1 generation of cross 2 have a parental phenotype (striped plumage) → dominance of the gene responsible for striped plumage (B) compared to the recessive gene responsible for plain plumage (n);	0.25 pt

*** Chromosomal interpretation of the cross 1 :**

Parents : P ♀ × P ♂
Phenotypes : [B] [n]
Genotypes : Z_B W Z_n Z_n
Gametes : 50% Z_B ; 50% W 100% Z_n

Punnett square :

	σ P ♀	50% Z _B	50% W
σ P ♂		Z _B Z _n [B] ♂ 50%	Z _n W [n] ♀ 50%
	100% Z _n		

0.5 pt

We obtain at F₁ : 50% [B] ♂ and 50% [n] ♀ .

The theoretical and experimental results are similar

The cross between individuals of F₁ hybrids of cross 2:

Parents : F₁ ♀ × F₁ ♂
Phenotypes : [n] [B]
Genotypes : Z_n W Z_B Z_n
Gametes : 50% Z_n ; 50% W 50% Z_B ; 50% Z_n

Punnett square :

	σ F ₁ ♀	50% Z _n	50% W
σ F ₁ ♂		Z _B Z _n [B] ♂ 25%	Z _B W [B] ♀ 25%
	50% Z _B		
	50% Z _n	Z _n Z _n [n] ♂ 25%	Z _n W [n] ♀ 25%

0.5 pt

We obtain at F₂ : 25% [B] ♂, 25% [n] ♂, 25% [n] ♀ and 25% [B] ♀ .

The theoretical and experimental results are similar.

*** Chromosomal interpretation of the cross 3 :**

Parents : P ♀ × P ♂
Phenotypes : [n] [B]
Genotypes : Z_n W Z_B Z_B
Gametes : 50% Z_n ; 50% W 100% Z_B

Punnett square :

	σ P ♀	50% Z _n	50% W
σ P ♂		Z _B Z _n [B] ♂ 50%	Z _B W [B] ♀ 50%
	100% Z _B		

0.5 pt

We obtain at F₁ : 50% [B] ♂ and 50% [B] ♀ (100%[B]) .

The theoretical and experimental results are similar .

The cross between individuals of F₁ hybrids of cross 4:

Parents : F₁ ♀ × F₁ ♂
Phenotypes : [B] [B]
Genotypes : Z_B W Z_B Z_n
Gametes : 50% Z_B ; 50% W 50% Z_B ; 50% Z_n

Punnett square :

	$\sigma P \text{♀}$	$50\% Z_B$	$50\% W$
$\sigma P \text{♂}$		$Z_B Z_B$ [B] ♂ 25%	$Z_B W$ [B] ♀ 25%
	$50\% Z_n$	$Z_B Z_n$ [B] ♂ 25%	$Z_n W$ [n] ♀ 25%

We obtain at F_2 : 75% [B] (50%♂ and 25%♀) and 25% [n] ♀.
 The theoretical and experimental results are similar .

0.5 pt

Exercise 2 : (4points)

1 The intestinal absorption of iron is ensured by the enterocytes through its transporter → passage of iron to the blood through ferroportins (transporters) → in the case of an increase in iron stock, the liver secretes hepcidin → degradation of ferroportins → inhibition of the passage of iron from intestinal cells to the blood and accumulation of iron in liver cells in ferritin.
 Therefore, hepcidin decreases circulating (plasma) iron by blocking its intestinal absorption.

1 pt

The mRNA and the corresponding amino acid sequence :

- **The wild HFE allele :**

m RNA: CAG AGA UAU ACG UGC CAG GUG

amino acid sequence : Gln - Arg - Tyr - Thr - Cys - Gln - Val

0.25 pt
0.25 pt

- **The HFE mutated allele :**

mRNA : CAG AGA UAU ACG UAC CAG GUG

amino acid sequence : Gln - Arg - Tyr - Thr - Tyr - Gln - Val

0.25 pt
0.25 pt

3 In people with hemochromatosis, a substitution mutation of nucleotide G by A at the level of triplet 282 of the non-transcribed strand of the gene encoding the synthesis of the HFE protein (substitution of C by T at the level of the transcribed strand) → substitution of Cys by Tyr at the level of the amino acid sequence of the HFE protein → synthesis of a non-functional HFE protein → no synthesis of hepcidin in the hepatic cells → increase in the level of circulating iron and the appearance hemochromatosis...
 Consequently, a change in the nucleotide sequence of the gene induces a change in the character (appearance of a new phenotype).....

1.5 pt

0.5 pt

Exercise 3 : (6points)

1.a - The mean value of the conductivity of the water in the different rivers studied exceeds the Moroccan standard for irrigation water, it varies between a minimum of 1200 $\mu S / cm$ for the waters of Taza river and a maximum of 5873 $\mu S / cm$ in the Waters of the Larbâa river (OA) next to the landfill.
 - The BOD5 values are very high and far exceed the Moroccan standard.
 - The waters of the Larbâa river and Taza river contain a high level of iron (70 and 22 mg / L) which exceeds the standard, while the iron rate in the waters of Jâouna river is lower than the standard.
 - The bacterial load (quantity) in faecal coliforms in the waters of the different rivers studied is very high compared to the standards.

0.5 pt
0.25 pt

0.5 pt

0.25 pt

1.b - OA (Larbâa river): class C4S3, water with very high salinity of medium quality with significant danger of alkalization ;

0.25 pt

الصفحة			
4	NR 34E	الامتحان الوطني الموحد للبكالوريا - الدورة العادية 2021 - عناصر الإجابة	
4		- مادة: علوم الحياة والأرض - شعبة العلوم التجريبية مسلك العلوم الفيزيائية (خيار إنجليزية)	

	- OT (Taza river): class C3S1, high salinity water of excellent quality with low danger of alkalization;	0.25 pt
	- OD (Dfali river) and OJ (Jaouna river): class C4S2, water with very high salinity and of good quality with an acceptable danger of alkalization.	0.5 pt
1.c	The OA station is located near the public landfill installed on the edge of Larbâa river whose water is very polluted because this river collects the wastewater discharged at the level of Dfali river and Jaouna river → high organic and mineral loads generated by liquid discharges (wastewater) and leachate from the landfill of the Taza city → an average quality with significant danger of alkalization of the water from the OA station which is polluted.	1 pt
2.a	Effects of the use of wastewater in agriculture: -Improving crop yields..... The yield of common wheat and alfalfa irrigated by wastewater is equivalent to or greater than that obtained during irrigation by water from the dam using fertilizers and exceeds their yield in the case of irrigation by rainwater	0.25 pt
	- Bacteriological and chemical contamination (heavy metals) of crops..... We observe that the bacterial load (quantity) and the quantities of heavy metals are very high in plants irrigated by wastewater compared to that irrigated by water from the dam.....	0.5 pt 0.25 pt 0.5 pt
2.b	The high risk of water-related diseases in the Taza region between 2001 and 2005 is linked to the consumption of the vegetable plants contaminated by bacteria.	0.5 pt
3	Proposition of two procedures for example: - Construction of a wastewater treatment plant before discharging it into the rivers of Taza city . - Construction of a controlled public landfill far from rivers and water sources.	0.5pt