

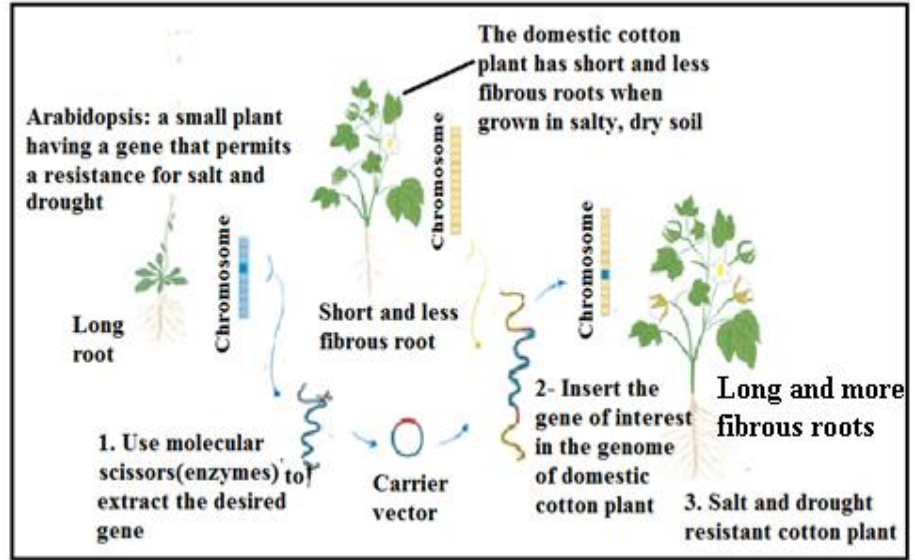
Answer the following three exercises.

### Exercise 1 (6 points)

### Salt and Drought Tolerant Cotton

Cotton cultivation is considered as the primary cultivated crop for fiber production, and it is the cornerstone for textile industry. Drought and salinity are two major environmental factors that limit agricultural productivity of cotton. Climate change is likely to enhance water scarcity and soil salinity in many areas.

To achieve sustainable cultivation of cotton that can escape the stress of environmental factors, scientists are still searching for effective strategies in biotechnology. The adjacent document represents the main steps of such a strategy.



1. Pick out,

- 1.1 From the text: the aim of the effective strategies followed in the field of Biotechnology.
- 1.2 From the document: the origin and the recipient of the transferred gene.

2.1 Distinguish the aspect of the domestic cotton plant from that of the genetically modified plant.

2.2 Draw out the role of the transferred gene.

3. Indicate the enzyme involved in:

- 3.1 The extraction of the desired gene.
- 3.2 Insertion of the desired gene into the vector.

4. Explain why the manipulated domestic cotton plant is qualified as transgenic.

5. Indicate one application of transgenesis in the field of medicine, and another application in the field of agriculture.

### Exercise 2 (7.5 points)

### Obesity

In the framework of studying the causes of obesity as well as the characteristics of tissue cells in obese individuals, a study is performed on the case of two individuals, A and B, of the same age and sex. The height and the body mass of these individuals are presented in document 1.

Body mass index (BMI) can give an idea about how an individual is classified as underweight, normal weight, overweight, or obese.

- If BMI is between  $18.5 \text{ Kg/m}^2$  and  $25 \text{ Kg/m}^2$ , the individual has a normal weight.
- If BMI is in the range between  $30.0 \text{ Kg/m}^2$  and  $34.9 \text{ Kg/m}^2$ , the individual has moderate obesity.
- If BMI is equal to  $35.0 \text{ Kg/m}^2$  and above, the individual has severe obesity.

Individual	A	B
Height (cm)	170	170
Body mass (Kg)	70	98

Document 1

1. Calculate the BMI of each individual in document 1.
2. Identify the obese individual and the type of obesity diagnosed.

Other studies are performed on these individuals, A and B, concerning their food diet and their level of activities. The results are presented in document 2.

Individual	Activity	Food Diet(g)		
		Carbohydrates	Proteins	Lipids
A	Moderate activity	380	185	65
B	Sedentary (Not active)	420	180	95

Document 2

3. Calculate the energetic value of the food diet consumed by each of the individuals, A and B (document 2),

Given that: the energy value of carbohydrates or of proteins is 17 kJ/g; the energy value of lipids is 38kJ/g.

Analysis of adipose tissue in the body is performed in these two individuals A and B. The results are represented in document 3:

Individual	A	B
Mass of lipids in the body (%)	20	40
Diameter of fat cells, adipocytes (µm)	36	67

Document 3

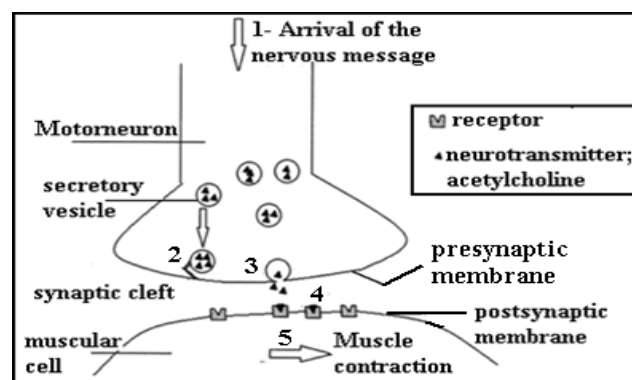
4. Compare, by referring to document 3, the characteristics of the adipose tissue in individuals A and B.

5. Determine, by referring to all of the above, the cause(s) of obesity in the identified obese individual.

### Exercise 3 (6.5 points)

### Muscular Paralysis in Worms

Caenorhabditiselegans is a small worm used as a model animal to study the function of the neuromuscular synapse. Document 1 shows a number of the steps of synaptic transmission in a normal worm.



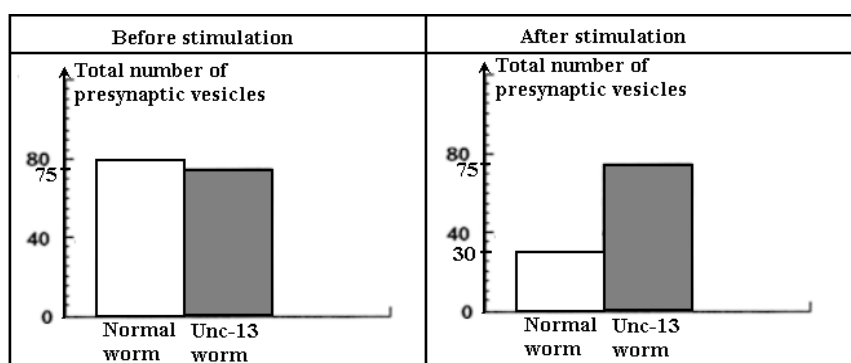
Document 1

- List, by referring to document 1, the steps of the synaptic transmission that leads to muscle contraction.
- Specify if the synapse presented in document 1 is inhibitory or excitatory.

Unc-13 worm is a one type of Caenorhabditiselegans, which shows complete muscle paralysis related to abnormality in the synaptic transmission. To find out the cause of this abnormality, the following studies are performed.

**Study 1:** Radioactive acetylcholine is injected into the synaptic cleft of the neuromuscular synapse of both worms, normal one and Unc-13 worm. Radioactivity is detected at the level of the postsynaptic membrane and muscle contraction is observed, in each of the worms.


3. Show that the paralysis of Unc-13 worm is not due to a defect in the postsynaptic receptors.



Document 2

**Study 2:** Document 2 presents the total number of presynaptic secretory vesicles containing acetylcholine in both worms, before and after an effective electric stimulation of a motor neuron innervating the muscle.

- Analyze the obtained results.
- Draw out the cause of paralysis in Unc-13 worm.

المادة: علوم الحياة – لغة انكليزية الشهادة: الثانوية العامة الفرع: إجتماع وإقتصاد نموذج رقم ٢٠١٩/١ المدة: ساعة واحدة	الهيئة الأكاديمية المشتركة قسم : العلوم	
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أسس التصحيح:

Part of exercise	Exercise 1 (6 points) Salt and Drought Tolerant Cotton	Mark
1.1	Scientists are still searching for effective strategies in biotechnology to achieve sustainable cultivation of cotton that can escape the stress of environmental factors.	0.5
1.2	The origin of the transferred gene is Arabidopsis plant that owns long roots. The recipient plant is the domestic cotton plant that owns short and less fibrous roots.	0.5
2.1	The domestic cotton plant has short and less fibrous roots when grown in salty, dry soil; while, the genetically modified plant has long and more fibrous roots making it tolerant to salt and drought.	1
2.2	The transferred gene is the gene responsible for the development of long roots that enables the domestic plant to grow in salty dry soil, or to become drought and salt tolerant.	1
3.1	The enzyme involved in the extraction of the desired gene is the restriction enzyme.	0.5
3.2	The enzyme involved in introducing the desired gene into the vector is the DNA ligase enzyme.	0.5
4	The manipulated cotton plant is qualified as transgenic because the gene coding for drought and salt resistance has been transferred from Arabidopsis plant (resistant to drought and salt soil) to another plant from another species (domestic cotton) and this gene became integrated into the genome of the latter plant and it was expressed phenotypically (development of long roots ...).	1
5	Application of transgenesis: - Application in the field of medicine : - Production of insulin or Vaccines - Application in the field of agriculture: - Production of insect resistant plants.	0.5 0.5

Part of exercise	Exercise 2 (7.5 points) Obesity	Mark
1	BMI of individual A = Mass ( Kg ) / Height <sup>2</sup> ( m <sup>2</sup> ) = 70 / ( 1.7 ) <sup>2</sup> = 24.2 Kg/m <sup>2</sup> BMI of individual B = Mass ( Kg ) / Height <sup>2</sup> ( m <sup>2</sup> ) = 98 / ( 1.7 ) <sup>2</sup> = 33.9 Kg/m <sup>2</sup>	0.75 0.75
2	Since BMI of Individual B is 33.9 Kg/m <sup>2</sup> which lies between 30.0 and 34.9 Kg/m <sup>2</sup> , thus he is obese and his type of obesity is moderate obesity.	1.5
3	Energetic value of food diet of individual A : 380 x17 + 185x17 + 65x38 = 12075 kJ Energetic value of food diet of individual B: 420 x17 + 180x17 + 95x38 = 13810 kJ	1
4	Individual B has a mass of lipids in his body (40 %) greater than that of the individual A (20%). The diameter of fat cells in the individual B (67µm) is greater than that of the individual A (36 µm).	1
5	The energetic value of the food diet of individual B is 13810 kJ, a value greater than 12075 kJ obtained in individual A, having a normal weight. Moreover, these two individuals do not have the same activity; the obese individual B leads sedentary life in comparison to individual A, who has a moderate activity. In addition, the fat cells diameter as well as the mass the lipids are higher in the body of individual B than those in the body of individual A. Thus, the causes of obesity in individual B are due to excessive consumption of food/overeating and sedentary lifestyle that result in the increase in the size of adipocytes and the mass of lipids in the body.	2.5

<b>Part of the exercise</b>	<b>Exercise 3 (6.5 points) Muscular Paralysis in Worms</b>	<b>Mark</b>
<b>1</b>	<p>The steps of the synaptic transmission that lead to muscle contraction:</p> <ol style="list-style-type: none"> <li>1. Arrival of the nervous message to the terminal buds of the motor neuron</li> <li>2. Fusion of the secretory vesicles containing the neurotransmitter, acetylcholine, with the presynaptic membrane.</li> <li>3. Exocytosis of the neurotransmitter, acetylcholine, into the synaptic cleft.</li> <li>4. Binding of acetylcholine to the postsynaptic receptors found on the postsynaptic membrane of muscular cells.</li> <li>5. This binding induces muscle contraction.</li> </ol>	<b>2</b>
<b>2</b>	<p>The synapse is excitatory since the binding of the neurotransmitter; acetylcholine, to its specific postsynaptic receptors launches a response at the level of the muscle (contraction).</p>	<b>1</b>
<b>3</b>	<p>The injection of radioactive acetylcholine in the synaptic cleft leads to muscle contraction in both worms, the normal one and the Unc-13, and radioactivity is detected at the level of postsynaptic membranes. This means that the postsynaptic receptors in Unc-13 worms are sensitive to acetylcholine and consequently they are normal. Thus, the worm paralysis is not due to a defect in the postsynaptic receptors.</p>	<b>1.5</b>
<b>4.1</b>	<p>Before the electric stimulation, the total number of presynaptic vesicles which contain acetylcholine is approximately the same in both, the normal worm, 80 vesicles, and the Unc-13 worm.75 vesicles. However, after applying an effective electric stimulation on the motor neuron innervating the muscles in both worms, the number of the presynaptic vesicles in the normal worm decreases to 30 vesicles, while that in Unc-13 worm remains the same, 75 vesicles.</p>	<b>1.5</b>
<b>4.2</b>	<p>The paralysis of Unc-13 worm is due to the absence of exocytosis of neurotransmitters (acetylcholine) in the synaptic cleft.</p>	<b>0.5</b>