

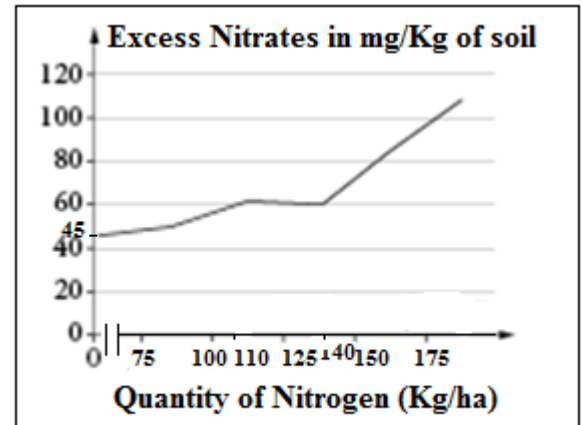
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|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| المادة: علوم الحياة<br>الشهادة: الثانوية العامة<br>فرع: الاجتماع والاقتصاد<br>نموذج رقم -٢-<br>المدة : ساعة واحدة | الهيئة الأكاديمية المشتركة<br>قسم : العلوم | <br>المركز التربوي للبحوث والإنماء |
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نموذج مسابقة (يراعي تعليق الدروس والتوصيف المعدل للعام الدراسي ٢٠١٦-٢٠١٧ وحتى صدور المناهج المطورة)

### Exercise 1 (7 points)

### Bioremediation of Polluted water

Nitrates used in agriculture as fertilizers become a threat to water quality. The nitrogen element contained in these chemical fertilizers is an important element which enhances plants growth, but excess of these fertilizers induce a polluting effect due to the accumulation of nitrates in the soil that leads to the contamination of the underground water. Document 1 shows the results of the study performed in a farm producing potato tuber in order to evaluate the quantity of excess nitrates in the soil as a function of the level of nitrogen utilized during cultivation.



Document 1

1. Show that nitrogenous fertilizers might be major pollutants of underground water.

Document 2 shows a study performed on the quality of water.

Water containing more than 50 mg of nitrates per liter is no longer drinkable or non-potable. In fact, it is better that the content of nitrates in drinkable water or potable water does not exceed 25 mg/L, because newborn babies have a bacteria present in their stomach which specifically transform nitrates into nitrites. The latter can be released in the blood, where it combines with hemoglobin and prevents oxygen fixation, leading to suffocation and death.

### Document 2

2. Pick out the quantity of nitrate which renders water not potable.
3. Explain how the excess use of chemical fertilizers leads indirectly to baby's death.

In the framework of studying the solutions that overcome the accumulation of nitrates in the soil due to the excessive use of chemical fertilizers, an experiment is performed by using a new strain of bacteria, *Streptomyces barakatei*. This strain is proved to be particularly effective in improving the assimilation of nitrogen by the plants.

**Experiment:** the roots of potato tuber seedlings are inoculated by a strain of *Streptomyces* bacteria before being cultivated in the above farm.

The results obtained after one week of cultivation are presented in document 3.

4. « *Streptomyces barakatei* enhances the productivity of potato tuber plants meanwhile reducing the risks of death among babies ». Justify the statement by referring to documents 2 and 3.

| Potato tuber seedlings | Control | Inoculated with bacterial strain |
|------------------------|---------|----------------------------------|
| Dry mass (in g)        | 0.140   | 0.235                            |
| Plant height (in mm)   | 38      | 46                               |
| Root length (in mm)    | 24      | 36                               |

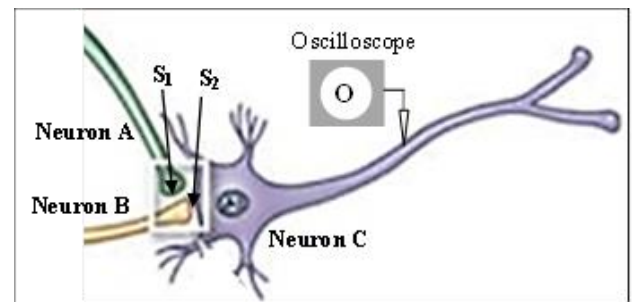
Document 3

### Exercise 2: (6 points) Presynaptic Facilitation

"Presynaptic facilitation" can lead to the increase in the release of the neurotransmitters by the terminal arborizations of the sensory neurons under the action of another neuron.

Document 1 represents the synapses between various neurons.

1. Indicate the presynaptic neuron and the postsynaptic neuron for each of the synapses  $S_1$  and  $S_2$ .



Document 1

Neuron B is effectively stimulated. Then, the two neurons A and B are simultaneously stimulated by a stimulation having the same intensity as the previous one. Document 2 represents the frequency of the action potentials recorded by the oscilloscope O as well as the quantity of the neurotransmitters released by the neurons A and B in each case.

2. Specify if synapseS<sub>2</sub>is excitatory or inhibitory.
3. Show that neuron A exerts a presynaptic facilitation on neuron B.
4. What caused the increase in the frequency of A.P in C?

|                                                   | Stimulation of neuron B                                                            | Simultaneous stimulation of neurons A and B                                         |
|---------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Frequency of A.P recorded on neuron C             |  |  |
| Quantity of neurotransmitter released by neuron A | 0                                                                                  | +                                                                                   |
| Quantity of neurotransmitter released by neuron B | +                                                                                  | +++                                                                                 |
| (+) Moderate quantity                             |                                                                                    | (+++ Important quantity                                                             |

Document 2

### Exercise 3 (7 points) The Healthy Runner’s Diet

During a physical activity, the energy expenditure can be estimated from the intensity of respiration. Document 1 represents the different intensities of respiration required for various activities.  
An athlete weighing 60 kg and of height 170 cm wants to participate in a marathon. He should run for 2 hours on a daily basis.

| Activities    | Intensity of respiration (L.kg <sup>-1</sup> .h <sup>-1</sup> ) |
|---------------|-----------------------------------------------------------------|
| At rest       | 0.25                                                            |
| Slow walking  | 0.40                                                            |
| Quick walking | 0.90                                                            |
| Running       | 2.50                                                            |

Document 1

1. Calculate:
  - 1.1. The volume of oxygen gas consumed by the athlete during two hours of training.
  - 1.2. The corresponding energy expenditure, knowing that the energy released by consuming 1 L of oxygen gas is 20 kJ.

In order to cover the supplementary energy requirements associated with this exercise, a dietitian prescribes for this athlete a high-carbohydrate diet (document 2) and provides him with the possible composition of this diet (document 3).

| Food categories        | Grain product | Fruits | Vegetables | Dairy products |
|------------------------|---------------|--------|------------|----------------|
| Quantity (in portions) | 15            | 6      | 6          | 5              |

Document 2

The best sources of carbohydrates are cereals (preferably whole grains) such as bread, rice, and pasta, as well as fruits, vegetables and low-fat dairy products. Food labels indicate the total amount of carbohydrate present in each of the given food portions.

- a portion of a cereal product, such as a slice of bread or 1/2 cup of cooked rice or pasta, and a portion of fruit, such as a piece of fruit or 3/4 cup of fruit juice, each provides 15 grams of carbohydrates.
- a portion of dairy products, such as 1 cup of low fat milk or yogurt or 1.5 ounces of cheese provides 12 grams of carbohydrates.
- a portion of vegetables, such as 1 cup of raw leafy vegetables, 1/2 cup of chopped vegetables, or 3/4 cup of vegetable juice, provides 5 grams of carbohydrates.

Document 3

2. Calculate:
  - 2.1 the quantity of carbohydrates, in grams, provided by the diet prescribed by the dietitian (doc.2 and doc.3).
  - 2.2 the total energy provided by this carbohydrate supplement, knowing that 1 g of carbohydrate gives 17 kJ.
3. Deduce if this calculated value of energy can cover the energy requirements related to the training program of this athlete.

|                                                                                                                     |                                            |                                                                                                                      |
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أسس التصحيح ( تراعي تعليق الدروس والتوصيف المعدل للعام الدراسي ٢٠١٦ - ٢٠١٧ وحتى صدور المناهج المطورة)

| Part of the Ex | Exercise 1 (7 points)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mark |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1              | The quantity of excess nitrates in soil increases slightly from 45 to 60 mg/kg of soil as the quantity of utilized nitrogen in cultivation increases from 0 to 110 kg/ha. Between 110 kg/ha and 140 kg/ha, the excess nitrates remains constant at 60 mg/ kg. Beyond 140 kg/ha, the excess nitrates increases rapidly from 60 to 110 mg/kg as the quantity of utilized nitrogen in soil increases from 150 to 190 kg/ha. Consequently, this increase permits the excess nitrates to accumulate in the soil and infiltrate to underground water, thus polluting it.                                                                                                                                                                                                                                                   | 2    |
| 2              | The quantity of nitrate which renders water not potable is 50 mg/L.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1    |
| 3              | Excess use of chemical fertilizers increases the excess nitrates in the soil which permits their accumulation in soil and consequently contaminating the underground water. Water containing more than 50 mg of nitrates per liter is no longer potable and when newborn babies drink it, the nitrates are transformed to nitrites by the bacteria present in their stomach. The produced nitrites can be released into the blood, where it combines with hemoglobin, thus, preventing oxygen fixation and leading to baby's death by suffocation.                                                                                                                                                                                                                                                                   | 2    |
| 4              | <p>The strain of <i>Streptomyces</i> bacteria inoculated into the roots of cultivated plants will enhance the assimilation of nitrates by plants; which in turn enhance the growth of plants. This growth is manifested by an increase in the dry mass of the plant (mass of 0.235 g &gt; 0.140g), their height (46 mm &gt; 38mm) and root length (36mm &gt; 24mm).</p> <p>By adopting the inoculation of such bacteria in the roots of plants before their cultivation, the need for supplying these plants with fertilizers decreases. Consequently, less amount of fertilizers are used, so the probability to have excess nitrates in the soil thus polluting underground water decreases. Hence, these bacteria enhance the productivity of potato plants; meanwhile, reducing the death of newborn babies.</p> | 2    |

| Part of the Ex | Exercise 2 (6 points)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mark |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1              | The presynaptic neuron of synapse $S_1$ is the neuron A and the postsynaptic neuron is the neuron B.<br>The presynaptic neuron of synapse $S_2$ is the neuron B and the postsynaptic neuron is the neuron C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1.5  |
| 2              | Synapse $S_2$ is excitatory since a response of 4 APs of the same amplitude are recorded by oscilloscope O connected to neuron C (postsynaptic neuron) when neuron B (presynaptic neuron) is stimulated.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1.5  |
| 3              | The quantity of neurotransmitters released by neuron A is null whereas, a moderate quantity of neurotransmitters is released when only neuron B is effectively stimulated. This released quantity increases to be moderate for neuron A and high for neuron B, always greater than that of A after the simultaneous stimulation of neurons A and B; this shows that the action of neuron A facilitates the release of neurotransmitters by neuron B which is the presynaptic neuron of synapse $S_2$ . This corresponds to a phenomenon of facilitation where the action of a neuron increases the liberation of neurotransmitters by the terminal arborizations of sensory neurons. | 2    |
| 4              | The increase in the frequency of A.P in neuron C is due to the increase in the quantity of neurotransmitters released by neuron B from moderate to important.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1    |

| Parts of Ex | Exercise 3 (7 points)                                                                                                                                                                                                                                                                                                       | Mark |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1.1         | Volume of dioxygen = $60 \text{ Kg} \times 2.5 \text{ L.kg}^{-1}.\text{h}^{-1} \times 2 \text{ h} = 300 \text{ L}$                                                                                                                                                                                                          | 1    |
| 1.2         | Energy expenditure = $I.R \times 20 \text{ KJ/L}$<br>Energy expenditure = $300 \text{ L} \times 20 \text{ KJ/L} = 6000 \text{ KJ}$ .                                                                                                                                                                                        | 1    |
| 2.1         | 15 portions of grain product $\times 15 = 225 \text{ grams}$<br>6 portions of fruit $\times 15 = 90 \text{ grams}$<br>6 portions of vegetables $\times 5\text{g} = 30 \text{ grams}$<br>5 portions of dairy products $\times 12 = 60 \text{ grams}$<br>Total amount of carbohydrates = $225 + 90 + 30 + 60 = 405 \text{ g}$ | 2    |
| 2.2         | Energy provided by these portions of the carbohydrate supplement is = $405 \times 17 \text{ kJ/g} = 6885 \text{ KJ}$                                                                                                                                                                                                        | 1    |
| 3           | The energy provided by 405g of carbohydrates is 6885KJ, which is slightly greater than the amount of energy expended by the athlete during his training which is 6000KJ. Hence, the energy requirements are met.                                                                                                            | 2    |