وزارة التربية والتعليم العالي
المديريّــة العامة للتربية
دائرة الامتحانات الرسمية

امتحانات الشهادة الثانوية العامة
فرع علوم الحياة

دورة العام ٢٠٢١ الاستثنائيّة
الإثنين ٦ أيلول ٢٠٢١

مسابقة في مادة علوم الحياة
المدة: ساعتان ونصف

الاسم:
الرقم:

**Exercise 1 (6 points)** **Huntington Disease**

**Huntington disease is a rare neurodegenerative disease of the central nervous system. It is characterized by uncoordinated and involuntary movements of great amplitude and by psychological problems. It is due to a mutation at the level of the gene coding for a protein called huntingtin which is essential for the survival of the neurons.**

**Document 1**

**1-** Pick out from the text:

**1.1-** the origin of Huntington disease.

**1.2-** the symptoms of this disease.

A study is performed on individuals carrying the mutated allele responsible for this disease. Document 2 represents the variation of the percentage of individuals showing the symptoms of the disease as a function of their age.

| **Age (years)** | 10 | 30 | 40 | 60 | 70 |
|---|---|---|---|---|---|
| **Percentage of individuals showing the symptoms of the disease (%)** | 0 | 30 | 60 | 90 | 100 |

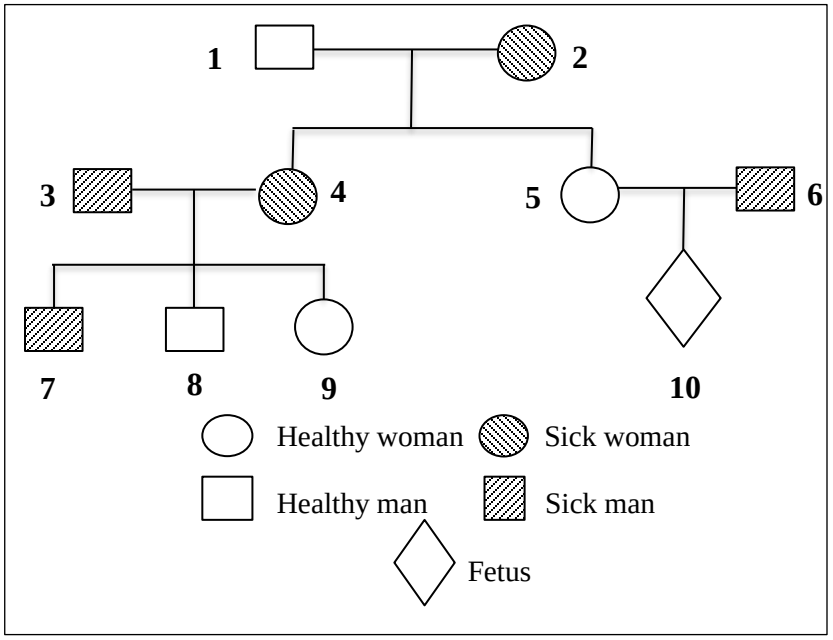
**Document *2***

**2-** Interpret the obtained results.

Document 3 shows the genealogical tree of a family which certain members are affected by the disease.

**3-** Indicate whether the allele of this disease is recessive or dominant. Justify the answer.

**4-** Determine the localization of the gene responsible for this disease.




**Document 3**

DNA analysis is performed on certain individuals of this family using the Southern blot method. The used probe permits to distinguish the mutated allele from the normal one of the studied gene. The obtained results are shown in document 4.

**5-** Specify the band which corresponds to the mutated allele.

**6-** Determine the genotype and the phenotype of the fetus.

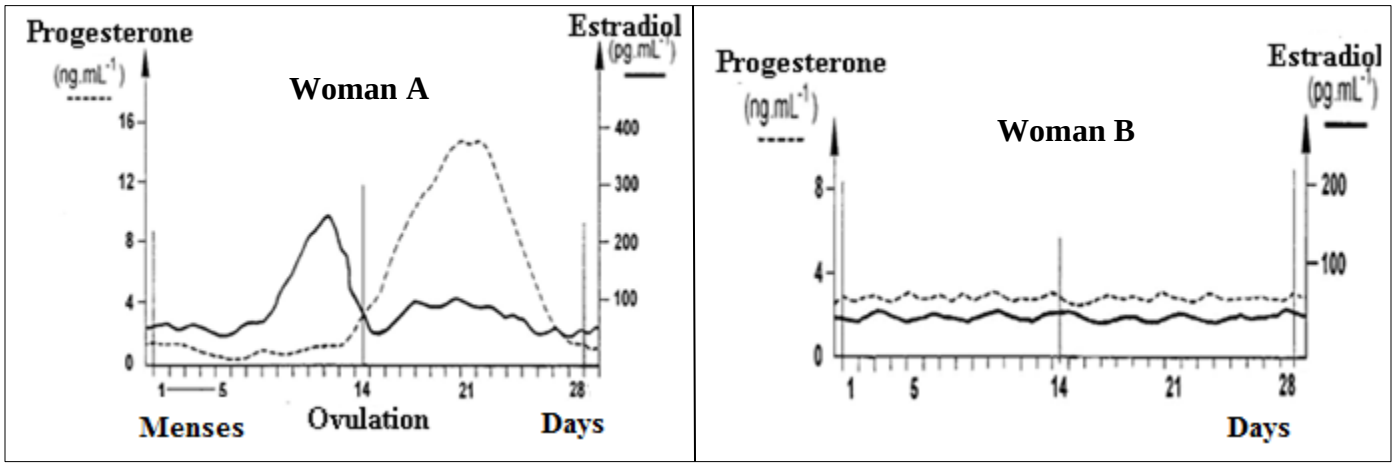
| | **Individuals** | | |
|---|---|---|---|
| **Bands** | **5** | **6** | **Fetus** |
| **A** | ▬▬▬ | ▬▬▬ | ▬▬▬ |
| **B** | | ▬▬▬ | ▬▬▬ |

**Document 4**

**Exercise 2 (6 points)** **Evolution of the Ovarian Hormones with Age**

Female fertility evolves with age; beyond 50 years old, the cyclic menses as well as ovulation disappear. Studies are done to explain the mechanisms at the origin of these modifications.

**Study 1:** During a period of 28 days, the levels of ovarian hormones are measured in two women: woman (A) whose age is 25 years old and woman (B) whose age is 50 years old, at menopause. The obtained results are presented in document 1.




**Document 1**

**1-** Compare in these two women:

**1.1**- the variations of estradiol levels.

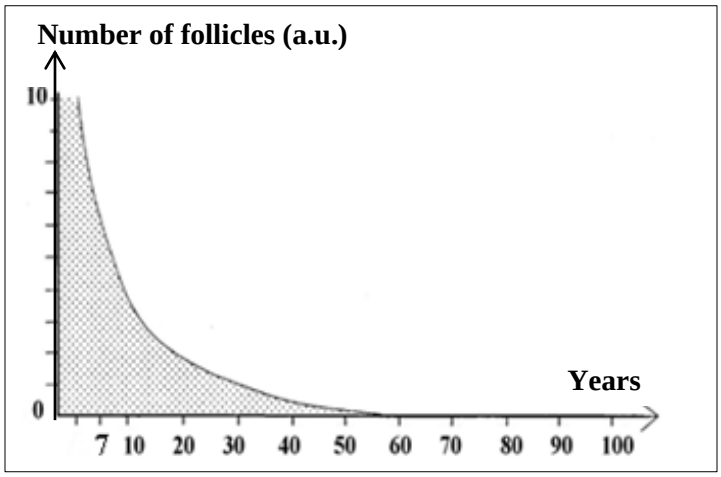
**1.2**- the variations of progesterone levels.

**2-** Draw out the effect of age on the ovarian activity.

**3-** Indicate a role of estradiol and a role of progesterone.

**Study 2:** The ovarian follicles which are responsible for the secretion of estradiol and progesterone are evaluated throughout the female life span. The obtained results are presented in document 2.

**4-** Deduce the cause of the variation of the ovarian hormones observed at menopause.




**Document 2**

In order to determine the cause of the disappearance of the ovarian follicles, two hypotheses are proposed:

**Hypothesis 1:** The disappearance is due to the aging of the ovary itself.

**Hypothesis 2:** The disappearance is due to the stoppage of the stimulation of the ovary by the anterior pituitary hormones.

| **Age ( years)** | **20-29** | **34-39** | **48-54** |
|---|---|---|---|
| **FSH (in mg.L$^{-1}$)** | 22 | 34 | 60 |

**Document 3**

Document 3 represents the evolution in the average plasma level of FSH (pituitary hormone) which stimulates the growth and maturation of ovarian follicles as a function of the age of a woman.

**5-** Determine which of the two hypotheses is valid.

**Exercise 3 (4.5 points)** **Cocaine**

In the framework of studying the mode of action of cocaine at the level of the dopamine synapses, the following experiments are performed.

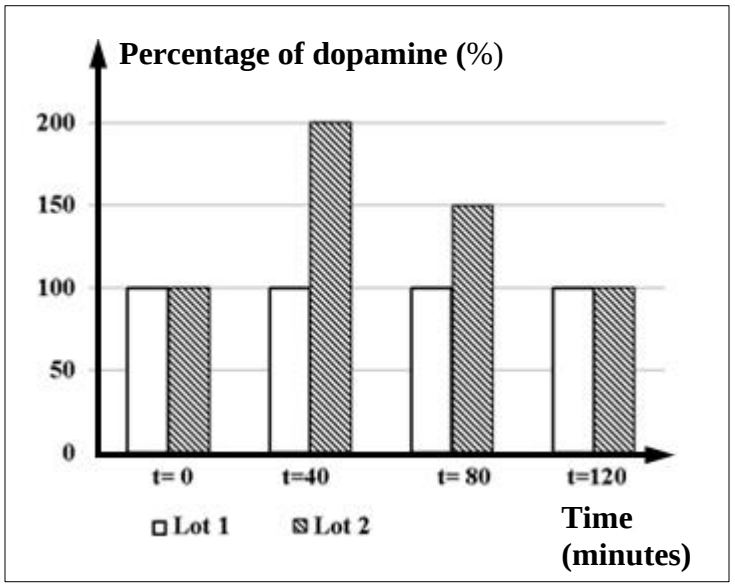
**Experiment 1:** Dopamine percentage is measured at the level of the synaptic clefts in two lots of rats: the rats of **lot 1** which are considered as control group, and those of **lot 2** which are injected with cocaine at time t = 0 minute.

Document 1 represents the obtained results.

**1-** Represent in the same table, the variation of the percentage of dopamine in the two lots as a function of time.

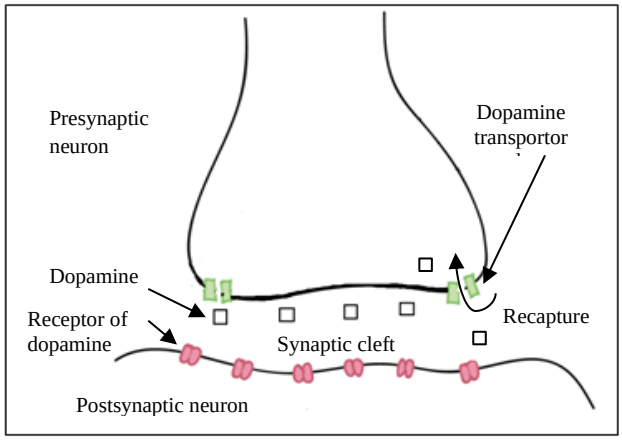
**2.1-** Analyze the obtained results.
**2.2-** What can you conclude?

**3-** Propose two hypotheses explaining the mode of action of cocaine at the level of this synapse.

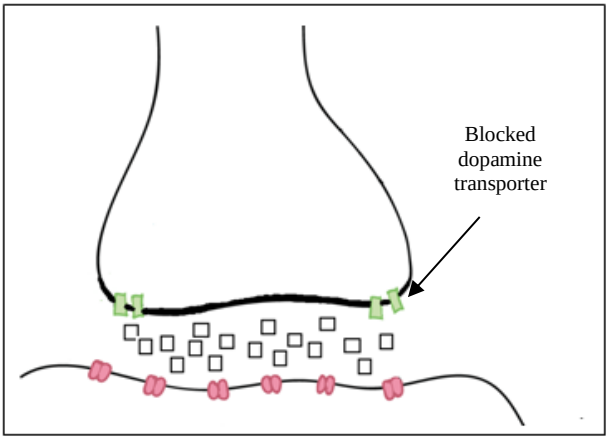



**Document 1**

**Experiment 2:** In order to determine the validity of the proposed hypotheses, cocaine is injected into the synaptic cleft of a dopamine synapse.
Document 2 shows the aspect of two synapses, synapse 1 not injected with cocaine (control) and synapse 2 injected with cocaine.




***Synapse 1***




***Synapse 2***

**Document 2**

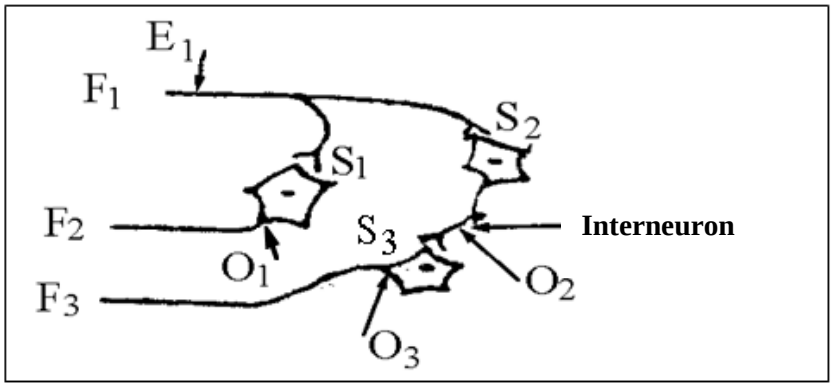
**N.B.: Dopamine transporters are responsible for the recapture of dopamine by the presynaptic neuron.**
**4-** Which of the two proposed hypotheses is valid? Justify the answer.
**5-** Explain the following statement: “Cocaine consumption induces a state of dependence and a state of tolerance”.

**Exercise 4 (3.5 points)**

# Synaptic Transmission

In order to study certain aspects of the synaptic transmission, the following experiments are performed using the experimental setup shown in document 1.

**Experiment 1:** Fiber $F_1$ is stimulated by an effective intensity ($E_1$). The results are recorded by oscilloscopes at the level of the three post-synaptic structures: the cone of implantation of the axon $F_2$ ($O_1$), the axon of the interneuron ($O_2$) and the cone of implantation of axon $F_3$ ($O_3$). The obtained results are shown in document 2.




**Document 1**

| Oscilloscopes | Recordings |
|---|---|
| **$O_1$** | Hypopolarization followed by an action potential |
| **$O_2$** | Action Potential |
| **$O_3$** | Hyperpolarization |

**Document 2**

**1-** List the steps of the transmission of the nervous message at the level of a synapse.
**2-** Specify the nature of each of the synapses $S_1$, $S_2$ and $S_3$.

**Experiment 2:** Two types of neurotransmitters, acetylcholine and GABA, are injected into the synaptic clefts of $S_1$ and $S_3$. The experimental conditions and the results are presented in document 3.

| Synapses | Injected Neurotransmitters | Oscilloscopes | |
|---|---|---|---|
| **$S_1$** | Acetylcholine | **$O_1$** | Hypopolarization |
| | GABA | | Resting potential |
| **$S_3$** | Acetylcholine | **$O_3$** | Resting potential |
| | GABA | | Hyperpolarization |

**Document 3**

**3-** Indicate the site of action (synapse(s) $S_1$ and/or $S_3$) for each of the utilized neurotransmitters. Justify the answer.

مسابقة في مادة علوم الحياة
اسس التصحيح

الاسم:
الرقم:

| Q. | Exercise 1 : Huntington Disease<br>Answer key (6 points) | Note |
|---|---|---|
| **1.1** | The origin of Huntington disease is a mutation at the level of the gene coding for a protein called huntingtin. | **0.5** |
| **1.2** | The symptoms of this disease are uncoordinated and involuntary movements of great amplitude and psychological problems. | **0.5** |
| **2** | The percentage of individuals showing the symptoms of the disease increases from 0 % to 100% as the age of these individuals increases from 10 to 70 years.<br>Therefore, the expression of Huntington disease symptoms is enhanced with age. | **1.5** |
| **3** | The mutated allele is dominant over the normal allele because the affected parents (3 and 4) have healthy children (8 and 9). This means that the allele for normal is present in the parents but it is masked by the allele responsible for the disease. (D = allele responsible for Huntington disease; n = normal allele) D> n | **0.5** |
| **4** | - If the allele responsible for the disease is carried on the non –homologous segment of chromosome Y then, it should be transmitted from father to son; however the affected father (3) has a healthy son (8). Therefore, the allele is not carried by the non-homologous segment of chromosome Y.<br>- If the allele of the disease is carried on the non-homologous segment of chromosome X, then the affected father (3) should transmit this dominant allele to all his daughters who should be all affected; however, his daughter (9) is healthy, thus the allele is not carried on the non-homologous segment of X chromosome.<br>- If the allele is carried on the homologous segment of chromosome X and Y, then boy (8) who is normal should have the genotype $X^n Y^n$, inheriting $X^n$ from his mother(4) and $Y^n$ from his father (3). His sister (9) who is normal should have the genotype $X^nX^n$ taking $X^n$ from her father (3) and therefore he should have the genotype $X^nY^n$ and should be healthy but it is not the case. Therefore, the allele is not carried by the homologous segment of chromosomes X and Y.<br>Hence the allele responsible for the disease is carried on an autosome. | **1** |
| **5** | The band at the level of B corresponds to the mutant allele. This is because the DNA analysis of individual 5 who is healthy shows only a thick band at the level of A indicating that band A corresponds to the normal allele. On the other hand, individual 6 who is diseased shows 2 thin bands at the level of A and another at the level of B. Hence, that band at the level of B corresponds to the mutant allele which is responsible for the disease. | **1** |
| **6** | Since the fetus has two thin bands at the levels of A and B corresponding to the normal allele and mutant allele respectively, then the genotype of the fetus is D//n. Since the mutant allele D is dominant over the normal allele n, the phenotype of the fetus is [D]. | **1** |

<table>
<tr><th>Q.</th><th>Exercise 2: Evolution of the Ovarian Hormones with Age<br>Answer key (6points)</th><th>Note</th></tr>
<tr><td>1.1</td><td>In woman A, during a period of 28 days, the estradiol level shows two peaks: the first peak reaches approximately 250 pg/ml around day 12, and a second lower peak that reaches 100 pg/ml around day 21. On the other hand, Woman B shows constant variation of estradiol that fluctuates around 50 pg/ml during the same interval of time (from day 0 till day 28).</td><td>1</td></tr>
<tr><td>1.2</td><td>In woman A, during a period of 28 days, the progesterone level shows only one peak that reaches approximately 15 ng/ml around day 21. On the other hand, Woman B shows constant variation of progesterone that fluctuates around 3ng/ml during the same interval of time (from day 0 till day 28).</td><td>1</td></tr>
<tr><td>2</td><td>At menopause, the cyclic variation of ovarian hormones disappear indicating the cease of the ovarian activity.</td><td>0.5</td></tr>
<tr><td>3</td><td><table><tr><th>Estrogen<br>(any of the following roles)</th><th>Progesterone<br>(any of the following roles)</th></tr><tr><td>- Proliferation of the uterine and vaginal mucosa<br>- Development tube-like glands of the endometrium.<br>- Development of the cervical glands<br>- Growth of blood vessels.</td><td>- Stimulation of gland secretions in the uterine mucosa and the cervix.<br>- Development of spiral arterioles.<br>- Increase in the body temperature.<br>- Inhibition of the uterine contractions.</td></tr></table></td><td>1</td></tr>
<tr><td>4</td><td>The number of the ovarian follicles which are responsible for the secretion of estradiol and progesterone decreases from 10 a.u. at around 7 years old to reach 0 a.u. beyond 50 years old. Therefore, the constant level of ovarian hormones and the absence of their cyclic variation observed at menopause are due to the depletion of ovarian follicles.</td><td>1</td></tr>
<tr><td>5</td><td>Given that FSH is responsible for the growth and maturation of ovarian follicles and since by referring to doc 3, the plasma level of FSH increases to 60 mg/l at menopause (48 -54 years old), then the cause of the disappearance of ovarian follicles is not due to the stoppage of the stimulation of the ovary by the anterior pituitary hormones (FSH), and therefore the first hypothesis (The disappearance of the follicles is due to the aging of the ovary) is the valid one.</td><td>1.5</td></tr>
</table>

<table>
<tr><th>Q.</th><th>Exercise 3: Cocaine<br>Answer key (4.5 points)</th><th>Note</th></tr>
<tr><td>1</td><td>
<table>
<tr><td colspan="2">Time (minutes)</td><td>0</td><td>40</td><td>80</td><td>120</td></tr>
<tr><td rowspan="2">Percentage of dopamine (%)</td><td>Lot 1</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
<tr><td>Lot 2</td><td>100</td><td>200</td><td>150</td><td>100</td></tr>
</table>
Variation of the percentage of dopamine (a.u.) as a function of time (minutes) in 2 lots of rats.
</td><td>1</td></tr>
<tr><td>2.1</td><td>The percentage of dopamine is 100% at time= 0 min in both lots of rats, lot 1,the control group, and lot 2 which are injected with cocaine. The % of dopamine remains constant(100%) during 120 min while it duplicates after 40 min in lot 2 to reach maximum of 200% then it decreases back to the initial level (100%) at 120 minutes.</td><td>0.5</td></tr>
<tr><td>2.2</td><td>Cocaine amplifies the level of dopamine in the synaptic cleft for a certain period of time.</td><td>0.5</td></tr>
<tr><td>3</td><td>Hypothesis1: Cocaine increases the release of dopamine into the synaptic cleft.<br>Hypothesis2: Cocaine prevents or decreases the recapture of dopamine by the presynaptic neuron.</td><td>1</td></tr>
<tr><td>4</td><td>Hypothesis 2 is valid, because according to document2, dopamine transporters which are responsible for the recapture of dopamine after being released in to the synaptic cleft are blocked in the presence of cocaine and eventually it leads to excess dopamine in the synaptic cleft for a longer duration of time. .</td><td>0.5</td></tr>
<tr><td>5</td><td>The consumption of cocaine leads to a sensation of pleasure followed by a desire to continue its use. This leads to a state of dependence.<br>The repetitive use of cocaine will lead to the adaptation of the body to the repeated doses of the product and loss of its effect. Consequently, the consumer tends to increase the dose in order to obtain the desired effect. This leads the consumer to a state of tolerance.</td><td>1</td></tr>
</table>

| Q. | Exercise 4: Synaptic transmission<br>Answer key (3.5 points) | Note |
|---|---|---|
| **1** | The steps of the transmission of the nervous message at the level of a synapse are:<br>- Arrival of action potential at the presynaptic terminal buds leads to the opening of calcium voltage gates. The inflow of $Ca^{2+}$ ions into the presynaptic terminal bud causes the fusion of vesicles that contain neurotransmitters with the presynaptic membrane.<br>- The release of neurotransmitters by exocytosis into the synaptic cleft.<br>- The Binding of neurotransmitters to postsynaptic receptors allow the opening of chemical-dependent channels that modifies the membrane potential thus creating PSP at the level of the postsynaptic membrane.<br>- Later, the neurotransmitters are rapidly destroyed by a specific enzyme or recaptured by the presynaptic neuron. | **1** |
| **2** | $S_1$ and $S_2$ are excitatory synapses because $O_1$ and $O_2$ connected to the fibers of the postsynaptic neurons recorded A.P after applying an effective intensity of stimulation, $E_1$, to the nerve fiber $F_1$ of the presynaptic neuron.<br>$S_3$ is an inhibitory synapse because for the same effective stimulation $E_1$, hyperpolarization is recorded by $O_3$ connected to the post synaptic neuron $F_3$. | **1.5** |
| **3** | Acetylcholine acts at the level of the synapse $S_1$ only because it records a hypolarization at the level of $O_1$ but not $O_3$ where it records a resting potential. On the other hand, GABA acts at the level of the synapse $S_3$ only because it records a hyperpolarization at the level of $O_3$ but not $O_1$ where it records a resting potential. | **1** |