Comprehensive Exam
Biology

Exam Details:

- This exam consists of 3 parts: Knowledge and Understanding, Applying Scientific Concepts and Interdisciplinary item.
- The duration of this exam is 120 minutes.

Student Details:

- Name: ……
- ID: | | | | | | | |

Instructions:

- Think of an answer for each of the multiple choice questions before reading the alternatives (A) through (D). Then read the alternatives, and choose the **one** that best matches your answer.
- Mark **only one** answer for each of the multiple choice questions.
- **Avoid guessing**. Your answers should reflect your overall understanding of the subject matter.
- Answer all questions to the best of **your knowledge and reasoning.**
- Return your completed work in **good shape.**

Marking *(Teachers Only)***:**

	1st Correction	2nd Correction	Final grade		1st Correction	2nd Correction	Final grade
Part I				**2**			
1				**3**			
2				**Part III**			
3				**1**			
4				**2**			
5				**3**			
6				**4**			
7				**5**			
8				**6**			
Part II				**7**			
1							
Feedback:							

Part I: Knowledge and Understanding. (40 points)

Use Document 1 to answer question 1 and 2

The variety of ornamentation of snails' shells of hedges is determined by four genes, each presenting a different allelic form. Populations of these species and the diversity of the ornamentation of the shell does not decrease with time.

Document 1: Ornamentation of snail shells

1. A genetic mutation designates a modification of the genetic information or DNA of a cell. It is through genetic mutations that species evolve.
A mutation of an allele through the deletion of six nucleotides: **(5 points)**

A. Can lead to the synthesis of a polypeptide with sequence of amino acids totally different from that at the point of deletion.
B. Can lead to the absence of a "stop" triplet anticipated in the sequence of the gene.
C. Should always have consequences on the biological activity of the polypeptide coded by the gene.
D. Cannot lead to the loss of two amino acids and the apparition of a new amino acid in the sequence of the polypeptide.

Justify your answer:

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2. The random segregation of chromosomes leads to an important gametes diversity.
A subject whose genotype is symbolized $\frac{A}{a}\frac{B}{b}\frac{C}{c}$ can form: **(5 points)**

A. 3^2 different gametes
B. 3^3 different gametes
C. 2^3 different gametes
D. 3 different gametes

Justify your answer:

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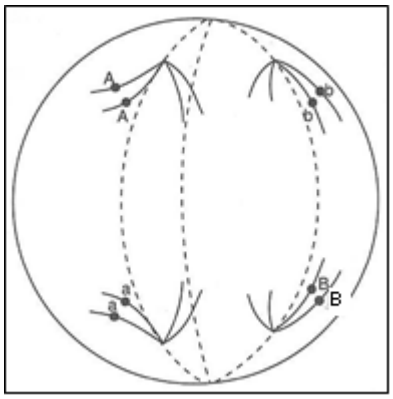
3. **Document 2** shows the anaphase of the first division of meiosis (we only considered 2 pairs of chromosomes and only 2 localized genes). Based on the observation of **document 2**, we can conclude: **(5 points)**



Document 2: Anaphase of the first division

A. That there had been a crossing-over between the centromere and the indicated gene at the level of one pair of chromosomes.

B. That the individual who has this chromosomal garniture produces 4 types of gametes for the considered genes.

C. That the individual received the alleles A and b from one of his parents and a and B from the other.

D. That the figure illustrates the notion of intrachromosomal recombination.

Justify your answer:

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4. A male and a female are both heterozygous for three genes of the HLA system (HLA A, HLA B, HLA C) and do not possess any alleles in common for these genes. They have six children. It is possible: **(5 points)**

A. That one child has the same genotype as his father.

B. That two children do not share the same genotype.

C. That all the children have identical genotypes.

D. That one child has, for each of his alleles, an allele that his grand-mothers had.

Justify your answer:

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More than 2000 hereditary genetic diseases are known and 0.7% of child births present chromosomal abnormalities. In total, almost 4% of the subjects born alive present abnormalities resulting from genetic causes. Based on this prevalence, genetic advisors take it on themselves to explain to couples the medical facts, to define the affection risk (incurable, transmissible…) and to show them the possible prevention options to help families handle the recurrence risk.

Document 3: Genetic Diseases

Use document 3 to answer questions 5, 6, 7 and 8.

5. Hemophilia A is a recessive genetic disease. The implicated gene is situated on the non-homologous segment of chromosome X. The frequency of men affected of hemophilia A is of 1 on 10 000.

We can conclude that: **(5 points)**

A. The frequency of hemophilic females is much lower.
B. The mother of a hemophilic child has a probability of 1/2 of being heterozygous.
C. The father of a hemophilic child is surely heterozygous.
D. The sister of a hemophilic child has a probability of 1/5 000 of having a hemophilic son.

Justify your answer:

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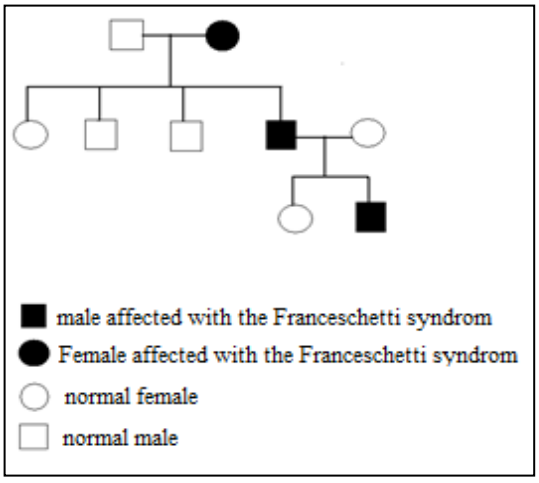
6. Franceschetti disease is a genetic disease that leads to malformations of the face, eyes and ears. This disease is due to a mutation of a gene coding for the protein: TCOF1. Here's the pedigree of a family with some affected members.
The gene coding for the protein TCOF1 is located on:
(5 points)

A. An autosome
B. Chromosome X
C. Chromosome Y
D. The homologous segment of X and Y



Document 4: Pedigree of a family with some affected members

Justify your answer:

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7. Vitamin D-resistant rickets is considered a sex-linked dominant disease (gene located on the non-homologous segment of chromosome X). We can conclude that: **(5 points)**

A. Every boy with an affected mother is affected
B. Every girl with an affected father is affected
C. An affected male definitely transmits the disease to his children
D. The children of an affected male and a normal female are not affected

Justify your answer:

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8. The frequency of heterozygous for the set of alleles at the origin of cystic fibrosis in Europe is of almost 1 person in 25. This means that: **(5 points)**

A. The frequency of people affected with cystic fibrosis is 1 in 50
B. The non-affected brother of a child affected with cystic fibrosis has 1 in 25 risk of being heterozygous
C. The risk of having an affected child for a sister of an affected subject is 1 in 150 (the sister being non-affected)
D. The paternal uncle of the affected child has 1 in 25 risk of being heterozygous

Justify your answer:

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Part Two: Applying Scientific Knowledge. (25 points)

Exercise 1: Immunology and viral transmission

Since April 2012, several cases of infection by the Corona virus of the Middle-East Respiratory Syndrome (MERS-Co V) have been identified in the following Middle-Eastern countries: Jordan, Saudi Arabia, Qatar, United Arab Emirates, Oman, Kuwait, Yemen, Lebanon, Iran and Bahrain.

Between the 19th and the 22nd of June 2016, WHO published 3 reports on the Disease Outbreak News (DON) describing 25 cases of Middle East Respiratory Syndrome (MERS). Twenty-four of the cases were identified as having contact with a probable, single index case who was diagnosed with MERS in a hospital in Riyadh City, Riyadh Region. On the 22nd of June 2016, DON reported that the index case had died.

Based on available information, the probable index case is a woman who was admitted on the 10th of June 2016 to the hospital with a critical health condition, not consistent with MERS symptoms. She was triaged in the emergency room of the hospital and admitted to the vascular surgery ward. Following admission, the patient showed signs of respiratory illness, and MERS was suspected. The hospital diagnosed and confirmed MERS on the 12thof June 2016, within 48 hours of her original admission. The patient's MERS clinical symptoms were initially masked by other predominant symptoms.

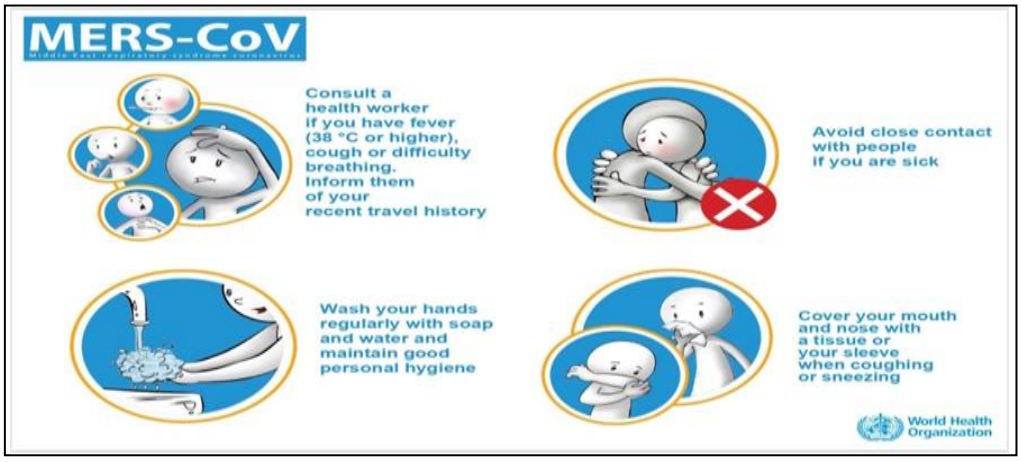
Immediately following diagnosis, the Ministry of Health of Saudi Arabia dispatched a rapid response team to the hospital. The team conducted active screening and contact tracing to identify health care workers, visitors, patients and household contacts who may have been exposed to MERS by the probable index patient. In addition, other public health control measures were immediately implemented in the hospital to limit further transmission.

As of June 22, 2016 twenty-four (24) contacts have tested positive for MERS including twenty (20) healthcare contacts and three (3) household contacts. In addition, one case has been diagnosed in a household contact of a hospital patient who was diagnosed with the disease after exposure to the probable index case.

WHO-World Health Organization

http://www.who.int/emergencies/mers-cov/saudi-arabia-update/en/

Document 1: A new syndrome in the Middle East



Document 2: Precautions from MERS-CoV

This woman was diagnosed at the hospital through the ELISA technique.

1. After Reading **document 1**, describe this test that can identify the presence of specific antibodies in this female. **(10 points)**

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2. Illustrate through an explicative diagram showing the positive results faced with an MERS-CoV negative test. **(10 points)**

MERS-CoV Positive Test	**MERS-CoV Negative Test**

3. Based on the two documents, indicate the advice that should be given to the family and relatives. **(5 points)**

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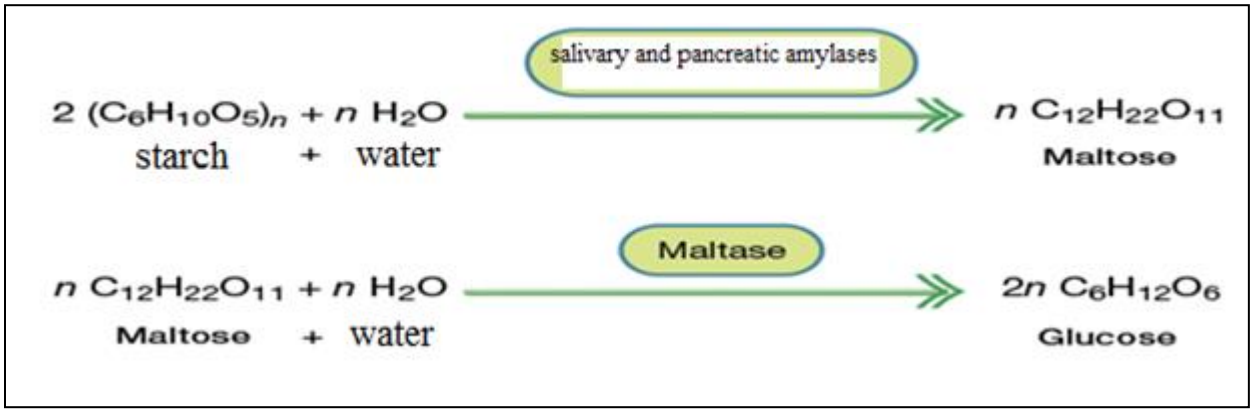
Part three: Interdisciplinary Item. (35 points)

Regulation: Diabetes and glycemia

The acarbose, an anti-diabetic medicine

A doctor prescribes a medication with acarbose as its active principle to one of his patients affected with a type 2 diabetes. Through its original action mode, acarbose allows to correct the troubles linked to this disease.
During digestion, the ingenerated starch is cut through the action of digestive enzymes, such as amylase (salivary and pancreatic) and maltase.
This reaction provides glucose that crosses the intestinal wall to the blood.
The chemical equations relative to this reaction are mentioned below**.**



Document 1: Reaction Between starch and digestive enzymes

Referring to document 1, answer questions 1, 2 and 3.

1. Identify the type of this reaction. **(2 points)**

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2. Why is starch considered an organic substance? **(2 points)**

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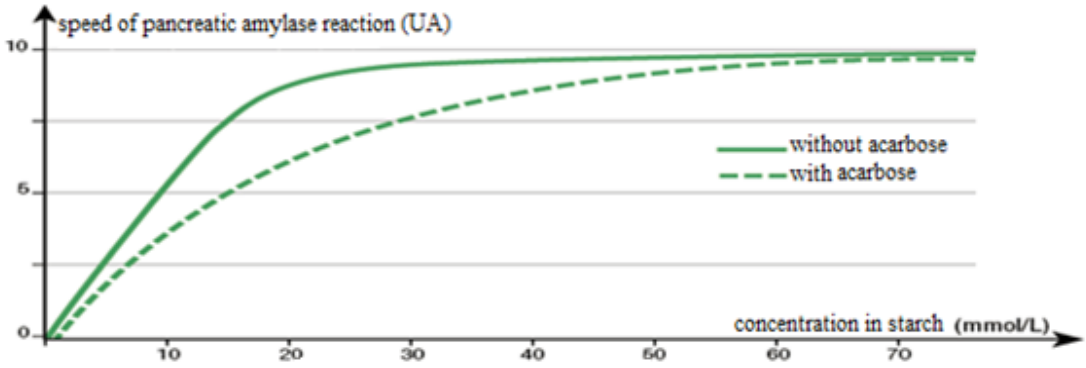
3. Indicate the constituent monomer of starch. What is the type of bonds between the monomers in a starch molecule? **(4 points)**



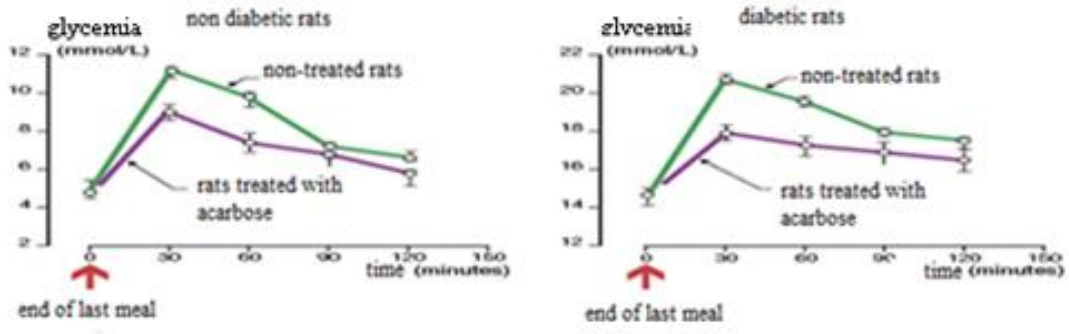
(Based on K.S Lam and al., Diabetes Care, 21-7,1154-1158, 1998)

Document 2: variations of speed of the pancreatic amylase reaction, in absence or presence of acarbose in function of starch concentration

Referring to **document 2**, answer question 4 and 5.

4. Find the speed of the pancreatic amylase reaction with and without acarbose for a starch concentration of 20 mmol/L. What can we notice? **(7 points)**

5. Can we consider acarbose a catalyst? Justify. **(5 points)**

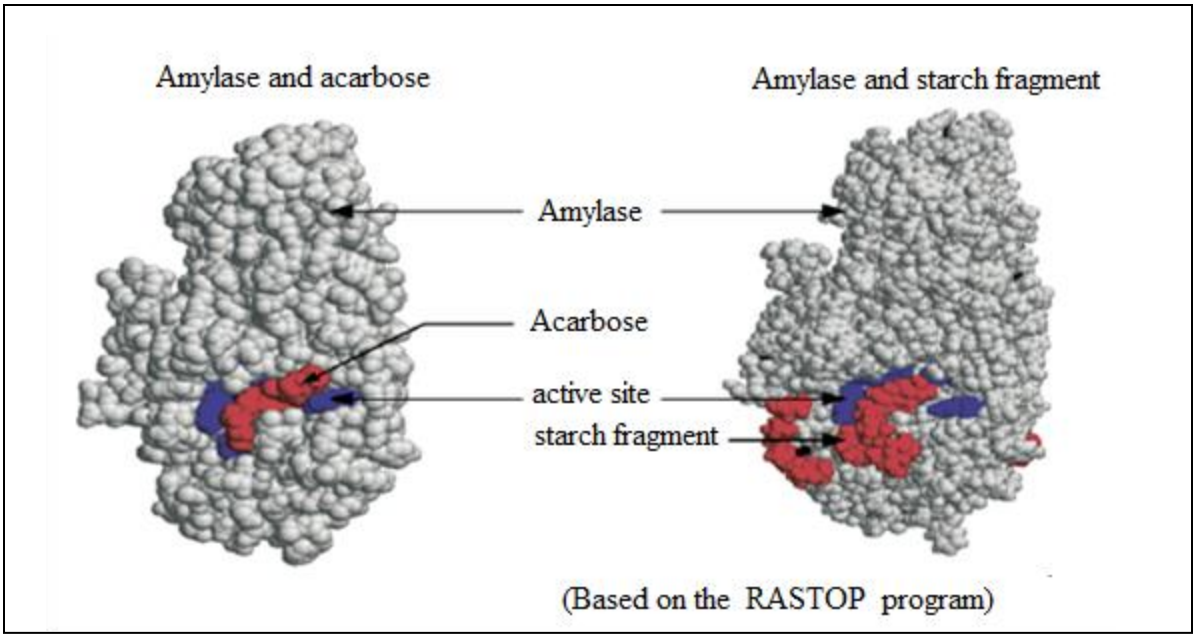


(Based on M.A. Mogale and al., African Journal of Biotechnology, 10-66,15033-15039, 2011)

Document 3: Glycemia measured in postprandial period (after a meal), after treatment with acarbose or not, in diabetic and non-diabetic rats

Referring to document 3, answer question 6.

6. Analyze these two graphs. What can we deduce concerning the role of acarbose in the regulation of glycemia? **(6 points)**



Document 4: Molecular models of pancreatic amylase in presence of starch (fragment) or in presence of acarbose

7. Based on the exploitation of the 4 documents above and on your knowledge, explain to this patient the action mode of acarbose and its role in treating diabetes. **(9 points)**