



## EmSAT Achieve Biology Public Test Specification

**Test Description:** EmSAT Biology Achieve measures test taker proficiency in Biology and determines their readiness for college. EmSAT Biology Achieve has four major sections: (1) From molecules to living organisms - Structure and function; (2) Heredity and genetic technology; (3) Evolution and Diversity of Life; (4) Ecology - Interdependence, energy, and dynamics.

The exam is adaptive. Exam content and difficulty is customized to the individual test taker. When a test taker answers a question correctly, they will be given more difficult content; when they answer a question incorrectly, they will be given easier content. This process of continuous adjustment delivers optimized content for each test taker throughout the exam, maximizing their opportunity to perform at their best and providing a more accurate measure of their ability. Test takers should do their best to answer each question correctly; once a question is answered, they will not be able to go back and change the answer.

<b>Test Duration:</b>	120 minutes
<b>Questions:</b>	50 questions
<b>Content Areas:</b>	(1) From molecules to living organisms: Structure and function (2) Heredity and genetic technology (3) Evolution and Diversity of Life (4) Ecology: Interdependence, energy, and dynamics
<b>Task Types:</b>	Multiple Choice, Multi-select, Fill-in the-Blank, and Drag and Drop

EmSAT Achieve Biology	
Score	Score Descriptors
1500 – 2000	<b>High Proficiency:</b> High Proficiency: students at this level are well-prepared for first-year biology courses at the university level.
1100-1475	<b>Proficient:</b> students at this level are at a satisfactory level of preparation to begin first-year biology courses at the university level.
900-1075	<b>Borderline Proficient:</b> students at this level are minimally prepared for first year biology courses at the university level and may need additional support in some areas
700-875	<b>Basic:</b> students at this level do not have sufficient mastery of prerequisite knowledge for first-year courses in chemistry at the university level and will likely need some additional support in some biology topics.
500-675	<b>Needs Improvement:</b> students at this level need additional instructional support in basic chemical concepts and skills before beginning any first-year biology courses.
< 500	<b>Little knowledge of basic science:</b> students at this level lack knowledge and skills of basic science concepts.



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### Appendix 1: Content Areas

Below are the major sections and related content specifications that grade 12 students should be able to demonstrate to meet the expectations of this test.

#### **Section 1: From molecules to living organisms: Structure and function**

This section includes the chemistry of life as well as living organisms' organization and development. The chemistry of life focuses on the importance of biological macromolecules in the body and the properties of water that allow life to exist on earth, as well as the role of enzymes in chemical reactions carried out in living organisms. It also focuses on the major cellular processes of breaking energy (photosynthesis and cellular respiration) and energy transformation.

Living organisms' organization and development focuses of the role of the cell in different living organisms emphasizing on cellular structures and their functions, as well as the use of microscopes in cellular studies. In addition, this part focuses on major body systems and processes in living organisms. It emphasizes the role of body systems in different living organisms with relation to the importance of the interaction between the body systems in maintaining the internal body environment.

#### Content Specifications

- Distinguish between the four major categories of carbon compounds in terms of composition, energy values, and primary functions in the body
- Relate the properties of water to its roles in living organisms
- Explain the role and effect of enzymes and other factors, such as pH and temperature, in the chemical reactions carried out in living organisms
- Identify and summarize the major cellular processes of breaking energy-rich molecules to obtain energy
- Demonstrate a good understanding of handling and using the light microscope for examination purposes, and compare with electron microscope in terms of resolution, magnification and use
- Explain the role of the cell in different living organisms and describe the cellular processes to sustain life and maintain homeostasis
- Relate the structure of major body systems in multicellular organisms to their specific functions and their interaction with each other to maintain homeostasis



## Section 2: Heredity and genetic technology

This section includes inheritance of traits and heredity and genetic technology. Inheritance of traits focuses on cell growth and division emphasizing on the behavior of chromosomes during different phases and consequences of specific errors during these phases. It also encompasses gene expression and regulation in eukaryotes and prokaryotes, genetic variations and modes of inheritance including Mendelian and non-Mendelian genetics.

Heredity and genetic technology focuses on the importance of genetic engineering in medicine, industry and agriculture with the emphasis on their impact on human's life.

### Content Specifications

- Explain the importance of cell growth and division and explain possible outcomes when errors occur during the cell cycle
- Explain transcription, post-transcriptional modifications and translation, and relate these processes to gene expression in prokaryotes and eukaryotes
- Use the genetic code rules to read the DNA sequence, and to identify the amino acids in the polypeptide chain
- Describe genetic variation and explain how and why it occurs with relation to the importance of population biodiversity and stability
- Identify the role of genes in determining the phenotype and predict the probable outcomes of offspring with reference to various modes of inheritance including dominance, codominance, sex-linked, polygenic and multiple alleles
- Evaluate the importance of genetic engineering in medicine, industry and agriculture and its impacts providing examples on its use in each field



### Section 3: Evolution and Diversity of Life

This section includes evolution and diversity of life. Evolution focuses on theory and evidence of evolution to determine the evolutionary relationships among different species, as well as evolutionary processes such as natural selection and genetic drift and their consequences on the populations' stability.

The focus of diversity of life is the classification of living organisms according to specific structural and functional characteristics. In addition, it focuses on the importance of biodiversity, and reasons for maintaining biodiversity emphasizing the impact of human activity on the survival of different species.

#### Content Specifications

- Discuss the early concepts of evolution and investigate different evidence to determine the evolutionary relationships among different species
- Identify the processes of microevolution and explain the mechanisms by which they function to influence alleles' frequencies in populations and lead to macroevolution.
- Describe how living organisms are classified, and categorize them according to specific structural and functional characteristics
- Explain the importance of and the reasons for maintaining biodiversity, and describe the threats that can lead to extinction including the impact of human activity



#### **Section 4: Ecology: Interdependence, energy, and dynamics**

This section includes ecological interdependence and environmental sustainability. Ecological interdependence focuses on the different ecological concepts used in ecology and community interactions, as well as biogeochemical cycles and energy flow with reference to food chains and webs, emphasizing on the effects of biotic and abiotic factors on ecosystem stability and biodiversity.

Environmental sustainability focuses on human impact on environment and the importance of sustainable management of resources on Earth, emphasizing on ways to manage the use of natural resources and possible solutions that could help to reduce the effect of changing climate on the health of natural ecosystems.

##### **Content Specifications**

- Distinguish between different ecological concepts (e.g. biomes, ecosystem, communities, habitats and niches) and give examples of interactions among different organisms
- Interpret food chains and food webs in terms of interaction of organisms through different trophic levels and flow of energy, and analyze the effects of biotic and abiotic factors on ecosystems dynamics
- Discuss the impact of human activities on the environment and explain the effect of density dependent factors and density independent factors on carrying capacity and changing ecosystems dynamics
- Explain the importance of individual contributions to sustainable management of resources on Earth



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### Appendix 2: Sample Items

1. Which of the following macromolecules contains a phosphate group? أي الجزيئات الكبيرة التالية تحتوي على مجموعة الفوسفات P-group؟

- A. Nucleic acids الأحماض النووية
- B. Carbohydrates الكربوهيدرات
- C. Lipids الدهون
- D. Proteins البروتينات

2. Which of the following statement is correct regarding the "induced-fit model" in enzyme-substrate interaction? أي العبارات التالية صحيحة عن نموذج التلاؤم المُستحث (induced-fit model) خلال تفاعل الأنزيم مع الركيزة؟

- A. The structure of the active site of the enzyme is changed by the substrate. تتغير بنية الموقع النشط للأنزيم من قِبَل الركيزة .
- B. The enzyme directly binds to the substrate to form an enzyme-substrate complex. يرتبط الأنزيم مباشرة بالركيزة لتشكيل معقد إنزيم - ركيزة (enzyme-substrate complex) .
- C. The shape of the enzyme is changed by the chemical reaction. يتغير شكل الأنزيم بالتفاعل الكيميائي .
- D. The active site of the enzyme changes its shape to accept a substrate. يُغير الموقع النشط للأنزيم شكله ليقبل الركيزة .



3. Cystic fibrosis is a chronic and frequently fatal genetic disease of the body's mucus glands. It is caused by an autosomal recessive mutation. In the European population, one out of approximately 10,000 babies is born with the disorder. What is the frequency of the cystic fibrosis allele in the European population assuming the Hardy-Weinberg conditions are met?

مرض التليف الكيسي هو مرض وراثي مزمن وقاتل يحدث في الغدد المخاطية في الجسم. سبب هذا المرض هو طفرة جسمية متنحية. تشير الإحصائيات عن سكان أوروبا، أنه يولد طفل من بين كل 10000 طفل مصاب بالإضطراب. ما هو تكرار أليل التليف الكيسي في السكان الأوروبيين على افتراض أن شروط هاردي-وينبرغ قد اكتملت.

A.

B.

C.

D.

4. Each alternative version of a gene is called \_\_\_\_\_.

كل نسخة بديلة من الجين تسمى ب \_\_\_\_\_.

A.  أليل

B.  القطعة المركزية

C.  شيفره

D.  شق صبغي (كروماتيد)



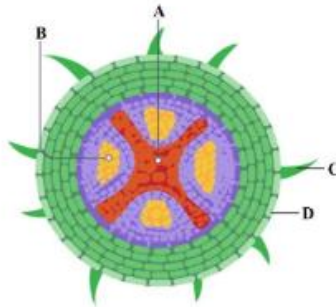
5. Which of the following cell structures is considered as a factory for protein synthesis?

أي من التراكيب الخلوية التالية يُعتبر مصنع لإنتاج البروتين في الخلية؟

- A. Rough endoplasmic reticulum الشبكة الإندوبلازمية الخشنة
- B. Golgi Apparatus جهاز جولجي
- C. Mitochondria ميتوكوندريا
- D. Nucleus النواة

6. The diagram below represents a cross section through a plant root. A student is given samples of a fluid that is rich with water. From which tissue does this fluid come?

الرسم التالي يوضح مقطع عرضي لجذر في نبات. تم إعطاء طالب عينة تحتوي على سائل غني بالماء. من أي نسيج يأتي هذا السائل؟



- A. A
- B. B
- C. C
- D. D

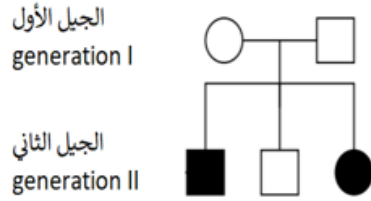








7.

The following pedigree represents the inheritance of an autosomal recessive syndrome in a family.

المخطط أدناه تمثل توارث متلازمة جسمية لصفة متنحية في عائلة ما.



KEY

-  affected male  
ولد مصاب
-  affected female  
أنثى مصابة
-  Normal male  
ولد طبيعي
-  Normal female  
أنثى طبيعية

If the affected male in generation II marries a normal female who is homozygous for the trait, what is the possibility to have an affected child?

إذا تزوج رجل مصاب من الجيل الثاني بامرأة طبيعية متجانسة للصفة، ما هي احتمالات إنجاب طفل مصاب؟

A.

B.

C.

D.



8. A scientist is studying the phylogeny of 4 species (species 1, 2, 3, and 4). To this end, she sequenced a fragment of DNA and she obtained the following alignment:

النوع 1 Species	A A T C G G A
النوع 2 Species	C A G G T A C
النوع 3 Species	A A T C T G A
النوع 4 Species	C A T G T G C

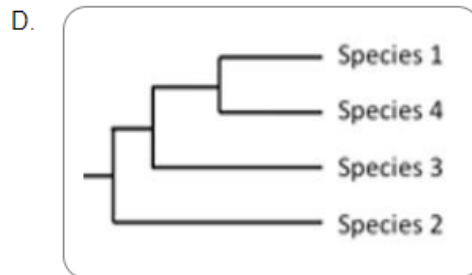
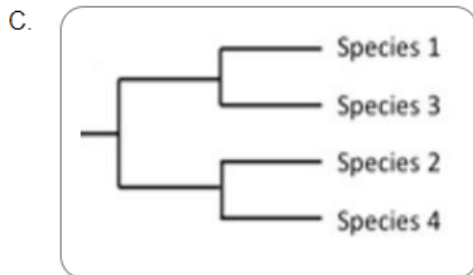
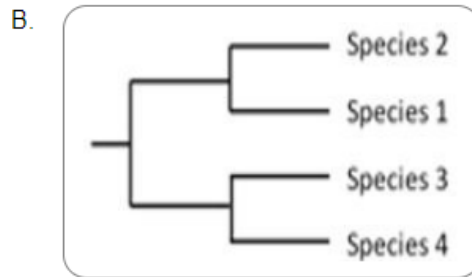
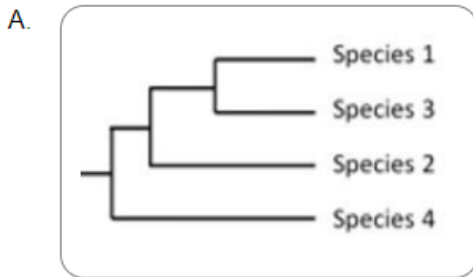
تدرس عالمة سلالة من 4 أنواع (الأنواع 1، 2، 3، 4). ومن أجل تحقيق هدفها من الدراسة، قامت بترتيب جزء من الحمض النووي DNA و حصلت على الترتيبات التالية:

With this alignment, she constructed a phylogenetic tree using the parsimony method (a method that minimizes the number of changes on a phylogeny).

إستناداً إلى هذا الترتيب، قامت ببناء شجرة تطور السلالة باستخدام طريقة تحليل العلاقات (الطريقة التي تقلل من عدد التغيرات على السلالة).

Which of the 4 phylogenetic trees below is supported by the DNA sequences?

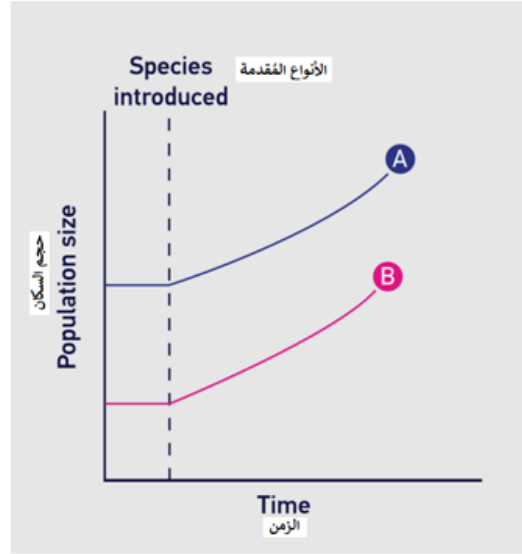
أي من الأشجار السلالية الأربعة أدناه يستند إليها ترتيب الحمض النووي DNA؟





9. The ecological relationship between two different species is shown in the graph below.

العلاقة البيئية بين نوعين مختلفين موضحة في الشكل أدناه.



What ecological relationship does the graph represent?

ما هي العلاقة البيئية التي يمثلها الرسم ؟

- A. Mutualism تبادل المنفعة
- B. Extinction الانقراض
- C. Commensalism التعايش
- D. Parasitism التطفل



10.

A student immersed a small piece of potato tissue in a  $0.25 \text{ mol.dm}^{-3}$  sucrose solution and the tissue showed no change in mass.

غمر طالب قطعة من أنسجة البطاطا في  $0.25 \text{ mol.dm}^{-3}$  من محلول السكر ولم يحدث أي تغيير على كتلة الأنسجة.

What would the student find out when he immerses the piece in a  $0.1 \text{ mol.dm}^{-3}$  sucrose solution?

ما الذي سيجده الطالب عندما يغمر القطعة في  $0.1 \text{ mol.dm}^{-3}$  من محلول السكر؟

A.

The mass would have increased because the water potential of the cells has decreased.

ستزداد الكتلة بسبب تناقص جهد الماء للخلايا.

B.

The mass would have decreased because the water potential of the cells has increased.

ستتناقص الكتلة بسبب تزايد جهد الماء للخلايا.

C.

The mass would have increased because the water potential of the solution has decreased.

ستزداد الكتلة بسبب تناقص جهد الماء للمحلول.

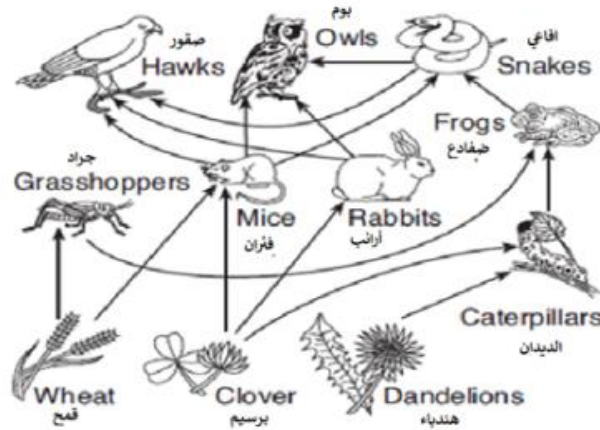
D.

The mass would have decreased because the water potential of the solution has increased.

ستتناقص الكتلة بسبب تزايد جهد الماء للمحلول.

11. The diagram below represents a food web in an ecosystem.

المخطط أدناه يمثل شبكة غذائية في النظام البيئي.



If the population of hawks in this area increases, What effect will this increase have on the web?

إذا ازداد عدد الصقور في هذه المنطقة، ما الأثر المتوقع من هذه الزيادة على الشبكة الغذائية؟



The prey populations of hawks might decrease. Later, the other populations in the web might decrease.

قد تتناقص أعداد فرائس الصقور. لاحقاً، قد تتناقص أعداد السكان الآخرين في الشبكة.



The prey populations of hawks might decrease. Later the hawk population might remain unchanged.

قد تتناقص أعداد فرائس الصقور. لاحقاً، قد تبقى أعداد الصقور بدون تغيير.



The prey populations of hawks might decrease. Later, the hawk population might increase.

قد تتناقص أعداد فرائس الصقور. لاحقاً، قد تزداد أعداد الصقور.



The prey populations of hawks might decrease. Later, the hawks would find another prey population.

قد تتناقص أعداد فرائس الصقور. لاحقاً، قد تجد الصقور أعداد أخرى من الفرائس.

12.

The chart below shows the mRNA codons for different amino acids.

Given the following codon sequence:

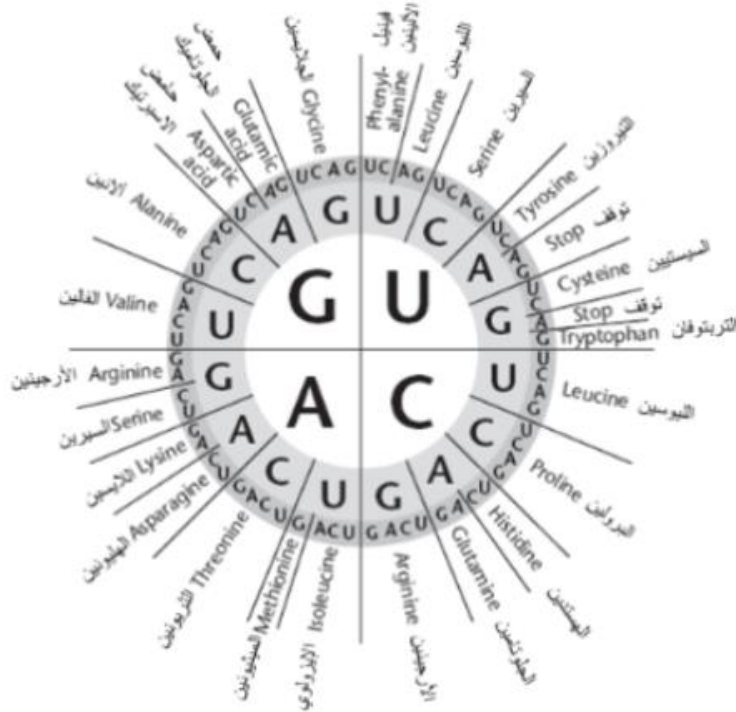
5' AUG UCU UAC CUG GCU CGG ... UAA 3'

Which of the following can be described as base substitution causing a nonsense mutation in the mRNA sequence above?

يشير المخطط أدناه كودونات mRNA للأحماض  
الأمينية المختلفة.

مستخدماً تسلسل الكودونات الآتي :

أي من الآتي يمكن أن توصف على أنها أساس طفرة  
إستبدال إيقافية ( nonsense ) في سلسلة mRNA  
أعلاه؟



- A. Substitution of UAC for UAA in the third codon      إستبدال UAC ل UAA في الكودون الثالث
- B. Substitution of UAC for UAU in the third codon      إستبدال UAC ل UAU في الكودون الثالث
- C. Substitution of UAC for UCC in the third codon      إستبدال UAC ل UCC في الكودون الثالث
- D. Substitution of UAC for UGC in the third codon      إستبدال UAC ل UGC في الكودون الثالث



13.

Which of the following could not be considered a density-dependent factor affecting population growth?

أي من الأتي لا يمكن اعتباره عاملاً يعتمد على الكثافة التي تؤثر على النمو السكاني؟

A.

climate temperature

درجة حرارة المناخ

B.

limited nutrients

محدودية العناصر الغذائية

C.

build-up of toxins

تراكم السموم

D.

predation

الافتراس



Key:

1. A.
2. A.
3. A.
4. A.
5. A.
6. A.
7. A.
8. A.
9. A.
10. A.
11. A.
12. A.
13. A.