



إلى السيدات والسادة:

مديرة ومديري الأكاديميات الجهوية للتربية والتكوين

المديرات والمديرين الإقليميين

مفتشات ومفتشي التعليم الثانوي التأهيلي

مديرات ومديري الثانويات التأهيلية العمومية والخصوصية

**الموضوع:** المسالك الدولية للبكالوريا المغربية - خيار انجليزية: الإطار المرجعي لاختبار الامتحان الوطني الموحد للبكالوريا.

مادة علوم الحياة والأرض - شعبة العلوم التجريبية - مسلك علوم الحياة والأرض.

**المراجع :** - قرار وزير التربية الوطنية والتكوين المهني رقم 52.16 صادر في 23 ربيع الأول 1437 (04 يناير 2016) بتغيير

وتتميم - قرار وزير التربية الوطنية والتكوين المهني رقم 2385.06 بتاريخ 23

رمضان 1427 (16 أكتوبر 2006) في شأن تنظيم امتحانات نيل شهادة البكالوريا ؛

- مقرر وزير التربية الوطنية رقم 029-16 صادر في 13 ماي 2016 موافق ل 06 شعبان 1437 بشأن دفتر مساطر

تنظيم امتحانات نيل شهادة البكالوريا؛

- مذكرة رقم 39 بتاريخ 26 فبراير 2010 في شأن الأطر المرجعية لاختبارات الامتحان الوطني الموحد للبكالوريا؛

- مذكرة رقم 14/105 بتاريخ 05 يونيو 2014 في شأن تحيين الأطر المرجعية لاختبارات الامتحان الوطني الموحد للبكالوريا.

## سلام تام بوجود مولانا الإمام،

وبعد، فمواصلة للجهود الرامية إلى الرفع من جودة التكوين، وانسجاماً مع التوجهات الهادفة إلى تحسين الممارسة التقويمية والرفع من مصداقيتها، وضماناً لمصداقية نتائج امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية وموثوقيتها، وكذا جعل القرارات المترتبة عنها تعكس بدقة أداء المترشحات والمترشحين، وفي سياق إرساء المسالك الدولية للبكالوريا المغربية، عملت الوزارة على إعداد الأطر المرجعية الخاصة باختبار مادة علوم الحياة والأرض، قصد اعتمادها في بناء مواضيع اختبارات المواد المعنية بالامتحان المذكور ابتداءً من الموسم الدراسي الحالي 2017-2018. هذا وقد تم إعداد الأطر المرجعية المعنية والمصادقة عليها من طرف لجن وطنية تخصصية.

## 1. الأهداف

تحدد الأهداف من اعتماد الأطر المرجعية في:

- التّحديد الأدق لما يجب أن يستهدفه الامتحان الوطني الموحد لنيل شهادة البكالوريا المغربية للمسالك الدولية من كفايات ومهارات ومضامين وذلك بهدف التوجيه الأنجع لتدخلات مختلف الفئات المعنية بإعداد المترشحين والمترشحات لاجتياز هذا الامتحان؛
- الرّفع من درجة صلاحية امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية بجعله أكثر تغطية وتمثيلية للمنهاج الرسمي؛
- تدقيق الأساس التعاقدى للامتحان بالنسبة لجميع الأطراف المعنية من أساتذة وتلاميذ ولجن إعداد المواضيع؛
- اعتماد معيار وطني موحد لتقويم مواضيع امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية.

## 2. بنية الإطار المرجعي

- يُستند وضع الأطر المرجعية لمواضيع امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية على التّحديد الدقيق والإجرائي لمعالم التحصيل النموذجي للتلاميذ عند نهاية الدراسة بمسالك البكالوريا المغربية للمسالك الدولية وذلك من خلال:
- ضبط المجالات المقررة بمرجع التكوين مع حصر درجة الأهمية بالنسبة لكل مجال من مجالاتها ؛
  - تحديد الكفايات والمهارات والقدرات المسطرة تحديداً إجرائياً، بالنسبة لكل مستوى مهاري داخل المنهاج الرسمي؛
  - تحديد شروط الإنجاز.

## 3. توظيف الإطار المرجعي

تُوظف الأطر المرجعية في بناء مواضيع الاختبارات المتعلقة بمختلف المواد المعنية بالامتحان وذلك بالاستناد إلى المعايير التالية:

1. التغطية : أن يغطي موضوع الامتحان كل المجالات المحددة في الإطار المرجعي الخاص بكل مادة دراسية.
2. التمثيلية : أن تعتمد درجة الأهمية المحددة في الإطار المرجعي لكل مجال من مجالات المواد الدراسية ولكل كفاية أو مستوى مهاري في بناء موضوع الاختبار وذلك لضمان تمثيلية هذا الأخير للمنهاج الرسمي المقرر.

3. المطابقة : أن يتم التحقق من مطابقة الوضعيات الاختبارية للمحددات الواردة في الإطار المرجعي على ثلاث مستويات:

- الكفايات والمهارات؛
- المواد الدراسية ومجالاتها؛
- شروط الإنجاز.

هذا، وحتى يحقق هذا الإجراء الأهداف المتوخاة منه، باعتباره خطوة أساسية للرفع من صلاحية وموثوقية امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية، يشرفني أن أطلب منكم الحرص على تنفيذ ما يلي:

- استنساخ هذه المذكرة وتوزيعها على المعنيين بالموضوع، مع العمل على إطلاع مختلف المترشحين والمترشحات لامتحان نيل شهادة البكالوريا المغربية للمسالك الدولية على فحواها؛
  - تمكين السيدات والسادة المفتشات والمفتشين من عقد اجتماعات ولقاءات تربوية لإطلاع المتدخلين المعنيين على مضامين الأطر المرجعية مع التأكيد على ضرورة اعتماد هذه الأخيرة في تأطير المكلفين بإعداد اقتراحات مواضيع الامتحان الوطني الموحد لنيل شهادة البكالوريا المغربية للمسالك الدولية ابتداء من دورة 2018؛
  - دعوة السيدات والسادة المفتشات والمفتشين إلى تنظيم لقاءات تربوية مع السيدات والسادة الأساتذات والأساتذة لاعتماد هذه الأداة في التخطيط للتدريس وتوظيفها في إعداد فروض المراقبة المستمرة.
- واعتباراً للأهمية البالغة التي يكتسبها هذا الموضوع، فإني أهيب بالجميع، كل من موقعه، إيلاءه كل الاهتمام والعناية اللازمين.

والسلام.

عن الوزير ويتفويض منه  
الكتاب العام  
لقطاع التربية الوطنية  
يوسف بلقاسمي



**Reference Framework for the National Baccalaureate Exam**

**International Options of the Moroccan Baccalaureate**

**English Option**

**Subject: Life and Earth Sciences**

**Section: Experimental Sciences**

**Stream: Life and Earth Sciences**

**February, 2018**

## INTRODUCTION

This document is a reference framework for the National Moroccan Baccalaureate Exam – International English Options for Life and Earth Sciences: Experimental Sciences Section - Life and Earth Sciences Stream. It is divided into three sections specifying the major areas of assessment and outlining the major components to be included in designing Baccalaureate tests for Life and Earth Sciences Stream.

### Section I includes areas of assessment that:

1. **Specify** the competences targeted by the second year Baccalaureate programme - Life and Earth Sciences Stream;
2. **Identify six** content areas:
  - a. organic matter consumption and the flow of energy at the cellular level;
  - b. the nature of genetic information and the gene expression mechanisms - Genetic engineering;
  - c. transmission of genetic information through sexual reproduction and human genetics;
  - d. population genetics;
  - e. immunology;
  - f. the geological phenomena accompanying the formation of mountain ranges and their relationship to plate tectonics.
3. **Classify** content distribution for second year Baccalaureate programme (Experimental Sciences section - Life and Earth Sciences Stream).

### Section II depicts the organisation of notional and methodological areas:

1. Table of contents;
2. Skills table;
3. Specification Table: Knowledge and Skills.

### Section III deals with the design components and rubrics of the National Baccalaureate Exam.

## I. Areas of assessment:

### 1. Specific competences targeted by the second year Baccalaureate programme - Life and Earth Sciences Stream.

According to the pedagogical guidelines and the specific teaching programmes for Life and Earth Sciences at the secondary school, the target competences for Life and Earth Sciences Stream are:

- **to acquire** knowledge of the organic matter consumption and the flow of energy at the cellular level with a view to **understanding** the importance of energy in cellular activity and **become aware** of its role in maintaining the vital functions of the organism;
- **to deepen** knowledge of the nature of genetic information, the gene expression mechanisms and **the principles and techniques of genetic engineering** in order to **use** them in **understanding** and **explaining** heredity phenomena in living beings;
- **to acquire** knowledge of the transmission of genetic information through sexual reproduction and **use** this knowledge to solve problems related to the transmission of hereditary characteristics/traits and to sensitise learners to take the necessary precautions against hereditary diseases;
- **to acquire** basic knowledge of population genetics and the importance of the evolutionary factors in the stability of the population genetic structure and its equilibrium with its environment;
- **to deepen** knowledge on the functioning and dysfunctioning of the immune system, and the means of reinforcing this system. Use this knowledge to understand problems related to immunity so as to take the necessary precautions against health risks;
- **to acquire** knowledge of geological phenomena accompanying the formation of mountain ranges (rock deformations, metamorphism, and granitisation), and to **be able** to situate them in space and time and show their relationship to plate tectonics;
- **to adopt a suitable scientific approach to deal with issues related to:**
  - a. the organic matter consumption and the flow of energy at the cellular level;
  - b. genetics;
  - c. immunology;
  - d. the geological phenomena accompanying the formation of mountain ranges.
- **to use various modes of expression** (oral, written and graphic) to communicate and present phenomena **related to:**
  - a. the organic matter consumption and the flow of energy at the cellular level;
  - b. genetics;
  - c. immunology;
  - d. the geological phenomena accompanying the formation of mountain ranges.
- **to use laboratory equipment** and ICT (Information and Communication Technology) in the collection and processing of data **related to:**
  - a. the organic matter consumption and the flow of energy at the cellular level;
  - b. genetics;
  - c. immunology;
  - d. the geological phenomena accompanying the formation of mountain ranges.

### 2. Content areas:

## **2.1. First content area: organic matter consumption and the flow of energy at the cellular level.**

This area allows the learner to get further knowledge of the organic matter consumption and the flow of energy at the cellular level through the knowledge of aspects related to these phenomena. The aim of this area is to help the learner understand the mechanism of the use of organic matter by the living cell in order to supply itself with the energy needed for its activity.

**The study of reactions responsible for the stored energy release in organic matter in the cell consists of:**

- focusing on essential reactions allowing ATP production during respiration and during fermentation;
- determining the energy yield of these reactions;
- knowing the cellular structures responsible for ATP production;
- comparing efficiency of ATP production for respiration and fermentation.

**The study of the role of the skeletal striated muscle in energy conversion consists of:**

- showing that the muscle cell is the structural and functional unit of muscle contraction through the study of the structure and the ultra-structure of this muscle cell;
- showing the relationship between the structure and the ultra-structure of the muscle cell on the one hand, and the muscle contraction mechanism and the accompanying phenomena on the other;
- highlighting the conversion of chemical energy (ATP) in mechanical energy during muscle contraction;
- determining the different regeneration pathways of ATP in the muscle cell.

**At the end of the above content area, it is necessary that the learner manage to construct a synthetic flowchart summarising the relationships between the different reactions those which release energy, and those which consume it by placing emphasis on the role of the ATP molecule as an energy intermediary.**

## **2.2. Second content area: Nature of genetic information and the gene expression mechanisms - Genetic engineering.**

This area allows the learner to acquire knowledge of genetic information concerning its nature, its transmission from the mother cell to the daughter cells and its expression mechanisms. It also allows the learner to know some principles and techniques of genetic engineering.

**The construction of the notion of genetic information consists of:**

- highlighting the location of genetic information in the cell in unicellular and multi-cellular living beings;
- determining the mechanism by which the genetic information is transmitted from one cell to another;
- constructing the notion of cell cycle by studying the phases of mitosis and interphase and describing the behavior of chromosomes to deduce that mitosis is a process of cell division resulting in two genetically identical daughter cells;



- highlighting the chemical nature of genetic information and determining the structure and the replication mechanism of DNA, with an emphasis on the relationship between the evolution of DNA amount and chromosomes during the cell cycle;
- defining the notions of inherited characteristics/traits, gene, allele and mutation;
- establishing the relationship between trait-protein and gene-protein, which allows to deepen the notions of mutation and gene, and construct the notion of the genetic code;
- highlighting the relationship between genetic information and the proteins synthesis through the study of the mechanisms and stages of gene expression inside the cell: using the genetic code to explain the gene expression (transcription and translation).

**The knowledge acquisition of some principles of genetic engineering consists of:**

- Constructing the notion of genetic modification by highlighting the principle of genetic transformation through an example of natural transfer of genes from a bacterium (*Agrobacterium tumefaciens*) to a plant cell;
- Using the principle of genetic transformation to explain genetic engineering techniques and its possible applications in different fields (the manufacturing of human insulin hormone and toxic proteins to control insect pests). These genetic-engineering applications provide an opportunity to exploit the already-acquired knowledge of the chemical nature of genetic information and its expression.

**2.3. Third content area: Transmission of genetic information through sexual reproduction and human genetics.**

**The study of the transmission of genetic information through sexual reproduction consists of highlighting the role of meiosis and fertilisation in the karyotype stability, and in the recombination and genetic diversity. To achieve that, it is necessary to:**

- define meiosis, identify its different phases and show its role in the recombination of alleles (genetic recombination of homologous chromosomes by linkage/crossing-over and chromosomes independent assortment), and therefore deduce the genetic diversity of gametes;
- define fertilisation and show its role in genetic recombination and in genetic diversity of individuals within the same species;
- show the role of alternation of fertilisation and meiosis in karyotype stability in individuals of the same species from one generation to the next.

**The study of Mendel's laws explaining the transmission of hereditary characteristics/traits in diploid organisms consists of:**

- formulating the notion of genotype, pure lineage (wild type and mutant) and hybridization;
- learning Mendel's laws and their exceptions through the study of examples of autosomal monohybridism (dominance and codominance, lethal gene), sex-linked gene and dihybridism (independent and linked genes);
- showing the role of linkage/crossing-over in genetic diversity of generations and gene mapping/construction of gene maps.

**The study of human genetics consists of:**

- knowing the methods and the means of studying the transmission of hereditary characteristics/traits in humans (pedigree, karyotypes) and studying the modes of transmission



of some hereditary autosomal and sex-linked diseases using pedigree, karyotypes, and gene detection techniques;

- highlighting certain chromosomal abnormalities and their consequences by using karyotypes.

## 2.4. Fourth content area: Population genetics.

**The study of population genetics consists of:**

- defining the notion of population and determining its characteristics;
- defining the notion of population gene pool;
- learning and applying Hardy-Weinberg equilibrium principle (Hardy-Weinberg law) to an ideal theoretical population ;
- studying the variation/evolutionary factors affecting population (mutations, natural selection, genetic drift and migration) by highlighting their influence on genetic structure and equilibrium population. These influences are inferred from the variation of allele frequencies from a generation to the next ;
- determining the criteria that characterise a species, and having the ability to construct the notion of species.

## 2.5. Fifth content area: Immunology.

**This area allows the learner to construct the notion of self and non-self, to know the different types and mechanisms of the immune response, and to know the dysfunctions of the immune system and its support system. This area enables the learner to:**

- **know** the self-markers (the Major Histocompatibility Complex (MHC) proteins and the cell surface markers on human red blood cells of the ABO Blood Groups), and deduce the role of the MHC proteins in the presentation of the self and the non-self (notion of self and non-self);
- **distinguish / recognise** the means of the nonspecific and specific immune response;
- **describe and interpret** aspects of the inflammatory response and phagocytosis and then demonstrate their roles as a means of nonspecific immunity;
- **know** the elements of the immune system and the origin of the immune cells as well as the organs responsible for the maturation of lymphocytes;
- **know** the mechanisms and the characteristics of the specific immune response (humoral and cellular) and determine the role of cellular cooperation.
- **realise/construct** a synthetic flowchart summarising the steps of the immune response and showing the relationship between the nonspecific response and the specific response;
- **study** certain dysfunctions of the immune system through the determination of the elements and mechanisms involved in allergy due to immediate hypersensitivity and those involved in AIDS that results from an immunodeficiency due to the destruction of the specific immune response (structure of HIV, its infection cycle, its effect on T4 lymphocytes and the HIV evolution and progression to AIDS);

- **study** the ways to boost the immune system by recalling the notion of adaptive (acquired) immunity response and the notion of immune memory on which the principle of vaccination is based, and the ways to reinforce the humoral immune response on which serotherapy is based;
- **know** the technique of bone marrow transplantation as a means of the immune system reinforcement;
- **use** previous knowledge to **interpret** the serotherapy principles, vaccination, and bone marrow transplantation as a means of reinforcing the immune system.

## **2.6. Sixth content area: the geological phenomena accompanying the formation of mountain ranges and their relationship to plate tectonics.**

This area allows the learner to acquire a set of knowledge related to:

- the recent mountain ranges and their relationship to the plate tectonics;
- the nature of rock deformations characterising subductional and collisional mountain ranges;
- metamorphism and its relationship to the plate tectonics;
- granitisation in its relation to metamorphism.

**At the end of the above content area, it is necessary for the learner to devise a flowchart summarizing the various geological phenomena studied and highlighting their relationship to the plate tectonics.**

**The study of recent mountain ranges and their relationship to the plate tectonics aims to:**

- consolidate /deepen the knowledge of the petrographic and structural characteristics of subductional, obductional and collisional mountain ranges;
- show the relationship between the recent mountain ranges and the plate tectonics through the reconstitution of the stages of the formation of these mountain ranges, and determine the conditions of their formation.

**The study of rock deformations characterising the subductional and collisional mountain ranges aims to:**

- consolidate/ deepen the knowledge of the characteristics of the main rock deformations characterising the subductional and collisional mountain ranges;
- highlight the relationship between tectonic forces responsible for orogeny and the main rock deformations.

**The study of metamorphism and its relationship to the plate tectonics aims to:**

- determine the structural and petrographic characteristics of metamorphic rocks in subduction and collision zones, and infer the conditions of temperature and pressure that are responsible for the formation of these rocks;
- construct the notion of the index minerals and the notion of the metamorphic series;
- construct the notions of the dynamic and thermodynamic metamorphism and their relationship to the geophysical conditions of the formation of subductional and collisional mountain ranges.

**The study of the granitisation in relationship to metamorphism aims to:**

- deepen the knowledge of conditions of the formation of the anatectic and intrusive granite;
- show the relationship between these two types of granites and metamorphism (regional metamorphism and contact metamorphism).

**The realisation of a flowchart summarizing** the various geological phenomena under study in its relation to the plate tectonics makes it possible to:

- highlight the relationship among all the geological phenomena (mountain ranges, rock deformations, metamorphism and granitisation);
- show the relationship between the different geological phenomena accompanying orogeny in its relation to the plate tectonics.

### **3. Content distribution of second year Baccalaureate programme, Experimental Sciences Section - Life and Earth Sciences Stream:**

*(See the Moroccan Baccalaureate programme - English Option- Second year Baccalaureate, Life and Earth Sciences Stream)*

## II. Organisation of notional and methodological areas.

### 1. Table of content.

Area 1: The organic matter consumption and the flow of energy at the cellular level. (Coverage 17%)		
Sub-areas	Content	Basic objectives ( notional / methodological)
1.1. The reactions responsible for the release of the stored energy in organic matter in the cell	<ul style="list-style-type: none"> <li>- Notion of respiration ;</li> <li>- Notion of fermentation ;</li> <li>- The main stages of glycolysis;</li> <li>- Energy yield from glycolysis ;</li> <li>- Mitochondrion structure and ultra-structure;</li> <li>- The main stages of the Krebs cycle;</li> <li>- Energy yield of the Krebs cycle;</li> <li>- Electron Transport Chain and oxidative phosphorylation</li> <li>- Energy yield of respiration;</li> <li>- The main stages of fermentation;</li> <li>- Energy yield of fermentation;</li> <li>- Energy efficiency.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Compare</b> respiration and fermentation through the exploitation of data based on observation and experimentation;</li> <li>- <b>Show/highlight</b> the relationship between respiration, fermentation and the cellular structures involved through the exploitation of data based on observation and experimentation;</li> <li>- <b>Apply</b> scientific reasoning (<b>formulate</b> a problem, <b>make/test/verify</b> a hypothesis, suggest an experimental protocol...) while studying data related to respiration and fermentation;</li> <li>- <b>Deduce</b> the conditions of respiration and fermentation through the exploitation of data based on observation and experimentation;</li> <li>- <b>Determine</b> the main stages of the reactions responsible for the release of the energy stored in organic matter, and <b>deduce</b> its energy yield;</li> <li>- <b>Describe</b> the components, the structure and ultra-structure of the mitochondrion and relate them to the reactions of cellular respiration;</li> <li>- <b>Compare</b> the energy yield of respiration and of fermentation.</li> <li>- <b>Calculate</b> energy efficiency of respiration and of fermentation;</li> <li>- <b>Represent</b> the aspects of respiration and of fermentation <b>using graphs</b>;</li> <li>- <b>Draw /make</b> an energy yield flowchart of respiration and of fermentation.</li> </ul>
1.2. The role of the skeletal striated muscle in energy conversion	<ul style="list-style-type: none"> <li>- The myogram: the muscle twitch, the complete and incomplete tetanus;</li> <li>- Thermal and chemical phenomena accompanying the muscle contraction;</li> <li>- Skeletal muscle structure and ultra-structure;</li> <li>- Molecular structure of the myofilaments;</li> <li>- Source of the energy necessary for the muscle contraction;</li> <li>- Muscle contraction mechanism;</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Analyse and interpret</b> myogram;</li> <li>- <b>Compare</b> the state of a muscle fiber at rest and during a contraction;</li> <li>- <b>Apply</b> scientific reasoning (<b>formulate</b> a problem, <b>make/ test/verify</b> a hypothesis, suggest an experimental protocol...) while studying data related to muscle contraction;</li> <li>- <b>Use</b> the structure and ultra-structure of the skeletal muscle cell in order to <b>explain</b> the mechanisms of muscle contraction;</li> <li>- <b>Determine</b> thermal and chemical phenomena accompanying the muscle contraction;</li> <li>- <b>Show/highlight</b> the relationship between thermal and chemical phenomena and muscle contraction;</li> <li>- <b>Deduce</b> metabolic pathways for ATP regeneration required for muscle contraction;</li> <li>- <b>Show/highlight</b> the relationship between the pathways of ATP regeneration and the type of</li> </ul>



	<ul style="list-style-type: none"> <li>- Metabolic pathways of ATP regeneration.</li> </ul>	physical effort; - <b>Draw/make</b> diagram/ flowchart of muscle contraction mechanism.
<b>1.3. Outcome: synthetic flowchart of organic matter consumption and energy flow in the cell</b>	Pre-requisite knowledge in this area.	<b>Draw</b> a flowchart of the consumption of organic matter and energy flow in the cell.
<b>Area 2: nature of genetic information and the gene expression mechanisms - Genetic engineering.. (Coverage 18%)</b>		
<b>Sub-areas</b>	<b>Content</b>	<b>Basic objectives ( notional / methodological)</b>
<b>2.1.The notion of genetic information</b>	<ul style="list-style-type: none"> <li>- The location of genetic information in the nucleus of the cell;</li> <li>- The role of chromosomes in the transmission of genetic information from one cell to another:               <ul style="list-style-type: none"> <li>• phases of mitosis in plant and animal cells;</li> <li>• The cell cycle.</li> </ul> </li> <li>- The chemical nature of genetic material:               <ul style="list-style-type: none"> <li>• Composition and structure of chromosomes and DNA;</li> <li>• Mechanism of DNA replication.</li> </ul> </li> <li>- The notions of inherited characteristics/traits, gene, allele and mutation;</li> <li>- The relationship between trait -protein and gene-protein;</li> <li>- The meaning of gene mutation;</li> <li>- The genetic code.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Deduce</b> the location of genetic information in the nucleus of the cell through <b>data analysis</b>;</li> <li>- <b>Describe</b> and <b>identify</b> phases of mitosis;</li> <li>- <b>Construct</b> and <b>represent</b> the cell cycle and <b>deduce</b> its role in the stability of genetic information;</li> <li>- <b>Deduce</b> the role of chromosomes in the transmission of genetic information from one cell to another through exploitation of data based on observation and experimentation.</li> <li>- <b>Determine</b> the chemical nature of genetic material through exploitation of data based on observation and experimentation with the aim of applying scientific reasoning (<b>formulate</b> a problem, <b>make/test/verify a hypothesis</b>, <b>suggest</b> an experimental protocol...);</li> <li>- <b>Show/ highlight</b> the relationship between chromosomes and DNA molecule;</li> <li>- <b>Show/ highlight</b> the role of the DNA replication in the stability of genetic information;</li> <li>- <b>Show/ highlight</b> the relationship between traits - protein and gene-protein through <b>data exploitation</b>;</li> <li>- Deduce the meaning of gene mutation by using genetic code;</li> <li>- <b>Draw schemes</b> related to mitosis phases and chemical nature of genetic material.</li> </ul>
<b>2.2. The gene expression mechanisms: Protein synthesis stages</b>	<ul style="list-style-type: none"> <li>- Structure of RNA.</li> <li>- Transcription.</li> <li>- Translation (initiation, elongation and termination).</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Describe</b> and <b>interpret/explain</b> the process of transcription of RNA molecule;</li> <li>- <b>Show / highlight</b> the relationship between DNA, RNA and protein by using genetic code (the meaning of the genetic code);</li> <li>- <b>Describe</b> the stages of protein synthesis;</li> <li>- <b>Draw a diagram</b> summarizing the stages of proteins synthesis.</li> </ul>

### 2.3. Genetic engineering: its principles and techniques

The stages of gene transfer - the notion of genetic transformation:

- natural gene transfer from *Agrobacterium Tumefaciens* to a plant.
- techniques and steps of transferring a gene to a bacterium;
- some examples of applying the genetic engineering principles;
- manufacturing human insulin;
- manufacturing toxic proteins to fight insect pests.

- **Infer** the techniques and steps of gene transfer, **deduce** the genetic transformation notion by studying-a specific example;

- **Deduce** the importance of genetic engineering from data exploitation;

- **Draw/make** a diagram summarising the techniques and stages of genetic engineering.

### Area 3: Transmission of genetic information through sexual reproduction - Human genetics (Coverage 18%)

Sub-areas	Content	Basic objectives ( notional / methodological)
3.1. The transmission of genetic information through sexual reproduction	<ul style="list-style-type: none"> <li>- Stages/phases of meiosis ;</li> <li>- Karyotypes of diploid species ;</li> <li>- Role of meiosis and fertilisation in allelic recombination/ recombination of alleles(genetic recombination of homologous chromosomes by linkage/crossing-over and chromosomes independent assortment) and in karyotype stability across generations.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Describe</b> and <b>recognise</b> the meiosis phases;</li> <li>- <b>Analyse</b> karyotypes of diploid species;</li> <li>- <b>Deduce</b> through exploitation of data based on observation and experimentation : <ul style="list-style-type: none"> <li>○ the role of meiosis and fertilisation in allelic recombination and in the karyotype stability in the same species from one generation to the next;</li> <li>○ the role of meiosis and fertilisation in genetic diversity</li> </ul> </li> <li>- <b>Draw</b> diagrams in relation to the meiosis phases;</li> </ul>



<p><b>3.2. Mendel's laws of the transmission of hereditary characteristics/traits in the diploid organisms</b></p>	<ul style="list-style-type: none"> <li>- Mendel's laws of the transmission of hereditary characteristics/traits;</li> <li>- Monohybridism/ Monohybrid Cross ;</li> <li>- Dihybridism/dihybrid cross ;</li> <li>- Pure lineage and wild type, homozygosity and heterozygosity, hybridisation, test cross/back cross;</li> <li>- Punnett squares ;</li> <li>- Autosomal heredity (independent of sex) and sex-linked heredity;</li> <li>- Dominance, codominance and lethal gene.</li> <li>- Unlinked genes (genes of independent assortment);</li> <li>- Linkage/crossing-over, genetic recombination of homologous chromosomes by linkage/crossing-over and genetic diversity.</li> <li>- Gene maps.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Analyse and interpret</b> the results of the transmission of a couple of alleles from the study of a specific example (in cases of a sex-linked gene and autosomal gene);</li> <li>- <b>Analyse and interpret</b> the results of the transmission of two couples of alleles from the study of a specific example (in cases of two unlinked genes and two linked genes);</li> <li>- <b>Draw a diagram</b> of genetic recombination of homologous chromosomes by linkage/crossing-over and independent assortment of homologous chromosomes, according to the example studied;</li> <li>- <b>Calculate</b> the distance between linked genes and <b>draw</b> a gene map/gene mapping..</li> </ul>
<p><b>3.3. Human genetics</b></p>	<ul style="list-style-type: none"> <li>- Notions of pedigree and karyotype.</li> <li>- Hereditary autosomal diseases.</li> <li>- Hereditary sex-linked diseases.</li> <li>- Chromosomal abnormalities and their consequences.</li> <li>- Chromosomal interpretation of hereditary diseases.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Analyse, interpret and explain</b> pedigree and karyotype data by inferring/deducing the mode of transmission of a gene in the case of: <ul style="list-style-type: none"> <li>o Hereditary autosomal diseases ;</li> <li>o Hereditary sex-linked diseases;</li> </ul> </li> <li>- <b>Analyse, interpret/explain</b> the chromosomal abnormalities by drawing appropriate diagrams;</li> <li>- <b>Give opinion</b> on the prenatal diagnosis of chromosomal abnormalities based on <b>data exploitation</b>.</li> </ul>

**Area 4: Population genetics (Coverage 11 %)**

Sub-areas	Content	Basic objectives ( notional / methodological)
<b>4.1. Criteria of genetic equilibrium of population (Hardy-Weinberg equilibrium)</b>	<ul style="list-style-type: none"> <li>- the notion of population.</li> <li>- The population gene pool.</li> <li>- Hardy-Weinberg law and its application in some cases of the transmission of a couple of alleles.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Deduce</b> the characteristics of a population.</li> <li>- <b>Apply</b> Hardy-Weinberg law in the case of the transmission of a couple of alleles.</li> <li>- <b>Calculate</b> the frequencies of the genotypes and phenotypes across generations within a population.</li> </ul>
<b>4.2. The evolutionary factors and their impact on the genetic structure of a population</b>	<p>The evolutionary factors:</p> <ul style="list-style-type: none"> <li>- mutations.</li> <li>- natural selection.</li> <li>- genetic drift.</li> <li>- migration.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Highlight</b> the modes of action of evolutionary factors (factors affecting population variation): at the genetic structural level by using <b>data</b>.</li> <li>- <b>Deduce</b> the effect of evolutionary factors at the genetic structural level by using <b>data</b> provided.</li> </ul>
<b>4.3. Criteria specifying of a species. Definition of a species</b>	<ul style="list-style-type: none"> <li>- Criteria characterising a species.</li> <li>- Definition of a species.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Determine</b> the distinctive criteria of species and <b>give</b> a definition.</li> </ul>

**Area 5: Immunology (Coverage 18 %)**

Sub-areas	Content	Basic objectives ( notional / methodological)
<b>5.1. Concept of self and non-self</b>	<ul style="list-style-type: none"> <li>- Definition of the major histocompatibility complex (MHC) proteins and determination of its role;</li> <li>- The notion of self;</li> <li>- The cell surface markers on human red blood cells of the ABO Blood Groups;</li> <li>- The notion of non-self and modified self;</li> <li>- The genetic characteristics of the (MHC) proteins.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Analyse</b> experimental data about self and non-self;</li> <li>- <b>Deduce</b> the role of the self identity markers in the presentation of the self and the non-self;</li> <li>- <b>Infer</b> the genetic characteristics of the (MHC) proteins.</li> </ul>
<b>5.2. The ways how the human organism protects the self</b>	<ul style="list-style-type: none"> <li>- Notion of immune response;</li> <li>- The nonspecific immune response: inflammatory response, phagocytosis and complement system;</li> <li>- The adaptive (acquired) immunity response - both humoral and cell-mediated: <ul style="list-style-type: none"> <li>• The elements responsible for this response;</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- <b>Describe and explain</b> the events of inflammatory response and phagocytosis;</li> <li>- <b>show</b> the role of inflammatory response and phagocytosis as natural defenses (nonspecific immune response);</li> <li>- <b>Exploit, use by applying</b> a scientific approach, the data of the observation and the experimentation in relation with</li> </ul>

	<ul style="list-style-type: none"> <li>• The mechanisms and characteristics of the specific immune response (specificity and immunological memory);</li> <li>• The organs of the immune system;</li> <li>• Origin of immune cells and lymphocyte maturation sites;</li> <li>• The phases and mechanisms of the specific immune response (induction, amplification and effector phases);</li> <li>• Cellular cooperation.</li> </ul>	<p>the stages and the mechanisms of the specific immune response;</p> <ul style="list-style-type: none"> <li>- <b>Apply</b> scientific reasoning (formulate the problem, propose and test the hypothesis, propose an experimental protocol ...) to the data related to the immune response;</li> <li>- <b>Show</b> the role of cellular cooperation in the specific immune response through exploitation of data based on observation and experimentation;</li> <li>- <b>Graphically represent</b> the manifestations and mechanisms of the immune response;</li> <li>- <b>Draw /make</b> a summary diagram/flowchart of the stages of the immune response.</li> </ul>
<b>5.3. Some dysfunctionings of the immune system</b>	<ul style="list-style-type: none"> <li>- Elements and mechanisms of allergy due to immediate hypersensitivity;</li> <li>- The acquired immunodeficiency syndrome: <ul style="list-style-type: none"> <li>• HIV structure and its infection cycle;</li> <li>• Action of HIV on CD4<sup>+</sup> T cells;</li> <li>• HIV evolution and progression to AIDS.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- <b>Determine</b> the elements and <b>show</b> the allergy mechanisms related to immediate hypersensitivity through exploitation of data based on observation and experimentation;</li> <li>- <b>Exploit, use</b> data (acquired and documents) to explain the effect of HIV on the immune system;</li> <li>- <b>Graphically represent</b> the effect of HIV on the immune system;</li> <li>- <b>Draw /make</b> a summary diagram/flowchart concerning the dysfunctionings of the immune system.</li> </ul>
<b>5.4. Ways of helping the immune system</b>	<ul style="list-style-type: none"> <li>- Vaccination ;</li> <li>- Serotherapy;</li> <li>- Bone marrow transplantation.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Use data and</b> pre-requisite knowledge <b>to explain</b> the principles of vaccination, serotherapy and bone marrow transplantation as a means of helping the immune system;</li> <li>- <b>Show/highlight</b> the importance of vaccination, passive immunotherapy and bone marrow transplantation as a means of helping the immune system.</li> </ul>

**Area 6: The geological phenomena accompanying the formation of mountain ranges and their relationship to plate tectonics. (Coverage 18 %)**

Sub-areas	Content	Basic objectives ( notional / methodological)
<b>6.1. The recent mountain ranges and their relationship to the plate tectonics</b>	<ul style="list-style-type: none"> <li>- Different types of recent mountain ranges;</li> <li>- The petrographic and structural characteristics of subductional, obductional and collisional mountain ranges;</li> <li>- Relationship between the recent mountain ranges and plate tectonics.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Extract</b> structural and petrographic characteristics of recent mountain ranges from the study of geologic maps and cross sections;</li> <li>- <b>Establish</b> the relationship between recent mountain ranges and plate dynamics;</li> <li>- <b>Determine</b> the stages of recent mountain formation by use data of geologic cross sections;</li> <li>- <b>Graphically represent</b> the conditions of the formation of the recent mountain ranges;</li> <li>- <b>Draw /make</b> a summary diagram/flowchart on the stages of recent mountain ranges formation.</li> </ul>
<b>6.2. The nature of rock deformations characterising subduction and collision of mountain ranges</b>	<ul style="list-style-type: none"> <li>- The main rock deformations (folds, flaws and thrust sheets) that characterise subductional and collisional mountain ranges;</li> <li>- Relationship between the main rock deformations and tectonic forces.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Classify</b> folds and faults ;</li> <li>- <b>Analyse</b> maps and geologic cross sections of recent mountain ranges;</li> <li>- <b>Determine</b> the structural characteristics of thrust sheets;</li> <li>- <b>Establish</b> the relationship between rock deformations and tectonic forces;</li> <li>- <b>Establish</b> the relationship between rock deformations and conditions of formation of subductional and collisional mountain ranges;</li> <li>- <b>Draw/make a diagram /flowchart of rock deformations</b> in relation to tectonic forces.</li> </ul>



### 6.3. Metamorphism and its relationship to the plate tectonics

- The notion of metamorphism.
- Mineralogical and structural characteristics of metamorphic rocks in subduction and collision zones;
- Pressure and Temperature (PT) conditions responsible for the formation of metamorphic rocks;
- The notions of index mineral and metamorphic series;
- The notions of dynamic metamorphism and regional metamorphism.

- **Determine** the mineralogical and structural characteristics of metamorphic rocks in subduction and collision zones through:
  - the study of samples and thin section microscopy of rocks;
  - the analysis of their data (tables of mineralogical and chemical composition).
- **Determine** the stability zones of index minerals in metamorphic rocks and metamorphism zones using PT diagram of rocks.
- **Establish** the relationship between index minerals, metamorphic series and the dominant type of metamorphism in subductional and collisional mountain ranges.
- **Distinguish / recognise** the dynamic from regional metamorphisms;
- **Graphically represent** the stages of metamorphism using PT diagram;
- **Deduce**, from the study of maps and geologic cross sections, the mineralogical and structural characteristics of metamorphic rocks in subduction and collision zones related to plate tectonics.

### 6.4. Granitisation and its relationship to metamorphism

- The notion of anatectic and intrusive granite;
- Source and formation of anatectic granite;
- The relationship between anatectic granite and neighbouring metamorphic rocks;
- The notion of intrusive granite;
- Source and formation of intrusive granite;
- The notion of contact

- **Determine** the mineralogical and structural characteristics of neighbouring metamorphic rocks through:
  - the study of samples and thin section microscopy of rocks;
  - the analysis of their data (tables of mineralogical and chemical composition).
- **Use** pressure-temperature diagram to determine the

	<p>metamorphism;</p> <ul style="list-style-type: none"> <li>- The relationship between the intrusive granite and surrounding metamorphic rocks.</li> </ul>	<p>source of anatectic granite;</p> <ul style="list-style-type: none"> <li>- <b>Determine</b> the mineralogical and structural characteristics of intrusive granite and surrounding metamorphic rocks through: <ul style="list-style-type: none"> <li>• the study of rock samples and thin section microscopy of rocks;</li> <li>• the analysis of their data (tables of mineralogical and chemical composition).</li> </ul> </li> <li>- <b>Analyse</b> maps and geological cross sections showing the relationship between granitisation and metamorphism.</li> <li>- <b>Express/represent graphically</b> the relationship between granitisation and metamorphism.</li> </ul>
<p><b>6.5. Outcome: the various geological phenomena under study in their relation to the plate tectonics.</b></p>	<ul style="list-style-type: none"> <li>- Pre-requisite knowledge in this area.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Draw</b> a data flowchart establishing the relationship between the various geological phenomena studied and the plate tectonics.</li> <li>- <b>Draw</b> a summary flowchart showing the relationship between the various geological phenomena studied and the plate tectonics.</li> </ul>



## 2. Skills Table.

Skills areas	Skills	Weighting in (%)
<b>Knowledge Retrieval.</b>	<p>This Section, knowledge retrieval, aims to assess the degree of mastery of content using the following:</p> <ul style="list-style-type: none"> <li>- Multiple choice questions (MCQ).</li> <li>- True/false statements.</li> <li>- Matching.</li> <li>- Classification/seriation/rearranging.</li> <li>- Short-answer questions (give definitions, label a diagram or a graph, and know theories, laws, scientific terms, facts, signs, etc.).</li> </ul>	<b>25%</b>
<b>Scientific reasoning and communication in graphic and written modes.</b>	<p>This Section, <b>scientific reasoning and communication in graphic and written modes</b>, aims to assess the degree of mastery of skills and competencies:</p> <ul style="list-style-type: none"> <li>- <b>Determine and formulate</b> a scientific problem;</li> <li>- <b>Use</b> background knowledge, <b>select</b> and <b>organise</b> information in relation to the subject of study;</li> <li>- <b>Link</b> information with acquired knowledge to resolve a scientific problem;</li> <li>- <b>Make/formulate</b> a hypothesis in relation to a scientific problem;</li> <li>- <b>Use knowledge</b> to solve a scientific problem or to <b>explain</b> the phenomena under study;</li> <li>- <b>Suggest</b> appropriate tools to <b>test</b> hypotheses;</li> <li>- <b>Describe</b> and <b>analyse</b> scientific data;</li> <li>- <b>Compare</b> and <b>explain/interpret</b> results;</li> <li>- <b>Infer</b> and <b>generalise the results</b>;</li> <li>- <b>Use</b> principles, laws, models to <b>explain/interpret</b> scientific phenomena and data;</li> <li>- <b>Conduct a synthesis</b> of information and data and turn it into a text or a diagram;</li> <li>- <b>Give</b> an opinion and support it with arguments.</li> <li>- <b>Present</b> a structure or biological and geological phenomena using a diagram;</li> <li>- <b>Turn</b> numerical data into a chart, a graph or a text;</li> <li>- <b>Draw</b> a functional diagram;</li> <li>- <b>Achieve/realise</b> a synthetic flowchart.</li> </ul>	<b>75%</b>

### 3. Specification table: Knowledge and skills

In accordance with the Ministerial Circular No.10-142, the specification table below specifies the process of assessment in secondary school with regard to Life and Earth Sciences. The national Baccalaureate exam is divided into two sections: Section I is related to knowledge retrieval and Section II is related to scientific reasoning and communication in graphic and written modes.

The circular also emphasises the adoption of a scientific approach and takes into account the time allotted to each content area in the programme in order to set the weighting and scoring.

Section I deals with knowledge retrieval that allows the assessment of the learners' knowledge in one of the six content areas.

Section II deals with scientific reasoning and communication in graphic and written modes which allows the assessment of learners in other content areas not assessed in Section I.

Areas of knowledge (areas and sub-areas)		Skills		Knowledge Retrieval (25%)	Scientific Reasoning and Communication in graphic and written modes 75%	Total (%)	Scores assigned to each area
1. The organic matter consumption and the flow of energy at the cellular level	The reactions responsible for the release of the stored energy in organic matter in the cell; The role of the skeletal striated muscle in energy conversion; Outcome: synthetic flowchart of organic matter consumption and energy flow in the cell;				<ul style="list-style-type: none"> <li>15% if this area is not included in Section I;</li> <li>0% if this area is included in Section I.</li> </ul>	15% or 25%	3 or 5 pts
2. The Nature of genetic information and the gene expression mechanisms - Genetic engineering.	The notion of genetic information; The gene expression mechanisms: Protein synthesis stages; Genetic engineering: its principles and techniques;						
3. Transmission of genetic information through sexual reproduction - Human genetics.	The Transmission of genetic information through sexual reproduction; Mendel's laws of the transmission of hereditary characteristics/traits in the diploid organisms; Human genetics; Criteria of genetic equilibrium of population (Hardy-Weinberg equilibrium);				<ul style="list-style-type: none"> <li>45% if these three areas are not included in Section I;</li> <li>25% if one of these three areas is included in Section I.</li> </ul>	45% to 50%	9 to 10 pts
4. Population genetics.	The evolutionary factors and their impact on the genetic structural of a population; Criteria specifying a species. Definition of a species;			25%			
5. Immunology.	Concept of self and non-self; The ways used by the human organism to protect the self; Some dysfunctions of the immune system; Ways of supporting the immune system;				<ul style="list-style-type: none"> <li>15% to 20% if this area is not included in Section I;</li> <li>0% if this area is included in Section I.</li> </ul>	15% to 20% or 25%	3 to 4 pts or 5 pts
6. The geological phenomena accompanying the formation of mountain ranges and their relationship to plate tectonics	The recent mountain ranges and their relationship to the plate tectonics; The nature of rock deformations characterising subduction and collision of mountain ranges; Metamorphism and its relationship to the plate tectonics; The granitisation and its relationship to the metamorphism; Outcome: the various geological phenomena under study in their relation to the plate tectonics.				<ul style="list-style-type: none"> <li>15% to 20% if this area is not included in Section I;</li> <li>0% if this area is included in Section I.</li> </ul>	15% to 20% or 25%	3 to 4 pts or 5 pts
Total (%)				25%	75%		
The scores assigned to each section				5 pts	15 pts	100%	20 pts

### III. Design of the National Baccalaureate Exam.

#### TEST SECTIONS

##### Section I: Knowledge Retrieval

This Section, knowledge retrieval, aims to assess the degree of mastery of content using the following:

- Multiple choice questions (MCQ);
- True/false statements;
- Matching;
- Classification/seriation/rearranging;
- Short-answer questions (provide definitions, legend a diagram or a graph, and know theories, laws, scientific terms, facts, signs, etc.).

**This Section tests the learners' knowledge in one of the six following content areas:** **Scoring**

1. The organic matter consumption and the flow of energy at the cellular level;
2. The nature of genetic information and the gene expression mechanisms – Genetic engineering;
3. The transmission of genetic information through sexual reproduction – Human genetics;
4. Population genetics;
5. Immunology;
6. The geological phenomena accompanying the formation of mountain ranges and their relationship to plate tectonics.

**5 pts**

##### Section II: Scientific reasoning and communication in graphic and written modes

It comprises 3 or 4 exercises	1 <sup>st</sup> case: Section I tests one of the content areas related to the genetic	Exercise 1 : related to the organic matter consumption and the flow of energy	3 pts
		Exercise 2 : related to one or two content areas of genetics not included in Section I.	5 pts
		Exercise 3 : related to immunology	3 to 4 pts
		Exercise 4: related to the geological phenomena accompanying the formation of mountain ranges and their relationship to plate tectonics.	3 to 4 pts
	2 <sup>nd</sup> case: Section I tests one of the content areas not related to the genetics	One or two exercises related to two or to three content areas of genetics.	9 pts
		Two exercises; each of them covers one of the two areas not included in Section I.	6 pts

### NB. Necessary exam tools:

In addition to the ID card and the invitation letter for the exam, the candidate must have the following tools:

- Pens, pencils, ruler, eraser and a pencil sharpener ;
- Non-programmable calculator ;
- Graph paper.