Science and Technology

The Living World (First Year of Cycle Two)

In Secondary Cycle Two, the concepts related to the living world focus on the study of how the different functions of the principal systems of the human body sustain life. The seven general concepts presented in this section are associated with life-sustaining processes: cell division and the organization of cells into tissues, organs and systems. The latter are presented according to their function: nutrition (digestive, respiratory and circulatory systems), relationships (nervous and musculoskeletal systems) and reproduction (reproductive system). The survival of an organism requires that the systems integrate harmoniously and efficiently.

The study of the concepts related to the human body does not involve an in-depth view of each system; rather it should be approached with a view to helping students develop a better understanding of their interrelationships. The theme for the first year of the cycle, *The Human Organism,* should be considered an integrative element and used as a basis for the assimilation of concepts related to other areas. For example, a study of the sense of sight can integrate a variety of concepts and knowledge such as the path of light inside the eye, the formation of images on the retina and the function of corrective lenses.

Orientations	Compulsory Concepts
Hierarchical organization of life	
Cell division In Cycle One, students learned that there are two types of reproduction (sexual and asexual). They were introduced to a wide range of living organisms in the plant and animal worlds. The perpetuation of life is based on cell division. From the more specific point of view of human beings, studying the functions of mitosis (reproduction, growth, regeneration) and meiosis helps students understand the specific role of the cell in maintaining and reproducing life. In sexual reproduction, descendants are genetically different from their parents. This type of reproduction can be broken down into two steps: meiosis and fertilization. Meiosis produces the sexual gametes (spermatozoa and ova) needed for sexual reproduction. Reproductive cells are haploid (23 chromosomes), while somatic cells are diploid (46 chromosomes). The fusion of male and female sex cells ensures genetic diversity, since the result is a combination of the mother's and father's genes. These genes (DNA) carry the blueprint of the human organism's heredity. The genetic information inherited by a cell is called the genome. The transmission of hereditary characteristics, which ensures the continuation of life, is based on the replication of the characteristic double helix of the DNA macromolecule. **Note:** The compulsory content includes only the general characteristics of mitosis and meiosis. The main objective is to enable students to differentiate between the two types of cell division (not their respective phases) and to understand the basis of genetic diversity. For this reason, the phases of embryonic development are not compulsory content.	– DNA – Mitosis – Functions of cell division (reproduction, growth, regeneration) – Meiosis and sexual development (meiosis, fertilization) – Genetic diversity

The Earth and Space (First Year of Cycle Two)

The knowledge of the Earth and space addressed in Cycle One enabled students to interpret different terrestrial and astronomical phenomena and to become aware of the dynamic aspect of the Earth. In the first year of Cycle Two, the students learn about the origins of life and the appearance of human beings on Earth. An introduction to the dimensions of space and time enable them to make connections between the processes associated with the development of living beings and the physical characteristics of our planet. It is therefore important to address the geological time scale, the major stages in the development of life on Earth and our place in the universe.

Orientations	Compulsory Concepts
The Earth	
The geological time scale helps students understand the environmental conditions that existed during the major stages in the development of life on Earth. It begins with the creation of the Earth more than 4.55 billion years ago. After the formation of the Earth's crust and the oceans at the beginning of the Precambrian Era, the first forms of life (bacteria, prokaryotes) appear. Living organisms proliferated and diversified during the Paleozoic Era. This era is characterized by the massive extinction of almost all marine life forms and nearly 70 per cent of land species at the end of the Permian Period. The Mesozoic Era is associated with the reign of the large reptiles and dinosaurs. The Cenozoic Era (Tertiary and Quaternary periods) begins with the disappearance of the dinosaurs in another major extinction at the end of the Cretaceous Period. This era is associated with the diversification of mammals and the development of the primate and hominid lines. The Quaternary Period was the age of great glaciations and saw the disappearance of a number of mammal species, including the woolly mammoth. Modern man has been evolving for hundreds of thousands of years, but has been sedentary only for the past ten thousand years. Many traces of these changes are recorded in rock formations and on the ocean floor. Fossils provide traces of organisms that lived in the past. In a stratigraphic column, the older fossils are usually below the younger ones. Their arrangement helps us date the layers of the Earth. **Note:** Given the complexity of the taxonomy of living species and the names of the geological eras, students should be expected to learn only the main divisions of these classification systems. The biochemical evolution of prebiotic molecules into primitive cells is not compulsory learning.	– Geological time scale – Major stages in the history of life on Earth – Extinctions – Fossils – Stratigraphic layers

Orientations (cont.)	Compulsory Concepts (cont.)
Space	
Curious about the universe and its size, human beings have been watching the sky since the beginning of time. The astronomical unit is useful for comparing planetary orbits. The solar system is part of a much larger galaxy of stars, gases and dust: the Milky Way. At this scale, distances are expressed in light years. While the light from the Sun takes eight seconds to reach the Earth, the light from the closest star takes about four years. Beyond the Milky Way, observations indicate that there are billions of galaxies in the universe and that they are millions of light years away. It is generally accepted that life appeared on Earth as a result of chemical changes that took place under certain conditions including the presence of water, energy sources and a gaseous atmosphere. The atmosphere plays a role in the water cycle and protects us from harmful radiation. The absence of an atmosphere around a planet or satellite, like the Moon, results in a sterile world incapable of supporting life. Studying the conditions conducive to supporting life may enable humans to one day discover the existence of other life forms in the universe.	– Scale of the universe – Astronomical unit – Light year – Location of the Earth in the universe – Conditions conducive to the development of life

Cultural References			
History	**Community resources**	**Applications**	**Events**
Galileo Arthur Holmes Copernicus Hubert Reeves Johannes Kepler Edmond Halley Edwin Hubble	Parc national de Miguasha Mont Mégantic Observatory Canadian Space Agency Montréal Planetarium Laval Cosmodôme Geological Survey of Canada	Space exploration missions SETI program Hubble space telescope	Solar eclipse Lunar eclipse Meteoric impacts Ice ages Formation of the Canadian Shield

The Living World

Ecology
– Study of populations (density, biological cycles)
– Dynamics of communities
  • Biodiversity
  • Disturbances
– Dynamics of ecosystems
  • Trophic relationships
  • Primary productivity
  • Material and energy flow
  • Chemical recycling

The Technological World[7]

Examples of objects, systems, products and processes
– Resources (maps and aerial photographs)
– Rain gauge, thermometer, barometer, anemometer, hygrometer
– Probes
– Radar, sonar
– Communications satellites
– Seismograph
– Geiger counter
– Waste collection and processing equipment (e.g. glass, plastic, tires)
– Antipollution systems on motorized vehicles (catalytic converter)

CLIMATE CHANGE

The Earth and Space

Biogeochemical cycle
– Carbon cycle
– Nitrogen cycle

Climate zones
– Factors that influence the distribution of biomes
– Marine biomes
– Terrestrial biomes

Lithosphere
– Permafrost

Hydrosphere
– Catchment area
– Oceanic circulation
– Salinity
– Glacier and ice floe

Atmosphere
– Greenhouse effect
– Atmospheric circulation
– Air mass
– Cyclone and anticyclone

Space
– Solar energy flow

The Material World

Chemical changes
– Combustion
– Photosynthesis and respiration
– Balancing chemical equations

Organization of matter
– Rutherford-Bohr atomic model
– Lewis notation
– Groups and periods of the periodic table

Transformation of energy
– Distinction between heat and temperature

7. Concepts related to The Technological World are relevant to every environmental topic.

THE ENERGY CHALLENGE OF HUMANKIND

The Living World

Ecology
- Study of populations (density, biological studies)
- Dynamics of communities
  - Biodiversity
  - Disturbances
- Dynamics of ecosystems
  - Trophic relationships
  - Primary productivity
  - Material and energy flow
  - Chemical recycling

The Technological World[9]

Examples of objects, systems, products and processes
- Electricity: thermal power plant, hydraulic power plant, solar power plant
- Wind turbine
- Oil: well, platform, refinery
- Internal combustion engine
- Electric motor
- Turbine
- Batteries

The Earth and Space

Biogeochemical cycle
- Carbon cycle
- Nitrogen cycle

Climate zones
- Factors that influence the distribution of biomes
- Marine biomes
- Terrestrial biomes

Lithosphere
- Minerals
- Energy resources

Hydrosphere
- Catchment area
- Oceanic circulation
- Energy resources

Atmosphere
- Greenhouse effect
- Atmospheric circulation
- Air mass
- Cyclone and anticyclone
- Energy resources

Space
- Solar energy flow
- Earth-Moon system (gravitational effect)

The Material World

Chemical changes
- Combustion
- Photosynthesis and respiration
- Acid-base neutralization reaction
- Balancing chemical equations
- Law of conservation of mass

Organization of matter
- Rutherford-Bohr atomic model
- Lewis notation
- Groups and periods of the periodic table

Electricity and electromagnetism
- Electrical charge
- Static electricity
- Ohm's law
- Electrical circuits
- Relationship between power and electrical energy
- Forces of attraction and repulsion
- Magnetic field of a live wire

Transformation of energy
- Distinction between heat and temperature
- Law of conservation of energy

9. The concepts related to The Technological World are relevant to every environmental topic.

The Living World

Ecology
- Study of populations (density, biological cycle)
- Dynamics of communities
  - Biodiversity
  - Disturbances
- Dynamics of ecosystems
  - Trophic relationships
  - Primary productivity
  - Material and energy flow
  - Chemical recycling

The Technological World[11]

Examples of objects, systems, products and processes
- Dam
- Road, highway
- Bridge, tunnel
- Road signs
- Street lights

DEFORESTATION

The Earth and Space

Biogeochemical cycle
- Carbon cycle
- Nitrogen cycle

Climate zones
- Factors that influence the distribution of biomes
- Marine biomes
- Terrestrial biomes

Lithosphere
- Minerals
- Energy resources

Hydrosphere
- Catchment area
- Oceanic circulation

Atmosphere
- Greenhouse effect
- Atmospheric circulation

Space
- Solar energy flow

The Material World

Chemical changes
- Combustion
- Photosynthesis and respiration
- Balancing chemical equations

Organization of matter
- Rutherford-Bohr atomic model
- Lewis notation
- Groups and periods of the periodic table

Transformation of energy
- Distinction between heat and temperature
- Law of conservation of energy

11. The concepts related to The Technological World are relevant to every environmental topic.

The Living World (Second Year of Cycle Two)

In Secondary Cycle Two, the compulsory concepts associated with ecology are indispensable for truly understanding the environmental issues addressed. This study involves three main concepts: populations, dynamics of communities, and dynamics of ecosystems.

Orientations	Compulsory Concepts
Ecology When several individuals of a single species occupy the same territory, they form a population. The density of organisms and their distribution are the main characteristics of populations. The influence of abiotic and biotic factors is an essential aspect of the study of population dynamics. Many of these factors, such as natality, mortality, immigration and emigration, play an important role in the biological cycle of these populations. Reproduction and survival are closed linked to the accessibility of resources. Populations are never alone in their territory. Several types of biotic interactions occur between these populations, which constitute a community. Each community is characterized by a trophic structure and a relative abundance of constituent species (biodiversity). The trophic structure, in which organisms interact and form food webs, is an important concept for explaining the dynamics of communities. These food webs are influenced by the nutrients available at the bottom of the food chain and by the major predators at the top. Modifications in the structure and composition of communities occur when disturbances cause an imbalance. At that point, a series of changes gradually takes place in order to re-establish a balance in the community: this is referred to as ecological succession. Human activity and natural calamities are the main causes of disturbance in communities. Another factor can also play an important role in the disturbance of community relations: the presence of pathogenic microorganisms in the environment (bacteria, viruses, fungi, parasites). Some of these agents can be allergenic, toxic or even deadly in some cases. Ecosystems are all characterized by the relationships between the organisms in a community and abiotic factors. Autotrophic organisms introduce energy into the ecosystem, where it becomes organic matter. This primary productivity (biomass) influences the total amount of energy in the ecosystem. Solar energy is converted into chemical energy, transmitted from one trophic level to the other through the food chain and dissipated in the form of heat. At every trophic level, biological and geological processes return various nutrients to the environment. This is referred to as chemical recycling. Microorganisms and decomposers play an essential role in the process of organic decomposition, which allows various inorganic elements to reenter circulation.	– Study of populations (density, biological cycles) – Dynamics of communities • Biodiversity • Disturbances – Dynamics of ecosystems • Trophic relationships • Primary productivity • Material and energy flow • Chemical recycling

Orientations (cont.)	Compulsory Concepts (cont.)
Climate change and the energy challenge are particularly useful in understanding energy circulation and recycling in ecosystems. **Note:** The study of microorganisms and decomposers should be limited to their role in the organic decomposition cycle and the return of nutrients to circulation. Their taxonomy should not be addressed.	

Cultural References			
History	**Community resources**	**Applications**	**Events**
Charles Darwin Alfred Wallace Hermann Muller Alfred Hershey Martha Chase	Museums of natural science Montréal Biodôme Protected areas Zoos UNESCO world reserves Environmental groups	Depollution activities Environmental protection	Discovery of the structure of DNA Great scientific expeditions

The Earth and Space (Second Year of Cycle Two)

In the second year of Cycle Two, students study the interactions between life forms and abiotic elements in the biosphere. Within certain limits and setting aside human activity and exceptional climatic phenomena, various biogeochemical cycles, such as the carbon and nitrogen cycles, regulate the biosphere and ensure the survival of ecosystems. More than ever, the means used to support the development of certain socioeconomic models have an impact on certain biomes. In studying the proposed topics, students will learn about different terrestrial systems and come to understand the balance of the geosphere. Space-related concepts are addressed in terms of the future of our energy resources.

Orientations	Compulsory Concepts
The Earth	
Biogeochemical cycles A biogeochemical cycle describes the natural process during which an organic or mineral element circulates in the biosphere. The carbon cycle is regulated by the interaction of continental plates, the atmosphere, the oceans and living organisms. Although plants use photosynthesis to fix carbon in nonvolatile forms, carbonate rock, precipitated or created by living beings, constitutes the largest reserve of CO2. While this gas is released during volcanic eruptions, anthropogenic emissions restore the natural balance. Certain environmental biotechnologies contribute to the chemical recycling of carbon. Although it is abundant, atmospheric nitrogen can be assimilated by plants only in the presence of certain bacteria. The metabolism of biological organisms—alive or dead—produces waste that returns nitrogen to its mineral state and the cycle begins anew. Significant variations in the humidity, temperature or pH of the soil affect the regulation of the nitrogen cycle. Plants are the only source of nitrogen usable by animals, which is a good reason for preserving the world's plant life.	– Biogeochemical cycles • Carbon cycle • Nitrogen cycle
Climate zone The distribution of biomes is a function of geographic latitude and other factors such as altitude, temperature and soil type. Their composition varies, since habitat conditions influence the distribution of plant and animal species. Marine biomes are at the bottom of an immense food pyramid; their continued health is therefore critical for humans. The types of animals present in a terrestrial biome depend on the types of plants there. Any imbalance caused by habitat destruction or contamination will have an impact on the ecosystems and, eventually, on a wide range of human activity.	– Factors that influence the distribution of biomes – Marine biomes – Terrestrial biomes

Orientations (cont.)	Compulsory Concepts (cont.)
The Earth (cont.)	
Lithosphere The lithosphere contains a wide variety of mineral resources essential to the development of civilization, including metals, industrial minerals and construction materials. The use and transformation of minerals, however, have an impact on the environment. In addition, minerals exist in limited amounts, hence the growing need to take another look at residual materials and recycling in general. The layers we see in a core sample, called horizons, differ in structure and composition. Studying a soil profile helps us understand the circulation of chemical elements in the soil and predict how it will evolve. Humidity, pH and mineral content help regulate the biological activity of soils, which is essential for feeding living organisms. The permafrost is sensitive to climate change because the underground ice it contains is unstable. Warming of the permafrost can cause landslides and damage to infrastructures and alter the landscape and ecosystems. Fossil fuels are nonrenewable sources of energy, as are the radioactive materials used in nuclear power plants. The search for new energy sources and the use of renewable resources are two major concerns in today's world.	– Minerals – Soil profile (horizons) – Permafrost – Energy resources
Hydrosphere A catchment area is a territory bounded by crest lines (geomorphology) surrounding a waterway, into which flow ground and surface water. Human activity in a catchment area, for example the creation of a reservoir upstream of a hydroelectric power plant, can disturb ecosystems. Because of their ability to absorb heat, the oceans play an essential role in regulating climate by standardizing the temperature of the Earth. There are two types of marine currents, which are interrelated. Surface currents, generated by wind, ensure wide-scale horizontal circulation. Deep currents, caused by differences in temperature or salinity, ensure vertical circulation between the different layers of the ocean. These vertical currents are very sensitive to small local variations in temperature. The rise in sea level, due to the accelerated thawing of glaciers and ice floes, is a major concern for coastal populations. Marine currents and tides create large quantities of energy. Tidal power plants use tides to produce electrical energy.	– Catchment area – Oceanic circulation – Salinity – Glacier and ice floe – Energy resources

Orientations (cont.)	Compulsory Concepts (cont.)
The Earth (cont.)	
Atmosphere The Earth reflects part of the heat generated by solar radiation back into space. Some gases in the atmosphere absorb this heat and cause the temperature to rise: this is the greenhouse effect. Carbon dioxide is the most abundant greenhouse gas. Its proportion has increased over the past century because of the use of fossil fuels and the manufacture of cement. Methane and other gases also contribute to the greenhouse effect. The different types of air masses can be distinguished by their temperature and humidity. These masses circulate around the globe at the whim of wind, convection currents and the Earth's rotational movement. Cloud systems are the result of the meeting of air masses with different characteristics. A cyclone is a large area of rotating cloud, winds and storms around a low-pressure area. Cyclones form over warm tropical seas and cause abundant precipitation accompanied by strong winds and generally devastating effects. Pressure variations caused by cyclones and anticyclones ensure atmospheric circulation. Wind is also a resource. Whether it be to move around, perform mechanical tasks or produce electrical energy, humans take advantage of wind energy by using sails and blades whose shapes, materials and dimensions vary depending on the application. Wind energy is an abundant source of soft energy.	– Greenhouse effect – Atmospheric circulation – Air mass – Cyclone and anticyclone – Energy resources
Space	
Space The Sun emits a phenomenal amount of energy in every region of the electromagnetic spectrum. Humans have been using the Sun's heat to meet their needs for a very long time. The photovoltaic sensors on solar panels transform radiation energy into electrical energy. The gravitational pull of the Moon on the Earth's large surfaces of water is in large part responsible for the tides. The energy of the tides is captured in tidal power plants. This is one of the means humans have of meeting their energy needs.	– Solar energy flow – Earth-Moon system (gravitational effect)

Cultural References			
History	**Community resources**	**Applications**	**Events**
Niels Steensen James Hutton Henry Cavendish Sir Charles Lyell Alfred Wegener	Geological Survey of Canada Agence de l'efficacité énergétique Natural Resources Canada Ouranos Consortium Greenpeace	Observation satellites Global positioning systems	Earth summits Kyoto Protocol Meteorological phenomena