CAISL
Carlucci American International School of Lisbon

**GRADE 11 ADVANCED BIOLOGY LEVEL 1 - IB BIOLOGY Y1**

**Contents**



## NATURE OF SCIENCE, SCIENTIFIC METHODOLOGY AND ENQUIRY

Throughout grade 11 Biology students are expected to:

- Develop a testable hypothesis, design and conduct an investigation identifying ethical and safety implications of the research.
- Identify variables, organize and present quantitative and qualitative results, looking for trends and discrepancies.
- Apply error measurements and calculation as well as basic statistical analysis and mathematical correlations.
- Discuss data from multiple perspectives, critically concluding and evaluating the results and future applications of experimental results.
- Explore the use of technology in order to reduce uncertainty and infer about validity of data.

## THEMES AND CONTENT

### Cell biology

- Introduction to cells
- Ultrastructure of cells
- Membrane structure
- Membrane transport
- The origin of cells
- Cell division

### Molecular biology

- Molecules to metabolism
- Water
- Carbohydrates and lipids
- Proteins
- Enzymes
- Structure of DNA and RNA
- DNA replication, transcription and translation
- Cell respiration
- Photosynthesis

### Genetics

- Genes
- Chromosomes
- Meiosis
- Inheritance
- Genetic modification and biotechnology

**Ecology**

- Species, communities and ecosystems
- Energy flow
- Carbon cycling
- Climate change

## OTHER SKILLS AND EXPECTATIONS

### MATHEMATICAL SKILLS

- Perform the basic arithmetic functions: addition, subtraction, multiplication and division.
- Carry out calculations involving means, decimals, fractions, percentages and ratios.
- Represent and interpret frequency data in the form of bar charts, graphs and histograms, including direct and inverse proportion.
- Plot graphs (with suitable scales and axes) involving two variables that show linear or non-linear relationships.
- Plot and interpret scattergraphs to identify a correlation between two variables and appreciate that the existence of a correlation does not establish a causal relationship.
- Determine the mode and median of a set of data, calculate and analyze standard deviation.
- Select statistical tests appropriate for the analysis of particular data and interpret the results.

### SCIENCE NOTEBOOK

- Notebooks are an independent responsibility of the student.
- Students are expected to keep an organized notebook with notes from class, work done at home and data collected during labs.

### SCIENTIFIC WRITING

- Students will write Laboratory Reports about experiments conducted in class, related to the subject content, which will include (but not limited to) the following requirements:
    - Conduct independent background research to sustain their findings.

- Include in-text citations for research.
- Use reliable sources, correctly cited in MLA format or APA style.
- Provide a bibliography.
- Submit personal investigation/Internal Assessment via Turnitin.

(Additional information about research parameters is available on the CAISL website).

**INFORMATION TECHNOLOGY**

- Students are expected to use digital measurement tools (probes) in order to collect data and make appropriate use of data collection and analysis software (Logger Pro).
- Students are expected to master the use of Excel to manipulate and interpret collected data.

**SCIENCE LABORATORY SAFETY EXPECTATIONS**

- Students will be expected to learn and to follow the expectations for safe and appropriate practices during laboratory activity, as shown on the "Science Laboratory Safety" document.

**ASSESSMENT**

**For students to receive a credit towards their High School Diploma and successfully conclude Y1 of the IB program, they must demonstrate proficiency on:**

- Summative Tests
- Formative worksheets
- Lab Reporting
- Data based questions
- Virtual (on-line/Digital) lab work
- Personal Investigation – students will work on the first steps of their personal investigation by placing a hypothesis, research an appropriate background information to support their hypothesis, and research/create a procedure to test their hypothesis.
- Participate and complete successfully an integrated scientific work / Group 4 Project with students from all scientific areas (Physics, Chemistry, Computer Science).
- Final exam

**Students who are pursuing the IB Diploma in addition to the High School Diploma must complete both years of the program.**

Note: While there are no internal assessments sent to the IB nor external exams set by the IB during the 1st year of the program, much of the work done will be revised or adapted early in Year 2 to be evaluated by the IB.

## PERFORMANCE INDICATORS

*Cell biology*

Understand the cell theory and that the evolution of multicellular organisms allowed cell specialization and cell replacement.

Recognize the importance of the *surface area to volume ratio* in the limitation of cell size and explore the importance of multicellularity and differentiation.

Recognize the importance of gene expression and cell's genome in embryonic and mature tissues development as well as the importance of stem cells.

Use proficiently a light microscope to investigate the structure of cells and tissues, with drawing of cells and calculation of the magnification of drawings and real cell size.

Name and explain nutrition, metabolism, growth, response, excretion, homeostasis and reproduction as main functions of life.

Understand how the structure of biological membranes makes them fluid and dynamic and that they control the composition of cells by active and passive transport.

Recognize the evidence for the endosymbiotic theory and the possible origins of life.

Identify the sequence and phases of mitosis and meiosis in cells viewed with a microscope or in a micrograph and determine a mitotic index.

*Molecular biology*

Understand that living organisms are made of a complex web of chemical reactions which support biological processes.

Recognize some examples of falsification of theories - e.g. the artificial synthesis of urea helped to falsify vitalism.

Comprehend that life is based on carbon compounds including carbohydrates, lipids, proteins or nucleic acids, and that metabolism is the web of all the enzyme-catalyzed reactions in every organism.

Draw and identify molecular diagrams of glucose, ribose, saturated fatty acids, triglycerides, phospholipids, steroids and a generalized amino acid, including peptide bonds, as well as some other biochemical structures.

Identify water as the medium of life and use theories to explain natural phenomena – e.g. the theory that hydrogen bonds form between water molecules explains some of the properties of water.

Explain the cohesive, adhesive, thermal and solvent properties of water and understand how some substances can be hydrophilic or hydrophobic.

Understand that compounds of carbon, hydrogen and oxygen are used to supply and store energy in living organisms and that cellulose and starch in plants and glycogen in humans play an essential role.

Recognize the health risks of trans fats and saturated fatty acids and evaluate the evidence and the methods used to obtain the health claims made about lipids and other components.

Use of molecular visualization software and determine body mass index by calculation or use of a nomogram.

Understand that proteins have a very wide range of functions in living organisms, the amino acid sequence of polypeptides is coded for by genes and determines the three-dimensional conformation of a protein.

*Enzymes in Molecular Biology*

Understand that enzymes control the metabolism of the cell, have an active site to which specific substrates bind, which involves molecular motion and the collision of substrates with the active site and that temperature, pH and substrate concentration affect the rate of activity.

Recognize that enzymes can be denatured, immobilized, and are widely used in industry.

Design experiments to test the effect of temperature, pH and substrate concentration on the activity of

enzymes.

Understand graph analysis showing the expected effects of temperature, pH and substrate concentration on

the activity of enzymes.

*DNA and RNA in Molecular Biology*

Understand how the structure of DNA allows efficient storage of genetic information and the importance of models as representation of the real world.

Recognize the physical and chemical differences between the nucleic acids DNA and RNA as polymers of nucleotides.

Draw and label diagrams of the structure of single and multiple nucleotides of DNA and RNA.

Recognize how genetic information in DNA can be accurately copied and translated to make the proteins needed by the cell.

Understand the need to obtaining evidence for scientific theories (e.g. Meselson and Stahl and the semi-conservative replication of DNA).

Recognize semi-conservative replication, complementary base pairing, transcription is the synthesis of mRNA copied from the DNA base sequences and translation, essential is the synthesis of polypeptides on ribosomes.

Recognize that the amino acid sequence of polypeptides is determined by mRNA according to the genetic code, that codons of three bases on mRNA correspond to one amino acid in a polypeptide and that translation depends on complementary base pairing between codons on mRNA and anticodons on tRNA.

Use a table of the genetic code to deduce which codon(s) corresponds to which amino acid.

*Cell respiration and Photosynthesis in Molecular Biology*

Understand how cell respiration supplies energy for the functions of life.

Analyze the results from experiments involving measurement of respiration rates in yeast, germinating seeds or invertebrates using a respirometer.

Identify how photosynthesis uses the energy in sunlight to produce the chemical energy needed for life.

Control relevant variables in photosynthesis experiments and recognize that Chlorophyll absorbs red and blue light most effectively and reflects green light more than other colors.

Recognize that temperature, light intensity and carbon dioxide concentration are possible limiting factors on the rate of photosynthesis.

Draw an absorption spectrum for chlorophyll and an action spectrum for photosynthesis and design an experiment to investigate the effect of limiting factors on photosynthesis.

Separate photosynthetic pigments by paper chromatography and spectrometry.

*Genetics*

Understand that every organism inherits a genetic blueprint for life from its parents.

Recognize that developments in scientific research follow improvements in technology.

Know that a gene is a heritable factor that consists of a length of DNA and influences a specific characteristic.

Discuss the importance of mitosis, how new alleles are formed by mutation and how the genome is the whole of the genetic information of an organism.

Outline the causes of sickle cell anemia and the need to use a database to determine differences in the base sequence of a gene in two species.

Understand that chromosomes carry genes in a linear sequence that is shared by members of a species.

Identify genetic differences between prokaryotes and eukaryote including the importance of plasmids and the existence of linear DNA molecules associated with histone proteins.

Outline chromosomic homology, ploidy and chromosome number as features of members of a species or life cycle.

Identify a karyogram and an idiogram.

Discuss how alleles segregated during meiosis allow new combinations to be formed by the fusion of gametes

Understand how one diploid nucleus divides by meiosis to produce four haploid nuclei and the halving of the chromosome number allows a sexual life cycle with fusion of gametes.

Explain how crossing over and random orientation, together with the fusion of gametes from different parents promotes genetic variation.

Understand the consequences of the non-disjunction of chromosomes (e.g. Down syndrome) and analyze studies showing how the age of parents influences chances of nondisjunction.

*Inheritance, gene modification, Biotechnology and Genetics*

Explain how the inheritance of genes follows patterns initially identified by Mendel's genetic crosses with pea plants and related principles of inheritance.

Discuss how the fusion of gametes results in diploid zygotes with two alleles of each gene that may be the same allele or different alleles.

Understand how dominant alleles mask the effects of recessive alleles but co-dominant alleles have joint effects.

Show how many genetic diseases in humans are due to recessive alleles of autosomal genes, some genetic diseases are sex-linked, and the pattern of inheritance is different due to their location on sex chromosomes.

Recognize that radiation and mutagenic chemicals increase the mutation rate and can cause genetic diseases and cancer.

Understand the inheritance of ABO blood groups and suggest examples of sex-linked inheritance.

Construct Punnett grids for predicting the outcomes of monohybrid genetic crosses and compare predicted and actual outcomes of genetic crosses using real data.

Analyze pedigree charts to deduce the pattern of inheritance of genetic diseases.

Identify techniques for artificial manipulation of DNA, cells and organisms.

Assess risks associated with scientific research.

Use Gel electrophoresis to separate proteins or fragments of DNA according to size and understand the use of PCR technique.

Comprehend that genetic modification is carried out by gene transfer between species and clones are groups of genetically identical organisms, derived from a single original parent cell.

Explain how gene transfer to bacteria using plasmids makes use of restriction endonucleases and DNA ligase.

Assess critically the potential risks and benefits associated with genetic modification of crops.

Design an experiment to assess one factor affecting the rooting of stem-cuttings.

*Ecology*

Discuss how continued survival of living organisms including humans, depends on sustainable communities.

Understand the concepts of specie, community, ecosystem and biomes and look for patterns, trends and discrepancies in ecological systems.

Identify and name consumers, detritivores, saprotrophs, producers, amongst other in different ecosystems and food webs.

Explain how the supply of inorganic nutrients is maintained by nutrient cycling.

Set up a sealed mesocosms to try to establish sustainability.

Test for the association between two species using the chi-squared test with data obtained by quadrat sampling.

Recognize and interpret statistical significance of data.

Use theories to explain natural phenomena and how chemical energy in carbon compounds flows through food chains.

Understand that energy losses between trophic levels restrict the length of food chains and the biomass of higher trophic levels.

Produce quantitative representations of energy flow using pyramids of energy of number and biomass.

Understand that continued availability of carbon in ecosystems depends on carbon cycling.

Recognize that methane is produced from organic matter in anaerobic conditions by methanogenic archaeans and some diffuses into the atmosphere or accumulates in the ground.

Recognize that carbon dioxide is produced by the combustion of biomass and fossilized organic matter.

Construct a diagram of the carbon cycle.

Discuss how concentrations of gases in the atmosphere affect climates experienced at the Earth's surface and assess the claims that human activities are producing climate change.

Recognize carbon dioxide and water vapor as the most significant (but not only) greenhouse gases.

Understand that a warmed Earth emits longer wavelength radiation (heat) which is absorbed by greenhouse gases that retain the heat in the atmosphere.

Establish a correlation between rising atmospheric concentrations of carbon dioxide since the start of the industrial revolution 200 years ago and average global temperatures.

Evaluate the claims that human activities are not causing climate change.