

## Sciences at Alto

### Middle Years Program / IB Diploma Program

#### Introduction

##### **Grades 6 - 8 Integrated Science:**

This course enables students to develop their understanding of basic concepts in biology, chemistry, earth and space science, and physics, and to relate science to technology, society, and the environment. Throughout the course, students will develop their skills in the processes of scientific investigation. Students will acquire an understanding of scientific theories and plan and conduct investigations into practical problems and issues related to the impact of human activity.

##### **Grades 9 - 12 Biology, Physics and Chemistry:**

All three sciences are taught in parallel during the first two years in high school. In the IB diploma program (grades 11 and 12) students can specialize in one or more sciences, choosing standard or higher level for any of them.

#### Middle Years Program

##### **Grade 6 - Integrated Sciences**

Major Unit	Statement of Inquiry	Topics / Content
Being a scientist and the particle model	Modelling particulate nature of matter allows us to better understand the form of our surroundings and describe relationships between properties and behaviours of substances.	<ul style="list-style-type: none"> <li>• Scientific method</li> <li>• Lab safety</li> <li>• Making measurements</li> <li>• Particle model and state changes</li> <li>• Planning and conducting investigations</li> </ul>
Ecosystems	Imbalance in an environment creates altered conditions for life affecting future generations of species.	<ul style="list-style-type: none"> <li>• The biological environment</li> <li>• Ecosystems &amp; biodiversity</li> <li>• Interdependence</li> <li>• Niches</li> <li>• Adaptations and evolution (basic intro)</li> </ul>
Energy and energy transfer	Humankind and the environment are affected by energy being transformed into different forms.	<ul style="list-style-type: none"> <li>• Types of energy</li> <li>• Energy transfers</li> <li>• Systems</li> <li>• Fuels and energy sources</li> </ul>
Atomic structure	Models are created and modified over time to express new ideas formed by experimental evidence.	<ul style="list-style-type: none"> <li>• History of the atomic model</li> <li>• Dalton's atom</li> <li>• Periodic table basics</li> <li>• Elements, compounds &amp; mixtures</li> </ul>
Diversity and classification	The relationships and patterns identified amongst organisms provide evidence that allows the natural world to be classified using human-made systems.	<ul style="list-style-type: none"> <li>• Living organisms (MRS GREEN)</li> <li>• Adaptations / survival</li> <li>• Classification systems</li> <li>• Kingdoms</li> </ul>
Forces and motion	The application of force has consequences for an objects' movement that can be expressed scientifically.	<ul style="list-style-type: none"> <li>• Types and applications of forces</li> <li>• Measuring forces</li> <li>• Describing motion, speed with speed distance time graphs</li> </ul>

## Grade 7 - Integrated Sciences

Major Unit	Statement of Inquiry	Topics / Content
Thermal physics	As systems interact, hidden energy can be exchanged over long periods of time which later reveals itself in spectacular displays of nature.	<ul style="list-style-type: none"> <li>• Kinetic Model</li> <li>• Methods of heat transfer</li> <li>• Expansion of solids and liquids</li> <li>• Plate tectonics</li> </ul>
Ecosystems	Evidence shows that global ecological systems are composed of delicately balanced relationships between organisms and the environment; even minor changes within them can have great consequences and affect the sustainability of the planet.	<ul style="list-style-type: none"> <li>• The biological environment</li> <li>• Ecosystems &amp; biodiversity</li> <li>• Interdependence</li> <li>• Niches</li> <li>• Adaptations and evolution (basic intro)</li> </ul>
Periodic Table	Pioneering discoveries can challenge conventional wisdom and open pathways toward deeper understanding.	<ul style="list-style-type: none"> <li>• Metals/Nonmetals</li> <li>• History, organization of elements</li> <li>• Holes in the table leading to discoveries</li> <li>• Theory &amp; Experiment</li> <li>• Groups &amp; Columns</li> </ul>
Astrophysics	Earth's movements and interactions within the context of time, place and space within the universe can be explained using models.	<ul style="list-style-type: none"> <li>• History of astronomy</li> <li>• Heliocentric Vs. Geocentric model</li> <li>• Our solar system</li> <li>• Scales and sizes</li> <li>• Phases of the moon</li> <li>• Structure of the universe</li> </ul>
Health	Positive lifestyle choices develop through awareness and refinement.	<ul style="list-style-type: none"> <li>• Reproductive systems</li> <li>• Sexual health</li> <li>• Bacteria</li> <li>• Infectious disease</li> <li>• Immune system</li> <li>• Ethics</li> </ul>
Mixtures and solutions	Changes in form are caused by interactions of substances and drive advances in technology.	<ul style="list-style-type: none"> <li>• Elements compounds mixtures review</li> <li>• States of matter review</li> <li>• Pure and impure substances</li> <li>• Solubility</li> <li>• Separating mixtures different phases</li> <li>• Separating mixtures same phase</li> </ul>

## Grade 8 - Integrated Sciences

Major Unit	Statement of Inquiry	Topics / Content
Manipulating reactions	Substances undergo transformations, often accompanied by a change in form and energy, through their interaction with other substances.	<ul style="list-style-type: none"> <li>• Bonding</li> <li>• Rates of reaction</li> <li>• Balancing equations</li> <li>• Equilibrium</li> <li>• Enthalpy</li> </ul>
Diversity of living things	Imbalance in an environment creates altered conditions for life affecting future generations of species.	<ul style="list-style-type: none"> <li>• Classification</li> <li>• Dichotomous keys /phylogenetic trees</li> <li>• kingdoms and characteristics</li> <li>• Viruses</li> </ul>
Electricity	Communities rely on electrical systems that humans have developed through using components that have specific forms and functions.	<ul style="list-style-type: none"> <li>• Electric charge</li> <li>• Electric fields</li> <li>• Current in a simple circuit</li> <li>• Potential difference (voltage)</li> <li>• Electrical resistance</li> <li>• Ohm's law</li> <li>• Static electricity</li> </ul>

		<ul style="list-style-type: none"> <li>• Electromagnetic induction</li> </ul>
Green chemistry IDU	A consequence of changing climates is the search for technological solutions to world power-production that will impact upon future generations.	<ul style="list-style-type: none"> <li>• Covalent compounds</li> <li>• Greenhouse effect</li> <li>• The atmosphere</li> <li>• Plastics</li> <li>• Local chemistry issues</li> </ul>
Evolution	Population change is a consequence of the unbalanced opportunities provided by natural selection.	<ul style="list-style-type: none"> <li>• Contributors to the theory of evolution</li> <li>• Evidence of evolution</li> <li>• Mechanisms of evolution</li> <li>• Allele frequencies and population</li> <li>• Speciation</li> </ul>
Waves	Wave theory demonstrates the interaction of energy with the environment through modelling a law of the natural world.	<ul style="list-style-type: none"> <li>• Types of waves - transverse &amp; longitudinal</li> <li>• Sound waves - characteristics</li> <li>• Light waves and rays</li> <li>• Differences between sound &amp; light</li> <li>• Refraction</li> <li>• Total internal reflection</li> <li>• The electromagnetic spectrum and its applications</li> </ul>

## Grade 9 - Biology, Physics, Chemistry

<b>Biology</b>		
Major Unit	Statement of Inquiry	Topics / Content
Diversity of living things	Through the classification of organisms based on their form and function, we are better able to understand the relationships between and among organisms, as well as the role of humans in helping to maintain biodiversity and sustainability of the environment.	<ul style="list-style-type: none"> <li>• All living things can be classified according to their anatomical and physiological characteristics.</li> <li>• Human activities affect the diversity of living things in ecosystems.</li> </ul>
Cellular biology and genetics	The natural and/or artificial transformation of genetic material into inherited traits connects individuals to one another through patterns of inheritance.	<ul style="list-style-type: none"> <li>• Genetic and genomic research can have social and environmental implications.</li> <li>• Variability and diversity of living organisms result from the distribution of genetic materials during the process of meiosis.</li> </ul>
Anatomy and physiology	How do the form and function of our body systems interact to carry out the necessary functions for daily life.	<ul style="list-style-type: none"> <li>• Groups of organs with specific structures and functions work together as systems, which interact with other systems in the body.</li> <li>• The development and uses of technology to maintain human health are based, in part, on the changing needs of society.</li> </ul>
Plant Anatomy (extension unit)	How do the form and function of plant anatomy and physiology interact to carry out photosynthesis, growth and reproduction.	<ul style="list-style-type: none"> <li>• Plants have specialized structures with distinct functions that enable them to respond and adapt to their environment.</li> <li>• Plant variety is critical to the survival and sustainability of ecosystems.</li> </ul>
<b>Physics</b>		
Major Unit	Statement of Inquiry	Topics / Content
Kinematics and dynamics	Scientists model forces to predict the change in movement so that we can better understand our place in the universe.	<ul style="list-style-type: none"> <li>• Express the motion of an object using narrative, graphical, diagram, and algebraic models.</li> </ul>

		<ul style="list-style-type: none"> <li>Understand the consequences of unbalanced and balanced forces on a system.</li> </ul>
Energy, work, and power	In order to meet growing demands for energy, societies often turn to new technologies that interact with the natural world.	<ul style="list-style-type: none"> <li>Different forms of energy</li> <li>Conservation of energy</li> <li>Work-energy principle</li> </ul>
Electricity and magnetism	Communities rely on electrical systems that humans have developed through using components that have specific forms and functions.	<ul style="list-style-type: none"> <li>Behavior and nature of static charges</li> <li>Explain the nature of the relationship between an electric force and electric field</li> <li>A changing magnetic field in a conductor can induce an emf</li> </ul>
<b>Chemistry</b>		
<b>Major Unit</b>	<b>Statement of Inquiry</b>	<b>Topics / Content</b>
Acid and base chemistry	Scientists develop models to study the function of different chemicals and the changes they can undergo and bring about.	<ul style="list-style-type: none"> <li>What is an acid and a base?</li> <li>pH scale</li> <li>Reactions of acids and bases</li> <li>Metals</li> <li>Oxides</li> <li>Alkalies</li> <li>Carbonates</li> <li>Acid rain</li> </ul>
Reactions	A change in matter is a consequence of energy differences between substances. Scientists and technicians make use of this to create a range of innovative products.	<ul style="list-style-type: none"> <li>Types of reactions: <ul style="list-style-type: none"> <li>Displacement</li> <li>Oxidation (including combustion)</li> <li>Decomposition</li> </ul> </li> <li>Reaction conditions</li> <li>Enthalpy/ exo and endothermic</li> <li>Reversible reactions &amp; equilibrium</li> <li>Kinetics</li> </ul>

### Grade 10 - Biology, Physics, Chemistry

<b>Biology</b>		
<b>Major Unit</b>	<b>Statement of Inquiry</b>	<b>Topics / Content</b>
Biochemistry	Scientific and technological advances enable societies to use, control and transform the function of organisms and biological molecules.	<ul style="list-style-type: none"> <li>Technological applications that affect biological processes and cellular functions are used in the food, pharmaceutical, and medical industries.</li> <li>Biological molecules and their chemical properties affect cellular processes and biochemical reactions.</li> <li>Biochemical compounds play important structural and functional roles in cells of all living organisms.</li> <li>The biochemical basis of life (water, carbohydrates, lipids, proteins and nucleic acids)</li> <li>Cell structure and function (cell membranes, transport across cell membranes)</li> </ul>
Metabolic processes	Scientists use life processes that are the consequence of interactions between molecules to create a variety of everyday products.	<ul style="list-style-type: none"> <li>All metabolic processes involve chemical changes and energy conversions.</li> <li>An understanding of metabolic processes enables people to make informed choices with respect to a range of personal,</li> </ul>

		<p>societal, and environmental issues.</p> <ul style="list-style-type: none"> <li>• Metabolism and energy (ATP, enzymes &amp; food as fuel)</li> <li>• Cellular respiration (aerobic and anaerobic pathways)</li> <li>• Photosynthesis</li> </ul>
Molecular genetics	<p>Scientists explore the relationship between DNA and life processes to develop biotechnology. Biotechnology has presented new ways to change organisms by transforming DNA.</p>	<ul style="list-style-type: none"> <li>• DNA contains all the genetic information for any living organism.</li> <li>• Proteins control a wide variety of cellular processes.</li> <li>• Genetic research and biotechnology have social, legal, and ethical implications.</li> <li>• DNA (molecules, structure, function, repair and replication)</li> <li>• Genes to proteins (transcription, translation, gene expression)</li> </ul>
Homeostasis (extension unit)	<p>Balance in complex organisms requires effective interaction between systems to regulate internal conditions based on feedback.</p>	<ul style="list-style-type: none"> <li>• Organisms have strict limits on the internal conditions that they can tolerate.</li> <li>• Systems that maintain homeostasis rely on feedback mechanisms.</li> <li>• Environmental factors can affect homeostasis.</li> <li>• Endocrine and nervous system</li> </ul>
<b>Physics</b>		
<b>Major Unit</b>	<b>Statement of Inquiry</b>	<b>Topics / Content</b>
Waves	<p>Relationships and patterns among wave types transfer energy that is reflected, absorbed and transmitted through various materials and used to create systems.</p>	<ul style="list-style-type: none"> <li>• Waves have properties, such as reflection, refraction, diffraction, and interference</li> <li>• We use waves as a model of phenomena we observe in the universe</li> <li>• How light and sound waves are alike and different</li> <li>• Applications of different waves in the electromagnetic spectrum</li> </ul>
Modern physics	<p>Technical innovations take advantage of the change of atoms as they transform and give off energy.</p>	<ul style="list-style-type: none"> <li>• Atomic structure</li> <li>• Radioactive decay</li> <li>• Carbon dating</li> <li>• Nuclear energy generation</li> </ul>
<b>Chemistry</b>		
<b>Major Unit</b>	<b>Statement of Inquiry</b>	<b>Topics / Content</b>
Stoichiometry	<p>Mathematical functions can be used to describe changes, patterns, and transfer within chemistry.</p>	<ul style="list-style-type: none"> <li>• Balancing equations</li> <li>• Moles</li> <li>• Molecules</li> <li>• Concentration</li> <li>• Reactions</li> </ul>
Organic chemistry	<p>In order for structure and energy to continue driving change, finite fossil fuels will need to be replaced by renewable raw materials.</p>	<ul style="list-style-type: none"> <li>• Naming organic compounds</li> <li>• Alkanes</li> <li>• Alkenes</li> <li>• Alcohols</li> <li>• Applications of organic compounds</li> </ul>

## IB Diploma Program

Alto offers biology, physics, and chemistry in the IB diploma program. In addition, students can choose design technology as a science subject. Students select either higher level (HL) or standard level (SL) for all science subjects.

### IB Diploma Biology - Grade 11

Major Unit	HL/SL	Topics / Content
Cell biology	SL/HL	<ul style="list-style-type: none"> <li>• Ultrastructure of cells</li> <li>• Membrane structure</li> <li>• Membrane transport</li> <li>• Origin of cells</li> <li>• Cell division</li> </ul>
Molecular biology	SL/HL	<ul style="list-style-type: none"> <li>• Molecules to metabolism</li> <li>• Water</li> <li>• Carbohydrates &amp; lipids</li> <li>• Proteins</li> <li>• Enzymes</li> <li>• DNA &amp; RNA structure</li> <li>• DNA replication, transcription &amp; translation</li> <li>• Cell respiration &amp; Photosynthesis</li> </ul>
Genetics	SL/HL	<ul style="list-style-type: none"> <li>• Genes</li> <li>• Chromosomes</li> <li>• Meiosis</li> <li>• Inheritance</li> <li>• Genetic modification and biotechnology</li> </ul>
Ecology	SL/HL	<ul style="list-style-type: none"> <li>• Species, communities and ecosystems</li> <li>• Energy flow</li> <li>• Carbon cycling</li> <li>• Climate change</li> </ul>
Evolution and biodiversity	SL/HL	<ul style="list-style-type: none"> <li>• Evidence for evolution</li> <li>• Natural selection</li> <li>• Classification of biodiversity</li> <li>• Cladistics</li> </ul>
Plant biology	HL	<ul style="list-style-type: none"> <li>• Transport in xylem and phloem of plants</li> <li>• Growth in plants</li> <li>• Reproduction in plants</li> </ul>

### IB Diploma Biology - Grade 12

Major Unit	HL/SL	Topics / Content
Humans	SL/HL	<ul style="list-style-type: none"> <li>• Structure of the digestive system</li> <li>• The blood system</li> <li>• Defence against infectious disease</li> <li>• Gas exchange</li> <li>• Neurons and synapses</li> <li>• Hormones, homeostasis and reproduction</li> </ul>
Option	SL/HL	<ul style="list-style-type: none"> <li>• Choice of: <ul style="list-style-type: none"> <li>○ A: Neurobiology and behaviour</li> <li>○ B: Biotechnology and bioinformatics</li> <li>○ C: Ecology and conservation</li> <li>○ D: Human physiology</li> </ul> </li> </ul>
Nucleic acids	HL	<ul style="list-style-type: none"> <li>• DNA structure and replication</li> <li>• Transcription and gene expression</li> </ul>

		<ul style="list-style-type: none"> <li>● Translation</li> </ul>
Metabolism, cell respiration and photosynthesis	HL	<ul style="list-style-type: none"> <li>● Metabolism</li> <li>● Cell respiration</li> <li>● Photosynthesis</li> </ul>
Animal physiology	HL	<ul style="list-style-type: none"> <li>● Antibody production and vaccination</li> <li>● Movement</li> <li>● The kidney and osmoregulation</li> <li>● Sexual reproduction</li> </ul>
Extra option	HL	<ul style="list-style-type: none"> <li>● Choice of... <ul style="list-style-type: none"> <li>○ A: Neurobiology and behaviour</li> <li>○ B: Biotechnology and bioinformatics</li> <li>○ C: Ecology and conservation</li> <li>○ D: Human physiology</li> </ul> </li> </ul>

Learn more: IB diploma biology subject brief for DP: [Standard Level](#) / [High Level](#)

## IB Diploma Physics - Grade 11

Major Unit	HL/SL	• Topics /Content
Mechanics	SL/HL	<ul style="list-style-type: none"> <li>• Distance/Displacement/Position</li> <li>• Speed/Velocity</li> <li>• Acceleration</li> <li>• Motion in 2D</li> <li>• Forces</li> <li>• Free body diagrams</li> <li>• Unbalanced vs. balanced forces</li> <li>• Action/Reaction pairs</li> <li>• Kinetic and potential energies</li> <li>• Work and power</li> <li>• Conservation of energy</li> <li>• Efficiency</li> <li>• Momentum</li> <li>• Force and impulse</li> <li>• Conservation of momentum</li> <li>• Collisions</li> </ul>
Circular motion	SL/HL	<ul style="list-style-type: none"> <li>• Period, frequency, and other angular quantities</li> <li>• Centripetal force and acceleration</li> <li>• Law of gravitation</li> <li>• Gravitational field strength</li> </ul>
Thermal physics	SL/HL	<ul style="list-style-type: none"> <li>• Kinetic model</li> <li>• Temperature</li> <li>• Internal energy</li> <li>• Specific heat capacity and latent heat</li> <li>• Pressure</li> <li>• Ideal gases</li> </ul>
Thermodynamics and fluid dynamics	HL	<ul style="list-style-type: none"> <li>• Laws of thermodynamics</li> <li>• Cyclic processes and engines</li> <li>• Density, pressure, and buoyancy</li> <li>• Continuity equation</li> <li>• Bernoulli effect and equation</li> <li>• Viscosity</li> <li>• Laminar and turbulent flow</li> </ul>
Rotational motion	SL/HL	<ul style="list-style-type: none"> <li>• Torque</li> <li>• Moment of inertia</li> <li>• Rotational equilibrium</li> <li>• Conservation of angular momentum</li> </ul>
Waves I	SL/HL	<ul style="list-style-type: none"> <li>• Simple harmonic motion</li> <li>• Wave properties</li> <li>• Transverse and longitudinal waves</li> <li>• Electromagnetic waves</li> <li>• Sound waves</li> <li>• Intensity</li> <li>• Interference and superposition</li> <li>• Polarization</li> <li>• Reflection, refraction, Snell's Law</li> <li>• Total internal reflection</li> <li>• Diffraction</li> <li>• Double slit interference</li> <li>• Standing waves</li> </ul>
Waves II	HL	<ul style="list-style-type: none"> <li>• Energy changes in simple harmonic motion</li> <li>• Single slit diffraction</li> <li>• Modulation of double slit interference by single slit diffraction</li> <li>• Diffraction Gratings</li> <li>• Thin film interference</li> </ul>

		<ul style="list-style-type: none"> <li>• Aperture</li> <li>• Resolution</li> <li>• Doppler effect for sound and light waves</li> <li>• Q factor</li> <li>• Damped oscillations and driving frequency</li> <li>• Resonance</li> </ul>
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## IB Diploma Physics - Grade 12

Major Unit	HL/SL	Topics / Content
Electricity and magnetism	SL/HL	<ul style="list-style-type: none"> <li>• Electrostatics and charges</li> <li>• Coulomb's Law</li> <li>• Current, potential difference</li> <li>• Circuits</li> <li>• Resistance, resistivity, and Ohm's Law</li> <li>• Electric power</li> <li>• Cells and batteries</li> <li>• Internal resistance</li> <li>• Secondary cells</li> <li>• Emf</li> <li>• Magnetic fields and magnetic force</li> </ul>
Fields	HL	<ul style="list-style-type: none"> <li>• Gravitational and electric fields</li> <li>• Electric and gravitational potential</li> <li>• Field lines</li> <li>• Equipotential surfaces</li> <li>• Potential and potential energy and potential gradient</li> <li>• Escape speed</li> <li>• Orbital motion, speed, and energy</li> </ul>
Electromagnetic induction	HL	<ul style="list-style-type: none"> <li>• Magnetic flux and flux linkage</li> <li>• Faraday's Law of Induction</li> <li>• Lenz's Law</li> <li>• Alternating current (AC) generators</li> <li>• Transformers</li> <li>• Diode bridges</li> <li>• Full and half-wave rectification</li> <li>• Capacitance</li> <li>• Dielectric materials</li> <li>• RC circuits</li> <li>• Time constant</li> </ul>
Energy Production	SL/HL	<ul style="list-style-type: none"> <li>• Specific energy and energy density of fuel sources</li> <li>• Sankey diagrams</li> <li>• Renewable and non-renewable sources</li> <li>• Blackbody radiation</li> <li>• Solar constant</li> <li>• Albedo and emissivity</li> <li>• Energy balance of earth's surface-atmosphere system</li> </ul>
Atomic, nuclear, and particle physics	SL/HL	<ul style="list-style-type: none"> <li>• Discrete energy levels and transitions between them</li> <li>• Radioactive decay</li> <li>• Fundamental forces</li> <li>• Nuclear fission and fusion</li> <li>• Quarks, leptons, and their antiparticles</li> <li>• Hadrons, mesons, baryons</li> <li>• Conservation laws</li> <li>• Exchange particles</li> <li>• Feynman diagrams</li> <li>• Confinement</li> <li>• Higgs boson</li> </ul>

Quantum & nuclear physics	HL	<ul style="list-style-type: none"><li>● Photoelectric effect</li><li>● Matter waves</li><li>● Pair production and annihilation</li><li>● Quantization of angular momentum</li><li>● Wave function</li><li>● Uncertainty principle</li><li>● Tunneling</li><li>● Rutherford scattering</li><li>● Nuclear radius and energy levels</li><li>● Neutrinos</li></ul>
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Learn more: IB diploma physics subject brief for DP: [Standard Level](#) / [High Level](#)

## IB Diploma Chemistry - Grade 11

HL/SL	Topics / Content
SL/HL	Atomic structure (nuclear atom)
SL/HL	Stoichiometric relationships
SL/HL	Measurement and data processing (uncertainties & graphs)
SL/HL	Atomic structure (electron configuration etc.)
SL/HL	Periodicity (minus halogens & transition metals)
SL/HL	Chemical bonding & structure
SL/HL	Chemical bonding & structure (cont.)
SL/HL	Energetics/thermochemistry
SL/HL	Redox processes
SL/HL	Periodicity (halogens and transition metals)

## IB Diploma Chemistry - Grade 12

HL/SL	Topics /Content
SL/HL	Equilibrium
SL/HL	Organic chemistry
SL/HL	Acids and bases
SL/HL	Chemical kinetics
SL/HL	Measurement, data processing & analysis (spectroscopic identification)
SL/HL	Option: A. Materials B. Biochemistry C. Energy D. Medicinal chemistry
SL/HL	Individual scientific investigation
SL/HL	Review

Chemistry syllabus for DP can be found [here](#).