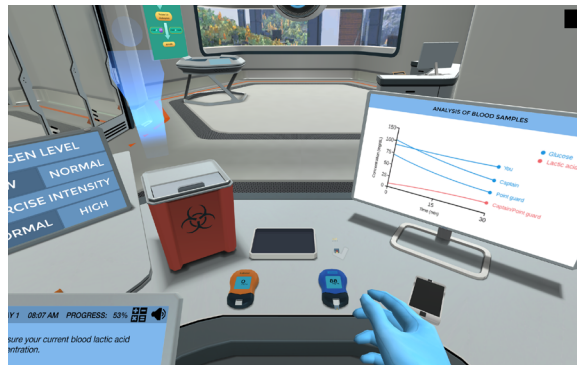
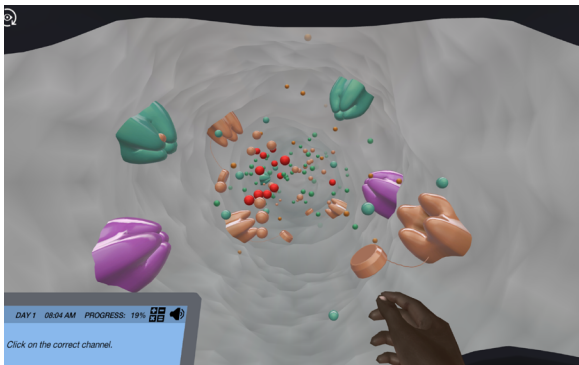
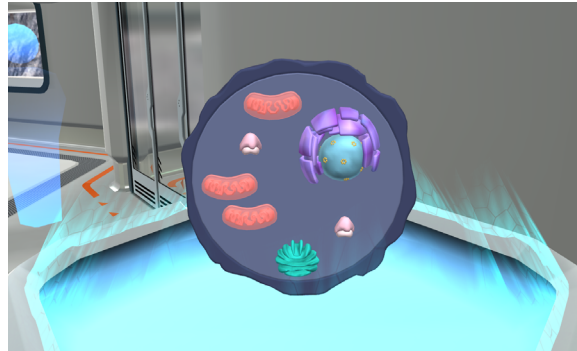
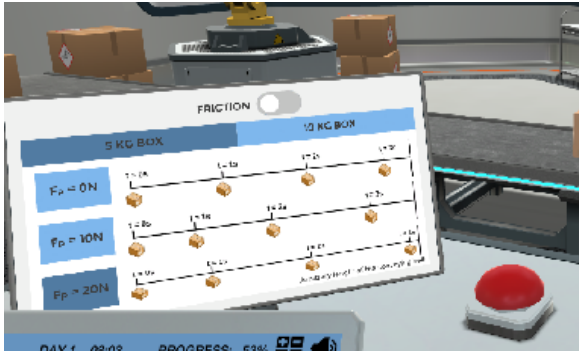


# Labster Principles (High School) Simulations Curriculum Alignment



Labster is a world-leading provider of virtual lab simulations for higher education and high schools.

The simulations are designed to let students learn by doing in a virtual laboratory, solving real-case problems. Quiz questions test the students' knowledge, supporting an inquiry-based and deep-learning approach. The students will train real lab skills in a safe virtual environment where they can safely make mistakes, and learn at their own pace.

The most basic simulations are ideal as a self-study activity since the students will review essential concepts. The more advanced simulations are designed to support the course syllabus, reinforcing concepts and giving the students an innovative tool to deepen their learning.

# Labster Principles (High School) Simulations Curriculum Alignment

## Biology

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Lab Safety</b>	Level may be too advanced for HS. With educators' guidance can be used to support many areas.	Level may be too advanced for HS. With educators' guidance can be used to support many areas.	Level may be too advanced for HS. With educators' guidance can be used to support many areas.	<ul style="list-style-type: none"> <li>• Use the correct clothing to work in the lab</li> <li>• Describe the do's and don'ts in a laboratory</li> <li>• Correctly use the lab safety equipment</li> <li>• React in an emergency situation</li> </ul>
<b>Carbohydrates</b>	HS-LS1-3 HS-LS1-6	2.3 Carbohydrates and lipids	Unit 1: Chemistry of Life	<ul style="list-style-type: none"> <li>• Understand the molecular structure of sugars and polysaccharides</li> <li>• Understand digestion and appreciate the complexity of the human body</li> <li>• Experiment with different foods and measure their impact on the blood sugar level</li> </ul>
<b>Cellular Respiration (Principles):</b> Measure energy consumption during exercise	HS-LS1-2 HS-LS1-7 HS-LS2-3	8.1 Metabolism 8.2 Cell respiration	Unit 3: Cellular Energetics	<ul style="list-style-type: none"> <li>• Analyze blood glucose and lactic acid concentrations of athletes before and after exercise</li> <li>• Outline the relationship between the cell, mitochondria and cellular respiration</li> <li>• Compare aerobic and anaerobic cellular respiration</li> <li>• Understand the role of glycolysis, the Krebs cycle and the electron transport chain in generating ATP</li> <li>• Experiment on oxygen consumption in mice at various exercise intensities</li> </ul>
<b>Cell Division:</b> Mitosis and Meiosis	HS-LS1-4 HS-LS3-1 HS-LS3-2 HS-LS3-3	1.6 Cell division 3.3 Meiosis 10.1 Meiosis	Unit 4: Cell Communication and Cell Cycle	<ul style="list-style-type: none"> <li>• Describe the role cell division plays in growth, tissue repair, and reproduction</li> <li>• Describe the principle of cell cycle regulation and control</li> <li>• Distinguish between the different stages of the cell cycle: interphase (G1, S and G2) and mitosis/meiosis</li> <li>• Model how meiosis ensures genetic diversity</li> <li>• Summarize the main events that occur in the sequential phases of mitosis and meiosis</li> <li>• Categorize outcomes of meiosis and mitosis</li> </ul>

## Biology (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Mendelian Inheritance</b>	HS-LS1-4 HS-LS3-1 HS-LS3-2 HS-LS3-3	3.4 Inheritance	5.3 Mendelian Genetics	<ul style="list-style-type: none"> <li>Explain how traits are passed on from parents to their offspring and what causes variation between siblings</li> <li>Describe Mendel's Laws of Inheritance in color deficiency</li> <li>Compare and predict the phenotypes of offspring with given genotypes using Punnett squares</li> <li>Analyze dominant and recessive alleles, and how they play a part in an individual's biological make-up</li> </ul>
<b>Evolution</b>	HS-LS4-1 HS-LS4-2 HS-LS4-3 HS-LS4-4 HS-LS4-5 HS-LS3-3	Topic 5	Big Idea 1: Evolution Unit 7: Natural Selection	<ul style="list-style-type: none"> <li>Understand how populations evolve by adapting to their environment</li> <li>Understand the basic mechanisms of evolution</li> <li>Understand evolution as the foundation of biology and show evidence for it</li> <li>Use DNA sequencing and phylogenetic trees to identify an unknown creature</li> <li>Deal with common misconceptions about the theory of evolution</li> </ul>
<b>Evolution:</b> Theory and founding principles  (Coming soon)	HS-LS4-3 HS-LS4-2 HS-LS3-1 HS-LS4-1 HS-LS4-4 Partially HS-LS3-3	1.5 The origin of cells 5.1 Evidence for evolution 5.2 Natural selection 5.3 Classification of biodiversity	Big Idea 1: Evolution	<ul style="list-style-type: none"> <li>Critically determine how evolutionary processes have contributed to contemporary life</li> <li>Describe how the theory of evolution was derived</li> <li>Explain the concepts of natural selection, genetic drift and mutation</li> <li>Apply the Hardy-Weinberg principle to demonstrate genetic variance in evolution</li> <li>Explain the evolutionary relationships linking and separating the major kingdoms of Life</li> <li>Predict the physiological and anatomical features of organisms within a kingdom and group</li> <li>Explain why viruses are not part of any kingdom</li> </ul>
<b>Marine Biology</b>	Level may be advanced for HS but aid in achieving HS-ESS3-4, HS-ESS3-6	Out of scope	Potentially too high level, but could support: Unit 8: Ecology	<ul style="list-style-type: none"> <li>Understand basic concepts of sample collection</li> <li>Perform fish necropsy and learn the information you can get from this kind of approach</li> <li>Understand the concepts of trophic levels, trophic pyramids and the energy flow in an ecosystem</li> <li>Understand the difference between heterotroph and autotroph organisms</li> <li>Analyze the level of dissolved oxygen level in your water sample using a spectrophotometer</li> <li>Understand the concepts of calibration curve, linear regression and related polation</li> </ul>

## Biology (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Biomes: Identify and create the main biomes on Earth</b>	HS-LS2-5 HS-LS2-2	4.1 Species, communities and ecosystems 4.4 Climate change C.2 Communities and ecosystems C.3 Impacts of humans on ecosystems	Unit 8: Ecology	<ul style="list-style-type: none"> <li>• Explore the definitions of ecosystems, biodiversity and habitats.</li> <li>• Define and relate biomes, ecosystems and habitat</li> <li>• Explain the basic concept of biodiversity</li> <li>• Differentiate between the different biomes</li> <li>• Relate climate and geology to the structure and biogeography of biomes and ecosystems</li> </ul>

## Biology - Related Simulations

<b>Cell Membrane and Transport: Learn how transporters keep cells healthy</b>	HS-LS1-2	1.4 Membrane transport	Unit 2: Cell Structure and Function	<ul style="list-style-type: none"> <li>• Describe the plasma membrane structure using the fluid mosaic model</li> <li>• Recognize the relative permeability of lipid bilayers to different classes of molecules</li> <li>• Compare active and passive transport of molecules</li> <li>• Identify the 3 modes of active transport and the different classes of ion channel and carrier molecules</li> <li>• Relate the expression of specific transport proteins to the cell's role</li> </ul>
<b>Antibodies</b>	Not included	11.1 Antibody production and vaccination	No Alignment  May support: Topic 4.1: Cell Communication	<ul style="list-style-type: none"> <li>• Understand the structure and function of antibodies (different isotypes and parts of an antibody)</li> <li>• Understand the formation of the antibody-antigen complex</li> <li>• Name the four major blood types (phenotypes) in the ABO system</li> <li>• Explain the principles of blood typing using Eldon cards</li> <li>• Describe rhesus incompatibility and hemolytic disease</li> </ul>
<b>Animal Genetics</b>	HS-LS3-1 HS-LS3-2	2.7 DNA replication, transcription and translation	5.4 Non-Mendelian Genetics	<ul style="list-style-type: none"> <li>• Explain different hereditary traits and modes of inheritance</li> <li>• Construct a pedigree analysis based on observed phenotypes</li> <li>• Perform genome scanning to identify candidate genes for double muscling in cattle</li> <li>• Develop a DNA test for double muscling in cattle</li> </ul>

## Biology - Related Simulations (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Bacterial Isolation</b>	Out of scope	B.1 Microbiology: organisms in industry  6.3 Defence against infectious disease	Topic 6.8: Biotechnology	<ul style="list-style-type: none"> <li>Understand the importance of bacterial growth for the investigation of pathological microorganisms</li> <li>Work under aseptic techniques</li> <li>Understand the concept of a single colony</li> <li>Perform plate-streaking techniques</li> <li>Use selective media for isolation purposes</li> </ul>
<b>Cell Structure: Cell theory and internal organelles</b>	Supports HS-LS1-4 indirectly	1.1 Introduction to cells 1.2 Ultrastructure of cells 1.3 Membrane structure	Unit 2: Cell Structure and Function	<ul style="list-style-type: none"> <li>Explain cell theory</li> <li>Describe the main differences between the prokaryotes, eukaryotes, plants and animals</li> <li>Describe the different intracellular and extracellular components forming eukaryotic cells</li> </ul>
<b>Polymerase Chain Reaction (Principles)</b>	HS-LS1-1, HS-LS3-1	2.7 DNA replication, transcription and translation 3.5 Genetic modification and biotechnology B.4 Medicine	Unit 1: Chemistry of Life	<ul style="list-style-type: none"> <li>Explain the function of DNA polymerase in DNA replication and synthesis</li> <li>Perform a PCR experiment using DNA from a blood sample as the template</li> <li>Carry out a gel electrophoresis that separates DNA according to its size</li> <li>Interpret the unique signature of the human genome and the use of tandem repeated regions (TRR) in DNA profiling</li> </ul>
<b>Competition: Learn to identify and quantify competition between species</b>	HS-ESS3-3, HS-LS2-1, HS-LS2-2, HS-LS4-2	Potentially too high level, but could support: Topic 4: Ecology Option C: Ecology and Conservation	Potentially too high level, but could support: Big Idea 4: Systems interactions Unit 8: Ecology	<ul style="list-style-type: none"> <li>Identify competition between species and quantify the strength of competition between two species</li> <li>Establish evidence of competition in an agricultural environment</li> </ul>
<b>Embryology: Discover the genetics of limb development</b>	HS-LS4-1	Topic 3: Genetics Too high level for 6.6 Hormones, homeostasis and reproduction	Topic 6.8: Biotechnology	<ul style="list-style-type: none"> <li>Window a chicken egg</li> <li>Dissect a limb bud</li> <li>Identify different Hamilton-Hamburger stages of chick development</li> <li>Analyze Next Generation Sequencing data</li> </ul>
<b>Electron Transport Chain</b>	HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4, HS-LS1-5, HS-LS2-3	8.2 Cell respiration	Unit 3: Cellular Energetics	<ul style="list-style-type: none"> <li>Understand the importance and uses of photosynthesis</li> <li>Understand the photolysis of water and electron transport</li> <li>Understand properties of light and why pigments are colorful</li> <li>Develop a hypothesis and set up an experiment to test it</li> <li>Understand how to measure the redox potential of the electron transport chain</li> </ul>

## Biology - Related Simulations (Continued)

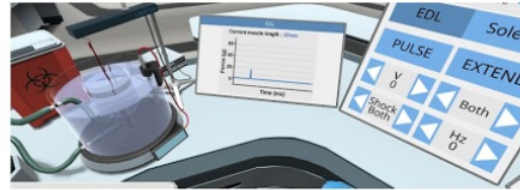
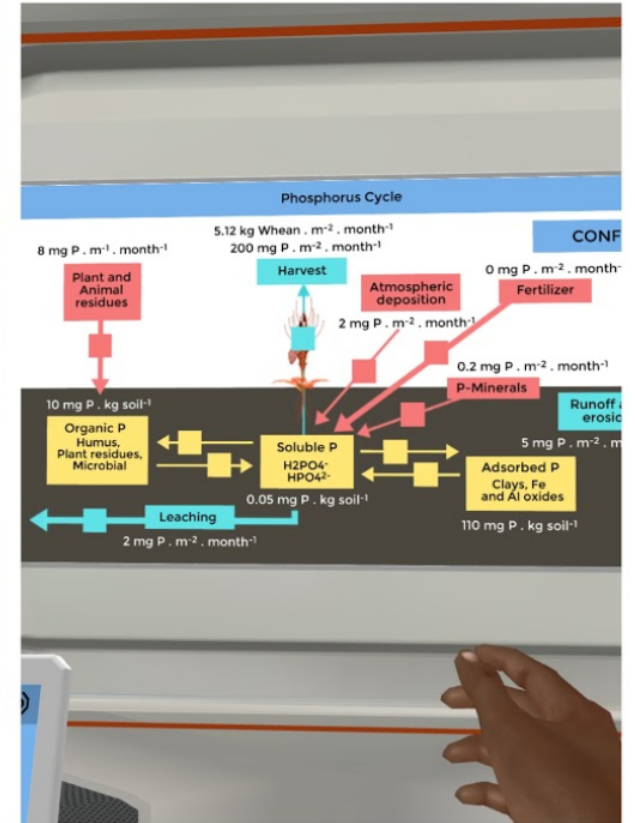
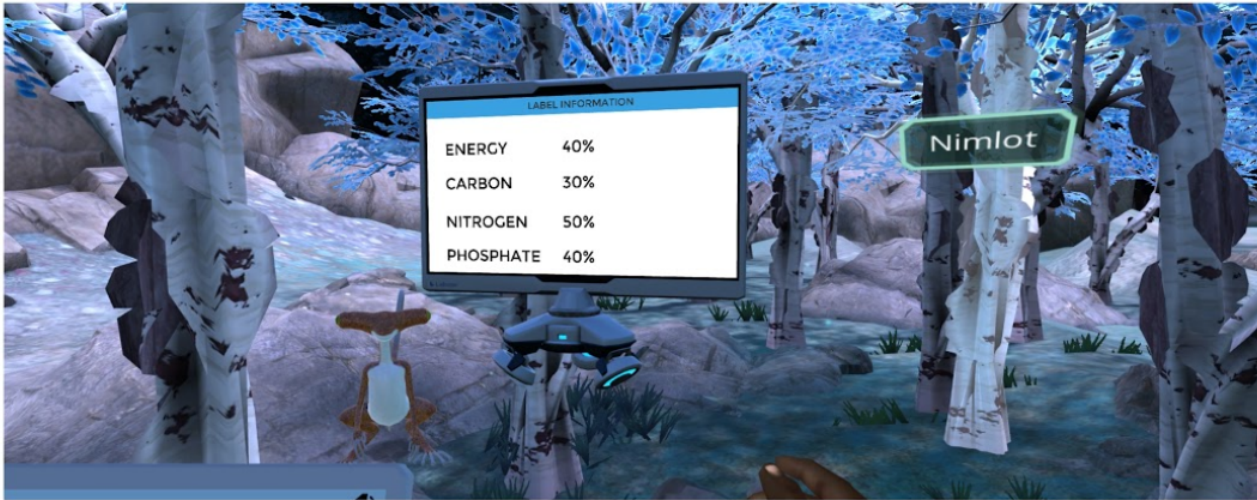
Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Eutrophication</b>	HS-ESS2-5, HS-ESS3-6, HS-ETS1-1, HS-LS2-4	4.2 Energy flow C.6 Nitrogen and phosphorus cycles	8.7 Disruption to Ecosystems	<ul style="list-style-type: none"> <li>Understand the nitrogen cycle and its importance for living beings</li> <li>Understand the concept of eutrophication and harmful algal bloom, and the impact that it has on the ecosystem</li> <li>Analyze dissolved nitrogen levels in the water sample</li> <li>Understand the importance of sampling from different locations to get representative data</li> </ul>
<b>Experimental Design</b>	Potentially too high level.	Too high level, due to storyline and topic chosen	Too high level, due to storyline and topic chosen	<ul style="list-style-type: none"> <li>Explain and apply the scientific method</li> <li>Design an experiment and test a hypothesis</li> <li>Correctly use experimental controls</li> </ul>
<b>Fermentation (Principles)</b>	HS-ETS1-1, HS-ETS1-2	B.1 Microbiology: organisms in industry 2.8: Cell Respiration	3.6: Cellular Respiration	<ul style="list-style-type: none"> <li>Understand cell growth, goals of fermentation and application to the real-world</li> <li>Understand the function and various parts of the bioreactor and auxiliary equipment</li> <li>Understand microbial growth kinetics with examples of batch and chemostat fermentations</li> <li>Understand how parameters such as pH, temperature, aeration, and agitation affects fermentation</li> <li>Perform virtual fermentations to identify optimal process conditions</li> </ul>
<b>Gene Expression Unit</b>	HS-LS3-1, HS-LS3-2	Topic 1: Cell Biology	Unit 6: Gene Expression and Regulation	<ul style="list-style-type: none"> <li>Prepare samples for Next Generation Sequencing</li> <li>Understand the principles behind the Next Generation Sequencing technique</li> <li>Perform a qPCR experiment with the proper controls</li> </ul>
<b>Introduction to Food Macromolecule</b>	HS-LS1-7	2.1 Molecules to metabolism 2.3 Carbohydrates and lipids D.1 Human nutrition D.2 Digestion	Unit 1: Chemistry of Life	<ul style="list-style-type: none"> <li>Understand the types of macromolecules found in food</li> <li>Understand the structure of carbohydrates, proteins, and lipids</li> <li>Detect macromolecules in food samples</li> </ul>
<b>Introductory Lab</b>	Not directly assessed, could support many areas depending on educators approach	Not directly assessed, but could support laboratory skill development depending on the educational approach of the educator	Not directly assessed, but could support guided inquiry principles	<ul style="list-style-type: none"> <li>Understand the basics of safety in the laboratory</li> <li>Calculate pH of strong acids, weak acids, strong bases and weak bases</li> <li>Understand how acid dissociates in water</li> <li>Understand the principle of diffusion and osmosis</li> <li>Understand the different blood type groups and how to perform a blood type test</li> </ul>

## Biology - Related Simulations (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Trophic Levels: Grazer vs. predator</b>	HS-LS2-3 Partially HS-LS2-6	4.1 Species, communities and ecosystems 4.2 Energy flow 4.3 Carbon cycling C.2 Communities and ecosystems	Unit 8: Ecology	<ul style="list-style-type: none"> <li>Define trophic levels, food webs and ecological pyramids</li> <li>Elaborate on definitions of autotrophic, heterotrophic and mixotrophic organisms.</li> <li>Differentiate between food chains and food webs</li> <li>Explain how energy flows between different trophic levels and how this impacts ecosystem structure</li> <li>Predict how pests and parasites fit into trophic systems</li> </ul>
<b>Meiosis: Understand how traits are inherited</b>	Potentially HS-LS3-1, may be too high level (phases of mitosis out of scope)	10.1 Meiosis 3.3 Meiosis	Unit 5: Heredity	<ul style="list-style-type: none"> <li>Outline how traits are inherited</li> <li>Use the microscope to observe the phases of meiosis and understand their main characteristics</li> <li>Compare phases and outcomes of mitosis and meiosis</li> <li>Evaluate how meiosis and mitosis build and maintain a complex organism</li> <li>Understand the basics of assisted reproduction technology</li> </ul>
<b>Microscopy</b>	Not directly assessed, could support many areas depending on educators approach	1.1 Introduction to cells* 1.2 Ultrastructure of cells	Unit 2: Cell Structure and Function	<ul style="list-style-type: none"> <li>Understand different microscopy techniques and their limitations</li> <li>Identify various cell types and cellular structures</li> <li>Understand coeliac disease and intestinal inflammation</li> <li>Understand staining techniques</li> </ul>
<b>Mitosis: Using a toxic compound from the yew tree in cancer therapy</b>	HS-LS1-4	1.6 Cell Division	Topic 4.6: Cell Cycle	<ul style="list-style-type: none"> <li>Understand and visualize basic concepts about eukaryotic cells such as main cellular components and DNA packaging by immersive animations</li> <li>Understand the key characteristics of the cell cycle 's different stages: interphase (G1, S and G2) and mitosis</li> <li>Use different microscopy techniques to observe the different phases of the mitosis (Prophase, Metaphase, Anaphase, Telophase) and describe their main characteristics</li> <li>Explain the cell cycle checkpoints and name the molecules that control them (cyclins and cyclin-dependent kinases) and their function</li> <li>Describe the main differences between mitosis and meiosis</li> </ul>
<b>Pigment Extraction</b>	HS-ESS3-2, HS-ESS3-3, HS-ESS3-4	2.9: Photosynthesis	Topic 2.2: Cell Structure and Function	<ul style="list-style-type: none"> <li>Understand the importance and uses of photosynthesis</li> <li>Understand properties of light and why pigments are colorful</li> <li>Analyze the absorbance spectra and chemical properties of pigments</li> <li>Develop a hypothesis and set up an experiment to test it</li> </ul>

## Biology - Related Simulations (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Pipetting: Master the Technique</b>	Not directly assessed, could support many areas depending on educators approach	Not directly assessed, could lab skill development depending on educators approach	Not directly assessed, but will support guided inquiry and developing science practices	<ul style="list-style-type: none"> <li>Select the correct micropipette for its purpose</li> <li>Use the two stops of the pipette</li> <li>Explain pipetting techniques</li> <li>Perform a serial dilution</li> <li>Quantify the protein content in a sample with a Bradford assay</li> </ul>
<b>Plant Reproduction</b> (Coming soon)	HS-LS4-2  Potentially HS-LS4-2	9.1 Transport in the xylem of plants 9.2 Transport in the phloem of plants 9.3 Growth in plants 9.4 Reproduction in plants	Unit 8: Ecology	<ul style="list-style-type: none"> <li>Identify components of angiosperm reproductive system and the process of seed generation</li> <li>Identify components of the gymnosperms reproductive system and the process of cone generation</li> <li>Broadly compare the reproductive mechanisms of the other phyla to angiosperms and gymnosperms</li> </ul>
<b>Protein Synthesis</b>	HS-LS1-1	2.4 Proteins  2.7 DNA replication, transcription and translation	Big Idea 2: Energetics  Unit 6: Gene Expression and Regulation	<ul style="list-style-type: none"> <li>Understand the translation process from mRNA to amino acid</li> <li>Understand the post-translational modification</li> <li>Understand the protein synthesis processing in the ribosome</li> <li>Understand the primary, secondary, tertiary and quaternary structures of protein</li> <li>Understand the basic principles of mass spectrometry (MALDI-TOF)</li> </ul>
<b>Spatial Ecology: Learn how the environment can influence the distribution of species</b>	HS-ESS3-2, HS-ESS3-3, HS-ESS3-4, HS-LS2-1, HS-LS2-2, HS-LS2-7	C.1 Species and communities	Potentially too high level, but could support:  Unit 8: Ecology	<ul style="list-style-type: none"> <li>Map the distribution of species over a region and identify hotspots for biodiversity.</li> <li>Relate patterns of biodiversity to abiotic or anthropogenic conditions.</li> <li>Describe and explain gradients in abiotic factors in an area.</li> </ul>
<b>Signal Transduction</b>	Out of Scope	6.6: Hormones, Homeostasis and Reproduction	Unit 4: Cell Communication and Cell Cycle	<ul style="list-style-type: none"> <li>Explain the principles and importance of intracellular signal transduction</li> <li>Explain receptor tyrosine kinase (RTK) cell signaling</li> <li>Analyze dysregulated signal transduction in human cancer cells</li> <li>Understand the connection between angiogenesis and tumor growth</li> <li>Investigate the involvement of vascular endothelial growth factor receptor (VEGFR) signaling in human breast cancer</li> </ul>



# Chemistry

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Atomic Structure:</b> Atoms and isotopes	HS-PS1-1	2.1 The nuclear atom 2.2 Electron configuration	1.5 Atomic Structure and Electron Configuration	<ul style="list-style-type: none"> <li>Explain the concept of an atom</li> <li>Explain the properties of the basic subatomic particles: protons, neutrons, and electrons</li> <li>Use of the nuclear symbol notation to deduce the number of protons, neutrons and electrons in atoms and ions.</li> <li>Define atomic number and atomic mass</li> <li>Define isotopes and explain how they relate to naturally occurring element mass</li> <li>Describe how the atomic number and atomic mass apply to isotopes</li> </ul>
<b>Atomic Structure:</b> Bohr and quantum models	HS-PS1-1	2.1 The nuclear atom 2.2 Electron configuration	1.5 Atomic Structure and Electron Configuration	<ul style="list-style-type: none"> <li>Compare and contrast the Bohr Model and the quantum model of the atom</li> <li>Describe how the electron configuration relates to the orbitals of an atom</li> <li>Describe how the atomic emission spectra are produced using the Bohr model to explain this natural phenomena</li> <li>Discuss de Broglie's role in the development of the quantum model of the atom</li> <li>Explain how the Heisenberg uncertainty principle and the Schrodinger wave equation led to the idea of atomic orbitals</li> <li>List the four quantum numbers and describe their significance</li> </ul>
<b>Stoichiometric Calculations:</b> Identify a compound using gravimetric analysis	HS-PS1-1 HS-PS1-2	1.1 Introduction to the particulate nature of matter and chemical change 1.2 The mole concept 1.3 Reacting masses and volumes	1.1 Moles and Molar Mass 1.3 Elemental Composition of Pure Substances 4.1 Introduction for Reactions 4.2 Net Ionic Equations 4.3 Representation of Reactions 4.5 Stoichiometry	<ul style="list-style-type: none"> <li>Explain the relationship between mass, molecular weight, and numbers of atoms or molecules and perform calculations deriving these quantities from one another</li> <li>Perform mass-to-mass stoichiometric calculations via conversions to mole</li> <li>Identify the limiting and excess reagents in a chemical reaction</li> <li>Calculate the theoretical, actual and percent reaction yield</li> <li>Define Avogadro's number and describe the mole quantification of matter</li> </ul>
<b>Periodic Table (Principles):</b> Get the table organized in time	HS-PS1-1 HS-PS1-2	3.1 Periodic table 3.2 Periodic trends	1.7 Periodic Trends 1.8 Valence Electrons and Ionic Compounds	<ul style="list-style-type: none"> <li>Describe the structure and organization of the periodic table</li> <li>Classify elements of a family based on their location in the periodic table</li> <li>Distinguish metals from other element classes based on typical characteristics</li> <li>Use the flame color test to identify metals based on their position in the periodic table</li> <li>Relate valence electrons and oxidation state of a main group element to its position in the periodic table</li> <li>Describe the main trends among groups and periods for atomic properties</li> <li>Explain the causes on the atomic level for the main trends among groups and periods concerning atomic radii, ionization energy and electronegativity</li> </ul>

## Chemistry (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Ionic and Covalent Bonds</b>	HS-PS1-1 HS-PS2-6	4.1 Ionic bonding and structure 4.2 Covalent bonding 4.3 Covalent structures	2.1 Types of Chemical Bonds 2.3. Structure of Ionic Solids 2.5 Lewis Diagrams	<ul style="list-style-type: none"> <li>Describe the formation of ionic and covalent bonds</li> <li>Identify anions and cations</li> <li>Apply the octet rule</li> <li>Describe ionic lattice structure</li> <li>Draw Lewis dot structures</li> <li>Explain the formation of single, double, and triple bonds</li> <li>Distinguish between ionic compounds and covalent compounds</li> </ul>
<b>Matter and Phase Changes:</b> Distill ethanol	HS-PS1-3 HS-PS1-4 HS-PS1-5	4.4 Intermolecular forces	2.2 Intramolecular Force and Potential Energy 3.1 Intermolecular Forces 3.2 Properties of Solids 3.3 Solids, Liquids, and Gases 4.4 Physical and Chemical Changes 6.5 Energy of Phase Changes	<ul style="list-style-type: none"> <li>Explain solid, liquid, and gas states in terms of particle interaction and bonding energy</li> <li>Describe and explain the characteristics of a phase change</li> <li>Read a phase diagram and explain each region</li> <li>Interpret a heating curve of a given substance</li> <li>Explain the difference between a heating curve and a phase diagram, and the difference between specific heat and latent heat</li> <li>Understand the basic steps of performing a distillation</li> <li>Distinguish between physical and chemical properties of matter and classify changes of matter as physical or chemical</li> <li>Name the main phase changes: boiling, evaporation, freezing, melting, and sublimation</li> </ul>
<b>Solution Preparation:</b> From salt to solution	HS-PS1-3 HS-PS1-2 HS-PS1-4 HS-PS1-5	1.3 Reacting Masses and Volumes	3.8 Representations of Solutions	<ul style="list-style-type: none"> <li>Prepare an aqueous solution of a specific concentration from a pure salt</li> <li>Correctly use an analytical balance, a volumetric pipette, a volumetric flask, and a measuring cylinder</li> <li>Explain the relationship between molarity and mass concentration</li> </ul>
<b>Acids and Bases (Principles):</b> Acidity and alkalinity in everyday substances	HS-PS1-2 HS-PS1-5	8.1 Theories of acids and bases 8.2 Properties of acids and bases 8.3 The pH scale	4.8 Introduction to Acid-Base Reactions 8.1 Introduction to Acids and Bases 8.2 pH and pOH of Strong Acids and Bases	<ul style="list-style-type: none"> <li>Understand pH</li> <li>Interpret the acidity of a solution</li> <li>Define an acid and a base</li> <li>Explain how pOH and pH relate</li> <li>Understand how different everyday solutions have different pH</li> </ul>
<b>Redox Reactions</b>	HS-PS1-2 HS-PS1-5	9.1 Oxidation and reduction	4.9 Oxidation-Reduction (Redox) Reactions	<ul style="list-style-type: none"> <li>Describe the concept of oxidation states and explain trends in the periodic table</li> <li>Apply the rules for determining oxidation states</li> <li>Describe the role of the electron in reduction-oxidation</li> <li>Describe and give examples of common redox reactions</li> <li>Identify in a redox reaction which species are being oxidized and reduced</li> <li>Represent a balanced redox reaction equation for a given chemical phenomena using half-equations (under both acidic and basic conditions)</li> <li>Predict the direction of redox reactions using Activities Series</li> </ul>

## Chemistry (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<p><b>Titration:</b> Neutralize an acid lake contamination</p>	<p>HS-PS1-6 HS-PS1-7</p>	<p>1.3 Reacting Masses and Volumes 8.2 Properties of Acids and Bases 8.3 The pH Scale</p>	<p>4.6 Introduction to Titration 8.5 Acids-Base Titrations</p>	<ul style="list-style-type: none"> <li>Assemble the apparatus required for titration</li> <li>Describe the function of each part of the titration apparatus</li> <li>Explain the general steps of a colorimetric acid-base titration and its uses</li> <li>Perform a titration experiment</li> <li>Describe the role of the 3 main reagents used in a titration: sample, titrant, and indicator</li> <li>Explain what is the endpoint of a titration and the role of the indicator</li> <li>Explain why the use of high-precision volumetric material is essential for a titration</li> <li>Calculate the concentration of the titrated solution from the results of the titration experiment</li> </ul>
<p><b>Reaction Kinetics</b></p>	<p>HS-PS1-3 HS-PS1-4 HS-PS1-5</p>	<p>6.1 Collision theory and rates of reaction</p>	<p>Unit 5: Kinetics</p>	<ul style="list-style-type: none"> <li>Explain the factors that influence the rate of a chemical reaction (reactant concentration, temperature, solvent, catalysts).</li> <li>Determine the reaction rate of simple reactions by examining concentration data over time.</li> <li>Describe the relationship between temperature and reaction rate, and explain the related concepts of collision theory and activation energy (<math>E_a</math>).</li> <li>Explain the individual mechanistic steps of a simple reaction and the relevant terminology (molecularity, reaction intermediates, transition states)</li> <li>Interpret reaction energy diagrams and relate them to energy changes during the course of a reaction.</li> <li>Suggest a suitable experimental setup for measuring the kinetics of a reaction.</li> </ul>
<p><b>Basic Chemistry Thermodynamics:</b> Solve the challenge of storing renewable energy</p>	<p>HS-PS3-1 HS-PS3-2 HS-PS3-3 HS-PS3-4 HS-PS2-1 HS-PS2-2</p>	<p>5.1 Measuring energy changes 5.2 Hess's Law 5.3 Bond enthalpies</p>	<p>6.1 Endothermic and Exothermic Processes 6.2 Energy Diagrams 6.3 Heat Transfer and Thermal Equilibrium 6.4 Heat Capacity and Calorimetry 6.6 Introduction to Enthalpy of Reaction 6.7 Bond Enthalpies 6.8 Enthalpy of Formation 6.9 Hess's Law 9.3 Gibbs Free Energy and Thermodynamic Favorability 9.5 Free Energy and Equilibrium</p>	<ul style="list-style-type: none"> <li>Define the core thermodynamics concepts of entropy, enthalpy, and free Gibbs energy, and their units</li> <li>Explain the first and second laws of thermodynamics</li> <li>Understand and apply the concept of reaction spontaneity</li> <li>Explain the differences between the enthalpy of combustion, and enthalpy of formation</li> <li>Understand the relationship between internal energy and enthalpy</li> <li>Present Hess's law in connection with performing enthalpy change calculations</li> <li>Present the concepts of exothermic and endothermic reactions</li> </ul>

## Chemistry (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Equilibrium</b>	HS-PS1-6	7.1 Equilibrium	7.1 Introduction to Equilibrium 7.2 Direction of Reversible Reactions 7.3 Reaction Quotient and Equilibrium Constant 7.4 Calculating the Equilibrium Constant 7.5 Magnitude of the Equilibrium Constant 7.6 Properties of the Equilibrium Constant 7.7 Calculating Equilibrium Concentrations 7.8 Representations of Equilibrium 7.9 Introduction to Le Châtelier's Principle 7.10 Reaction Quotient and Le Châtelier's Principle	<ul style="list-style-type: none"> <li>• Predict the directionality of reversible reactions according to Le Chatelier</li> <li>• Calculate the equilibrium constant and reaction quotient</li> <li>• Understand the Haber process</li> </ul>
<b>Lab Safety</b>	Level may be too advanced for HS. With educators' guidance can be used to support many areas.	Level may be too advanced for HS. With educators' guidance can be used to support many areas.	Level may be too advanced for HS. With educators' guidance can be used to support many areas.	<ul style="list-style-type: none"> <li>• Use the correct clothing to work in the lab</li> <li>• Describe the do's and don'ts in a laboratory</li> <li>• Correctly use the lab safety equipment</li> <li>• React in an emergency situation</li> </ul>



# Chemistry - Related Simulations

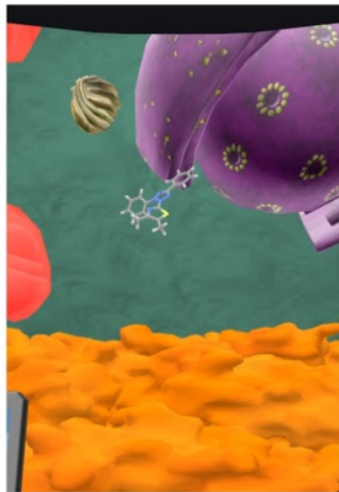
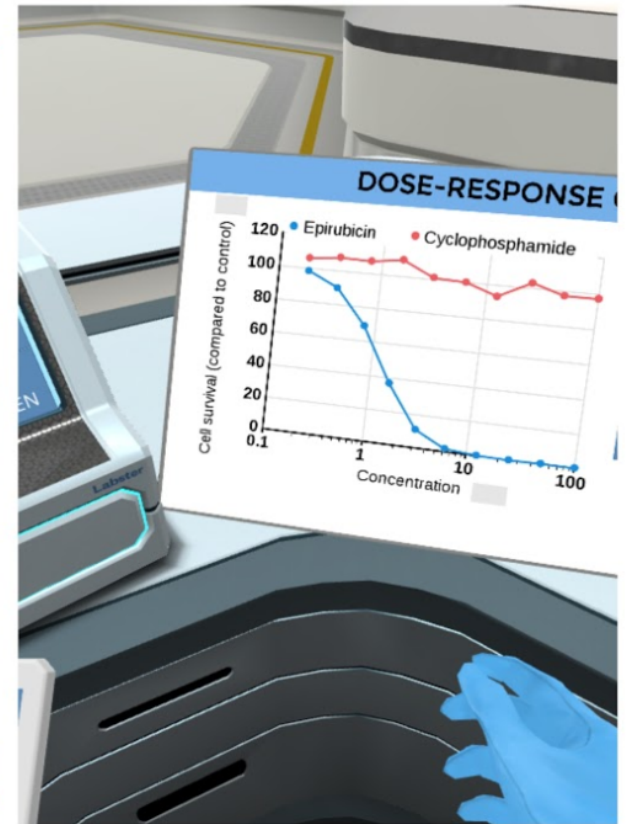
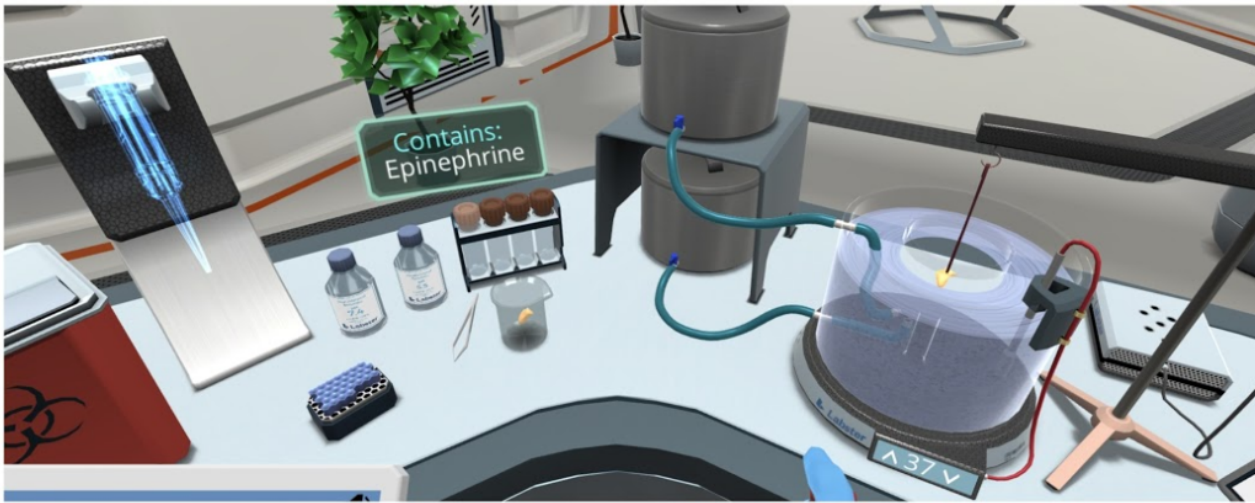
Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Advanced Acids and Bases</b>	HS-PS1-2, HS-PS1-5	8.4 Strong and weak acids and bases	8.3 Weak Acid and Base Equilibria 8.4 Acid-Base Reactions and Buffers 8.7 pH and pKa	<ul style="list-style-type: none"> <li>Calculate the pH of weak acids and bases</li> <li>Illustrate the reactions of weak acids and bases</li> <li>Categorize acids and bases based on their strength</li> <li>Prepare various types of salts through neutralization</li> <li>Review the concept of the acid dissociation constant (<math>K_a</math>) and its logarithmic form (pKa)</li> </ul>
<b>Organic Chemistry Introduction: Learn about organic compounds</b>	HS-PS1-3, HS-PS1-6	10.1 Fundamentals of organic chemistry 10.2 Functional group chemistry 20.1 Types of organic reactions	Unit 2: Ionic Compounds Structure and Properties	<ul style="list-style-type: none"> <li>Give examples of uses of organic compounds</li> <li>Identify the carbon valence electrons and the hybridization of their orbitals</li> <li>Predict the angles of covalent bonds of carbon atoms in hydrocarbons</li> <li>Apply the nomenclature of simple hydrocarbons</li> <li>Interpret some of the important representations of hydrocarbons</li> <li>Give examples of functional groups of organic compounds and their reactions</li> </ul>
<b>Chemistry Safety</b>	Basic Safety Rules	Support The Laboratory Safety Institute's Laboratory Safety Guidelines stated in the curriculum	Basic lab safety instruction should be an integral	<ul style="list-style-type: none"> <li>Understand how to create biodiesel from algal oil</li> <li>Identify the hazards posed by chemicals and how to handle them</li> <li>React quickly and save lives in case of a fire emergency</li> <li>Use the CAS numbers to plan your experiment</li> <li>Understand how to dispose of halogenated and non-halogenated waste</li> <li>Lookup H and P phrases in the safety data sheet</li> <li>Safely use a chemical fume hood</li> </ul>
<b>Flow Injection Analysis</b>	HS-PS1-3, HS-PS2-6	B.9 Biological Pigments	3.9 Separation of Solutions and Mixtures Chromatography	<ul style="list-style-type: none"> <li>Measure caffeine concentration in different samples using the Flow Injection Analysis (FIA) technique</li> <li>Describe the importance of the different parts of the FIA machine (e.g. the spectrophotometer, the pump, or the mixing coil)</li> <li>Describe the advantages of the FIA method</li> <li>Calculate the velocity at which a sample will be eluted</li> <li>Prepare sample dilutions and standard curves</li> <li>Interpret the results from a FIA experiment</li> <li>Determine the concentration of an unknown caffeine sample by using the standard curve</li> </ul>

## Chemistry - Related Simulations (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Ideal Gas Law</b>	HS-PS1-7	3.1 – Thermal concepts 3.2 – Modelling a gas	3.4 Ideal Gas Law	<ul style="list-style-type: none"> <li>• Explain the physical concepts of temperature and absolute zero</li> <li>• Define the relationship between pressure, volume and temperature in gases using gas thermometry</li> <li>• Apply the Ideal Gas Law</li> </ul>
<b>HPLC</b>	HS-PS1-3, HS-PS2-6	B.9 Biological Pigments	3.9 Separation of Solutions and Mixtures Chromatography	<ul style="list-style-type: none"> <li>• Understand the different compartments of an HPLC machine and functions</li> <li>• Understand the principles of HPLC separation</li> <li>• Understand the lipophilic interaction between the analyte and the mobile and stationary phase</li> <li>• Understand the different changes in parameters (such as the column, mobile phase, temperature etc.) and its effects on analyte separation and concentration measurements</li> </ul>
<b>Kjeldahl Method</b>	HS-PS1-3, HS-PS2-6	B.2 Proteins and enzymes	3.9 Separation of Solutions and Mixtures Chromatography	<ul style="list-style-type: none"> <li>• Describe the steps involved in the Kjeldahl method</li> <li>• Analyze the nitrogen content of a food sample</li> <li>• Calculate the protein content of a sample from the determined nitrogen content</li> <li>• Explain why the Kjeldahl method cannot be used to identify milk powder that was cut with melamine</li> <li>• Apply the principles of spiking and recovery in analytical chemistry</li> <li>• Interpret basic LC-MS/MS data</li> <li>• Describe the fundamentals of an LC-MS/MS analysis</li> <li>• Argue whether food fraud has been conducted based on available data</li> </ul>
<b>Organic Chemistry Reactivity Rules: Time to react!</b>	HS-PS1-2,HS-PS1-4	10.1 Fundamentals of organic chemistry 10.2 Functional group chemistry 20.1 Types of organic reactions	Unit 4. Chemical Reactions	<ul style="list-style-type: none"> <li>• Explain the concept of electronegativity and how the distribution of electrons across a molecule determines its reactivity</li> <li>• Describe what a nucleophile, electrophile and leaving group are, and identify them</li> <li>• Describe an organic chemical reaction and its mechanism using the correct terminology and notations (lonepairs, curly arrows, reactants, reagents, products, catalysts, intermediates, transition states)</li> <li>• Draw reaction mechanisms using the correct notations</li> <li>• Explain the differences between the three fundamental types of reactions: Addition, elimination and substitution</li> <li>• Describe the typical reactivity of the main functional groups</li> </ul>

## Chemistry - Related Simulations (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Organic Chemistry Introduction: Carbon Valence, Hybridization and Angles</b> (Coming soon)	HS-PS1-3, HS-PS1-6	10.1 Fundamentals of organic chemistry 10.2 Functional group chemistry 20.1 Types of organic reactions	Unit 2: Ionic Compounds Structure and Properties	<ul style="list-style-type: none"> <li>• Give examples of uses of organic compounds</li> <li>• Identify the carbon valence electrons and the hybridization of their orbitals</li> <li>• Predict the angles of covalent bonds of carbon atoms in hydrocarbons</li> </ul>
<b>Organic Chemistry Introduction: Hydrocarbon Nomenclature and Representations</b> (Coming soon)	HS-PS1-3, HS-PS1-6	10.1 Fundamentals of organic chemistry 10.2 Functional group chemistry 20.1 Types of organic reactions	Unit 2: Ionic Compounds Structure and Properties	<ul style="list-style-type: none"> <li>• Give examples of uses of organic compounds</li> <li>• Identify the carbon valence electrons and the hybridization of their orbitals</li> <li>• Predict the angles of covalent bonds of carbon atoms in hydrocarbons</li> </ul>
<b>Organic Chemistry Introduction: Functional Groups and Basic Chemical Tests</b> (Coming soon)	HS-PS1-3, HS-PS1-6	10.1 Fundamentals of organic chemistry 10.2 Functional group chemistry 20.1 Types of organic reactions	Unit 2: Ionic Compounds Structure and Properties	<ul style="list-style-type: none"> <li>• Apply the nomenclature of simple hydrocarbons</li> <li>• Interpret some of the important representations of hydrocarbons</li> </ul>



# Physics

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Electromagnetic Spectrum:</b> Discover the uses and dangers of electromagnetic waves	HS-PS4-1 HS-PS4-4 HS-PS4-5	4.2 – Travelling waves 4.4 – Wave behaviour	10.1 Properties of Waves (this module is mainly part of AP physics 2)	<ul style="list-style-type: none"> <li>Use the electromagnetic spectrum to classify waves based on their wavelength and frequency</li> <li>Examine the relationships among the frequency, wavelength, and speed of waves</li> <li>Evaluate the damage to living cells by electromagnetic radiation</li> </ul>
<b>Wave Model of Light:</b> Use reflection and refraction to take the perfect photo	HS-PS4-3 HS-PS4-4 HS-PS4-5	4.4 – Wave behaviour	10.1 Properties of Waves	<ul style="list-style-type: none"> <li>Understand the wave/particle duality of light and how it explains the different features of electromagnetic radiation</li> <li>Apply the law of reflection and refraction to predict how light interacts with interfaces</li> </ul>
<b>Springs and Masses (Principles):</b> Learn how to detect and record earthquakes	HS-PS4-1 HS-PS3-3 HS-ETS1-2 HS-ETS1-4 HS-ESS2-2	2.1 – Motion 4.1 – Oscillations	6.1 Period of Simple Harmonic Oscillators 6.2 Energy of a Simple Harmonic Oscillator 10.1 Properties of Waves 10.2 Periodic Waves	<ul style="list-style-type: none"> <li>Understand the motion of a mass oscillating on a vertical spring</li> <li>Determine the equilibrium position of a vertical oscillator</li> <li>Understand the basic properties of Simple Harmonic Motion</li> <li>Understand Hooke's law in relation to a spring-mass system</li> <li>Determine the magnitude and epicenter of an earthquake from a seismogram</li> </ul>
<b>Vectors and Scalars:</b> Guide two astronauts on a mission to Mars	HS-PS2-1	1.3 – Vectors and scalars 2.1 – Motion	1.1 Position, Velocity, and Acceleration 3.1 Vector Fields	<ul style="list-style-type: none"> <li>Describe the difference between vector and scalar quantities</li> <li>Identify the magnitude and direction of a vector</li> <li>Determine the product of two vectors</li> <li>Define the components of a vector</li> </ul>
<b>Forces and Free-body Diagrams:</b> Learn how to navigate a drone	HS-ETS1-2 HS-PS2-1	2.2 – Forces	2.3 Contact Forces 2.5 Newton's Third Law and Free-Body Diagrams 3.2 Fundamental Forces 3.7 Free-Body Diagrams for Objects in Uniform Circular Motion	<ul style="list-style-type: none"> <li>Draw and interpret free-body force diagrams to represent forces</li> <li>Understand the concept of center of gravity of an extended body</li> <li>Determine the net force exerted on a body</li> </ul>
<b>Newton's Laws of Motion:</b> Understand active and passive safety in motorsports	HS-ETS1-2 HS-PS2-1	2.2 – Forces	2.4 Newton's First Law 2.5 Newton's Third Law and Free-Body Diagrams 2.6 Newton's Second Law 2.7 Applications of Newton's Second Law 3.7 Free-Body Diagrams for Objects in Uniform Circular Motion	<ul style="list-style-type: none"> <li>Describe Newton's first law</li> <li>Define inertia and frames of reference</li> <li>Derive Newton's second law</li> <li>Identify the action and reaction forces in different situations</li> </ul>

## Physics (Continued)

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Basic Electricity:</b> Understand how electricity works	HS-PS3-5	5.1 – Electric fields	8.1 Conservation of Charge 8.2 Electric Charge 9.1 Definition of a Circuit	<ul style="list-style-type: none"> <li>Define the concepts of charge, voltage, current, and their units</li> <li>Describe the flow of current and electrons in a circuit</li> <li>Define the essential components of a basic electric circuit</li> <li>Build a functional basic electric circuit</li> <li>Apply the principles of charge and energy conservation to a basic circuit</li> </ul>
<b>Electrical Resistance:</b> Apply Ohm's law to simple circuits	HS-PS3-5 HS-ETS1-2	5.2 – Heating effect of electric currents	9.1 Definition of a Circuit 9.2 Resistivity 9.3 Ohm's Law, Kirchhoff's Loop Rule (Resistors in Series and Parallel)	<ul style="list-style-type: none"> <li>Define the concepts of resistivity and resistance</li> <li>Explain how resistance is affected by length, width, type of material, and temperature</li> <li>Apply Ohm's law to simple circuits</li> <li>Determine the effect of combining resistances in series and parallel</li> <li>Apply the principles of charge and energy conservation to more advanced circuits</li> </ul>
<b>Conservation of Energy:</b> maximize the mechanical energy of a rollercoaster	HS-PS3-1 HS-PS3-3 HS-PS3-4 HS-ETS1-2	2.3 – Work, energy and power	4.1 Open and Closed Systems: Energy 4.2 Work and Mechanical Energy 4.3 Conservation of Energy, the Work-Energy Principle, and Power	<ul style="list-style-type: none"> <li>Define the mechanical energy of an isolated system</li> <li>Separate conservative from nonconservative forces</li> <li>Define the mechanical energy of a body</li> <li>Explain the conservation of mechanical energy</li> <li>Apply conservation of energy to describe the movement of a body</li> <li>Use the equations for kinetic and potential energy, related to velocity and displacement</li> <li>Identify sources of energy and energy transformation</li> </ul>

## Physics - Related Simulations

Simulation Name	Next Generation Science Standard (NGSS)	International Baccalaureate (IB) Curriculum	Advanced Placement Curriculum	Learning Objectives
<b>Law of Universal Gravitation:</b> Use gravity to orbit the moon	HS-PS2-4, HS-ESS1-4	2.2 – Forces 6.1 – Circular motion 6.2 – Newton's law of gravitation	2.2 The Gravitational Field 3.3 Gravitational and Electric Forces 3.8 Applications of Circular Motion and Gravitation 3.4 Gravitational Field/Acceleration Due to Gravity on Different Planets 6.1 Period of Simple Harmonic Oscillators	<ul style="list-style-type: none"> <li>Understand the difference between weight and mass.</li> <li>Measure gravitational acceleration near the Earth's surface.</li> <li>Describe the mechanism for circular orbits.</li> <li>Describe the distance dependence of g.</li> <li>Distinguish between bound and unbound trajectories</li> </ul>

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