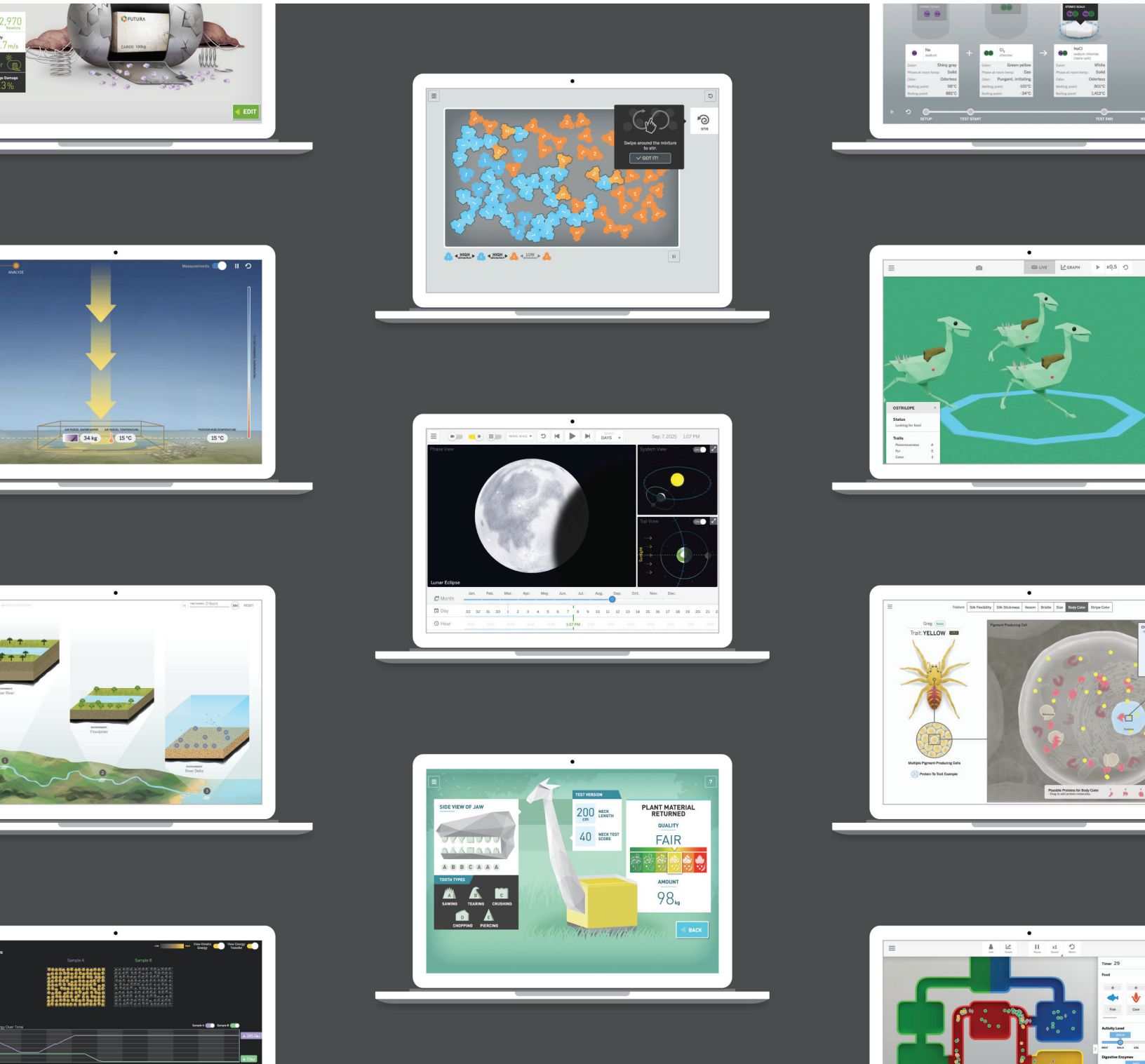
Amplify Science

Digital simulations in Grades 4–8



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Table of contents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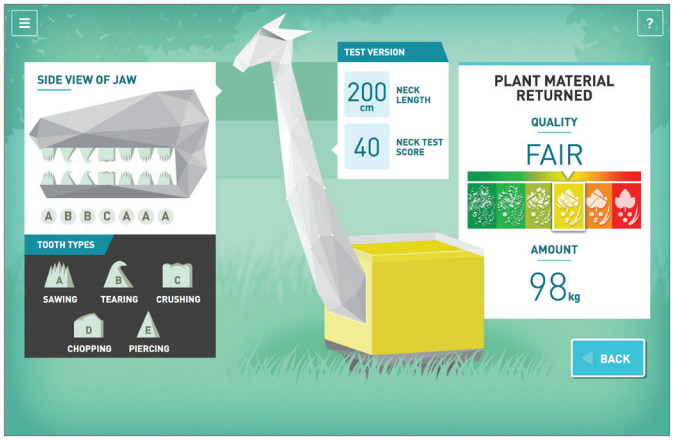
Introduction

Developed exclusively for Amplify Science, digital simulations, or "sims," are interactive, virtual worlds that allow students to discover and construct understanding of science concepts and phenomena. Sims provide students with opportunities to explore scientific phenomena that might otherwise be challenging to investigate in a classroom because they are too small, large, slow, distant, dangerous, or difficult to manipulate directly. Much like real scientists do, students in Amplify Science use technology to explore and investigate phenomena, observe and identify relationships, model processes, make predictions, gather evidence, and apply their understanding of science concepts.

Environments and Survival

Grade 3

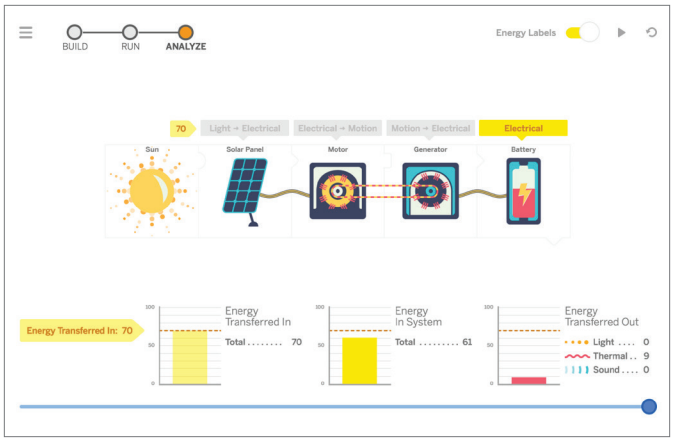
The Environments and Survival sim (also known as RoboGrazer) is an interactive design app that allows students to make, test, and revise their designs for a robot that can remove and grind up invasive plants.



Energy Conversions

Grade 4

The Energy Conversions sim allows students to set up, modify, and compare different energy system configurations in order to explore different energy sources and investigate how energy changes as it moves through a system.



Vision and Light

Grade 4

The Vision and Light sim allows students to observe the movement of light and discover how light allows animals to see. Students are able to visualize how a predator sees and recognizes prey by changing the amount of light released, the direction of light released, and the size of the predator's pupil.

Earth's Features

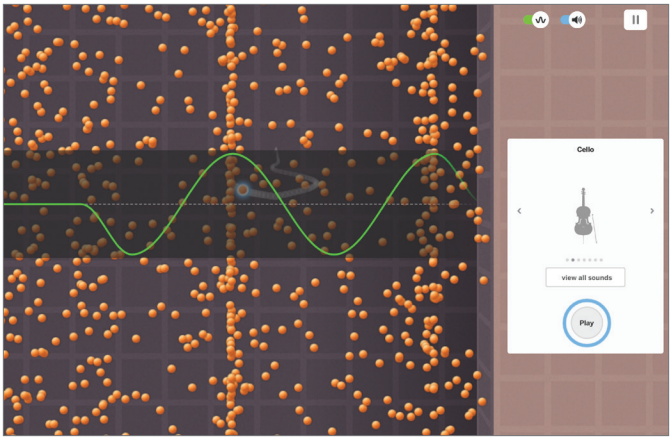
Grade 4

The Earth's Features sim is a dynamic model that shows the processes of rock and fossil formation through the accumulation and compression of sediment over time. The sim allows students to see how different sediment accumulates in different environments, leading to the formation of different rock layers in those environments. It also models the formation of different kinds of fossils in different environments.

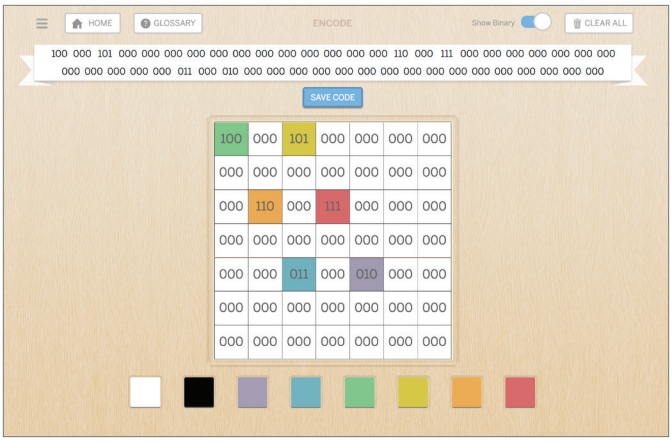
Waves, Energy, and Information

Grade 4

The Sound Waves sim allows students to explore and visualize how sound energy travels through a material. Sounds are represented as longitudinal (compression) waves, traveling through particles, and as waveforms. Students can play different pre-recorded sounds to view the corresponding sound waves. They can also design custom sounds by manipulating the amplitude and wavelength of waveforms.



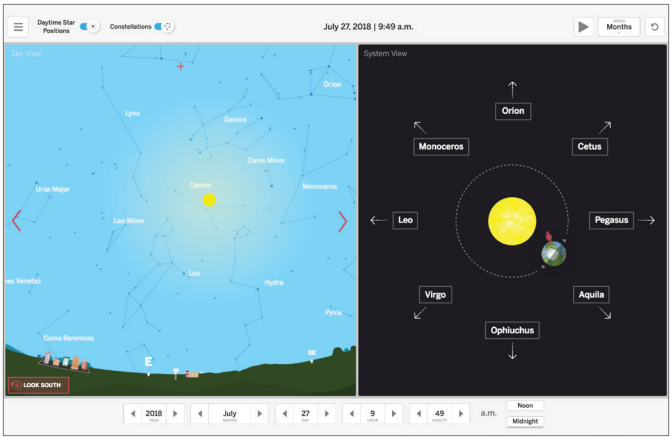
The Code Communicator Tool supports students in understanding how information can be translated into patterns of zeroes and ones (binary code) and communicated via digital devices. By using the tool, students are able to explore how images, text, and sounds can be encoded into binary code, the language of computers, and also decoded back into images, text, and sounds.



Patterns of Earth and Sky

Grade 5

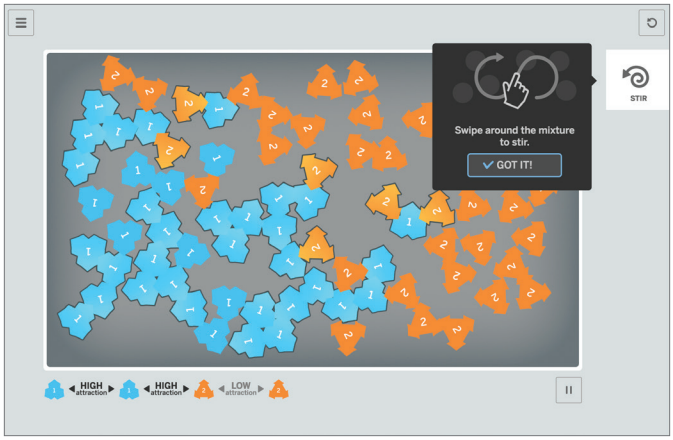
The Patterns of Earth and Sky sim allows students to investigate the appearance of the sky any time from 2000 CE to 2100 CE. The sim also includes a model of the Earth/Sun system along with eight benchmark constellations. This model makes the sim different from other planetarium simulations, because students can use this Earth/Sun system to discover the causes of the daily pattern of daytime and nighttime and the yearly pattern of when certain constellations are visible in the night sky.



Modeling Matter

Grade 5

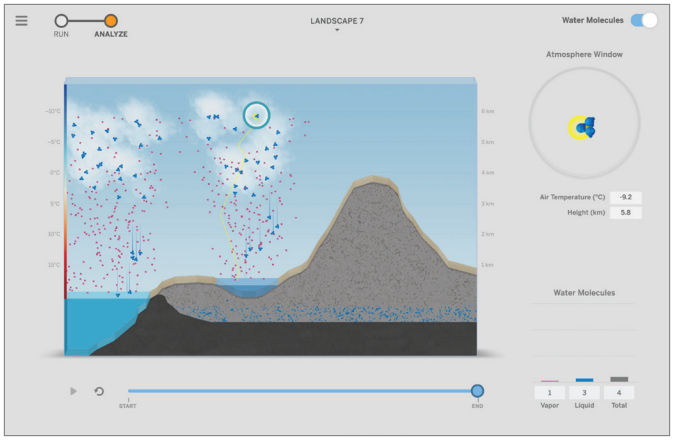
The Modeling Matter sim allows students to study solubility at the nanoscale. The sim is a dynamic model showing interactions of molecules based on their attraction to molecules of the same kind or to other kinds of molecules.



The Earth System

Grade 5

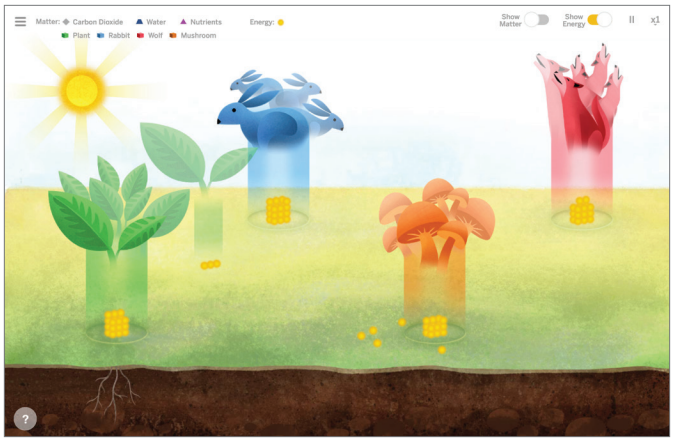
The Earth System sim is intended to help students connect the behavior of water molecules to the macroscopic weather patterns produced through these interactions. Students can investigate different landscapes—with varying configurations and sizes of oceans, lakes, and mountains—to understand how interactions between different parts of the Earth system create different patterns of rain.



Ecosystem Restoration

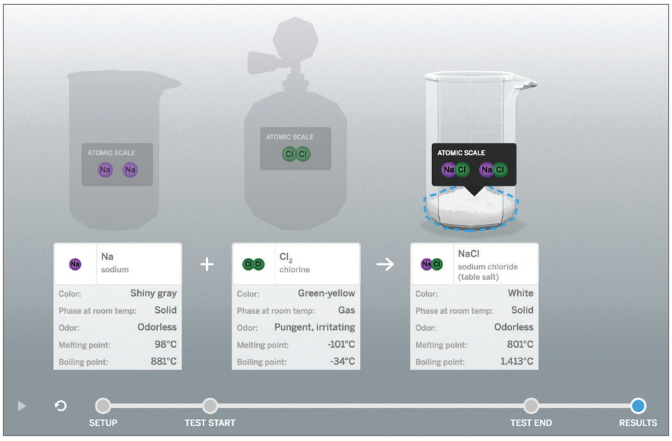
Grade 5

The Ecosystem Restoration sim allows students to control and observe the movement of matter in an ecosystem and discover how this affects the flow of energy through the ecosystem. There are visual data represented in the sim to help students develop an understanding of matter flow through an ecosystem and the connections between energy and matter in plants and animals.



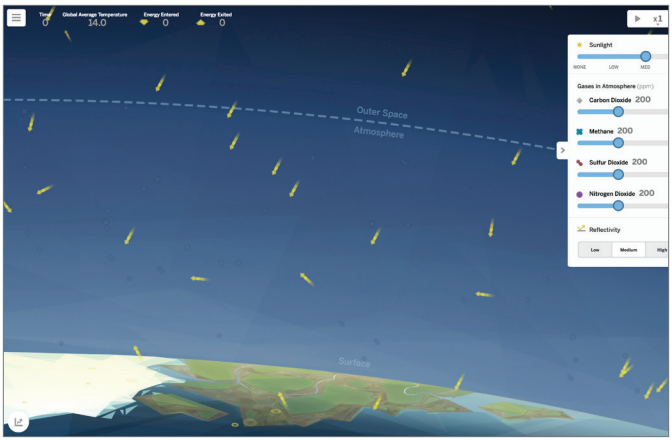
Chemical Reactions

The Chemical Reactions sim offers students the opportunity to explore chemical reactions on several levels. Students observe details and properties of numerous substances and run tests on a smaller set of substances to see if they react to form new substances. The sim allows students to learn about the connection between the arrangement of atoms and the formation of different substances with different properties. Students can observe how atoms rearrange to form new substances during a reaction and learn about how matter is conserved in these reactions.



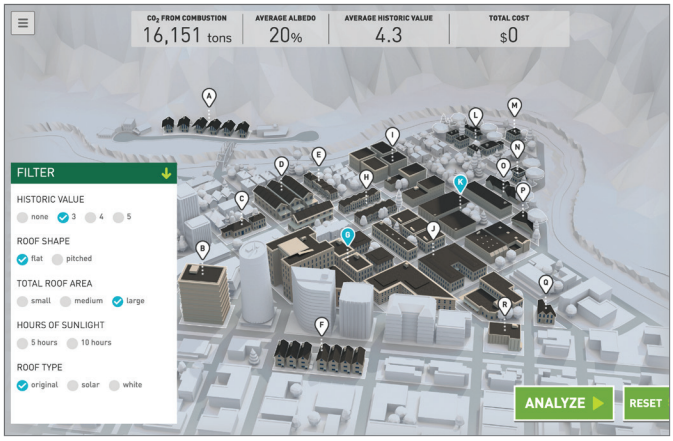
Earth's Changing Climate

Earth's Changing Climate sim is an interactive model with two modes: Earth System mode and Human Activities mode. Earth System mode allows students to investigate factors that affect Earth's global average temperature. Students can change the amount of sunlight, atmospheric gas concentrations, or surface reflectivity, and then evaluate the effects on temperature, ice cover, and energy absorbed by Earth's surface. Human Activities mode focuses on the impact of human actions on Earth's climate. Changes in human activities or population size are represented in real time both visually (through interactions of energy and matter in Earth's surface and atmosphere), as well as quantitatively (through graphs and numerical readouts).



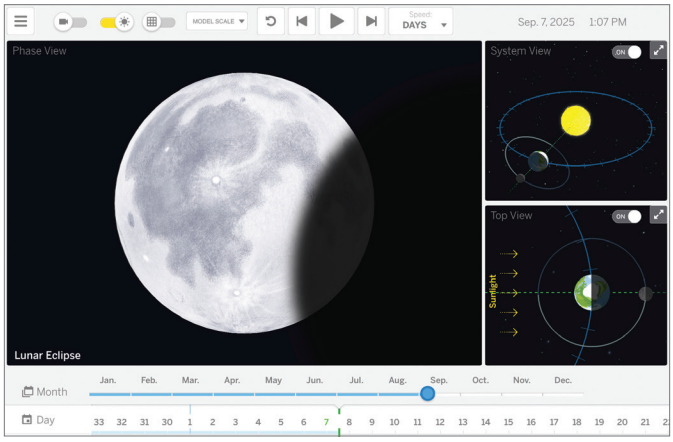
Earth's Changing Climate: Engineering Internship

The RoofMod Design Tool is a digital model that allows students to test various roof modification designs for the fictional city of Solton. This tool offers students the ability to explore a model of the city by studying the various buildings to determine which roof modifications to apply. Students can try a variety of roof combinations in each design to observe the cause and effect of their design decisions. When a student analyzes the design, the numerical outputs are presented with summary graphs to compare how the design performed compared to the original, unmodified roofs. Students use the design tool multiple times throughout the design cycle in order to iterate the roof modification strategies.



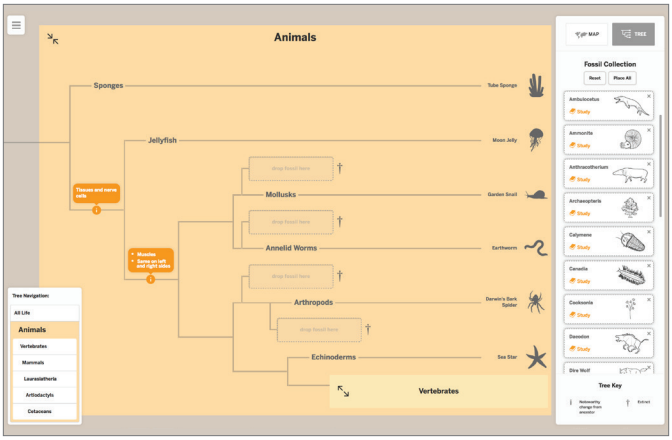
Earth, Moon, and Sun

The Earth, Moon, and Sun sim is an interactive model of the Earth, Moon, and sun system. It has two modes: Two View mode and Three View mode. In Two View mode, students can explore the causes of Moon phases by changing the position of the Moon in its orbit around Earth. In Three View mode, in addition to exploring Moon phases, students can discover the causes of lunar eclipses by manipulating a full three-dimensional model of the Earth, Moon, and sun system.



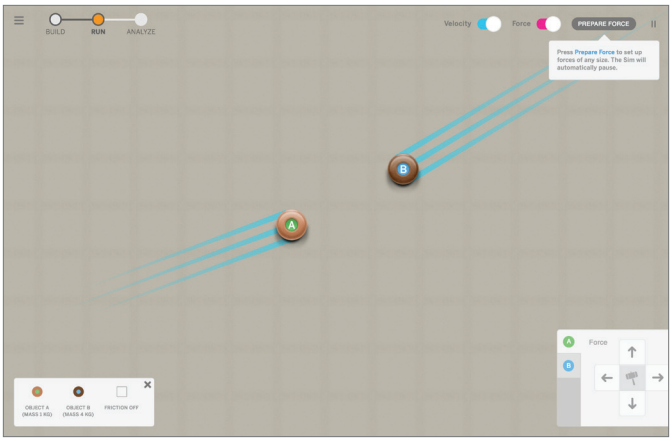
Evolutionary History

The Evolutionary History sim is an interactive model that allows students to explore a simplified, student-friendly version of the evolutionary "tree of life." The sim features 55 real species, including 23 living species and 22 extinct species represented in the fossil record. The sim allows students to consider the changes that have taken place throughout the history of life, starting with the first single-celled organisms and ending with the complex and diverse array of species that we see today.



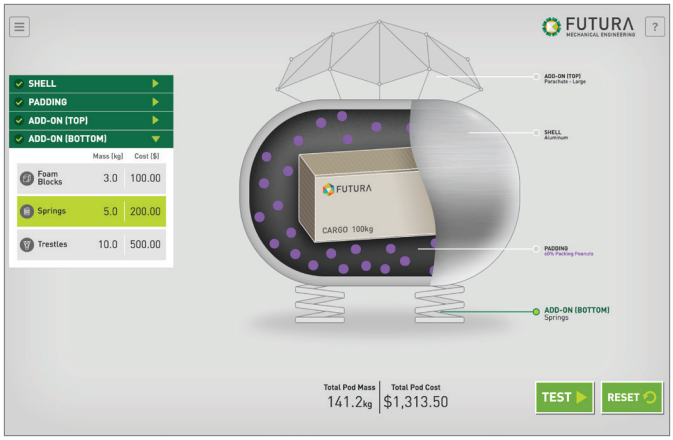
Force and Motion

The Force and Motion sim is an interactive model where students can visualize the motion of objects and investigate how an object's motion changes based on forces exerted on the object. Students can observe the effects of collisions between objects, observe friction's effect on objects, and directly exert forces on objects. By using this sim, students can gather data about the relationships among force, mass, and change in velocity, as well as the relationships among mass, velocity, and kinetic energy.



Force and Motion: Engineering Internship

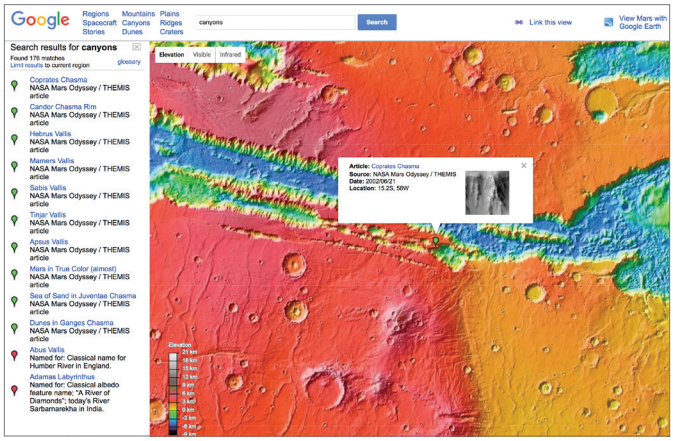
The SupplyDrop Design Tool is a digital model that allows students to test various designs of supply pods for delivering emergency supplies to people in need. The tool offers students the ability to add and adjust features on their design. When a student runs a test, their supply pod is "dropped" and their choices are tested. Various numerical outputs are provided to give the student information on how the design performed. Students use the design tool multiple times throughout the unit in order to perform iterative tests on their supply pod design.



Geology on Mars

In the Geology on Mars unit, students use Google Mars™ to explore landforms on the surface of Mars. This provides students with experience in analyzing and interpreting data, a Next Generation Science Standard: Science and Engineering Practice.

Google Mars™ was created by Google® and NASA researchers at Arizona State University. Over the past 50 years, scientists have used different instruments and cameras that they've placed on satellites, landers, and rovers to collect information about the surface of Mars. Google Mars™ is an interactive mapping service that allows students to directly examine the information that has been collected about the surface of Mars.



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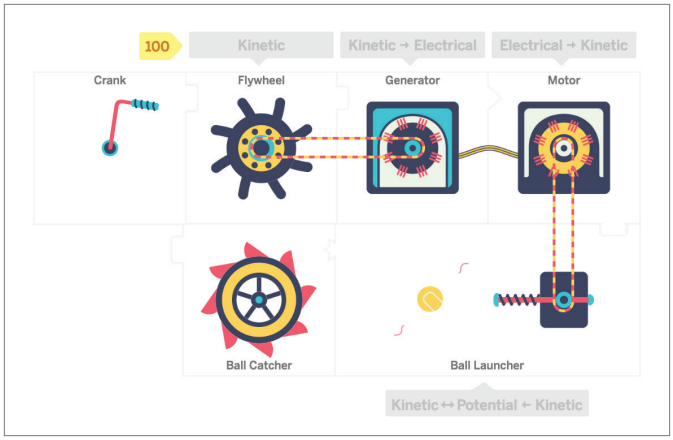
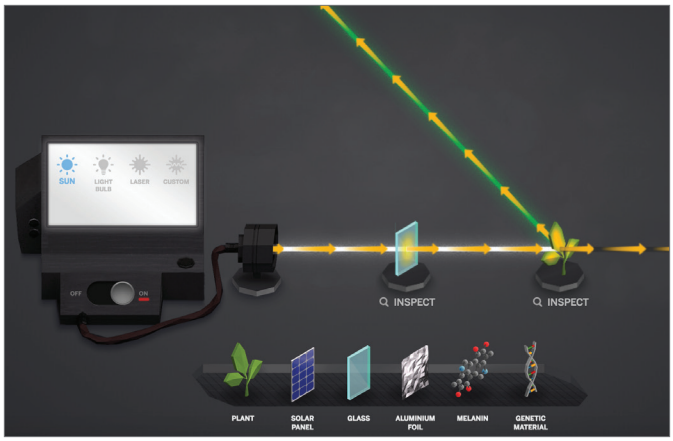
Harnessing Human Energy

The Harnessing Human Energy sim allows students to set up, modify, and compare different energy system configurations in order to explore different energy sources and investigate how energy changes as it moves through a system.

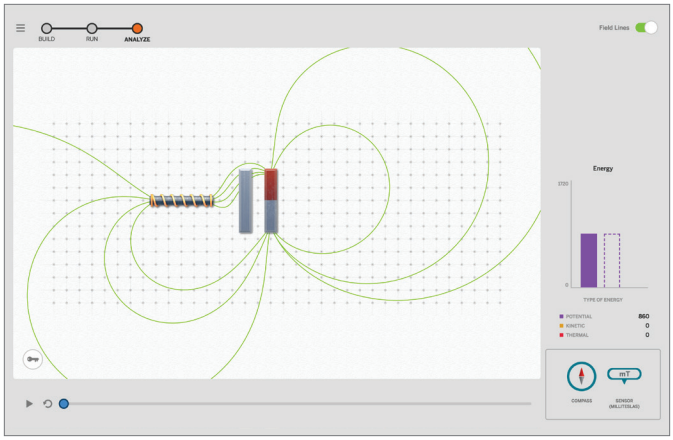


Light Waves

The Light Waves sim allows students to view the results of interactions between light and materials. Students choose between different light sources that emit a variety of types of light, and see representations of the path that light takes and the energy carried by the light. Students can place different materials in the path of the light and observe the light reflecting off, transmitting through, or being absorbed by a material. They also observe the changes to the materials that result when light is absorbed. Students can manipulate the wavelength and amplitude of a light waveform, and then observe the resulting changes to the type of light and its interaction with materials.

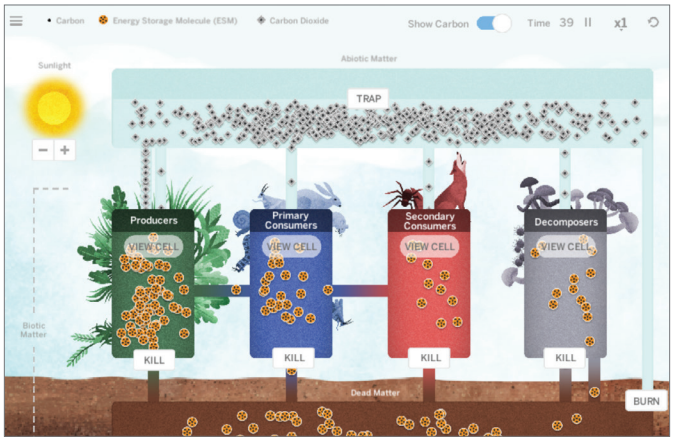


Magnetic Fields



The Magnetic Fields sim is an interactive model with two modes: Permanent Magnets and Electromagnets. In Permanent Magnets mode, students can investigate properties of bar magnets. In Electromagnets mode, students can investigate properties of both bar magnets and electromagnets. Each mode allows students to investigate the attractive and repulsive forces between magnetic objects, the magnetic field lines around these objects, and the strength of the magnetic fields around these objects. Students can also make observations about the conversion of potential energy to kinetic energy (and thermal energy) due to magnetic force.

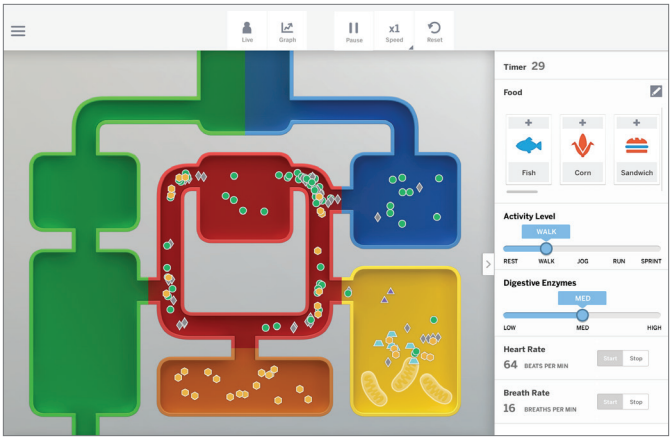
Matter and Energy in Ecosystems



The Matter and Energy in Ecosystems sim shows how the movement of carbon through an ecosystem is affected by changes to parts of that ecosystem. Students can use the preset closed ecosystem or set up their own ecosystems by selecting the number of organisms of each type, the amount of dead matter, and the amount of carbon dioxide in abiotic matter. Students will be able to observe how carbon in abiotic and biotic matter changes over time, but see that the total amount of carbon does not change. While the sim is running, students can change the level of sunlight, kill organisms, burn and bury dead matter, and trap carbon dioxide to see how each change affects the movement of carbon through the closed ecosystem.

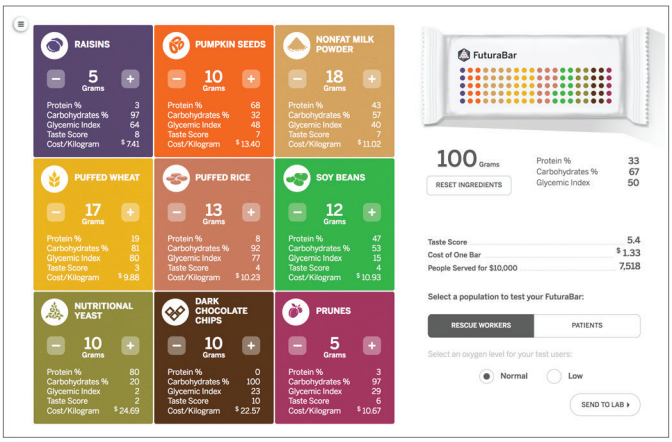
Metabolism

The Metabolism sim models how human body systems work together to transport molecules from food and air to the body's cells, and how these molecules are used in the cells to release energy in the process of cellular respiration. Students can feed the body different types of food, change the body's activity level, stop and start the heart and breathing, and manipulate the enzyme levels in the digestive system to observe the effects on cellular respiration in the cells of the body. Metabolic processes are displayed visually through molecule interactions in a schematic representation of the body, as well as quantitatively in graphs and numerical readouts.



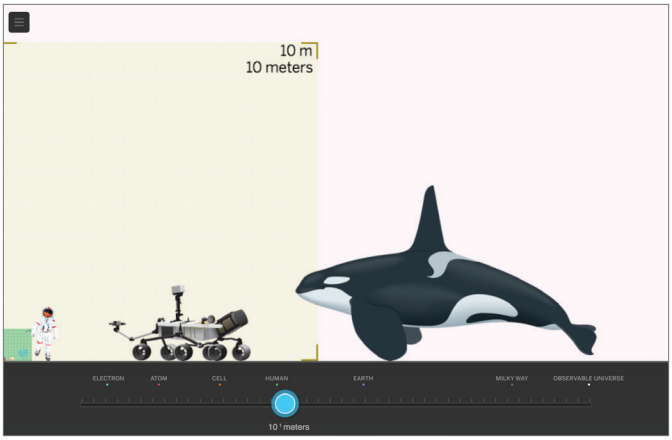
Metabolism: Engineering Internship

The RecipeTest Tool allows students to design and test FuturaBar recipes. As they use the tool, students consider how the amounts of carbohydrates and protein in the bars affect energy release as well as growth and repair. RecipeTest allows students to test their recipes on a variety of test users. These individuals have different needs in terms of energy and growth and repair. Through iterative testing using the RecipeTest Tool, students improve their FuturaBar designs.



Microbiome

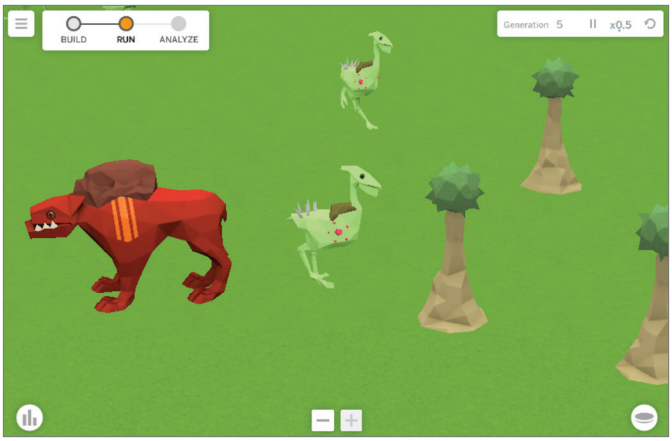
The Scale Tool is a digital model that allows students to explore and compare the relative sizes of different objects in order to develop a conceptual understanding of scale. The Scale Tool, and the activities in which it is used, address the crosscutting concept of Scale, Proportion, and Quantity, one of seven crosscutting concepts called out in the Next Generation Science Standards that bridge core ideas across disciplines in science and engineering.



Natural Selection

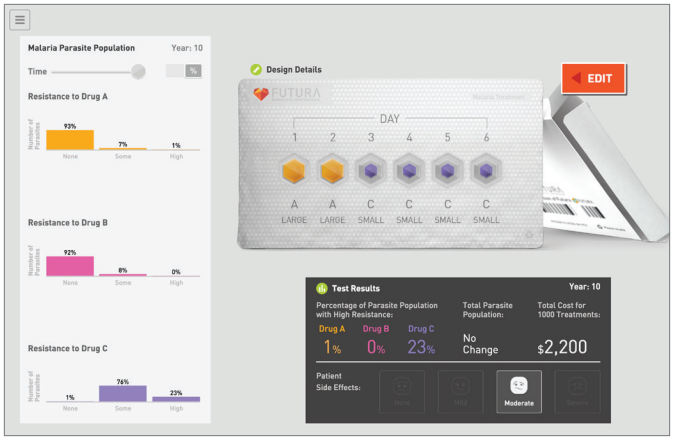
The Natural Selection sim is a dynamic, interactive, virtual world based on the rules of natural selection, a process that is difficult to observe directly because it takes place gradually, over long periods of time. By enabling students to set up populations with different trait distributions, manipulate environmental conditions, and investigate populations over time, the sim allows the complex process of natural selection to come alive for students.

Students can modify abiotic factors in the environment and adjust the presence and initial trait distributions of plant, herbivore, and predator populations. Students can then run the sim to quickly observe the results of their tests and analyze and interpret histograms to figure out how trait distributions change over time.



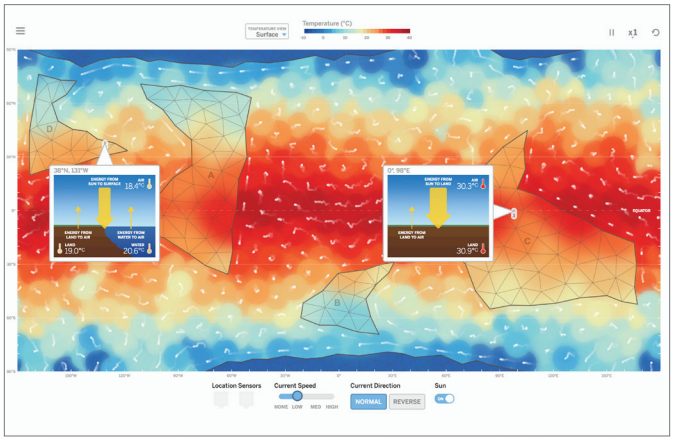
Natural Selection: Engineering Internship

The MalariaMed Design Tool is a digital model that allows students to build and test antimalarial drug treatment designs that fight malaria parasite populations. Students use MalariaMed to research the effects of particular drug treatment regimens on a parasite population, and to iteratively design and test different antimalarial drug treatment plans. Students can use a variety of drug combinations in each design to observe the cause and effect of their design decisions. Students' ultimate goal is to design an optimal malaria treatment that can keep drug resistance low and minimize patient side effects, all for a low cost, while still reducing the number of malaria parasites in the population.

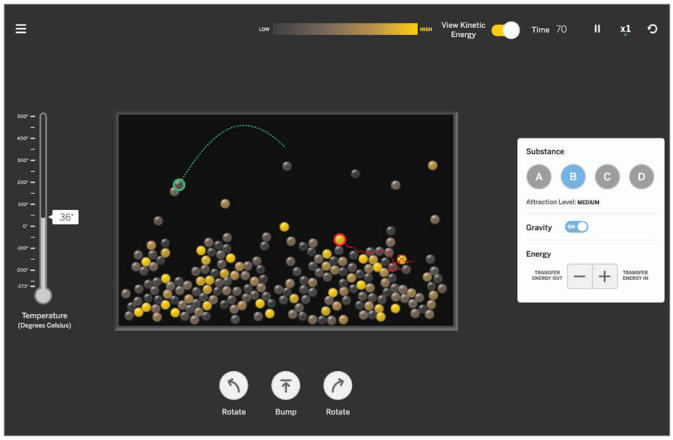


Ocean, Atmosphere, and Climate

The Ocean, Atmosphere, and Climate sim is an interactive computer model with four modes. Current Map mode allows students to investigate how currents travel around a planet and how they affect air temperature at different locations. Wind Map mode allows students to investigate how currents are affected by wind. Energy Test mode allows students to observe energy transfer between the surface and the air. Surface Test mode allows students to investigate how energy from the sun warms the air on the planet.



Phase Change



The Phase Change sim is an interactive, scientific model of several substances at the molecular scale. It provides students with the ability to investigate molecular behavior in substances, and explore what happens to molecules when substances change phase. The four substances in the sim have different levels of attraction between molecules, allowing students to investigate how molecular attraction affects phase change. Students can select a substance and transfer energy into or out of the substance in order to understand the behavior of solids, liquids, and gases at both the macroscopic and molecular scales. At the molecular scale, students can influence and closely observe how molecules move. Students can also observe the behavior of the substance in response to macroscale changes to the conditions of the container. These changes include bumps, rotations, and changes to gravity.

Phase Change: Engineering Internship

The Futura BabyWarmer Design Tool is a digital model that allows students to test various portable baby incubator designs by adding and testing different phase change materials (PCMs) and insulating materials. Students then analyze numerical data on a graph to evaluate their designs. Students use the BabyWarmer Design Tool multiple times throughout the unit to iteratively optimize and evaluate their designs.

Plate Motion

The Plate Motion sim is an interactive model that allows students to observe the interactions between plates and the mantle at different types of plate boundaries. The sim enables students to manipulate and investigate the effects of a number of variables that affect plate motion, including the boundary type, the composition of the plates (oceanic or continental rock), and the rigidity of the mantle. After setting the initial conditions for a region, students can watch the motion of the plates over a timespan of 200 million years. Students can measure how far the plates move in this time, investigate plate-mantle interactions, and observe patterns of earthquakes and volcanoes that occur near the plate boundaries.

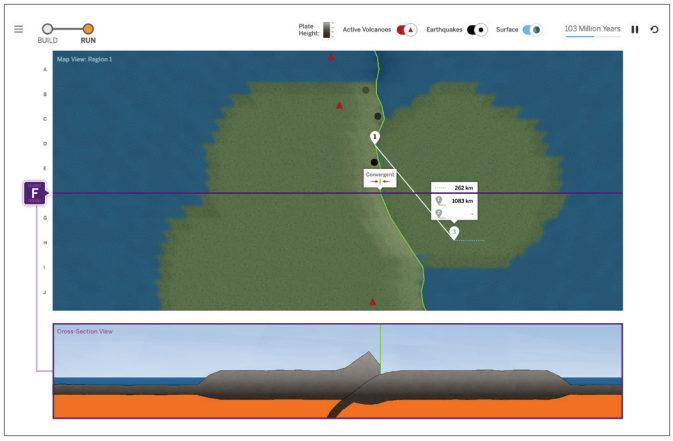
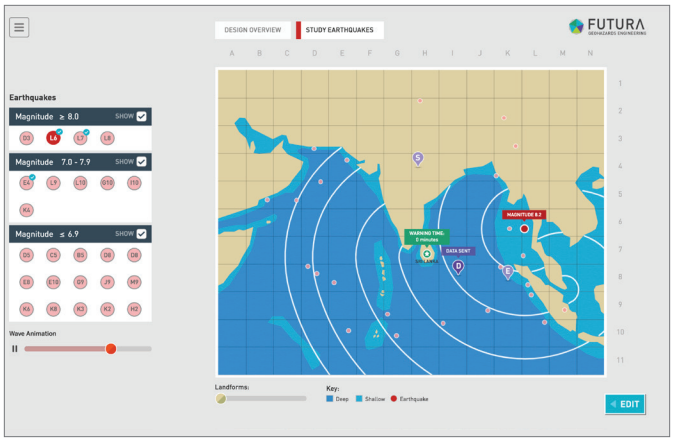


Plate Motion: Engineering Internship

The Futura Tsunami Alert Design Tool is a digital model that allows students to test various tsunami warning system designs. Students try many combinations of sensor types and locations in their designs to observe how the system performs in this 50-year predictive model, working to maximize average warning time for the people of Sri Lanka while minimizing false alarms and keeping costs low. When students analyze a design, they evaluate how each sensor performed, and then study each earthquake to better understand which sensors were involved in which types of warnings for the target location, Sri Lanka.

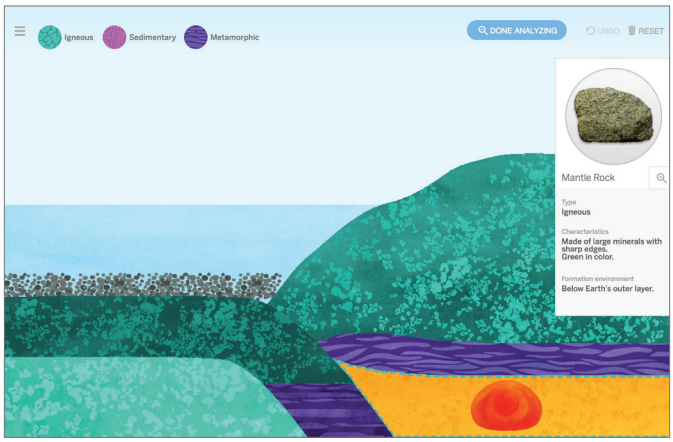


Populations and Resources

The Populations and Resources sim is a dynamic, interactive virtual ecosystem that shows how populations interact with one another. The sim allows students to observe stable ecosystems as well as change the numbers of organisms in a certain population to observe how this affects other populations in the ecosystem. Students can view interactions between individual organisms, and open the food web overlay to observe interactions between populations.

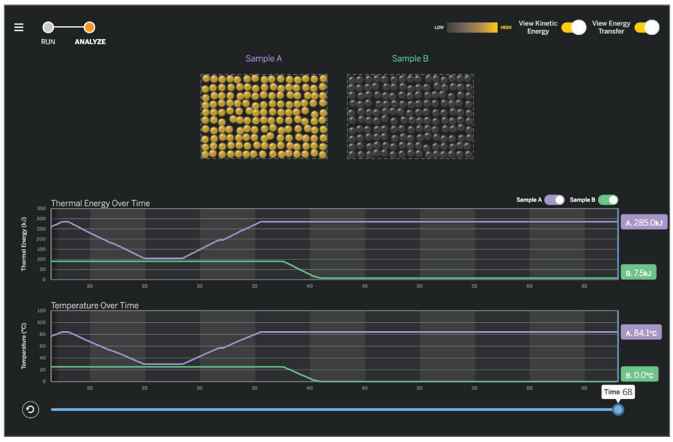
Rock Transformations

The Rock Transformations sim shows rock formations and transformations driven by different energy sources over millions of years. Students observe how different rock types form, change, and move at and below Earth's surface. They also observe how the landscape changes as these processes occur. Students can either directly apply different transformation processes to their landscape using the Process mode, or they can select energy sources in Energy mode and observe the transformations that occur. In both modes, students can analyze the rock formations they have created using the Analyze Rocks feature. This feature allows students to view the distribution of igneous, sedimentary, and metamorphic rocks in the landscape and to select individual rock formations to learn more about their composition and characteristics.



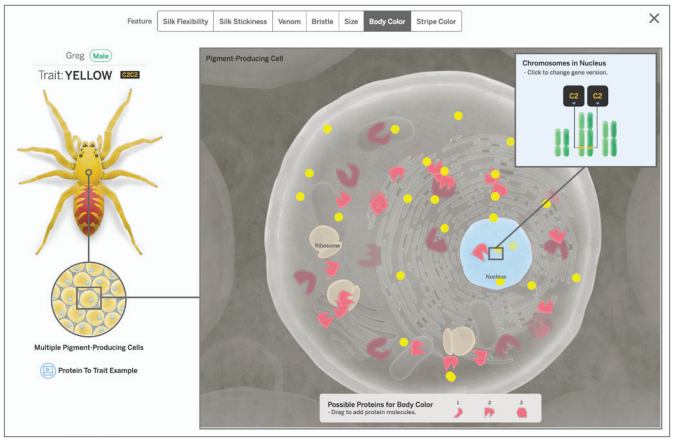
Thermal Energy

The Thermal Energy sim is an interactive model that allows students to investigate the concepts of temperature and thermal energy at the molecular level. The sim also enables students to observe energy transfer when samples at different temperatures are put into contact with one another. Students can transfer energy into and out of a sample in order to change the sample's temperature and its thermal energy.



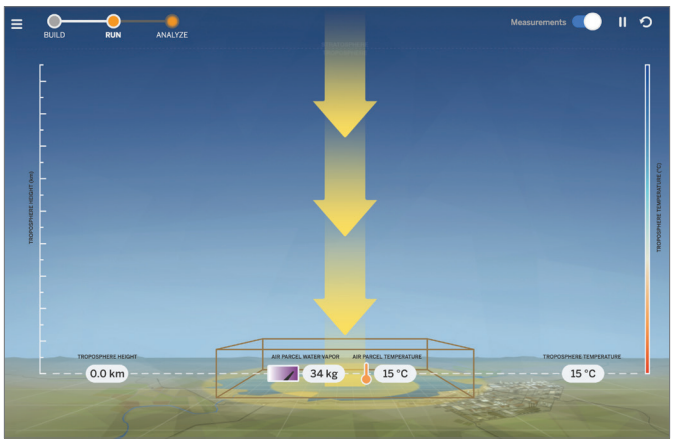
Traits and Reproduction

The Traits and Reproduction sim is an interactive, scientific model that allows students to understand the factors that lead to variation among organisms and their offspring. The sim models how genes provide instructions for building proteins that lead to observable traits in organisms. It also shows how organisms inherit different traits from their parents through sexual reproduction. Students explore these concepts in the sim by investigating different features of model spiders. In the sim, students can select a specific spider to investigate and then change its traits. Students can also mate two spiders to observe the processes of creating and fertilizing reproductive cells, examining the traits and genes of spiders' offspring. Students are also able to mutate genes in reproductive cells and investigate the effect of mutations on the traits of offspring.



Weather Patterns

The Weather Patterns sim is an interactive, scientific model that allows students to understand the factors that lead to different weather outcomes with respect to the amount of rain. The sim models how air parcel temperature, the amount of water vapor in an air parcel, and the surrounding air temperature can produce different amounts of clouds and rain. The sim visualizes energy transfer and allows students to investigate the relationship between energy transfer and the severity of weather events.



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