Division of Instruction
Los Angeles Unified School District

Interactions AB 361319/20

Title:
Interactions AB
Length of course: Full Year
Subject area: College-Preparatory Elective (G) / Laboratory Science – Physical Sciences
UC honors designation? No
Prerequisites: None
Co-requisites: Algebra One (Required)
Integrated (Academics / CTE)? No
Grade levels:
9th, 10th

Course Description

Course overview:
Fundamental forces, unseen yet felt in every moment of our existence, govern the interactions of matter and energy that in turn shape our lives. By understanding these forces, we create a foundation that support doing and understanding modern science and technologies. Why do clothes stick together when they come out of the dryer? How is it that a tiny spark can trigger an explosion? Working from these and other questions, students start their explorations by asking their own questions and discussing what they already know. They observe phenomena, engage in hands on activities and use online simulations to collect evidence. From their evidence, they construct mental models of the forces that drive interesting phenomena and test their models by predicting future events.

The Interactions course introduces students to science as an endeavor, a process we engage in, rather than solely a set of discoveries by others. Through engaging in modeling and scientific explanation, students explore curious aspects of the everyday world, discovering how the unseen world of atomic level interactions and energy transformations are responsible for much of what we observe in the world around us.

As a project-based science curriculum, Interactions engages students in

1) Pursuing a solution to a meaningful question,

2) engaging in three-dimensions to achieve learning goals,

3) Using scientific practices to figure out phenomena, including developing models and writing evidence based explanations,

4) Reading materials that support understanding by building on in-class experiences,

5) Engaging in collaborative activities with peers,

6) developing critical thinking skills, written and oral communication, and scientific literacy – both in the capacity to conduct research, and to read and write scientific literature,

7) Using learning technologies to explore ideas typically beyond their ability,

8) Developing artifacts – tangible products – that address the driving question and represent what they have learned, and

9) Conducting research, gathering evidence and collaborating with peers to solve relevant problems and explain natural phenomena.

Course content:

Unit 1: Why do some clothes stick together when they come out of the dryer?

In unit one, students develop a model of electric interactions to explain electrostatic phenomena. Students develop and revise their models by conducting investigations, collecting evidence from scientific texts, and evaluating ideas collaboratively based on evidence – requiring them to both listen to the ideas of others, and communicate their ideas effectively. At the end of this investigation, the class develops a particulate model of model of atomic structure and electrostatic interactions to carry forward into unit 2.

Unit Assignment(s):

Investigation 1: Why do some things stick together and other things don't?

In this investigation, students will begin to develop a conceptual model of electrostatic interactions by investigating how various charged objects (scotch tape, balloons, rods of various materials, and a Van de Graaff generator) interact with each other and with uncharged objects (paper, water bottle, a hand). Readings in this investigation introduce students to modeling as a scientific practice, and throughout the investigation students will work with their peers to draw models, gather evidence, communicate as a class to determine which ideas are supported by evidence, and finally revise their models based on class decisions about scientific ideas. By the end of the investigation, student models will include positive and negative charges as well as patterns that can be used to explain and predict how charged objects interact.

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects

Objective: Target Model
Throughout this investigation, students develop, revise, and use their models to explore electrostatic interactions. During this process, students will present their models to each other orally, and critique in writing their peer models using evidence. After participating in collaborative modeling, student's target model should include:

- Objects can be positively charged, negatively charged, or uncharged (Neutral)
- Objects with the same charge repel each other, Oppositely charged objects attract each other. Charged and uncharged objects attract each other regardless of whether the charged object has a positive or negative charge.

Objective: Target Explanation

During this investigation, students investigate electrostatic interactions between objects, and collaborate with peers to develop and revise models over time to develop a written, evidence-based explanation to explain what the charges are on each piece of tape, the observational evidence that supports the claim, and how this understanding informs *"Why do some things stick together and other things don't".*

Activities:

Activity 1.1 What are some examples of things that stick together and things that don't?

Activity 1.2 What are some patterns in how things stick together or push apart?

Activity 1.3 What effect do charged objects have on uncharged objects?

Activity 1.4 How do I know if something is positively or negatively charged?

Activity 1.5 How does an object's charge affect its interactions with neutral objects?

Investigation 2: What are factors that affect the interactions between objects?

In this investigation, students develop a model of electric fields to explain how charged objects interact. Students analyze and discuss as a class how the charge on objects and the distance between them affects the strength of the interactions between those objects. Based on their analysis and class decisions, students will revise their models with the new ideas agreed upon as a class.

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Objective: Target Model
Throughout this investigation, students develop, revise, and use their models to explore factors that affect interactions between objects such as magnitude of charge, and distance between objects. During this process, students will present their models to each other orally, and critique in writing their peer models using evidence gathered during investigations, such as testing the effect of distance on objects. After participating in collaborative modeling, student's target model should include:

- Objects can be positively charged, negatively charged, or uncharged (neutral).
- Objects with the same charge repel each other; oppositely charged objects attract.
- The distance between charged objects affects the interactions between them. The closer they are, the stronger the interaction.
- The amount of charge on the charged objects affects the interactions between them. The greater the charge, the stronger the interaction.
- Charged objects generate an electric field in the region around them.
- It is through the electric field that charged objects interact with each other.

Objective: Target Explanation:
During finish this investigation by developing a written, evidence-based explanation to describe the factors that affect the interaction between objects, and to summarize how the information gathered in the first two investigations supports the unit driving question "Why do some clothes stick together when they come out of the dryer. After students complete their writing samples, the teacher leads a group discussion identifying what questions the class still needs to answer to fully explain the unit driving question.

Activities:

Activity 2.1 How can charged objects have an effect on each other without touching?

Activity 2.2 How do factors like distance and amount of charge affect the interactions between objects?

Activity 2.3 How does our model of charge interactions connect with a variety of Phenomena?

Investigation 3: What are all materials made of?

In this investigation, students will start by analyzing observations of matter in order to evaluate continuous and particle models of matter. Readings in this investigation introduce students to scientific writing in the form of evidence-based explanations. Students will communicate their ideas and evaluate them based on evidence from mixing water and ethanol. Finally, students will use their previous model to explain a new phenomenon, their observations of gases.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Objective: Target Model
Throughout this investigation, students develop models of what materials are made of. Gathering evidence to support a model of the atom as particle instead of continuous requires investigating solids, liquids and gasses at the molecular scale, and revisions models with the new evidence collected. During this process, students will present their models orally, and critique or support peer models using evidence. After participating in collaborative modeling, student's target model should include:

- All substances are made of particles that are too small to be seen
- There is empty space between the particles making up substances

Objective: Target Explanation
At the end of this investigation, students revise their written claims from activity one based on the new evidence collected. The writing prompt asks students "Do you agree with your original claim, and what changes would you make to your original ideas based on the new evidence collected?" After which, students will be able to support the notion that Materials are made up of particles.

Activities:

Activity 3.1 Can the same piece of paper be cut into pieces indefinitely?

Activity 3.2 Does 5 + 5 always equal 10?

Activity 3.3 Is the particle model always better?

Activity 3.4 Which model best supports our observations?

Investigation 4: What are nature's building blocks?

This investigation follows the historical development of models of atomic structure and provides students with the opportunity to explore simulations of some of the experiments that led to these models. Students will follow and participate in gathering evidence from important, historical scientific research on atomic theory, and use critical and analytical thinking skills to further develop their model of the atom. In addition, through hands-on activities involving representative objects, this investigation helps students gain insight into the size of atoms as compared with other small objects.

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Objective: Target Model
Throughout this investigation, students revise, their atomic models and use simulations to investigate what "particles" are made of. As they investigate, students will present their models to each other orally, and critique in writing peer models using evidence. After participating in collaborative modeling, student's target model of the atom should include:

- All materials are made of particles that are too small to be seen.
- These particles are called atoms.
- Atoms have a dense, positively charged nucleus that consists of neutrons and protons; the nucleus is surrounded by much smaller, negatively charged electrons.
- Electrons can be modeled as a "cloud" surrounding the nucleus and are best represented in terms of probability maps.

Objective: Target Explanation
Toward the end of this investigation, students develop a written argument supported with collected evidence supporting the Bohr model of the atom, and draft written scientific predictions about the mass of atoms, and the distribution of electrons based on their revised models. These explanations provide a more detailed explanation to describe "What are nature's building blocks?"

Activities:

Activity 4.1 What are the particles that make up all substances and how small are they?

Activity 4.2 If you can't see it, how do you know it's there?

Activity 4.3 How do we know what's inside an atom?

Activity 4.4 Where are the electrons?

Investigation 5: How does an object become charged?

By collecting evidence as to how the composition of an atom relates to its identity, students will build upon the model of atomic structure developed in the previous investigation. Readings in this investigation are focused on helping students understand the elements and their organization on the periodic table. Students will extend their conceptual model of electrostatic interactions to include 1) electron transfer as the mechanism for how an object becomes charged and 2) shifting electron distribution to explain how neutral objects can be attracted to both positively and negatively charged objects. Students will revise their models and written, evidence based-explanations for atomic structure and electrostatic interactions.

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Objective: Target Model
Throughout this investigation, include ideas about how objects become charged to their models. During this process, students will present their models to each other orally, and critique or support peer models in writing using evidence collected during electrostatic investigations after which:

Students' models of the structure of matter should include:

- All materials are made of particles called atoms which are too small to be seen with the unaided eye.
- Atoms have a dense, positively charged nucleus that consists of neutrons and protons surrounded by much smaller, negatively charged electrons. The nucleus takes up only a small fraction of the volume of an atom.
- Every element consists of a different type of atom; the identity of an element is determined by the number of protons in the nucleus of an atom of that element.
- An atom has an electric charge when it contains an unequal number or protons and electrons.

Students' models of electrostatic interactions should include:

- Opposite charges attract; like charges repel.
- The strength of the interaction between charged objects depends on the distance between them and the amount of charge on each object (qualitative understanding of Coulomb's law).
- Neutral objects are attracted to both positively and negatively charged objects.
- There is more than one way to charge an object.
  - An object can be rubbed with another material
  - Charge can be transferred to or from an object when it touches another object.
- Charge is due to electrons from atoms of one object transferring to atoms of another object.

Objective: Target Explanation
At the end of this investigation – and unit – students use all their previous written explanations and experiences collecting evidence in class to describe how object become charged, and then answer the overarching driving question for the unit "Why do clothes stick together when they come out of the dryer?" Students will include their understanding of charged objects, and materials consisting of small particles called atoms that have a small, densely packed positive nucleus, and a cloud of electrons around the outside that are negatively charged.

Activities:

Activity 5.1 What is the effect of changing the composition of an atom?

Activity 5.2 How do objects become charged?

Activity 5.3 What causes neutral objects and charged objects to interact with each other?

Activity 5.4 Revisiting our models of charge interactions.

Division of Instruction
Los Angeles Unified School District

Unit 2: How does a small spark trigger a huge explosion?

In this unit, students develop and revise evidence-based explanations that focus on the electrostatic attractions and energy conversions involved in the formation of molecules (chemical reactions). Students also learn new ways to represent ideas about chemical interactions, and work together to discover that chemical reactions are the rearrangement of molecules.

Unit Assignment(s):

Investigation 1: What is happening when a spark occurs?

In this investigation, the class begins discussing and exploring energy. Students start by defining energy and gathering evidence to explain the differences between potential and kinetic energy. Readings in this investigation support students in conceptualizing what energy is, and how it can be thought of as an accounting system. The class collaboratively completes investigations and analyze data to explore energy transfer and energy conservation. Through these investigations, students collaboratively develop a model of energy that can be used to predict and explain observable phenomena and the macroscopic and sub-microscopic scales.

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).

Objective Target Model:

In this investigation, students conduct experiments and gather evidence to develop a model of energy transfer. During this process, students will present their models to each other orally, and critique or support peer models in writing using evidence. After participating in collaborative modeling, student's target model should include:

- Energy is useful to track changes in systems,
- The model of energy should include the following:
    - Energy transfer
    - Energy conversion
    - Conservation of energy
    - The idea that energy is either associated with motion (kinetic energy) or stored (potential energy)

Objective: Target Explanation

At the end of this investigation, students develop a written explanation of "what happens to a pendulum's kinetic energy as the pendulum comes to a stop?" They will use evidence gathered during the investigation to support their claim, and include kinetic and potential energy, and the idea of energy transfer in their explanation.

Activities:

Activity 1.1 Can my finger start a fire?

Activity 1.2 What happens to energy when objects collide?

Activity 1.3 If moving objects have kinetic energy, do moving atoms have kinetic energy?

Activity 1.4 If energy cannot go away, why don't things move forever?

Investigation 2: Where does the energy of a spark come from?

In this investigation, Students start by defining potential energy as energy that is stored in a system of interacting objects. Readings help students explore observable phenomena using their definitions of potential and kinetic energy. Student then explore the relationship between potential energy and fields in order to explain how the objects interact without touching. The class uses the evidence collected to evaluate factors that affect the amount of potential energy stored in a system.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

Objective Target Model:
In this Investigation, students revise their models to incorporate ideas about electric fields into their models of energy. During this process, students will present their models to each other orally, and critique or support peer models using evidence. After participating in collaborative modeling, student's target model should include:

- When the amount of charge increases, the amount of force and electric potential energy stored in a field both increase.
- For objects that are interacting through attractive forces (have opposite charges), when the distance between the objects increases, the amount of electric potential energy stored in the electric field increases.
- For objects that are interacting through repulsive forces (have the same charge), when the distance between the objects increases, the amount of electric potential energy stored in the electric field decreases.
- In general, if you have to apply a force to move the objects away from their natural position you have increased the amount of potential energy stored in the system.
- If a system is free to move on its own, it will tend to move in a direction that will lower the potential energy stored in the system.

Objective: Target Explanation
At the end of this Investigation, students develop a written explanation taking everything they have learned about potential energy, kinetic energy and energy transfer to explain "How does lightening form". This explanation is then taken up into whole class discussion to answer the question "Where does the energy of a spark come from?"

Activities:

Activity 2.1 How does potential energy change when things are pushed or pulled?

Activity 2.2 Where does the energy that was used to charge the Van de Graaff generator go?

Activity 2.3 Why is lightning so much bigger than a spark from the Van de Graaff generator?

Activity 2.4 Why do I get shocked if I am too close the Van de Graaff generator?

Investigation 3: How can a small spark start a huge explosion?

This investigation focuses on how electric forces and energy are connected to molecules. Readings in this investigation support students in representing their ideas about atoms and molecules the way that scientists do in the field – helping them both develop and learn from scientific text. Students will explore various simulations to build their understanding of the relationships among electric forces, energy, and the relative distance of two atoms. They will also explain the energy transfers that occur when molecules form and break using the concept of conservation of energy (developed in previous investigations).

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Objective Target Model:
In this investigation, students are taking their ideas about energy to the molecular level by conducting experiments and gathering data on what makes different substances explosive. They will revise their original ideas about energy to include relationships between energy, electric forces, and distance between atoms. During this process, students will present their models to each other orally, and critique or support in writing peer models using evidence. After participating in collaborative modeling, student's target model should include:

- Students will develop a model that a molecule is formed when different atoms combine because the electric field energy is lower for the molecule than for the individual atoms.
- Students will provide an explanation of a chemical bond in a molecule using attractive and repulsive interactions at the atomic level.

Objective: Target Explanation
At the end of this investigation, students develop a written explanation of "What happens to the energy of the atoms when there are only two atoms, and they collide?" Students then build on this explanation in class discussion to identify "How can a small spark start a huge explosion?"

Activities:

Activity 3.1 Why are some materials explosive, while other materials are not?

Activity 3.2 What holds the atoms of a molecule together?

Activity 3.3 When atoms get close to each other, what happens to their potential energy?

Activity 3.4 Why is a spark needed to start an explosion?

Investigation 4: Where does all the energy in an explosion come from?

Through collaborative class discussions using evidence from previous investigations, students will characterize a chemical reaction as a process of rearrangement of atoms that results in the formation of a new substance. Readings in this investigation help students see where chemical reactions show up in their everyday lives, and connect those real-life experiences to what is going on in class. Students will track energy throughout a chemical reaction, and develop a written evidence-based explanation to answer the driving question "*How can a small spark start a huge explosion?"*

Division of Instruction
Los Angeles Unified School District

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).

Objective Target Model:
Throughout this investigation, students revise their models using evidence collected during investigations to depict what happens during chemical reactions to produce the energy necessary for an explosion. During this process, students will present their models to each other orally, and critique or support peer models using evidence. After participating in collaborative modeling, student's target model should include:

- If the properties of the substances before and after a process differ, than new substances have formed and a chemical reaction has occurred.
- Chemical reactions involve bonds breaking and forming such that the same atoms rearrange to form new molecules.
- Breaking bonds requires an input of energy. When bonds form, the potential energy decreases; the available energy is used to continue the reaction or is transferred to the surroundings, or both.
- When a chemical reaction transfers energy to the surroundings after the product molecules have formed, it is an exothermic reaction; if energy must continually be transferred in from the surroundings for the chemical reaction to continue, it is an endothermic reaction.

Objective: Target Explanation
Students wrap up this investigation and unit by producing a written explanation that incorporates everything they learned over the course of the unit to explain "How does a small spark start a huge explosion?" They will support their claim with evidence gathered in class, and reasoning of how the content presented relates back to the overall phenomena.

Activities:

Activity 4.1 What energy changes occur during an explosion?

Activity 4.2 What happens to atoms during a chemical reaction?

Activity 4.3 What changes in energy occur when atoms rearrange during a chemical reaction?

Activity 4.4 How does a spark trigger an explosion?

Unit 3: What powers a hurricane?

Students use their models to predict and explain observed properties of liquids. They conduct research, analyze, and compare the energy transformations and conversions that occur during phase changes of water. Ultimately, the class uses the big ideas they have discovered to write an evidence based explanation for "what powers a hurricane"

Unit Assignment(s):

Investigation 1: What makes water special?

In this investigation, students explore the properties of liquids to determine patterns in their molecular make-up. As a class, students investigate properties of water and work with peers to determine how the structure of water molecules can be used to predict and explain properties of water. Readings in this investigation support students in exploring natural phenomena that stem from water's properties such as how a water strider can walk on top of the water.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Objective Target Model:
Throughout this investigation, students develop an initial model that depicts the special properties of water, and revise that model to include electronegativity and polarity. During this process, students will present their models to each other orally, and critique or support in writing peer models using evidence. After participating in collaborative modeling, student's target model should include:

- Given an atom's electronegativity, students will make and support claims about the polarity of molecules.
- Predict how electron distribution within molecules affects the way molecules interact with each other.
- Predict and explain the effect that differences in polarity of molecules of a substance have on observable phenomenon.

Objective: Target Explanation
At the end of this investigation, students will develop a written explanation that describes properties of polar and nonpolar molecules, and how those properties arise from the specific structure of each molecule. They will use evidence from class investigations and demonstrations to support their claim, and ultimately describe why water is special, and how it is different than other molecules.

Activities:

Activity 1.1 How are water and other liquids similar and different?

Activity 1.2 Why is water different from other liquids?

Activity 1.3 Is oxygen really that special?

Activity 1.4 How does electron distribution impact our observations?

Investigation 2: What happens to the energy of water molecules during hurricanes?

Students develop a model to explain what holds water molecules together in the liquid state. This will require them to analyze evidence and to make claims about what happens to water molecules during phase changes. Readings in this investigation support students in making connections between molecules, energy, and temperature changes. During class discussion, students share their claims in class, and support or refute ideas with the evidence collected to reach consensus. Finally, students will use their refined ideas to answer the question "What powers a hurricane?"

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Objective Target Model:
Students will revise their model of water as an important molecule to include what intermolecular forces and intramolecular forces contribute to the observable properties of water. During this process, students will present their models to each other orally, and critique or support peer models using evidence. After participating in collaborative modeling, student's target model should include:

- Students will develop a model that explains how intramolecular and intermolecular interactions result in arrangements that lower potential energy.
- Intramolecular interactions (such as the formation of chemical bonds) and intermolecular interactions (such as the formation of hydrogen bonds) involve similar kinds of electrostatic interactions. However, the former involve interaction between full charges, and the latter involve interactions between partial charges. Therefore, the magnitude of each types of interaction is different; the interaction is stronger for chemical bonds and weaker for intermolecular interactions.

Objective: Target Explanation
At the end of this investigation, students will develop a written explanation of "What powers a hurricane?". Support their claim with evidence gathered over the course of the year – particularly during this unit, and connect how each of the important scientific ideas presented connect back to the overall phenomena of a hurricane.

Activities:

Activity 2.1 What does boiling do to water molecules?

Activity 2.2 How hot can water get?

Activity 2.3 How does energy change when evaporation is reversed?

Unit 4: Why is a temperature of 107 degrees deadly?

Students will apply idea of stability and energy to describe how a fever can disrupt biologically important molecules (proteins). The class will use and apply big ideas learned over the entire school year to develop an evidence-based explanation describing how sub-microscopic interactions in the human body can impact our health to answer the question "Why is a fever of 107 degrees deadly?"

Unit Assignment(s):

Investigation 1: How are interactions with water important for maintaining my life?

In this investigation, students will investigate how molecular interactions between the water-based environment ubiquitous to life and molecular interactions within the larger molecules themselves result in molecules with just the right shape to have a particular biological function. Students will engage in hands on activities, simulations, and class discussions to explore sub-microscopic interactions in the human body that support our health and well-being. In the final Investigation, students will explore why shape is important and how thermal energy levels are important to the stability of the molecular interactions.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.

Objective Target Model:
Throughout this investigation, students develop, models of interactions between substances with different properties. During this process, students will present their models to each other orally, and critique or support peer models using evidence. After participating in collaborative modeling, student's target model should include:

What should student's conceptual model include?

- Polar and nonpolar molecules have different attractive forces.
- The different attractive forces between polar and nonpolar molecules affect how one substance dissolves or doesn't into another substance.
- Proteins are large molecules that have polar and nonpolar parts that can interact with each other and the surrounding molecules.

Objective: Target Explanation
Student's target written explanation includes students explaining why polar and non-polar portions of a protein end up forming predictable structures. Students will support their written ideas with evidence collected in this investigation.

Activities:

Activity 1.1 Why don't oil and water mix?

Activity 1.2 Can a substance dissolve in both nonpolar and polar?

Activity 1.3 What are proteins and how do they fold into biologically important shapes?

Investigation 2: Why can't you uncook an egg?

In this investigation, students will use hands-on activities and simulations to further explore how charges and the contact area of interacting molecules affects the strength of attraction between proteins and other molecules. Readings in this investigation support student understanding of protein structure, and how why proteins may be affected by temperature. In the final activity, students will explore how energy changes during interactions and how temperature affects stability of protein and ligand binding so they can answer the question "Why is a temperature of 107 degrees deadly?"

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.

Objective Target Model:
Throughout this investigation, revise models of molecular interactions in biological systems to include both polar and non-polar molecules and incorporate ideas about energy and fields. During this process, students will present their models to each other orally, and critique or support peer models using evidence. After participating in collaborative modeling, student's target model should include:

- Polar and nonpolar molecules have different attractive forces.
- The different attractive forces between polar and nonpolar molecules affect how one substance dissolves or doesn't into another substance.
- Proteins are large molecules that have polar and nonpolar parts that can interact with each other and the surrounding molecules.
- The interactions within molecules and/or with other the molecules around them can cause specific structures to form.
- The resulting configurations result in lower potential energy for the entire system.
- The resulting configuration is affected by temperature of the system: higher temperature is associated with higher kinetic energy of the protein.
- Higher kinetic energy of the protein results in distorting and sometimes (if temperature is high enough) overcoming polar and nonpolar intermolecular interactions causing the 3D structure of the protein to be changed.
- Specific 3D structure is essential for protein to carry out its functions. If the 3D structure is changed, a protein can no longer carry out the intended function.

Objective: Target Explanation
Students final written explanation includes multiple prompts designed to help them make connections between the mechanism behind clothes sticking together when they come out of the dryer, and protein denaturing in heat. The final written prompt reads "How are interactions between clothes sticking together in a dryer and proteins and small molecules similar and different?". Students bring their responses into a final class discussion where students use evidence collected throughout the year to support claims and develop connections across the phenomena explored throughout the course.

Activities:

Activity 2.1 How do polar interactions affect protein structure and properties?

Activity 2.2 How do nonpolar interactions affect protein structure and function?

Activity 2.3 How do polar and nonpolar interactions involved in a "lock and key" mechanism help cure various diseases?

Division of Instruction
Los Angeles Unified School District

Course Materials

Title	Author(s)/Editor(s)/Compiler(s)	Affiliated Institution or Organization	URL
Interactions	CREATE for STEM Institute - Michigan State University	Concord Consortium	https://learn.concord.org/interactions
Interactions	CREATE for STEM Institute - Michigan State University	Interactions Workbook	