CREATE for STEM Institute

Interactions

Curriculum Overview:

This NGSS aligned curriculum is designed to support high school physical science students in developing an understanding of the forces and energy involved in atomic and molecular interactions. The year-long Interactions curriculum could be used in a physical science class, or adjusted to embed activities into a chemistry class. Interactions can be offered as a paper-pencil curriculum with the teacher facilitating web based simulation activities on a classroom computer, or it can be offered completely online for classrooms where students have personal (or shared) computers. In particular, students will:

- Develop and use models of interactions at the atomic molecular scale to explain observed phenomena.
- Develop a model of the flow of energy and cycles of matter for phenomena at macroscopic and submicroscopic scales.

These goals support students in building a foundation that prepares them for explaining and making predictions about important phenomena in all science disciplines.

The design principles and goals used to guide the development of the materials include:

- Building understanding of ideas within and across units
- Explicitly stating learning performances to guide the development of learning and assessment tasks
- Engaging students in scientific practices
- Engagement with phenomena to help illustrate and involve students with disciplinary core ideas
- Physical models and computer simulations to help students connect observable phenomena with sub-microscopic mechanisms
- Reading materials that support understanding by building on in-class experiences

The curriculum consists of four units that focus on answering a driving question designed to engage students in the learning goal and help them relate and build connections among ideas developed throughout the unit. Each unit is made up of a series of investigations, which are in turn consists of several activities. Driving questions and overviews for each unit are included below.

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

Students develop a model of electric interactions to explain electrostatic phenomena. To develop and revise their models, students collect evidence related to how charged objects interact with other objects. They develop a particulate model of materials and a model of atomic structure to start building an understanding of the mechanism of charging objects.

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

Students further develop their model of electrostatic interactions by incorporating the relationship between electric potential energy and electric forces. In particular, the unit focuses on the electrostatic attractions and energy conversions involved in the formation of molecules (chemical reactions).

Unit 3: What powers a hurricane?

Students use their models of molecular structure to explain and predict observed properties of materials. Then, students analyze and compare the energy transformations and conversions that occur during phase changes and chemical reactions. The model of electric interactions expands to incorporate permanent dipoles at the molecular level.

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

Students explore how molecular interactions in water based environments are important for life and result in shapes necessary for biological functions. Students will apply the notion of stability and energy to describe how a fever can disrupt biologically important molecules (proteins). They will use simulations to see how temperature changes can affect the binding structure of proteins.

Alignment to NGSS

The materials will help students build competency in the scientific practices defined in the Next Generation Science Standards (NGSS). The curriculum targets and builds toward the following performance expectations from NGSS:

- 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.
- 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-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-PS3-2. 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-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).
- 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.

If you would like more information, the URL below provides a link to the instructional materials.

- http://concord.org/projects/interactions

Curriculum Stance

The Interactions Curriculum is designed to provide a learning experience for students as described in *The Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (National Research Council, 2014). The approach referred to in *The Framework* approach is called three-dimensional learning. In three-dimensional learning, students make sense of observations or develop solutions to problems by 1) engaging in scientific and engineering practices, 2) using crosscutting concepts, and 3) developing disciplinary core ideas. The emphasis in *The Framework* is that students are practicing, developing, and evaluating all these ideas rather than hearing or reading about what others did. Further, students should develop an understanding of how science works and useable knowledge through simultaneous use of the dimensions rather than focusing on one dimension at a time. Alignment with *The Framework* requires the Interactions Curriculum includes a particular pedagogical stance in addition to the resources found in all curriculums.

Pedagogical Stance

Three-dimensional learning means that students are making sense of phenomena and developing solutions to problems. This means students should be the ones who evaluate their own ideas, using the evidence they have collected as a class. Rather than having knowledge come from an authority - such as the textbook or the teacher, the knowledge is developed as students debate their ideas and the evidence they have gathered. The teacher plays a very important role in this process but must refrain from evaluating, validating, or presenting ideas and focus instead on providing a structure for students to share, evaluate, and make decisions. Students should be developing a consensus around accepted scientific ideas; however, it is the students who are deciding if the ideas are reasonable based on the evidence rather than the teacher evaluating which ideas are reasonable and which are not. Students should constantly be reflecting if they have enough evidence to support the claims being expressed. Consensus is based upon evidence and not opinion or persuasion. As such, the teacher plays a critical role in supporting students' evaluation of evidence and clarification of ideas.

Teacher Role

Since the students are evaluating their own ideas using the evidence, this means the teacher is no longer the evaluator of ideas. In three-dimensional learning, the role of the teacher shifts dramatically compared to more traditional classrooms. Instead of presenting ideas or evaluating student responses, the teacher's role is to 1) set-up a safe environment where students feel their ideas are important and 2) guide students to evaluate if they have sufficient evidence to support their own ideas, and support students in clarifying their ideas.

One way to think of this is that the teacher is "studying" the students' ideas in the same way scientists study phenomena. The teacher should gather as many students' ideas as possible. Then through labs and activities, give the students access to evidence that will push the students' thinking forward. After students have gathered some evidence, the teacher needs to sample the student ideas again to see how they have changed and how they could move even farther forward.

Classroom Environment

In order for students to evaluate their own explanation of phenomena, they will need to discuss their initial ideas, observations, thoughts about what could explain those observations, and analysis of how well their initial ideas fit with the evidence. Though the Interactions Curriculum is delivered through computers, it is not a self-paced or individual curriculum. Students should be regularly discussing their ideas with their partners and as a whole class. The classroom may be a bit noisey at times!

Discussions are an essential part of this curriculum. That means, the classroom needs to be a place where students feel safe to share their ideas, even if they are uncertain about those ideas. The teacher plays a very important role for setting up this environment. The teacher needs to communicate and role-model that all ideas are important and that everyone has something to add to the conversation. This is part of the reason that it is so important that the teacher is not an evaluator. Instead, the teacher should respond neutrally to students ideas while showing interest in what students have to say. Instead of saying "*that is a great idea*" or "*not quite, does anyone else know?*", you can summarize what you heard from the student to make sure you understood or say "*Did anyone else have a similar or different idea?*". As the students gather evidence, the teacher can then start to push students to use that evidence to evaluate their own ideas and, eventually, the ideas of others, while still being interested in what the students are sharing. This can be difficult, at first, for students who are used to getting validation for their ideas from the teacher. Some students may get frustrated when their ideas are not immediately validated as correct, or incorrect. However, it is very important that students are allowed to wrestle with these ideas and ultimately come to their own conclusions about what is happening based on the evidence they uncover. This learning process more closely resembles the nature of science learning, and leads to deeper content understanding for students.

Educative Materials

The Framework for K-12 Science Education, three-dimensional learning, and the Interactions Curriculum do represent a pedagogical stance that is a significant shift away from traditional classroom instruction. As such, these materials were written to be educative for the teachers in addition to the students. Throughout the teacher materials, there are boxes indicating important points for discussion, possible questions the teacher could use to start these discussions, and information about how students might respond to questions in the curriculum. Please do not read these as scripted curriculum. Teachers can and should be making decisions about how to respond based on what the students are sharing; however the teacher materials are meant to give you guidance and additional information to help with making these decisions.

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

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 exploring 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). By the end of the investigation, the student model will include positive and negative charges as well as patterns that can be used to explain and predict how charged objects interaction. *This investigation builds toward NGSS PE: HS-PS2-4*

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and[1] electrostatic forces between objects

Objective: Target Model

What should the student's conceptual model 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.

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?

1 The interactions curriculum focuses on electrostatic interactions. Throughout this document, portions of PE's are greyed if they are not addressed in the associated investigation.

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 how the charge on objects and the distance between them affects the strength of the interactions between those objects. *This investigation builds toward NGSS PEs: HS-PS2-4 and HS-PS3-5.*

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

What should the student's conceptual model 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.

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. Students will then use evidence from mixing water and ethanol to evaluate those models. Finally, students will apply their model to explain observations of gases. *This investigation builds towards NGSS PE: HS-PS1-3*

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

What should the student's conceptual model include?

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

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. 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. *This investigation builds toward NGSS PEs: HS-PS1-1 and HS-PS1-3.*

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

What should the student's conceptual model 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.

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 that they developed in the previous investigation. In addition, they will explore the forces involved in maintaining an atom’s structure and the effect that introduction into an electric field has on electron distribution. 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. Finally, students will revise their models of some phenomena developed during previous investigations. *This investigation builds toward NGSS PEs: HS-PS1-1 and HS-PS1-3.*

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

What should the student’s conceptual model include?
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.

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.

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

Investigation 1: What is happening when a spark occurs?

In this investigation, students begin talking about the idea of energy. Students start by defining energy and investigating differences between potential and kinetic energy. They then explore energy transfer and energy conservation. Finally, they connect energy to charges and atomic structure of matter. *This investigation builds toward NGSS PE: HS-PS3-2.*

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:

What should the student's conceptual model 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)

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 define potential energy and factors that impact the amount of potential energy that exists in a system. Students start by defining potential energy as energy that is stored in a system of interacting objects. Student then explore the relationship between potential energy and fields in order to explain how the objects interact without touching. Finally, students evaluate factors that affect the amount of potential energy stored in a system. *This investigation builds toward NGSS PEs: HS-PS3-5 and HS-PS3-4.*

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:

What should the student's conceptual model include?

- Students will use and apply a model to explain the relationship between electric force and electric potential energy as the distance between two charged particles changes and the amount of charges changes.
  - 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.

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. 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). *This investigation builds toward NGSS PE: HS-PS1-4.*

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:

What should student's target model 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.

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?

In this investigation, students will construct a model of chemical reactions involving energy and electrostatic interactions. Students learn that a chemical reaction is a process that involves the atoms of substances rearranging to form new substances and that to start any chemical reaction, energy is needed to break bonds in the reactants. Students will compare reactions and changes in energy. Students develop several models to describe observations of reactions. T*his investigation builds toward NGSS PEs: HS-PS1-4, HS-PS1-5 and HS-PS3-2.*

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:

What should the student's conceptual model include?
Students will construct a model to explain how energy and electrostatic forces are involved in chemical reactions. The model should include the following:

- 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.

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

Investigation 1: What makes water special?

In this investigation, students will connect observations of different substances to properties of the molecules of those substances. *This investigation builds toward NGSS PE: HS-PS1-3.*

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:

What should the student's conceptual model 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.

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?

In this investigation, students will add energy to their descriptions of how molecules interact. *This investigation builds toward NGSS PEs: HS-PS3-2 and HS-PS1-3.*

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:

What should the student's conceptual model 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.

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?

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

Students will look at 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. In the Investigation that follows students will explore why shape is important and how thermal energy levels are important to the stability of the molecular interactions. *This investigation builds toward NGSS PEs: HS-PS3-5, and HS-LS1-6.*

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:

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.

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 is shape important to the role a molecule plays in our body?

Students will take the notion of stability and energy and apply this to how having a fever can disrupt the structure (and thus the function) of biologically important molecules. They start by exploring how shape affects the strength of attractions between molecules, both the amount of surface area contact and the opportunity for oppositely charged areas of molecules to come in contact with each other. Students will use simulations to see how temperature changes can affect the binding and structure of biologically important molecules. *This investigation builds toward NGSS PE: HS-PS2-6.*

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Objective: Target Model

What should the student's conceptual model include?

- The attractive forces between polar and nonpolar molecules are of different strengths.
- The different attractive forces between polar and nonpolar molecules affect how one substance does or does not dissolve into another substance.
- Proteins are large molecules that have polar and nonpolar parts that can interact with each other and the surrounding molecules.
- The interaction between molecules and the molecules around them can cause specific structures to form.
- The resulting configurations result in lower potential energy for the entire system.
- The greater the surface contact between molecules the stronger the attraction between them.
- Molecules with specific shapes have specific functions due in large part to those shapes.
- Increasing temperature causes increased molecular motion which can overcome the interactions between molecules and different parts of the same molecule, thus affecting the shape and function of the molecule.

Activities:

Activity 2.1 How does shape affect the strength of interactions between molecules?
Activity 2.2 How does a protein's structure affect its function?