What superhero are you?

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This curriculum unit is recommended for:
Life Science, General Science Grades 6-8 (adaptable)

Keywords: Nanoscale, nanomaterial, nanomedicine, nanotechnology, organelles, energy, mitochondria, super hero

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: If I were a superhero? At some point in our lives we have all asked ourselves that question. In this unit I seek to explore the use of nanoscience in an effort to create the perfect super human with superpowers by introducing nanoparticles into a cell to produce a superhero result. Middle schoolers are fascinated by superheroes so why not let them imagine and have fun while they learn properties of the cell, its functions, and how nanoparticles could help cells function more efficiently. Students will complete hands on activities to create models. Students will read text allowing them to understand the role of nanoscale, nanoparticles, and nanoscience in their projects. Students will navigate websites and evaluate roles of organelles in the human cell.

I plan to teach this unit during the coming year to 100 students in 7th Grade Integrated Science

What superhero are you?

Lisbel Allard

Introduction:

Cochrane Collegiate Academy is a middle school that serves students in grade 6-8. Cochrane Collegiate Academy shares its building with our magnet high school known as I-Meck. Cochrane Collegiate Academy is a Title I School based on the federal Elementary and Secondary Education Act (ESEA). Cochrane's student body is approximately 986. The ethnic breakdown of the school is as follows: approximately 57% African American, 40% Hispanic, and 3% other. The school EOG scores for the past several years have shown that students scored below grade level on the Science EOG. I teach 7th grade science to approximately 105 students daily for 75 minutes. My student body also consists of many ELL (English Language Learners). I create differentiated activities within the school's objective to meet the diverse educational needs of my students.

My science curriculum is based on the North Carolina Essential Standards and paced according to the CMS yearly pacing guides. Following a science as inquiry pedagogy: traditional laboratory experiences provide opportunities to demonstrate how science is constant, historic, probabilistic, and replicable. Although there are no fixed steps that all scientists follow, scientific investigations usually involve collections of relevant evidence, the use of logical reasoning, the application of imagination to devise hypotheses, and explanations to make sense of collected evidence. Student engagement in scientific investigation provides background for understanding the nature of scientific inquiry. In addition, the science process skills necessary for inquiry are acquired through active experience. The process skills support development of reasoning and problem-solving ability and are the core of scientific methodologies.

Cochrane is a one to one technology school. Students have access to a chrome book on a daily basis. I therefore, use many online resources to help them learn the content, such as, video clips, discovery education, youtube, and other miscellaneous resources. The blended learning strategy helps student experience a more hands-on approach if we lack the adequate lab resources.

For each unit, I assess my students in order to develop appropriate lessons and activities.

Rationale:

If I were a superhero? At some point in our lives we have all asked ourselves that question. In this unit I seek to explore the use of nanoscience in an effort to create the perfect super human with superpowers by introducing nanoparticles into a cell to produce a superhero result. Middle schoolers are fascinated by superheroes so why not let them imagine and have fun while they learn properties of the cell, its functions, and how nanoparticles could help cells function more efficiently.

This is my second year teaching this standard, and understanding the cell and its function was an area where the students struggled. I therefore want to make it more hands-on and more engaging so that students will learn and remember how the cell actually functions in our bodies. Because of the research in the "It's a Small World! Exploring Science at the Tiniest Scale Seminar" and the field experience this summer, I plan to incorporate what I learned about the use of silver and gold nanoparticles - to help students create a mechanism that will interact with the cell. Each student will be allowed to create a super cell that will give the student superhero qualities. The mechanism the students create will have as a component gold or silver nanoparticles. The goal is not only for students to learn the functions of the human cell but also to learn how the properties of the nanomaterials can interact with the organelles in the cell to produce the desired result of superhero qualities.

Objectives:

During this unit I plan to address the following process skills and concepts:

- *Identify and create qualitative and quantitative observations within a science experiment or investigation.*
- *Design and perform an experiment or investigation demonstrating the scientific process. Collect, record, and share data within an experiment or investigation.*
- *Evaluate experimental data, draw conclusions based on the data, and communicate the conclusion within the science classroom.*
- *Evaluate complex text for reading elements, context clues, and applicable research data.*

Students will be introduced to vocabulary, reading materials, lab activities and hands-on exercises that will help them learn and be more successful with this topic, as well as make learning fun and enjoyable. Students will learn how to create a merge the properties of nanomaterials with the functions of cell organelles to create a super hero. Students will learn about the cell, each organelle, its function, nanomaterials, and all the properties of the cell as they complete different exercises and activities.

The following objectives from the North Carolina Essential Science Standards will be addressed within the unit:

The essential standard that I want to address and explore in this fellowship in order to create a curriculum for my students is the standard **7.L.1, substandard 7.L.1.2.**

7.L.1 - Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

7.L.1.2 - Compare the structures and functions of plant and animal cells, including major organelles (cell membrane, cell wall, nucleus, chloroplasts, mitochondria, and vacuoles).

What does this standard mean a child will know, understand and be able to do?

All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. A cell is the smallest part of any living thing. There are many parts of a cell. Each part of a cell completes a certain function for the cell. Students should be able to identify each part of the cell and explain its function.

Students will concentrate on these organelles:

- Cell Membrane
- Cytoplasm
- Nucleus
- Mitochondria
- Vacuoles
- Endoplasmic Reticulum
- Lysosome
- Golgi Apparatus
- Ribosome

The following Cross-Curricular Essential and Common Core Standards will be addressed within this curriculum unit:

Common Core Standard CCSS.ELA-Literacy.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Scientific Content: Overview for Teachers

Vocabulary:
Cell Membrane - forms the outer boundary of the cell and allows only certain materials to move into or out of the cell
Cytoplasm - a gel-like material inside the cell; it contains water and nutrients for the cell

Nucleus - directs the activity of a cell; it contains chromosomes with the DNA
Nuclear Membrane - separates the nucleus from the cytoplasm
Mitochondria - break down food and release energy to the cell
Vacuoles - are storage areas for the cell
Atom- the smallest component of the element having the chemical properties of the element.
Nanoscience - The study of phenomena at the nanoscale (e.g. atoms, molecules and macromolecular structures), where properties differ significantly from those at a larger scale.
Nanoscale - of a size measurable in nanometers or microns.
Nanomaterial - a material having particles or constituents of nanoscale dimensions, or one that is produced by nanotechnology.
Nanometer – One nanometer is equivalent to one-billionth of a meter.
Nano – extreme smallness, one-billionth.
Surface Area- the outside part or uppermost layer of something (often used when describing its texture, form, or extent).

Teaching Strategies:
Many of the instructional strategies that I will incorporate this year in my classroom will be from Teaching for Excellence, 5th Edition by Spence Rogers. Teaching for Excellence is a model focused on and driven by one thing. Performance Excellence for All Kids. (PEAK)

1. **Warm ups:** prepare students for what they are about to do and learn. The warm up is designed and used to very specific criteria. As the students enter class and before new instruction begins, the students are asked to respond to questions, problems or prompts that will engage the students in general type of mental activity that will be part of the instruction.
2. **Vocabulary Cards:** vocabulary cards provide a simple vehicle for supporting vocabulary development on a 3 x 5 card that is based on the Frayer Model. PEAK vocabulary cards are designed so the student can put the target word in the arched area. This placement facilitates the kids quizzing themselves or their classmates. The four boxes have prompts that are all designed to facilitate students learning the concept. It is important to note that the prompts can be easily modified to fit the targeted word, and that no prompt is asking for a definition since definitions can be artificial and confusing.
3. **Interactive Notes:** students take notes in Cornell form, but have an area where they can have an interaction with the notes. The interaction could be in the form of a drawing, writing the notes in their own words, or any other interaction the student deems appropriate. In this strategy, notes are prompted in any one of several ways, but with each, I stop after each important point for note taking and interactions with the notes.

4. **Reading Assignments:** reading assignments provide the basis for understanding. Reading assignments will be at appropriate Lexile levels for students' learning abilities. Students will also read web-based articles, magazines, and excerpts from books.
5. **Labs:** students will complete various steps in lab work as they work through this unit. Labs will be mostly completed by illustration (creating posters and other drawings) or virtually (creating a virtual superhero via Minecraft).

Introduction to Lesson:

This lesson is a first exposure to nanoscience for students. The goal is to spark student's interest in nanoscience, introduce them to common terminology, get them to start thinking about issues of size and scale, and familiarize them with the special properties of nanomaterials and how those properties can be used to manipulate the cell functions and processes of the human cell.

The students will create a fictional super hero by extracting the special properties from nanomaterials and introducing those materials to cells. By linking cell functions and processes with different nanomaterials, the student will "enhance" the cell organelles function and create a "super cell." The students will define, explain, and manipulate the organelle in order to create a superhero capable of overcoming the limitations of a human.

The following resources will guide the student into a journey that will be fun and fascinating where the student will feel like he is being transported into the future:

- TedEd Series: What if superheroes were real, which would you choose? (Several short videos).
- The Personal Touch reading, worksheet and class discussion focus on applications of nanotechnology (actual and potential) set in the context of a futuristic story. They are designed to spark student's imaginations and get them to start generating questions about nanoscience.
- The Introduction to Nanoscience reading, PowerPoint slides and worksheet explain key concepts such as why nanoscience is different, why it is important, and how we are able to work at the nanoscale.
- The Scale Diagram and models show, for different size scales, the kinds of objects that are found, the tools needed to "see" them, the forces that are dominant, and the models used to explain phenomena.
- The Cell models explain key cell functions and cell processes that are necessary to determine how and what type of nanomaterials can be used to partner for better functionality.

Introduction to Nanoscience:

What is Nano Science?

The discovery of this world is, of course, not a recent one, but one which began a long time ago. The ancient Greeks imagined the atom as the smallest unit which could not be split. This theory was then followed by a long evolution of quantum mechanics and the quantum mechanics model.[1]

Today with the improvement of microscopes we are able to see atoms in their smallest forms. In fact, with the invention of the transmission electron microscope, we are now able to manipulate the atom individually, change their position one by one and use them to create a new code. Incredible as it may sound, we can now create something that we can actually see.[2]

In 1959, the physicist Richard Feynman, Nobel Prize winner for Physics in 1965, came up with the brilliant concept of the nano during a conference of the American Physical Society at Caltech.

> I would like to describe a field in which little has been done, but in which an enormous amount can be done in principle. This field is not quite the same as the others in that it will not tell us much of fundamental physics (in the sense of, 'What are the strange particles?') but it is more like solid-state physics in the sense that it might tell us much of great interest about the strange phenomena that occurs in complex situations. Furthermore, a point that is most important is that it would have an enormous number of technical applications. What I want to talk about is the problem of manipulating and controlling things on a small scale.[3]
>
> Richard Feynman, Caltech, 1959, "There's Plenty of Room at the Bottom"

Nanoscience is the study of the performance of ultrasmall structures, materials, and devices, usually 0.1 to100 nm; also, the study of manipulating materials on an atomic or molecular scale.[4] Nanoscience is an emerging, interdisciplinary science involving physics, chemistry, biology, engineering, materials science, and computer Science.

What is nanoscale?

The study of objects and phenomena at a very small scale, roughly 1 to 100 nanometers (nm). For example, 10 hydrogen atoms lined up measure about 1 nm and a grain of sand is 1 million nm, or 1 millimeter, wide.

The nanoworld is the intermediary between the atom and the solid, from the large molecule or the small solid object to the strong relationship between surface and volume.

This world has existed for a very long time and it is up to all scientists in this field to study the structure and properties of molecules and learn how to manipulate them and build and build more complex structures. [5] The concept of the nanoworld is based on the convergence of a real mix of scientific and technological domains which once were separate.[6]

There are three important factors of the nanoscale that permeates all of the nanoscience: the pronounced effects of the surface, the importance of the quantum-bulk boundary, and the inapplicability of bulk scaling laws.[7] Everything has a surface (or interface) and both physical and chemical properties depend on the nature of that surface, regardless of whether it is a bulk material like a table or a nanoscale material like allotropes of carbon.[8] The surface is important regardless how large or small the material is.

Why do we care about surface area?

The smaller something is, the larger its surface area is compared to its volume. This high surface-to-volume ratio is a very important characteristic of nanoparticles. For example, imagine that you have a big block of gold with one-meter sides (see Figure 1). This block has a surface area of 6square meters (1square meter on a side ×6 sides) and a volume of 1cubic meter. In this case, the surface area to volume ratio for the ice block is 6/1 or 6. Suppose that cut the gold into 8 pieces that are one-half of a meter per side. The surface area of each piece of gold would be 1.5square meters (0.5m×0.5m×6 sides). So the total surface area of all the pieces would be 12square meters. However, the total volume of gold would stay the same: we haven't added or removed any gold. So in this case, the surface area to volume ratio is 12/1, or 12—twice the surface area to volume ratio of the block before it was cut. Imagine how big the surface area to volume ratio would be for something as small as a bunch of nanoscale particles.

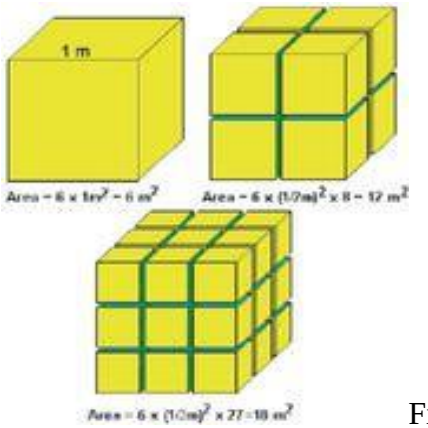


Figure 1

The vastly increased ratio of surface area to volume makes interactions between the surfaces of particles very important. If something has more surface area, there are more places for other chemicals to bind or react with it. For example, fine powders offer greater reaction speed because of the increased surface area. Nanoscale particles maximize surface area, and therefore maximize possible reactivity![9]

Why is Large Surface Area Important?

The large surface area to volume ratio of nanoparticles opens many possibilities for creating new materials and facilitating chemical processes. In conventional materials, most of the atoms are not at a surface; they form the bulk of the material.
In nanomaterials, this bulk does not exist. Indeed, nanotechnology is often concerned with single layers of atoms on surfaces. Materials with this property are unique. For example, they can serve as very potent catalysts or be applied in thin films to serve as thermal barriers or to improve wear resistance of materials.[10]

What is nanotechnology?

The design, characterization, production and application of structures, devices and systems that take advantage of the special properties at the nanoscale by manipulating shape and size. Nanotechnology is the natural progression of technology minitiarization from the bulk to the microscopic world (e.g., the plow) to millimeter-sized objects (e.g. the first transistor) to micron dimensions (e.g., integrated circuits), and finally into the nanoworld (e.g., the quantum dot).[11]

There are two approaches for the manufacturing of nanotechnology: cut-down and build-up. The cut-down enables us to control the manufacture of smaller, more complex objects such as RNA. The build-up enables us to control the manufacture of atoms and molecules.[12]

What concerns can be raised from advancements in nanoscience and nanotechnology?

Nanosciences and nanotechnologies are leading to a major turning point in our understanding of nature. Such a force has its consequences. Our future depends on how we use new discoveries and what risks they bring upon humanity and our natural environment. The ethical implications of this must therefore be discussed.[13]

Are nanomaterials safe for humans and safe for the environment? To make Federally funded nanoEHS research practical and timely, the framework underlying the 2011 nanoEHS research strategy integrates several important concepts—risk assessment, product life cycle stages, and exposure—into the basic and applied research to understand the potential EHS impacts of nanomaterials.

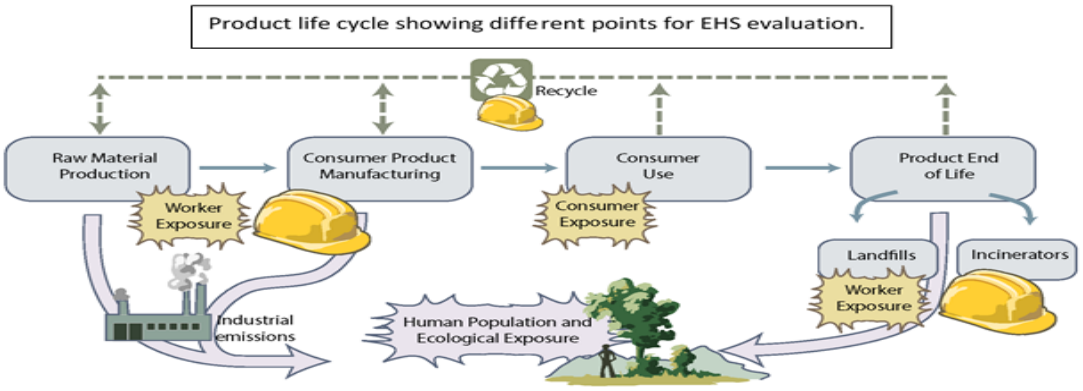


Figure 2

Regardless of the hazard, in order for any potential effects to occur, the individual or the environment must be exposed to an agent of interest. Exposure to nanomaterials may occur unintentionally in the environment or through use of nanotechnology-enabled products. [14]Therefore, it is extremely important that the handling and disposal of nanomaterials should be minimized as much as possible. It is not clear as to how the environment is affected when nanomaterials are released in the form of gases.

What are some of the ethical implications of nanotechnology? An important component of responsible development is the consideration of the ethical, legal, and societal implications of nanotechnology. How nanotechnology research and applications are introduced into society; how transparent decisions are; how sensitive and responsive policies are to the needs and perceptions of the full range of stakeholders; and how ethical, legal, and social issues are addressed will determine public trust and the future of innovation driven by nanotechnology.[15] It is human nature to want to continually develop more and more nanotechnology, but at the expense of who and what? That is the question we must all ask ourselves.

Introduction to Cell Functions and Processes:

The cell is the smallest unit that is able to perform the basic functions of life. Some organisms are made up of a single cell. These organisms are unicellular and usually too small to see with the human eye. Organisms made of more than one cell are multicellular. Multicellular organisms also cannot be seen with the human eye.

The cell is made up of different parts called organelles and it is protected on the outside by a cell membrane. Every cell has this boundary that separates the inside from the outside. Any material coming into or out of the cell must pass through the cell membrane. Contained inside the cell membrane is a gelatin-like material called cytoplasm. Most of the work of the cell is carried out in the cytoplasm. Organelles

inside of the cell is what makes the cell function, do its job. Scientist use the word organelle to describe any part of the cell that is enclosed by membrane. Different organelles have different functions. There are organelles that process information, organelles that provide energy, organelles that process and transport materials to and from the cell, and organelles that store, recycle, and get rid of waste. The organelle that processes information is the nucleus, the organelle that provide energy is the mitochondria, the organelle that process and transport is the endoplasmic reticulum, and the organelle that stores, recycles, and gets rid of waste is the vacuole.[16]

Introduction to the Properties of Nanomaterials:

What is happening lately at a very, very small scale? Properties of materials change at the nanoscale. For example, is gold always gold? Let's look at a piece of gold. If you have a cube of pure gold and cut it, what color would the pieces be? Now cut those pieces. What color will each piece be? If you keep doing this – cutting each block in half- will the pieces of gold always look "gold"? [17]

Well, strange things happen at the small scale. If you keep cutting until the gold pieces are in the nanoscale range, they don't look gold anymore. The pieces look red! In fact, depending on the size, they can turn red, blue, yellow, and other colors. Why? Different thickness of materials reflect and absorb light differently.[18]

Nanomaterials come in different types. There are organic, inorganic, and hybrid. The organic nanomaterials contain mostly carbon and hydrogen. The inorganic contain everything else besides carbon and hydrogen. The hybrid contain both organic and inorganic nanomaterials. Some examples of organic nanomaterials are the allotropes of carbon: graphene, graphite, fullerenes, and carbon nanotubes. These materials have many different qualities, they are stable, strong, semi-conductive, multi-dimensional, tightly bound, inert, very light in weight, and other numerous qualities. The hybrid and inorganic materials can be highly manipulated and synthesized. For example, they could be taken off a surface and placed somewhere else like in solutions, they tend to grow like a sugar crystal in clusters and therefore you could manipulate the size.

Light interacts with nanomaterials in such a way that some materials change colors. Quantum dots are tiny particles or nanocrystals of a semiconducting material with diameters in the range of 2-10 nanometers (a few hundred to a few thousand atoms).[19] Quantum dots display unique electronic properties, intermediate between those of bulk semiconductors and discrete molecules, that are partly the result of the unusually high surface-to-volume ratios for these particles. The most apparent result of this is fluorescence, wherein the nanocrystals can produce distinctive colors determined by the size of the particles. [20]


Figure 3

The versatility of these nanomaterials make for great ability to create something incredible at the molecular level.

Linking cell functions and processes with Nanomaterials to enhance cell function:

What kind of nanostructures can we make?

Carbon Nanotubes- using new techniques we have created amazing structures like carbon nanotubes. The carbon nanotubes are 100 times stronger that steel and they are very flexible. They can be woven into threads. If added to materials like car bumpers, they can increase strength and flexibility. How about if we add them to cell organelles? Nano-fiber coated cells that are able to resist destruction. Can we make a super hero that is able to resist speeding bullets and massive explosions? [21]

Carbon Buckyballs (C60) – These have incredible strength due to their bond structure and "soccer ball" shape. These could be useful "shells" for drug delivery to cells. They can penetrate cell membranes and walls. The Buckeyballs are also nonreactive so they can move safely through the bloodstream and the human body. How about if we use them to surround organelles? Can we make a super hero that is able to spin through and away from speeding bullets and massive explosions?[22]

Graphene and Fullerenes- These carbon structures have incredible elasticity and strength. They are strong, create friction, yield strain, have beneficial electrical properties, and are difficult to fracture. Graphene could be useful for building strong molecular structures. How about if we use them to support mitochondria? Can we make a super hero that can shoot electrical currents through his fingers and shut down ongoing threats. [23]

Gold and Silver- When irradiated by light of proper wavelength, the free electrons of a metal collectively oscillate in phase with the incident light, driven by the alternating electric field. This effect is known as surface plasmon resonance, enabling effective scattering and absorption of light under a resonant condition. This gives, for example, to metal colloids, like Ag and Au, their brilliant colors.[24]

Quantum Dots - Quantum dots display unique electronic properties, intermediate between those of bulk semiconductors and discrete molecules, that are partly the result of the unusually high surface-to-volume ratios for these particles. The most apparent result of this is fluorescence, wherein the nanocrystals can produce distinctive colors determined by the size of the particles.[25]

Lessons:

Lessons 1-3
These lessons will be for the introduction of Nanoscience, Nanoscale, Surface Area, and Nanotechnology.

Day	Activity	Materials	Comments
Prior to this lesson	Homework: The Personal Touch reading & Student Worksheet Homework: Introduction to Nanoscience: Reading & Student Worksheet Students are to start creating vocabulary cards for their vocabulary words.	Photocopies of readings and worksheets: The Personal Touch Introduction to Nanoscience Vocabulary Lists (are provided at beginning of lesson from CU list)	These readings were found on Ck-12 website. Students can be given an electronic version to the link: http://www.ck12.org/section/Introduction-to-Nanoscience
Days 1-3 Hook	Show video: *If superpowers were real, which would you choose?* *TedEd* – *https://youtu.be/0jF9xyF8mxQ* *This video introduces students to the notion of super powers, but asks the question, how does science impact our desires.* Use The Personal Touch reading &	Student handout. Inquiry questions that students will reflect on while watching the video. Handout questions to reflect on: 1. What superhero do you want to be? 2. What ways do you think you could become this super hero? 3. What changes would you have	Differentiation should be made for ELL and EC students. – video can be shown in Spanish or translated via google translator.

	worksheet as a basis for class discussion. Show the Introduction to Nanoscience: PowerPoint slides, Group and Pair work: have students review answers to Nanoscience student worksheet Show students the video about nanotechnology https://www.youtube.com/watch?v=UE5X892EnPU&feature=player_embedded Whole class discussions for questions and comments Hand out Scale Diagram and explain the important points represented on it. Tell students to keep the handout since it will be used throughout the unit.	to make to yourself or your body to achieve this goal? 4. What kinds of things exist in science that can help you get to your goal? Have you read about any of these science advancements? Introduction to nanoscience PowerPoints Computer / Projector Photocopies of all handouts	
Hook	Introduce students to surface area Students will be	Students should have their Scale Diagram from Day 1 and a Handout – Surface Area Calculators if needed.	Every student will measure and make calculations on worksheets.

Surface Area is Big!!!	given a piece of clay and instructed to make a ball with the clay. Students will then be instructed to break clay in half and make 2 balls of clay, The students will continue this pattern until they cannot make any more balls of clay. Goal: For students to realize that the same amount of clay is taking up much more room as it is divided into smaller units.	Rulers Measuring tapes and ribbons Clay Students will calculate the dimensions and area of ball as they divide it into smaller and smaller pieces.	

Lessons 4-6

These lessons will be for the introduction of cell structures and organelles.

Days 4-6 **Hook**	Show another video in the TedEd series: *If superpowers were real, which would you choose? TedEd* – *https://youtu.be/ryGR06dlpf0* In this video the super power is super strength. Introduction to cells and cell structures, and organelles. Students will be given a handout with	Reading Cell Handout Video Handout Construction Paper, Modeling Clay, pipe cleaners, markers, crayons, foam balls, glue. Students should use technology for ideas on how to make a cell model using foam balls and other materials on list.	Remember when watching these videos – students are to start reflecting as to how they will defy these scientific problems that arise in becoming a superhero.

	an introduction reading and the parts of an animal cell. Students will be given materials to create a model animal cell and the cell's organelles. Throughout the lessons – to check for understanding, students will complete various parts of the handout.		

Lessons 7-9

These lessons are for the linking of nanomaterials and cell functions and the creation of the superheroes.

Days 7-9 **Hook**	Show another video from the TedEd series http://ed.ted.com/lessons/if-superpowers-were-real-super-speed-joy-lin In this video – the super power is flying. Explain to students that for the next 3 days they are going to determine what nanomaterials are needed to create a superhero. They will examine the properties of different types of nanomaterials and determine which of those properties can the increase the	Computer / Projector Chromebook for students to do research or re-watch the videos on their own Video Handouts Nanomaterials handout Nanomaterials/Organelle Handout Posters, Pencils, Markers Crayons, Clay Notebook Paper for Interactive Notes. Chromebooks or computers should be provided to students to aid them in the	Remember when watching these videos – students are to start reflecting as to how they will defy these scientific problems that arise in becoming a superhero. In addition, students are to start thinking about how the nanomaterials they are learning about will solve these problems. Students will take interactive notes on the ethical, legal, and financial implications of creating the superhero.

	efficiency of the function of the organelles and the cell overall. Students will be lectured on ethical, legal and financial implications of creating the superhero and creating super cells. Completed product for assessment will be a poster or a virtual superhero created in Minecraft.	illustrations of their superheroes and or/to create a virtual super hero using Minecraft.	Emphasis should be made on the following characteristics of nanomaterials: Strength Malleability Light Features Color Emission Lasers Durability Students should be given plenty of time to implement these features into their illustrations.

Resources

1. List of Materials Needed
   Poster Board
   Modeling Clay
   Measuring Ribbons
   Pipe Cleaners
   Foam Balls- various sizes
   Glue
   Construction Paper
   Poster Paper
   Markers
   Colored Pencils
   Crayons

2. Resources for Students
   a. The Personal Touch, http://www.ck12.org/book/NanoSense, this reading is set in a futuristic story and it is designed to get students excited about nanotechnology and what cool things they can do in the future.
   b. Introduction to Nanoscience, http://www.ck12.org/book/NanoSense, this reading explains to the student how nanoscience is different, why it is important, and how we are able to work at the nanoscale.
   c. Cells Alive Reading, Class Handout, this reading is designed to help students identify the different organelles in the cell that makes the cell function.
   d. Nanooze.org, this website is a fun place where students can explore hear about the latest exciting stuff in science and technology, particularly things related to Nanotechnology, the science of really small things.

3. Resources for Teachers
   a. TedEd Series *https://youtu.be/0jF9xyF8mxQ* If superpowers were real, which would you choose? This video introduces teachers and students to the notion of super powers, but asks the question, how does science impact our desires. (This series has many parts and the teacher can pick and choose what other videos to share with the students).
   b. http://www.ck12.org/book/NanoSense, this lesson and resources has a lot of background to help the teacher get content knowledge. It also has additional activities for different grade levels. All of the student readings are from this website. The website could be linked to a student web platform.
   c. Nouailhat, Alain. 2008. *An introduction to nanoscience and nanotechnology*. London: ISTE. This easy to read book translates the difficult concept of nanoscience to laymen terms.

Appendix 1: Implementing Teaching Standards

- 7.L.1 - Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

- 7.L.1.2 - Compare the structures and functions of plant and animal cells, including major organelles (cell membrane, cell wall, nucleus, chloroplasts, mitochondria, and vacuoles).

All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. A cell is the smallest part of any living thing. There are many parts of a cell. Each part of a cell completes a certain function for the cell. Students should be able to identify each part of the cell and explain its function.

Appendix 2: Class Handouts

Name:_____Date:_____Block:_____

TedEd and other Video Series Questions

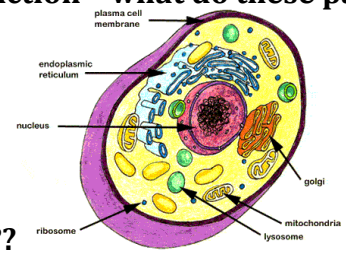
Directions: While you watch the various TedEd videos -reflect on these questions, and jot down some of your responses in the spaces below. Remember to jot down the title of video and date you watched the video.

1. What superhero do you want to be?
2. What ways do you think you could become this super hero?
3. What changes would you have to make to yourself or your body to achieve this goal?
4. What kinds of things exist in science that can help you get to your goal? Have you read about any of these science advancements?
5. What are some of the ethical, legal, and financial hurdles you think you may have to overcome to make your superhero dream come true?

Title of Video	Date watched	Answers to questions

Name: _____Date: _____Block:_____

Animal Cell Structure and Function

Cell Structure	**Function – what do these parts do??** 
Cell membrane	
Endoplasmic Reticulum	
Nucleus	
Ribosome	
Lysosome	
Mitochondrion	
Golgi Apparatus	
Cytoplasm	
Vacuole	

Name:_____Date:_____Block:____

Nanomaterials Handout

Using your notes and research- fill in handout below:

Nano material	**Description and uses:**	**What organelle is being helped and made more efficient?**	**What super power will I get?**
Carbon Nanotubes			
Buckeyballs			
Silver Nanoparticles			
Gold Nanoparticles			
Fullerenes			
Graphene			
Quantum Dots			

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Figure 1 https://dr282zn36sxxg.cloudfront.net/datastreams/f-d%3A844a6fb55512166d8eb0f9094a8631294b921e32e56a09dd2f139fe8%2BIMAGE_THUMB_LARGE_TINY%2BIMAGE_THUMB_LARGE_TINY.1

Figure 2 http://www.nano.gov/you/environmental-health-safety

Figure 3 http://www.sigmaaldrich.com/technical-documents/articles/materials-science/nanomaterials/quantum-dots.html

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