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Adapted Living Environment Lessons to Support All Students: A toolkit of strategies and scaffolds for teaching science to students with learning disabilities in an inclusive setting

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Adapted Living Environment Lessons to Support All Students:
A toolkit of strategies and scaffolds for teaching science to students with learning
disabilities in an inclusive setting

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Abstract

Students with disabilities continue to lag behind their non-disabled peers in academic achievement. Continued support is required to help them bridge this gap, and realize academic success. Increasingly, students with mild to moderate disabilities are spending the majority of their school day mainstreamed into integrated, inclusive classes. While there are potential benefits for all parties to this arrangement, it can present challenges to the educator trying to balance multiple interest levels, learning styles and ability levels in the same classroom. The vast majority of special education students don't require classroom modifications, or changes to the content delivered or expectations; but many do need accommodations or adaptations, changes to how material is learned. This project reviews available literature to determine the most successful accommodations for helping special education students be successful in inclusive science classes, and investigates how the principles of universal design can be utilized to apply suggested strategies to lessons for all students. The final project includes sample lessons and activities illustrating the use of the most recommended strategies for accommodating special education students in a high school living environment class unit on cells and genetics. There is a special focus on active learning and hands on activities.

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Chapter One: Introduction

Rationale of the Project

One of the biggest challenges facing science educators is how to best help special education students, who are increasingly integrated into the general education setting, succeed. While there are many benefits to students with disabilities (SWD) being included in general education classes (the least restrictive environment), inclusion is not without struggles for both students and educators. Many content area educators feel unprepared to deal with the challenges of classes of mixed ability students, leading to frustration on the part of both students and teachers without support. Traditionally many students with disabilities were exempted from main stream science instruction, however a greater emphasis on science, technology, engineering and math education (STEM) instruction, brought about by both the Common Core Curriculum and the Next Generation Science Standards, has more students with disabilities enrolled in general education science classes than ever before. Students with Learning Disabilities (SWLD) make up about 5% of the general population, and Students with Other Health Impairments (including ADD and autism spectrum disorders) make up an additional 2% of the general population (National Center for Educational Statistics). Therefore, these two groups of students with disabilities who are most typically integrated into general the general education setting currently make up about 7% of the general classroom population.

Unfortunately, the outcomes for SWLD are still not as good as we would like. Almost 50% of SWLD perform more than three grade levels below their enrolled grade, and 20% drop out of high school, versus an 8% drop out rate for the general population. Additionally, only

10% of SWLD enroll in a four year college within two years of graduation, versus 28% of the general population (National Center for Learning Disabilities, 2014). Clearly, there is still plenty of room for improvement, and much of work to be done to in order improve the educational outcomes for students with disabilities. Integration, and inclusion in mainstream classrooms of students with disabilities appears to be part of the recipe for success. While levels of inclusion vary, making it difficult to quantify success, studies like that by Tremblay (2013) make it clear that students with disabilities who are included in general education classes with appropriate supports do better in school, as measured by test results, than their non-included peers.

Ultimately, the goal of this project was to provide educators, who increasingly face the challenge of educating students with disabilities in the same classroom alongside general education students, a toolkit of supports to help them meet this challenge. This project includes a Lesson Plans focusing on a Cell Unit for an integrated High School Living Environment Class. The lessons contain a toolkit of strategies and scaffolds to assist teachers in creating the best possible learning conditions for both students with disabilities and those without. The toolkit is based on the philosophy of Universal Design and other research based strategies for how best to teach science to all students. It is focused on meeting the unique needs of science teachers who teach in integrated classrooms and is aimed at helping them improve the educational experience and success for both their students with disabilities, and those without.

In the short term, success of these adaptations would be defined as resulting in improved student motivation, conceptual understanding and knowledge retention. This is a critical challenge in all subjects, but emphasis on improving overall student understanding in science, technology, engineering and math (STEM subjects) has put a greater focus on student

performance in the sciences than ever before. Short term success will be measured during teaching by student response to interest surveys before and after units, by performance on formative assessments during unit and summative assessments at the end of units, and by student ability to successfully design and complete projects. In the longer term, the overarching goal of high school education is for students to graduate (something that is not a given for many students with disabilities), and not only graduate, but graduate having demonstrated college or career readiness.

Significance of Project

Students with learning disabilities are taking science courses in greater numbers than ever before, and they are increasingly integrated into general education classes. Thus, they are no longer getting specialized instruction tailored just for them. However, in both the special education and general education setting, students with disabilities continue to struggle, and fail to achieve learning milestones such as graduation more often than their non-classified peers. As a Special Education teacher who co-teaches in science classrooms at the high school level, almost half of the students in my classes are classified as a student with disabilities. Additionally, many of the remaining students, while not classified, have a variety of issues that make learning in a typical classroom setting a challenge. Therefore, teachers must find ways to scaffold instruction for these students within the general education setting. Inquiry based approaches are typical (and recommended) in science classes, so finding ways to scaffold inquiry instruction that can be utilized without interfering with the instruction of all, is essential. Using concepts of universal design and research based strategies for improving

science learning for students with disabilities will prove essential in helping all our students, including those with disabilities reach the goals of graduation and college and career readiness. While the lessons in this unit are tailored specifically to teach a Unit on Cells to Living Environment Students, the focus on inquiry with Universal Design can be used as a template for other educators seeking to adapt their lessons based on these principles.

Definition of Terms

- **Accommodations:** An accommodation refers to any change designed to help a student work around a disability. With accommodations, it is important that the end expectations, in terms of content learned, be the same for all students.

Accommodations are typically physical or environmental changes that affect how information is learned, while keeping what is learned the same.
- **Adaptations:** See *Accommodations*. These terms are typically used interchangeably to describe changes to the learning environment that allow students to work around their disabilities.
- **Cooperative Learning:** Refers to a type of active learning where students work together to support one another, learn together, and perform tasks as a small group.
- **Graphic Organizer:** Refers to any number of notetaking/organizational tools that use visual representations to express knowledge of concepts, express thoughts and ideas, and show the relationships between them.
- **Inclusive Education:** Inclusive education refers to the practice of combining all students, including those with and without disabilities, in the same classroom where they can

participate in the same lessons and activities and learn together. In order for this educational model to be successful, students with disabilities must be supported by educators and peers so they may fully participate in all aspects of school learning.

- **Inquiry Based Learning:** Inquiry based learning (IBL) refers to a learning and teaching approach where students investigate a question, scenario or problem, often guided by their teacher. The goal of inquiry based learning is that students develop their own knowledge or solutions to an issue based on their research and experimentation.
- **Integrated Classroom:** This term is often used interchangeably with *inclusive classroom*, and the basic tenets are the same, however the term integrated classroom assumes the presence of two co-teachers, one of whom is a content area specialist, and the other who is a special education teacher. In this way, the needs of both students with disabilities and those without can be met in the same classroom, and extra support is provided for those with disabilities. Students in this model are still viewed as being in general education classes, and are considered mainstreamed, but ideally they all receive extra support. While all schools are moving towards models of inclusion for students, not all of them provide the presence of a special education teacher in the classroom that would be considered integration.
- **Modifications:** Modifications are typically only made for students with the most severe learning disabilities. With modifications, the expectations for learning outcomes are changed, making assignments and assessments easier and generally lowering the grade level expectations.

- **Scaffold:** Another term borrowed from building and architecture, a scaffold for learning refers to a temporary framework or support put up to help a student reach their learning goals, and that is taken away as a student becomes proficient at a task or skill. The term owes much to the work of psychologist Lev Vygotsky and Social Development Theory.
- **Students with Disabilities (SWD):** A broad term referring to students with physical impairments such as blindness, deafness, or mobility challenges such as cerebral palsy; or mental impairments such as learning disabilities, ADD/ADHD, and autism spectrum disorders that make it difficult for them to do well in an academic setting without accommodations or modifications.
- **Universal Design/Universal Design for Learning:** Refers to principles designed to “level the playing field” for all participants. The concepts of universal design originated with architecture, and were intended to make buildings and public spaces accessible to all. An example of a universal design in this setting would be hallways and doorways that are wide enough to accommodate a wheelchair, or a ramp at the entrance of a building rather than steps. The universal design for learning has adapted these principles to make curriculum changes that remove barriers for students with disabilities, and give all students equal opportunities to learn. Examples of this in the classroom would be providing vocabulary support embedded within a text, or providing multiple means for demonstrating understanding of material.

Chapter Two: A Review of Literature

Introduction

The girl sat at her desk, head bowed, eyes downcast, hands hanging limply at her side. I approached her and asked if she needed help with the work sitting on the desk before her, if she could describe where she was stuck, and her eyes filled with tears. “I just can’t do this stuff,” she whispered. “I’m not smart in science.” Across the room, a young man was muttering under his breath, “This is stupid. I don’t feel good.” Raising his hand, he asked, “Can I go to the nurse?”

Everyone who has had to learn something new has felt discouraged or frustrated from time to time. For special education students, however, this frustration can be a daily occurrence, a constant presence, waiting to show up and make them feel useless, stupid and inferior. In response, they may give up, get angry, or avoid work. This in turn is incredibly frustrating for their teachers, who are increasingly tasked with teaching students at multiple ability levels in a single inclusive classroom. Inclusion describes the principle that “all students are entitled to equitable access to learning, achievement and the pursuit of excellence in all aspects of their educational programs” (McGhie-Richmond & Sung, 2013). How to balance the needs of so many different students? How can teachers ensure that the academically talented are challenged, and the academically struggling are supported? And how can they do it all at the same time?

The good news is, that while how best to educate students with disabilities remains a challenge, and a topic requiring more high quality research, since the 1997 reauthorization of

the Individuals with Disabilities Education Act (IDEA) (it has since been updated and realigned again, in 2004), inclusion of students with disabilities in mainstream classes has increased, with 80% of all special education students spending 50% or more of their day in mainstream classes during the 1999-2000 school year (Torreno, 2012). This means that educators today have more access to information on research based strategies for what works best for educating special education students in mainstream classrooms than ever before. So, what does that research say? Where should the harried educator turn?

Active Thinking and Hands on Activities

Inquiry

It is impossible to investigate how best to teach science without coming across the term “inquiry.” It is, by multiple accounts, the gold standard for science education. So, what is truly meant by inquiry, and does it work for students with disabilities as well as it does for the general population? Coburn (2000) provides an excellent definition of inquiry based instruction as “the creation of a classroom where students are engaged in essentially open-ended, student centered hands-on activities.” While this paints a vivid picture, it is important to recognize that there are various levels of inquiry, and that by this definition, a wide variety of techniques and instructional approaches can be considered inquiry. Coburn helps to clarify this for educators by further breaking the topic of inquiry into three categories; structured inquiry, guided inquiry and open inquiry. In structured inquiry, students are given a hands-on problem to investigate, along with procedures and materials, but are not informed of the expected outcomes. In guided inquiry, the teacher provides the problem to investigate and the materials to do so, but does

not provide the procedure students are to follow -- they develop those themselves. Open inquiry is similar to guided inquiry, but takes it a step further in that the students themselves also choose the problem they would like to investigate. This approach most closely resembles “real” scientific research. In addition, a fourth category, called “learning cycle,” is a hybrid that provides a method for utilizing inquiry based techniques in the classroom. In the learning cycle, students are introduced to a new topic through an inquiry activity, then the teacher explains the concept, and then students carry out another inquiry activity where they have to apply the information in a new or more advanced situation (Coburn, 2000).

Challenges of Inquiry for Students with Disabilities

While inquiry is the method most touted for teaching science, many educators wonder if their students with disabilities can truly handle learning using this method, or whether these approaches are best reserved for only the highest performing students. This question is addressed by Coburn (2000), as well. While Coburn does recommend that inquiry investigations be confined to concrete rather than abstract concepts, as the risk of confusion and developing misconceptions can be quite high with students especially in the younger grades and with struggling students, this is presented as a way to ensure that younger students and students with disabilities can gain the most from inquiry instruction, and not as a suggestion to abandon the approach. Kirschner et al. (2006) worry that limitations in working memory of students with disabilities might make it very difficult for those students to transfer information to long term memory (in essence, to learn) while at the same time processing new information from hands-on learning methods such as inquiry based learning, discovery learning and problem based

learning. However, they do concede that minimally guided activities, such as open ended inquiry, can lead to superior learning, but caution that this only occurs when the student already has significant understanding and background knowledge upon which to build. Therefore, they advocate inquiry for only the highest level students, and those with significant previous experience in the topic. It appears as if they are recommending that only scientists should engage in true scientific research. This leads one to wonder how students are to experience the joy of scientific discovery, or to learn how to engage in scientific research. It seems that it would be more valuable to investigate how best to scaffold the learning of students with disabilities to allow them to experience the excitement and deeper conceptual learning of inquiry based approaches, rather than to dismiss it entirely for all but the most advanced students. Perhaps younger students could begin with structured inquiry lessons, and as they grow in skill and confidence move on to guided inquiry, and finally proceed to open ended inquiry.

Benefits of Inquiry for Students with Disabilities

As addressed earlier, it is well recognized that students with disabilities have poorer academic outcomes than regular education students. Does this mean that students with disabilities should be taught using different methods than those recommended for regular education students? Should inquiry and other constructivist pedagogical approaches used in science classrooms be avoided for special education students, in favor of an emphasis on direct instruction? Minner, et al (2010) investigated this question in a synthesis of research done between 1984 and 2002. On the pro side, over half of the studies showed significant benefits to

students from inquiry based approaches. On the flip side however, slightly less than half of the studies showed minimal or insignificant benefits from inquiry based approaches over other approaches. It's important to recognize though, that even students in studies where there was no significant gain experienced with inquiry based learning and teaching approaches, students did not suffer in achievement compared to similar students taught with more traditional, direct instruction methods. Basically, while inquiry isn't always better (very likely based on how it was presented, and how confident and skilled the educator was in using these instructional methods), the results were never worse than those achieved through traditional, less engaging methods. Indeed, according to Minner et al, what appeared to be most important to achieving student success was whether or not students were involved in active thinking, drawing of conclusions and hands-on activities; all features that are intrinsic to inquiry based teaching and learning approaches. Similarly, Lynch et al. (2007) studied a group of both students with and without disabilities who participated in lessons utilizing a highly rated, inquiry based science curriculum. While admittedly student with disabilities did not perform as well as those without, both groups did improve their scores on tests of understanding, and both groups, including those with disabilities outperformed similar groups of students who were taught with more traditional, direct instruction and text book based approaches. Preus (2012) comes to a similar conclusion, admitting that while students with disabilities do not generally do as well with inquiry as those without disabilities, additional studies show that students with disabilities who were given challenging inquiry tasks performed better than students without disabilities who were given less challenging tasks. Additionally, she emphasizes that comparisons between the performance of students with disabilities and those without are not exactly fair, and further

admonishes that these results should not lead to educators limiting their students with disabilities to less challenging and less thought provoking tasks as the gains in achievement for both groups is greater with inquiry than with other approaches. Likewise, Kaldenberg et al's research (2011) shows that students with disabilities who took part in an inquiry based approach called the Science Writing Heuristic (SWH), a writing to learn technique in which students help to construct their knowledge through a series of writing steps, where they brainstorm questions and ideas, test their ideas, make observations, create a claim based on evidence, research the results of others, and finally reflect upon their learning, showed significantly greater improvement in test scores, over five years, than did similar students who did not participate in the program. McCarthy (2005) also supports the effectiveness of hands-on, inquiry based learning approaches for students with disabilities, noting that measurable improvement was greatest when students performed hands on and short answer assessments, despite the fact that no improvement was seen between inquiry and traditional instruction on answering multiple choice questions, which makes sense, as inquiry is a hands on approach that is likely to cause the greatest benefit in areas of skills and problem solving. While the results are mixed, a great number of studies support benefits of hands on, inquiry based approaches for students with disabilities. Therefore, it seems clear that it is important to continue to provide both students with and without disabilities with the opportunity to engage in hands on inquiry based learning experiences, while finding ways to support and scaffold student learning to allow them to achieve maximum gain from these opportunities. Additionally, there is a clear need for teachers to be more involved in the process of educational research, and in developing

studies to help students with disabilities be more successful in inquiry based courses (Keys and Bryan, 2001).

Additional Supports to Help Students with Disabilities

Clearly, while both researchers and teachers in the trenches express different levels of buy-in for inquiry instruction, it shows promise on many levels for both students with disabilities and those without. Given the potential benefits of inquiry based instruction, it is important that we investigate based on available research, what factors make inquiry instruction truly effective? In short, how do we go from good to great, and how do we scaffold the learning process to ensure that this approach works for students with disabilities? As Minner et al. (2010) pointed out, studies that show the greatest success for students utilizing inquiry techniques were those where the students were actively engaged in their learning and in the lesson, and where they were given time and opportunity to reflect on their learning and to draw conclusions. How do we keep the engaging, hands on, constructionist elements of inquiry while supporting students with disabilities? Jimenez et al. (2012) recommend calling in backup to help; using peer tutors to scaffold the understanding of students with disabilities, helping them to more fully participate in inquiry science classes. In their research when groups were well structured by teachers, and ground rules were clearly expressed and followed, both tutored and tutoring students showed significant gains in learning. Peer tutoring can be accomplished formally, or informally, by assigning groups of mixed ability students to work through problems together. Eick and Reed (2002) discuss which factors make a teacher more likely to utilize inquiry based strategies in their lessons, and determined that better teachers;

those who are more experienced, have more pedagogical knowledge, who view themselves as both learners and teachers and value connections and drawing conclusions, are most likely to use inquiry techniques. Clearly teacher training in pedagogy, and toolkits such as this one to aid teachers in educating students with disabilities in inclusive classrooms play a role in how well inquiry is performed. Mastropieri and Scruggs (1992), who were early advocates of science education as a tool for to help students with disabilities obtain the skills they need to succeed both academically and in life beyond school, believe that activities oriented strategies such as inquiry, and hands on projects promote not only science content knowledge, but processing (thinking) skills and manipulative skills. They also suggest that as lack of science vocabulary understanding can inhibit student understanding of a topic, that teachers should focus on direct vocabulary training. Additionally, they recommend providing students with study guides and text adaptations. Further recommendations for teaching science to students with disabilities include enthusiastic delivery, a structured environment, and specific study skills training. Vanest et al. (2012) additionally suggest regular, formative assessments or progress checks to enable teachers to evaluate the progress of students with disabilities, enabling them to step in and offer timely remediation, re-teaching and support. This way, students do not get hopelessly lost and fall behind. Vanest, et al. also stress that what is key in these progress checks is not that students obtain perfect scores, but rather that they are showing growth and progress. With this approach, a teacher shouldn't be alarmed if a student only scores a 65 on an intermediate progress check, as long as the slope of their scores during the unit follows a positive trend. Waldman and Crippen (2009) recommend the use of writing to learn to help students utilize the

learning cycle, stay organized and reflect on their learning. These strategies will be utilized in the following lessons to support students with disabilities – and those without, learn science.

Universal Design

What is most interesting about these research based modifications to lessons is that they don't apply exclusively to students with disabilities. In fact, one might argue that many, if not all of them, would be considered best practices for teaching all students. This is the idea behind Universal Design, a concept that began in the field of architecture. Proponents of Universal Design argue that rather than retroactively adapting and modifying instruction (or originally, buildings) for a few individuals whose needs are not being met, it is important for educators to examine their lessons in order to make them as accessible as possible for all students. Watt et al. (2013) recommend that students with disabilities can be made able to participate in inquiry based learning through use of Universal Design for Learning (UDL) defined as the teacher providing multiple means of representation, expression and engagement. Most human abilities and disabilities fall on a continuum, and Universal Design seeks to incorporate features such as those listed above that benefit, if not all, at least most students, into lessons (McGuire et al, 2006). According to McGhie-Richmond and Sung (2013), teachers who become adept at adapting their lessons to accommodate students with disabilities become better teachers of all students. Universal Design for Learning Principals don't seek to teach students with disabilities one way, and those "without" another way, rather they stress providing all students with multiple means. Following are the nine guidelines of universal design for learning,

which expand upon the three principles mentioned earlier, providing teachers with more guidance, as presented by McGhie-Richmond and Sung:

Principle 1--Use multiple means of representation:

Guideline 1, Provide options for perception.

Guideline 2, Provide options for language, mathematical expressions, and symbols.

Guideline 3, Provide options for comprehension.

Principle 2--Use multiple means of expression:

Guideline 4, Provide options for physical action.

Guideline 5, Provide options for expression and communication.

Guideline 6, Provide options for executive functions.

Principle 3--Use multiple means of engagement:

Guideline 7, Provide options for recruiting interest.

Guideline 8, Provide options for sustaining effort and persistence.

Guideline 9, Provide options for self-regulation.

The lessons and activities that follow seek to create science lessons for a Living Environment Unit based on the Cell, utilizing the ideas from research on educating students with disabilities and the concepts of Universal Design.

Chapter Three: Capstone Project

Project Design

My goal with this project is to use research based techniques for teaching science in order to improve the outcomes for not only my students with disabilities, but for all the students in the class. In doing so, I will rely heavily on the philosophy of universal design. The structure of my classes means that I need to find a way to tailor lessons to support all students, as I do not have the option to split my class into “special education” and “non special education” sections. I want all my students to succeed, and in order to do this, I need to build in scaffolds and supports that all students can benefit from, without excluding them from the regular instructional activities.

This specific unit focuses on teaching a High School Living Environment Unit on Cells. The lessons and activities included in this unit incorporate the following ideas for teaching science to all students – those with disabilities, and those without:

- Opportunities for students to be involved in building knowledge. This includes hands on and activity based learning opportunities, using many of the elements of inquiry based learning. (To improve student engagement and motivation)
- Use of the learning cycle (To support all students in engaging in scientific inquiry)
- Opportunities to create connections, draw conclusions and reflect on knowledge
- Graphic Organizers (To help students organize information when direct instruction is necessary)
- Direct Vocabulary Support (Science requires a great deal of new vocabulary. Vocabulary supports will be integrated into readings and lessons, to help all students understand important concepts)
- Analogies (To construct understanding of non-concrete/theoretical concepts.)
- Collaborative Learning, in the form of Group Work/Peer tutoring/Peer teaching (These strategies have been shown to help students build understanding, as well as increasing motivation)
- Enthusiastic Delivery

- Concrete rather than abstract inquiries (Inquiry will be used when the students can gain a concrete, observable result, but all forms of inquiry – structured, guided and open ended will be used depending upon the lesson)
- Student choice in how to learn and/or demonstrate knowledge

Outline of Project

Unit Title: Cells and Genetics

While there is a significant overlap in all topics of the Living Environment Curriculum, these lessons will focus on the material from the New York State Living Environment Standard 4, Performance Indicators 1.2-1.3, 2.1.

Lesson #	Lesson Title/Supplement	General Description/Overview	Length of time
1	What is a cell? Lesson Plan/Activity	Basic properties of a cell, cell organization. Includes a cell reading.	75 min
2	Cell Theory, You and Pro Karyo- whatic? Activity	Students learn about the history of the cell's discovery, and the modern cell theory. They read to answer questions and create a graphic organizer (Venn Diagram) comparing and contrasting eukaryotic and prokaryotic cells.	75 min
3	Plants vs Animals Activity	Students explore the difference between plant and animal cells.	75 min
4	Analogy Option 1 – RAFT Activity	Students create a RAFT Analogy. Includes a student notes sheet, suggested ideas, and rubric	2 x 75 min
5	Alternative Option: Cell Analogy Poster Activity	Students create a poster of their cell analogy, rather than a RAFT	2 x 75 min
6	Let's Build a Cell! Lesson Plan/Activity	Students use an on-line game to build a cell, and increase their understanding of how a cell functions	75 min
7	The Scale of the Universe Activity	Students use the on-line program "The Scale of the Universe" to gain an understanding of the size of a cell, and how they are arranged into tissues, organs, organ systems and organisms	75 min

8	Litty Bitty: The Care and Feeding of a Microscope	Students will investigate the basics of using a microscope.	75 min
9	Cells and Other Itty Bitty Things	Students will use a microscope to observe both plant and animal cells.	75 min
10	Transport POGIL: Diffusion and Osmosis	Students will use a POGIL activity to build understanding of diffusion and osmosis and how the cell membrane works.	75 min
11	Making Connections: How are These Things Like a Cell?	A formative assessment activity to determine students understanding and possible misconceptions of the cell and cellular functions.	75 min
12	It's Alive! (Or is it?)	Students will review the basic life functions, and what classifies something as living or non-living. Includes a reading of "Substituted Sammy" (author unknown) 11and class discussion.	75 min.
13	It's All Greek and Latin to Me!	Students will use the vocabulary strategy of vocabulary wheels to learn genetics vocabulary words.	75 min
14	And So It Grows (If It's Alive)	A lesson on cell growth, and mitosis	75 min
15	Monster Traits	A basic lesson in genetics and heredity, using "monsters."	75 min
16	Monster Love...and Monster Babies	Students investigate how sexual reproduction results in genetic diversity, using their "monsters" from the previous lesson.	75 min
17	Learning About Meiosis Using SQ3R Reading Strategy	Students will use the SQ3R Reading Strategy to learn about Meiosis. Contains instructions for SQ3R as well as a reading on Meiosis, adapted from "Life's Greatest Miracle."	75 min
18	Reading a Pedigree Chart: Guided Reading Lesson	This lesson guides students through reading a pedigree chart. Several pedigree charts are included.	75 min

19	Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering	A web quest to guide students through issues in genetic engineering.	2 x 75 min
20	Ugly Sweater Vocabulary Activity	This vocabulary activity can be used with any unit (best as a winter activity, though) to get students to attempt to visualize the meaning behind their vocabulary words). When completed, I set this up as a station activity where students travel around the room and try to determine the vocabulary represented on each of the "sweaters"	2 x 20-30 min
21	Vocabulary Triangle Puzzle Template	I use this to create a warm-up puzzle activity using vocabulary and definitions. A good, quick formative assessment.	10-15 min
22	Cell Transport Graphic Organizer	Quick review/note sheet for the end of cell transport.	10-15 min
23	Cell Membrane and Transport Graphic Organizer	A good end of unit check of knowledge.	10 min

1) “What is a cell?”

Purpose to share with students

Cells are the fundamental structure of life -- all living things, from Christmas trees and roses to toenail fungus, your pet cat, and you yourself are made up of these tiny structures, just as a house or building might be made up of bricks. But these tiny “building blocks” of life are more than inert, unresponsive blocks or placeholders. In fact, they are the smallest units capable of independent life, and there is a whole world of activity going on within each and every cell. Just as our bodies are made up of specialized organs, which help our body carry out necessary processes, within each cell are organelles – smaller components, which help the cell carry out the functions necessary for it to live. Today we will be investigating the components that make up a cell, and allow for it to remain alive on its own.

State Standard and Objectives

Standard 4, Key Idea 1.1a, 1.1c. Objectives for this lesson are that students will begin to understand the basic cellular components, and their functions. They will work cooperatively to review material to come to a better understanding of new material, and they will teach newly acquired information to their peer group.

Major Concepts

Students should develop an understanding that living things are composed of cells, come to an understanding of what a cell is, recognize the major cellular organelles, and begin to understand their functions.

Instructional Objectives

1. Develop an understanding of what a cell is.
2. Use literacy skills to learn about basic cell components (organelles).
3. Have students carry out peer teaching to explain the form and function of the structures they have read about. This teaching experience will help students to better learn the concepts they have read about, allow the teacher to informally assess students comprehension levels of the new material, and allow stronger students to support struggling students in a non-intimidating manner.

Instructional Activities

1. As a pre-assessment, ask students to brainstorm all the terms they can think of that contain the word “cell”(3 minutes) (jail cell, cell phone, etc.)

2. Engage -- Class activity, where students are assigned roles in creating a cell. Students will form a “barrier”, creating an inside and outside environment, a “boss” will order everyone inside around, “doorways” will be created to allow big things in and out (although smaller students might be able to wriggle their way into and out of the cell), a snack shop will pass out snacks, a sanitation worker might need to be called in to pick up messy wrappers, etc. (approx. 10 minutes)
3. Reading Strategy – Pairs Read

Anticipatory Set: Our complex and amazing bodies have more in common with the simple protozoans and amoebas than you might think. In both our bodies, and in the protozoan, the cell is the basic unit of life -- the difference is, we are made up of many cells, whereas a protozoan’s entire body is composed of just one cell! Cells are invisible to the naked eye, and are often referred to as “building blocks” of life, but there’s a whole world of activity going on inside even the simplest of cells. The cell is made up of organelles (Get it? Little organs!) which carry out all the vital functions of the cell. You can almost think of the cell as a city, with factories, restaurants, a decent transportation system, and a waste disposal system! Today you are going to be pairing up and reading about what goes on inside a cell, and together you will work to construct and understanding of how the organelles in your cell function to keep the cell in balance. If it helps you to compare the cell to a city, or a factory, or a school, go for it!

Objective: To learn about the functions of cellular components by working in a team with another student. Students will assist each other in constructing meaning by taking turns reading and listening, then putting the text in their own words, and by asking and answering questions to help refine understanding.

Purpose: Today we will be reading a text which explains the internal workings of a cell, and which talks about how the smaller components of a cell, the organelles help to keep the cell functioning properly. Working in pairs, students will take turns reading and listening, and then listeners will summarize the passage for the reader, making sure to include important supporting details. Both the reader and the listener can ask each other questions to clarify understanding. Reading is often seen as only a solo activity, but today we will explore how two heads really can often be better than one, as we work to develop a clear understanding of the functioning of a cell.

Body of the Lesson/Guided Practice: All right class, today you will be reading a short text about the things you can find inside a cell. Often, cells are referred to as building blocks,

but in reality, they are anything but block like. Inside that microscopic ball, is a whirl of activity! Because we can't actually see most of what goes on inside a cell, however, it can be hard to remember all of the little organelles and what they do for the cell. Students will take turns reading a portion of the text. The listener -- or coach -- will then break down the main idea of the paragraph, and summarize it for the reader, making sure to include supporting details to augment understanding. The reader and listener/coach switch roles for the next section of text, and then continue to read and discuss alternate sections of the text until the reading is complete. Students will then cooperatively summarize the main ideas and supporting details of the text. Students are welcome and encouraged to come up with analogies to describe the cell and organelles in order to help them remember and understand how the components of the cell function. Some more popular analogies include comparing the cell to a city, school or factory.

Let me start with the first section of the passage, to show you what I want you to do. I will be the reader, and you all will be my listeners. Feel free to take notes as I am reading if that helps you keep track of your thoughts, but don't worry about using complete sentences -- I really want you to pay attention to the reading, so you will be able to summarize, in your own words, what was read. Once I'm done reading, I will ask you to tell me what you think the passage was about, and I will write your thoughts up on the board. Remember, you can ask for clarification, or for me to re-read a portion of the passage if you like! All right, here goes! (Teacher reads the first portion from "Animal Cells" about cell membranes, aloud for the class). Okay, who would like to tell me what that was all about? (Several students raise hands, and the teacher calls on them for their input. Teacher writes all of their main ideas and supportive details on the board, occasionally asking for clarification. Students fuss a bit about one student's interpretation, and after some back and forth, they ask that a portion of the passage be re-read.) Excellent job, class! You really listened to my reading, and worked hard to figure out what it meant. I really like that you all worked together to come up with a great understanding of what the cell membrane really does! That's exactly what I'd like you to do for the rest of the passage. Find a partner, and take turns being the reader and the listener. Make sure that you write down what you think the text means when you are summarizing together. When you have completed the article, I'd like each group to help us figure out as a class what is going on inside our cells (teacher passes out article and table for notes -- see attached). If it helps you to visualize the organelles, draw pictures, or compare the cell parts to other objects to help make sense of them, go for it. For example, I always imagine the cell as a miniature city, and the organelles all play a role in keeping the city functioning properly.

Post Reading Closure: Anyone want to tell share how the cell membrane functions in the cell? Come on up to the smart board, and write down your idea, so we can all see. (Example: describing the cell membrane as a moat around an old fashioned city. Why do you think the cell membrane is like a moat? Because it keeps things out. Excellent. Anything else a moat does? Yeah, keeps things in, too! So, is it possible for people to get in and out of your city, or are they locked in all the time? Oh yeah, that's what the drawbridge is for! How does having a drawbridge make the moat function more like the cytoplasm? Okay, the drawbridge lets people in and out of the city, but you can control who comes in or goes out. Very nice. Anyone else have a different idea they want to share?)

Closure: Excellent, you all have some really great ideas, and a deep connection to what is happening inside those tiny cells of yours. How many of you knew they were so busy?!

Assessment: The in-class sharing activity was a great way for the teacher to see how students were thinking about the concepts, and to assist those who were struggling. Working together allowed students to interact with each other and with the text much more actively, and helped them in constructing meaning. It also forced students to really think about whether they understood or not, as they had to summarize it for another student, and not just for themselves.

Inclusive Adaptations: Students have the opportunity to share ideas and ask questions about the assignment and about the concepts. Students are paired together, so readers and listeners can support each other, even if one reader is stronger than another. Everything is presented visually on the smart board, as well as orally. Students are provided with clear handouts, which they can use to take notes and reference at a later time. Information will also be posted on-line, on the classroom web-page for those students who have difficulty taking notes. Students grouped in heterogeneous manner, with tables arranged in clusters to allow for easy group interaction, and minimal distraction from other groups. Ensure that weaker readers and stronger readers are assigned to the same text set, and allow for all students who read on the same topic to discuss and come to a consensus before returning to their own groups as teachers, allowing everyone the opportunity to feel confident and "expert" in their understandings, be available to students to assist them in staying on task.

Technology: The smart board is used to allow students to see as well as hear the information that is being shared. The classroom webpage is used as a site to post ideas

generated in class, for students who have difficulty paying attention and taking notes at the same time.

Questions

Tell me about...? Explain how ... works? How does ... compare to our group activity?

Instructional Materials

Signs for students to hold/wear during class activity (i.e., THE BOSS, CAFETERIA, etc.), cell organelle readings and note sheets

1) What is a Cell?

Animal Cells The Cast of Organelles (little organs!):

1. Every cell needs to have a way of keeping important stuff inside, and keeping unwanted stuff outside. The animal cell doesn't have walls like our house to keep the heat in, and snow and burglars out, but it does have a **cell membrane**. The cell membrane forms a barrier between the inside of the cell and the world outside. It is made up of two layers of oily, fatty molecules called **phospholipids**. This layer is flexible and fluid. Imagine a drop of oil floating on the surface of water. While some small substances can fit through the molecules of the cell membrane, larger substances cannot. Just like you need doors to enter your house (squeezing through the walls is pretty hard) big molecules need to have a passageway into and out of the cell. **Protein channels** stuck into the cell membrane provide these larger molecules with a doorway into and out of the cell.
2. The animal cell isn't hard and rigid – if it could be expanded, it would feel kind of like a water balloon. The cell can't maintain its curvy figure without help, though. A network of thin protein tubes and fibers give the cell structural support, like girders on the Eiffel Tower, or the bones of your skeleton. This network of tubes and fibers is called the **cytoskeleton (cyto means "cell")**, and the fibers of the cytoskeleton crisscross throughout the cell. All of these tubes and fibers are attached to barrel shaped structures called **centrosomes**, which work like spools (think thread) to anchor and organize the tubes and fibers of the cytoskeleton.
3. The inside of the cell is filled with a liquidy gooey substance called the **cytoplasm**.
4. Just like our bodies need our brain to coordinate and control all of our activities, the cell needs guidance too. The "brain" of the cell is a large organelle called the **nucleus**. The nucleus is surrounded by a **membrane** that functions like the cellular membrane, controlling what goes in and out of the nucleus. Inside the nucleus, the blueprints (plans) for all the proteins made by the cell are stored as **DNA**. At the center of the nucleus is another structure, called the **nucleolus (little nucleus)**, which manufactures **ribosomes**.
5. So, the nucleus contains the blueprints (or plans) to make proteins. But the nucleus doesn't do the actual work of assembling those proteins. So how do the blueprints get made into proteins? There are several steps. First, when the cell needs to make proteins, the nucleus translates the instructions from the DNA blueprints onto **messenger RNA (mRNA for short)**. Why does it do this? You can imagine that the DNA blueprints are too precious and valuable to leave the safety of the nucleus. The nucleus makes copies to send out into the cell, while the "originals" stay safe and sound inside the nucleus. Once the plans have been sent out of the nucleus into the

cell, tiny two-part organelles called **ribosomes** attach to the mRNA plans, and follow the directions to assemble proteins out of **amino acids (smaller molecules that are considered the building blocks of proteins)**. Ribosomes can either be floating freely around the cytoplasm of the cell, or attached to the surface of another organelle called the **endoplasmic reticulum (ER for short)**. Typically free-floating ribosomes make proteins that will be used in the cell. Ribosomes attached to ER usually become membrane channel proteins, or are sent outside the cell.

6. The cell is a busy place. To keep things from getting too messy in there, the cell has organelles to manufacture and package some of the things that are made in the cell. One of these organelles, called **endoplasmic reticulum (ER for short)**, extends from the membrane of the nucleus, almost like sacs hanging off of the nuclear membrane. By the way, “endo” means “inside”; “plasma” is a liquidy substance, in this case the liquidy stuff inside the cell; and “reticulum” is a network. So the endoplasmic reticulum is a network of membranes inside the cell! Why didn’t they just say that in the first place? ER comes in two forms, **rough ER** and **smooth ER**. Rough ER is called that because its outer surface is covered with little ribosomes, which give it a bumpy, or rough appearance. A rough ER packages protein made by the ribosome and sends them to the cell membrane or outside of the cell. Smooth ER does not have ribosomes on its surface. Smooth ER makes fatty substances called **lipids**, which are used to make cell membranes, or are sent out of the cell.
7. Warehouses receive shipments from external sources, repackage and modify them, and send them on their way to the final destination. The cellular organelles, which receive shipments from the endoplasmic reticulum, modify and repackage the shipments, and send them on to their final destinations, are the **Golgi Bodies**. (“Go, busy body!”)
8. Just as it takes energy for you to walk across the room, pay attention in class, or even fidget, it takes a lot of energy for the cell to do all the things it does. Where does it get that energy? The mighty **mitochondria** (singular = mitochondrion) are the cell’s power plants, generating energy in the form of ATP from sugars. Unfortunately, like many power plants, mitochondria are also responsible for generating a large portion of the cells damaging waste products. Mitochondria are long and narrow, with an outside membrane, and a much larger inside membrane. How is that possible? How could a larger membrane fit inside a smaller one?
9. While the cytoplasm of the cell is a very crowded place, there are things that cannot be allowed to hang out loose in the cell. For instance, enzymes that breakdown and digest proteins can’t be left lying out (any idea why that would be problematic?). In order to compartmentalize, or separate items from the rest of the cell, the cell creates containers used to store all sorts of things. These containers are called **vesicles (or “little vessels”)**. One type of vesicle is the **lysosome** (“lyse” means to break down, or break apart), which contains digestive enzymes. These enzymes are

used to digest food and release nutrient to the cell, and also to recycle worn out organelles. Another type of vesicle is the **peroxisome**, which picks up and breaks down damaging peroxide waste products produced by the mitochondria.

(Jigsaw Reading/Teaching opportunity, text written for inquiry lessons, by Kristen Kimble)

2) Cell Theory, “You” and “Pro” Karyo-whatic?

Together as a class, we will be watching a TED Talk on the wacky history of cell theory (<http://ed.ted.com/lessons/the-wacky-history-of-cell-theory>)

Together, we will discuss the associated questions.

Students will work in pairs and use the following timeline to build their version of early cell theory.

(http://www.softschools.com/timelines/cell_theory_timeline/96/)

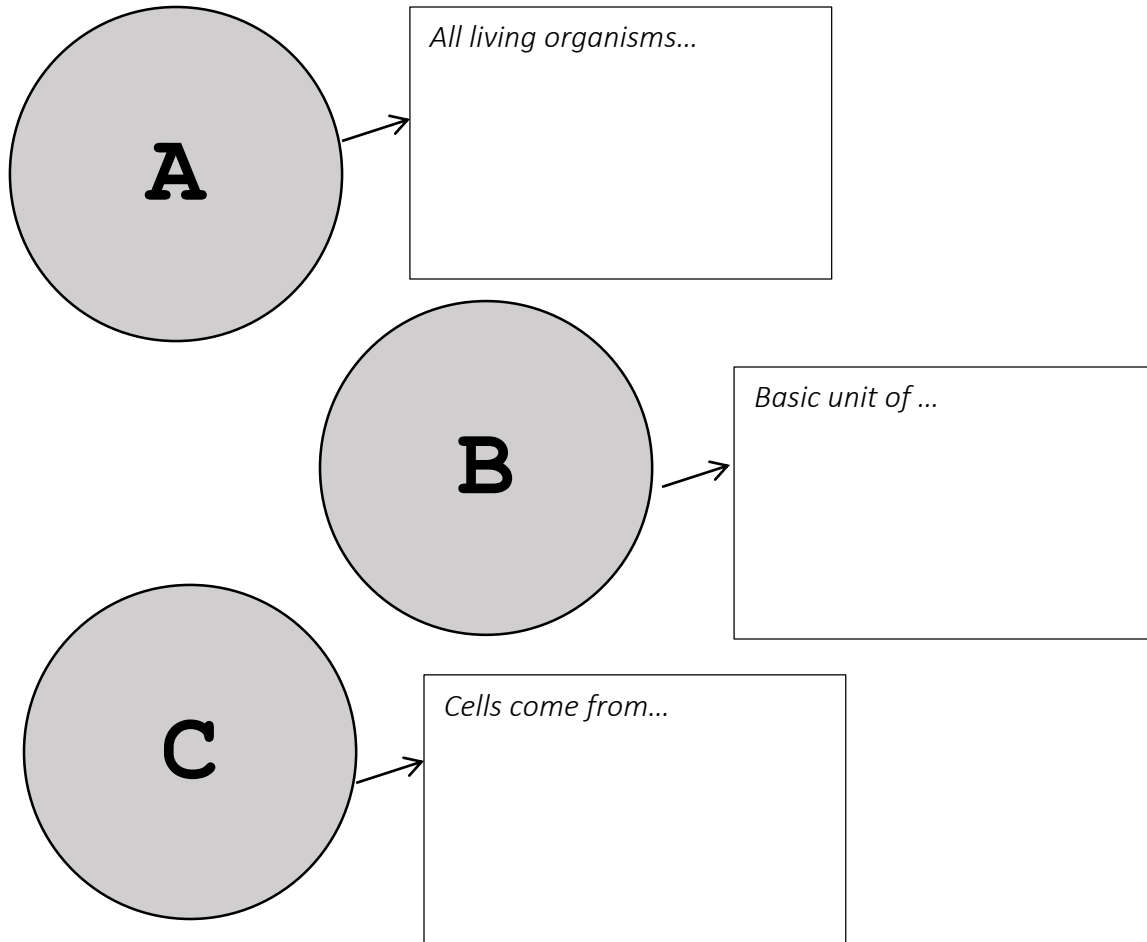
Following this, they will read a brief article on the two types of cells, and use this information to answer questions and construct a Venn Diagram

2) Cell Theory, “You” and “Pro” Karyo-whatic?

Early Cell Theory...Use the information from the timeline

(http://www.softschools.com/timelines/cell_theory_timeline/96/)

to build your version of early cell theory.



Modern Cell Theory

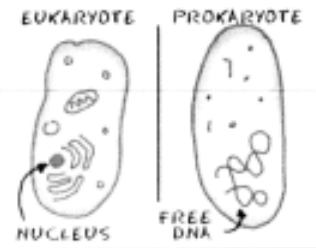
The generally accepted parts of modern cell theory include:

1. All known living things are: _____
2. All living cells arise from: _____
3. The fundamental unit of structure and function in all living organisms is: _____
4. The activity of an organism depends on: _____
5. Energy flow: _____
6. Cells contain: _____
7. All cells are: _____

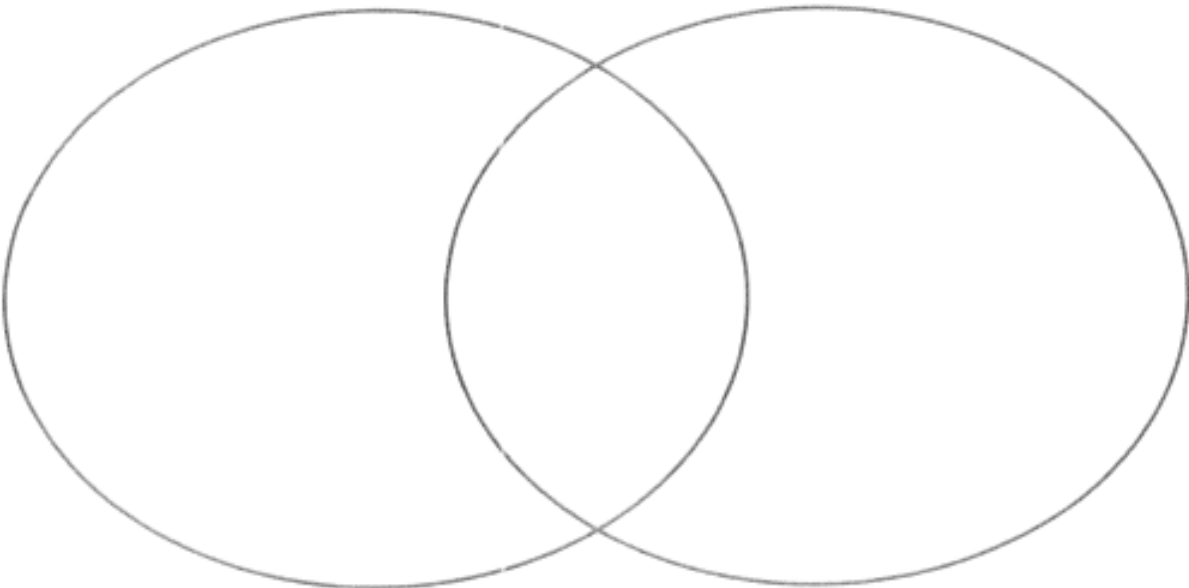
I. Types of Cells

Two major classes of cells:

a.) Prokaryotes:

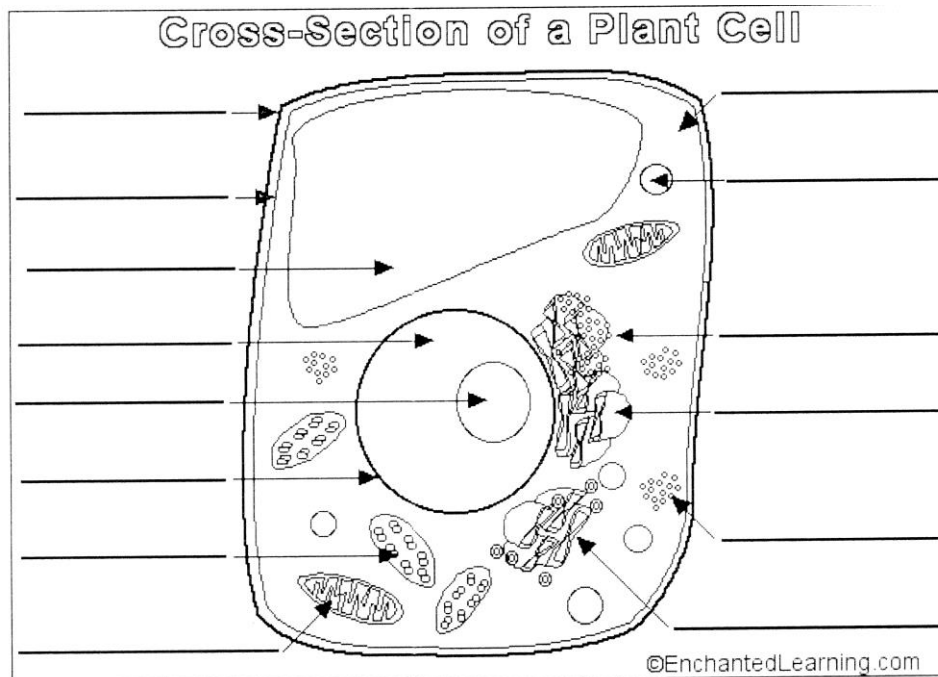
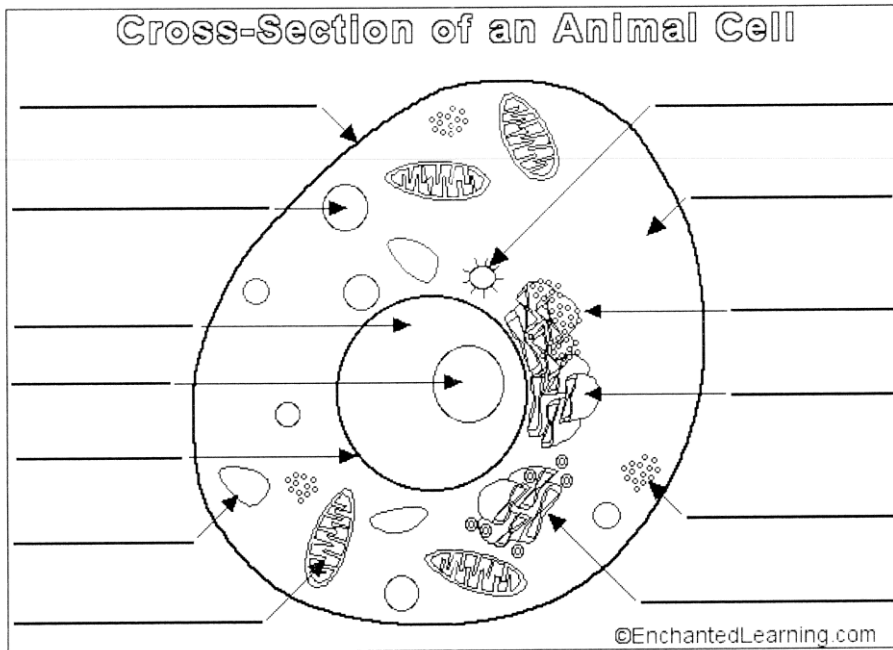


b.) Eukaryotes:



3) Plants vs. Animals

Use your notes and the powerpoint to label the animal and plant cells. Then, check your work by going to: <http://enchantedlearning.com/subjects/animals/cell/label/glossary.shtml> and <http://enchantedlearning.com/subjects/plants/cell/label/glossary.shtml>



Identify three differences between an animal cell and a plant cell.

Identify at least two similarities between the animal and the plant cell.

Coloring for knowledge

1. Use yellow for the part that regulates what enters and exits the cell.
2. Use green for the parts that make food.
3. Use brown for the thick outer covering that protects and supports the cell.
4. Use blue for the parts that store substances.
5. Use red for the parts that make energy from food.
6. Use purple for the parts that contain hereditary information.
7. Use black for the parts that create protein.
8. Where do most chemical reactions take place?

4) Analogy Option 1: Post Reading Strategy – RAFT

An alternative literacy strategy for reading and learning the functions of cellular organelles. This strategy could be used as an end-of-unit summary for unit on cells.

Title: Mapping Cell City

Anticipatory Set: Our complex and amazing bodies have more in common with the simple protozoans and amoebas than you might think. In both our bodies, and in the protozoan, the cell is the basic unit of life -- the difference is, we are made up of many cells, whereas a protozoan's entire body is composed of just one cell! Cells are invisible to the naked eye, and are often referred to as "building blocks" of life, but there's a whole world of activity going on inside even the simplest of cells. Today we are going to be reading about what goes on inside a cell, and you are going to be using this information to compare the happenings inside your cell with those of a busy city.

Objective: To learn about the functions of cellular components by comparing the organelles of a cell to parts of a city. Students will write about their city, describing the "points of interest" as they relate to cellular organelles.

Purpose to share with students: Today we will be writing to learn, using a reflection strategy known as a R.A.F.T. to describe the functions of cellular organelles. RAFT is an acronym that stands for role of the writer, audience, format and topic. Writing helps students to think about a concept and evaluate comprehension, and writing for a different audience, from a creative viewpoint helps the writer clarify their understanding, and helps to make meaningful connections to the subject matter.

Body of the Lesson: All right class, today you will be reading a short text about the things you can find inside a cell. Often, cells are referred to as building blocks, but in reality, they are anything but block like. Inside that microscopic ball, is a whirl of activity! Because we can't actually see most of what goes on inside a cell, however, it can be hard to remember all of the little organelles and what they do for the cell. To help get around this, after you have read about the functions of the organelles inside the cell, you will then try to visualize the cell as a city, and each organelle as playing some role in the functioning of the city. For example, you could compare an organelle that provides nutrition to the other parts of the cell to a restaurant -- perhaps your favorite pizza place. You will need to take some time to establish the role of each organelle in your city, making sure that you are clear about how each part of your city is like a particular organelle. Once you have created your cell city, you imagine you are touring a

visitor around the city, or describing your city to someone who has not been here, making sure to share with them the many wonderful places in your city. You could, for example, be a realtor, touring a prospective property buyer around the city, or someone from the chamber of commerce writing a brochure or web page to attract tourists to your city. You could even imagine that your visitor is an alien from another planet. You could also write a letter to a friend who is coming to visit you in your city. It is up to you to decide what role you would like to play, and with whom you are sharing information about your city. Your homework assignment will be to write about your city from a different perspective. It's up to you to decide who you want to be, and how you want to represent your city. We'll brainstorm some additional ideas after we've done the reading.

All right, (passing out article and table -- see attached), for the next fifteen minutes I want you to read about the organelles in your cell, and take notes about what you think each organelle does. Then we will start the process of brainstorming about the role of the organelles in the city.

All right, we're going to be doing a think-pair-share on the reading. As you finish up your reading, you can start to work on filling out the table on your own -- be as creative as you want, just make sure to support why you think each organelle is like whatever it is in your city. When you're done, find a partner, and share your ideas, then we'll have fun going over your ideas as a class!

Guided Practice: After students have read the article, and thought about how they would choose to represent each organelle as a part of their cell city, they will share their ideas with a partner. Finally, we gather together as a group, and go over students' ideas. (Example: Anybody have a really great idea for how to represent a cell membrane in your city, which you want to share with the class? Super, come on up to the smart board, and write down your idea, so we can all see. Ahh, so you are describing the cell membrane as a moat around an old fashioned city...I like it. Why do you think the cell membrane is like a moat? Because it keeps things out. Excellent. Anything else a moat does? Yeah, keeps things in, too! So, is it possible for people to get in and out of your city, or are they locked in all the time? Oh yeah, that's what the drawbridge is for! How does having a drawbridge make the moat function more like the cytoplasm? Okay, the drawbridge lets people in and out of the city, but you can control who comes in or goes out. Very nice. Anyone else have a different idea they want to share?)

All right, did any of you have an organelle you just couldn't come up with a connection for? Yes, Joey and Claire? Endoplasmic reticulum? That can be tough. Anyone want to help? Yeah, Amy and Jamar? You envisioned the endoplasmic reticulum to be like a subway system? Interesting.

What made you think of it this way? Okay, because it provides a network connecting different areas of the cell. I like it. Anyone else? (We now take time to continue the process of sharing ideas as a class, with students coming up to the white board to add their ideas to the list. This is especially valuable, as it allows the teacher the opportunity to see and hear what the students are thinking, and the kinds of connections that are being made, and also to step in and correct any misconceptions that may have emerged. Additionally, students are learning from each other's ideas, and making multiple connections to the material they have just read, which will help them to really conceptualize what is happening inside the cell).

So now, how could you write about your city? I will share with you part of my RAFT, to give you some ideas. (Teacher introduces her own RAFT - I am writing as a representative from the chamber of commerce, to try and attract tourists - "Come to Cell City! a safe, gated community, our cell membrane will make sure that unwanted bacteria are kept off our streets, while inside, children are safe to play. Mitochondria Energy, Inc., provides a clean, steady source of energy for residents of Cell City. While our power plants do produce some waste products, our waste management company, Peroxisome Management, does a wonderful job of keeping the environment here clean and unpolluted..."

This is just one idea...do any of you have any other ideas for how you would like to write about your city? (students share ideas, and they are written up on the smart board - at the end of class, the teacher takes the table and RAFT ideas, and posts them on-line for students to reference at home)

Closure: Excellent, you all have some really great ideas, and a deep connection to what is happening inside those tiny cells of yours. How many of you knew they were so busy?! So now, your assignment for Friday is to go home, and write about the city you have just developed. You can write a letter, tour around a visiting guest, sell your city in a brochure attracting business or tourism (see the attached table of suggestions) just as long as you include at least 8 organelles, make clear connections to your organelles, stay on task, are creative, and use good writing mechanics. You will also have class time to work on this essay on Wednesday. I'm so looking forward to reading your RAFTS, and seeing what you come up with!

Assessment: The in-class sharing activity was a great way for the teacher to see how students were thinking about the concepts, and to assist those who were struggling. The RAFT assignment itself will be graded using a rubric, a general example of which is attached.

Adaptations: Students have the opportunity to share ideas and ask questions about the assignment and about the concepts. Everything is presented visually on the smart board, as

well as visually. Students are provided with clear handouts, which they can use to take notes and reference at a later time. Information will also be posted on-line, on the classroom webpage for those students who have difficulty taking notes. Additionally, students will have the opportunity to view a teacher produced sample of work.

Technology: The smart board is used to allow students to see as well as here the information that is being shared. The classroom webpage is used as a site to post ideas generated in class, for students who have difficulty paying attention and taking notes at the same time.

4/5)Analogy -- Anatomy of a Cell Notes:

Organelle	Function	Analogy
Cell Membrane		
Cytoskeleton		
Cytoplasm		
Nucleus		
Ribosome		
Endoplasmic Reticulum		
Golgi Body		
Mitochondria		
Vacuole		
Lysosome		

Feel free to use the back of the paper to draw a picture of the cell you envision!

4) Analogy Option 1 – RAFT

Examples of possible RAFT assignments

Role	Audience	Format	Topic
Chamber of commerce	Tourists	webpage/brochure/advertisement	our fair city
Realtor	Potential buyer	Tour	a great place to live
Yourself	cousin from out of town	a letter	Things we can do/see when you come visit
Mayor	investor	Plea	why we need your help
Kid	ET/space alien	Tour	how to escape
Map Maker	Map Reader	map with key	How to find your way around

4) Analogy Option 1 – RAFT

Sample RAFT Rubric

	4	3	2	1
Accuracy	Information, details in RAFT always accurate. Properly reflects information, ideas, and themes related to the subject.	Provides accurate information in RAFT but could use more support.	Provides information in RAFT that has some inaccuracies or omissions.	Provides information in RAFT that is incomplete and/or inaccurate.
Perspective	RAFT maintains clear, consistent point of view, tone, and ideas relevant to role played; ideas and information always tied to role and audience.	Explains how character would feel about the event(s).	Shows little insight into how character would feel or act during the event(s).	Does not accurately develop characters, thoughts or reactions to the event(s).
Focus	RAFT stays on topic, never drifts from required form or type; details and information are included that are pertinent only to developed purpose.	Spends most of the RAFT discussing issues on topic, but occasionally strays from the focus.	Spends some time discussing issues off topic.	Spends most of RAFT on issues that do not directly deal with the RAFT chosen.
Class Time	Uses class time appropriately to research the era and create well-written stories.	Seldom needs to be reminded to get back on task.	Uses library and computer time to do work for other classes and/or chat with friends or lounge on couches.	Treats research time as an open period to be seen chatting with friends and hanging out on the couches.
Mechanics	Essay contains few to no fragments, run-on sentences; rare errors or mechanical mistakes; writing is fluent.	Essay contains some fragments, run-ons or other errors; occasional mistakes; writing is generally clear.	Essay contains several sentence errors and mechanical mistakes that may interfere with ideas and clarity of ideas in writing.	Essay contains mechanical mistakes; is marred by numerous errors.

5) Alternative Option: Cell Analogy Poster

Now that you have learned the key cell organelles functions and where to find them in a diagram, let's apply this knowledge to a new challenge!

YOUR JOB:

1. Choose one of the items from the list below.

Your Choices:

- | | |
|---------------------|----------------------|
| a. Mall | e. Computer |
| b. House | f. Earth |
| c. Football stadium | g. Government system |
| d. Car/Truck | h. Restaurant |

2. Find a component of your choice (mall, etc.) that represents each cell organelle and explain why. Use the chart to organize your thoughts. (See teacher for chart.)
3. Create a poster or a story that has an illustration of your choice with the "organelles" clearly identified including the why(analogy because).
4. Attach your chart from step 2 to the poster.

Organelles that Must be Included:

Nucleus	Cell Membrane	Ribosome	Mitochondria
Cytoplasm	Vacuole	Chloroplast	Cell Wall

Organelles that Can be Included:

Endoplasmic Reticulum	Lysosome	Golgi Body	Nucleolus
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6) Let's Build a Cell!

Purpose

Everything living is made up of cells. The problem is, we can't usually see them, and we don't really know what they look like, and how they do all the things they are supposed to do. In this lesson, we strive for a better understanding of the components of a cell, and their functions. We utilize a very fun computer game aimed at middle and high school students to build a cell from the ground up.

State Standards and Objectives

Standard 4, Key Ideas 1.1a-1.1c. Objectives for this lesson are that students develop a deeper understanding of the cell parts and their functions that were introduced in the previous lesson.

Major Concepts

Students should develop a further understanding of the idea that living things are composed of cells, investigate the components of a cell (major cell organelles), and begin to develop a deeper understanding of their functions as specialized structures of the cell that help the cell carry out the basic processes necessary for life.

Instructional Objectives

1. Observe a model cell in action, think about what is happening inside a cell
2. Students will build a cell using a computer simulation, and develop a deeper understanding of what a cell needs, and how various organelles help the cell to meet those needs.
3. Using knowledge gained during the exercise, re-evaluate what is occurring in the cell model video. What was learned? How did their view change?

Instructional Activities

1. Engage. Students watch a brief cell animation video.
2. Reflect/Pre-assessment. Using what they learned about cells from the previous lesson, students attempt to describe what they saw occurring in the cell, recording their observations in their journals.
3. Engage/Explore/Explain. Students utilize a computer game "CellCraft" to build a cell and keep it functioning, by making ATP, building proteins, etc
4. Post Reflection. Students observe a brief video of the cell, and reflect on what they see. A special focus should be made on how their view changed, as they learned more about how the cell functions.
5. Evaluate. What did you learn today?

6. Clean up

Inclusive Adaptations

The use of an interactive computer game is an inclusive adaptation. Most of the students really enjoy playing on the computer, so this helps to cast the task in a positive light. In addition, many of the students are struggling readers. While there is reading in the game, it is always presented in context to a situation, and visually represented, helping them to draw meaning from text through multiple pathways.

Questions

Students will have the opportunity to reveal their deepening understanding of how the cell functions in their journals, which will be collected.

Instructional Materials

Cell Video (youtube), Cell Craft game, computers or laptops (schedule class time in the computer lab), student journals (Links to the cell video and to the Cell Craft Game are included in the Supplemental Materials at the end of the Lesson Plan)

7) The Scale of the Universe

Open a browser and go to htwins.net/scale2/

ESL Students Only:

Click on **Other Languages** to select your language

Click on **Start** to begin

Only zoom in to view objects smaller than humans

- 1.) **Human:** - How tall is the average human? _____ meters
- How many humans are there on Earth? _____
- 2.) **Shrew:** - How long is a shrew? _____ centimeters
- Describe one unique characteristic of a shrew's body. _____

- 3.) **Grain of Salt:** - How big is a grain of salt? _____ micrometers
- How much salt would you need to eat all at once to risk death? _____

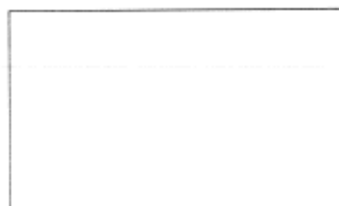
- 4.) **Paramecium:** - How big is a paramecium? _____ micrometers
- Where do paramecia live? _____
- How far can a paramecium move in one second? _____ millimeters
- 5.) **Skin Cell:** - How big is an average skin cell? _____ micrometers
- 6.) **White Blood Cell:** - How big is an average white blood cell? _____ micrometers
- What is the job of white blood cells? _____
- 7.) **Chloroplasts:** - How big is a chloroplast? _____ micrometers
- What type of organisms have chloroplasts in their cells? a) Animals b) Plants
- What is the function of chloroplasts? _____

- 8.) **Cell Nucleus:** - How big is the nucleus of a cell? _____ micrometers
- What is inside the nucleus of a cell? _____

9.) **Red Blood Cell:** - How big is a red blood cell? _____ micrometers

- What do red blood cells transport? _____

- Draw a picture of a red blood cell in the box



10.) **Mitochondrion:** - How big is a mitochondrion? _____ micrometers

- Mitochondria turn chemical energy from glucose into _____

11.) **HIV:** - How big is the HIV virus? _____ nanometers

- What disease is caused by this virus? _____

- Draw a picture of the HIV virus in the box.



12.) **DNA:** - What is the width of DNA? _____ nanometers

- Can DNA be seen with a compound microscope? Y or N

- DNA is a _____ acid

- Human DNA has 3 billion _____ pairs.

- Draw a picture of DNA in the box.



13.) **Glucose Molecule:** - Glucose is a simple _____.

- Plants make glucose through _____.

14.) Based on what you have seen, which sequence represents objects *from smallest to largest*?

(1) human → cell → nucleus → organ system → organ

(2) organ system → organ → human → cell → nucleus

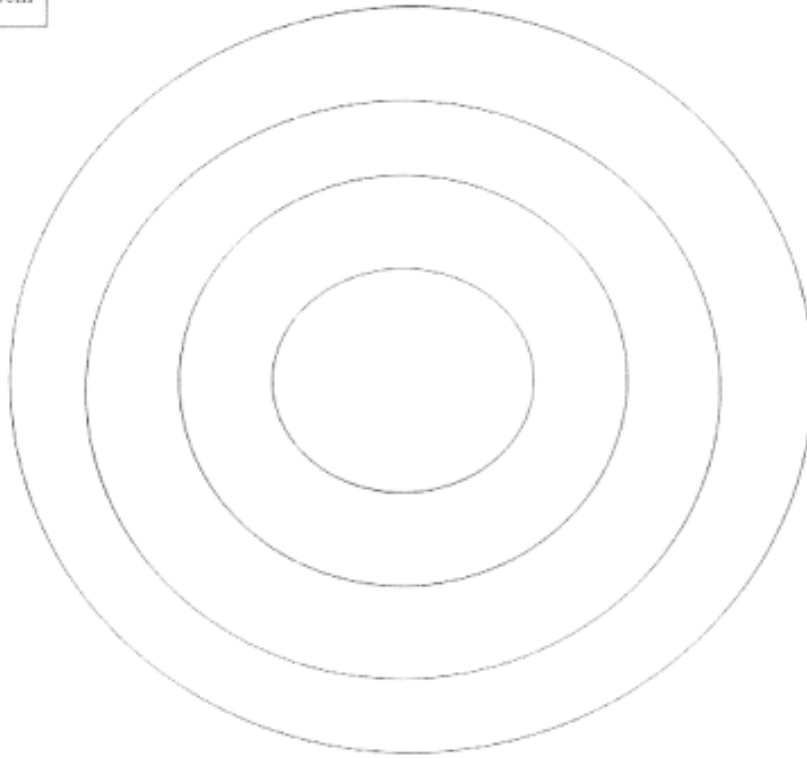
(3) nucleus → cell → organ → organ system → human

7) The Scale of the Universe Activity

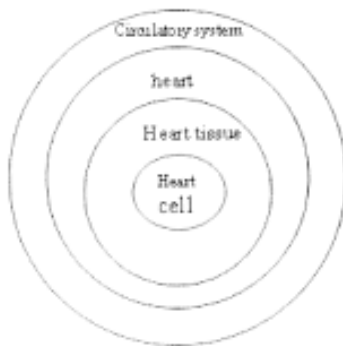
Levels of Organization

Place the word-bank words in the diagram below so they demonstrate increasing complexity.

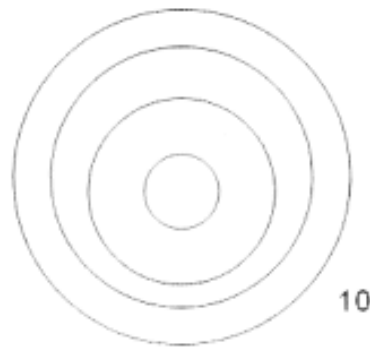
Organ
Tissue
Cell
Organ system



Here is an example of levels of Organization for Heart Cells



Now try to create your own example using a different type of cell



10

8) Little Bitty: The care and feeding of a microscope

Purpose

The purpose of this lab is to allow students to learn how to use a compound light microscope, and to create a wet-mount microscope slide. They should gain an appreciation for how much more can be seen when magnified, and how objects appear under magnification by a compound microscope.

State Standards and Objectives

Process Skills based on standard 4: Microscope Techniques

Major Concepts

Microscopes are used to envision things up to 1,000 times smaller than we can see with the naked eye. Safe and successful microscope use: microscope parts, focusing. Construction of a wet mount slide. Observation of how a microscope affects our view of the object observed.

Instructional Objectives

1. To allow students to compare what can be seen with the naked eye to what can be seen using magnification
2. To teach basic microscope skills
 - a. Microscope Parts (microscope anatomy)
 - b. Focusing skills
 - c. Construction of a wet mount slide
 - d. Evaluation of the effect of magnification on field of view

Instructional Activities

1. Engage. Give students a magazine picture to examine. What is the smallest thing they can see?
2. Engage. Hand students magnifying glasses. What can be observed now, that couldn't be seen before?
3. Allow students to handle microscopes
4. Teach students to make a wet mount slide of a letter cut from a newspaper or magazine
5. Microscope anatomy and safety lesson – students attempt to focus their slides, while learning about the various parts of a microscope, and focusing safety rules (no broken objectives or slides)
6. Students observe their slides, take notes on what happens when they move their slide left or right, up or down. How does the image appear (normal, flipped?).

7. Students use clear plastic rulers to estimate the field size (the size of the area they can see under the microscope) at lower and at higher power.
8. Clean up
9. Review of microscope parts (fill out microscope part diagram for future reference)
10. Discuss class observations
11. Assign HOMEWORK – bring in something to look at under the microscope for the next class. Suggestions – pond water sample, feather, hair, small fabric sample, etc

Inclusive Adaptations

Students will learn about microscope parts by using an actual microscope to study, explore, and experiment. All instructions will be given both orally, and visually, using visual diagrams and demonstrations. Students will have the opportunity to figure out what happens to the view when they manipulate objects under a microscope. In order for ANY student to want to learn, the learning process needs to be FUN and RELEVANT to their lives. Involving students in selecting what THEY want to see, helps to accomplish this.

Questions

What is the size of the field of view under low power? Approximately how big does that make your letter? What happens to the field of view when you increase magnification? What happens to the image when you move the slide to your left?

Instructional Materials

Microscopes, preferably one per student, but no more than two students per scope.

Microscope diagram (for notes). Slides, cover slips, water and eye droppers. Magazines, scissors and hand lenses (magnifying glasses)

8) Little Bitty: The Care and Feeding of a Microscope

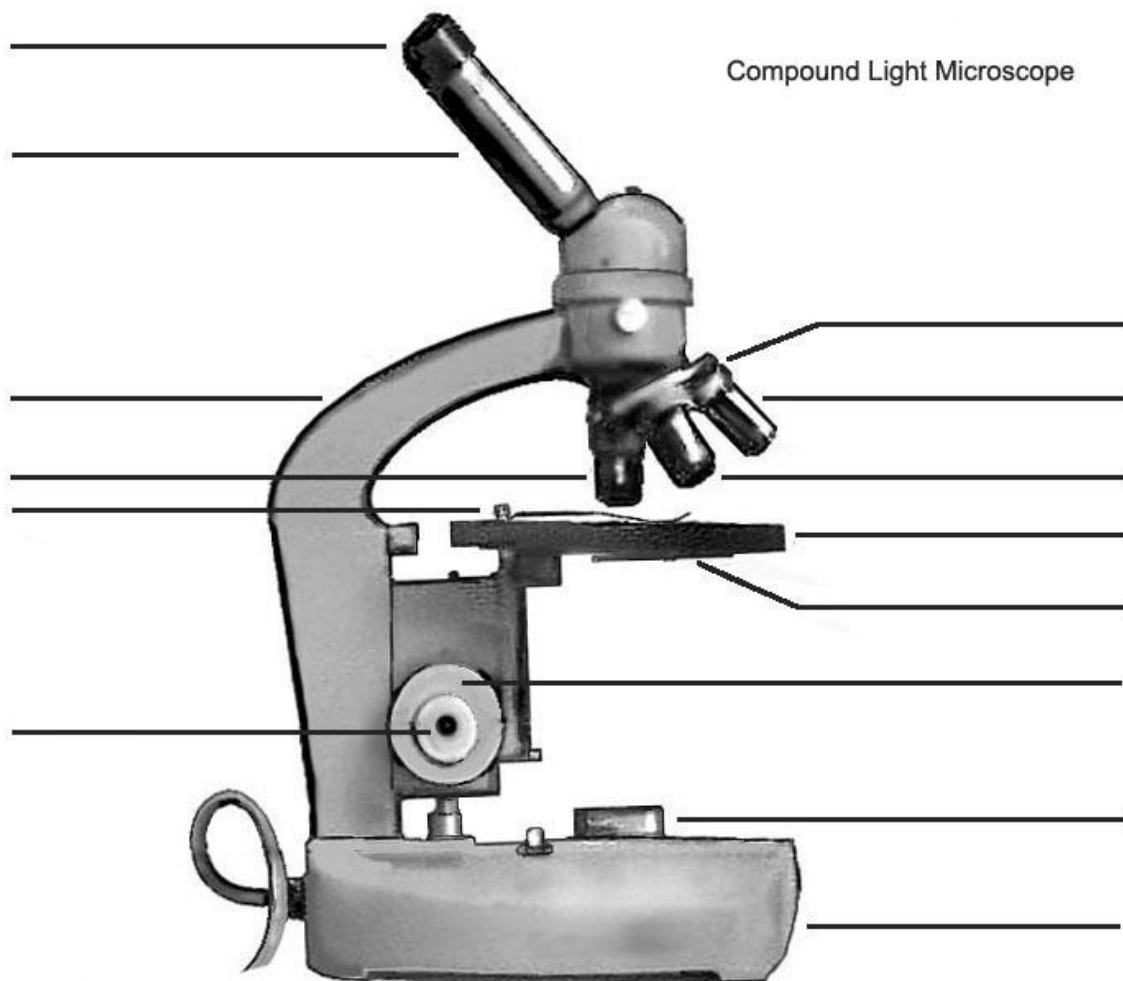


Illustration by WWeinkle 2002 - free for classroom use

Calculating Total Magnification

Eyepiece Magnification	Objective Magnification	Total Magnification
10x	4x (scanning)	
10x	10x (low)	
10x	40x (medium)	

The size of an object is often measured in millimeters (mm), however, it can also be measured in micrometers (μm). To convert between the measurements you need to know the following:

1 meter (m) = 1,000 millimeters (mm)

1 mm = 1,000 μm

9) Cells and Other Itty Bitty Things

Purpose

We spend a lot of time in biology talking about cells, those most basic forms of life. However, even though cells are all around us, and we ourselves are made up of cells, most students have never seen a cell in real life. The purpose of this lab is to allow students to observe real living cells, from both plants and animals, and to continue to reinforce the idea of scale covered in a previous lesson. They should also be identify the features that can be seen in those cells under magnification, making special note of any differences in the appearance between plant and animal cells. Additionally they should, continue to develop proficiency using a compound light microscope.

State Standards and Objectives

Process Skills based on standard 4: Microscope Techniques

Standard 4; Key Idea 1.1a, 1.1c, 1.1d

Major Concepts

Plant cell, animal cell, microscope skills, scale concepts

Instructional Objectives

1. Observe plant and animal cells under a microscope
 - a. Make a wet mount slide of a human cheek cell (animal cell)
 - b. Stain slide with iodine
 - c. Make a slide using elodea, an aquatic plant
2. Observe differences between plant and animal cells
3. Continue to develop microscope proficiency
 - a. Improving focusing techniques
 - b. Improved awareness of how magnification level changes what can be seen, and how much can be seen (field of view)
4. Have fun exploring the world of itty bitty, by examining objects brought from home (and instructor provided)
5. Gallery walk for students to tour the microscopic world

Instructional Activities

1. Students will make a wet mount slide of a cheek cell smear, stain the cells using iodine, and observe their own cells.

2. Students will make note of what they can see with the magnification provided by a light microscope (most will use 100x and 400x magnification levels), by drawing how the cells appear under different levels of magnification. What can be seen? What can't be seen?
3. Students will make a wet mount slide of plant cells, using elodea, and easily acquired aquatic plant (available at aquarium supply stores).
4. Students will make note of what they can see with the magnification provided by a light microscope (most will use 100x and 400x magnification levels), by drawing how the cells appear under different levels of magnification. What can be seen? What can't be seen?
5. Students will compare the shape and structure of the animal cells they observed to the shape and structure of the plant cells. What differences could be seen?
6. Students will have the opportunity to explore the microscopic world further, by examining items brought in from home.
7. Students will engage in a gallery walk tour of the microscopic world
8. Class discussion/sharing
9. Clean up

Inclusive Adaptations

Students have the opportunity to work at their own pace, and record their findings either in words or using a drawing (visual representation). Students who are done quickly, or who are very interested, will have the opportunity to examine multiple microscopic samples.

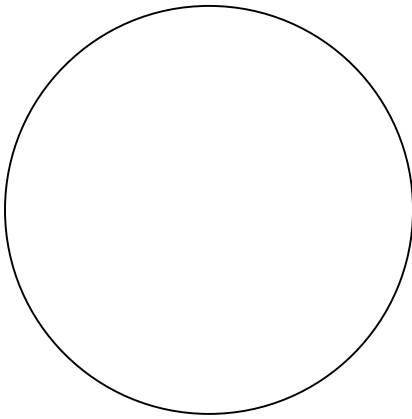
Questions

What can you see? What organelles and cell parts are visible? What can't you see? Are you surprised by what can't be seen? What happens when you increase magnification? How do the plant cells differ from the animal cells?

Instructional Materials

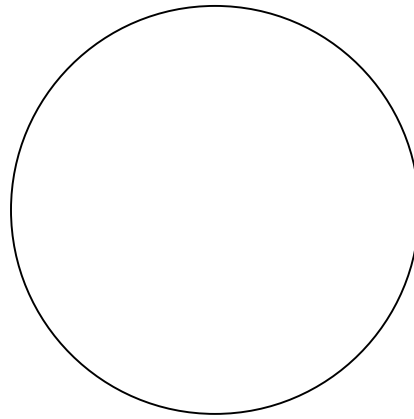
Microscopes, slides, cover slips, water and eye dropper, toothpicks, iodine, elodea. Hand outs for drawing cells/making observations. Additional objects: red onion, textile, salt and sugar crystals, hair, pond water sample, student samples

9) Cells and Other Little Bitty Things: Plant and animal cells
Microscope Drawings



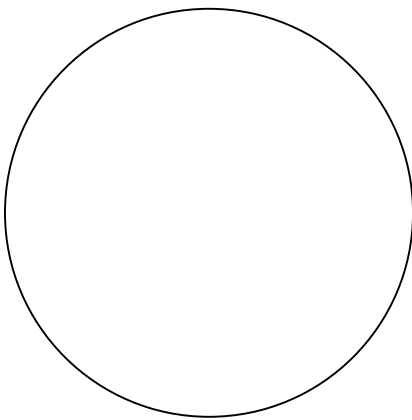
Cheek cell at low power

Total Magnification



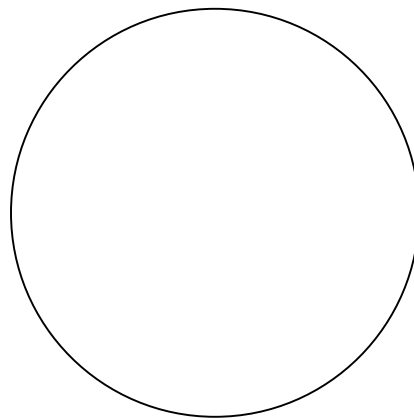
Cheek cell at high power

Total Magnification



Elodea cell at low power

Total Magnification



Elodea cell at high power

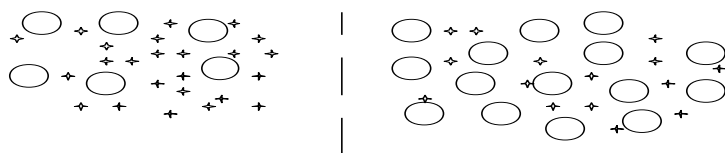
Total Magnification

10) Transport POGIL: Diffusion and Osmosis

MODEL 1: Movement of water – a special type of diffusion.

We have seen that some molecules move by diffusion across a cell membrane along a concentration gradient (from high concentration to low concentration). We have also seen that some molecules are aided in this process using carrier molecules (facilitated diffusion).

Schematic Diagram of Transport of Water in a Sugar Solution:



Key:

○ – sugar molecules (solute)

✱ – water molecules (solvent)

| – selectively permeable membrane

Critical Thinking Questions (CTQ):

For each question use the above diagram:

1. Complete the following table:

	Left side of membrane	Right side of membrane
# water molecules		
# sugar molecules		
Ratio of water:sugar		

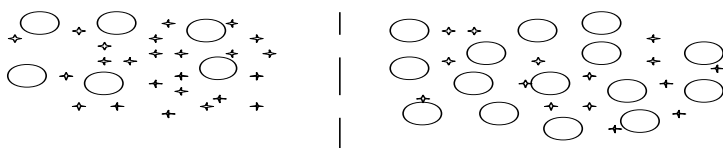
2. a. What is the **solvent** in the diagram?

b. What is the **solute** in the diagram?

3. Using the terms from question 2, define a solution (use complete sentences)

MODEL 2 : Osmosis

***Osmosis** is the term used to describe the diffusion of water across a membrane. Osmosis occurs in all living cells.*



A **concentrated solution (strong solution)** is one where the ratio of solvent to solute is low.

A **dilute solution (weak solution)** is one where the ratio of solvent to solute is high.

a. Which side of the diagram has a more concentrated sugar solution?

b. In a concentrated solution there is **more/less** water. (Circle the correct response)

5.a. Which side of the diagram has a more dilute sugar solution?

b. In a dilute solution there is **more/less** water. (Circle the correct response)

6.a. Looking **only** at the diagram and key, which molecule(s) will be able to move through the membrane? Explain your reasoning.

b. Which molecule(s) will NOT be able to move through the membrane? Explain your reasoning.

7. Predict the direction of movement of the molecule from 6a. by drawing an arrow on the diagram. (left to right, or right to left)

8. How will the concentration of the sugar solution on each side of the membrane change as the molecule from 6a. moves?

a. On the left side it will become

b. On the right side it will become...

9. Thinking back to the process of diffusion, what will eventually happen to the concentration on both sides of the membrane?

10. Using your responses to the questions above, complete the following definition:

_____ molecules move from a _____ solution to a _____ solution, through a selectively permeable membrane until the concentration on both sides of the membrane is _____.

- *When a plant cell swells, it becomes TURGID.*
- *When a plant cell loses water, the inner membrane pulls away from the cell wall. This process is PLASMOLYSIS and the cell is said to be FLACCID*
- *When an animal cell shrinks, it is said to be CRENATED.*
- *When an animal cell swells, it will eventually burst. This is known as LYSIS.*
- *An ISOTONIC solution has the same concentration as the cell.*
- *A HYPERTONIC solution is more concentrated than the cell.*
- *A HYPOTONIC solution is more diluted than the cell.*

POGIL based on:

<http://www.hamilton-local.k12.oh.us/Downloads/11%20Transport%20in%20Cells-S.pdf>

and

http://webcache.googleusercontent.com/search?q=cache:r3anVE_UrZ0J:https://www.myhaikuclass.com/amykempler/lchonorsbiology/cms_file/show/5137030.doc%3Ft%3D1347998206+&cd=1&hl=en&ct=clnk&gl=us

10) Transport POGIL: Diffusion and Osmosis

Teacher Notes

POGIL stands for Process Oriented Guided Inquiry Learning. This was adapted from one found online. While at first glance a POGIL may appear to be a typical worksheet, they use models to guide students through from basic to advanced understanding. POGILS should not be given out as homework; they are to be completed in small groups working together in class, with a teacher available to help if groups get stuck, as they are used to build understanding. Some teachers have very involved rules and groupings for POGILs, and others are more relaxed, but at the very least a POGIL should be completed with the group reading the questions together, discussing the question, and agreeing on their answers. No one should race ahead, nor should anyone be left behind. Using them this way can prove to be a great opportunity for students to be engaged in constructing their own knowledge of challenging concepts which are not easily visualized, and to take advantage of peer tutoring.

11) Making Connections – How are These Things Like a Cell?

Purpose

At this point, students have had multiple opportunities for exploring cells and cellular organelles, but for many of them, this was their first encounter with in-depth learning about cellular biology. Therefore, they feel overwhelmed by terms and functions. This exercise provides them an opportunity to put the functions performed by cells in the context of objects from their own daily life, and reviews what they do know in a quirky and fun manner. This activity serves as a formative assessment/progress check for what they have learned.

State Standards and Objectives

Standard 4; Key Idea 1.1a-1.1c

Major Concepts

Organelle functions. The functions of various cellular organelles can be compared to the functions of everyday items in our non-microscopic world. To better understand these functions, we create a large scale cell model out these everyday objects.

Instructional Objectives

1. Relate the functions of the major cellular organelles and components: membrane, cytoskeleton, vacuoles, nucleus and nucleolus, ER, golgi bodies, ribosomes and transport proteins to everyday items. Students may use notes and cooperative learning to link cellular functions to objects.
2. Create a cellular model based on function of cellular components, rather than on appearance of organelles and components

Instructional Activities

1. Engage. Students visit multiple stations around the room, each with an everyday object.
 - a. At each station, students take note (in journal) of what that object does in our world
 - b. Students attempt to come up with a link to an organelle in the cell that provides the same function as the object
2. Class discussion of findings and links
3. Cooperative cell model construction
 - a. Students take turns deciding what organelle an object should represent, labeling the object, and constructing a large cell model.
 - b. Walk around and admire the cell
 - c. Record functional links in journals

4. Reflection and cleanup

Inclusive Adaptations

This exercise attempts to take the theoretical, and bring it into the level of concrete understanding for students, by allowing them to compare the function of cells to familiar everyday objects.

Questions

What is...used for? What part of the cell might do the same kind of thing?

Instructional Materials

Large tape circle on the floor. Station objects: water balloon, blocks (Legos), brain model, stomach model, blueprints/instructions, FedEx/USPS box and envelopes, factory, restaurant, food, garbage can, Tupperware containers, foreign language dictionary, etc. Index cards with prompts at each station, asking the student to think about what the object is used for in their life.

12) It's Alive! (Or is it?)

Purpose

During this unit, we have been referring to cells as the most basic unit of life. While students can usually clearly define something as living or nonliving, they often have considerable difficulty determining what exactly it is about an object that makes it living or nonliving. The purpose of this lesson is to have students start to think about what characteristics are shared by all things living, and could therefore be used to define whether or not life is really occurring. Additionally, some common answers used to describe living things (i.e., they move – animals do, but so do cars and trees do not...) are misconceptions that are best dealt with and refined now.

State Standards and Objectives

Standard 4; Key Idea 1.1a-1.1d

Major Concepts

Cells are the most basic unit of life. The things that cells require to sustain life are also requirements for larger organisms.

Instructional Objectives

1. Students should be able to come up with a list of requirements/definition for living things.
2. Misconceptions about what living things must be able to do will be addressed.

Instructional Activities

1. Engage. Begin with Oingo Boingo's "Weird Science"
2. Teacher reads "Substituted Sammy" to the class, pausing after each "substitution to ask the class if Sammy is still alive. Why or why not?"
3. Students will take a tour of stations set up throughout the classroom. At each station they will observe an object, and decide if the object is living or non-living.
4. Students will record their decision about the object, as well as a reason for their decision, in their journals
5. Students share their beliefs about each station, and reasons for those beliefs are collected on the board
6. Think/pair/share. Students contemplate what is required for life, in small groups and share with the class (representative from the group will write one thing from the list on the board)
7. Class vote

8. Watch video depicting objects (icicle, clouds, animals, seed, etc.)
9. Discussion. Did the video make you change any ideas?
10. (If time permits) groups will act out one of the requirements for life from the class list
11. Reflection and cleanup

Inclusive Adaptations

Use of concrete objects, audiovisuals and cooperative learning to uncover and refine existing knowledge

Questions

Does a bubble grow? Move? Is it alive? Plants don't move. What can they do that makes you think they are alive?

Instructional Materials

Multiple objects, images and models. For example, plants, bugs, cat/dog, egg, seed, flashlight, car, computer. Student journals, video.

12) It's Alive (Or is it?)

Substituted Sammy

An Exercise in Defining Life

"Substituted Sammy" was a normal healthy boy. There was nothing in his life that indicated that he was any different from anyone else. When he completed high school he obtained a job in a factory operating a press. On this job he had an accident and lost his hand. It was replaced with an artificial hand that looked and operated like a real one.

Soon afterward, Sammy developed severe intestinal difficulty and a large portion of his lower small intestine had to be removed. It was replaced with an elastic silicon tube.

Everything looked good for Sammy until he was involved in a serious car accident. His legs and good arm were crushed and had to be amputated. He also lost an ear in the accident. Artificial legs enabled Sammy to walk again and an artificial arm replaced the real arm. Plastic surgery and the use of silicon plastic enabled doctors to rebuild the ear.

Over the next several years, Sammy was plagued with internal disorders. First, he had to have an operation to remove his aorta and replace it with a synthetic vessel. Next, his kidneys malfunctioned and the only way he could survive was to use a kidney dialysis machine. A kidney donor was sought but never found. Later, his digestive system became cancerous and was removed, which resulted in Sammy having to receive his nourishment intravenously. Finally, his heart failed. Luckily for Sammy a donor heart was available and transplanted into his body.

It was now obvious that Sammy had become a medical phenomenon. All of his limbs were artificial. Nourishment was supplied through his veins; therefore, he had no solid wastes. All chemical wastes were removed by the kidney dialysis machine. The heart that pumped his blood, to carry oxygen and food to his cells, was not his original heart.

Unfortunately, Sammy's transplanted heart began to fail. He was immediately placed on a heart-lung machine. This supplied oxygen and removed carbon dioxide from his blood as it circulated through his body.

The doctors consulted bioengineers about Sammy. Since almost all of his life-sustaining functions were being carried on by machines, they thought it might be possible to compress all of these machines into one mobile unit which could be controlled by electrical impulses from his brain. This unit would be equipped with mechanical arms to enable him to do multiple tasks. A mechanism to create a flow of air over his vocal cords might enable him to speak. In order to do all this, they would have to amputate at Sammy's neck and attach his head to the machine, which would then supply all nutrients to his brain. Sammy consented, and the operation was successfully performed.

Sammy functioned well for a few years. However, slow deterioration of his brain cells occurred and the bioengineers diagnosed him as terminal. So the medical/bioengineer team that developed around Sammy began to program his brain. A miniature computer was developed; it could be housed in a machine that was like a human head in appearance, movement, and mannerisms. As the computer was installed, Sammy's brain cells completely deteriorated. Sammy was once again able to leave the hospital, this time with the COMPLETE assurance that he would not return with any biological illness.

(Author Unknown), reading readily available online

Ex. www.rcsdk12.org/site/.../filedownload.ashx?...Sammy%20Substituted...
msstarkscience.weebly.com/uploads/3/8/0/5/.../substituted_sammy.doc

13) It's All Greek and Latin to Me!

Title: It's all Greek and Latin to me!

Using Vocabulary Wheels

Anticipatory Set: There's an old song that goes, "You say potay-toe, I say puhtah-toe, let's call the whole thing off..." (play clip of song for students) Vocabulary is how we communicate with others, and differences in vocabulary -- or confusion about what certain words mean -- can make communication at best tricky, and at worst, impossible. In this unit on genetics, there is a LOT of new vocabulary...words you've never heard of before, or that you know from other contexts, but that you might not quite know how it applies here, to genetics. Today, I am going to provide you with a list of new vocabulary words that you'll need to learn in order to understand and communicate effectively about genetics. I don't want you to just memorize a list words, however. It's actually really important that you not only understand what these words mean, but how they relate to each other. To accomplish this, we are going to use a strategy called Vocab Wheels, and we'll be making a game out of learning new vocabulary.

Objective: To learn, through the literacy strategy of vocabulary wheels, a list of new words that will be necessary to getting the most out of our unit on genetics.

Purpose: Language is how we humans communicate with each other. In order to do so successfully, we have to have a common vocabulary. While learning new words is often seen as a dry exercise far removed from hands on learning, the truth is that without a common vocabulary, students will be unable to communicate about new concepts they have learned. The strategy of vocabulary wheels attempts to help students move beyond simple memorization of new vocabulary, to an understanding of relationships between new words.

Body of the Lesson: (Note, this lesson is designed as an introduction both to the new vocabulary, and to the strategy of using a vocabulary wheel. In this version of the lesson, the students will receive a handout with two vocabulary wheels (see attached) which have already been filled out with the words they will be defining and comparing. Students will be using an on-line glossary to define the terms, <http://biology.about.com/od/biologydictionary/a/geneticsgloss.htm> and during the demonstration/modelling portion of the lesson, this glossary will be projected up on the smart board. More advanced versions of the listen can take place when students are already familiar with the strategy, and select the words to place on the vocabulary wheels themselves, as part of a pre-reading exercise, where they identify new vocabulary in a text.

Alternatively, a larger set of vocabulary wheels, with spinners can be constructed and used as a station/center activity for vocabulary enrichment.)

Hello! In to truly “get” a new concept, like genetics, we need to be familiar with the vocabulary that’s used. You need to not only know the definition of a word, but also be able to apply the word, and relate it to other terms. These vocabulary wheels (pass out vocabulary wheel handouts) are going to help us do just that. Actually, looking at your handouts, these diagrams look more like a fresh, sliced pie...I must be getting hungry...! What we are going to do, is select a slice of pie...I mean word...from each of the two vocabulary wheels/pies -- you want to try both flavors, don’t you? And then we write a sentence explaining how the two words are related. For example, let’s do a first one together: Which word should we select from wheel 1? Okay, Genotype. How about wheel 2? Phenotype sounds good. Now do you remember what genotype and phenotype are? If not, we can go to the glossary and look them up...All right, so genotype is the actual genetic makeup of an organism. Since you have two versions of every gene in your body (Remember, one version came from Mom, and the other from Dad?), your genotype consists of both of those versions of the gene. How about phenotype? Exactly, phenotype is the physical appearance of an organism. What causes your physical appearance? True, your genes...anything else? What if you had an identical twin? You guys looked so similar, that no one could tell you apart...you had all the same genes, after all (you are genetically identical). Then, one day when you were climbing the slippery ladder to the slide at the playground, you slipped and gashed your chin. You even had to go to the hospital for stitches. It healed up well, but to this day you have a scar...is your phenotype still identical to your twin? No? Why not? Exactly, your interaction with the environment changed your appearance. So, how should we connect these two terms? (Writing on the board) “Genotype is the genetic makeup of an organism, and phenotype is the physical appearance of an organism. Physical appearance is determined by genetic makeup plus environment.” All right! Now, we’ll work on another one as a class...

Guided Practice: Which two slices of pie (I mean words!) should we choose this time?

Chromosome and chromatin? Okay, good call. These two words sound similar, and are closely related, so they’re often confused...Why don’t you work in pairs, and each of you look up the definition in the glossary for one of these words. Then, you can share with your partner what the word you looked up means. Once you’ve all had a chance to do that, we’ll share with the class, and see if we can come up with a connection for the two words. (Teacher circles around the room, observing students and asking questions as they look up words and explain meaning to their partner). Okay, what did you find? Yeah, chromosomes are made of chromatin, which is DNA plus structural proteins. Great job! I’d like you to continue to work with your partner now, choosing a word from each wheel, looking up the definitions, and determining how the words are related. You can choose any combination of words, as long as you choose one from each

wheel...so all of you groups are going to have different connections. We'll work on this activity for the rest of class, and I will hang the connections you've come up with on our vocabulary wall, to help you out as we continue our unit on genetics.

Closure: All right, for homework tonight, I want you to read the following article on genetics (passes out article). Having just defined the words, and made all your connections, you should be well on your way to really understanding the article. Bring your Vocabulary Wheel connections home with you to help you out, and tomorrow, bring back your wheels, and at least three questions that the article raised for you.

Assessment: It's easy for students to copy out definitions from a glossary, without really learning and understanding the meaning of the word. This exercise requires them to make connections between words, which helps them to really think about the vocabulary, and also enables the teacher to see whether they really "get it" or are just parroting back a definition. The connections are valuable both in forming knowledge, and assessing understanding.

Technology: Use of on-line glossary for looking up words, use of projector and smart board.

Adaptations: Students are walked through the lesson as a class before attempting it independently. All information is provided both orally and visually. Students work together to support each other and develop ideas. Students develop their own study guides and understanding of the material. The purpose of the lesson is to pre-teach vocabulary in order to help students be more independent and build knowledge.

14) And So It Grows (If It's Alive)

Purpose

Based on the previous day's lesson, students will have been thinking about the things that a living thing can do. Cells grow and divide, producing new cells. Students also know that DNA instructions are locked up in the nucleus of the cell. We will be investigating how a cell can grow and divide, without messing up that DNA.

State Standards and Objectives

Standard 4; Key Idea 1.1b, Key Idea 2.1a, 2.1c, 2.1d, 2.1e

Major Concepts

The cell cycle, interphase, mitosis, (all cells can do this!)

Instructional Objectives

1. Students will recognize that they grow because their cells divide, not just because cells get bigger (you get new cells/more cells)
2. Students will consider what would happen if DNA in the nucleus just divided in two.
3. Students will engage in a class role play illustrating mitosis, and uncovering misconceptions about how DNA divides
4. Students will learn the basic steps of mitosis

Instructional Activities

1. Engage. Class discussion of how big they were when they were born (anyone know how big they were before they were born? How many cells did they start out with? How many do they have now and how big they are now. How did that happen?)
2. Explain. Cells take turns resting and then growing, duplicating ALL of their contents (like what?)
3. Engage. Hand out twizzlers to class. One twizzler per pair of students. Have students play tug of war with twizzler, to rip it in half...what happened? Even split or not? Would that be a problem if it was DNA? Why?
4. Engage. Show mitosis video
5. Experience. Mitosis role play. Give half of the class either a colored circle or a colored triangle. Have triangles and circles find their matching color. Explain that they are a pair of chromosomes. Ask students why one is a circle and one is a triangle? Have pairs line up and move apart. All done. That was easy...or...? Any problems?
6. Hopefully students will come up with "Each cell only has half the DNA..."

7. Hand out colored circles and triangles to remainder of class. Have newly made chromosome copies find their identical pair. Have identical pairs line up, split apart. Now do we have two cells worth of DNA? Are these cells the same or different than the original?
8. Explain. Mitosis notes, including the mitosis love story (Jo Pro Met Ana & Telephoned her...), steps of mitosis (Prepare = Prophase, Middle = Metaphase, Apart = Anaphase, Two nuclei = Telophase), vocabulary (chromosome, chromatid)
9. Class role play using pool noodles to carry out the process of mitosis

Inclusive Adaptations

This is a visual and kinesthetic hands-on lesson, which should be approachable to all levels of students. Lots of opportunity to get up and move, and to see the concepts in action.

Questions

(See Questions in the Activities Section)

Instructional Materials

Mitosis video, Colored circles and triangles (2 each red, orange, yellow, green, blue and purple)

15) Monster Traits

Purpose:

To continue the investigation of what is meant by genotype and phenotype, and develop a deeper understanding of how recessive and dominant alleles combine to create an individual's phenotype. To introduce students to the idea that genotypes can be heterozygous or homozygous, and to introduce the idea of more complicated patterns of inheritance, such as co and incomplete dominance, and multiple alleles.

State Standards and General Learning Objectives:

NYS Living Environment Core Curriculum, Standard 4, Performance Indicator 2.1. Special Emphasis on Major Understandings 2.1b: Every organism requires a set of coded instructions for specifying its traits. For offspring to resemble their parents, there must be a reliable way to transfer information from one generation to the next. Heredity is the passage of these instructions from one generation to another; 2.1c: Hereditary information is contained in genes, located in the chromosomes of each cell. An inherited trait of an individual can be determined by one of by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes in its nucleus; 2.1d: In asexually reproducing organisms, all the genes come from a single parent. Asexually produced offspring are normally genetically identical to the parent; 2.1e: In sexually reproducing organisms, the new individual receives half of the genetic information from its mother (via the egg) and half from its father (via the sperm). Sexually produced offspring often resemble, but are not identical to, either of their parents.

Students will learn how they have two copies of every gene in their body, and together, those genes make up their **genotype**. They will learn that genotypes can be either homozygous or heterozygous, and they will learn that how those genes are expressed results in their **phenotype**, or physical appearance.

Instructional Objectives:

1. Students will work in groups to create “monsters” from a bucket of traits. Students will be presented with a list of traits, and will decide, as a class, which traits are to be dominant, and which are to be recessive. Students will then select two alleles for each trait at random from trait buckets, and will use that information to construct both the genotype and the phenotype (drawings) for their monsters.
2. During the course of this exercise, students will develop a stronger understanding of genotype and phenotype, of dominant and recessive traits, and what it means to be homozygous or heterozygous for a trait.

3. After students have constructed their original monsters, we will introduce the ideas of co, and incomplete dominance, and the idea of multiple genes determining a trait.

Major Concepts:

A continued investigation of genotype vs. phenotype, through the combination of recessive and dominant alleles, resulting in recessive and dominant traits. Heterozygous vs. homozygous genotypes. Introduction to different, more complicated inheritance patterns: co and incomplete dominance, multiple alleles determining one trait.

Instructional Materials:

Smart board/white board, trait buckets, list of traits, beakers of water and food coloring, construction paper, markers, poster board/large pieces of paper.

Instructional Activities

1. **Engage** As students enter, tell them that today they are going to be designing their very own ferocious monsters – but the catch is, there monsters will have to follow the rules of heredity. Introduce students to the possible monster traits: Fur Color (yellow or purple), Fur Length (long or short), Number of Eyes (one or two), Eye Color (red or green), Wings (yes or no), Fangs (yes or no), Horns (one or three). Students will receive a chart with the traits and the possible choices, and this will be posted on the smart board as well.
2. **Explore** Students will need to decide, as a class, which versions of each traits are going to be dominant, and which are going to be recessive. They will also determine what letter to use to represent each trait/version of a trait.
3. **Explore/Evaluate** Working in pairs, students will come up to the front of the room, and select two alleles for each trait. They will then be tasked with creating their monster's phenotype and genotype. They will draw their monster's appearance, and also write the genotype their monster has for each trait, and determine if the monster is homozygous or heterozygous for the trait.
4. **Explain** One student from each group will visit the other monsters in the room, comparing what they created to what their class mates created. One partner will stay and explain their monster's genotype and phenotype. Students will then switch roles, so that all students have the opportunity to explain and visit.
5. **Elaborate** What if it turns out that a trait is not simply dominant or recessive? Demonstrate co and incomplete dominance using beakers of food coloring. Tell students that hair length is incomplete dominance, and horns are co-dominant. Have them brainstorm how this would change their monsters.

Quick Check Students respond on white boards.

16) Monster Love...and Monster Babies

Purpose:

To have students understand how in sexual reproduction, gametes are formed in order to pass on genetic material to offspring, and to keep the number of chromosomes present in offspring the same as in the parent organisms. Students will also learn to use Punnett squares to track traits from parents.

State Standards and General Learning Objectives:

NYS Living Environment Core Curriculum, Standard 4, Performance Indicator 2.1. Special Emphasis on Major Understandings 2.1b: Every organism requires a set of coded instructions for specifying its traits. For offspring to resemble their parents, there must be a reliable way to transfer information from one generation to the next. Heredity is the passage of these instructions from one generation to another; 2.1c: Hereditary information is contained in genes, located in the chromosomes of each cell. An inherited trait of an individual can be determined by one of by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes in its nucleus; 2.1d: In asexually reproducing organisms, all the genes come from a single parent. Asexually produced offspring are normally genetically identical to the parent; 2.1e: In sexually reproducing organisms, the new individual receives half of the genetic information from its mother (via the egg) and half from its father (via the sperm). Sexually produced offspring often resemble, but are not identical to, either of their parents.

Students will learn why it is necessary for gametes to be formed in sexually reproducing organisms.

Instructional Objectives:

1. Students will learn why it is necessary for sexually reproducing organisms to form gametes.
2. Students will learn how to predict the types of offspring that might result from two sexually reproducing partners, using Punnett squares.
3. Students will learn why siblings can often look very different from one another, even though they have the same parents.

Major Concepts:

Sexual reproduction, formation of gametes, punnett squares.

Instructional Materials:

Monster babies from the previous day, punnett square worksheets, smart board.

Instructional Activities:

1. **Engage** Ask students groups if any of them believed that they had a girl monster or a boy monster (female/male). Call one group two of the groups to the front of the classroom (one girl monster and one boy monster) and explain to them that their monsters have fallen passionately in love, and are going to make monster babies...Ask each group to write their monster's genotype from one of the traits up on the board (teacher will pick, or class will vote – both need to consider the same trait). Now, ask them to combine the genes from their two monsters in order to see what the babies will look like. Hopefully, students will just jam the genes together...And we will have to discuss how many genes and chromosomes the baby has compared to the parent monsters...Why is this a problem? How do we solve it?
2. **Explain** In order to keep the number of chromosomes constant from generation to generation, we only get half of Dad's genetic information, and half of Mom's genetic information. When the two halves combine, we get a full set of chromosomes/genes. Illustrate on the board, how sexually reproducing organisms create gametes, which only have half of the DNA in the organism. Ask students if they can give any examples of gametes, and where they might be formed.
3. **Explore** Have original students come back up to the board, and list the possible gametes that each monster could produce for the trait in question. Have them "jam" the gametes together...Does the baby have the right number of chromosomes now?
4. **Explain** Punnett Square literacy lesson. Explain to students that punnett squares are used to help geneticists keep track of genetic information, and determine the likelihood of different traits showing up in the offspring. Walk students through the process of setting up a punnett square using information from the two monsters we've already compared. Have students complete the square while the teacher walks around the room. Discuss the ratios. Does the square show genotype or phenotype ratios?
5. **Explore** Have groups from the previous day pair up, and determine the likelihood of babies from their parent monsters having the different genotypes and phenotypes.
6. **Evaluate** Students will hand in their punnett squares for all of their monster traits with phenotypic and genotypic ratios.

Vocabulary

Haploid Cell
Diploid Cell
Gametes
 Sperm
 Egg
Gonads
 Testes
 Ovaries
Meiosis

16) Monster Love...and Monster Babies

Building a Monster Using Genetics

Monster Traits

	Gene 1	Gene 2	Dominant Gene	Recessive Gene
Fur color	Orange	Purple		
Number of eyes	One	Three		
Body shape	Triangle	Rectangle		
Horns	One	None		
Personality	Friendly	Grouchy		

What genes does your monster have for each trait (what is its **genotype**)?

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Mom					
Gene from Dad					
Baby Monster's Genes					

What does your monster look like (what is its **phenotype**)?

	Fur color	Number of eyes	Body Shape	Horns	Personality
Baby Monster's appearance					

16) Monster Love...and Monster Babies

Monster Eggs

(strips of paper students will select from a hat)

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Mom	Orange	One	Triangle	One	Friendly

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Mom	Purple	One	Triangle	One	Friendly

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Mom	Orange	Three	Triangle	One	Friendly

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Mom	Orange	One	Rectangle	One	Friendly

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Mom	Orange	One	Triangle	None	Friendly

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Mom	Orange	One	Triangle	One	Grouchy

16) Monster Love...and Monster Babies

Monster Sperm

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Dad	Purple	Three	Rectangle	None	Grouchy

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Dad	Orange	Three	Rectangle	None	Grouchy

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Dad	Purple	One	Rectangle	None	Grouchy

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Dad	Purple	Three	Triangle	None	Grouchy

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Dad	Purple	Three	Rectangle	One	Grouchy

	Fur color	Number of eyes	Body Shape	Horns	Personality
Gene from Dad	Purple	Three	Rectangle	None	Friendly

17) Learning About Meiosis Using SQ3R

Pre/During/Post Reading Strategy – SQ3R

State Standards and Objectives

Key Concept 2.2 Meiosis and Genetics

Title: Reading (and learning!) about Meiosis using the SQ3R strategy

Objectives: To teach students how to use the SQ3R reading strategy to comprehend a text on the biological process of meiosis. They will use this strategy to improve comprehension of a difficult text, and also to better retain information and to easily review the reading.

Anticipatory Set: Several weeks ago we learned about the process of mitosis, whereby cells duplicate the genetic material located in their nuclei, and then divide the genetic material in an orderly fashion, allowing for the formation of (How many? – that’s right, two) new cells. What kind of cells go through the process of mitosis? (Yup, all the cells of your body are capable of going through mitosis) When do cells do this? (When you are growing, when cells are worn out and need to be replaced. Excellent.) Now we’re working on a unit in genetics, and learning how genetic information from your Mom’s and Dad’s cells combine to make you! So, can I just grab a cell from, say, your Mom’s liver and your Dad’s skin and put them together in a test tube and make a new organism? (No!) Why not? All the genetic information from each of them is in a single one of their cells...(You’d end up with too many chromosomes in the baby – Down’s Syndrome causes all kinds of problems, and that’s only one extra chromosome copy). Exactly. So, the parts of the body that make sex cells, known as gametes – by the way, what would those body parts be? (Testes and ovaries – they make sperm and eggs) have to do something special when they make those sex cells – they have to reduce the number of chromosomes in each of those cells in HALF. Anybody remember what a cell with only half the amount of DNA is called? (haploid). Is this something that cells in, say, your stomach would EVER do? (NO!) (During this time, teacher uses the white board to visually represent combining cells to create a new organism, first with diploid cells, and then splitting the genetic material in half, and recombining to create an offspring with the same # of chromosomes as each parent.) Today we are going to be reading a short text all about the process of meiosis. There is a lot of information that you need to know about this process, and there is likely quite a bit of new vocabulary. To help you understand and retain all this information, I’m going to be modeling a reading strategy called SQ3R. (Sounds kind of like SQUIRREL!)

Purpose: Today we will be using the SQ3R strategy to better understand and remember the

processes of meiosis, which is how sexually reproducing organisms make gametes that can combine to create a new organism, while keeping the number of chromosomes constant from generation to generation. This strategy will be especially useful, as using the strategy will help you to comprehend text better, and the resulting notes can be used to review the new information.

Body of the Lesson: (Teacher hands out the instructions for SQ3R (from Billmeyer, p. 130) to each student, as well as the text on Meiosis (from Nova). Both are attached to this lesson) All right, I have passed out the text we will be reading, as well as instructions for performing SQ3R. So, class, what does the 'S' stand for (No, not Superman - but this strategy is pretty super!)? It's "survey" – so, what should we do to survey this article? Excellent, look at the title, think about what you know about meiosis, looking at the section headings in bold is another good idea. How about the pictures? Will they be helpful to you? How about the first paragraph – often that sets you up for what you will be learning. Jonah, would you read the first paragraph to us, where it says "Before we split?" Everyone else, please follow along. (Jonah reads). Now, Catelyn, will you read the very last paragraph. Thank-you both. So, what do you think the article in between is going to tell us? Very good, we're going to learn the steps that take us from a regular cell, with the full number of chromosomes (anyone remember what it's called when we have a cell with paired chromosomes? – diploid) to FOUR cells, each containing HALF the genetic material of the original cell. So, what next? What questions do you have about this process? Very good. So, the next thing you want to do, is pull out a piece of notebook paper, and fold it in half, like this (teacher demonstrates, and also opens a page on the smart board, divided into two columns). Now, on the left side, you are going to write down all the questions that you are wondering about. Todd's question about whether all the cells are identical at the end of meiosis is a great one to write down. (Teacher writes down question on the left hand column of the smartboard page) Take a minute to think of any other questions you have about this process. Are any of you having a hard time coming up with questions? Okay, what should you do, then? (No, not give up!) Sure, turn the title and the headings into questions. How about vocabulary. Anybody see any words they weren't familiar with? Write those down too. (Teacher also writes down the questions that are shouted out in the left hand column of the smart board page) Very good. What next? Yup, you FINALLY get to read! I'm going to ask you to read the article to yourself, but don't just sit there like a blob and read! You want to search for the answers to your questions. When you find an answer, write it down on the right hand side of the page. When you complete your reading, I want you to pair up with the person next to you. You will QUIETLY review what you learned with each other. Anything you're both not sure about? What should you do? Yup, go back to the text and see if you can find the right answer. Afterwards, we will review what you've learned as a class, and your ticket out the door will be to answer a few brief questions.

Guided Practice: Students begin to actively read the article, while taking notes on the right side of their divided notes answering the questions they had. The teacher circulates among the students at this time, observing what they are writing, and asking/answering questions. When two students are done with the reading portion, they get together, and compare their answers to the questions which they (and the class) developed earlier. This is an opportunity for students to support each other in their reading comprehension and science comprehension. Every effort will be made to pair weaker and stronger readers together during this portion. At the end of the Reading and Recite portions of the strategy, the class will reassemble to review what they have learned about the process of meiosis. The teacher will have “bubbles” drawn up on the smart board to represent cells at various stages of meiosis, and students will come up to the board to fill in what is occurring in the cells at each stage. Students will draw the chromosomes and their placements, and classmates will have the opportunity to help and correct students. This provides a good opportunity for the teacher to assess student understanding and retention of the basic steps of meiosis.

Closure: Excellent job, everyone! Understanding what happens on the little itty bitty level of chromosomes inside our cells is not an easy process, and you have all made great progress! I want you to continue to think about what happens in meiosis – what kinds of cells result from meiosis, where in the body meiosis occurs, and how meiosis differs from our old friend mitosis.

To wrap things up, we watch a video on meiosis, the topic we just read about:

<http://www.youtube.com/watch?v=iCL6d0OwKt8> (Corny animated meiosis square dance)

Assessment: Students will have been assessed multiple times during the course of the lesson, both for their understanding of how to use the SQ3R strategy, and their knowledge of meiosis. This assessment is carried out through full class and small group discussions and by observations of the students as they work. Additionally, students will be asked to list 3 ways that meiosis differs from mitosis, and 3 ways that meiosis and sexual reproduction increase variability of an offspring (ie, we aren’t clones of our parents).

Adaptions: Students will have written directions for performing the strategy, and the class and teacher model the strategy together. Students will have the opportunity to use the strategy in a supportive environment in class (teacher is there to help) and stronger and weaker readers will be paired to discuss, allowing for peer tutoring to occur. Additionally, the class reviews the concepts a final time together, allowing for further review of the new concepts. The ticket out the door questions allow the teacher to evaluate for deeper understanding, and get the students to think on a larger scale about what is happening during meiosis. Class will use music

and movement to reinforce the concepts that learned about, appealing to auditory and kinesthetic learners.

Thinking Questions:

Why might it be a bad idea for everyone to be identical?

What increases variety?

Independent sorting

Crossing over

Vocabulary:

Genotype = genes = genetic makeup

Phenotype = what you see! Genes plus environment

How many of you know your genotype for X? For sure?

Dominant Trait that shows up - conventionally written with a capital letter (bully)

Recessive - Trait that is hidden, unless paired with another recessive trait - written with a lowercase letter (wimp)

Homozygous - 2 of the same gene for a trait

Heterozygous - 2 different genes for a trait

17) Learning about Meiosis Using SQ3R Reading Strategy: Instructions for SQ3R (Survey, Question, Read, Recite, Review)

Instructions courtesy of Billmeyer, p 130.

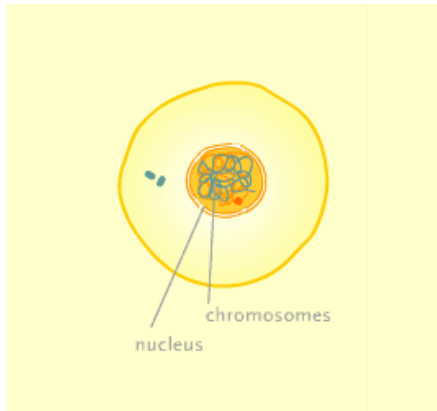
1. Survey the text you are about to read
 - a. Think about the title. What do I know about this subject? What do I want to know?
 - b. Glance over headings and/or skim the first sentences of paragraphs.
 - c. Look at illustrations and graphic aids
 - d. Read the first paragraph
 - e. Read the last paragraph or summary
2. Question
 - a. Turn the title into a question. This becomes the major question for your reading.
 - b. Write down any questions that came to mind during your survey.
 - c. Turn headings into questions.
 - d. Turn subheadings, graphic aids and illustrations into questions.
 - e. Write down any unfamiliar vocabulary and determine the meaning.
3. Read Actively
 - a. Read to search for answers to your questions.
 - b. Respond to questions and use context clues for unfamiliar words.
 - c. React to unclear passages, confusing terms and questionable statements by generating additional questions.
4. Recite
 - a. Look away from the answers and the book to recall what you read.
 - b. Recite answers to questions out loud or in writing (discuss with your partner).
 - c. Reread text for unanswered questions.
5. Review
 - a. Answer the major purpose questions.
 - b. Look over answers and all parts of the text to organize information.
 - c. Summarize the information learned by creating a graphic organizer that depicts the main ideas, by drawing a flow chart, by writing a summary by participating in a group discussion, or by writing an explanation of how this material has changed your perceptions or applies to your life.

17) Learning about Meiosis Using SQ3R Reading Strategy

The Story of Meiosis

Text courtesy of NOVA Online, Life's Greatest Miracle

http://www.pbs.org/wgbh/nova/miracle/divi_text.html



Before We Split

Though the genetic code of a human being is contained within 46 chromosomes, only half of this number exists within the cell of a sperm or egg. If the cells didn't have half, a fertilized egg would contain 92 chromosomes and be untenable. Meiosis, a type of cell division specific to reproduction, avoids this by halving the number of chromosomes in a cell.

The cell shown here will divide twice, resulting in four cells. Each of these cells will have only half the number of chromosomes, but each chromosome will contain genetic information from both parents.

Interphase I

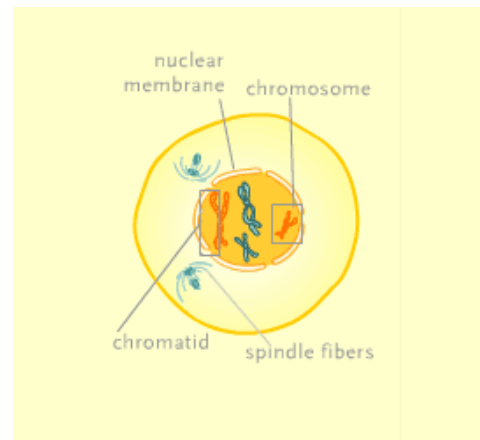
The activities within this cell are the same as in the mitosis-dividing cell.

NOTE: Blue indicates chromosomes from the father; orange indicates chromosomes from the mother. The titles used for each step—e.g., "Interphase," Interphase I"—are those used in biology textbooks.

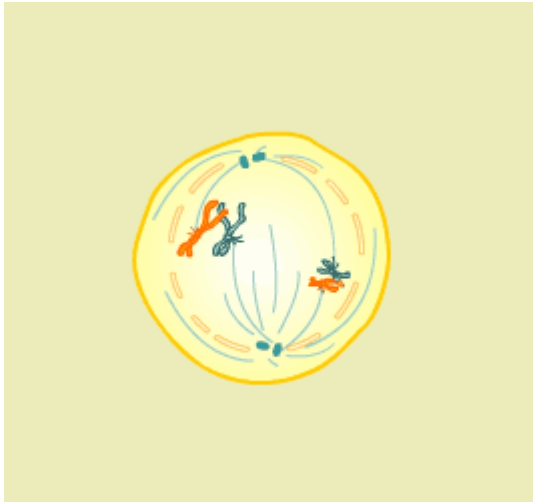
Prophase I

The activities are the same as in mitosis, except that in this cell the chromosomes attach to the membrane of the nucleus and then pair up with their corresponding chromosome.

While paired up, enzymes cut sequences of DNA (genes) from the chromosomes. These sequences are exchanged between the chromosomes, which allows for an exchange of genes between the two.



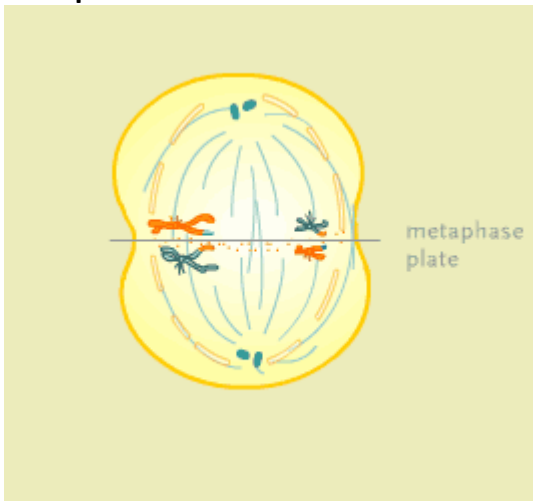
Prometaphase I



Same as in mitosis, except that the spindle fibers from each centriole attach to one chromosome of a matching chromosome pair.

In other words, the fibers from one centriole attach to 23 chromosomes, and the fibers from the other centriole attach to the other 23 chromosomes. (Again, only four chromosomes are shown here in order to simplify the illustration.)

Metaphase I



The chromosome pairs line up on either side of the metaphase plate, an imaginary line that divides the cell in two.

Also, the fibers begin to tug each chromosome toward opposite ends of the cell.

Anaphase I

The chromosome pairs separate; half of the chromosomes move toward one end of the cell, the other half, to the other end.



The chromosomes' sister chromatids do not separate as they do in mitosis.

Telophase I



As in mitosis, the chromosomes arrive at opposite ends of the cell, and new nuclear membranes form.

The dividing cell shown here is a male's sperm cell. With meiosis in a female, most of the cell's cytoplasm will be concentrated in one of the two emerging cells, which will result in one large cell and one small cell. The large cell will go on to divide again (as shown on the following screens); the small cell will degenerate.



End of cytokinesis

The rest of the cell divides. Cytokinesis, the division of the cell's cytoplasm, is now complete.

Interphase II

The chromosomes do not replicate during this phase, as they do in interphase in mitosis and interphase I in meiosis.

Prophase II

As in prophase I, the chromosomes condense, spindles form, the centrioles begin to separate, and the nuclear membrane fragments and disperses.

Unlike prophase I, the chromosomes do not attach to the nuclear membrane in order to exchange genetic information.

Prometaphase II

The spindle fibers attach to the chromosomes. The centrioles are now at opposite ends of the cell.

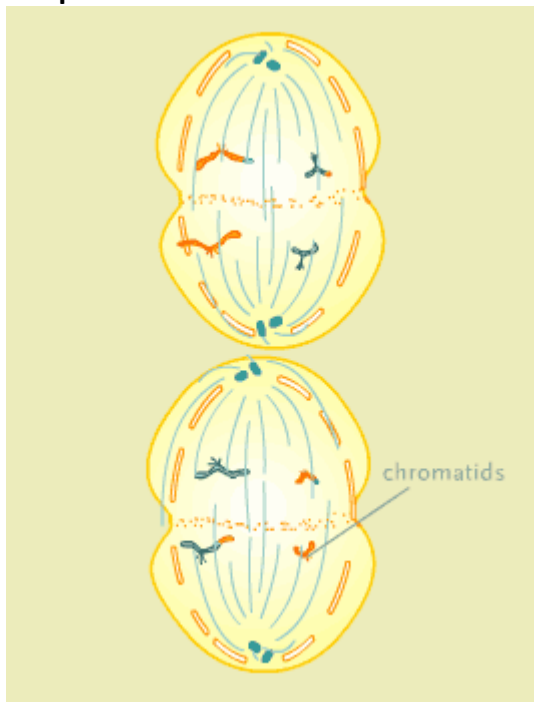
As in mitosis prometaphase, fibers from both ends of the cells attach to each one of the four chromosomes.

Metaphase II

The chromosomes align along the metaphase plate.

As in mitosis metaphase, (and unlike meiosis metaphase I), fibers from the centrioles begin to pull on each one of the chromosomes from both directions.

Anaphase II



As in anaphase in mitosis (and unlike anaphase I in meiosis), the fibers pull the chromatids apart and toward opposite ends of the cells.

Telophase II

The chromatids arrive at the either end of each cell and new nuclear membranes form.

With meiosis in a female, there is only one dividing cell at this point. As in telophase I, the

cytoplasm of the cell will be concentrated in one of the two emerging cells. The resulting large cell will become an egg cell. The smaller cell will degenerate.

End of cytokinesis



The rest of the cell continues to divide. Only when two, distinct cells form will cytokinesis, the division of the cell's cytoplasm, be complete.

There are now four daughter cells. Each cell has one set of chromosomes, or one half the number of the initial cell.

18) Reading a Pedigree Chart: Guided Reading Lesson

Title: Reading a Pedigree Chart

Anticipatory Set: So, you've met the guy or girl of your dreams. You're strongly considering getting married soon, and since you're both crazy about kids, you'd like to have a family SOON. There's only one snag...dream guy/girl's grandfather and an aunt had a rare disease that caused them to lose their strength in their early 40s. You're concerned that this might be a genetic condition...and if so, could dream guy/girl be affected? And even if they aren't, what is the likelihood that it might be something that can be passed on to your kids? You'd like to just take a DNA sample from Gramps and Auntie, and have that analyzed, but unfortunately for you, both have passed away, so that isn't an option. How can you unravel this mystery, and determine the likelihood of your children having this condition? Should you think about adoption?

Objective: To learn how genetic pedigrees can provide information about the patterns of inheritance of certain traits, and determine the likelihood of offspring having certain inheritable conditions.

Purpose: Diagrams are often used to present information at a glance, which might otherwise be unwieldy and difficult to grasp. However, without instruction, the diagrams themselves can at times be confusing! In order to gain information from a genetic pedigree, we need to learn the rules of construction, and how to read them.

Body of the Lesson: Students will be given a set of pedigree charts (see attached). Take a look at the charts I've handed out to you. Any idea how these might help us? (Some students comment that they look like family trees). Exactly, these are special family trees that focus on the genetic trait we're interested in tracking. Let's start with the shapes on the charts. Any idea what the circles and squares represent? Yup, males and females. The males are represented by a square, and females are represented by a circle. What about those Roman Numerals on the left hand side of the chart? Right, they represent generations. The Roman numeral 'I' is the first generation. So, if you were in generation 'IV' what would your relationship to generation I be? Absolutely, those folks would be your great grandparents. So, who is married in this diagram, and how do you tell brothers and sisters from married couples? Exactly, if the line connecting two shapes connects them at the middle of the shape, they are a couple. If they are connected by a line to the top of the shape, they are siblings (during this discussion, the pedigree chart is displayed on the smart board, and the teacher is drawing on the examples on the board). So why are some of the shapes colored in, and some of them are not? Remember, we're looking for genetic traits...the colored in shapes represent individuals that have the trait we're concerned about, and the ones that are not colored in are "normal" -- at least for that particular trait. So, how would you describe which individuals on the chart have the trait? (students brainstorm) Yes, you noticed that the individuals in each generation have a different number under their symbol. So, the affected individuals are generation III, individuals 2, 3, and

8, and individuals 1 and 2 in generation IV. So, what do you think about the pattern of inheritance for this trait? Is it dominant? (again, students brainstorm, and teacher writes answers on the board) Students eventually decide that it is NOT dominant (what's that called? right, recessive) because no one in the previous generations appears to have the trait.

Guided Practice: (Students and teacher discuss this chart, and students answer, with the teacher writing the answers on the board) All right, now let's take a look at Pedigree chart #2. Take a moment to study the diagram. All right, how many generations are there? How many children did the grandparents have? How many boys and how many girls? Which individuals are the children of generation I, and which are the in-laws? Which individuals are affected with the trait? Do you think this trait is dominant or recessive? Why?

Excellent job, you really have the hang of these. All right, this last one is on your own -- although there is one new symbol you should know about...that circle that is half colored in and half plain...what do you think that means? Right, she "sort of" has the trait. She is a carrier of the trait...she is **not** affected herself, but she has one copy of the gene with that trait. Often, we don't know who is a carrier, but in this case, it was determined from her father's genes that she has at least one copy of the trait (that's a big hint!). So, you need to determine the pattern of inheritance for this trait. Take a look at who is affected, and pay special attention to who is a carrier. You may need to construct a punnett square based on the information from this pedigree... (Teacher wanders around while students are working on the chart, and answers questions as needed).

Closure: These types of charts are often used by people who study genetics, by genetic counselors, and by breeders, who want to determine the likelihood of certain traits showing up in future generations. They are a low tech, easy way of showing patterns of inheritance.

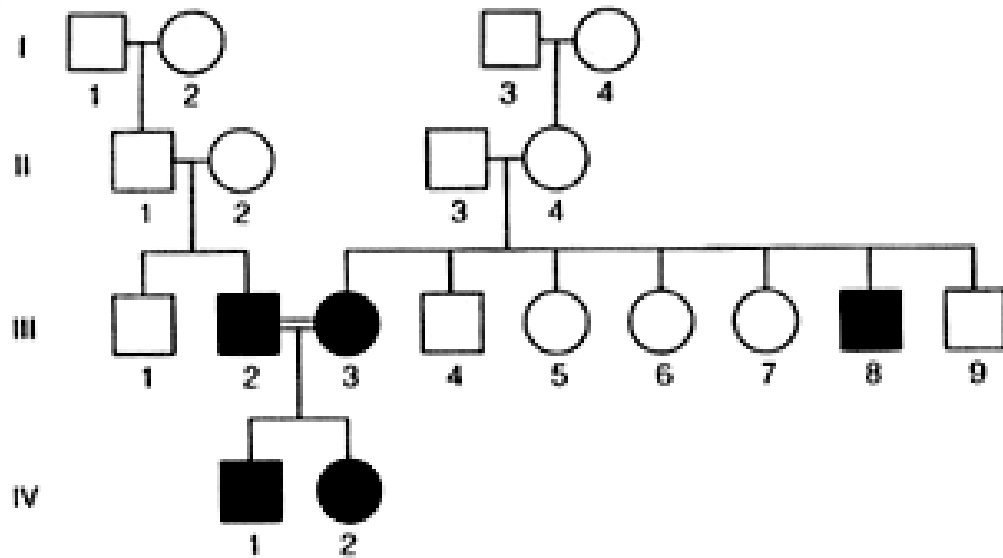
Assessment: Your ticket out the door is to tell me the pattern of inheritance that is shown on the third pedigree chart. Also, label the generations and the individuals to make it easier to describe individuals.

Technology: Overhead projector, smart board.

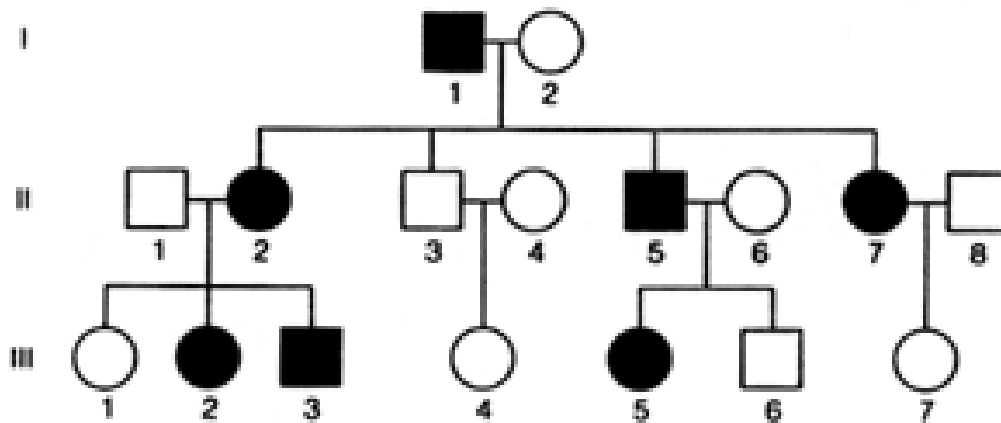
Adaptations: Students have individual copies of all charts, as well as being able to view charts on the smart board. Group discussions help to build knowledge for all students before they have to tackle the assignment independently.

18) Reading a Pedigree Chart: Guided Reading Lesson

Pedigree Chart #1

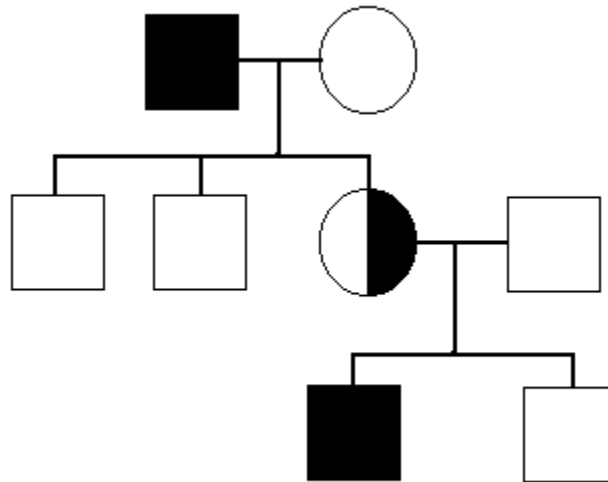


Pedigree Chart #2 - Guided Practice



18) Reading a Pedigree Chart: Guided Reading Lesson

Pedigree Chart #3 - Independent Practice



http://sciencecases.lib.buffalo.edu/cs/files/sickness_and_health_notes.pdf

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering

Purpose:

The technology of genetic engineering has allowed humans to alter the genetic makeup of organisms. This makes possible new fields in health care and research, and also raises questions about the acceptable limits of our role in manipulating the makeup of organisms. Students will use their literacy skills to perform a webquest researching major up and coming issues in the field of genetics, and will then collect and organize their ideas into a visual and oral presentation. This assignment will allow students to find real world, authentic text, to take ownership of ideas, and work on expressing themselves in writing.

State Standards and General Learning Objectives:

NYS Living Environment Core Curriculum, Standard 4, Performance Indicator 2.2. Special Emphasis on Major Understandings 2.2a: For thousands of years new varieties of cultivated plants and domestic animals have resulted from selective breeding for particular traits; 2.2b: In recent years new varieties of farm plants and animals have been engineered by manipulating their genetic instructions to produce new characteristics; 2.2c: Different enzymes can be used to cut, copy and move segments of DNA. Characteristics produced by the segments of DNA may be expressed when these segments are inserted into new organisms, such as bacteria; 2.2d: Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it; 2.2e: Knowledge of genetics is making possible new fields of health care; for example, finding genes which may have mutations that can cause disease will aid in the development of preventive measure to fight disease. Substances, such as hormones and enzymes, from genetically engineered organisms may reduce the cost and side effects of replacing missing body chemicals.

The field of genetic research is one of the fastest growing fields in biology, and has the potential to impact every area of our lives. Students need to develop an awareness of what is possible, what might be possible, and the implications of this knowledge for good and for ill.

Instructional Objectives:

1. Students will research and learn about issues involved in manipulating genes.
2. Students will utilize literacy skills in order to perform research using authentic text, and to organize the information they find into a coherent presentation.
3. Students will utilize teamwork in developing their presentations, and in presenting.

Major Concepts:

DNA alteration through genetic engineering.

Instructional Materials:

Smartboard, computers.

Instructional Activities:

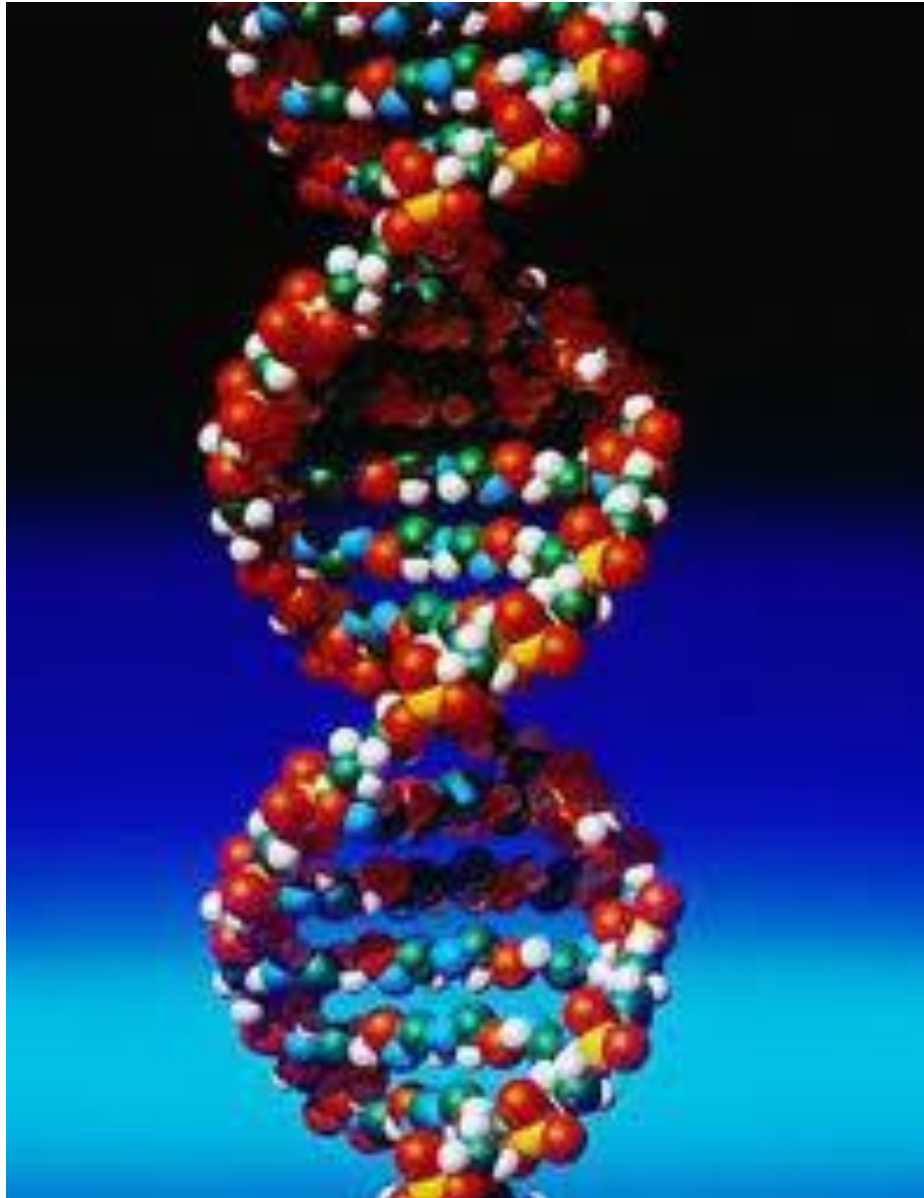
1. **Engage** Begin class by showing students slides of a wolf, and then photos from the Westminster dog show. Show pictures of the wild mustard plant, and then of broccoli, cauliflower, cabbage, Brussels sprouts, and kohlrabi. We humans created these dogs and these vegetables from the original wild varieties. We deliberately, over many generations, selected for certain traits over others. At this point, many of the dogs scarcely resemble their original wolf ancestor. This is known as selective breeding.
2. **Explain** Present students with the webquest assignment, and go over the expectations and rubric. Students will have the remainder of this class period and two others for research, presentations will take a class and a half, with the remainder of the class being used for review for a final unit test.

Tricky, Sticky Genetics

Moral and Ethical Considerations

A Living Environment Webquest

By Kristen Kimble



19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering: Introduction

With great knowledge, also comes great responsibility. Scientific knowledge about the nature of DNA and genetics is increasing more rapidly than almost any other field of biological research. Aided greatly by powerful computers, which make sequencing the genome of many different organisms quick and painless, scientists today have a growing knowledge of the genome of a great number of creatures. Now that scientists are able to decode the genes inside our cells, they have been experimenting with how to alter those genetics. Why would a scientist want to manipulate the genes of an organism? One of the major reasons is quite simply because they can. Now that gene manipulation is possible, many scientists experiment with manipulating genetics to push the limits of what can be accomplished with the new found scientific knowledge. There are of course, other reasons given. Some scientist work with manipulating genes because they seek to eliminate disease and lessen human suffering. Others see a great financial opportunity to be had in successfully manipulating and designing genes. This increasing ability of scientists to change the genome of an organism or to “genetically engineer” an organism opens up many heretofore unimaginable moral and ethical questions. Is it okay to mess with the genes of an organism, and if so, under what circumstances? What are some of the potential benefits and risks from doing so?

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering: Your Task

For this web quest, you will be working first independently to research background information on three “hot topics” in the field of modern genetics, making sure to take careful notes, and then you will narrow your focus and work with a partner to explore an angle of one of the issues in more depth. You will be responsible for finding information about the pros and cons of your specific topic, and to develop your own opinion, supported by your research. You will then use this information to create, with your partner, a media presentation to accompany a 5-10 minute class presentation.

Process

1. Following are three “hot topics” in the field of genetic research and genetic manipulation. Your first task, working on your own, is to follow the web links to learn about each of the three main issues. Make sure to take good notes about what you learn. You may use one of the graphic organizers you’ve learned about in class, or you may take notes on three by five cards. Part of your grade will be based on the notes you take. Make sure you take the time to put important information in your own words (copying directly from a book, magazine, or website is plagiarism, and can get you in big trouble, in addition to hurting your grade!). Writing ideas in your own words also helps you evaluate your comprehension of the topics. You want to get an overview of each of the three main topics and also consider whether you feel manipulating genes is a good idea or not. I have included questions for you to think about.

2. Once you've completed your initial research (you will need to see me for approval to move onto the next step!) you will be working with a partner to explore one angle from the topics you've researched in more depth. I've included a list of questions along with each "hot topic" to help guide your thinking, but I'm open to other ideas, just run them by me first.
3. Once you and your partner have chosen your topic, you will need to find a minimum of four additional sources, using google, to help you learn about and discuss your topic. You must make sure you consider both the pros and cons of the topic, and that you are supported by your research. Be sure to consider the quality and bias of any sources you use, and make sure that when you find new information, that you include the source of that information in your notes.
4. Once you've completed your research, you and your partner will prepare a media presentation to accompany a 5-10 minute class presentation/discussion. You must include background information about your topic, and discuss the pros and cons of your type of genetic manipulation. Some examples of things you may use for the visual portion of your presentation include a poster, video, or powerpoint presentation. See me to run by any other ideas you might have!
5. You will be graded for this project on your notes, your teamwork, and your final presentation. Good ability to collaborate with a partner or team, perform research, take good notes and present information in an appealing and professional manner will all be valuable skills called into frequent use in post high school life!

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering



Moral and ethical issues in genetics

1. Genetically Modified Organisms (GMOs)

<http://www.csa.com/discoveryguides/gmfood/overview.php> - a very comprehensive source of information, but also the most technical source. Not written to be a quick read.

http://www.ornl.gov/sci/techresources/Human_Genome/elsi/gmfood.shtml - brief background information about the types and prevalence of GMO crops, and a bulleted list format presenting pros and cons.

<http://www.gmo-compass.org/eng/home/> - a source of a great number of articles on issues related to GMOs.

http://nature.ca/genome/03/d/30/03d_33_e.cfm - a shockwave game that walks you through the process of making a GMO

Questions to consider:

Do you think GMOs could be used to eliminate famine? Think about:

- Disease and pest resistant crops
- Drought resistant crops
- Vitamin enriched crops

Do you think GMOs could endanger other non-target organisms? Think about:

- Butterflies
- People with allergies

Do you think heavy use of GMOs could result in organism becoming resistant to them? Think about:

- Weeds that are resistant to herbicides
- Pests no longer affected by GMO alterations

Could GMOs be used to produce medicines? Think about:

- Bacteria that produce insulin
- Bananas that produce vaccines

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering

2. Designer Babies and Gene Therapy



http://www.bionetonline.org/english/content/db_cont1.htm - good overview, with links to other issues.

<http://www.time.com/time/magazine/article/0,9171,989987,00.html> – Time Magazine article from 1999. Older information, but good description of the principles of pre-implantation genetic screening

<http://www.wired.com/wiredscience/2009/03/designerdebate/> - an interview with someone in support of parents' right to use genetic screening to choose their child's attributes

<http://ghr.nlm.nih.gov/handbook/therapy/genetherapy> - basics about gene therapy

Questions to consider:

- What is meant by a designer baby?
- In your opinion, is it okay for parents to genetically select for a blonde haired, blue eyed girl?
- What if the parents select an embryo to avoid a fatal genetic disease?
- Should parents be allowed to design a baby with a certain genetic make-up in order to save the life of a family member? For example, a child who would be a perfect bone marrow match for a family member suffering from leukemia?

18) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering

How does gene therapy differ from pre-implantation genetic screening? Think about:

- What are some potential benefits of gene therapy?
- What are some potential risks/dangers with gene therapy?
- In what areas has gene therapy been successful?

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering

3. Cloning



http://www.ornl.gov/sci/techresources/Human_Genome/elsi/cloning.shtml - Great overview of cloning, with multiple links to new articles and other information

Questions to consider:

- Should we be cloning? Think about:

Dolly the sheep, the first successfully cloned mammal, died at six years old, after suffering from debilitating arthritis and lung cancer. Sheep of her breed normally live a dozen years. Are cloned animals somehow genetically damaged, resulting in shorter life expectancy?

- Could cloning be used to bring back extinct species?
- How about bring back the dinosaurs?
- What about bringing back an extinct plant, believed to hold the cure for cancer
- Do you think that humans will ever be cloned? How do you feel about this?
- What about the possibility of cloning organs for transplants? Currently, with most organ transplants, someone needs to die in order for a transplant patient to receive a new organ.



Evaluation

You will be graded on your notes from your research, your ability to work collaboratively with your partner on your presentation (each member of the team will be filling out an evaluation of your own, and your partner's work!), and on your presentation. Were you creative? Was your work careful and neat? Did you introduce background knowledge about your topic, and address the pros and cons, using research to support your opinions? During the presentation, were you well organized, and clear and easy to understand? Finally, you will also be graded on your participation as an audience member. Since you will all be focusing on different aspects of genetic research, you all have something to learn from each other. You need to be a considerate audience, and you need to make sure that you prepare at least two questions for each presentation (to ask the presenters, and to be handed in to me). (See attached rubric)

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering

Conclusion

Congratulations! You have completed your web quest investigating moral and ethical issues in genetics. This is one of the hottest topics in science today, and one that will continue to affect our lives for many years to come. In completing this project, you have developed your research skills, your collaborative working skills, your presentation skills, and learned a great deal about issues that you will be hearing about in the news, and that affect all our lives.

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering

Research Presentation Rubric

Category	5	3	1
Notes 20%	Notes show thorough research of the topic, are clear and well organized, and are in the students own words	Notes could be more thorough and better organized, but show evidence of good quality research of the topic, primarily in the students own words	Notes show poor evidence of research, are poorly organized, and when notes are taken, they are directly copied from the research
Presentation 20%	Well scripted and organized, voices loud clear and easily understood. Class very engaged!	Evidence of rehearsal and organization, but could be smoother. Class somewhat engaged	Presentation seems thrown together, poorly organized, and hard to understand. Class is not involved.
Content 20%	The group provides excellent background information on the topic, and thoroughly examines the pros and cons of the controversial topic.	Group provides background information on the topic, and the pros and cons are both mentioned, although not in great detail.	Minimal background information, and pros and cons not addressed, or only one side of the issue addressed.
Visual Component (PowerPoint, Poster, Video, etc.) 20%	The visual component clearly adds to the understanding and enjoyment of the presentation. Work is neat and creative!	The visual component somewhat adds to the understanding of the presentation. Work is mostly neat.	The visual component detracts from the presentation. Work looks sloppy.
Group Collaboration 10%	Teams worked well together, work was evenly divided.	Teams worked together with some assistance, one team member may have contributed more.	Teams were in conflict, one team member completed most of the work.
Audience Participation 10%	Student was polite and attentive during presentations, came up with at least two good quality questions for each presentation.	Student was polite and attentive during presentations, usually came up with at least 1-2 questions per presentation.	Student was not polite or attentive during presentations; questions were not developed, or only minimally developed.

19) Tricky, Sticky Genetics...Ethical Issues in Genetic Engineering

Credits

Images courtesy of:

http://www.jewishjournal.com/whats_annoying_jews_today

<http://3healthychicks.blogspot.com/2010/10/october-non-gmo-month.html>

nwso.net

<http://grtu.net/data/index.php>

<http://www.fitbuff.com/fitbuff-morning-mix-monkey-clone-cancer-prevention-holiday-wash/>

Rubistar.com was very helpful in designing grading rubrics

<http://webquest.sdsu.edu/templates/lesson-template1.htm> was a useful site for determining how to structure the webquest.

Standards Addressed

NYS Living Environment Core Curriculum, Standard 4, Performance Indicator 2.2 “Explain how the technology of genetic engineering allows humans to alter genetic makeup of organisms”

Major Understandings 2.2a -2.2e

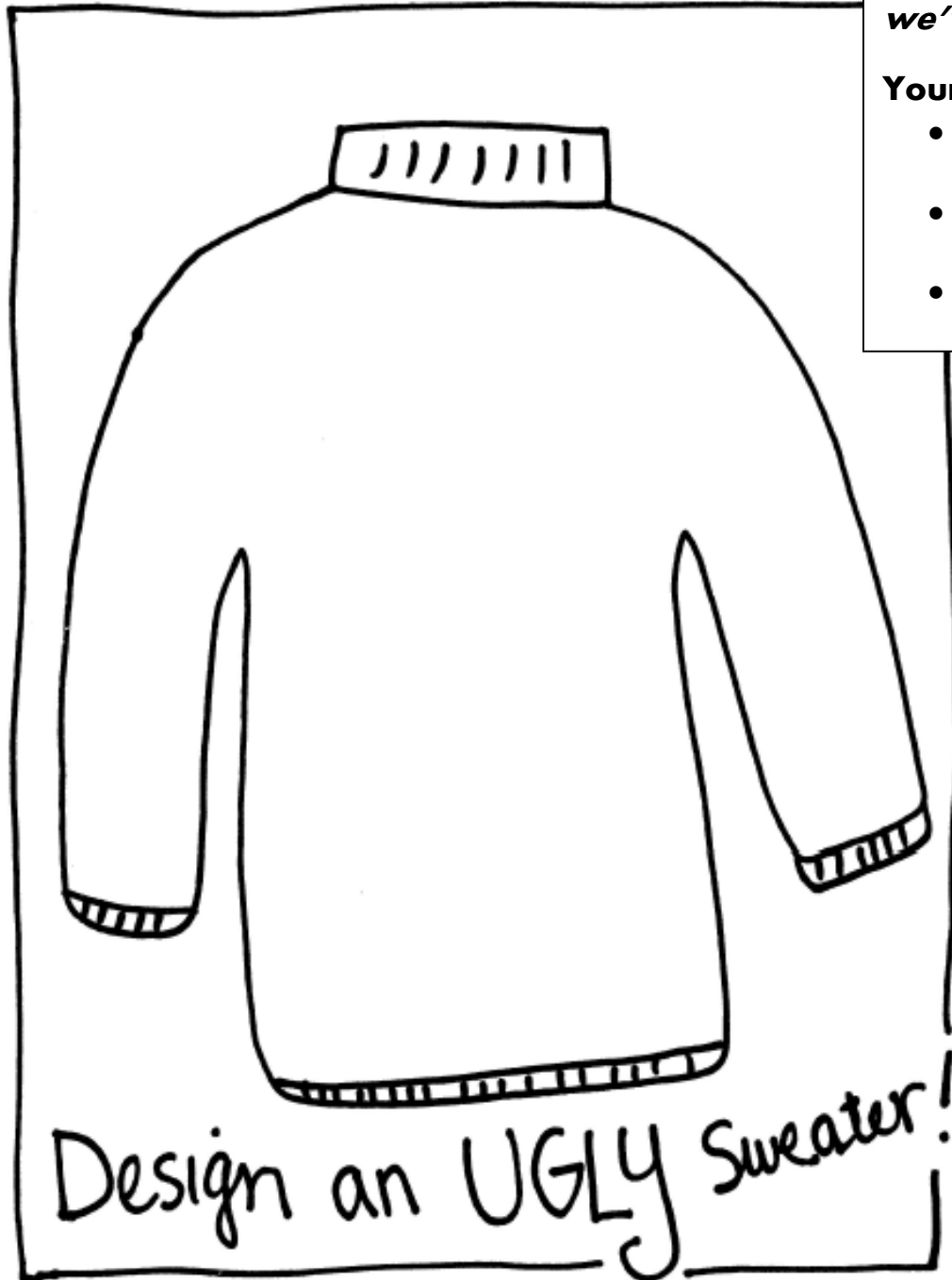
20) Ugly Sweater Vocabulary Activity

Ugly Sweater Competition

Design and color an ugly sweater based on a vocabulary term we've used this unit.

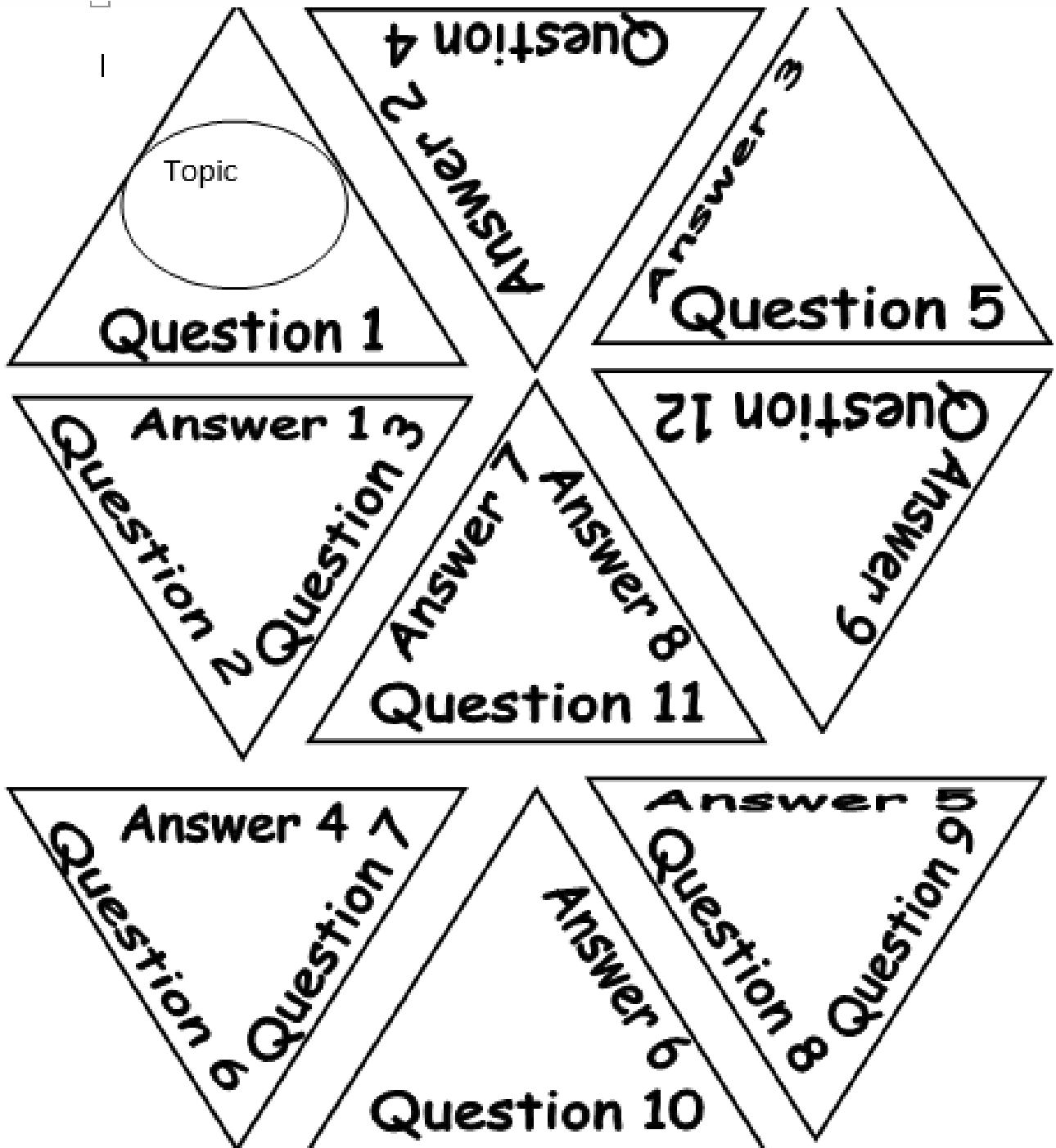
Your design should be:

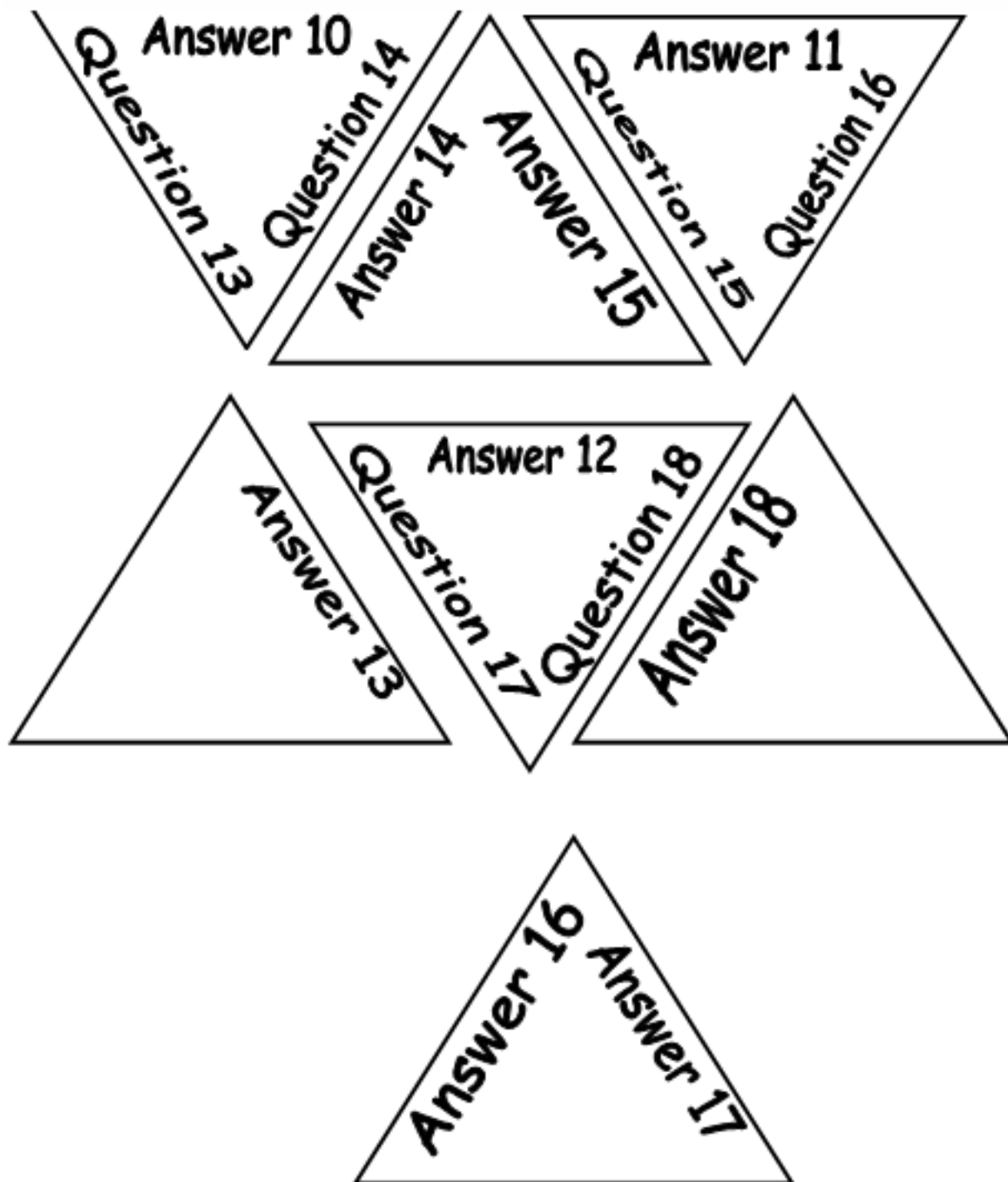
- **Original, colorful and UGLY**
- **Easily identified as that term**
- **School appropriate**

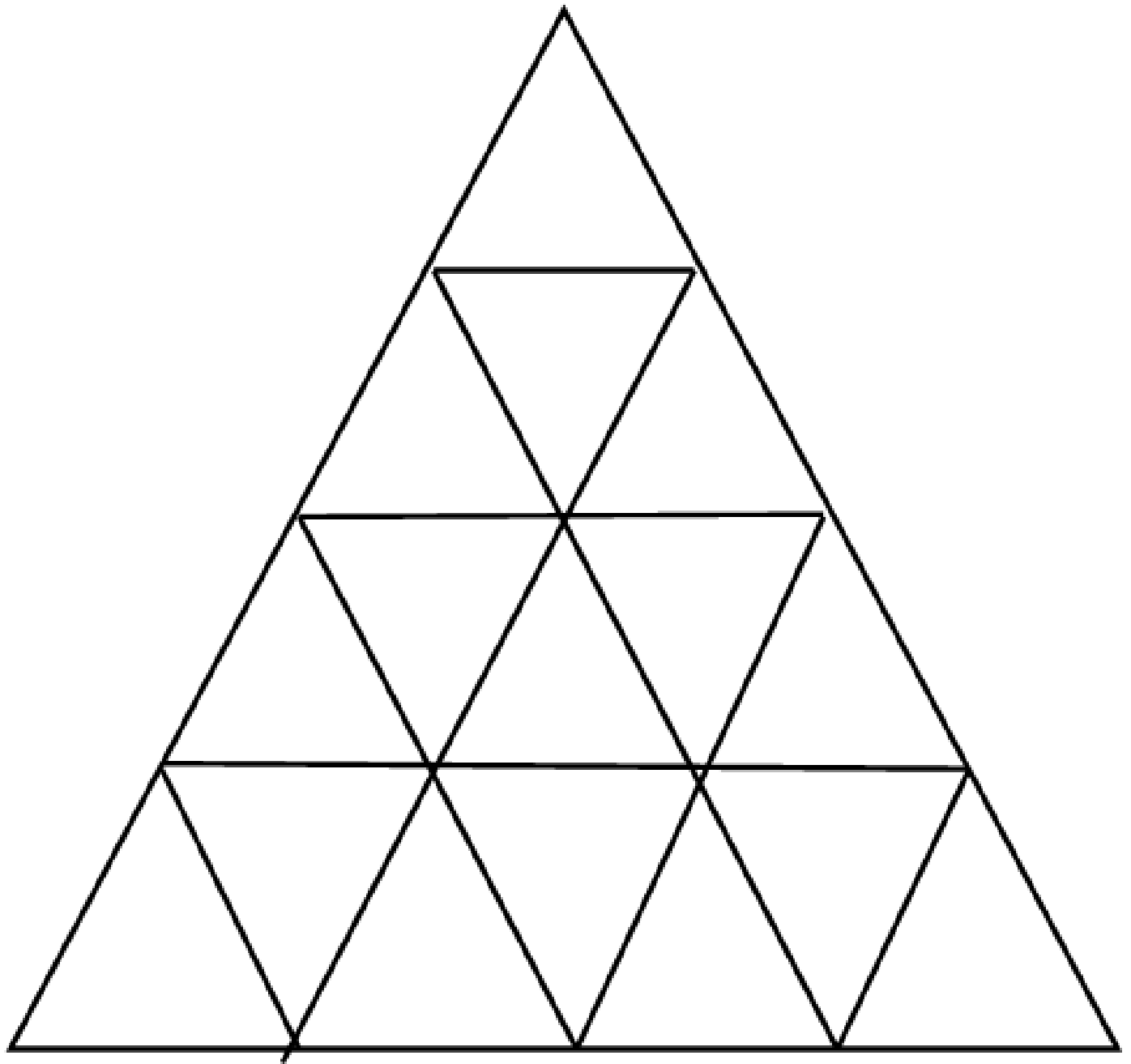


Put your name, class period, and vocabulary term on the back of your sweater after you cut it out.

21) Vocabulary Triangle Puzzle Template







22) Cell Transport Graphic Organizer

Name _____

Date _____

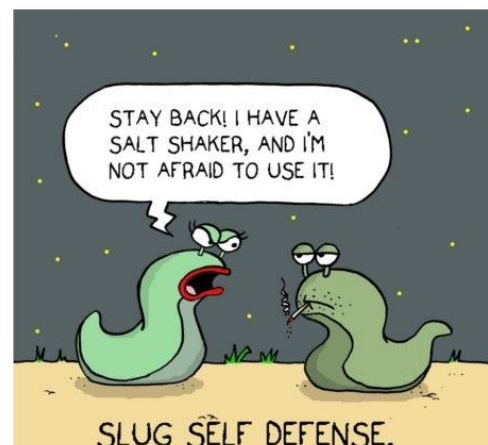
Cell Transport Review

Pocess	Description	Gradient Required?	Energy Required?	Examples
Passive Transport				
Simple Diffusion				
Osmosis				
Active Transport				
Endocytosis				
Exocytosis				

1. Analyze this cartoon.

a. What would happen if the slug shook the salt shaker on the other slug?

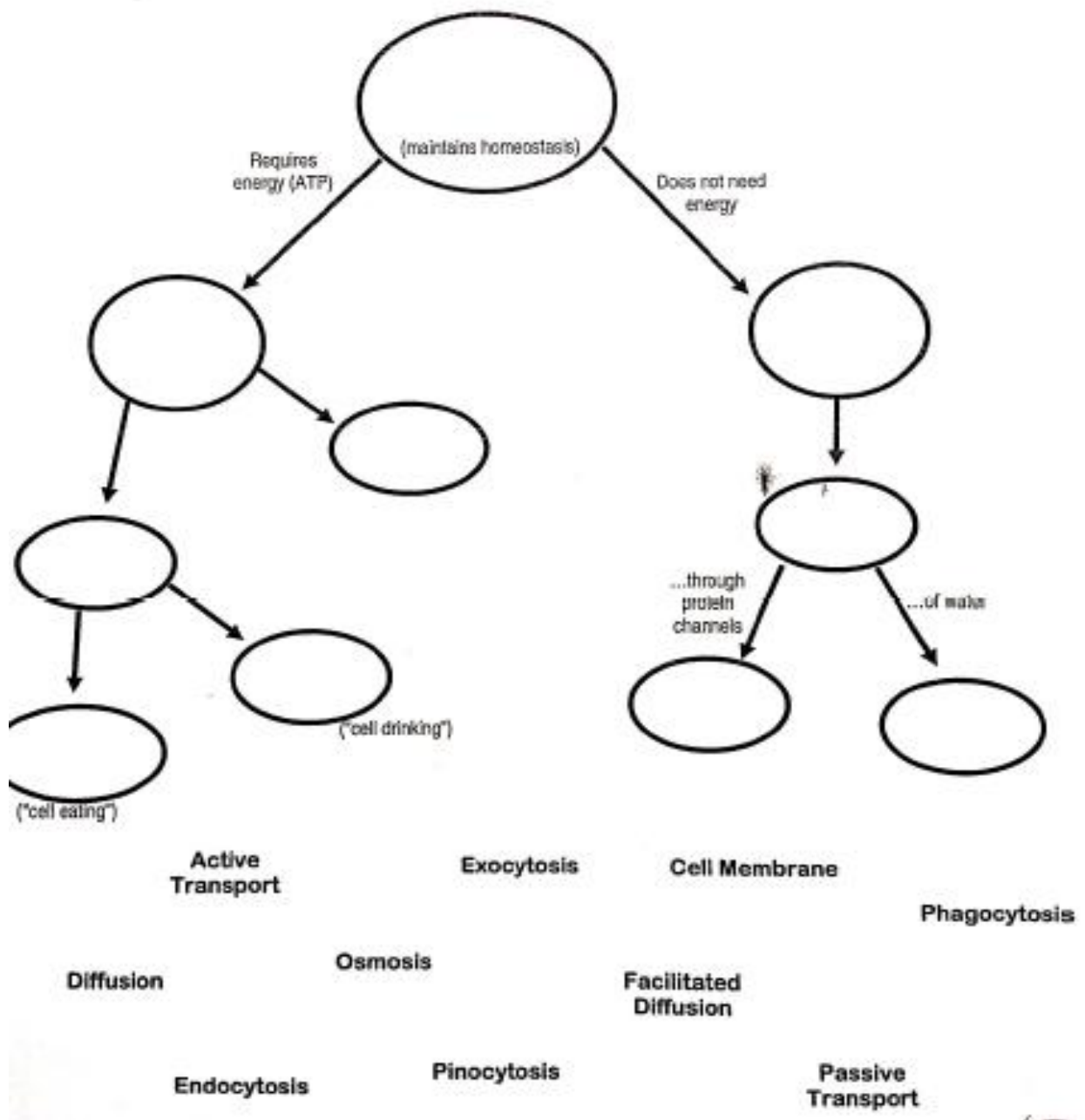
b. Name the transport process the cartoon refers to.



23) Cell Membrane and Transport Graphic Organizer

Graphic Organizer: Cell Membrane

The words given below represent topics that you have learned about in this unit. Use the words to fill in the circles on the graphic organizer. (Write in pencil!) Once you have all of the words in the correct spot, ask your instructor to verify that it is correct.



Supplemental Materials/Links

Let's Build a Cell

- Stunning cell animation! <http://multimedia.mcb.harvard.edu/> (approximately 8 minutes)

http://multimedia.mcb.harvard.edu/anim_innerlife_music.html (Same video, abridged 3 minute version)

- Cell Craft Game - www.kongregate.com/games/CellCraft/cellcraft

Sweet Cells and the Scale of things

They Might Be Giants – Here Come Cells – great song and animated video about cells!
<http://www.youtube.com/watch?v=ZK6YP1Smbxk>

Relative sizes of Cellular Organelles

Cellular Part	ACTUAL SIZE (AVERAGE)	WHEN MAGNIFIED 3 MILLION TIMES
Cell Diameter	30 micrometers	90 meters Approximately the length of a football field
Nucleus Diameter	5 micrometers	15 meters
Mitochondrion Length	1-2 micrometers (typical) BUT CAN BE UP TO 7 micrometers	3-6 meters 21 meters
Lysosome diameter	50-3,000 nanometers	15 centimeters -9 meters
Ribosome diameter	20-30 nanometers	6-9 centimeters

*A micrometer is one millionth (10^{-6}) of a meter. A nanometer is one billionth (10^{-9}) of a meter.

(Chart showing relative sizes of a “typical” cell and its organelles, from <http://publications.nigms.nih.gov/insidethecell/chapter1.html>,

English measurement converted to metric by Kristen Kimble)

Technology link showing the scale of tiny things:

LearnGenetics.utah.edu/content/begin/cells/scale/

Little Bitty: The care and feeding of a microscope

Microscope Handout, for student notes, from

<http://home.earthlink.net/~wweinkle/microscope.htm>

Cell Theory

ed.ted.com/lessons/the-wacky-history-of-cell-theory

Fantastic cell theory video from TED talks

It's Alive!

http://www.youtube.com/watch?v=WwsVvuQe_eM Oingo Boingo, Weird Science (It's Alive!)

Is it Alive? Video

<http://www.teachersdomain.org/resource/tdc02.sci.life.colt.alive/>

And so it grows...

<http://www.youtube.com/watch?v=VGv3fv-uZYI> Nicely modeled video of mitosis - No

voiceover, just music, ~1 1/2 minutes

My toe goes through mitosis

<http://www.youtube.com/watch?v=eFuCE22agyM> synchronized swimming routine acting out mitosis!

Mitosis "square dance" where students act out the process of mitosis - pool noodles can make good spindle fibers...

**All join round and mingle fine
Shake hands now, it's interphase time
More join in and dance just fine
All clap hands, it's interphase time
Centrioles move outside
All join partners- then face inside
One to the left- one to the right
Join your partner- it's prophase time
Chromosomes: Do-Si-Do**

And line up in the equatorial zone
It's metaphase- just grab hands
Twirl your partner around and dance!
Now anaphase has come to town
All drop hands and step back now
Keep in line and wave so long
It's to a new cell that you belong
Cells join hands and circle right
Telophase is on tonight
Circle left, you're almost through

Go to the center and say Yahooooo!

<http://www.songsforteaching.com/scienceinsong/mitosisphases.htm>

Chapter Four: Summary and Discussion

Unlike teachers in the past, today's educators do not have the option of sending their special education students out of their classes when the material gets challenging. Special education students are no longer being educated "elsewhere, by someone else" in an alternative setting. The vast majority of special education students spend the vast majority of their days in inclusive classrooms together with students of all ability levels. This situation is becoming the norm across the country, and while the debate continues to rage over whether this is truly the ideal situation for students with disabilities, the reality is that with more and more students in inclusive, integrated classrooms, all teachers have the possibility of "becoming a special education teacher" at one point or another, regardless of their certification or training. While the educational achievements for students with disabilities continue to lag behind their non-disabled counterparts -- graduation and college attendance rates are significantly lower for students with disabilities, and dropout rates are higher -- the importance of having an education has never been greater. The highly paid unskilled manufacturing jobs that existed a generation ago have long since left the United States, and the minimum wage jobs that students without a high school degree are qualified for rarely come with benefits, and leave a family living below the poverty line. As teachers then, we have a professional and moral obligation to do what we can to help set all of our students up for success. This project was an attempt to provide science educators with an example of some of the ways to try and meet the needs of all their students in the same classroom. None of these suggestions is a magic bullet. Doing them all perfectly will not suddenly and miraculously elevate the test scores of a student with disabilities to be equal with their non-disabled peers. They will likely still struggle, and need to put in extra work, and

receive extra assistance. However, an engaging, hands on curriculum that helps to support their needs might go a long way in alleviating the crushing frustration that causes a student to give up in defeat, or decide to become the class troublemaker rather than the class dunce. Perhaps the most important thing that an educator facing the challenge of teaching students in an inclusive classroom can do is to consider all the options. Students need to read and write to succeed in school, so make sure to offer vocabulary support. This can be as simple as providing the definition of words in the margin of an authentic text selection, and making sure that readings have large enough margins for students to write down the definitions they come up with using context clues, or it can involve vocabulary games and review. Ideally, teachers should use some combination of approaches. Even in a room with two teachers, students may need additional support. Strategic grouping can be a powerful tool to support struggling students, while helping more advanced students deepen their understanding. Teaching can be a wonderful way to learn. All students need to have the opportunity to experience productive struggle, building knowledge in a supportive environment. Giving students lots of opportunities to build knowledge, and to reflect on the knowledge they build helps both special education and mainstream students. Analogies, POGILs, web quests and investigative labs are all ways to give students these chances. Just as it would be ridiculous to make one size of shoe to fit all feet, it is even more ridiculous to create one size fits all instruction for all levels of ability and disability, interest and lack of interest. Keeping options open, and giving students multiple ways and multiple opportunities to learn new material, multiple methods for expressing their knowledge and multiple different approaches for the different personalities that all of our

students bring to the classroom allows for a greater chance of success for all students. This is the essence of universal design for learning.

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