UNIT – CONCEPTS: Understanding Cell Theory and Microbiology

SUMMARY – This unit is divided into 2 major sections: Cell Theory and Microbiology. During the Cell Theory section, students will use models, lab simulations, inquiry-based activities, and Internet resources to assist them in describing the cell theory; analyzing structures, functions, and processes within animal cells (including mitosis, meiosis, diffusion, osmosis, and cellular transport; and comparing life functions of protists. During the Microbiology unit, students will complete hands-on inquiry and use the Internet to compare and contrast microbes; explore diseases caused by microbes; analyze the spread of infectious disease; evaluate treatments for microbial infections; and investigate aspects of the biotechnology industry.

TARGET AUDIENCE – Middle School Science, Math, Technology

BACKGROUND INFORMATION – A German zoologist (Theodor Schwann) and a German botanist (Matthias Schleiden) proposed the cell theory over 150 years ago; however, cells were not widely studied until the 1800s when microscopes were approved for use. Cell Theory states that all organisms are composed of similar units of organization, called cells. As the basic units of life, individual cells have needs and functions that are similar to those of multi-cellular organisms. Cells capture and release energy, dispose of wastes, reproduce and move. Cells provide a feedback/communication system to the entire organism. Therefore, the basic functions of multi-cellular organisms are carried out in cells. Each cell contains structures called organelles, which are the sites for specific functions such as cellular metabolism. The microscopic world of cells is very diverse and includes two types: those without a nucleus (the prokaryotic bacteria), and those with a nucleus (the eukaryotes: plants, animal, protozoa, algae, and fungi). Protists are unique in that they are single-celled organisms that have combinations of mechanisms to enable their survival. To remain alive and functioning, cells must maintain a biological balance (homeostasis) by controlling and regulating movement of nutrients and waste into and out of the cell. Metabolism is the sum total of all chemical reactions involved in maintaining the living state of the cells, and thus the organism.

Microbiology explores microscopic organisms including viruses, bacteria, protozoa, fungi, and algae. These organisms lack tissue differentiation, are unicellular, and exhibit diversity of form and size. Scientists study microbial pathogens (disease causing agents) to find methods for prevention and treatment of disease. Biomedical research studies the microbes that cause infectious diseases in both plants and animals. Various techniques and strategies, including computer modeling, cell cultures, animal models, and clinical trials are used to analyze microbes and disease. Researchers and the emerging biotechnology industry strive to prevent contamination of food products and develop pharmaceuticals to promote human health.

LESSON SEQUENCE –

I. Cell Theory, including Size, Shape, Function, and Processes Within Structure of Plant and Animal Cells
II. Microbes: The Good, The Bad, and the Ugly
III. Comparing Life Functions of Protists
IV. Our Future With Microbes

WEB RESOURCES – The following websites are accessed during this unit:

- www.cellsalive.com (Cell size, scale, mitosis, meiosis)
- www.library.thinkquest.org/12413/index.html (Cell theory, types, structure, function, processes)
- http://learn.genetics.utah.edu/content/begin/cells/scale/ (Cell size and scale from Coffee to Carbon)

LESSON I: Cell Theory and Function

SUMMARY – This lesson includes inquiry-based investigations that guide students through an exploration of the cell theory and cellular function. The Cells and Function Matching Game, followed by the Specialized Cells Board Game will allow students to review the various parts and functions of a cell and transfer this knowledge to an understanding of the role cells play in the function of a body system and the ultimate survival of an organism. Students will observe cellular transport during the Diffusion/Osmosis lab and develop an understanding of the size limitations and restrictions placed on cells.

KEY CONCEPTS – Cell theory, Cell functions, Cell-System-Organism relationships, cellular transport, mitosis, meiosis, photosynthesis, cellular respiration.

OBJECTIVES – Students will:
- Create a chronological history leading to cell theory.
- Describe the role of various parts of a cell.
- Explain various functions of a cell.
- Differentiate between single-celled organisms and multi-cellular organisms.
- Create a sequential drawing to correlate the relationship between a cell, tissue, organ, system, and living organism.
- Illustrate/demonstrate cellular transport that allows nutrients to enter the cell and waste to exit.
- Illustrate and differentiate between mitosis and meiosis in living cells.

MATERIALS –
- Science textbook, Chapters 17 and 18
- Bacteria-Microbes Power Point Presentation
- United Streaming videos – "Introducing the Cell" and Bill Nye's Greatest Discovery - Biology
- Cell Cards and Functions Matching Game
- LAB: "Why Cells Aren't Big" (Student Lab)
- Life Functions of Protists Power Point and Worksheet
- LAB: Diffusion/Osmosis (Demonstration or Student Lab)
- Specialized Cells Board Game
- Science Test: Cell Theory and Function

PROCEDURES –
PRIOR to DAY ONE: Reserve the computer lab if the Cells ALIVE! Web quest will be used during this unit.
DAY ONE and TWO:

I. Use the Bacteria – Microbe PPT to introduce students to cell theory and the history behind its development.
   a. Introduce students to concepts that will be explored in this unit and allow them to share their probing questions during an open-class discussion. (Option: "Introducing the Cell" video clip.)
   b. Cell Cards and Functions Matching Game – This activity allows students to work in pairs or small groups to match the correct cell part with its function and its location within the cell.

DAY THREE and FOUR:

I. Understanding Cell Size and Limitations (**Prepare materials for the lab activity 1-day ahead)**

a. Use the **Why Cells Aren't Big Lab Activity** – See Lab Materials and Handout for directions and lab sheets.
b. Follow-up the activity with the discussion questions found in the lab materials.

II. **Specialized Cells Board Game** – After a review of the parts of the cell and cell theory, pair students for the board game and facilitate their discussion as they match the correct cell type with the appropriate organ and body system.

III. Assist students to create a sequential drawing to correlate the relationship between a cell, tissue, organ, system, and living organism.

DAY FIVE through SEVEN: (Two options are available for Cellular Function: Diffusion/Osmosis. The LAB DEMONSTRATION described below may be used if learning levels discourage the STUDENT LAB.)

I. **LAB DEMONSTRATION: Observing Diffusion and Osmosis** – Distribute the Diffusion/Osmosis Lab Report and guide students through the report as you demonstrate the lab. Prompt students for observations that discern the chemical differences occurring between diffusion and osmosis.

I. **STUDENT LAB: Cellular Function with Diffusion and Osmosis** -

II. Assist students with illustrations that can be used to compare and contrast the following functions for animal cells: (OPTIONAL: Booklet or foldable format)

c. Capture and release energy – Photosynthesis vs. Cellular Respiration
d. Feedback information – Temperature, Water, etc. regulation
e. Dispose of waste – Active vs. Passive Transport; Endocytosis vs. Exocytosis
f. Reproduce – Mitosis vs. Meiosis
g. Movement – Autotrophs vs. Heterotrophs
h. Provide for specialized needs

PROCEDURES for ASSESSMENT – Options for assessment of this lesson are listed below:

I. Class notes and illustrations
II. Lab Report: Why Aren't Cells Big
III. Lab Report: Diffusion/Osmosis
IV. Science Test: Cell Theory and Function

LESSON II: Microbes: The Good, The Bad, and the Ugly

SUMMARY – This lesson uses a variety of hands-on and inquiry activities to assist students with an exploration of microbes that can cause disease in humans. Students will gain an understanding of various pathogens (viruses, bacteria, and parasites) and how they can be transmitted, prevented, and treated. Students will also investigate the reproduction of these organisms and address the importance of proper antibiotic treatments for infectious diseases. Students will complete a project-based investigation to explore a life-altering disease: its cause, symptoms, and treatment.

KEY CONCEPTS – Bacteria, virus, parasite, pathogens, contagions, mutagen, vectors, antibiotics, disease

OBJECTIVES – Students will:
- Model the transmission of a virus during a lab activity.
- Model the treatment of bacterial infections with antibiotics during a lab activity.
- Use computer research skills to investigate a life-altering disease
- Differentiate between various pathogens that cause disease, including their prevention, spread, and treatment.

MATERIALS –
- Virus Tracker Lab Activity
- Antibiotic Resistance and Bacterial Growth
- Life-Altering Diseases Template
- Science Test: Understanding Disease

PROCEDURES –
PRIOR to DAY ONE: (Allow students to select from a list of diseases for the completion of the Disease Template and reserve at least 2 days in the computer lab for this activity.)

DAY ONE THROUGH THREE:
I. Modeling the Activity – Use the "GOUT" Disease Template to review the rubric and requirements for this activity. Encourage students to use the websites listed below the rubric to assist them in locating information outlined in the rubric.

II. Disease Template – Monitor student progress and assist as needed for successful completion of the template.

III. Disease Presentations – Each student should provide an overview of their Disease Template. Instruct students to create a table to catalogue each disease based on its origin or pathogen. (See table below)

Bacteria	Virus	Parasite	Mutagen	Genetic
Strep Throat	AIDS	Malaria	Lung Cancer	Diabetes

PROCEDURES for ASSESSMENT – Options for assessment of this lesson are listed below:
I. Lab Report: Virus Tracker
II. Lab Report: Antibiotic Resistance and Bacteria Growth
III. Disease Template
IV. Disease Template Catalogue Table
V. Science Test: Diseases that Affect Our Lives

LESSON III: Comparing Life Functions of Protists

SUMMARY – Students will apply cell theory and cellular functions while exploring the microscopic world of protist. Key groups of Protists will be explored, including flagellates, amoebas, ciliates, colonies, and molds. Students will observe microscopic samples and create labeled illustrations of each group to assist their understanding. The latter part of this lesson will allow students to explore fungi and lichen.

KEY CONCEPTS – Cell theory, Cell functions, cellular transport, mitosis, meiosis, Protists, (including euglena, amoeba, paramecium, Volvox, water, and slime molds)

OBJECTIVES – Students will:
- Compare and contrast the life functions of protists.
- Differentiate between producers, consumers, and Heterotrophs.
- Use microscope skills to view and identify protists.
- Differentiate between various forms of reproduction used by single-celled organisms.
- Identify vital roles played by single-celled organisms to our environment and climate record.

MATERIALS –
- Science textbook, Chapters 17 and 18
- Protists Comparison Power Point presentation
- Our Microbial World Power Point presentation
- Microscopes
- Ken-a-Vision Scope and Projector
- Pond Water and Pond Scum

PROCEDURES –
PRIOR to DAY ONE through SIX:

I. **Life Functions of Protists** – This activity will allow students to explore four different single-celled protists and analyze structures within these organisms that allow survival. This activity can be completed in small groups of students as a project-based investigation or using a PowerPoint presentation of the required information provided during classroom instruction. A foldable or booklet may help students to organize each unique type of protist and its functions.

a. Euglena – (flagellates) is known for unique feature of an eye spot, some contain chlorophyll and are common in fresh water.
b. Amoeba – (pseudopods) movement by cytoplasmic streaming surrounds food and engulfs it using pseudopods.
c. Paramecium – (ciliates) most complex and specialized protists
d. Volvox – (colony of ciliates) visible to naked eye; contain chlorophyll
e. Molds – (spore-forming protists) including water and slime molds

II. Compare and contrast the following functions for each protist:

a. Capture and release energy
b. Feedback information
c. Dispose of waste
d. Reproduce
e. Movement
f. Provide for specialized needs

III. Life Functions of Fungi and Lichen – This section will allow students to explore a variety of fungi and their role in Earth's environment.

a. Compare and contrast various types of fungi and lichen using information from Chapter 20, Section 3
b. Create a foldable to assist student understanding and organization of fungi and lichen characteristics.

PROCEDURES for ASSESSMENT – Options for assessment of this lesson are listed below:

I. Foldable Illustrations and Descriptions of Protists
II. Foldable Illustrations and Descriptions of Fungi
III. Science Test: Our Microbial World

LESSON IV: Our Future with Microbes

SUMMARY – This portion of the unit focuses on cutting edge research with microbes as the focal point. Students visit an interactive website to determine the Microbial Personality and follow their discovery with an investigation of the special characteristics of their microbe and what science has learned from studying these unique organisms.

KEY CONCEPTS – microbe abundance and size, classification, protists, biotechnology, climate

OBJECTIVES – Students will:
- Visit the Center for Microbial Oceanography website and complete a personality inventory that matches them to a microbe.
- Use Internet research skills to locate information specific to their microbe "personality."
- Develop an understanding of the key roles microbes play in our health, future, and ecosystem.

MATERIALS –
- C-MORE Website: http://cmore.soest.hawaii.edu/education/kidskorner/ur_q1.htm
- Your Microbial Personality Handout
- Computers with Internet access

PROCEDURES –
PRIOR to DAY ONE: (Reserve 1 or 2 days in the computer lab prior to this activity.)

I. Microbe Personality – Instruct students to visit the C-MORE website and answer the questions provided in the Microbe Personality inventory. Students should copy the scientific name of their microbe to the handout before starting the research portion of the activity. There are 19 different microbes mapped through the various personality questions in the inventory. Encourage students to consider retaking the personality quiz if duplicates are occurring in the class.

II. Microbe Investigation – Instruct students to read and complete the handout using the websites provided at the top of the page. It may also be helpful if students search for information about the specific type of microbe they have identified (e.g. foraminifera, diatoms, radiolarians, coccolithophores).

III. Microbe Discussion – Lead a class discussion to assist students in understanding the following concepts:
1. most microbes are "good guys"
2. new microbes are discovered each year
3. microbes provide a wealth of information about earth's past climate
4. microbes assist scientists with innovative medical treatments

PROCEDURES for ASSESSMENT – Options for assessment of this lesson are listed below:
I. Microbe Personality Handout completion
II. Classroom Discussion participation

UNIT ACTIVITIES

I. Cells and Organelles Card Game

II. Specialized Cells Board Game

III. United Streaming – Introduction to Cell

IV. Lab: Why Cells Aren't Big

V. Lab: Cellular Function - Observing Diffusion and Osmosis

VI. Lab: Virus Tracker

VII. Lab: Antibiotic Resistance and Bacteria Growth

VIII. Your Microbial Personality

Cells and Organelles Card Game

(Prior to the game, students should read Chapter 17, Section 2, reviewing cell organelles, their function, and the differences between animal and plant cells.) Allow one 65-minute class period to complete Phase I and II. Phase III should be completed for homework using notes from game and the science textbook.

GAME DIRECTIONS:

1. Distribute sets of cards to students in groups of 2 – 4 students, depending on class size and number of card sets (total number of card sets =6) available.

2. Provide minimal instruction and encourage students to use classifying skills to determine the matching sequences for the game. Monitor student progress and provide positive feedback for correct matches. Students typically complete the game in three phases, shown below:

Phase I: Match each organelle photo with the correct function description

Phase II: Classify organelles according to the correct placement in the cell (e.g. surface, cytoplasm, nucleus)

Phase III: Draw a plant and animal cell and include the appropriate organelles for each cell.
Animal Cell Organelles include all except the chloroplast and cell wall.
Plant Cell Organelles include all except the mitochondria and plasma membrane. Plant vacuoles should be drawn differently than the animal vacuole picture shown in the game.

3. Locations and cell parts include:

- I. Surface
  - i. Cell wall – a rigid structure surrounding the cell membrane in plant cells to support the cell. (ST506)
  - j. Plasma membrane – a protective barrier in animal cells that encloses a cell and allows nutrients in and waste out. (ST507)
- II. Cytoplasm
  - k. Centrioles – composed of 9 tubes involved in cell division.
  - l. Chloroplasts – uses energy from sunlight to make food for plant cells. (ST510)
  - m. Cytoskeleton - a web of protein in the cytoplasm that act as muscle and bone for the cell. (ST508)
  - n. Endoplasmic reticulum – (Smooth without ribosomes; rough with ribosomes) assists in processing, production, and transport of lipids (blood fats). (ST509)
  - o. Golgi complex/apparatus
  - p. Lysosomes – digests food particles. (ST512)
  - q. Mitochondria – power house of the animal cell; break down sugars to produce energy (ATP). (ST510)
  - r. Ribosomes – smallest organelle; adds amino acids to proteins. (ST509)
  - s. Vacuoles – stores water and other materials, larger in plants (ST512)
- II. Nucleus
  - a. Nucleolus – circular shaped organelle that contains DNA. (ST508)
  - b. Nuclear membrane – a protective barrier for the nucleus.
  - c. Chromosomes – contains the DNA (genetic material)

Specialized Cells Board Game

(Prior to the game, students should read Chapter 17, Section 3, reviewing the relationship between a single cell and the specialized system it supports.) Allow one 65-minute class period to complete this activity.

GAME DIRECTIONS:

1. Distribute sets of cards to students in groups of 2 – 4 students, depending on class size and number of card sets (total number of card sets =6) available.

2. Provide minimal instruction and encourage students to use classifying skills to determine the matching sequences for the game. Monitor student progress and provide positive feedback for correct matches.

3. Assess student understanding by encouraging students to select a body system (from the 7th grade curriculum) and create a sequential drawing from a single cell to the complete body system.

United Streaming - Introducing the Cell

United Streaming's "Introducing the Cell" is a 20-minute video segment that can be used at the beginning of this unit as an introduction to the cell or later in the unit to reinforce content covered in class. Encourage students to take note the following while viewing the video clip:

I. Parts of the cell
II. Differences between animal and plant cells
III. Different types of cells and tissues formed:
    d. Skin cells
    e. Muscles cells
    f. Bone cells
    g. Nerve cells
    h. Blood cells
III. Cells => Tissues => Organs => Systems => Organisms

LAB: Why Cells Aren't Big

LAB OBJECTIVES:

- Create model cells of various sizes.
- Observe the process of diffusion by watching color change in the model cells.
- Predict how cell size influences the rate of diffusion.
- Discover why a circulatory system is necessary for large, multi-cellular organisms.

BACKGROUND INFORMATION:

The largest single cells are only approximately 100υm (micrometers) long. This means that 100 of these cells lined up end to end equal just one centimeter! Although organisms such as humans are large in size, their bodies are made up of billions of cells.

What limits the size of cells? The size of individual cells is limited by their ability to obtain nutrients and eliminate wastes. Many of the nutrient molecules needed by cells enter the cell through a process called ______________________________. Diffusion also allows many waste products from cellular metabolism to leave the cells.

All molecules move through space in a random fashion. As they move, they collide with one another a spread themselves out across the available space. Diffusion occurs when a concentration of any type of molecule is greater in one area than in another. For example, if you place a single drop of red food coloring into a glass of water, you initially see a concentrated area of red color in the water. However, if you leave the glass alone for a few minutes without stirring or shaking it, you will observe that the red color has dispersed and the water appears uniformly red or pink in color. This occurs because the molecules of food coloring collide with each other and the water molecules. In the process, they become distribute evenly throughout the container. This is the process of ____________________.

Diffusion is considered a type of _______________ transport process. This means that no energy input is required for this type of molecular motion to occur. As long as there is a difference in concentration between two areas (e.g. a concentration gradient), diffusion will take place. No __________ is necessary for some substances, like oxygen, to enter a cell. Oxygen diffuses into the cell as long as the concentration of oxygen inside the cell is _______________ than the concentration of oxygen outside the cell.

Diffusion is a very effective method of getting nutrients into and wastes out of cells, as long as several conditions are met. First, diffusion occurs very quickly, but only across short distances. The larger the distance, the longer it takes for the diffusing molecules to spread out. Second, temperature influences the rate of diffusion. When molecules are warmed, the speed of their motion increases and they bounce into one another more frequently and more quickly. Warmer temperatures, therefore, _____________ the rate of diffusion. Molecule size also plays an important role in diffusion rate. Larger, heavier molecules tend to move more slowly than lighter, ________________ molecules. Finally, there is more opportunity for diffusion to occur when the surface area is _________________. In the case of cells, which are enclosed by a plasma membrane, the surface area of the membrane is important in determining how fast diffusion can occur.

Most cells depend upon oxygen for their survival. In order to use the nutrients from their food sources, organisms must have oxygen present. Since oxygen enters cells by the passive process of diffusion, and the rate of diffusion is limited by the size of the cell, there is an upper limit on cell size of about 100υm.

QUESTIONS: Address the following questions in your hypothesis: How does cell size affect the rate of diffusion? Why do multi-celled organisms need a circulatory system?

HYPOTHESIS: ____

____

____

____

MATERIALS: (per team)

1 Clear plastic cup
4 cell models (Sizes 1cm, 2cm, 3cm, 4cm)
1 Plastic knife
Watch or timer
1 ruler
200mL Diffusion media
Paper towels

PROCEDURES:

1. Record the dimensions (cm) for each cell model in Data Table #1.

2. Calculate the Total Surface Area of each cell model based on the formula:
   Surface Area (cm^2) = Sum of areas of each side of the cell model (6 sides total)
   HINT: To find the surface area of a single side of the cell model, multiply the length of the side (cm) by the width of the side (cm).

3. Calculate and record the total volume for each cell model based on the formula:
   Volume (cm^3) = Length (cm) X Width (cm) X Height (cm)

4. Calculate the Ratio of Surface Area-to-Volume for each cell model using the formula:
   Ratio = $\frac{\textbf{Surface Area}}{\textbf{Volume}}$

5. Once you have completed Data Table #1, gently place each cell model into a clear cup and let the teacher know you are ready for the Diffusion media. Be sure the Diffusion media completely submerges your cell models.

6. Start your timer when the Diffusion media has been added and record observations every 2 minutes for 10 minutes.

7. After 10 minutes, carefully pour the diffusion media in the sink, remove your cell models, and place them on a clean paper towel.

8. Slice each cell model in half and measure the diffusion distance from the outer edge of the model to the point where the color change stops. Measure the diffusion distance on the opposite side and add the 2 distances together to obtain the Total Diffusion Distance for each model. Record your measurements in Data Table #2.

9. Calculate the diffusion distance of each side of each cell model by subtracting your length, width, and height calculations in Data Table #1 from the Total Diffusion Distance for each cell model recorded in Data Table #2. EXAMPLE: Cell Model Number 1's length = 1cm. **If** Cell Model Number 1's Total Diffusion Distance = 0.8cm, then the Length-Diffusion Distance would be 0.2cm. Use this example to complete Length, Width, and Height Diffusion Distances for Data Table #2.

10. Calculate and record the Volume of the Cell Model Not Affected by Diffusion (cm3) in Data Table #2 using the formula:
    Volume of cell model not affected by diffusion (cm^3) = Length-diffusion distance (cm) X Width-diffusion distance (cm) X Height-diffusion distance (cm)

DATA COLLECTION:

DATA TABLE #1
Calculation of Each Cell Model's Area-to-Volume Ratio

Cell Model Number	Length (cm)	Width (cm)	Height (cm)	Total surface area of cell model (cm^2)	Volume of cell model (cm^3)	Ratio of Surface Area-to-Volume
1						
2						
3						
4						

OBSERVATION TABLE

MINUTE	OBSERVATIONS DURING DIFFUSION MEDIA
2	
4	
6	
8	
10	

DATA TABLE #2
Calculation of Diffusion Area in Model Cells

Cell Model Number	Total Diffusion Distance (cm) (Sum of opposite sides)	Subtract the Diffusion Distance from the Cell's Dimensions (from Data Table #1):			Volume of cell model not affected by diffusion (cm^3)
		Length- diffusion distance (cm)	Width – diffusion distance (cm)	Height- diffusion distance (cm)	
1					
2					
3					
4					

Use your completed data tables to complete your analysis and conclusion.

DATA ANALYSIS:

1. As a cell gets larger, do both its volume and surface area increase by the same amount? Explain your response.
2. Based on your data, where would a greater rate of diffusion occur: Within a cell with a surface area-to-volume ratio of 6:1 or in a cell with a surface-to-volume ratio of 3:1?
3. What does the area of the cells NOT affected by diffusion (Data Table #2) represent in living cells?
4. Can cell shape influence the rate of diffusion of nutrients and wastes? How will a thin, flat cell (shaped like a pancake) compare to a cube-shaped cell in terms of diffusion rate? Why?

CONCLUSION: Consider the following questions as you complete your conclusion to the lab:

1. How does cell size influence the rate of diffusion?
2. Why do large, multi-cellular organisms need a circulatory system if all of their individual cells are small?
3. Why Aren't Cells Big?

Lab: Cellular Function - Observing Diffusion and Osmosis

BACKGROUND INFORMATION:

Not all particles can pass through a cell membrane with equal ease. Particles move by diffusion. Look on page 528 and write the definition of diffusion: ______________________________

____

________________. What regulates this passage of substances diffusing in and out of a cell? Sometimes scientists use models to help answer such a difficult question. This investigation will use a model of a living cell to show changes that are controlled by the cell membrane.

The cell membrane determines which substances can diffuse into or out of a cell. Each cell membrane thus has its characteristic *permeability*. Some chemicals can pass through the cell membrane, but others cannot.

In this investigation you will use an egg with the shell dissolved as a model for a living cell membrane. You will then predict the results of an experiment involving the movement of materials through a membrane.

MATERIALS:

- 2 Fresh Eggs
- Corn Syrup
- Vinegar
- Balance
- 2 large beakers
- 2 small beakers
- Tape and Marker to label beakers

PROCEDURES:

DAY ONE:

1. Use tape and a marker to label one large beaker "Water" and the other large beaker "Syrup."
2. Determine the mass of each egg to the nearest 0.1 g and **record the data** in the "Initial Mass" column on the data table.
3. Gently place each egg in a beaker, noting the mass of each egg placed in each beaker on your data table.
4. Pour just enough vinegar in each beaker to cover the egg.
5. Gently place a small beaker on top of the egg to keep the egg submerged in the vinegar.
6. Store beakers in a secure location for 24 hours.

DAY TWO:

1. After 24 hours, observe the eggs and record your observations in the table. Pour the vinegar and tap water in the sink and remove the eggs, GENTLY rinse them with water, and place them on the paper towels labeled "Water" for the water egg and "Syrup" for the syrup egg. DO NOT rub the egg…it will break.
2. Determine the mass of each egg and **record in the table**.
3. Place the "Syrup" egg in the "Syrup" beaker and add corn syrup just until the egg is covered.
4. Place the "Water" egg in the "Water" beaker and add distilled water just until the egg is covered.
5. Store the beakers in the same location for another 24 hours.
6. Predict how the mass of the egg is going to change in the next 24 hours. Keep in mind that the egg is covered with a membrane. The inside of the egg is made of egg white (water and dissolved proteins), and that the egg yolk is mainly fat and water. Syrup is sugar dissolved in water. Record your predictions below your data table.

Predictions after DAY TWO:

<u>DAY THREE:</u>

1. After the 24 hours, observe the eggs and **record your observations** in the table.
2. Carefully pour the water and syrup into the sink and remove the eggs. Place them on the paper towels labeled "Water" for the water egg and "Syrup" for the syrup egg. <u>DO NOT rub the egg.</u>
3. Determine the final mass of each egg and **record in your data table**.
4. Dispose of your egg in the trashcan and clean your work area thoroughly.
5. Use your data table and lab experience to **answer the Analysis Questions** listed below the data table.

OBSERVATIONS AND DATA TABLE:

Type of Egg	Initial Mass of Fresh Egg with Shell	After 24 hours in Vinegar		After 24 hours in Water or Syrup Solution	
		Observations	Mass Recorded	Observations	Final Mass of Egg
"Water" Egg					
"Syrup" Egg					

DATA ANALYSIS:

1. What effect did the vinegar have on the egg?
2. How did the results of this investigation compare with your predictions?
3. What kind(s) of material(s) apparently moved through the egg membrane?
4. What is the movement of water across a membrane?

CONCLUSION:

Lab: VIRUS TRACKER

(Activity adapted from CIBL: Center for Inquiry-Based Learning workshop and kit)

SUMMARY: This activity simulates the spread of infectious disease throughout a population of people. Students will exchange safe liquids in plastic cups among classmates and then work backwards to identify the two originally infected people. The following NC Standard Course of Study objectives are met during this activity:
7.03 Analyze data to identify trends or patterns and determine how an infectious disease may spread including:

- Carriers
- Vectors
- Conditions conducive to disease

MATERIALS: The following materials are needed to complete this activity for 4 classes of 25 students:

- 1 dropper bottle of Phenolphthalein (virus indicator solution)
- 8 permanent markers
- 3 liter (~100 oz.) of Sodium carbonate solution ("infected saliva")
- 3 liter (~100 oz.) of Distilled water ("uninfected saliva")
- 6 Dice (1 die per group)
- 6 Destination Cards labeled:
    - Cafeteria, 3 exchanges
    - Concession/snack stand, 2 exchanges
    - Homeroom, 2 exchanges
    - Gymnasium, 2 exchanges
    - Library, 1 exchange
    - Principal's office,1 exchange
- Destination and Exchange Table (for class display and reference)
- 25 trays (for storing cups)
- 400 plastic cups with lids: 100 for original "saliva" and marked with unique ID number; 300 without ID number
- 100 Virus Tracker activity sheets

Prior to DAY ONE: (Homework: Chapter 21, Section 3, Viruses, pp. 482 – 485)
PREPARATION: (Preparations may be completed one day or more before the lab.)

- Place Destination Cards at 6 stations around the room
- Prepare "original saliva" cups
    - Label one cup for each student with a unique ID number
    - Fill 2 cups ¾ full with sodium carbonate solution. These are the "infected" cups. *Be sure to record the ID# of these 2 cups before placing them with the other cups.*
    - Fill the rest of the cups ¾ full with distilled water ("uninfected saliva").
    - Fill a few extra infected and uninfected saliva cups in case of spillage during the lab and to use during the demonstration of the exchange procedures.

DAY ONE: Spreading Infectious Disease?

I. Compare and Contrast Infectious (Communicable) Diseases with Noninfectious (Non-communicable) Diseases. Lead a brief discussion of the ways infectious diseases can be spread, including:
    1. sharing drinks or food
    2. kissing or sexual contact
    3. shaking hands
    4. touching objects (doorknobs, fountains, etc.) and then touching your eyes, mouth, or nose
    5. coughing or sneezing

II. Modeling the Epidemic

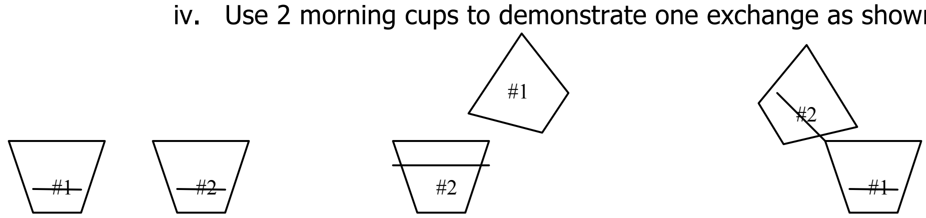
a. Distribute the Virus Tracker activity sheet and instruct students to record their name and date

b. Distribute 1 tray with the following items:
   - i. a cup of original saliva, marked with the unique ID #
   - ii. 3 unmarked cups and lids
   - iii. a marker
   - iv. a die

c. Instruction students to label the unmarked cups as "morning", "lunch", and "after school" (one location per cup) and to also include their initials on each cup.

d. Provide an overview of the directions: Students will travel to 3 locations and exchange "saliva" based on the number of exchanges noted on each card (Ex. Cafeteria = 3 exchanges)

e. Demonstrate and Describe the Infection Process including:
   - i. Locations and number of exchanges
   - ii. Dice rolling to determine which locations each student will visit
   - iii. Display the Destination Table in class to assist this review
   - iv. Use 2 morning cups to demonstrate one exchange as shown below



Start with 2 morning cups ½ full with "original" saliva, one for Student #1, one for Student #2.

Show how to pour ALL of "saliva" from Student #1 cup to #2.

Show how to pour 1/2 of the "saliva" from Student #2 cup back to Student #1 cup

   - v. At the end of the morning exchange, students return to their seats and transfer ½ of the morning saliva into their 'Lunch' cup.
   - vi. After completing this transfer, place the lid on the cup and place it on the tray. The students will then repeat these steps for the 'lunch' destination and exchanges and return to their seats again for another transfer to the 'after school' cup and one final set of destinations and exchanges.
   - vii. REMINDER: Depending on class size, students may not be able to make the total number of exchanges noted on the destination cards. STUDENTS SHOULD NOT EXCHANGE WITH THE SAME PERSON MORE THAN ONCE AT EACH DESTINATION.
   - viii. REMINDER: If students roll the die and match a previous destination, they should roll the die again until a new destination is rolled. STUDENTS SHOULD NOT GO TO EITHER OF THEIR PREVIOUS DESTINATIONS.

III. Infectious Exchanges

a. Instruct students to pour ½ of their original saliva into the "Morning" cup and begin the exchange procedures:

b. **Morning Exchange**: Roll die, Go to Destination, Make Exchange(s), Return to Seat, Make Transfer, Move Morning (with lid) to Tray

c. **Lunch Exchange**: Roll die, Go to Destination, Make Exchange(s), Return to Seat, Make Transfer, Move Lunch (with lid) to Tray

d. **After school Exchange**: Roll die, Go to Destination, Make Exchange(s), Return to Seat (no addition transfer or lids)

e. **TEACHER NOTE**: Set up trays and cups for the next class while students are completing the exchanges.

IV. Checking for Infection

a. Instruct students to have their "After school" cup ready for testing and add 2 drops of "virus indicator" to each student's after school cup.
b. Pink = *positive results* = infected with virus; Clear = *negative results* = not infected with virus
c. Students should place their final lid on the 'after school' cup and place it with the other cups on their tray.
d. All trays should be safely stored for the next class period.

V. **Lab Report** - If time allows, students should complete the hypothesis, materials, and procedures sections of the lab report.

DAY TWO: Tracking Infectious Disease – This part of the activity will allow students to determine the origin of the virus using the scientific method. Students may complete the lab report individually, in pairs, or small groups.

I. Question: Students should make predictions and complete the hypothesis after Day One and prior to completing the lab report. Their hypothesis should address this question: Where did the infection begin?

II. Hypothesis: (Make a prediction based on where you think the virus originated.)

III. Materials/Procedures: Students should summarize the procedures followed during Day 1 of the lab and include the materials required for the lab procedures.

IV. Data Collection: Students will use the Virus Tracker Activity Sheet to collect and analyze data.

V. Data Analysis: Students will construct a diagram or outline to illustrate your problem solving steps. Diagrams may resemble flow charts that depict the "track" used to determine the origin of the virus.

VI. Conclusion/Findings: Students will summarize the results from their virus tracking and indicate the actual origin of the virus and the route at which it spread across the population. Although diagrams are encouraged in the Data Analysis, students should be encouraged to express their conclusion using a written format to reinforce accurate and scientific writing skills.

OPTIONS: If small groups are used for Day Two, students may be encouraged to file their Centers for Disease Report and release it to the class as an Epidemic Warning or other creative scenarios.

News Article: Instruct students to write a news brief or create a news flash announcing the virus outbreak and containment by the researchers who traced and isolated the spread of the virus before it attacked the world.

Notes for Tracking procedures:
Lunch Test: After initial investigation, agree to test the lunch cups to help students narrow down when they were infected. Prior to this test, ask students to note if they thought they became infected at lunch. Usually, ½ or fewer were infected at lunch.
Three Additional Tests: Inform students that 3 tests of the original cups will be permitted to determine the original 2 carriers. Students must present their rationale for each person they want to test. If the original carriers are not identified during these 3 tests, you may provide 1 more test if a strong rationale is presented.
Morning Test: Once the original carriers have been identified, instruct students to note when they were infected and then reveal by placing "virus tracker" drops in the morning cups.

LAB: Virus Tracker

(Activity adapted from CIBL: Center for Inquiry-Based Learning workshop and kit)

This activity simulates the spread of infectious disease throughout a population of people. Students will exchange safe liquids in plastic cups among classmates and then work backwards to identify the two originally infected people.

NAME _________________________ Original Sample # _______ Date _____________

Morning Exchanges:

Location ______________________________ # of exchanges ____________

Name and number ____________________________

Name and number ____________________________

Name and number ____________________________

Lunch Exchanges:

Location ______________________________ # of exchanges ____________

Name and number ____________________________

Name and number ____________________________

Name and number ____________________________

After school Exchanges:

Location ______________________________ # of exchanges ____________

Name and number ____________________________

Name and number ____________________________

Name and number ____________________________

Where you infected with the virus? __________

LAB: Antibiotic Resistance and Bacterial Growth

(Activity adapted from LAB-AIDS 904S – Natural Selection of Antibiotic Resistance Kit)

BACKGROUND: Have you ever taken antibiotics? Did you follow the directions completely? All antibiotics need to be taken as directed, which usually means taking all the pills and not stopping even if you begin feeling better. Why? Millions of harmless bacteria naturally live on and inside of your body. When harmful bacteria appear on the scene, your body's immune system can usually keep a small population of them under control. If, however, these bacteria reproduce too quickly, you suffer the consequences of an ________________________________.
___________________________ help your body fight off an infection by killing these harmful bacteria. Unfortunately, a small number of bacteria in any population may not be affected by the antibiotic as quickly. These bacteria, which are considered more resistant to the treatment, continue to reproduce and grow. Completing the full course of the antibiotic as prescribed by your doctor helps to make sure that these bacteria do not survive and therefore won't make you ill or infect someone else.

QUESTION: Why is it important to take an antibiotic as prescribed?

HYPOTHESIS: (Base your hypothesis on your response to the Question.)

____

____

MATERIALS:
50 disks (20 blue, 15 yellow, 15 red)
1 die

PROCEDURES:

1. In this activity, 50 disks represent the harmful bacteria living in your body before you begin to take the antibiotic. Separate your disks based on the following:

Disease Causing Bacteria	**Represented By**
a. Least resistant bacteria	blue disks
b. Resistant bacteria	yellow disks
c. Extremely resistant bacteria	red disks

2. It is time to take your antibiotic. Toss your die and refer to the Antibiotic Key for your directions:

DICE KEY		
You Toss	**What Happened**	**What You Are To Do**
1, 3, 5, 6	You took the antibiotic on time, so bacteria are being killed!	Remove 5 disks, starting with the removal of the blue disks first, then the yellow, then the red.
2, 4	You forgot to take the antibiotic.	Do nothing.

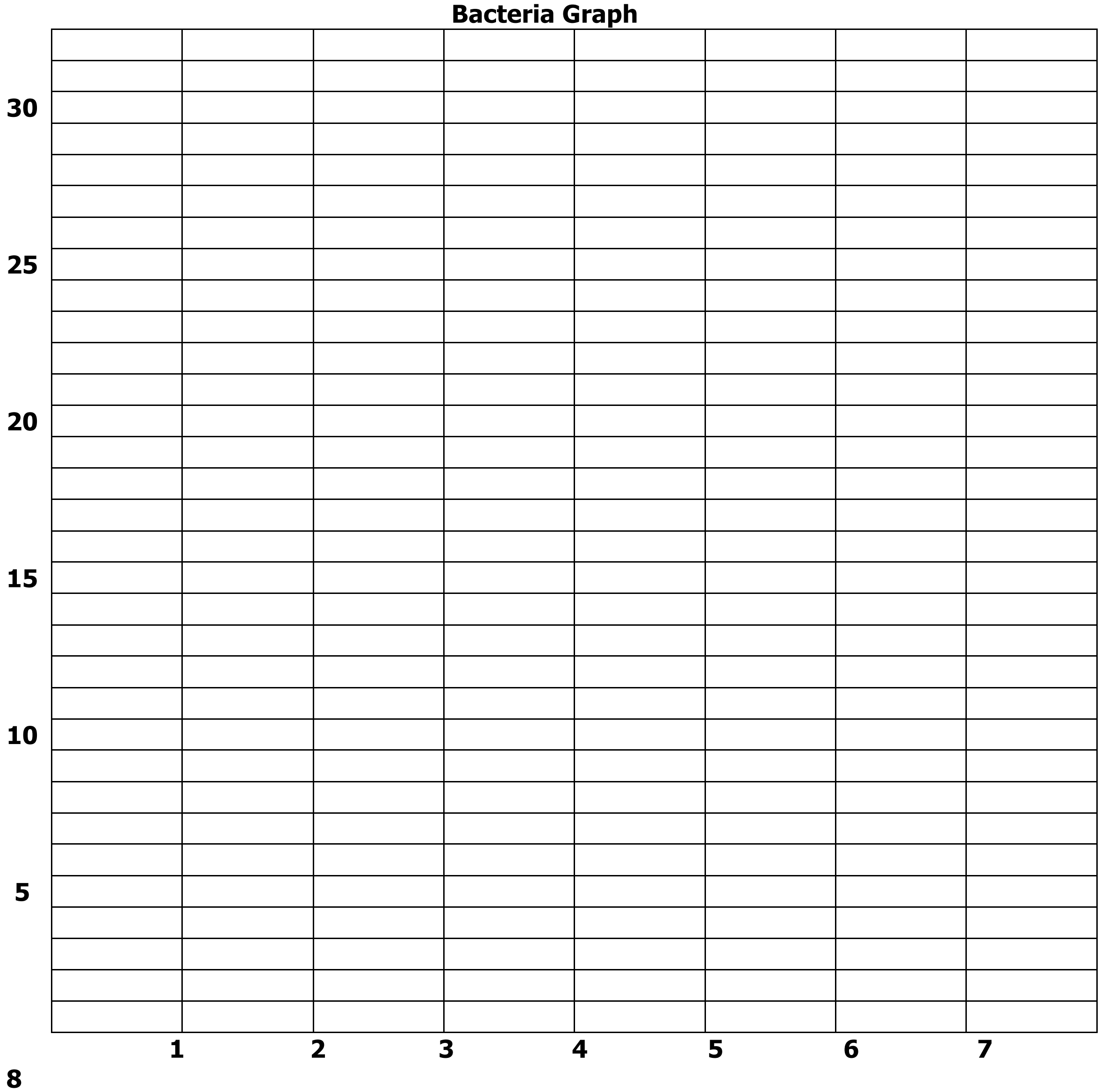
3. Record the number of each type of bacteria in your body on the data table.
4. Bacteria are reproducing all of the time! If one or more bacteria of a particular type are still alive in your body, add 1 disk of that color to your population. (Example: If you still have yellow and red bacteria, add 1 yellow and 1 red disk to your population.)
5. Repeat steps 2 through 4 until you have completed the data table.
6. Use your data table to graph the population of each type of bacteria. Use different colors to represent each type of bacteria and the total number of bacteria. Include a key with your graph and label your X and Y axes.
7. Use your data to complete the data analysis questions and your conclusion.

DATA COLLECTION:

Number of Harmful Bacteria in Your Body

Toss Number	Least Resistant Bacteria (BLUE)	Resistant Bacteria (YELLOW)	Extremely Resistant Bacteria (RED)	TOTAL
Initial	13	6	1	20
1				
2				
3				
4				
5				
6				
7				
8				

Bacteria Graph



DATA ANALYSIS:

1. Did the antibiotic help you to completely kill all of the harmful bacteria living in your body? Explain.

2. a. Imagine infecting someone else immediately after catching the infection (before you started taking the antibiotic). With what type of bacteria would you be most likely to infect them?

   b. Imagine infecting someone else near the end of your antibiotic course. With what type of bacteria would you be most likely to infect them?

   c. Suppose most infected people stopped taking the antibiotic when they began to feel better. (For example, consider the point in this model when there were only three harmful bacteria left.) What do you predict might happen to an antibiotic's ability to kill the harmful bacteria if the infection returns? Explain your reasoning.

3. Use your graph to describe how the population of each type of bacteria changed over the course of the antibiotic treatment.

CONCLUSION: Why is it important to complete the full course of an antibiotic as prescribed?

YOUR MICROBIAL PERSONALITY

Go to the following website and take the Microbe Personality Quiz to determine the type of microbe that best matches your personality:
http://cmore.soest.hawaii.edu/education/kidskorner/ur_q1.htm

Write the name of your Microbe here: ______________________________

Use the following websites, and the key search terms listed under each objective, to locate the required information about your microbe:

- http://cmore.soest.hawaii.edu/education/kidskorner/ur_q1.htm
- http://genamics.com/cgi-bin/genamics/genomes/genomesearch.cgi?field=ID&query=381
- http://microbewiki.kenyon.edu/index.php/Microbial_Biorealm
- http://zipcodezoo.com/default.asp

Record your notes below:

1. Is your microbe classified as a Prokaryote or a Eukaryote? ____________________
   (Key Terms: Domain or Kingdom)
2. Is your microbe considered to be an Extremophile? ____________________
   (Key Terms: Domain)
3. Is your microbe classified as Terrestrial or Aquatic? ____________________
   (Key Terms: Ecology)
4. How big is your microbe? ____________________
   (Key Terms: cell structure or size)
5. Does your microbe have flagella, cilia, or pseudopods? ____________________
   (Key Terms: cell structure)
6. Is your microbe rod, sphere, or spiral-shaped? ____________________
   (Key Terms: cell structure)
7. What is your microbe's "claim to fame"? ____________________
   (Key Terms: Significance, Current Research, Applications)
   ____
8. Locate an image of your microbe. Copy and paste the image here and cite your source:

IMAGE SOURCE: ______________________________