Richmond Public Schools

Department of Curriculum and Instruction
Curriculum Pacing and Resource Guide – Unit Plan

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Scientific Method /#1

Start day: 1

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
a) observations of living organisms are recorded in the lab and in the field;
b) hypotheses are formulated based on direct observations and information from scientific literature;
c) variables are defined and investigations are designed to test hypotheses;
d) graphing and arithmetic calculations are used as tools in data analysis;
e) conclusions are formed based on recorded quantitative and qualitative data;
f) sources of error inherent in experimental design are identified and discussed;
g) validity of data is determined;
h) chemicals and equipment are used in a safe manner;
i) appropriate technology including computers, graphing calculators, and probeware, is used for gathering and analyzing data, communicating results, modeling concepts, and simulating experimental conditions;
j) research utilizes scientific literature;
k) differentiation is made between a scientific hypothesis, theory, and law;
l) alternative scientific explanations and models are recognized and analyzed; and
m) current applications of biological concepts are used.

Essential Understandings/ Big Ideas

- In order to explore and explain the natural world scientist use theories, hypothesis, and laws.
- A theory consists of a set of related hypotheses.
- A law is meant to explain an action or set of events.
- The independent variable is the one that the scientist changes or manipulates.
- The dependent variable responds to changes in the independent variable; it is the data you collect.
- The experimental group and the control group should be identical except that the experimental group receives the treatment (independent variable) and the control group does not.
- When using a line or a bar graph the independent variable goes on the horizontal axis and the dependent variable goes on the vertical axis.
- Data that is descriptive and do not involve numerical measurements or calculation is qualitative data.
- Data that uses numbers to describe length, mass, temperature, and density are quantitative data.
- Scientific journals are your most reliable sources of information because they are reviewed by other persons in that field of work.

Key Essential Skills and Knowledge

Students will

- conduct investigations in the classroom and field, as appropriate, and critically examine investigations reported in scientific literature and databases.
- collect preliminary observations, both qualitative and quantitative.
- make clear distinctions among observations, inferences, and predictions.
- formulate hypotheses based on cause-and-effect relationships.
- justify hypotheses based on both preliminary observations and scientific literature.
- identify the independent variable (IV) and the values of the IV that will be used in the experiment.
- select dependent variables that allow collection of quantitative data.
- identify variables that must be held constant.
- establish controls as appropriate.
- write clear, replicable procedures.
- identify and use appropriate technology for data collection and analysis, including probeware (i.e., sensors for temperature, pH and dissolved oxygen).
- record quantitative data in clearly labeled tables with units.
- include labeled diagrams in the data record.
- determine the range, mean, and values for data, using a graphing calculator and/or computer spreadsheet software.
- plot data graphically, showing independent and dependent variables.

- describe trends from the data where appropriate, using a graphing calculator and/or computer spreadsheet.
- recognize and discuss contradictory or unusual data.
- determine the extent to which data support/do not support a hypothesis, and propose further hypotheses and directions for continued research.
- discuss the validity of results as related to accuracy, confidence, and sources of experimental error based on number of trials and variance in the data.
- use evidence, apply logic, and construct an argument for conclusions based on reported data.
- recognize that in order to ensure the validity of scientific investigations, they must be evaluated by other members of the scientific community.
- compare and contrast hypotheses, theories and laws.
- identify and describe scientific theories that have been changed or modified over time.

Vocabulary

- observation
- field study
- laboratory study
- scientific question
- scientific method
- hypothesis
- scientific theory
- theory
- law
- independent variable
- dependent variable
- experimental group
- control group
- trial
- precision
- accuracy
- constants
- control
- qualitative data
- quantitative data
- median
- mode

- range
- mean/ average

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Conduct experiments using appropriate tools
- Record data on scientific investigations performed
- Read and interpret data on a list, table, bar graph, and dot plot.
- Determine basic statistics including range, mode, and median of a data set.
- Compare data sets from related experiments.
- Draw conclusions based on data.
- Discover what conditions affect seed germination.
- Explore the effects of water, temperature, and light on seed germination.
- Discover that the requirements for germination will vary for different seeds.
- Design controlled experiments to test the effect of different variables on germination.

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

- Students are tasked with identifying each step of the scientific method and applying each through a fun activity that compares variables between 2 types of bubble gum. Students will be asked to hypothesize, collect and organize data, use scientific measurement, and differentiate between qualitative and quantitative data. http://serc.carleton.edu/sp/mnstep/activities/27600.html
- Observational skills will be utilized to determine if an object is living, dead, dormant, a product of a iving thing, or never alive using the main characteristics of life.

MWEE Connections:

- Students will design an experiment to investigate litter distribution, make predictions of litter distribution, and participate in a cleanup at the site. Based on the data students collect, they will make conclusions relating litter to the local ecosystem as well as human health and safety. http://www.longwood.edu/cleanva/images/sec6.scientificclean.pdf
- http://rivanna-stormwater.org/lessonplans.htm
- http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml
- http://pacd.org/education/chesapeake-bay-education-office/chesapeake-bay-lesson-plans/
- http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay/lesson-plans
- http://www.mdsg.umd.edu/lesson-plans

Technology Integrations

- http://www.explorelearning.com/
- Vernier Labquest
- Graphs and Statistic-Reaction Time 1
- Graphs an Statistics-Reaction Time 2
- Khan Academy
- Brain Pop
- Biology Review Games PowerPoints/games/worksheets
- The Biology Corner
- Scientific Method Lesson Plans
- Explore Biology
- Expierience Science with ExploreLearning:
- VDOE- Sceince Sample Lesson Plans:
- VDOE- Scientific Process and Experimental Design:
- Khan Academy
- VDOE- Safety and the Material Safety Data Sheet:
- VDOE- Current Applications in Science
- Helena Easter- Live Binder
- Identifying Variables Worksheet

Resources

- http://baybackpack.com/teaching_resources/a_scientific_cleanup_lesson
- Chesapeake Bay Foundation "Clean the Bay Day" every spring.www.cbf.org/calendar/ ctbd.htm
- Chesapeake Bay Program. Chesapeake Bay Program Office, 410 Severn Avenue, Suite 109, Annapolis, MD 21403. 800-YOURBAY or www.chesapeakebay.net
- http://www.biologycorner.com/lesson-plans/scientific-method/
- http://www.lessonplansinc.com/science.php?/biology/lessonplans/C92/
- http://www.explorebiology.com/apbiology/labs/

Trade books

1. Adler, D.A. 1996. *A picture book of Thomas Alva Edison.* New York: Holiday House.
2. Anderson, M.J. 1996. *Isaac Newton: The greatest scientist of all time.* Springfield, NJ: Enslow.
3. Barretta, G. 2006. *Now and Ben: The modern inventions of Benjamin Franklin.* New York: Henry Holt.
4. Brown, D. 2004. *Odd boy out: Young Albert Einstein.* New York: Houghton Mifflin.
5. Mortensen, L. 2007. *Thomas Edison: Inventor, scientist, and genius.* Minneapolis, MN: Picture Window Books.

6. St. George, J. 2002. *So you want to be an inventor?* New York: Philomel Books.
7. Schaefer, L.M., and W. Schaefer. 2005. *Marie Curie.* Mankato, MN: Capstone Press.
8. Bilash, B., and Shields, M. 2001. *A Demo A Day A Year of Biological Demonstrations.* Batavia, IL: Flinn Scientific
9. Laying The Foundation Science Participant Manual (ISBN 978-1-935167-33-4)
10. Redding, K., and Masterman, D. 2007. *Biology with Vernier.* Beaverton, OR: Vernier Software and Technology

Cross Curricular Connection

Phys Ed and Physics

What better way to learn about physics than to get students physically moving? In this invigorating activity, students can measure the amount of time it takes them to walk, jog, or sprint a particular distance and then calculate their speed and average speed. Students can alter the variables to determine what affects the speed of their performance.

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Biochemistry/ #1

Start day: 3rd week

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

BIO.2 The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include

a) water chemistry and its impact on life processes;
b) the structure and function of macromolecules;
c) the nature of enzymes; and
d) the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration.

Essential Understandings/ Big Ideas

- Water has a high specific heat capacity.

- When water molecules are attracted to one another it is known as cohesion and when they are attracted to other molecules it is known as adhesion.
- Adhesion and cohesion working together is known as capillary action.
- Water is a universal solvent. It is a polar covalent molecule.
- Water is less dense when it freezes; this enables organisms in aquatic environments to survive when the weather is cold.
- The four organic macromolecules that all living things possess are: carbohydrates, lipids, proteins, and nucleic acids.
- The structure of each type of macromolecule is related to its function.
- All enzymes are proteins but not all proteins are enzymes.
- Enzymes are biological catalysts; they speed up the rate of chemical reactions by lowering the amount of energy (activation energy) needed for that reaction to take place.
- Enzymes can also break things apart.
- pH, temperature, substrate concentration, and enzyme concentration are things that effect enzyme activity.
- Photosynthesis is the process by which light energy is transformed into chemical energy.
- Cellular respiration is the process by which the products of photosynthesis are converted into ATP.
- Photosynthesis and Cellular respiration are a cycle; the end product of one is the reactants of the other.
- Adenosine triphosphate (ATP) is the primary energy source in living things.

Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- explain the importance of the chemical and physical properties of water that make it vital to life.
- recognize that the main components of a living cell are carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur. Carbon atoms can easily bond to several other carbon atoms in chains and rings to form large complex molecules.
- explain the role and function of the four major categories of macromolecules (lipids, carbohydrates, proteins and nucleic acids).
- identify the functions of different types of proteins and recognize the significance that their conformation play in their functions.
- describe the structure of enzymes and explain their role in acting as catalysts to control the rate of metabolic reactions.
- explain how light is the initial source of energy for most communities.
- recognize the equations for photosynthesis and respiration and identify the reactants and products.
- describe the role of ATP in the storage and release of chemical energy in the cell.
- explain the interrelatedness of photosynthesis and cell respiration.

Vocabulary

- solvent
- polarity
- homeostasis
- carbohydrate
- protein

- amino acid
- lipid
- nucleic acid
- enzyme
- substrate
- active site
- activation energy
- autotroph
- heterotroph
- photosynthesis
- glycolysis
- cellular respiration
- aerobic
- anaerobic

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Analyze how photosynthesis and cellular respiration are a cycle.
- Have students summarize their overall findings for laboratory activities and discuss any experimental errors or problems they encountered.
- Quizlet's flashcards, tests, and study games make learning fun and engaging for students of all ages.
- Students should take the quiz at the end of each GIZMO simulation and they should complete accompanying worksheets.
- Test/assessment

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

- Use an indicator to measure concentrations of oxygen and carbon dioxide.
- Design controlled experiments to test hypotheses.
- Through exploration students will discover what gases are used and produced by animals and those by plants.
- Explain how animals and plants help each other survive.
- Have students use their diagrams of a glucose molecule to build a model of glucose using toothpicks and gum drops. Make sure all students use the same color of gum drops to represent each type of atom. Write the color key on the board as a reminder for students. After each student builds their gum drop model, have students form pairs. The students should model how two glucose molecules can bond to form a molecule of maltose and a molecule of water. Next, have the class model hydrolysis by reversing the reaction.
- Bingo with related vocabulary.

- Students should take the quiz at the end of each GIZMO simulation and they should complete accompanying worksheet.
- Students will watch Discovery Streaming videos and will answer discussion questions regarding the video.

MWEE Connections:

1. http://rivanna-stormwater.org/lessonplans.htm
2. http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml
3. http://pacd.org/education/chesapeake-bay-education-office/chesapeake-bay-lesson-plans/
4. http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay/lesson-plans
5. http://www.mdsg.umd.edu/lesson-plans

Technology Integrations

- BIO.2d BIO.1i, l
  Leaf Photosynthesis [41]
- BIO.2d BIO.1d, g, i
  Transpiration [40]
- Docking an Enzyme in an Active Site - Labeled
- Leaf Photosynthesis - Macro
- Leaf Photosynthesis - Micro
- Leaf Photosynthesis With Sugar Plot
- Photosynthesis 5: How Does Chlorophyll Work? (SAM)
- Photosynthesis 1: What is Sunlight?
- Photosynthesis 2: When Light Shines on Leaves
- Photosynthesis 3: Meeting Chlorophyll in a Leaf (SAM)
- Photosynthesis 4: Photosystems in Chloroplasts
- Cellular Respiration 6: Exploring the Electron Transport Chain
- Cellular Respiration 7: Disrupting the Electron Transport Chain
- Cellular Respiration 1: Introduction to the ATP Molecule
- Cellular Respiration 2: Glycolysis and the Production of ATP
- Cellular Respiration 3: The Role of Enzymes
- Cellular Respiration 4: The Krebs Cycle, Forming Molecules to Make ATP
- Cellular Respiration 5: The Krebs Cycle and the Electron Transport Chain

Resources

- Photosynthesis lab
- Newton's Apple - photosynthesis:
- PBS/Nova resource on photosynthesis
- Carbon and oxygen cycles: http://www.natgeoeducationvideo.com/film/1226/the-carbon-and-oxygen-cycles, http://www.realtrees4kids.org/sixeight/cycles.htm
- EPA site on climate change
- Yeast lab
- Cellular respiration and fermentation: http://biology.clc.uc.edu/Courses/bio104/cellresp.htm, http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/CellularRespiration.html
- Photosynthesis
- Vent communities

Related Gizmos:

- *Photosynthesis Lab*:
- *Plants and Snails*
- *Cell Structure*

Trade books

1. Bilash, B., and Shields, M. 2001. *A Demo A Day A Year of Biological Demonstrations.* Batavia, IL: Flinn Scientific
2. Laying The Foundation Science Participant Manual (ISBN 978-1-935167-33-4)
3. Redding, K., and Masterman, D. 2007. *Biology with Vernier.* Beaverton, OR: Vernier Software and Technology

Cross Curricular Connection

Environmental Connection

A potential environment crisis has recently been receiving a great deal of attention from scientists, the news media, and governments around the world. The concern is global warming – a gradual increase in the temperature of Earth's atmosphere.

Global warming is not an unnatural event. It has occurred many times throughout Earth's history (along with its counterpart, global cooling), but scientists are concerned that the current trend may be more than a natural cycle – that it may be a direct result of human activity. (Explore Learning)

Physical Education and English

Water intoxication: Did you know that overhydration can be deadly?

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Surface area to volume ratio & Cell Structure and Function/ #1

Start day: 6 weeks

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

BIO.3 The student will investigate and understand relationships between cell structure and function. Key concepts include

a) evidence supporting the cell theory;
b) characteristics of prokaryotic and eukaryotic cells;
c) similarities between the activities of the organelles in a single cell and a whole organism;
d) the cell membrane model; and
e) the impact of surface area to volume ratio on cell division, material transport, and other life processes.

Essential Understandings/ Big Ideas

- The Cell Theory is a set of proven hypotheses from various scientists: Hooke, Virchow, Schleiden, and Schwann.
- The Cell Theory states that:
    1. The cell is the basic unit of life.
    2. All cells arise from preexisting cells.
    3. All organisms are composed of one or more cells.
- There are two types of cells; prokaryotic cells and eukaryotic cells.
- All cells have:
    1. Ribosomes
    2. A cell membrane
    3. Genetic material
    4. Cytoplasm
- All organisms must maintain homeostasis.
- Cell membranes are selectively permeable; they help the cell maintain homeostasis, they regulate what enters and exists the cell.
- Passive transport does not require energy. There are three types of passive transport; diffusion, osmosis, and facilitated diffusion.
- Cells are affected by the three types of osmotic solutions:
    1. In an isotonic solution the concentration of solutes is equal both inside the cell and outside the cell.

2. In a hypertonic solution the concentration of solutes is greater outside the cell than inside the cell.
3. In a hypotonic solution the concentration of solutes is greater inside the cell than outside the cell.

- Active transport requires energy input from the cell. Three types of active transport are endocytosis, exocytosis, and the sodium-potassium pump.
- The endosymbiont theory proposes that some early prokaryotic cells began evolving internal cell membranes. The result was a primitive eukaryotic cell.

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Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- describe the key events leading to the development of the cell theory.
- compare and contrast characteristics of prokaryotic and eukaryotic cells.
- compare and contrast the activities of an organelle in a single cell and a whole organism.
- identify the following essential cell structures and their functions
  - the nucleus (contains DNA; site where RNA is made)
  - ribosome (site of protein synthesis)
  - mitochondrion (site of cell respiration)
  - chloroplast (site of photosynthesis)
  - endoplasmic reticulum (transports materials through the cell)
  - Golgi (site where cell products are packaged for export)
  - lysosome (contains digestive enzymes)
  - cell membrane (controls what enters and leaves the cell)
  - cell wall (provides support)
  - vacuole (storage of material)
  - cytoplasm (contains organelles and site of many chemical reactions)
  - centriole (organizes spindle fibers in animal cells)
  - cytoskeleton
- describe how the selective permeability of the cell membrane affects the life of a cell.
- describe processes associated with movement across the membrane for diffusion, facilitated diffusion, osmosis, and active transport.
- describe the relationship between a cell's external solute concentration and its effect on the cell's internal solute concentration.
- compare the efficiency of the ability of a cell to transport material based on surface area to volume ratios.

Vocabulary

- cell
- cell theory
- microscope
- endosymbiont theory

- disease
- Germ Theory of Infectious Disease
- Pathogen
- Prokaryotic cell
- Eukaryotic cell
- Nucleus
- Cell membrane
- Cytoplasm
- Ribosome
- Endoplasmic reticulum
- Golgi apparatus
- Mitochondrion
- Lysosome
- Cell wall
- Vacuole
- Plastid
- Chloroplast
- Unicellular
- Multicellular
- Cell specialization
- Tissue
- Organ
- Organ system
- Diffusion
- Passive transport
- Equilibrium
- Selectively permeable membrane
- Osmosis
- Concentration gradient
- Hypertonic
- Hypotonic
- Isotonic
- Facilitated diffusion
- Active transport
- Endocytosis

- exocytosis

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Conduct experiments using appropriate tools
- Record and analyze data on the experiments conducted
- Test/ assessment
- Have students create a game jam, teams are challenged to design a game in a short period of time. The theme of the game should be based on the topic under study.
- **Open-ended or constructed response items** that ask students to respond in their own words--to "construct" their answers--to questions that may have multiple good answers. Students usually reason out their solutions as part of their answers. Usually students can answer these questions in just a few minutes, and in that way they differ from some of the performance activities described below. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
- **Performance-based items or events:** questions, tasks, or activities that require students to perform an action. Although performances can involve demonstrations or presentations, most typically they involve students explaining how they would answer the question or solve a problem by writing a few sentences or paragraphs, drawing and explaining a diagram, or performing an experiment. Such tasks may take from 15 minutes to an hour or more and may involve some work with a group of students who think through the answers and later provide their own individually written answers. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
- **Projects or experiments:** extended performance tasks that may take several days or even several weeks to complete. Students generate problems, consider options, propose solutions, and demonstrate their solutions. Students often work in groups, at least for some of the project, to analyze options and to consider ways to present their thinking and conclusions. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
- **Portfolios:** collections of student work that show teachers and others who may "score" portfolios the range and quality of student work over a period of time and in various content areas. There are almost as many approaches to compiling and evaluating portfolios as there are proponents of this form of assessment. Portfolios can be used both formally and informally; ideally, portfolios capture the evolution of students' ideas and can be used instructionally and as progress markers for students, teachers, and program evaluators. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*

http://www.celt.iastate.edu/teaching-resources/classroom-practice/teaching-techniques-strategies/check-student-learning/

Angelo, Thomas A. and K. Patricia Cross, 1993, *Classroom Assessment Techniques: A Handbook for College Teachers*, Second Edition, San Francisco: Jossey-Bass Publishers.

- During last few minutes of class period, ask students to use a half-sheet of paper and write “Most important thing I learned today and what I understood least.”
- Ask students to describe what they didn’t understand and what they think might help.

- Pass around a large envelope with a question about the class content. Each student writes a short answer, puts it in the envelope, and passes it on.
- During last 15 minutes of class, ask students to write a short news article about how a major point applies to a real-world situation. An alternative is to have students write a short article about how the point applies to their major. Sort articles and pick several to read at next class, illustrating range of applications, depth of understanding, and creativity.
- Divide the class into groups and assign each group a topic on which they are each to write a question and answer for the next test. Each student should be assured of getting at least one question right on the test. Use as many of the questions as possible, combining those that are similar.
- Ask students to keep journals that detail their thoughts about the class. May ask them to be specific, recording only attitudes, values, or self-awareness. Have students turn in the journals several times during the semester so you can chart changes and development.
- Select a test that you use regularly and add a few questions at the end which ask students to evaluate how well the test measures their knowledge or skills. Make changes to the test that are reasonable. Track student responses over time.
- Ask students to volunteer to meet as a small group with you on a regular basis to discuss how the course is progressing, what they are learning, and suggestions for improving the course.
- Put a box near the classroom door and ask students to leave notes about any class issue. Review and respond at the next class session.

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

- What's Inside – This can be done individually, with a partner or in small groups. Students get a sealed envelope that contains a slip of paper with a topic, vocabulary word or problem written on it. Students then have to explain, describe, or solve the contents of the envelope.
- Provide students with wooden cubes to be assembled into one large cube. Have them calculate the surface-area-to-volume ratio of the large structure as if it were one large cube (cell) instead of individual cubes (cells).
- Create Smart Board Activities - SMART Exchange

MWEE Connections:

1. http://rivanna-stormwater.org/lessonplans.htm
2. http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml
3. http://pacd.org/education/chesapeake-bay-education-office/chesapeake-bay-lesson-plans/
4. http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay/lesson-plans
5. http://www.mdsg.umd.edu/lesson-plans

Technology Integrations

- Diffusion and Osmosis 5: Dynamic Equilibrium
- Diffusion and Osmosis 6: Concentration and Breathing
- Diffusion and Osmosis 12: Osmosis
- Diffusion and Osmosis 2: A Simple Example of Diffusion)
- Diffusion and Osmosis 8: The Role of Surface Area
- Diffusion and Osmosis 14: Active Transport
- Osmosis: Diffusion Through A Membrane - Full Controls
- Diffusion In and Out of the Cell: Water, Oxygen and CO_2
- Simple Osmosis with One Pore
- Diffusion and Osmosis 10: Which Atoms or Molecules Need Pores?
- Diffusion and Osmosis 11: Exploring an Aquapore
- Diffusion and osmosis
- Potato demonstration
- *Elodea* lab
- Egg lab
- Grape lab
- Diffusion and osmosis labs
- Osmoregulation in fish
- Why we can't drink salt water

Resources

- Sciencegeek.net - Biology Interactive Review Activities
- Discovery Education
- Classroom Clips
- About Education
- Jefferson Lab
- Science Monster
- Student Science
- The Biology Project
- Khan Academy
- Helena Easter- Live Binder
- Discovery Streaming:
  1. Inside Cells
  2. Organelles
  3. Cell with Golgi body highlighted
  4. Plant and Animal Cells

5. Simply Science (Spanish Version): Kingdoms
6. Cellular structures; nucleus, vacuole, cytoplasm, and cell membrane
7. Cell Walls and Cell Membranes
8. The Cell Wall and Vacuoles
9. Cell Size
10. Tamaño de las células (The size and efficiency of a cell is limited by its surface area-to-volume ratio.)

- Observing cells lab activity
- Jell-O cells
- More Jell-O cells
- Interactive cell model
- Endosymbiotic theory

Related Gizmos:

- *Cell Energy Cycle*
- *Cell Division*

Cells

1. Balkwill, F. 1990. *Cells are us.* Minneapolis, MN: Carolrhoda Books.
2. Balkwill, F. 2002. *Enjoy your cells.* Woodbury, NY: Cold Spring Harbor Laboratory Press.
3. Wells, R.E. 1995. *What's smaller than a pygmy shrew?* Morton Grove, IL: Albert Whitman and Company.
4. Bilash, B., and Shields, M. 2001. *A Demo A Day A Year of Biological Demonstrations.* Batavia, IL: Flinn Scientific
5. Laying The Foundation Science Participant Manual (ISBN 978-1-935167-33-4)
4. Redding, K., and Masterman, D. 2007. *Biology with Vernier.* Beaverton, OR: Vernier Software and Technology

Cross Curricular Connection

Find artistic inspiration in science through the poetic writing of Nobel prize winning scientist, Charles Scott Sherrington. Dr Lizzie Burns encourages independent thinking via this excellent series of slides where students can devise questions, create colourful artwork and write poems about cells and the brain. To see more like this, visit: https://history.medsci.ox.ac.uk/art/activities/ © Dr Lizzie Burns, Department for Physiology, Anatomy and Genetics.

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Life Functions Archaea, Bacteria & Eukarya/ #3

Start day: 4

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

BIO.4 The student will investigate and understand life functions of Archaea, Bacteria and Eukarya. Key concepts include

a) comparison of their metabolic activities;
b) maintenance of homeostasis;
c) how the structures and functions vary among and within the Eukarya kingdoms of protists, fungi, plants, and animals, including humans;
d) human health issues, human anatomy, and body systems;
e) how viruses compare with organisms; and
f) evidence supporting the germ theory of infectious disease.

Essential Understandings/ Big Ideas

- Living things are categorized into three domains: Archaea, Bacteria, and Eukarya.
- Organisms get their nutritional requirements as either autotrophs or heterotrophs.
- Autotrophs can be either photosynthetic autotrophs or chemosynthetic autotrophs.
- Heterotrophs must obtain their nutrients by either eating autotrophs, organisms that eat autotrophs, or they absorb their nutrients.
- Homeostasis is when an organism tries to maintain internal conditions suitable for life. If an organism fails to maintain homeostasis then it will become ill or it may die.
- Organisms that are Eukarya have cells that contain a nucleus and membrane bound organelles.
- Organisms that belong to the domain Eukarya or bacteria have cells that do not contain a nucleus.
- Viruses are encased in a protein coat.
- Viruses are not considered living because they can only replicate inside a host cell. They have some characteristics in common with living things; proteins and genetic material.
- The scientific research of Louis Pasteur showed that microorganisms caused certain kinds of diseases and it helped to disprove spontaneous generation.

- Robert Koch developed a technique for identifying the pathogen that causes a disease known as Koch's postulates.

Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- compare and contrast the metabolic activities of all domains of life.
- identify the proper response an organism would exhibit in response to changes in the environment to maintain homeostasis.
- categorize and compare the Eukarya kingdoms based on cell structure, locomotion, reproduction, response to the environment and metabolism.
- identify the main factors that affect human health.
- describe the major functions of the human body systems and the role of each in maintaining homeostasis.
- compare and contrast a virus and a cell in relation to genetic material and reproduction.
- describe how Pasteur's and Koch's experimentation and hypotheses led to an understanding of the presence of microorganisms and their relationship to diseases.

Vocabulary

- protista
- fungus
- eubacteria
- archaea
- plantae
- animalia
- metabolism
- catabolism
- anabolism
- photoautotrophs
- photoheterotrophs
- chemoautotrophs
- chemoheterotrophs
- stimulus
- tropism
- gravitropism
- phototropism
- thigmotropism
- ectotherm
- endotherm
- negative feedback mechanism

- positive feedback mechanism
- homeostasis
- circulatory system
- blood
- artery
- vein
- capillary
- heart
- respiratory system
- trachea
- alveolus
- diaphragm
- nervous system
- central nervous system
- peripheral nervous system
- impulse
- neuron
- nerve
- muscular system
- dendrites
- cell body
- axon
- nodes
- myelin sheath
- axon terminals
- virus
- bacteriophage
- lytic infection
- lysogenic infection

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Conduct experiments using appropriate tools
- Record and analyze data on the experiments conducted
- Test/ assessment

- Have students create a game jam, teams are challenged to design a game in a short period of time. The theme of the game should be based on the topic under study.
- **Open-ended or constructed response items** that ask students to respond in their own words--to "construct" their answers--to questions that may have multiple good answers. Students usually reason out their solutions as part of their answers. Usually students can answer these questions in just a few minutes, and in that way they differ from some of the performance activities described below. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
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Angelo, Thomas A. and K. Patricia Cross, 1993, *Classroom Assessment Techniques: A Handbook for College Teachers*, Second Edition, San Francisco: Jossey-Bass Publishers.

- During last few minutes of class period, ask students to use a half-sheet of paper and write “Most important thing I learned today and what I understood least.”
- Ask students to describe what they didn’t understand and what they think might help.
- Pass around a large envelope with a question about the class content. Each student writes a short answer, puts it in the envelope, and passes it on.
- During last 15 minutes of class, ask students to write a short news article about how a major point applies to a real-world situation. An alternative is to have students write a short article about how the point applies to their major. Sort articles and pick several to read at next class, illustrating range of applications, depth of understanding, and creativity.
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- Ask students to keep journals that detail their thoughts about the class. May ask them to be specific, recording only attitudes,

values, or self-awareness. Have students turn in the journals several times during the semester so you can chart changes and development.

- Select a test that you use regularly and add a few questions at the end which ask students to evaluate how well the test measures their knowledge or skills. Make changes to the test that are reasonable. Track student responses over time.
- Ask students to volunteer to meet as a small group with you on a regular basis to discuss how the course is progressing, what they are learning, and suggestions for improving the course.
- Put a box near the classroom door and ask students to leave notes about any class issue. Review and respond at the next class session.

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

- Have students research a communicable disease they may have had. Have them include where they contracted the disease, whether they gave it to anyone else, how it is transmitted, and how others could be protected from getting it.
- Have students describe the changes that took place in municipal water supplies as a result of John Snow's work.
- Have students graph and present their data from their laboratory investigations.
- Create a flow chart following the SARS crisis from its outbreak to the discovery that peptides can prevent the SARS virus from penetrating cells. Students can find information for their charts in the story overview
  pbs.org/frontlineworld/stories/hongkong/thestory.html
  for "Hong Kong: Chasing the Virus" and in "Peptides, Antibodies, Membranes ... What?".
  pbs.org/frontlineworld/stories/hongkong/science.html
  Students also can complete their flow charts by watching the video (about 13 minutes long) of this story.

MWEE Connections:

1. http://rivanna-stormwater.org/lessonplans.htm
2. http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml
3. http://pacd.org/education/chesapeake-bay-education-office/chesapeake-bay-lesson-plans/
4. http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay/lesson-plans
5. http://www.mdsg.umd.edu/lesson-plans

Technology Integrations

- **BIO.4d BIO.1a**
  Body Temperature: Thermoregulation [38]
- **BIO.4d BIO.1a**
  Respiratory Rate During Exercise [39]

- **BIO.4d BIO.1a**
  Making and Hearing Sounds [89]
- Bubbabrain - Play the games to review important concepts and terms for many courses.
- Quizlet's flashcards, tests, and study games make learning fun and engaging for students of all ages.
- Vernier probware

Resources

- **Virginia Department of Education Science Enhanced Scope and Sequence Lessons:**
  1. **Prokaryotes**
  2. **The Germ Theory and Koch's Postulates**
  3. **Cell Parts**
  4. **Viruses**
  5. **Body Systems**

Selected Web Resources

- Disease transmission labs: http://www.science.org.au/nova/026/026act01.htm, http://www.smccd.net/accounts/case/epidemiology/epidemiology.pdf
- Infectious diseases: http://www.mayoclinic.com/health/infectious-diseases/DS01145
- Diseases and their pathogens: http://www.mwra.com/germs/germ10.htm, http://www.bacteriamuseum.org/cms/Pathogenic-Bacteria/pathogenic-bacteria.html
- CDC data and statistics: http://www.cdc.gov/DataStatistics/
- Legionnaires' disease: http://www.cdc.gov/legionella/patient_facts.htm

Related Gizmos:

- *Virus Lytic Cycle*: http://www.explorelearning.com/gizmo/id?448
- *Drug Dosage*: http://www.explorelearning.com/gizmo/id?525

Trade books

1. Bilash, B., and Shields, M. 2001. *A Demo A Day A Year of Biological Demonstrations.* Batavia, IL: Flinn Scientific
2. Laying The Foundation Science Participant Manual (ISBN 978-1-935167-33-4)

3. Redding, K., and Masterman, D. 2007. *Biology with Vernier*. Beaverton, OR: Vernier Software and Technology

Cross Curricular Connection

Cross-Curricular - Science

- Explore the Global Dangers and Scientific Foundation of Nuclear Bombs
- Track the Discovery, Spread and Control of Disease

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Cell Division & DNA and Genetics/ #2

Start day: 3rd week

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

BIO.5 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include

a) cell growth and division;
b) gamete formation;
c) cell specialization;
d) prediction of inheritance of traits based on the Mendelian laws of heredity;
e) historical development of the structural model of DNA;
f) genetic variation;
g) the structure, function, and replication of nucleic acids;
h) events involved in the construction of proteins;
i) use, limitations, and misuse of genetic information; and
j) exploration of the impact of DNA technologies.

Essential Understandings/ Big Ideas

The concepts developed in this standard include the following:

- All living cells come from other living cells. A typical cell goes through a process of growth, development, and reproduction called the cell cycle.
- Mitosis produces two genetically identical cells. During mitosis, the nucleus of the cell divides, forming two nuclei with identical genetic information. Mitosis is referred to in the following stages: prophase, metaphase, anaphase, and telophase.
- Many organisms are capable of combining genetic information from two parents to produce offspring. Sex cells are produced through meiosis. This allows sexually reproducing organisms to produce genetically differing offspring, and maintain their number of chromosomes. Meiosis occurs in sexual reproduction when a diploid germ cell produces four haploid daughter cells that can mature to become gametes (sperm or egg).
- Genetically diverse populations are more likely to survive changing environments. Recombination and mutation provide for genetic diversity. Some new gene combinations have little effect, some can produce organisms that are better suited to their environments, and others can be deleterious.
- Mitosis and meiosis refer to division of the nuclear material. Cytokinesis is the division of the cytoplasm and organelles.
- The many body cells of an organism can be specialized to perform different functions, even though they are all descended from a single cell and contain essentially the same genetic information.
- Mendel's laws of heredity are based on his mathematical analysis of observations of patterns of inheritance of traits. Geneticists apply mathematical principles of probability to Mendel's laws of heredity in order to predict the results of simple genetic crosses. The laws of probability govern simple genetic recombinations.
- Genotype describes the genetic make-up of an organism and phenotype describes the organism's appearance based on its genes. Homozygous individuals have two identical alleles for a particular trait, while heterozygous individuals have contrasting alleles. When one allele masks the effect of another, that allele is called dominant and the other recessive. When an intermediate phenotype occurs and no allele dominates, incomplete dominance results. Many other patterns of inheritance exist including multiple alleles, polygenic inheritance, and sex-linked inheritance.
- Once DNA was shown to be the genetic material, a race among scientists took place to work out its structure. Studies of the amounts of each DNA base in different organisms led to the concept of complementary base-paring. Interpretations of X-ray photographs of DNA were used to describe the shape and dimensions of the molecule. An analysis of this and other available data led to a structural model for the DNA double helix.
- DNA is a polymer consisting of nucleotides. A DNA nucleotide is identified by the base it contains: adenine (A), guanine (G),

cytosine (C) or thymine (T). DNA is a double-stranded molecule. The strands are composed of covalently bonded sugar and phosphate molecules and are connected by complementary nucleotide pairs (A-T and C-G) like rungs on a ladder. The ladder twists to form a double helix.

- The double helix model explained how heredity information is transmitted and provided the basis for an explosion of scientific research in molecular genetics. The sorting and recombination of genes in sexual reproduction results in a great variety of gene combinations in the offspring of any two parents.
- The genetic code is a sequence of DNA nucleotides in the nucleus of eukaryotic cells. Before a cell divides, the instructions are duplicated so that each of the two new cells gets all the necessary information for carrying on life functions. Cells pass on their genetic code by replicating their DNA.
- DNA stores the information for directing the construction of proteins within a cell. These proteins determine the phenotype of an organism. The genetic information encoded in DNA molecules provides instructions for assembling protein molecules. The code is virtually the same for all life forms.
- During DNA replication, enzymes unwind and unzip the double helix and each strand serves as a template for building a new DNA molecule.

Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- create a diagram to model the stages of mitosis and explain the processes occurring at each stage.
- describe the importance of cell specialization in the development of multicellular organisms.
- create a diagram to model the stages of meiosis and explain the processes occurring at each stage.
- compare and contrast the process of mitosis and meiosis and determine under which conditions each process will occur.
- explain how the Mendelian laws of heredity apply to the patterns of inheritance.
- identify the traits expressed from a given genotype.
- use a Punnett square to show all possible combinations of gametes and the likelihood that particular combinations will occur in monohybrid and dihybrid crosses.
- evaluate karyotype charts and make a determination of the gender and genetic health of the individual.
- provide examples of reasons for genetic diversity and why it can be an advantage for populations.
- provide examples of mutations that are lethal, harmful, and beneficial.
- describe the basic structure of DNA and its function in inheritance.
- describe the key events leading to the development of the structural model of DNA.
- given a DNA sequence, write a complementary mRNA strand (A-U, T-A, C-G and G-C).
- explain the process of DNA replication.
- explain the process of protein synthesis, including DNA transcription and translation.

- evaluate examples of genetic engineering and the potential for controversy.
- describe the uses, limitations, and potential for misuse of genetic information.

Vocabulary

- cell division
- binary fission
- cell cycle
- chromatid
- centriole
- mitosis
- centromere
- spindle
- metaphase
- anaphase
- telophase
- cytokinesis
- asexual reproduction
- sexual reproduction
- gamete
- somatic cell
- diploid
- haploid
- monoploid
- homologous chromosome
- synapsis
- crossing –over
- fertilization
- meiosis
- DNA
- Gene
- Chromatin
- Chromosome
- Egg cell
- Sperm cell
- Prophase I & II
- Metaphase I & II

- Anaphase I & II
- Telophase I & II
- Stem cell
- Specialized cell
- undifferentiated cell
- purebred
- allele
- dominant allele
- recessive allele
- homozygous dominant
- homozygous recessive
- heterozygous dominant
- law of segregation
- law of independent assortment
- genotype
- phenotype
- Punnett square
- Probability
- Trait
- Genetics
- Probability
- Mutation
- Gene mutation
- Chromosomal mutation
- Codon
- Point mutation
- Frameshift mutation
- Nondisjunction
- Deletion
- Inversion
- Translocation
- Duplication
- DNA replication
- RNA
- Transcription

- Messenger RNA
- Translocation
- Transfer RNA
- Ribosomal RNA
- Biotechnology
- Genetic engineering
- Recombinant DNA
- Plasmid
- Cloning
- Human Genome Project

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Conduct experiments using appropriate tools
- Record and analyze data on the experiments conducted
- Test/ assessment
- Have students create a game jam, teams are challenged to design a game in a short period of time. The theme of the game should be based on the topic under study.
- **Open-ended or constructed response items** that ask students to respond in their own words--to "construct" their answers--to questions that may have multiple good answers. Students usually reason out their solutions as part of their answers. Usually students can answer these questions in just a few minutes, and in that way they differ from some of the performance activities described below. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
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Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

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- Ask students to keep journals that detail their thoughts about the class. May ask them to be specific, recording only attitudes, values, or self-awareness. Have students turn in the journals several times during the semester so you can chart changes and development.
- Select a test that you use regularly and add a few questions at the end which ask students to evaluate how well the test measures their knowledge or skills. Make changes to the test that are reasonable. Track student responses over time.
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MWEE Connections:

1. http://rivanna-stormwater.org/lessonplans.htm
2. http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml
3. http://pacd.org/education/chesapeake-bay-education-office/chesapeake-bay-lesson-plans/
4. http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay/lesson-plans
5. http://www.mdsg.umd.edu/lesson-plans

Technology Integrations

- **BIO.5h BIO.1l**
  Protein Structure - From DNA to Proteins [51]
- **BIO.5h BIO.1l**
  Protein Biography [461]
- **BIO.5h BIO.1l**
  Protein Structure - DNA Mutations MW ITSISU [52]
- **BIO.5h BIO.1l**
  Protein Structure - From DNA to Proteins - Transcription and Translation LM (8) [1036]
- **BIO.5h BIO.1l**
  Protein Structure - From DNA to Proteins (3) [717]
- DNA Polymerase: Making A New DNA Molecule from A Template
- Proteins and Nucleic Acids 8.2: The Structure of DNA
- Tree of Life: Animal DNA 1
- Making a Sickle Cell Sequence
- DNA to Proteins 3: Transcription
- Protein Structure - Substitution Mutation
- Protein Structure: Silent Mutation
- Protein Structure - Stop Codon
- Biological Meiosis

Resources

Selected Web Resources

- Codominant genes: http://www.cccoe.net/genetics/codominant.html
- Inheritance patterns: http://ghr.nlm.nih.gov/handbook/inheritance/inheritancepatterns
- Probability games: http://www.betweenwaters.com/probab/probab.html
- Probability of inheritance: http://anthro.palomar.edu/mendel/mendel_2.htm
- High cholesterol—a genetic disease: http://en.wikipedia.org/wiki/Familial_hypercholesterolemia

- Hybrid dog breeds: http://dogs.thefuntimesguide.com/2006/09/hybrid_mixed_dog_breeds.php
- Mendel biography: http://www.strangescience.net/mendel.htm
- Mendel's original paper: http://www.mendelweb.org/Mendel.html

Related Gizmos
- *Inheritance*: http://www.explorelearning.com/gizmo/id?657
- *Mouse Genetics (One Trait)*: http://www.explorelearning.com/gizmo/id?449
- *Mouse Genetics (Two Traits)*: http://www.explorelearning.com/gizmo/id?382

Genetics Trade books

1. Bilash, B., and Shields, M. 2001. *A Demo A Day A Year of Biological Demonstrations.* Batavia, IL: Flinn Scientific
2. Laying The Foundation Science Participant Manual (ISBN 978-1-935167-33-4)
3. Redding, K., and Masterman, D. 2007. *Biology with Vernier.* Beaverton, OR: Vernier Software and Technology
4. Nicolson, C.P. 2001. *Baa! The most interesting book you'll ever read about genes and cloning.* Tonawonda, NY: Kids Can Press.
5. Patent, D.H. 1989. *Grandfather's nose: Why we look alike or different.* New York: Franklin Watts.

Cross Curricular Connection

Creating Activities Across ALL Subjects

The last cross-curricular suggestion can actually incorporate several subjects into one engaging lesson where students work together to develop commercials or public service announcements. This fun and motivating activity will allow teachers to cover expectations in reading, writing, oral communication, the arts (both visual arts and drama), media literacy, science, and, depending on the topic, even health & physical education.

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Classification System/ #3

Start day: 3rd week

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

BIO.6 The student will investigate and understand bases for modern classification systems. Key concepts include

a) structural similarities among organisms;
b) fossil record interpretation;
c) comparison of developmental stages in different organisms;
d) examination of biochemical similarities and differences among organisms; and
e) systems of classification that are adaptable to new scientific discoveries.

Essential Understandings/ Big Ideas

The concepts developed in this standard include the following:

- Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their relationships over a period of time.
- Binomial nomenclature is a standard way of identifying a species with a scientific two-word name. The first word is the genus name and the second the species name. Species is the basic unit of classification. A species is defined as a group of organisms that has the ability to interbreed and produce fertile offspring in nature.
- A dichotomous key is a classification tool used to identify and organize organisms using defining characteristics.
- Information about relationships among living organisms and those that inhabited Earth in the past is gained by comparing biochemistry and developmental stages of organisms and by examining and interpreting the fossil record. This information is continually being gathered and used to modify and clarify existing classification systems.
- Evolutionary relationships can be represented using a branching diagram called a cladogram or phylogenetic tree which are organized by shared, derived characteristics.
- Similarities among organisms on the structural and metabolic levels are reflected in the large degree of similarity in proteins and nucleic acids of different organisms. Diversity is the product of variations in these molecules.

Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- construct and utilize dichotomous keys to classify groups of objects and organisms.
- describe relationships based on homologous structures.
- compare structural characteristics of an extinct organism, as evidenced by its fossil record, with present, familiar organisms.
- recognize similarities in embryonic stages in diverse organisms in the animal kingdom, from zygote through embryo and infer relationships.
- compare biochemical evidence (DNA sequences, amino acid sequences) and describe relationships.

- interpret a cladogram or phylogenic tree showing evolutionary relationships among organisms.
- investigate flora and fauna in field investigations and apply classification systems.

Vocabulary

- classification
- taxonomy
- comparative morphology
- homologous structures
- analogous structures
- fossils
- fossil record
- Law of Superposition
- Relative age
- Embryology
- Incomplete metamorphosis
- Complete metamorphosis
- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species
- Domain
- Scientific name

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Conduct experiments using appropriate tools
- Record and analyze data on the experiments conducted
- Test/ assessment
- Have students create a game jam, teams are challenged to design a game in a short period of time. The theme of the game should be based on the topic under study.
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http://www.celt.iastate.edu/teaching-resources/classroom-practice/teaching-techniques-strategies/check-student-learning/

Angelo, Thomas A. and K. Patricia Cross, 1993, *Classroom Assessment Techniques: A Handbook for College Teachers*, Second Edition, San Francisco: Jossey-Bass Publishers.

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Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

- Matching – vocabulary words with their definitions and/ or pictures
- Bingo with related vocabulary
- Have students create a dichotomous key and have their classmates identify the objects based on the key.
- Students will watch Discovery Streaming videos and will answer discussion questions regarding the video.
- Obtain several owl pellets and have your students separate out the bones found in the pellets. Students then can use a dichotomous key to identify the remains of each type of animal. You can find a dichotomous key for mammalian bones typically found in owl pellets

MWEE Connections:

6. http://rivanna-stormwater.org/lessonplans.htm
7. http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml
8. http://pacd.org/education/chesapeake-bay-education-office/chesapeake-bay-lesson-plans/
9. http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay/lesson-plans
10. http://www.mdsg.umd.edu/lesson-plans

Technology Integrations

Related Gizmos:

- *Disease Spread*: http://www.explorelearning.com/gizmo/id?379
- *RNA and Protein Synthesis*: http://www.explorelearning.com/gizmo/id?442
- Dichotomous key information: http://www.mdsg.umd.edu/programs/education/interactive_lessons/key/index.htm
- Dichotomous key activities: http://sciencespot.net/Media/sillysci.pdf, http://www.lnhs.org/hayhurst/ips/dichot/
- Dichotomous key for trees, insects, etc.: http://dnr.wi.gov/org/caer/ce/eek/veg/treekey/index.htm, http://www4.uwsp.edu/cnr/leaf/Treekey/tkframe.htm, http://www.insectidentification.org/insect-key.asp, http://www.kidwings.com/teacher/owlpellets/dichotomouskey.htm, http://www.amnh.org/learn/biodiversity_counts/ident_help/Text_Keys/arthropod_keyA.htm
- Codons: http://commons.wikimedia.org/wiki/File:Codontable1.PNG
- Transcription and translation: http://elmhcx9.elmhurst.edu/~chm/vchembook/583rnatrans.html, http://www.wiley.com/college/boyer/0470003790/animations/translation/translation.htm,

https://www.youtube.com/watch?v=6gUY5NoX1Lk, http://learn.genetics.utah.edu/content/molecules/transcribe/

- *Building DNA* Gizmo: http://www.explorelearning.com/gizmo/id?439
- *DNA Fingerprint Analysis* Gizmo: http://www.explorelearning.com/gizmo/id?406
- *Cell Structure* Gizmo: http://www.explorelearning.com/gizmo/id?450

Resources

- Virus structure: http://web.uct.ac.za/depts/mmi/stannard/virarch.html
- Virus images: http://www.virology.wisc.edu/virusworld/viruslist.php
- Lytic and lysogenic cycles: http://biology.kenyon.edu/HHMI/Biol113/2virus.htm
- Lytic and lysogenic slides: http://www.k8science.org/slides/slide01.cfm?q=lytic
- Emerging diseases: http://www.who.int/topics/emerging_diseases/en/
- Interactive Achievement
- SOL Pass
- New York Regents
- Bubbabrain - Play the games to review important concepts and terms for many courses.
- Quizlet's flashcards, tests, and study games make learning fun and engaging for students of all ages.
- *Texas STAAR Review & Practice* gives your students the tools they need to succeed on the State of Texas Assessments of Academic Readiness exam.
- Vernier Probware
- Interpreting the Fossil Record

Understanding Evolution resources:

- A quick review of hominid evolutionary history

- A short essay on early ideas about human evolution
- A friendly tutorial on the nature of science

Trade books

1. Bilash, B., and Shields, M. 2001. *A Demo A Day A Year of Biological Demonstrations.* Batavia, IL: Flinn Scientific
2. Laying The Foundation Science Participant Manual (ISBN 978-1-935167-33-4)
3. Redding, K., and Masterman, D. 2007. *Biology with Vernier.* Beaverton, OR: Vernier Software and Technology

Cross Curricular Connection

Students will create classification posters of an organism found in one of the biomes discussed in class. Students will create travel brochures, commercials, public service announcement, etc. regarding the habitat where the organism lives. Students should also research the culture and people in the area.

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Evolution/ #4

Start day: 1st week

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

BIO.7 The student will investigate and understand how populations change through time. Key concepts include

a) evidence found in fossil records;
b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;
c) how natural selection leads to adaptations;
d) emergence of new species; and
e) scientific evidence and explanations for biological evolution.

Essential Understandings/ Big Ideas

In order to meet this standard, it is expected that students will

- determine the relative age of a fossil given information about its position in the rock and absolute dating by radioactive decay.
- differentiate between relative and absolute dating based on fossils in biological evolution.
- recognize that adaptations may occur in populations of organisms over a period of time.
- describe the impact of reproductive strategies and rates on a population's survival.
- describe how genetic variation can lead to gradual changes in populations and the emergence of new species over time.
- predict the impact of environmental pressures on populations.
- explain how natural selection leads to changes in gene frequency in a population over time.

- compare and contrast punctuated equilibrium with gradual change over time.

Key Essential Skills and Knowledge

The concepts developed in this standard include the following:

- A fossil is any evidence of an organism that lived long ago. Scientists have used the fossil record to construct a history of life on Earth. Although there is not a complete record of ancient life for the past 3.5 billion years, a great deal of modern knowledge about the history of life comes from the fossil record.
- Populations are groups of interbreeding individuals that live in the same place at the same time and compete with each other for food, water, shelter, and mates. Populations produce more offspring than the environment can support. Organisms with certain genetic variations will be favored to survive and pass their variations on to the next generation. The unequal ability of individuals to survive and reproduce leads to the gradual change in a population, generation after generation over many generations. Depending on the selective pressure, these changes can be rapid over few generations (i.e., antibiotic resistance).
- Genetic mutations and variety produced by sexual reproduction allow for diversity within a given population. Many factors can cause a change in a gene over time. Mutations are important in how populations change over time because they result in changes to the gene pool. Through his observations, including those made in the Galapagos Islands, Charles Darwin formulated a theory of how species change over time, called natural selection. Natural selection is a process by which organisms with traits well suited to an environment survive and reproduce at a greater rate than organisms less suited to that environment, and is governed by the principles of genetics. The change in frequency of a gene in a given population leads to a change favoring maintenance of that gene within a population and if so, may result in the emergence of a new species. Natural selection operates on populations over many generations.
- Depending on the rate of adaptation, the rate of reproduction, and the environmental factors present, structural adaptations may take millions of years to develop.
- Adaptations sometimes arise abruptly in response to strong environmental selective pressures, for example, the development of antibiotic resistance in bacterial populations, morphological changes in the peppered moth population, and the development of pesticide resistance in insect populations.
- Stephen Jay Gould's idea of punctuated equilibrium proposes that organisms may undergo rapid (in geologic time) bursts of speciation followed by long periods of time unchanged. This view is in contrast to the traditional evolutionary view of gradual and continuous change.

Vocabulary

- Extinct
- Geoglogic time scale
- Era
- Period

- Population
- Genetic diversity
- Gene flow
- Gene flow
- Gene pool
- Bottleneck effect
- Genetic drift
- Nonrandom mating
- Variation
- Natural selection
- Adaptation
- Speciation
- Geographic isolation
- Behavioral isolation

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Conduct experiments using appropriate tools
- Record and analyze data on the experiments conducted
- Test/ assessment
- Have students create a game jam, teams are challenged to design a game in a short period of time. The theme of the game should be based on the topic under study.
- **Open-ended or constructed response items** that ask students to respond in their own words--to "construct" their answers--to questions that may have multiple good answers. Students usually reason out their solutions as part of their answers. Usually students can answer these questions in just a few minutes, and in that way they differ from some of the performance activities described below. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
- **Performance-based items or events:** questions, tasks, or activities that require students to perform an action. Although performances can involve demonstrations or presentations, most typically they involve students explaining how they would answer the question or solve a problem by writing a few sentences or paragraphs, drawing and explaining a diagram, or performing an experiment. Such tasks may take from 15 minutes to an hour or more and may involve some work with a group of students who think through the answers and later provide their own individually written answers. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
- **Projects or experiments:** extended performance tasks that may take several days or even several weeks to complete. Students generate problems, consider options, propose solutions, and demonstrate their solutions. Students often work in groups, at least for some of the project, to analyze options and to consider ways to present their thinking and conclusions. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*

- **Portfolios:** collections of student work that show teachers and others who may "score" portfolios the range and quality of student work over a period of time and in various content areas. There are almost as many approaches to compiling and evaluating portfolios as there are proponents of this form of assessment. Portfolios can be used both formally and informally; ideally, portfolios capture the evolution of students' ideas and can be used instructionally and as progress markers for students, teachers, and program evaluators. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*

http://www.celt.iastate.edu/teaching-resources/classroom-practice/teaching-techniques-strategies/check-student-learning/

Angelo, Thomas A. and K. Patricia Cross, 1993, *Classroom Assessment Techniques: A Handbook for College Teachers*, Second Edition, San Francisco: Jossey-Bass Publishers.

- During last few minutes of class period, ask students to use a half-sheet of paper and write "Most important thing I learned today and what I understood least."
- Ask students to describe what they didn't understand and what they think might help.
- Pass around a large envelope with a question about the class content. Each student writes a short answer, puts it in the envelope, and passes it on.
- During last 15 minutes of class, ask students to write a short news article about how a major point applies to a real-world situation. An alternative is to have students write a short article about how the point applies to their major. Sort articles and pick several to read at next class, illustrating range of applications, depth of understanding, and creativity.
- Divide the class into groups and assign each group a topic on which they are each to write a question and answer for the next test. Each student should be assured of getting at least one question right on the test. Use as many of the questions as possible, combining those that are similar.
- Ask students to keep journals that detail their thoughts about the class. May ask them to be specific, recording only attitudes, values, or self-awareness. Have students turn in the journals several times during the semester so you can chart changes and development.
- Select a test that you use regularly and add a few questions at the end which ask students to evaluate how well the test measures their knowledge or skills. Make changes to the test that are reasonable. Track student responses over time.
- Ask students to volunteer to meet as a small group with you on a regular basis to discuss how the course is progressing, what they are learning, and suggestions for improving the course.
- Put a box near the classroom door and ask students to leave notes about any class issue. Review and respond at the next class session.

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

- Create a cartoon, poster board, public announcement, etc. that illustrates the concepts learned.

- Students will investigate the anatomy of various organisms and how these organisms have changed through adaptation and evolution.
- For a great pre-learning or during-learning activity, show a short video on adaptations, evolution, or comparative anatomy. One possibility is "By Land or by Sea – Comparative Anatomy" (available at http://www.sosq.vcu.edu/videos.aspx; click on "Anatomy"). Be sure to preview any video first. After students view the video, hold a brief discussion about it, pointing out key vocabulary and questioning students about important content.
- Have students read the article "Fire ants invade and evolve" (available at http://evolution.berkeley.edu/evolibrary/article/0_0_0/fireants_01) and then write responses to the questions "How does natural selection work? How does natural selection favor different genes based on environmental condition?"

Technology Integrations

- **BIO.7c, d, e**
  Competition [87]
- **BIO.7c, d, e BIO.1d**
  Producers and Consumers [86]
- **BIO.7b, c, d, e BIO.1d**
  A Selection Pressure [48]
- **BIO.7b, c, d, e**
  Conflicting Selection Pressures [49]
- **BIO.7b, c, d, e**
  Mutations [50]
- **BIO. 7c BIO. 1l**
  Allele Divergence [361]
- **BIO. 7b BIO. 1l**
  Mutations are Random! [1898]
- Sheep Mutation
- Bug Hunt Camouflage
- ER 9: Rabbit Variation: Feeding
- ER 12: Hawk And Rabbits (Controllable)
- ER 14: Open Model-Grass, Rabbits, and Hawks (with hypothesis)
- ER 16: Open Model-Grass, Rabbits, Hawks, And Foxes

Resources

- **GIZMOs**
  1. **Evolution: Natural and Artificial Selection**
  2. **Evolution: Mutation and Selection**
  3. **Human Evolution - Skull Analysis**
  4. **Hardy-Weinberg Equilibrium**
  5. **Rainfall and Bird Beaks**
  6. **Microevolution**
  7. **Natural Selection**
- Bio-Interactive – Free Resources for Science Education/ Videos
  1. The Origin of Species: The Making of a Theory
  2. The Origin of Species: The Beak of the Finch
- **Discovery Streaming**
  1. **Evidence for Evolution**
  2. **The Role of DNA in Genetic Variation Between and Among Species**
- *Evolution*
  1. Jackson, E. 2005. *The tree of life: The wonders of evolution.* Amherst, NY: Prometheus Books.
  2. Jenkins, S. 2002. *Life on Earth: The story of evolution.* Boston: Houghton Mifflin.
  3. Peters, L.W. 2003. *Our family tree: An evolution story.* San Diego, CA: Harcourt.
  4. Sis, P. 2003. *The tree of life: A book depicting the life of Charles Darwin, naturalist, geologist, and thinker.* New York: Frances Foster Books.

Cross Curricular Connection

Teaching Science with Social Studies

History and science fit together seamlessly. Scientific innovation has been a driving force in societal change.
To put it in perspective for students, have them consider what life would be like without the internet, phones or electricity. Or what it would be like to look up at the stars and not know what they are. If you're teaching an historical time period, you can focus on scientific discoveries and technological advances during that time. Have students create a presentation that highlights one or more scientific innovations and how they effected society (both then and now).

Course Title/ Course #: Biology

Unit Title/ Marking Period # (MP): Ecology/ #4

Start day: 3rd week

Meetings (Length of Unit): Ongoing

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

BIO.8 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include

a) interactions within and among populations including carrying capacities, limiting factors, and growth curves;
b) nutrient cycling with energy flow through ecosystems;
c) succession patterns in ecosystems;
d) the effects of natural events and human activities on ecosystems; and
e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.

Essential Understandings/ Big Ideas

The concepts developed in this standard include the following:

- As any population of organisms grows, it is held in check by interactions among a variety of biotic and abiotic factors.
- Abiotic factors are the nonliving elements in an ecosystem, such as temperature, moisture, air, salinity, and pH. Biotic factors are all the living organisms that inhabit the environment, including predators, food sources, and competitors.
- Population growth curves exhibit many characteristics, such as initial growth stage, exponential growth, steady state, decline, and extinction. Limiting factors are the components of the environment that restrict the growth of populations. Carrying capacity is the number of organisms that can be supported by the resources in an ecosystem.
- A community is a collection of interacting populations.
- Symbiosis is a close and permanent relationship between organisms of two different species. Examples include mutualism, commensalism, and parasitism.
- Ecosystems demonstrate an exchange of energy and nutrients among inhabiting organisms.
- An ecosystem consists of all the interacting species and the abiotic environment in a given geographic area. All matter including essential nutrients cycle through an ecosystem. The most common examples of such matter and nutrients include carbon, nitrogen, and water.
- Energy flows in an ecosystem from producers to various levels of consumers and decomposers. This flow of energy can be diagramed using a food chain

or food web. The efficiency of this flow of energy is represented by an energy pyramid.

- Ecological succession is a predictable change in the sequence of species that establish in a particular area over time.
- A climax community occurs when succession slows down and a stable community is established. The climax community in most of Virginia is a deciduous oak-hickory (hardwood) forest.
- As the human population increases, so does human impact on the environment. Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the environment, and intensive farming, have changed Earth's land, oceans, and atmosphere. Some of these changes have decreased the capacity of the environment to support some life forms.

Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- graph and interpret a population growth curve and identify the carrying capacity of the populations.
- make predictions about changes that could occur in population numbers as the result of population interactions.
- illustrate and/or model the key processes in the water, carbon, and nitrogen cycle and explain the role of living things in each of the cycles.
- given an illustration of a food chain and a food web, identify each organism as a producer (autotroph), consumer (primary/second order), or decomposer and describe their role in the ecosystem.
- interpret how the flow of energy occurs between trophic levels in all ecosystems in each of the following:
  - food chain
  - food web
  - pyramid of energy
  - pyramid of biomass
  - pyramid of numbers.
- identify and describe an ecosystem in terms of the following:
  - effects of biotic and abiotic components
  - examples of interdependence
  - evidence of human influences
  - energy flow and nutrient cycling
  - diversity analysis
- describe the patterns of succession found in aquatic and terrestrial ecosystems of Virginia.

Vocabulary

Ecosystem
Immigration
Emigration
Exponential growth
Limiting factor

Density-dependent limiting factor
Competition
Predation
Density- independent factor
Carrying capacity
Carbon cycle
Decomposer
Nitrogen cycle
Nitrogen fixation
Denitrification
Water cycle
Evaporation
Transpiration
Condensation
Precipitation
Succession
Pioneer species
Climax community
Pollution
Eutrophication
Deforestation
Renewable resource
Resource depletion
Nonrenewable resource
Global warming
Ecosystem
Abiotic factor
Biotic factor
Estuary
Habitat
Wetland

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

- Conduct experiments using appropriate tools
- Record and analyze data on the experiments conducted
- Test/ assessment

- Have students create a game jam, teams are challenged to design a game in a short period of time. The theme of the game should be based on the topic under study.
- **Open-ended or constructed response items** that ask students to respond in their own words--to "construct" their answers--to questions that may have multiple good answers. Students usually reason out their solutions as part of their answers. Usually students can answer these questions in just a few minutes, and in that way they differ from some of the performance activities described below. *Improving America's School: A Newsletter on Issues in School Reform - Spring 1996*
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- Divide the class into groups and assign each group a topic on which they are each to write a question and answer for the next test. Each student should be assured of getting at least one question right on the test. Use as many of the questions as possible,

combining those that are similar.

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- Put a box near the classroom door and ask students to leave notes about any class issue. Review and respond at the next class session.

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

- **Meaningful Watershed Experience – The Chesapeake 2000 agreement signed by the governors of Virginia, Maryland and Pennsylvania, as well as the mayor of the District of Columbia includes the goal of providing all students a "meaningful watershed experience" before graduation from high school. These experiences connect standards-based classroom activities with hands-on field investigations. The following resources will assist teachers in meeting this requirement:**
  - **Bay Backpack – Chesapeake Bay watershed-related lesson plans and activities, field studies, and professional development opportunities**
  - **Chesapeake Bay Program – Chesapeake Bay-related information and activities**
  - **Chesapeake Bay Foundation – SOL-aligned curricula and professional development**
  - **CHESSIE (Chesapeake Science on the Internet for Educators) – Bay-related education resources, online data and professional development opportunities from Mid-Atlantic Marine Education Association**
  - **Department of Game and Inland Fisheries (DGIF) – wildlife and fisheries resources for students and teachers**
  - **Virginia's Water Resources: A Tool for Teachers (K-8) – A guide containing information and activities supporting interdisciplinary and problem-based teaching about watersheds, water quality, stewardship and management issues**

MWEE Connections:

1. http://rivanna-stormwater.org/lessonplans.htm
2. http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/index.shtml
3. http://pacd.org/education/chesapeake-bay-education-office/chesapeake-bay-lesson-plans/
4. http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay/lesson-plans
5. http://www.mdsg.umd.edu/lesson-plans

Technology Integrations

- **BIO. 8a, BIO. 1l**
  Population Balance (45)
- **BIO. 8a BIO. 1l**
  Population Explosion (46)
- **BIO. 8a, BIO. 1l**
  Producers and Consumers [86]
- **BIO. 8d, BIO. 1l**
  Changing Environments [1398]
- **BIO. 8a, BIO. 1l**
  Wolf Sheep Predation [44]
- Worms
- Wolf-Sheep Predation
- Wolf-Sheep Predation (oversized)
- Sheep-Population
- PopGen Fish Bowl
- Bug Hunt Camouflage

Resources

- GIZMOs
  1. Food Chain
  2. Pond Ecosystem
  3. Forest Ecosystem
  4. Prairie Ecosystem

Ecology

1. Berger, M. 1994. *Oil spill!* New York: HarperCollins.
2. Cole, J. 1996. *The magic school bus gets eaten: A book about food chains.* New York: Scholastic.
3. Gibbons, G. 1994. *Nature's green umbrella: Tropical rain forests.* New York: Morrow Junior Books.
4. Gibbons, G. 1996. *Deserts.* New York: Holiday House.
5. Gibbons, G. 1998. *Marshes and swamps.* New York: Holiday House.
6. Gibbons, G. 2007. *Coral reefs.* New York: Holiday House.
7. Lauber, P. 1995. *Who eats what? Food chains and food webs.* New York: HarperCollins.
8. Seuss, T.G. 1971. *The lorax.* New York: Random House.
9. Bilash, B., and Shields, M. 2001. *A Demo A Day A Year of Biological Demonstrations.* Batavia, IL: Flinn Scientific
10. Laying The Foundation Science Participant Manual (ISBN 978-1-935167-33-4)
11. Redding, K., and Masterman, D. 2007. *Biology with Vernier.* Beaverton, OR: Vernier Software and Technology

Outstanding Science Trade Books for Students K–12: 2015
(Books published in 2014)

Cross Curricular Connection

Demonstrate Science Concepts through Movement

Have students get up and out of their seats to move around! Not only will students be incorporating science concepts throughout their drama activities, but being able to get up to stretch and move around will help students release a bit of energy and help them refocus on the task at hand.

Students can act out changes of state by starting off as a frozen piece of ice, melting into a pool of water, and then evaporating into vapor. The same concept can be used to learn about the water cycle, particles, and the four layers of the Earth.