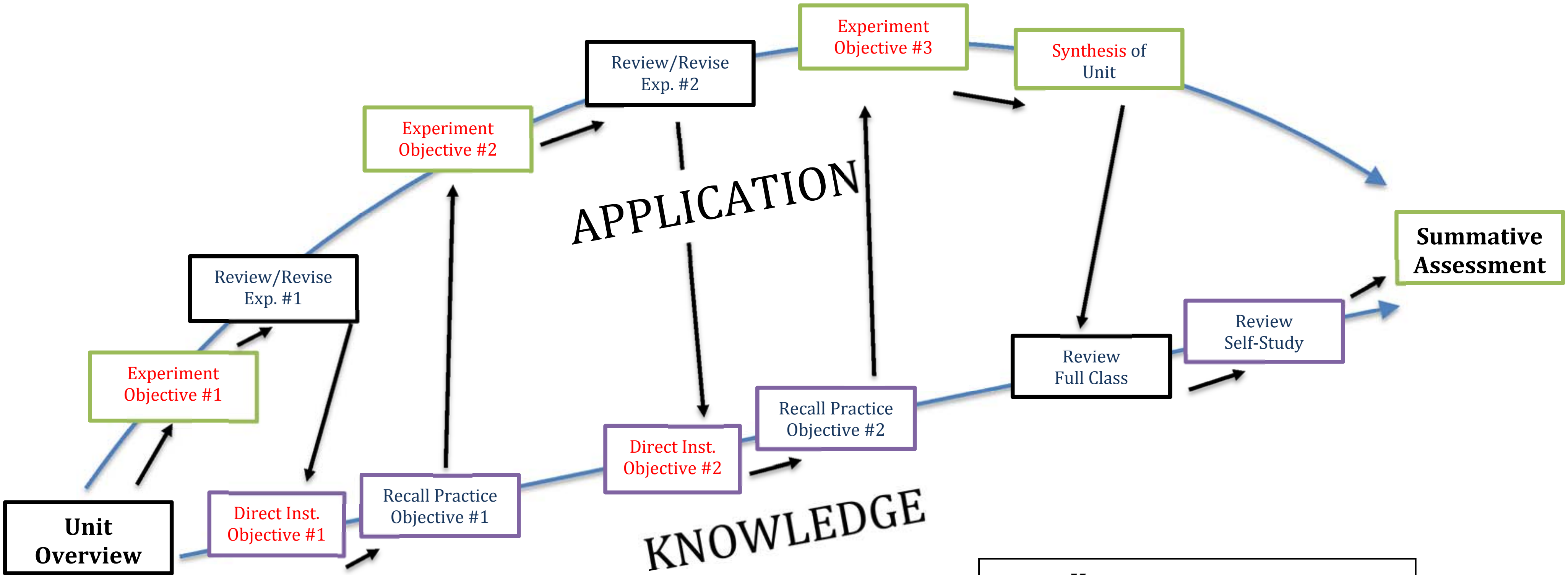
Unit Learning Trajectory

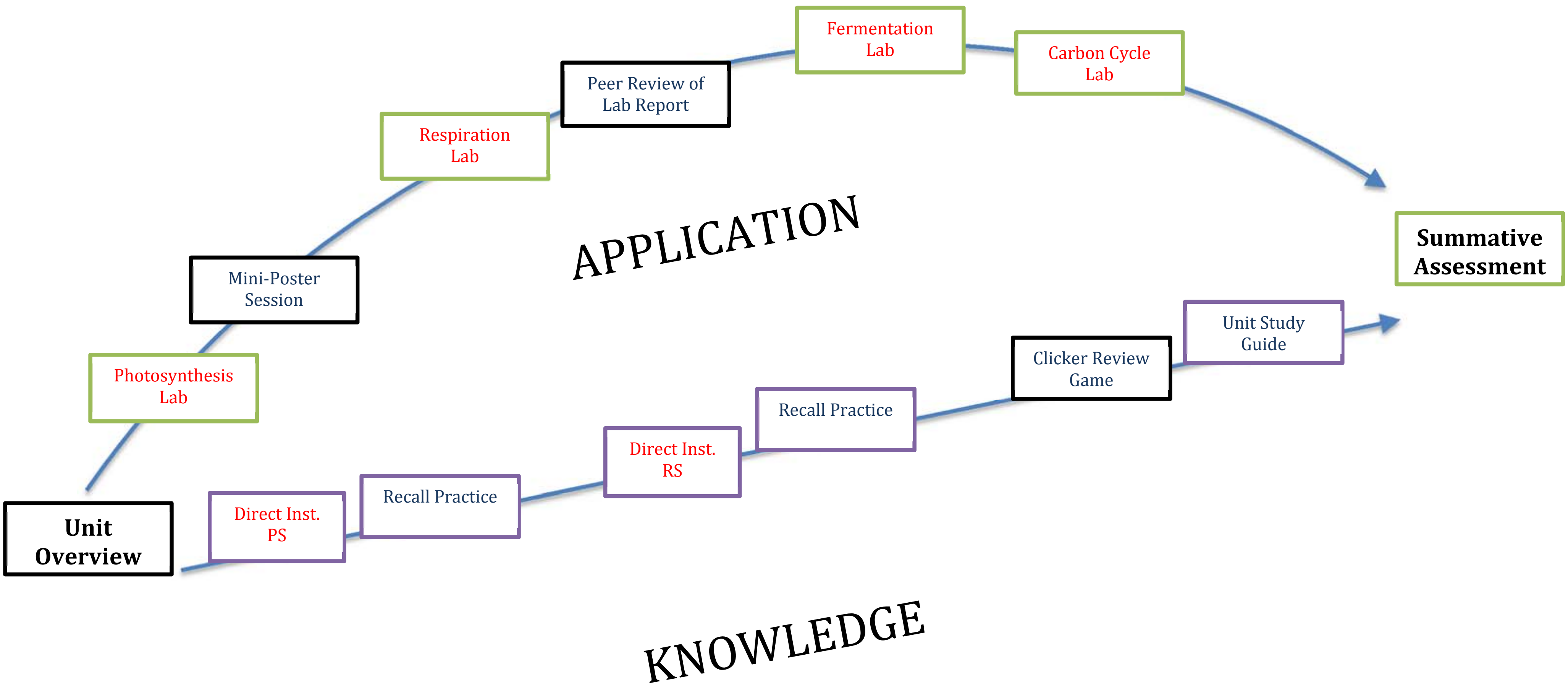


Key:
Direct Instruction – Delivers the basic vocabulary and concepts for the objective.
Recall Practice – Opportunity to practice knowing the concepts from objective #1. <u>Should **closely** reflect the summative assessment methods.</u>

Key:
Experiment – Inquiry activity. First exposure meant to explore the process being studied.
Review/Revise – Peer review, lab extension, or other review of lab experience.
Synthesis – Extension activity that requires synthesis of objectives 1 & 2 in a new context. Meant to push the limits of students' conceptions of the material.

Color Key:
Weighted grade
Checked, recorded, but not weighted ("ungraded")
Unchecked
New content
Review/feedback

Unit Learning Trajectory



Unit 5 – Energetics

Capturing and using energy.

Biology 1

Objectives

1. Describe the process of photosynthesis in plant cells.
2. Explore the process of cellular respiration in plant and animal cells.
3. Evaluate the purpose of fermentation (anaerobic respiration).

Keywords

Light Dependent Reactions	*Light Independent Reactions*	*Fermentation*
Glycolysis	*Citric Acid Cycle*	*Electron Transport Chain*
ATP	*Mitochondria*	*Chloroplast*

Practice Knowing

1. **Explain** how plants use the sun's energy to create sugar.

2. **Describe** the purpose of each step of cellular respiration.

3. **Explain** why a cell would ever use fermentation instead of aerobic respiration.

Next Generation Science Standards

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

8.2 PHOTOSYNTHESIS NAME______________________________HR____

LAB: FLOATING LEAF DISCS

PROBLEM/QUESTION:

-What factors affect the rate of photosynthesis in living leaves?

BACKGROUND INFORMATION:

- Photosynthesis provides oxygen for the atmosphere.
- The general summary equation for photosynthesis is:

$$H_2O + CO_2 + \text{light} \rightarrow \text{sugar} + O_2$$

- What could you measure to determine the rate of photosynthesis?
    - **Production of O_2** or
    - **Consumption of CO_2**
- In this investigation, you will use a system that measures the *production of oxygen*.
- Baking soda (sodium bicarbonate – $NaHCO_3$) dissolves in water to create H_2O and CO_2 (used in photosynthesis).

MATERIALS:

- baking soda (sodium bicarbonate)
- liquid soap
- 10 mL plastic syringe
- spinach leaves
- 2 50 mL beakers
- hole punch
- light source
- stopwatch
- petri dishes

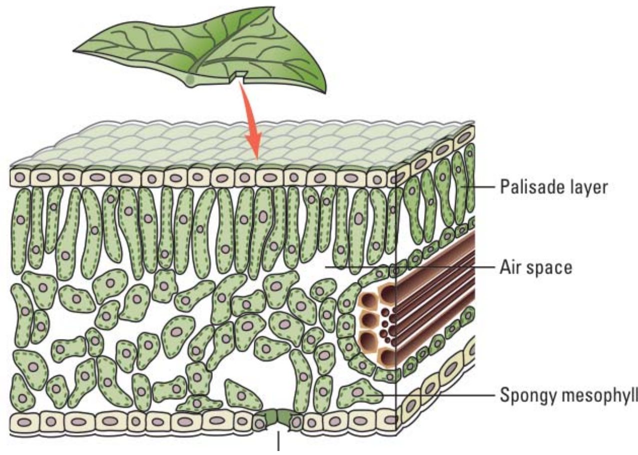


Figure 1: Inside a leaf

PROCEDURE:

1) Place 0.6 g of baking soda into 300 mL of tap water (0.2% solution). **Baking soda is the source of CO_2.*
2) Using a pipette, add three drop of liquid soap to the beaker. Mix gently with the pipette. <u>Don't</u> make bubbles.
   **The soap will wet the leaf surface, which will let the baking soda enter the leaf.*
3) Fill a petri dish ½ way with the baking soda solution. Label this dish "With CO_2." Fill a 2nd petri dish with only water to be used as a control group. Label this cup "Without CO_2."

*For the rest of the procedure you will do each step for **<u>both</u>** cups.*

4) Using a hole punch, cut 10 or more leaf disks for each dish. Avoid large leaf veins.
5) Draw gas out of the leaves and fill with solution:
    a. Take out the plunger of the syringe.
    b. Place the 10 leaf disks in the syringe.
    c. Replace plunger and push it in to remove almost all the air (around the 1 mL mark).
       **Be careful NOT to damage any leaves.*
    d. Pull up 5 mL of solution (baking soda for one and control for the other) into the syringe.
    e. Hole the syringe vertically (with opening pointing up) and place thumb over the syringe opening.
    f. <u>Slowly</u> pull down on the plunger (**this creates a vacuum*), making sure the leaf disks stay in the solution. Pull down to the 10 mL and hold the plunger there for 10 seconds. <u>Slowly</u> let the plunger move back up to the starting point.
    g. Check to see if all the leaves have sank (you may need to flick the syringe to make them sink). If not all of them have, try step F again.
       **Only try this procedure <u>1-3</u> times. Each time you do it you risk damaging the plant cells with the vacuum.*
    h. Remove plunger over the petri dish so that the disks fall into the dish.
6) Start timer once the leaf disks are in the petri dish.
7) Record the time (seconds) each time a new disk floats to the top.

SCIENTIFIC METHOD

IV: INDEPENDENT VARIABLE: ____

DV: DEPENDENT VARIABLE: ____

CONTROL GROUP: ____

EXPERIMENTAL GROUP: ____

CONSTANTS: ____

DATA TABLE: ____

CONCLUSION:

1) How did you know that photosynthesis was taking place? Explain using the PRODUCTS of photosynthesis.

2) What role did the water, light, and baking soda play in this experiment?

3) What would happen if you put the leaf discs in darkness?

4) What would happen if you left the leaf discs in the light overnight? Would they continue to float? Why/why not?

LAB EXTENSION:

Propose other variables you could test, including the control trial as well.

INDEPENDENT:

DEPENDENT:

CONTROL:

Direct Instruction

We all have different priorities and expectations of our students when it comes to the knowledge level content acquisition of our students. Vocabulary use, big ideas, context, and many other things are all priorities for different teachers. Direct instruction has a place in today's biology classroom, and often is used to reinforce basic understanding of the unit's material.

In each direct instruction section, use whatever method you will to deliver the learning objective's content to your students.

Direct Instruction Options:

1. Lecture (keep them brief!)
    a. PowerPoint
    b. Prezi
    c. Webcast
2. Flip Delivery
    a. Online activity
    b. Homework assignment
3. Class Discussion
    a. Whiteboards
    b. Group sharing
    c. Jigsaw
4. Individual Research Assignments

In this slot, deliver your content for:

<u>PHOTOSYNTHESIS</u>

Photosynthesis Recall Practice

Multiple Choice:

1. Which of these is NOT a use for the sugars created by plants in photosynthesis?
    a. Plants breakdown sugar for energy
    b. Plants use sugar to regulate temperature
    c. Plants use sugars to build plant structure
    d. Plants store sugar as starch for later use

2. The products of photosynthesis include (circle all that apply):
    a. Oxygen
    b. Carbon Dioxide
    c. Sugar
    d. Water
    e. Light energy

3. The reactants of photosynthesis include (circle all that apply):
    a. Oxygen
    b. Carbon Dioxide
    c. Sugar
    d. Water
    e. Light energy

4. The reactants and products of photosynthesis relate to the reactants and products of cellular respiration in that:
    a. they are the same.
    b. they are not related.
    c. they are reversed.
    d. they are conciliatorily synergistic.

5. On a large scale, photosynthesis results in a net change in both the oxygen and carbon dioxide levels in the atmosphere. During the Spring months the carbon dioxide levels in the atmosphere:
    a) Drop
    b) Rise
    c) Stay the same
    d) Fluctuate randomly

Short Answer/Essay Questions:

1. Energy cannot be created or destroyed, only transformed. During photosynthesis, light energy is absorbed from the sun and stored as potential energy in sugar. What form does this energy take in the products of cellular respiration? What is this energy used for?

2. Plants produce a great surplus of sugars beyond what they breakdown for energy needs. What are some possible purposes for this extra sugar?

Answer Key:

Multiple Choice

1. B — HS-LS1-6, HS-LS1-7
2. A, C — HS-LS1-5
3. B, D — HS-LS1-5
4. C — HS-LS1-5, HS-LS1-7
5. A — HS-LS1-5, HS-LS1-6, HS-LS2-5

Short Answer/Essay Questions

1. ATP (or heat). ATP is used to power the cellular functions required for life. Energy is lost as heat during these reactions as a matter of inefficiency.

   (HS-LS1-5, HS-LS1-6, HS-LS1-7)
2. The sugar can be stored in the form of starch for later use. Sugars can also be used as building materials for plant structure. For example, the use of cellulose in forming the rigid cell wall.

   (HS-LS1-5, HS-LS1-6)

<u>Yeast Respiration Lab</u>

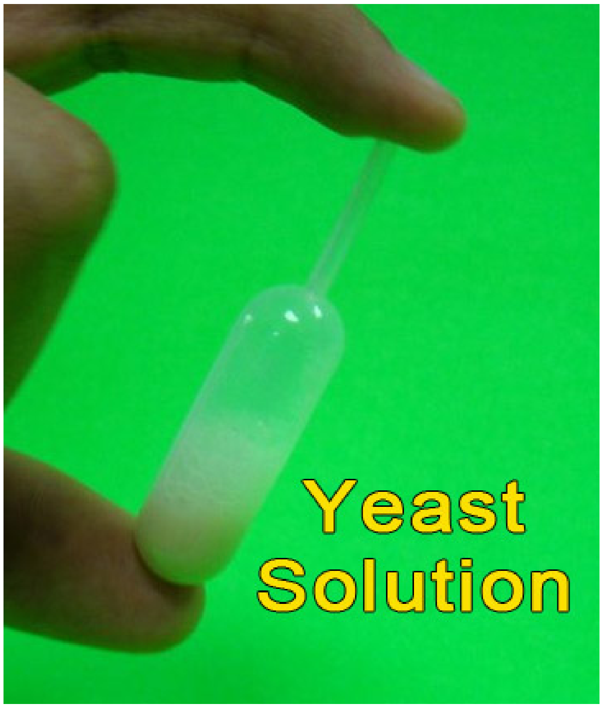
**This protocol is written for the teacher, not the student.*

Objective: Students design and conduct an experiment to determine how different variables affect the rate of respiration in yeast.

Materials: (there are many ways to set up this basic experiment. Have the students use whatever is available and figure out their experimental design.)

- Beakers, clear glasses of water, 18x150mm test tubes (or large enough for pipettes and washers to fit into), even clear plastic cups are an option (depending on variable tested).
- Digital thermometers
- Different types of sugar
- Different temperatures of water
- Yeast packets (in baking aisle of grocery store)
- Yeast solution (made from above ingredients: yeast, sugar and warm water)
- Metal washers to weigh down plastic pipettes
- Legos—students can build their own contraption to keep the pipette bulbs submerged. *(see photos at the end for student samples)*

Set-up: (there are a variety of ways to set this up, here are some ideas)



Procedure:

Discussion of cell respiration: What is it? How do cells do it? Where do cells get each of the reactants for cell respiration? Etc.

Mix up the yeast solution with a packet of yeast, sugar, and warm water from the tap (about 110-120 degrees F).

Demonstrate the set-up for students.   *Be sure to stir up the yeast solution before drawing it in to the pipettes each time.*

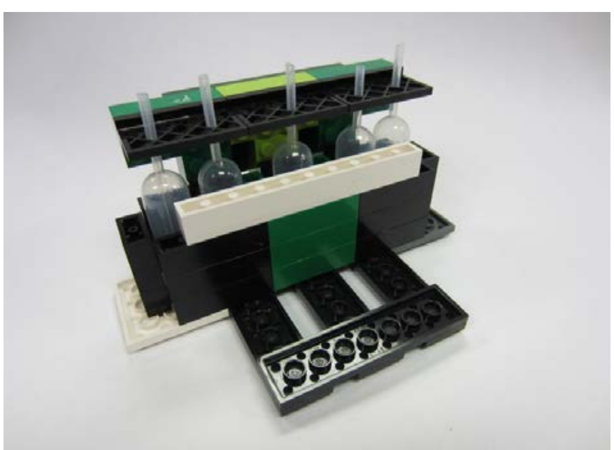
Students generate a list of possible variables they could test that might affect the rate of yeast respiration. (temperature of water bath, types of sugar in yeast solution, types of yeast, amount of sugar in yeast solution, etc.) *(*further thoughts: when mixing the yeast solutions, should the amount of water be kept constant? The amount of sugar? How do you measure amount of sugar in something like a variety of juices? Let students think through this.)*

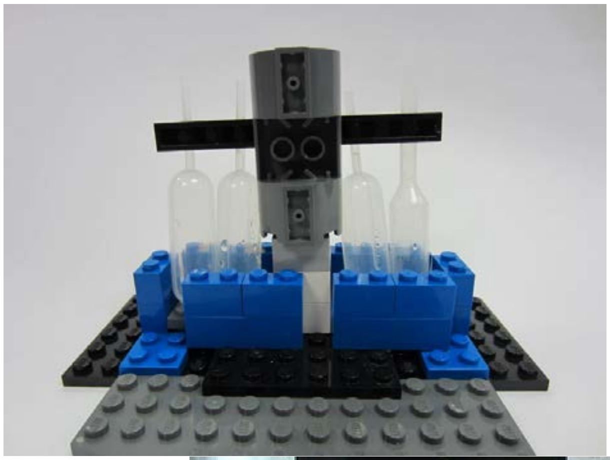
Students generate their question and hypothesis, design the experiment to test their hypothesis, design a standard way to measure respiration (what is the time frame to count bubbles?), set up their data tables.

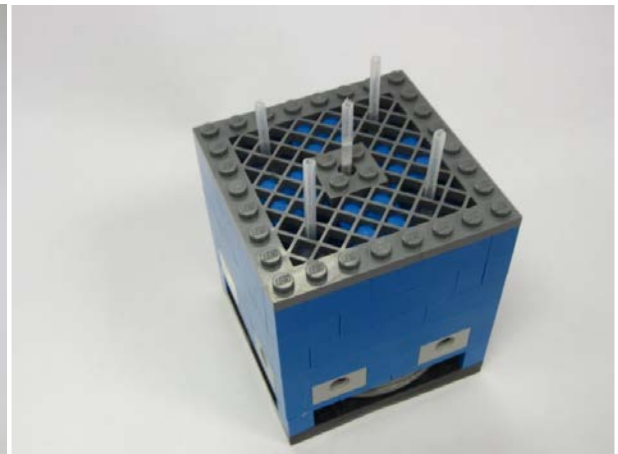
Students conduct experiment.

Students can further the experiment by discussing what they did, what difficulties they encountered, what the sources of error were, how to minimize error, and redesign/retest the experiment.

Student sample set-ups with Legos:






yeast bubbles

Names:
Block:
Date:

Yeast Cell Respiration Lab

Bubbling Yeast

Yeast are a single celled fungi that are a great model organism for studying respiration in the classroom. The species *Saccharomyces cerevisiae* is commonly used for leavening bread and fermenting beer but other species such as *Candida albicans* are known to cause infections in humans (vaginal yeast infections and diaper rash being the most common).

In this investigation you will fill the bulb of a disposable pipette (eyedropper) with yeast, then submerge the pipette in a test tube of water. You can then measure the rate of respiration by counting the number of bubbles of carbon dioxide gas that emerge from the tip of the pipette in a certain length of time. By varying the conditions, you can discover what variables affect the rate of respiration in yeast. By submerging the pipette in bromthymol blue (see Colorful Respiration activity), you can identify the gas being produced as carbon dioxide.

The idea of using inverted disposable pipettes to contain the yeast and measure their respiration rate came from a workshop led by Steve Ribisi of the University of Massachusetts.

Materials

- Fast-acting bread yeast (1 quarter ounce packet or 1 tablespoon per group)
- 1 tablespoon table sugar
- water
- Disposable plastic pipettes
- Metal washers from the hardware store (These will weigh the pipettes down so that they don’t float up to the top of the tube. Make sure that the hole in the washers is large enough to sit around the neck of the pipette and rest on top of the bulb.)
- Small test tubes for mixing yeast solution with sugar solution
- Large test tubes
- *Experimental Group*: **Other Nutrient Sources**: for the yeast such as milk, apple juice, soda, Kool-aid, salt water, potato starch solution, flour in water, chicken broth, etc. Most of these work better if diluted in water 1:1. **Other Environmental Conditions:** choose a way, *APPROVED BY YOUR TEACHER*, to alter the environmental conditions relative to the Control Group.
- Optional: bromthymol blue solution

Procedure

1. TEACHER: At least an hour before the activity, mix 1 packet of bread yeast with about 60mL of lukewarm water. Stir around 2 minutes until all the yeast is dissolved. Stir again just before use.
2. Coordinate all group members, so you can run the CONTROL GROUP and EXPERIMENTAL GROUPS **at the same time!**
3. CONTROL GROUP- Dissolve 12.5g of sugar in 120mL of lukewarm water. Stir around 1 minute until all the sugar is dissolved.
4. In a small test tube, mix equal quantities of the yeast solution and sugar solution. Stir gently to combine. Use separate droppers for each solution to avoid contaminating the original stock solutions.
5. Suck up some of this solution into a pipette. Invert the pipette and let the solution run down into the bulb. Carefully squeeze out the air and suck up some more yeast-sugar solution. Try to fill exactly half of the pipette bulb.
6. Thread 2 washers over the neck of the pipette so that they come to rest on top of the bulb.
7. Gently drop the pipette with washers into the large test tube.
8. Fill the large test tube with lukewarm water until the pipette is completely submerged.
9. Wait 5 minutes to allow the yeast time to equilibrate and begin respiration.
10. Count how many bubbles emerge from the top of the pipette each minute for 10 minutes.
11. Record this data on a table, and then complete the EXPERIMENTAL GROUP treatment.
12. EXPERIMENTAL GROUP- Alter the EXPERIMENTAL GROUP treatment so that you can discover something new about the way that the rate of cellular respiration in yeast can be affected by the conditions the yeast are in. Using the same yeast beaker from Step 1 in this procedure,
13. Record this data on a table, then graph data from both groups on the graph (pg 4 of 4).

‖-------------CONTROL GROUP-----------------		‖----------EXPERIMENTAL GROUP------------‖	
Time (in minutes)	**Number of Bubbles**	**Time** (in minutes)	**Number of Bubbles**
0 MIN ______		**0 MIN** ______	
1 MIN ______		**1 MIN** ______	
2 MIN ______		**2 MIN** ______	
3 MIN ______		**3 MIN** ______	
4 MIN ______		**4 MIN** ______	
5 MIN ______		**5 MIN** ______	
6 MIN ______		**6 MIN** ______	
7 MIN ______		**7 MIN** ______	
8 MIN ______		**8 MIN** ______	
9 MIN ______		**9 MIN** ______	
10 MIN ______		**10 MIN** ______	

Analysis Questions

1. Describe how your "Experimental Group" set-up was different than your "Control Group" set-up.

2. What was the experimental design you chose intended to measure? Was it successful? Explain.

3. After completing the activity and graph, analyze your graph and then describe your observations below, in as much detail as possible!

4. As a result of this lab, what did you discover about the way that cellular respiration in yeast? BE SPECIFIC!

5. Graph data from both tables on graph (next page). Be sure to include a title, key, and then label both axes. DON'T FORGET UNITS!

Project Author:
Reviewers Name:
Date:

Peer Review

As you review your classmate's project, please SCORE them using the SCIENTIFIC INVESTIGATION RUBRIC. This is the same rubric that I will use to give a final grade.

In the space below, please provide an equal number of constructive comments along with positive comments. You MUST provide at least ONE OF EACH.

When you have completed your peer review, please give this to the project author. Each student may make any changes they see fit to their project before turning it in for a final grade. **This peer review must be turned in by the project author along with the final project.*

Constructive Comments:

1.

2.

3.

Positive Comments:

1.

2.

3.

SCIENTIFIC INVESTIGATION RUBRIC
Standards: The levels at which students are expected to perform the task

Score		Advanced (5)	Proficient (3)	Needs Improvement (1)
______	Title and ID	• Name, date, and hour identified. Title is descriptive of experiment, clearly identifies variables and research organism(s).	• Name, date, and hour identified. Title relates directly to experiment.	• Two identification elements missing, title trivial or inappropriate to experiment.
______	Abstract	• Succinct but thorough description of the entire experiment including purpose and a brief statement of results.	• Experiment described in general including a brief statement of purpose or results.	• Statement related to the experiment but not descriptive of it and omits purpose and results.
______	Background	• Thorough review of prior research directly related to experiment.	• Material specifically related to the experiment and mostly accurate.	• Material unrelated to the topic of experiment or inaccurate or plagiarized.
______ ______	Introduction	• Purpose/statement of problem is accurate, clearly stated, and scientific in nature. • Hypothesis clearly stated in "If… then…" format. Specifically predicts relationship between dependent and independent variables.	• Purpose/statement of problem is mostly accurate and understandable. • Hypothesis predicts the influence of one variable on another.	• Purpose/statement of problem is incorrect &/or lacks clarity. • Hypothesis is poorly stated and doesn't directly mention the variables.
______ ______ ______ ______ ______ ______ ______	Methodology	• Complete, detailed list of appropriate materials (size, concentration, and quantity) presented in vertical list format. • Correctly identifies specific, measurable independent and dependent variables. At least one key constant identified. • Control setup clearly identified and appropriate to experiment. • Conducts or analyzes at least 15 trials. • Procedure - is in vertical list format; addresses hypothesis efficiently; uses metric measure; is accurate, complete, easy-to-follow, and reproducible by another person. Includes diagrams to clarify procedures. • Includes all appropriate safety concerns. • Statistical test procedures described and appropriate for the situation.	• List of materials mostly complete, includes critical materials, presented in list format. • Identifies variable being tested and variable being measured. Constant not directly identified. • Control setup present and appropriate but lacks clarity. • Multiple trials attempted or need is clearly demonstrated. • Procedure – is presented in step-by-step format; addresses hypothesis; is generally complete. Minor errors/omissions make it difficult to follow or not always repeatable. • Includes some critical safety concerns. • Data analysis approach(es) described and basically appropriate. Minor errors.	• Materials quite incomplete or inappropriate for experiment. • Variables and constants significantly incomplete &/or inaccurate. • Control setup is incomplete, inaccurate or inappropriate. • Single trial, poor understanding of need for multiple trials. • Procedure difficult to follow. Major omissions or errors. • Safety concerns trivial or inadequately addressed. • Data analysis approach inappropriate or inadequately described.
______ ______ ______	Results	• Data table(s), well organized and contain accurate, precise raw data & summary data reported in correct units with descriptive title. • Data illustrated in well-organized, easy-to-read graph(s) using the most appropriate format. Descriptive title, appropriate labeling, keys, etc. • Data summarized in a clear, logical manner. Patterns identified & described, no conclusions drawn.	• Data table(s) contain accurate data, most units labeled or implied. Minor errors. Title trivial. • Data displayed in neat, easy-to-read graph(s) &/or figures. Minor errors in use of units and labeling. Title trivial. • Reasonable, but somewhat unclear summary of data. Patterns in data not clearly identified.	• Data not in table format, inaccurate, confusing, and/or incomplete. Missing units, title absent. • Graph/figures presented in a confusing and/or sloppy fashion, fails to summarize data, title absent, units are missing, labeling is missing. • Summary is unclear and illogical. Patterns in data not identified.
______ ______ ______	Conclusion/Discussion	• Scientifically valid, logical conclusion well supported by the data collected. Clearly addresses problem and stated hypothesis. • Sources of error identified and explained. Appropriate recommendations made to eliminate errors. • Student transfers learning to other settings by generating specific questions for future study &/or suggesting ways the knowledge gained can be applied to the real world.	• Reasonable but somewhat unclear conclusion supported by data collected. Addresses problem and stated hypothesis. • Possible sources of error identified. • Student makes attempt to transfer learning or apply knowledge gained.	• Conclusion is incomplete or illogical. Does not address the problem or the hypothesis. • Weak/trivial attempt to identify sources of error. • Student makes incomplete or inappropriate attempt to extend or apply knowledge.
______ ______ ______ ______	Presentation	• Appropriate additional sources utilized and appropriately referenced. • Contains all components clearly labeled. Well-organized. No errors. • Excellent use of vocabulary, language mechanics and complete sentences. No errors. • Write-up is neat, presentable and enhanced (e.g. word processed, and contains diagrams, graphics, color, etc.	• Additional sources used and referenced. Minor errors. • Contains most components, most are labeled and organized. Minor errors. • Good use of vocabulary, language mechanics and complete sentences. Some errors detract from meaning. • Write-up is mostly neat and presentable.	• Sources incompletely or inaccurately referenced. Significant errors. • Components incomplete or missing. Labeling unclear or missing. Significant errors. • Improper use of vocabulary and/or language mechanics. Does not use complete sentences. • Unreadable, sloppy.

Direct Instruction

We all have different priorities and expectations of our students when it comes to the knowledge level content acquisition of our students. Vocabulary use, big ideas, context, and many other things are all priorities for different teachers. Direct instruction has a place in today's biology classroom, and often is used to reinforce basic understanding of the unit's material.

In each direct instruction section, use whatever method you will to deliver the learning objective's content to your students.

Direct Instruction Options:

1. Lecture (keep them brief!)
    a. PowerPoint
    b. Prezi
    c. Webcast
2. Flip Delivery
    a. Online activity
    b. Homework assignment
3. Class Discussion
    a. Whiteboards
    b. Group sharing
    c. Jigsaw
4. Individual Research Assignments

In this slot, deliver your content for:

<u>*RESPIRATION*</u>

After looking at the NGSS, I feel that these are the essential questions that need to be answered. NGSS is looking for a more conceptual knowledge of respiration based on models and energetics in the whole ecosystem and not so much steps of the process or the chemistry.

1. Compare the equation of photosynthesis with the equation of respiration.
2. Compare the ATP yield of glycolysis and ETS
3. What is needed for the oxidation of glucose in order to make ATP?
4. How is an electrochemical gradient made and what role does it play in the ETS?
5. Compare the ATP yield of Aerobic and Anaerobic respiration.
6. From one glucose molecule, approximately how many ATP do you yield?
7. Under what conditions would you find anaerobic respiration?
8. What kinds of organisms use respiration (aerobic and anaerobic)?

Obviously these are not in test form, but you could adapt these questions to your own testing style.
These are some suggested activities that might help with respiration using NGSS.

- Comparing respiration rates of a grasshopper and peas using a respirometer and what that means for ecosystems.- http://www.biologycorner.com/worksheets/cellular_respiration_AP_Lab5.html#.UflgUeCB0ts
- Graphing respiration rates of resting and active animals
- Explore anaerobic respiration using yeast. www.usc.edu/org/cosee.../Yeast_Cellular_Respiration_Labfin-2.doc

- I'm not sure exactly how to do this, but using excel, I'm sure you could show the relationship between oxygen and glucose input vs. ATP output to emphasize the math that NGSS is looking for.

- Use online models such as the one on concord consortium- http://concord.org/stem-resources/cellular-respiration

On the following page is a sample of questions that could be used with students.

Respiration Recall Practice

1. From one glucose molecule, how many ATP do you yield?
    A. 30
    B. 36
    C. 38
    D. 24
2. What is cellular respiration?
    A. Where plants gain energy from the sun
    B. Where energy from carbohydrates is transformed to ATP
3. Is glycolysis aerobic or anaerobic?
    A. Aerobic
    B. Anaerobic
    C. Both
    D. Neither
4. Which processes create ATP?
    A. Glycolysis
    B. Krebs cycle
    C. Electron Transport Chain
    D. Glycolysis, Electron Transport Chain, and Krebs Cycle
    E. Krebs cycle and Electron Transport Chain
5. Which process produces the most ATP?
    A, Glycolysis
    B. Krebs Cycle
    C. Electron Transport Chain

Short Answer

1. Compare the equations for photosynthesis and respiration.
2. Why do some organisms use both aerobic and anaerobic respiration?

Fermentation Lab: Making Homemade Yogurt

Adapted from the Small Notebook blog: http://smallnotebook.org/2010/03/29/how-to-make-homemade-yogurt/ and from: http://biology.clc.uc.edu/fankhauser/cheese/yogurt_making/yogurt2000.htm

Milk is a highly perishable food, and for hundreds of years people have used a variety of methods to preserve it. Fermenting milk to make yogurt is one way to preserve this food resource. Yogurt is made when you add something called a "starter" to milk and let it sit. A starter is a live bacteria culture (a spoonful of fresh yogurt is our starter in this lab). The bacteria that make yogurt make it by undergoing the anaerobic process of fermentation. The bacteria start with the lactose sugar in the milk, and since there is no oxygen available, they produce lactic acid and a small amount of energy during fermentation. The lactic acid lowers the pH, which makes it tart. This causes the milk protein to thicken and acts as a preservative since disease-causing bacteria don't grow well in acidic conditions. Yogurt is easily digestible, and helps maintain a healthy bacteria population in the intestines. It should also be eaten during antibiotic treatments, to help maintain healthy bacterial populations in the gut.

Generations of people have been making yogurt in their kitchens long before industries packaged it into convenient little containers for us (along with all the added sweeteners and thickeners). Even if you think you don't like yogurt, if you have only tried store-bought, you may very well like this homemade version.

Please read through all the directions FIRST: (my personal notes about how I make it are in blue)

Materials:

- Thermometer
- Sauce pan

- Milk *(I use ½ gal, and make 2 quarts of yogurt. I also use whole milk because it makes the thickest, best tasting yogurt!)*
- Small container of plain yogurt. **Be sure the container says "live cultures" on it** and be sure this is fresh—check the expiration date!
- 2 quart mason jars, sterile, and can be cooled upside down (run through dishwasher and taken out at the end of the dry cycle when they are hot, or you can boil them for 5 min).
- Quart jar lids
- Small cooler that will fit both quart jars when closed
- Spoon
- For the greek-style yogurt, you will also need cheesecloth or coffee filters and a strainer.
- Real vanilla extract

Directions:

1. Scald the milk: In the sauce pan, heat 2 quarts of milk on the stove to 180-185 degrees F, which is just below boiling. (A thermometer helps to ensure food safety.)

2. Let the milk cool to 120 degrees. *I let the pan cool on the counter, but you can also put the pan in a cold water bath to cool it down faster.*

3. Add about 2 tablespoons of plain yogurt to each quart jar.

4. Add about a cup of the cooled milk to the yogurt in each of the jars and swirl it around. Then pour the rest of the milk into the jars, and fill up to about ½ inch from the top. Put the lid back on and swirl it around gently.

5. The jar needs to stay warm for about 6 hours while the cultures do the work. Options:

- Put the jars inside the oven with the oven <u>light</u> on (not the oven).
- You can also heat your oven briefly to the lowest setting, <u>turn it off</u>, then put the jars in the warm area to incubate.
- Put the jars inside a small cooler with a lid, and fill the cooler with hot water (about 120 degrees). **This is what I do—I just use the hottest tap water straight from the faucet (which happens to be about 120 degrees) to fill the cooler and then put the jars in and close it for about 6 hours. The water should just cover the jar lids. I also put a folded tea towel on the top of the cooler to help keep more heat in.*

6. Depending on what kind of milk you use, your yogurt may be thick or thin.

- If you like thicker yogurt, strain your yogurt by pouring it into a sieve or small colander lined with cheese cloth, a coffee filter, or paper towels, and let the excess liquid drip into the sink. *(*I use cheese cloth in a sieve and let it drain for a few minutes—it doesn't take long. You can get cheese cloth at a grocery store). Note: your strained yogurt may look chunky—don't worry!*

- Spoon it back into the mason jar and just give it a good stir to smooth it out.
    - o *At this time I stir in about 1 tsp vanilla extract to each mason jar of yogurt, (which is now just over ½ full of yogurt since straining off excess liquid) because we like vanilla yogurt as a base.*

7. Cool the yogurt in the fridge and enjoy!

Once you've made your homemade yogurt, you can eat with any kind of toppings: honey, maple syrup, fresh fruit, granola, vanilla with some brown sugar, a couple teaspoons favorite fruit jam stirred in, etc.

Real world application:
The liquid you may have strained off of your yogurt, called the *whey*, is acidic. This produces an environmental problem for industrial yogurt companies—what to do with all that acidic liquid? Listen to this interesting story about how people are trying to figure out how to solve this issue: http://www.npr.org/blogs/thesalt/2012/11/21/165478127/why-greek-yogurt-makers-want-whey-to-go-away?ft=1&f=1007

Follow-up discussion/extension questions, aligned with NGSS:

1. In what type of environments do some organisms or cells undergo fermentation?
2. What is the benefit for an organism or cell to be able to do fermentation?

Biology
Sharp

Name:
Date:

Fermentation Quiz

1. Describe “fermentation” in a way that makes sense to you.

2. Explain the overall purpose of fermentation in a way that makes sense to you.

3. Describe specifically how organisms make energy (ATP) when oxygen is not available?

4. Describe the two types of fermentation and include the conditions under which each would occur. (i.e. what types of cells do each kind, and in what environment?)

5. How does fermentation relate to the energy requirements necessary for prolonged and/or intense exercise?

Connecting Photosynthesis and Cellular Respiration Summative Lab

Modified from Flinn Scientific's Respiration versus Photosynthesis

Introduction for Teachers:

Carbon dioxide dissolves in (and reacts with) water, forming carbonic acid then immediately dissociates into a hydrogen ion and a bicarbonate ion. The reaction occurring in solution is:

$$CO_2(g) + H_2O(l) \leftrightarrow H_2CO_3 \leftrightarrow H^+(aq) + HCO_3^-(aq)$$

The free hydrogen ions (H^+) lower the pH of the solution, making it more acidic. The degree to which the pH changes is proportional to the amount of CO_2 that dissolves in the water. In other words, as more CO_2 dissolves in water, the pH of the solution will continue to decrease. If CO_2 is removed from the solution, the pH will increase. A pH indicator such as **Bromothymol Blue** (BTB) can therefore indicate the relative amount of CO_2 dissolved in the water based on the color of the solution.

In this activity, photosynthesis occurring in the aquatic plant exposed to light removes CO_2 from the solution, thereby raising the pH. The general chemical equation representing photosynthesis is:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$$

The vial with only a plant in the dark will turn yellow to indicate that plants do respire and produce CO_2. In the absence of light, the CO_2 is not used in photosynthesis, so it is dissolved in the water. Therefore, there is net increase in CO_2 concentration and the pH drops as the CO_2 dissolves, producing carbonic acid.

The general chemical equation representing cellular respiration is:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$$

Here's an online practice version for extra scaffolding: http://eduweblabsnl.com/Database/Lab_FoldersG/Snail/Snail_P.html

Student Information:

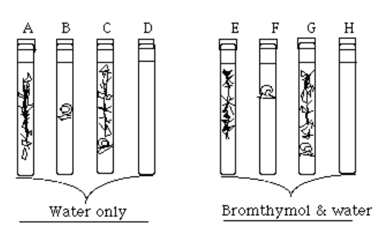
Carbon dioxide dissolves in (and reacts with) water, forming carbonic acid then immediately dissociates into a hydrogen ion and a bicarbonate ion. The reaction occurring in solution is:

$$CO_2(g) + H_2O(l) \leftrightarrow H_2CO_3 \leftrightarrow H^+(aq) + HCO_3^-(aq)$$

The free hydrogen ions (H^+) lower the pH of the solution, making it more acidic. The degree to which the pH changes is proportional to the amount of CO_2 that dissolves in the water. In other words, as more CO_2 dissolves in water, the pH of the solution will continue to decrease. If CO_2 is removed from the solution, the pH will increase. A pH indicator such as Bromothymol Blue (BTB) can therefore indicate the relative amount of CO_2 dissolved in the water based on the color of the solution.

Demonstrate the function of the BTB by adding a few drops of BTB to a beaker of water and blowing through a straw to cause it to change color to yellow. Safety: Wear goggles when blowing through straw!

Experimental setup may look something like this:



Summative Assessment: Students are asked to develop and implement a lab which demonstrates the biochemical connection between photosynthesis and cellular respiration using these materials and concepts. Students must use all relevant vocabulary and equations learned thus far to explain their experiment and data in writing (or orally). Time allowed based on availability.

Materials per team of 2-4 students:

2-3 Small plastic, lidded vials or X-large, stoppered test tubes

Bromothymol blue (BTB) about 10 drops

Dechlorinated water – about 10-20 ml

Small aquatic snails

Aquatic plant sprigs

Light bank

Drying rack lying on its back to put vials on at angle to get most light (optional)

Drawer / cupboard / aluminum foil for dark

Other upon request

Disposal

The snails and aquatic plant will not be harmed by the BTB solution and can be returned to their place of origin. All solutions can be flushed down the drain with excess water.

Connecting to NGSS

HS-LS1 From Molecules to Organisms: Structures and Processes

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- ·Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
- ·Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS- LS1-4),(HS-LS1-5),(HS-LS1-7)

Planning and Carrying Out Investigations

Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds.

- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

Build a Carbon Cycle Game

Tracking the carbon cycle – one piece at a time

Your task is to design a game board that will accurately demonstrate the carbon cycle – focusing on the interaction of photosynthesis and cellular respiration.
Biology students must be able to gather points as they work their way through your game board.

Procedure:
-Using ½ piece of poster board, or several pieces of computer paper taped together, you will design and build a game board that will allow the players to work their way through the carbon cycle by rolling dice and gathering points as they land on different spots.

-The game board must have a minimum of **10** stops (NOT including the start station.) Each stop must represent a specific process or product within the carbon cycle.

-**3** of the stops must be specific to the process of photosynthesis
-**3** of the stops must be specific to the process of cellular respiration
(See one example of the beginning of the game on the next page)

-You will design 6 playing pieces

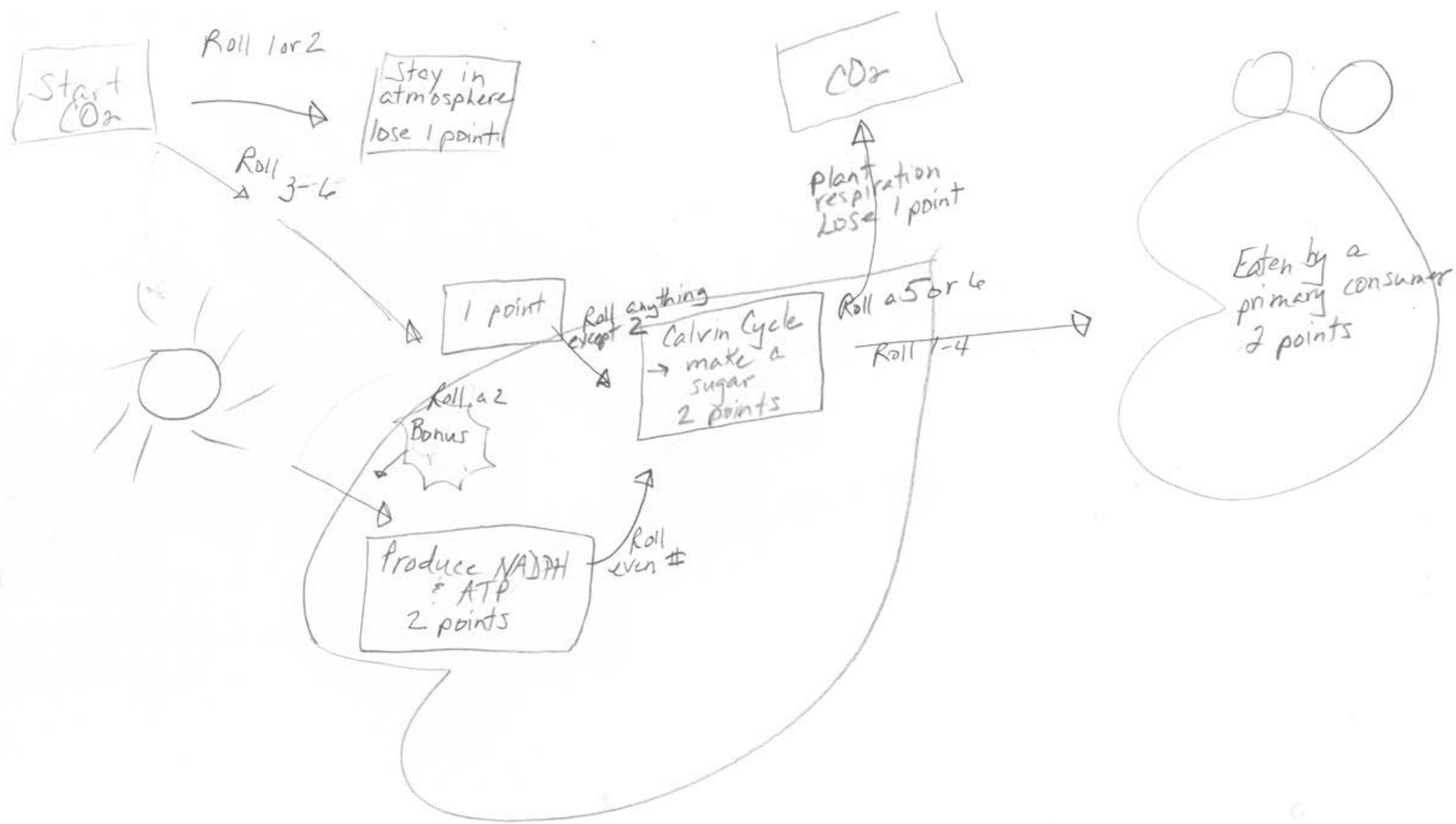
-You will develop the rules for your game and explain how to determine the winning team.

-Be creative! This is your chance to show off your creative self. Your game can take any form you see fit as long as it meets the criteria above.

-Be accurate! It is critical that you research your information so that your game board and game pieces are accurate (yes, you must list your resources – notes and activities done in class count as resources.)

-Be thorough! Make sure your game board and pieces demonstrate the complete carbon cycle

-Have fun!



Start CO_2
Roll 1 or 2
Stay in atmosphere lose 1 point
Roll 3-6
CO_2
plant respiration Lose 1 point
1 point
Roll anything except 2
Calvin Cycle → make a sugar 2 points
Roll a 5 or 6
Roll 1-4
Eaten by a primary consumer 2 points
Roll a 2
Bonus
Produce NADPH & ATP 2 points
Roll even #

ar

Carbon Cycle Project Rubric

Activity	Exemplary	Proficient	Partially Proficient	Developing
10 stops in game	All 10 stops included - each correctly describing a process or product within the carbon cycle	8 or 9 stops included each correctly describing a process or product within the carbon cycle	6 or 7 stops included each correctly describing a process or product within the carbon cycle	Less than 6 stops included each correctly describing a process or product within the carbon cycle
Photosynthesis stops	3 stops included for PS - each correctly placed or described	2 stops included for PS - each correctly placed or described	1 stop included for PS - correctly placed or described	No stops for PS
Cellular Respiration stops	3 stops included for CR - each correctly placed or described	2 stops included for CR - each correctly placed or described	1 stop for CR correctly placed or described	No stops for CR
Rules for game	Rules clear and precise. Game process easy to follow and winners identifiable	Most rules clear and precise Game process easy to follow and winners identifiable	Some rules clear and precise Game process difficult to follow and unable to define winners	Little to no rules Game process unclear and unable to define winners
Creativity	Game board and pieces unique and creative - clearly defines carbon cycle	Game board and pieces unique and creative - progression of carbon cycle unclear	Game board and pieces present but sloppy - progression of carbon cycle unclear	Incomplete game board or pieces - progression of carbon cycle unclear
Resources	Resources cited and reliable	Resources cited but unreliable	Not all resources cited - or all are unreliable	No resources cited

Structured Review

This review should provide a structured environment where both the teacher and the students can assess the class' understanding of the unit material prior to the final summative assessment.

Important Components:

1. Students should see all the material for which they will be held responsible on the summative assessment.
2. Students should get concrete feedback regarding their progress.
    a. Many students struggle with metacognition, so avoid a general "good" or "bad" result
    b. Concrete tasks are things for which students can identify their performance as success or failure.
        i. Doesn't NOT have to be a score, but this is a good way to achieve this goal.
3. The instructor should also have access to the same feedback to ensure there is no need to reteach any material before moving to the summative assessment and ultimately on to new material.

Possible Activities:

1. Clicker review games
2. Practice question sets
3. Online flipped assessments
4. Individual application tasks
    a. Small lab activity
    b. Problem solving

The goal of this review is to provide a clear picture of the student's learning of the unit's material in order to shape each student's study patterns prior to the final assessment of the content.

Energetics Study Guide

Vocabulary Overview

1. **Photosynthesis**
   I. Equation:
   _______ + _______ ---------> _______ + ______
      i. In a community, use photosynthesis.
      ii. There are **2** steps in photosynthesis:
         1. –
         2. –
      iii.
2. **Respiration**
   I. Equation:
   _______ + _______ ---------> _______ + ______ + ______
      i. In a community, use respiration.
      ii. There are **3** steps in respiration:
         1. –
         2. –
         3. –
3. **Fermentation**
   I. Purpose:
   II. Example #1
      i. Organism –
      ii. Product –
   III. Example #2
      i. Organism –
      ii. Product –

Other Terms

ATP -

Glucose –

Aerobic -

Anaerobic -

Drawings

Draw and label the entire carbon cycle.

Name: ________________________ Class: ___________________ Date: __________ **ID: A**

Energetics Unit Assessment

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. About how many ATP are produced from one glucose molecule being fully consumed by a cell using aerobic respiration?
a. 10
b. 48
c. 2
d. 36

____ 2. Which part(s) of photosynthesis require light?
a. Both
b. Neither
c. Light Independent Reactions Only
d. Light Dependent Reactions Only

____ 3. What process ocurrs instead of the Krebs cycle when there is no oxygen available?
a. glycolysis
b. electron transport system
c. light-independent reactions
d. fermentation

____ 4. Which process is used to make sugar in plants, algae, and some bacteria?
a. Alcohol fermentation
b. Cellular Respiration
c. Photosynthesis
d. Lactic acid fermentation

____ 5. Sugar (glucose) is broken apart during which step of respiration?
a. Krebs cycle
b. glycolysis
c. transition
d. electron transport chain

____ 6. Where does respiration occur in an energy pyramid within a community?
a. 1st consumers
b. decomposers
c. 2nd consumers
d. producers
e. all of the above
f. none of the above

____ 7. Which organelle is only found in plants and is responsible for photosynthesis?
a. cell wall
b. chloroplast
c. nucleus
d. flagellum

____ 8. Which type of cell does **NOT** perform cellular respiration of any kind?
a. bacteria cell
b. animal cell
c. plant cell
d. none of the above

____ 9. What is the ultimate source of energy for photosynthesis on Earth?
a. geothermal vents
b. carbon dioxide
c. ATP
d. the sun

____ 10. What organelle produces ATP for the cell?
a. rough ER
b. mitochondria
c. chloroplast
d. flagellum

____ 11. Which process is used to consume sugar in order to produce ATP using oxygen?
a. Photosynthesis
b. Lactic acid fermentation
c. Alcohol fermentation
d. Cellular Respiration

Name: ________________________ **ID: A**

____ 12. Which of the following DOES require oxygen?
- a. alcohol fermentation
- b. lactic acid fermentation
- c. electron transport system
- d. glycolysis

____ 13. What molecule is used to transfer energy stored from photosynthesis to the start of respiration?
- a. glucose
- b. water
- c. ATP
- d. carbon dioxide

____ 14. Which of the following processes is used in the production of yogurt and sour cream?
- a. alcohol fermentation
- b. respiration
- c. photosynthesis
- d. lactic acid fermentation

____ 15. The vast majority of the ATP produced in respiration is produced in which step of respiration?
- a. fermentation
- b. Krebs cycle
- c. electron transport chain
- d. glycolysis

____ 16. Where does photosynthesis occur in an energy pyramid within a community?
- a. 1st consumers
- b. 2nd consumers
- c. decomposers
- d. producers
- e. all of the above
- f. none of the above

____ 17. What molecule is used within cells to store energy to be used in any and all cellular processes (like the energy currency of the cell)?
- a. glucose
- b. oxygen
- c. ATP
- d. water

____ 18. Which of the following does NOT require oxygen?
- a. Krebs cycle
- b. glycolysis
- c. transition
- d. electron transport chain

____ 19. Which process is used in human muscle cells when no oxygen is available?
- a. Alcohol fermentation
- b. Cellular Respiration
- c. Lactic acid fermentation
- d. Photosynthesis

____ 20. Which process occurs in yeast cells **ONLY** when there is **NO OXYGEN**?
- a. fermentation
- b. glycolysis
- c. Krebs cycle
- d. electron transport system

Energetics Unit Assessment
Answer Section

MULTIPLE CHOICE

1.	ANS: D		PTS: 1
2.	ANS: D		PTS: 1
3.	ANS: D		PTS: 1
4.	ANS: C		PTS: 1
5.	ANS: B		PTS: 1
6.	ANS: E		PTS: 1
7.	ANS: B		PTS: 1
8.	ANS: D		PTS: 1
9.	ANS: D		PTS: 1
10.	ANS: B		PTS: 1
11.	ANS: D		PTS: 1
12.	ANS: C		PTS: 1
13.	ANS: A		PTS: 1
14.	ANS: D		PTS: 1
15.	ANS: C		PTS: 1
16.	ANS: D		PTS: 1
17.	ANS: C		PTS: 1
18.	ANS: B		PTS: 1
19.	ANS: C		PTS: 1
20.	ANS: A		PTS: 1

Name: ______________________________ Class: ____________________

Energetics Assessment

Long Response

Part 1 – Photosynthesis

- Give the equation for photosynthesis.

Part 2 – Respiration

- Give the equation for respiration.

Part 3 – Fermentation

Yeast are capable of both cellular respiration and fermentation, much like our muscle cells. When brewing beer, many brewers use sealed (air-tight) containers when they add yeast to their mixture to begin fermentation.

- Why would it matter to a brewer if she used a sealed container or not?
- Which would YOU use if you managed a brewery? Why?

Part 4 – Carbon Cycling

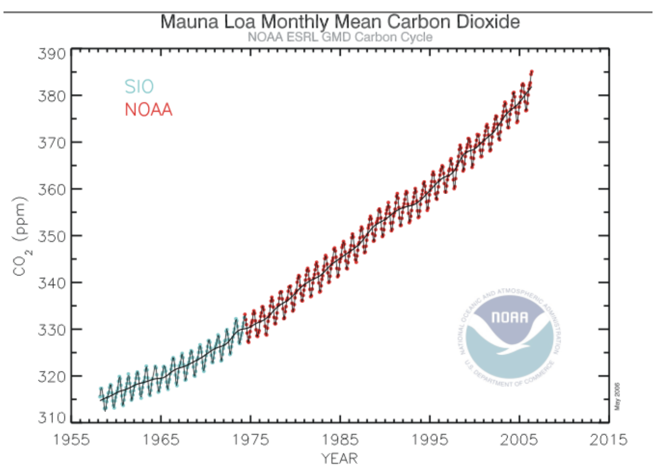
Photosynthesis and respiration work together and cycle many of their molecules back and forth.

- Draw a diagram of some kind that illustrates how photosynthesis and respiration fit together into a cycle.
    - Label where end products of one process become the starting materials of the other process.
    - Label the **ULTIMATE SOURCE** of energy for the whole cycle.
    - Label the **ULTIMATE PRODUCT** that comes from the whole process.

Extra Credit

The graph below shows the atmospheric CO_2 content for the last 50 years. The small spikes up and down every year correspond with the summer and winter seasons of each year.

- Explain the spikes in the graph below.



Atmospheric carbon dioxide monthly mean mixing ratios. Data prior to May 1974 are from the Scripps Institution of Oceanography (SIO, blue), data since May 1974 are from the National Oceanic and Atmospheric Administration (NOAA, red). A long-term trend curve is fitted to the monthly mean values. Contact: Dr. Pieter Tans, NOAA ESRL GMD Carbon Cycle, Boulder, Colorado, (303) 497-6678, pieter.tans@noaa.gov, and Dr. Ralph Keeling, SIO GRD, La Jolla, California, (858) 534-7582, rkeeling@ucsd.edu.

2013 KABT Task Force

Contributors

- Overview Graphic – Michael Ralph
- Unit Overview – Michael Ralph
- Photosynthesis Lab – Camden Hanzlick-Burton
- Photosynthesis Recall Practice – Billy Volle
- Respiration Lab – Kylee Sharp
- Respiration Feedback – Kylee Sharp
- Respiration Recall Practice – Caitlin Young
- Fermentation Lab – Kylee Sharp
- Synthesis Lab – Julie Schwarting
- Synthesis Activity – Shannon Ralph
- Study Guide – Michael Ralph
- Unit Assessment – Michael Ralph

Edited and Compiled by Michael Ralph.

Special thanks to Steve Young for his perspective and contributions.

KABT Kansas Association of Biology Teachers