Name: _____ Period: _____ Date: _____

Unity and Diversity of Respiration

"Do all living things give off CO_2?"

Background and Purpose

We know that we get our energy from food through some sort of chemical reaction in our body. Since figuring this out, we've returned to the idea that we might actually be "burning" our calories. Burning involves the reaction between a fuel source of Cs Hs and Os and the oxygen readily available in our atmosphere. The products are carbon dioxide and water and a bunch of energy.

Since we suspect this may be similar to what happens in our bodies, in this investigation we are trying to figure out if all organisms produce carbon dioxide, a testable product of the chemical reaction burning. We already know of one way to test CO_2, the indicator BTB (bromothymol blue). Here, we use a similar indicator called phenol red.

We place different kinds of organisms in test tubes with phenol red (PR) to see if they cause it to change, which would indicate the production of CO_2. In **Part A** you will run controls and known substances, helping you to properly interpret any changes you observe in **Part B**. You will use the results of both parts to try to answer the title question "Do all (actively) living things give off carbon dioxide?"

PRELAB QUESTIONS

1. What is an "indicator"? What indicator are we using in this investigation?
2. What is a "control" in an experiment? Why is it important to have controls?
3. To get the most meaningful results, when would be the best time to put stoppers in the test tubes for Part B? Why?
4. What is yeast? What would you expect to happen to yeast if you boil it?

PREPARE A DATA TABLE

1. Create a data table with 7 columns and 11 rows.
2. Use the top row for the following column labels: "Tube", "Material Added" (What did you put in besides PR and the screw?), "Prediction" (either 'change' or 'no change'), "Start Color", "End Color", "Time" (How long did it take for the color change?), and "Interpretation" (What does the result of this test tube tell you?)
3. Each row thereafter is for recording the results for one of the test tubes (10 test tubes for the remaining 10 rows).
4. Your teacher may provide a sample data table.

MATERIALS

Phenol red, carbonated water (CO_2 water), droppers, straws, paper towels, test tube rack, 6 small test tubes with stoppers, 6 small brass screws, 3 standard-sized test tubes, yeast-sugar solution, boiled yeast-sugar solution, dry radish seeds, sprouted radish seeds, 1 small live insect (medium-sized crickets work well). **NOTE: the instructor will provide the dead insect for test tube 7.**

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PROCEDURE

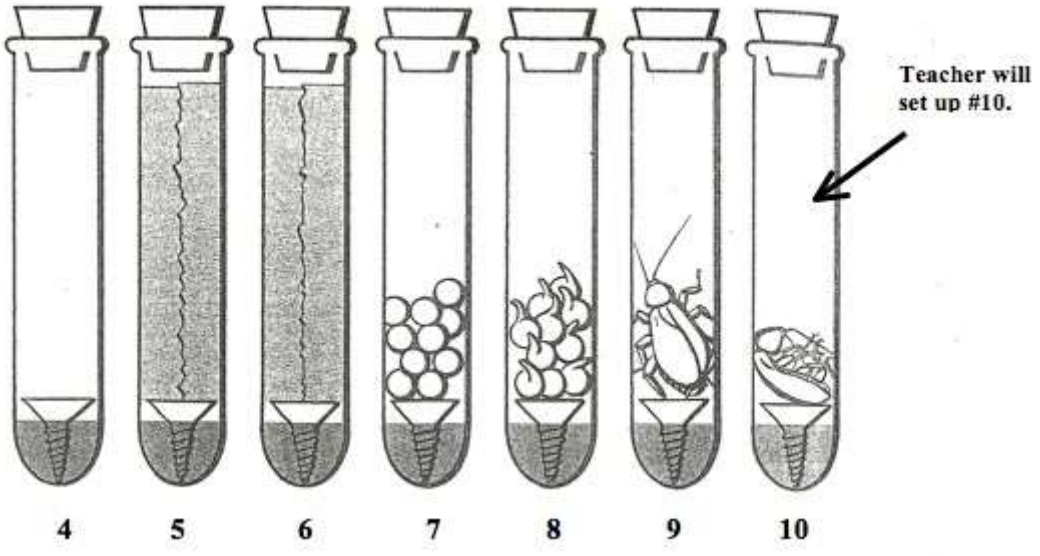
Part A. Characterizing the response of Phenol Red.

In the following series of tests, you will determine the response of phenol red to CO_2 so that you can interpret the results of ***Part B***.

Set up 3 standard-sized test tubes in a rack and place a paper towel under the rack on which you write numbers under each test tube: "1", "2", "3".

Perform some tests with known substances to determine what the color change of phenol red indicates:

1. Place phenol red in your 6 small test tubes. Add the screw. Add different items to each tube. Place stoppers in the tubes. Observe and record the color change in the phenol red over time.
2. In each tube place 10-12 drops of phenol red.
3. Then add the following:
    a. **Tube 1**: Nothing. (Phenol red only. Why do we do this?)
    b. **Tube 2**: 5-10 drops carbonated water.
    c. **Tube 3**: Your breath. Blow GENTLY through a straw for 30 seconds into the Phenol Red solution.



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Part B. Testing for the presence of CO_2 with Phenol Red

1. Set up 6 small test tubes in a rack as shown in the figure on the last page.
Add 5 drops phenol red to each. Tilt slightly and gently slide a screw to the bottom, point facing down.

NOTE: Do not set up test tube #10 (the seventh one in the diagram above). The teacher will do this for entire class. Remember to make observations of this test tube at the start and end of the observation period.

2. Now add the materials below to the tubes (as shown in the figure on the last page):

d. **Tube 4**: Nothing (except phenol red and screw).

e. **Tube 5**: A small, rolled piece of paper towel moistened with *boiled* yeast sugar solution (squeeze out excess so **no** dripping!).

f. **Tube 6**: A small, rolled piece of paper towel moistened with un*boiled* yeast-sugar solution (squeeze out excess).

g. **Tube 7**: Count how many of the radish seeds in your dish have sprouted. Place ALL of these sprouted seeds in tube 7.

h. **Tube 8**: Place an equal number of dry seeds in tube 8.

i. **Tube 9**: A live insect

j. **Tube 10**: A dead insect (teacher will do this)

3. Stopper the tubes only when all 6 are ready to go.

4. Observe and record changes in the phenol red and the approximate time required for each. Be patient – some may take 10-15 minutes to change.

5. Record "End Color" for each tube before emptying test tubes and cleaning up.

DISCUSSION QUESTIONS

1. Based on the results of Tube 2, what substance causes phenol red to turn yellow?

2. You are a living thing. Based on the results of Tubes 2 and 3, what substance do you give off?

3. List all the materials that changed the PR in Tubes 3-10. What do all these materials have in common?

4. List all the materials that DID NOT change the PR in Tubes 3-10. What do these materials have in common?

5. For those materials that changed the PR, hypothesize what specifically made the PR change.

6. Why were materials that caused no change in the indicator included in this investigation?