# LAB REPORT: Measuring soil microbial activity

Lab Partners:

Statement of the Problem:

* Investigate decomposition and measure carbon dioxide levels emitted from the soils by microbes and other organisms living in different habitats.
* What soil treatments would have the greatest effect? Think about energy containing compounds such as carbohydrates (sugars, starches, etc) and key elements such as nitrogen.
* What changes in the abiotic environment would affect soil respiration rates?
* What would be an effective control for your treatments?
* Be aware of what has happened to the soil recently before you dig it up. Was it fertilized, tilled, etc?
* Hypothesis:

Materials:

* Soil, at least 500 ml (200 mL per treatment / 100 mL per container)
  + A good topsoil with loamy characteristics (not very sandy or clayey) will be best. Clean of rocks, leaves, roots, etc.
  + Should be somewhat moist, but not saturated/muddy
* 2 or more CO2 probes (Vernier, or equivalent--probe-computer interface, software, etc) (Note: in a pinch you could use only one probe and do several runs in series.)
* 2 or more 250 ml bottles that can be sealed airtight, but with openings to fit probes
* 250 ml graduated cylinder
* 10 ml graduated cylinder or teaspoon
* 4 or more 9 oz (~250 ml) cups
* 2 or more spoons, for mixing solutions into soils
* Water (tap water or distilled)
* Sugar

Procedure:

1. Put 100 ml of soil in separate, clean labeled cup. Make one cup for each treatment and control.
2. Label the bottles with the types of soil they will receive.
3. Add 5 cc (or one teaspoon) of the appropriate treatments (Example: 1 teaspoon table sugar) to the soils and stir until the feedstock is evenly dispersed in the soil
4. Promptly transfer these soils in the corresponding Nalgene bottle.
5. Promptly insert the CO2 probes into the bottles and click the start button to begin collecting data.
6. Recommendations for data sampling:
   1. Run your analysis for 30 minutes to 3 hours. Two to three hours will likely be better in terms of getting a larger linear response time.
   2. Take data points every one to two minutes.

Data and Results:

|  |  |
| --- | --- |
| **Treatment** | **CO2 (ppm)** |
| **Control (dry soil)** |  |
| **5 cc of Sugar (dry soil)** |  |
| **Control (wet soil – 50 ml water)** |  |
| **5 cc of Sugar (wet soil – 50 ml water)** |  |

Data Analysis:

1. Can you identify different portions (curved verses linear) of your data?
2. Is there a linear portion to the data for your samples?
3. If yes, run a linear regression on this portion of your data. Use the slope from this regression as a respiration rate for your soil with that treatment.
4. If you had multiple treatments, what kinds of data comparisons can you make? Is there a time-period in your experimental run where all results were linear? If so, use the corresponding data from this period to compare relative respiration rates.
5. Consider transferring your data to Excel, or equivalent, to do additional analysis or graphing.

Conclusions:

1. Which solution saw the most microbial activity and released the most CO2? Why?

Research Solutions: Conduct research to answer the following questions.

1. Organisms above and below ground respire and produce CO2, and they are assembled into complex ecosystems. How do organisms above and below ground function similarly in terms of respiration and metabolism? Draw a diagram which demonstrates how carbon moves through your study site. Include the plants, roots, soil organisms with linking verbs describing the processes that are occurring.

*Organisms underground are undergoing cellular respiration just like those above-ground; however underground environments may be limited by oxygen and food availability more than for above-ground organisms. Below ground organisms have anaerobic alternatives.*

*Drawings should demonstrate photosynthesis, carbon storage in leaf,*

*stem, and roots, leaf and root death, decomposition of matter by microbes,*

*and plant respiration.*

1. How do you think climate (especially temperature and moisture levels) affects the rate of soil carbon cycling in each of the following states: Alaska, Iowa, New Mexico, Florida?

*Alaskan soil is dominated by permafrost, which is frozen year-round. Therefore, biological processes such as cellular respiration cannot take place except in a thin upper layer of soil that does thaw during warmer months.*

*Climate in a state like Minnesota is characterized by more variability between the cold winter months and the warm, rainy summer months. Bacteria and other microbes must be adapted to these fluctuations to survive. During the warm, moist summer months, there are high levels of respiration by soil microbes; during the winter months microbes become dormant in the freezing conditions and no respiration takes place.*

*New Mexico is characterized by warmer, more stable weather conditions but moisture is a limiting factor. Some bacteria are capable of surviving its dry conditions, but not in as high of a density. Given the warmer weather year-round, however, overall levels of microbial respiration may be comparable to that of Minnesota.*

*Florida is characterized by warmer weather year-round with fairly regular rainfall; therefore, levels of respiration by soil microbes would be highest in this location.*

1. CO2 production by soil microbial communities is often discussed in relationship to large-scale trends in atmospheric CO2 concentrations and global climate change. Think about your answer to the previous question. The Arctic, including the permafrost in Alaska, is currently experiencing a significant rise in overall temperatures. How might this affect the rate of soil respiration in this region? Would you expect this change to lead to a global change in the atmospheric CO2 levels?

*Microbes release CO2 in large amounts (due to their abundance); changes in climate as a result of fossil fuel combustion may lead to a positive feedback loop in which more CO2 is released – in this case by soil microbe activity as a result of overall warming of earth’s climate (e.g., thawing of permafrost exposes once frozen plant matter. If microbes colonize this biomass, they may release stored carbon and lead to increased atmospheric CO2 levels). So, soil microbial activity may be tied in to atmospheric CO2 concentrations and therefore global climate change. Since this is a relatively new research area, many questions remain about the role of microbial respiration in regulating climate.*