GATHER – REASON – COMMUNICATE (GRC)
LESSON: Soil pH

Target Grade: 9-12	**Lesson Title: Soil pH**
Course: Integrated Biology and Chemistry	**Developed by:** Diedre Young MAT Soybean Science Challenge

Performance Expectation(s) (Standard) from State Standards or NGSS:

Integrated Biology: ***Topic 6: Life and Earth's Systems***

BI-ESS2-5, BI6-ETS1-2, BI6-ETS1-3

Integrated Chemistry: ***Topic 1: Matter and Chemical Reactions***

CI-ESS2-5, CI1-ETS1-2

Chemistry II: ***Topic 3: Reactions***
CII-PS3-3AR, CII3-ETS1-3

Lesson Performance Expectation(s):

The students will understand:
1). The pH of soil is based on several chemical and biological factors.
2). The proper soil pH for each plant species is essential to know for proper growth for that plant.
3). Soil pH can be affected by manmade environmental factors such as pollution, acid rain, and water runoff.

***Materials*:**

Various soil samples*, measuring cups, plastic 8 oz cups, spoons, distilled water, pH measuring devices (this could be pH meters, pH paper, or liquid pH indicators). **Consider asking students to bring samples of soil from where they live the day before this lesson.*

Investigative Phenomenon:

Students will determine how the pH of the soil greatly impacts how plants grow.

Gather Phase

What is the Teacher Doing?	***What are the Students Doing?***
Do a KWL chart about what students know about soil pH and its importance to plants.	Each of these videos are approximately 3-5 minutes. You can pick and choose. https://www.youtube.com/watch?v=BouMFj9acX0 This video is about pH and nutrient availability in soil. https://www.youtube.com/watch?v=zQowljL8e5E This video is about basic pH in soil. https://www.youtube.com/watch?v=HmEyymGXOfI This video is about cation-anion exchange in soil.

In the Classroom: Students will be placed in groups of four and will be given four samples of soil to test for pH (these can include the soils students bring from home). Explain to the students that they will be given four 'hypothetical plants' that will need to be planted and they must determine which soil would be best for each plant. Some plants will require a pH different from what the soil provides, so students will also want to discuss (and research) what must be done to each soil to grow a particular plant. Strongly consider giving four different plants to each group so everyone will have to do their own work. ***Evidence Bullets (Look Fors)**:* • *Proper pH measurement and repeatability.* • *Proper comparison of pH to proper soil requirements.*	***In the Classroom:*** Each group of four students will be given a measuring cup, four spoons, four 8 oz plastic cups, four soil samples, 16 oz of distilled water, and pH measuring material. Students must label the four cups with the soil they are putting in them. • Each cup will get 2 oz of soil and 2 oz of distilled water. • Have students mix each cup and then let the soil settle out. • Have students then do a pH measurement on the water (twice) and have each group decide (from the attached plant-pH sheet) which soil is best for the plants they have.

Reason Phase	***Reason Phase:***
In the Classroom: 1). Students will hand in their 'lab sheet' for evaluation. *Teachers should "look for" evidence of the following when students are using the* pH LAB FORM: *1). Understanding the role of pH in plant growth.* *2). Understanding how different soils have different pH.* *3). Correctly identifying the correct pH for each plant.*	***In the Classroom:*** • Students will discuss in their group how to alter the soil's pH to meet each plant's requirement. • Each student fills out a form individually with their answers to be submitted for grading. These can be turned in at the end of the period or the next day.

<table>
<tr><th colspan="2"><u>Communicate Phase</u></th></tr>
<tr><td>In the Classroom:
Students will discuss in their group how to alter the soil's pH to meet each plant's requirement.
Each student fills out a form individually with their answers to be submitted for grading. These can be turned in at the end of the period or the next day.
Evidence Bullets (Look Fors):
1). Understand the role of pH in plant growth.
2). Understand that different plants have different pH requirements.</td><td>In the Classroom:
Students will discuss within their group what plants would work with what soil type.
Students will fill out attached worksheet and hand in for grading.</td></tr>
<tr><td colspan="2">Suggested Prompts Using Crosscutting Concepts to Structure Student Thinking:
What patterns in the pH of plants are you observing in the data?
What could be possible causes for the patterns?”
What role (function) does pH play in plant growth?
How has pH measurement changed over the years</td></tr>
<tr><td colspan="2">Assessment of Student Learning:
Students will be given a Group Reasoning Worksheet at the end of the period that covers what was learned in the mini lab. A example of this worksheet is at the end of the lesson.</td></tr>
</table>

Acidic Soils: 4.5-6.7 pH

Carrots
Potatoes
Tomatoes
Roses
Eggplant
Endive
Sweet potato
Radishes
Onions
spinach

Neutral Soils: 6.8-7.3 pH

Asparagus
Cabbage
Okra
Parsley
Peppers
Ferns
Pumpkins
Broccoli
Cauliflower
Lettuce

Alkaline Soils: 7.5+

Beans
Lavender
Celery
Beets
Garlic
Honeysuckle
Lily of the Valley
Artichoke
Arugula Lettuce
Peas

Appendix one:

Preparation: About 10-20 minutes depending on class size.
Time duration: One class period.

After the KWL chart and videos, students should now have an idea that soil pH is important to plants. Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units. Soil pH is defined as the negative logarithm of the hydrogen ion concentration. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases, the soil pH decreases thus becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or basic.

Descriptive terms commonly associated with certain ranges in soil pH are:

- Extremely acid: < than 4.5; lemon=2.5; vinegar=3.0; stomach acid=2.0; soda=2.0–4.0

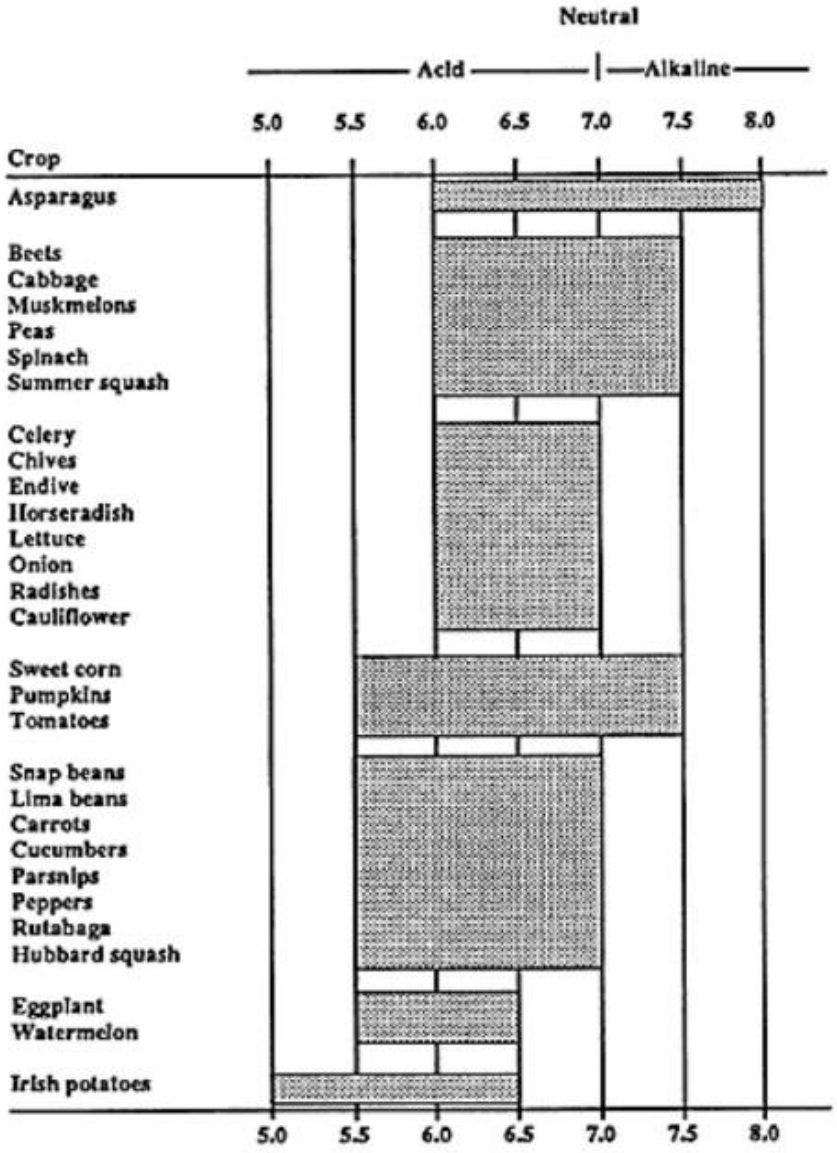
- Very strongly acid: 4.5–5.0; beer=4.5–5.0; tomatoes=4.5
- Strongly acid: 5.1–5.5; carrots=5.0; asparagus=5.5; boric acid=5.2; cabbage=5.3
- Moderately acid: 5.6–6.0; potatoes=5.6
- Slightly acid: 6.1–6.5; salmon=6.2; cow's milk=6.5
- Neutral: 6.6–7.3; saliva=6.6–7.3; blood=7.3; shrimp=7.0
- Slightly alkaline: 7.4–7.8; eggs=7.6–7.8
- Moderately alkaline: 7.9–8.4; sea water=8.2; sodium bicarbonate=8.4
- Strongly alkaline: 8.5–9.0; borax=9.0
- Very strongly alkaline: > than 9.1; milk of magnesia=10.5, ammonia=11.1; lime=12.0

The effect of soil pH is great on the solubility of minerals or nutrients. Fourteen of the seventeen essential plant nutrients are obtained from the soil. Before a nutrient can be used by plants it must be dissolved in the soil solution. Most minerals and nutrients are more soluble or available in acid soils than in neutral or slightly alkaline soils.

Phosphorus is never readily soluble in the soil but is most available in soil with a pH range centered around 6.5. Extremely and strongly acid soils (pH 4.0-5.0) can have high concentrations of soluble aluminum, iron and manganese which may be toxic to the growth of some plants. A pH range of approximately 6 to 7 promotes the readiest availability of plant nutrients.

The soil pH can also influence plant growth by its effect on activity of beneficial microorganisms. Bacteria that decompose organic matter are hindered in strong acid soils. This prevents organic matter from breaking down, resulting in an accumulation of organic matter and the tie up of nutrients, particularly nitrogen, that are held in organic matter.

Soils tend to become acidic because of: (1) rainwater leaching away basic ions (calcium, magnesium, potassium, and sodium); (2) carbon dioxide from decomposing organic matter and root respiration dissolving in soil water to form a weak organic acid; (3) formation of strong organic and inorganic acids, such as nitric and sulfuric acid, from decaying organic matter and oxidation of ammonium and sulfur fertilizers. Strongly acid soils are usually the result of the action of these strong organic and inorganic acids. Therefore, the correct soil pH levels are essential for growing plants, and plants vary as to their soil pH needs.


Neutral
Acid
Alkaline
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Crop
Asparagus
Beets
Cabbage
Muskmelons
Peas
Spinach
Summer squash
Celery
Chives
Endive
Horseradish
Lettuce
Onion
Radishes
Cauliflower
Sweet corn
Pumpkins
Tomatoes
Snap beans
Lima beans
Carrots
Cucumbers
Parsnips
Peppers
Rutabaga
Hubbard squash
Eggplant
Watermelon
Irish potatoes

Soil pH Lab Form

What is the pH of your four soils?

1).

2).

3).

4).

What are the four 'plants' you have been given and note which soil # and pH would best go with each plant. ***Be sure to note the pH range each plant can grow in.***

A).

B).

C).

D).

Do any of the plants need changes in the soil pH to grow? If yes, what would need to be done to the soil before planting your plant?

A).

B).

C).

D).