~~~~~~~~~~~~~Soil Texture Introduction~~~~~~~~~

It is time to be a *pedologist* (one who studies soil)! Soil performs vital functions: it sustains plant and animal life; it regulates and partitions water and solute flow; it filters, buffers, degrades, immobilizes and detoxifies; it stores and cycles nutrients. Soil is the basis of an ecosystem, because it supports organisms like bacteria, fungi, protozoa, nematodes, arthropods and annelids. It aids in decomposition and releases nutrients like nitrogen.

Fun fact: there are 23,000 soil series in the U.S. In most counties, the U.S. Soil Conservation Service has completed a soil survey, which is an inventory and description of all the soil types in the area. Soils are classified in a Soil Taxonomy System, much like plants and animals. There are twelve orders of soil: Alfisols, Andisols, Aridisols, Entisols, Gelisols, Histosols, Inceptisols, Mollisols, Oxisols, Spodosols, Ultisols, and Vertisols.

Soil characteristics determine a number of things, like the cost of excavating bedrock for a building, if the soil can properly filter waste from a septic system, if erosion or corrosion will eventually damage pipelines, or if flooding will be a hazard in the area.

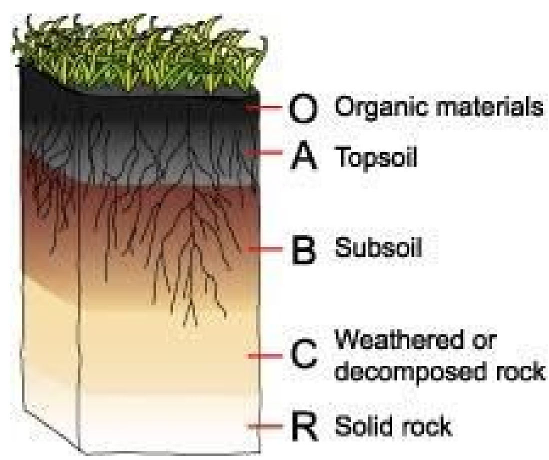
1. **Identify 3 purposes of soil.**

"The grain size of soil particles and the aggregate structures they form affect the ability of a soil to transport and retain water, air, and nutrients. *Grain size* is classified as clay if the particle diameter is less than 0.002 mm, as silt if it is between 0.002 mm and 0.05 mm, or as sand if it is between 0.05 mm and 2 mm. *Soil texture* refers to the relative proportions of sand, silt, and clay particle sizes, irrespective of chemical or mineralogical composition. Sandy soils are called coarse-textured, and clay-rich soils are called fine-textured. *Loam* is a textural class representing about one-fifth clay, with sand and silt sharing the remainder equally.

2. **Define *soil texture*.**
3. **Define *loam*.**

Sand particles often are composed of quartz and feldspars, silt particles have mica, and clay particles contain aluminosilicates. Organic matter and amorphous mineral matter also are important constituents of clay.

The bulk of soil consists of *silicate ions* (SiO_4^{4-}) combined with positively charged metal ions. The most common mineral found in the Earth's crust is *feldspar*, an aluminosilicate that contains sodium, potassium, or calcium in addition to aluminum ions. Weathering breaks up crystals of feldspars and other silicate minerals and releases chemical compounds, silica, and oxides of iron and aluminum. After some compounds are removed by leaching, the remaining silica and alumina combine to form crystalline clays.



The second major component of soils is organic matter produced by organisms. The total organic matter in soil is called *humus*. This solid, dark-colored component of soil plays a significant role in the control of soil acidity, in the cycling of nutrients, and in the detoxification of hazardous compounds." (eb.com, 1/3/11)

4. **Describe the most common mineral found in Earth's crust.**
5. **Describe humus, and predict in which layer of the soil you would find the most humus.**
6. **Predict which biome contains the most humus: desert, grassland or forest.**

~~~~~~~~~~SOIL TEXTURE OVERNIGHT TEST~~~~~~~~~~

Soil Texture Test Materials:
100 mL or more graduated cylinder   soil sample   tap water   Ruler

Soil Texture Test Procedure:
a. Fill the graduated cylinder with 25 ml of your soil sample.
b. Add 75 ml of water to the graduated cylinder.
c. Cover the graduated cylinder with your hand and invert several times until the soil is thoroughly mixed.
d. Place the cylinder on the table and let it settle. Wait overnight.
e. One day later, there should be 3 distinct layers. Sand is on the bottom (it's the biggest). Silt settles out in the middle, and clay will be on top. There may also be floating organic material (humus).

Analysis

7. **Create a data chart that includes an** estimate of the volume (in mL) of each layer of dirt, and the calculated percentage of each layer, found by doing this:

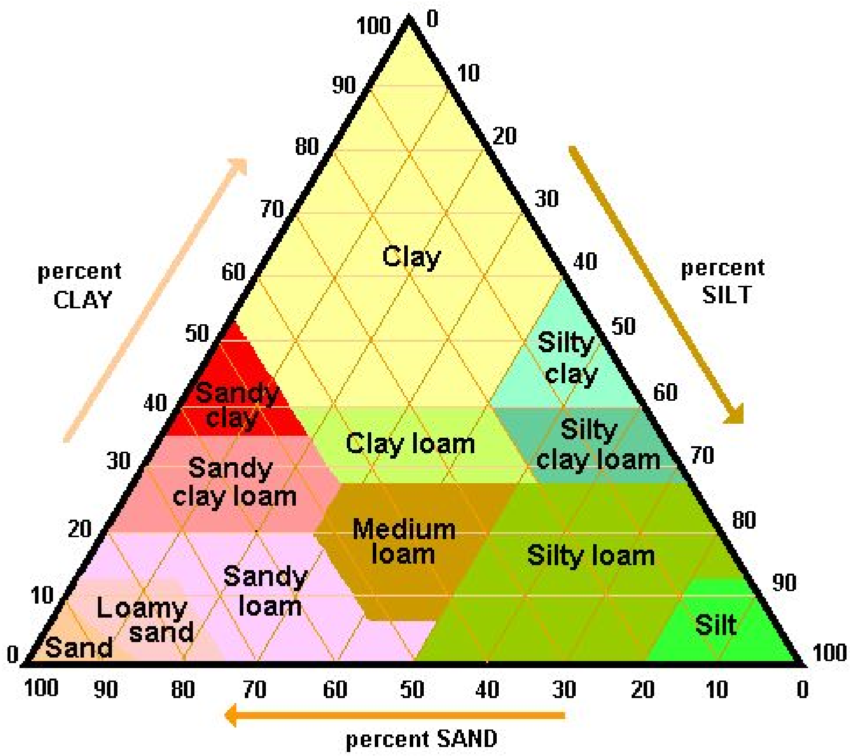
$$\frac{\text{Volume of layer}}{\text{Total volume of soil}} \times 100\% = \text{\% of sand, silt or clay}$$

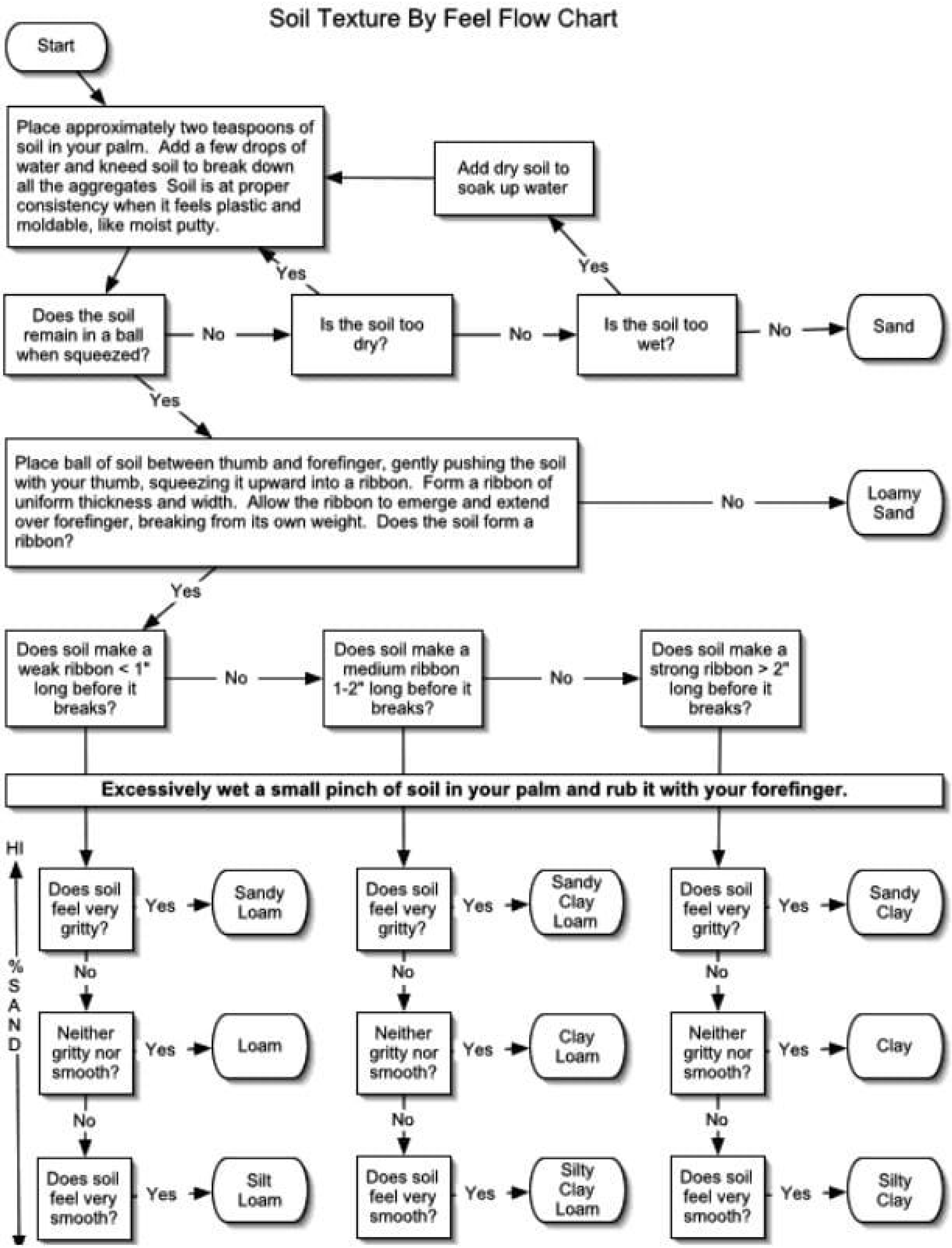
8. **Using the *Soil Texture Pyramid* and the directions below, identify the type of soil in your sample.**

Directions for using a Soil Texture Pyramid:

- Clay side first: extend a line horizontally from the percent clay (the lines should be parallel to the side labeled "percent sand.")
- Silt side second: extend a line diagonally downward from the percent silt (the line should be parallel with side labeled "percent clay.")
- Sand side last: extend a line diagonally upward and to the left from the percent sand (this line should be parallel with side labeled "percent silt.")

Ex: 30% clay, 30% silt, 40% sand = clay loam





Analysis:

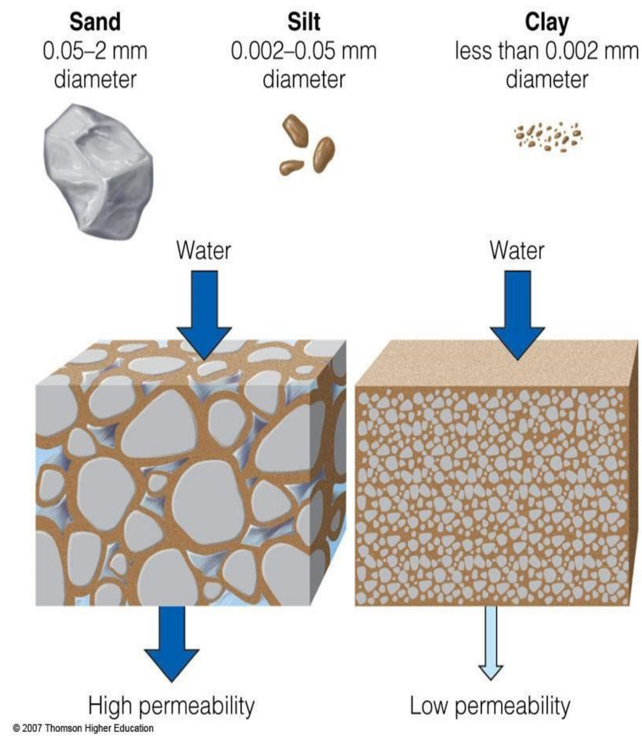
9. **Identify the soil texture you have in your sample, and explain how you know.**
10. **Identify what soil texture would be most likely to erode, and explain why.**
11. **Identify the soil you think would be best for agricultural use, and explain why.**

~~~~~~~~~~SOIL PERMEABILITY INTRODUCTION~~~~~~~~~~~~

A soil's permeability is a measure of the ability of air and water to move through it. Permeability is influenced by the size, shape, and continuity of the pore spaces, which in turn are dependent on the density, structure and texture. In most cases, soils with a slow, very slow, rapid or very rapid permeability classification are considered poor for irrigation.

Table 1. Soil Permeability Classes

Classification	Infiltration Rate (inches/hour)	Texture
Very Slow	Less than 0.06	Clays
Slow	0.06 to 0.2	
Moderately Slow	0.2 to 0.6	Silts
Moderate	0.6 to 2.0	
Moderately Rapid	2.0 to 6.0	
Rapid	6.0 to 20.0	Sands
Very Rapid	Greater than 20.0	



12. **Predict what infiltration rates (inches per hour) would be considered poor for irrigation.**

Infiltration is the downward flow of water from the surface through the soil. The *infiltration rate* is a measure of soil's ability to absorb an amount of rain or irrigation water over a given time period. It is commonly expressed in inches per hour. It is dependent on the permeability of the surface soil, moisture content of the soil and surface conditions such as roughness (tillage and plant residue), slope, and plant cover.

Coarse textured soils such as sands and gravel usually have high infiltration rates. The infiltration rates of medium and fine textured soils such as loams, silts, and clays are lower than those of coarse textured soils. Water and plant nutrient losses may be greater on coarse textured soils, or sands, so the timing and quantity of chemical and water applications is particularly critical on these soils.

13. **Water and plant losses are greatest in what type of soil textures?**
14. **Predict what area of the country would have better, native soil for growing crops: Florida or Iowa. Explain your reasoning.**

~~~~~~~~~~~~~~~SOIL PERMEABILITY TEST~~~~~~~~~~~~~~~~

Soil Permeability Test Materials

2 Plastic cups (one with holes, one without holes)   50 ml beaker   50 mL graduated cylinder

Soil Permeability Test Procedures:

a. Fill the *plastic cup with holes* half way with your soil sample. Be sure to mark the halfway point with a marker, and pack the soil down lightly so that there are not large air spaces.
b. Hold the cup with the soil above the *empty cup without holes* so that one can catch the water as it drips through the soil. Pour 50 ml of water on top of the soil.
c. Time for 2 minutes and then set the cup with the soil onto a tray. (Be careful, it will still drip water).
d. Pour the water from the cup into the graduated cylinder to see how much of the 50 ml percolated through.

Soil Permeability Test Analysis:

15. **Identify the amount of water that percolated through as a flow rate (mL/min).**
16. **Explain why a farmer needs to know the soil permeability on his land.**

~~~~~~~~~Soil Nutrient Introduction~~~~~~~

Nitrogen is synonymous with plant nutrition. It is directly responsible for producing leaf growth and green leaves. A deficiency causes yellow leaves and stunted growth. Too much nitrogen causes over-abundant foliage with delayed flowering. The plant becomes subject to disease and its fruit is of poor quality. Fun fact: Broccoli loves nutrient-rich soil.

Phosphorus is the major constituent of plant genetics and seed development. A deficiency causes stunted growth and seed sterility. Phosphorus aids plant maturity, increases seed yield, increases fruit development, increases vitamin content and aids the plant's resistance to disease and winterkill.

Potash or potassium (K) strengthens a plant. It helps form carbohydrates and promotes protein synthesis. It will improve the color and flavor of fruit. It further aids early growth, stem strength and cold hardiness. Plants deficient in potash are usually stunted and have poorly developed root systems. Leaves are spotted, curled and appear dried out at the edges. Yields for potash deficiency are low.

pH (potential of hydrogen) controls how well plants utilize the nutrients available in soil. All plants have a pH preference. "Sweet" soils are alkaline (above pH 7) and "sour" soils are acidic (below pH 7). You can make a soil more alkaline by adding lime, and more acidic by adding peat or sulphate.

The first number in a fertilizer label is the % nitrogen, the second is % phosphorus and the third is % potassium. For example, 24-8-24 is 24% nitrogen, 8% phosphorus and 24% potassium.

17. **Name one purpose that each element found in soil has for a plant.**
18. **Name one thing a deficiency in each element will cause in a plant.**

~~~~~~~~~~~~Soil Nutrient Test~~~~~~~~~

Soil pH Test Procedures:

a. Obtain a GREEN pH test chamber by RapiTest.
b. Fill the green container to the “soil” line. Only put soil on the left side—leave the right side empty.
c. Open the green tablet and pour it into the container.
d. Add water to the “water” line.
e. Replace the cap and gently shake the chamber.
f. Allow color to develop in the chamber (about 10 minutes).
g. Compare the color of the solution in the chamber with the color chart on the right.
h. Record your information in a data chart.

Soil N, P, K Test Procedures:

i. Obtain purple N, blue P and orange K test chambers by RapiTest.
j. Fill a beaker with 1 part soil to 5 parts water and stir. Allow the mixture to settle (about 30 minutes). No time? Take water off the top of your graduated cylinder from the first lab.
k. Fill the N, P and K chambers to the fill line with dirty water from the beaker. Only siphon water—not soil particles. Only put water on the left side of the test chamber—leave the right side empty.
l. Open the corresponding color tablets and pour into the corresponding chambers.
m. Replace the caps and gently shake each chamber.
n. Allow the color to develop in the chamber (about 10 minutes).
o. Compare the color of the solution in the chamber with the color chart on the right.
p. Record your information in a data chart.

Soil Nutrient Test Analysis:

19. **If you grew a plant in your soil, what problems would the plant likely show and why?**
20. **What do you recommend you do to your soil before planting a garden in it?**

Note: you can also use a LaMotte Kit. Order online for $65 at Frey Scientific for 15 tests each.
Note: RapiTest can be purchased at any garden shop, Ace hardware or Walmart. Online it’s $15 for 40 tests each.

Inquiry Labs

Based on your knowledge of soil textures, permeability rates, erosion and nutrients, design a controlled experiment in which you test which ratio of sand:silt:clay will produce the most green beans (quantity and speed of production).

Design a controlled experiment in which you test which amount of nitrogen & phosphorus in the soil will produce the most green beans (quantity and speed of production). Keep in mind -- you may need to add N and P over time as the plants assimilate it.

Design a controlled experiment testing whether or not clay, silt or sand will remove a particular pollutant from the water.

Fertilizer (nitrates, phosphates):

a. Use a LaMotte nitrogen test kit.
b. Obtain a RapiTest by Luster Leaf soil test kit for nitrogen and phosphorus.
c. Use the Vernier nitrogen sensors and the LabQuest.
d. NOTE: depending on the form of your nitrogen/fertilizer, your test kits may have a negative reading.

E. coli

a. Obtain a piece of 3M Petrifilm E. coli/Coliform Count Plate.
b. Using a plastic pipette, place one drop of sample water on the film.
c. Press it closed. Label with the Sharpie marker.
d. Place it in the incubator & wait 48 hours.
e. Count the number of bacterial colonies present.

Oil

a. Obtain a brown paper towel.
b. Using a plastic pipette, place one drop of sample water on the towel.
c. Wait until it air drys.
d. A positive oil test will leave an oil ring/residue on the paper. A negative oil test will leave zero residue.
e. To cross reference, use a Vernier Turbidity sensor and the LabQuest.

Metals

a. Use a LaMotte pH test kit.
b. Use a Vernier pH sensor and ORP sensor with a LabQuest.
c. Make note of the initial and final CLARITY of the water.

Here's an example of the lab report format we use across campus in the Science department. Our goal is to have all AP students produce their own inquiry-based labs throughout their course, and Prep/underclassman work towards a full lab report.

Details: 3rd person language; 12 point Ariel or Times New Roman font; double space; use headings

Title: Center it on the page; Be clever and relate the title to purpose of your lab; *Ex:* Terrible Title is "Bottle Lab" but a Rock Star title is "Investigation of the Effects of Different Salinities on Seed Growth"

Abstract: This is a one paragraph condensation of the entire lab. It should state:

a. purpose of the experiment
b. brief description of the methods in past tense
c. summary of results
d. conclusions (answer the problem question)

Introduction: This section contains relevant background information about the lab's purpose. Relate research to the purpose of the lab. Use credible sources. This must read like a research paper in third person language. Use internal documentation of all resources, and cite them in the works cited at the end of this document.

Experimental Design

State the problem question, the hypothesis, the independent & dependent variables.

Materials & Methods: Write this section in paragraph form and in the past tense. *Briefly* summarize the entire process that was followed, and include a list of materials. Try not to use "we, I, they, he;" instead of saying, "We checked the pH" say "A pH test was performed." Distinguish between the control & the experimental groups.

Results:

A. Publish a data table to show quantitative AND qualitative data to support the problem question.
B. Publish quantitative data in a graph.

Discussion: Was your hypothesis supported or refuted, or should it be modified? Justify your conclusion *with data* (that means use numbers from your data table) in an explanatory paragraph.

Error Analysis/Future Study:

a. Describe any possible experimental design flaws and be sure to explain how each source may have affected your results. Point out any errors or inconsistencies.
b. State whether or not your data is accurate and/or precise – should it be trusted? If not, suggest specific ways to improve upon the experimental design in order to get more accurate data.

Works Cited/References

Cite all reference materials in alphabetical order using APA format. Go here for citations: www.easybib.com

Use internal documentation in the Introduction, so go here for help:
https://owl.english.purdue.edu/owl/section/2/10/