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| **Title** | **Sustainability: Learning for a Lifetime - Soil** |
| **Introduction** | According to the Environmental Protection Agency (EPA), sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment.Soils are a crucial element of our survival and well-being. Soils enable not just the production of food, fiber, and fuel, but also lead to clean water, the sequestration and long term storage of carbon and nitrogen thus offsetting the release of greenhouse gases, the provision of wildlife habitat; and allow the temporary storage of water, decreasing the magnitude of flooding. |
| **Curriculum Alignment** | EEn.2.1.3 Explain how natural actions such as weathering, erosion (wind, water and gravity), and soil formation affect Earth’s surface.  EEn.2.2.1 Explain the consequences of human activities on the lithosphere (such as mining, deforestation, agriculture, overgrazing, urbanization, and land use) past and present.  EEn.2.7.1 Explain how abiotic and biotic factors interact to create the various biomes in North Carolina. |
| **Learning Outcomes** | Students will be able to explain the importance of soil on their way of life.  Students will be able to identify the properties of their local soil.  Students will determine what makes “good” planting soil. |
| **Time Required and Location** | * 2- 50 minute class periods plus 10 minutes each day for two weeks. * 1.5 90 minute class periods plus 10 minutes each day for two weeks. |
| **Materials Needed** | **For exploration:** One for each pair/group: t-shirt, bottle of water, small container with corn oil labeled biofuel, small bottle of maple syrup (Ask your local Cracker Barrel), and a fiber bar.  **For model system**: 1 bucket of sand, 1 bucket of clumps of dirt, 1 bucket of organic material(leaves/grass clippings), 1 bucket of small rocks, 1 bucket of compost, 1 bucket of potting soil, 1 bucket of local soil and enough small planting containers for each pair/group to have 4. Don’t forget a small scoop for each bucket (and extra cup works just fine), soil test kit for each group, quick spouting seeds such as alfalfa, broccoli, or sunflowers (enough for each pair/group) and Perfect Soil Write Up (attached as Appendix 1)  **Technology Resources:** computer with internet access/ digital pictures or cell phones for taking observation pictures. |
| **Safety** | Students should follow typical lab safety procedures. |
| **Participant Prior Knowledge** | Students should be familiar with sustainability. They should have background knowledge in pH and be able to use a test kit to test pH. |
| **Facilitator Preparations** | The teacher will need to collect the materials needed, prepare the buckets and locate a good site for growing the seeds. |
| **Activities** | **Exploration:**   1. Ask students to clear everything off the desk area. Students can work in pairs or small groups. Each group will receive a t-shirt, a bottle of water, small amount of corn oil in a small container labeled biofuel, a package of seeds, small maple syrup bottle (Cracker Barrel has the perfect example) and a fiber bar. Ask each group to figure out what all these items have in common. Give the pair/groups about 10-15 minutes to discuss and come up with their answer. 2. Pairs/Groups will report out their findings. Remind the students that there is no right or wrong answer at this time as long as they can justify their group’s position. Depending on the number of pair/groups this activity should take about 15-20 minutes. 3. Explain to the students that all the items are connected by the soil. The cotton from the T-shirt comes from a plant that cannot grow if there is not adequate soil. The clean water in could have come from an aquifer and the water was cleaned by traveling through the different layers of soil. Biofuels are one answer to our reliance on fossil fuels but we cannot make them if we don’t have good soil to grow the corn or other crops that are used in biofuel manufacturing. Seeds are used to plant and grow new crops but without good soil the seeds would not be here in the first place and there would be nowhere to plant them making them essential worthless. Maple syrup doesn’t just come from Cracker Barrel it comes from a tree that without fertile soil it would not be able to be made. The fiber in the fiber bar comes from grains that were grown…..where…..(the students should be able to say soil) yes the soil. The ground you walk on is much more important than you probably thought and in the next few class periods we are going to find out just how important soil really is to your daily life! If time allows have students come up with more items in their daily life that are dependent on the soil. 4. The homework for tonight will be for each student to find out what makes some soils good for growing plants. Make sure to have a list of at least 6 different factors that contribute to fertile soil.   **Day 2:**   1. **Guided Practice:** Students will work in pairs/groups to make a Venn diagram of the information they found in their homework assignment. Give the students 10 minutes to complete the Venn diagram and then have each group report their information to the class. Make sure to clear up any false information or question information you are not sure about. Have a student go to the internet right away to clear up any questions. 2. After all groups have presented and you feel comfortable that the students are on the right track to understanding what makes soils fertile (nutrients such as phosphorus, nitrogen, potassium, trace elements of calcium and magnesium, organic material, pH (depending on the plant), texture, water, air). Explain to each pair/group that they are going to be challenged to create the perfect soil for their assigned seeds. Each group will get to make 3 different soils and will use one control soil (local area soil). 3. **Model System:** Groups/pairs will use the buckets of materials to design their “perfect” soil. Each group will have computer access to research their plant type and determine what soil that particular seed grows best in. Each group needs to keep accurate data as to the amount and type of materials they used in their perfect soil. They must also make note of any special procedure they did to their perfect soil. Students will have 30 minutes to complete the making of their soil and the planting of the seeds. (This make take longer depending on the class) 4. For the next 2 weeks students will be allowed 10 minutes to take careful observations of their seed growth. Digital cameras and cell phones could be used for documenting results. |
| **Assessment** | **Wrap-Up:**  At the end of the two weeks pairs/groups will present their findings/results to the class. The class will compile a list of the characteristics of the most successful soils. The class will then use all these characteristics to come up with their own definition of the Perfect Soil.  \*\*\*\* We will then use this information to help start planning our school garden \*\*\*\*  **Assessment:** Perfect Soil Write Ups and class discussions |
| **Critical Vocabulary** | * Sustainability: Sustainability: the capacity to endure. For humans, sustainability is the long-term maintenance of well-being, which has environmental, economic, and social dimensions, and encompasses the concept of stewardship, the responsible management of resource use. * Soil: Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment. * Fertile: Producing or capable of producing abundant vegetation or crops. * Nutrients: Factors that make soils fertile for the specific crop planted. * Organic: Of, relating to, or derived from living organisms (biotic) * Inorganic: composed of matter that is not animal or vegetable (abiotic) |
| **Community Engagement** | This lesson can be timed to be the lead in to a community garden. Students will become aware of soil needs and upkeep. The plants that were started can be transplanted into the community garden. |
| **Modifications** | Soils could be made ahead of time for groups with special needs,research information could be provided for groups without internet access, Venn Diagram template can be given to groups with special needs. |
| **Alternative Assessments** | Oral presentation instead of written write up, pictures of plants instead of written write up. |
| **References** | * The National Aeronautics and Space Administration (NASA) Soil Education website provides resources including interview with soil scientists. <http://soil.gsfc.nasa.gov/index.php> * Soil Depletion think quest produced by students for students. <http://library.thinkquest.org/07aug/00526/soildepletion.html> * Natural news about soil depletion. <http://www.naturalnews.com/024581.html> * The Southeast Farm Press website provides an article about the importance of testing soils in North Carolina. <http://southeastfarmpress.com/management/north-carolina-soils-lab-speed-processing> * The United States Department of Agriculture site provides information and resources about soil and the importance of soil. <http://soils.usda.gov/education/facts/> |
| **Supplemental Information** | **Supplemental Information: Information obtained from** [**http://soil.gsfc.nasa.gov/soilfert/npk.htm**](http://soil.gsfc.nasa.gov/soilfert/npk.htm)  Soil and plants play a very important part in the survival of humans and animals. Soil protects plant roots from exposure to the Sun's heat at Earth's surface, soil filters pollution that comes from rain and water runoff from farms. Soil is used to build with and on, and soil is what plants need to grow and be supported while growing. Plants are not only used for food but are also used to make fabrics and dyes, medicines and beauty products, fragrances, rubber and building materials, just to name a few.  The most important function of plants involves photosynthesis. Photosynthesis is a process in which all plants and algae as well as certain types of photosynthetic bacteria produce their own food, and in doing so take in carbon dioxide (CO2) and then release oxygen (O2) into Earth's atmosphere, which many living species on Earth need to survive.  **You will learn here about three important minerals:**  Nitrogen  Phosphorus  Potassium  Plants must have these nutrients in order to grow healthy and strong.  **WHY PLANTS LIKE NITROGEN (N):**  Nitrogen (N) helps plants use carbohydrates to gain energy, like certain foods we eat help us to gain energy. Nitrogen controls how plants take their form and how they function inside, and nitrogen helps plants make protein that help them grow strong and healthy. Humans and animals benefit from eating vegetables and plants that are rich in nitrogen because proteins are passed on to humans and animals when they eat vegetables and plants.  **THE NITROGEN CYCLE AND HOW NITROGEN MOVES THROUGH THE SOIL:**  The nitrogen cycle involves certain processes that change nitrogen into different forms. Organic nitrogen in materials, like dead leaves and plants, are changed into inorganic nitrogen by microorganisms (critters) in the soil. Plants take up these available forms of inorganic nitrogen ( NO3- and NH4+ ) so they can grow. Unfortunately, these forms of nitrogen are not always used by plants because they either get onto clay particles in soil, they leach into the groundwater because they cannot be absorbed by the soil, or they change into nitrogen gases that escape into Earth's atmosphere. Luckily there are specific kinds of microorganisms living in the soil that can convert gaseous forms of nitrogen into inorganic nitrogen that plants can use.  When plants die the dead plant matter falls to the ground and certain microbes, yet again, do their job of decomposing dead plant matter (which contains organic N) and changing it into inorganic N that living plants can use! This cycle is continuous. Processes in the nitrogen cycle are: Adsorption/Fixation, Denitrification, Erosion, Immobilization, Leaching, Mineralization, Nitrification, and Volatilization.  **HOW PLANTS TAKE UP NITROGEN**  Plants take up nitrogen in forms of nitrate ( NO3- ) and ammonium ( NH4+ ). Most plants thrive on equal amounts of these ions but nitrates are more quickly available to plants because they move through the soil solution, whereas ammonium ions become fixed or held on to clay particles, called colloids, because of their positive charge.  **WHAT HAPPENS WHEN PLANTS DON'T GET ENOUGH NITROGEN:**  Plants deficient in nitrogen have thin, spindly stems and their growth is stunted. Their older leaves turn yellowish-green from nitrogen starvation (chlorosis), while newer leaves are supplied with the available, but limited nitrogen.  **WHAT HAPPENS WHEN PLANTS GET TOO MUCH NITROGEN:**  Plants that get too much nitrogen have a lot of foliage (leaf) growth but are not strong. Plants that are not strong can get diseases more easily, can be bothered more by bugs, and can eventually fall over and die. An excess amount of nitrogen in plants can affect the amount of sugar and vitamins in fruits and vegetables, making them taste different. More importantly excess nitrogen can build up in plant tissues causing toxicity (poisoning) in livestock and in small children who eat nitrogen rich, leafy vegetables.  **WHY PLANTS LIKE PHOSPHORUS (P):**  Phosphorus (P) plays an important part in how plants and animals form and in how they function and grow. Phosphorus is known to help plants during photosynthesis, P helps plants respire (breathe), P provides energy transfer and storage, and P also helps plants efficiently use water. Seedlings and roots grow more quickly and vegetable and fruit production is increased when plants get enough phosphorus. Soil phosphorus comes mainly from the weathering of rocks that contain the inorganic mineral Apatite  Because minerals containing P are mostly insoluble and because P is fixed, or held, on to soil particles that erode away during rain storms, plants cannot get enough P. Over the past 100 years, farmers and gardeners have heavily added phosphorus fertilizers to their fields to help plants get more of this nutrient. The main reason phosphorus pollution occurs in the environment is because too much P fertilizer is added to soil, then during rain storms it travels on soil particles, across the land, and into surface waters.  Unfortunately, excess P in the environment has caused and continues to cause pollution in streams, rivers, lakes, and groundwater which is used for drinking water. Aquatic life and wildlife living in and around these waterways also are affected.  **HOW PHOSPHORUS MOVES THROUGH THE SOIL AND HOW PLANTS TAKE UP PHOSPHORUS:**  Inorganic and organic forms of P are found in soils, with most organic P being located at the soil surface. The same processes for nitrogen also occur for P: organic forms of phosphorus are changed into inorganic forms of P by microbial activity in the soil (mineralization) or when inorganic forms of P are changed into organic forms of P that plants cannot use (immobilization).  Soil pH affects phosphorus availability to plants. In alkaline soils, in arid climates, calcium phosphate (CaPO4) is dominant. If soil pH gets too high a chemical reaction takes place that fixes the phosphorus and makes it insoluble and unusable by plants. In acid soils aluminum phosphate (AlPO4), iron phosphate (FePO4) and sometimes manganese phosphate (MnPO4) are dominant. If soil pH gets too low a chemical reaction takes place that fixes phosphorus to Al, Fe, or Mn and phosphorus becomes insoluble and unusable by plants.  Other factors that prevent plants from taking up phosphorus include lack of oxygen, low soil moisture, low organic matter, extreme temperatures within soil, soil type, and plant type. Plants living in highly weathered soils use organic forms of phosphorus; plants living in soils that contain organic matter and are less weathered use inorganic forms of phosphorus  When soil contains enough organic matter (dead leaves and plants) at Earth's surface P cannot become fixed as easily to clay surfaces. Adding organic matter to soil gives plants more time to take up P before P become fixed.  Of all phosphorus in existence on Earth, only 0.01% becomes available for plant use!  **WHAT HAPPENS WHEN PLANTS DON'T GET ENOUGH PHOSPHORUS:**  Plants that don't get enough P have spindly, thin-stems that are weak. Their growth is stunted or shortened, and their older leaves turn a dark bluish-green. The ability of phosphorus deficient plants to produce seeds, flowers, and fruits is diminished. Farmers and gardeners add P fertilizer to soil to so their plants won’t become unhealthy.  **WHAT HAPPENS WHEN PLANTS GET TOO MUCH PHOSPHORUS:**  Phosphorus is hard for plants to obtain, let alone get too much of because:  1.) inorganic P is scarce in the environment  2.) P can quickly become fixed on to soil  3.) P gets eroded in rain water runoff to streams, rivers, and lakes.  **WHY PLANTS LIKE POTASSIUM (K):**  Potassium (K) is very important in the plant photosynthesis process and in helping plants metabolize their food to get energy, like humans and animals do when they eat. Potassium controls water and chemicals inside plants that help plants function well. Potassium also controls the absorption of water into plant pores, like the pores on your skin.  **HOW POTASSIUM MOVES THROUGH SOIL AND HOW PLANTS TAKE UP POTASSIUM:**  K is found in high levels in most soils, except in those soils containing sand, but the availability of K to plants is low because a large percentage of K is held in mostly unavailable forms to plants. K can be held inside a clay particle as part of the clay's structure, or it can be held outside on the edges or surface of a clay structure because it has a positive charge.  Of all soil K, 90-98% is held in primary mineral structures that are very resistant to most weathering processes, and therefore not easily available to plants. This form of K is known as inorganic structural K. Roots of some plants do have the ability to take up K from solution around these primary minerals, making these minerals dissolve more easily.  Secondary minerals, such as vermiculite and smectite clays, adsorb or fix K on to their edges and in between their crystal layers, making K only slowly available to plants. This form of K is called nonexchangeable K.  More readily available K for plants is found on the surface of clay particles (colloids) where they can exchange places with other similar sized and positive charged ions in the soil solution. These forms of K are called exchangeable K and solution K. K in soil solution is the easiest form of K for plants to take up. The soil solution is, however, subject to loss by leaching.  As plants take up solution K, exchangeable K takes the place of solution K, while another K ion (from nonexchangeable and structural K sources) moves into the position the exchangeable K was once using. In other words, these different forms of K move around (like people do in the game "musical chairs" ) to replace K used up by plants or to replace K that is lost in the environment.  Plants are known to take up five to ten times more K, as compared to N and P, however; plants cannot take up potassium (and other nutrients) when soil moisture and temperatures are low, when root growth is small, and when enough oxygen is not available. Like phosphorus, potassium is only available to plants in small amounts and is hard for plants to get. Like certain forms of nitrogen and phosphorus, potassium also becomes fixed onto clay particles in soil, making it even harder for plants to obtain..  **WHAT HAPPENS WHEN PLANTS DON'T GET ENOUGH POTASSIUM:**  Plants lacking in K do not have enough energy to properly grow, their roots are not well formed, and they have weak stems and stalks. The edges of older plant leaves appear "burned", as K deficient plants cannot regulate and use water efficiently. K deficient plants are more easily affected by pests, bugs, and diseases. Also, they cannot survive through winters or droughts (periods of time when water is not available to plants).  So, you see, plants that do not get enough of these very important nutrients, (don't forget them- they are N, P, and K!) cannot grow well and eventually can die. But we also must use our knowledge about soils to ensure that nutrients are added to soil in the right amounts and that soil is managed in ways to prevent nutrients from leaving the soil and polluting our groundwater (drinking water), streams, lakes, and rivers. |
| **Comments** | This lesson can be timed to be the lead in to a community garden. Students will become aware of soil needs and upkeep. The plants that were started can be transplanted into the community garden. |
| **Author Info** | Tara Nye earned her Bachelor of Science degree from the University of Kansas and her Masters in Teacher Leadership from Lamar University. Mrs. Nye is currently a 7th grade science teacher and STeAM coordinator at Shughart Middle School located on Fort Bragg, NC. Mrs. Nye has worked with the DoDEA school system for 14 years. She has spent 10 of those years as a 7th grade science teacher and 4 of those years as a 9th grade Earth Science and Biology teacher.  This sustainable lesson was developed with the help of Mindy Love-Stanley of Sustainable Fort Bragg and Jon Parsons of Sustainable Sandhills. Mindy Love-Stanley is a sustainability education and outreach coordinator with the Environmental Management Branch in the Directorate of Public Works at Fort Bragg. In 2002, Mindy pursued completion of her Bachelor’s Degree at UNC Pembroke. She earned her B. S. in Environmental Science and graduated magna cum laude in 2008. That same year, Mindy accepted a position as a NEPA analyst in the Environmental Management Branch in the Directorate of Public Works at Fort Bragg. For nearly 2 years, she performed environmental analysis on construction projects.  In November 2010, Mindy moved to her current position in sustainability education and outreach. Since that time, the sustainability outreach program has expanded significantly to include Arbor Day, Earth Day, National Public Lands Day, conservation awareness campaigns and classes. Mindy is also active in her community. She serves on the Fayetteville Beautiful Board of Directors and the Fayetteville Area Metropolitan Planning Organizations Citizens Advisory Committee.  Jon Parsons has been the Executive Director of Sustainable Sandhills since August 2005. Jon holds a B.S. in Mechanical Engineering from the University of California at Santa Barbara. Jon is a registered Professional Engineer and Geothermal Ground Loop Designer and Installer (International Ground Source Heat Pump Association). As a research engineer in the Solar Heat Division of the Solar Energy Research Institute (now known as the National Renewable Energy Laboratory) in Golden, Colorado, Jon’s research focused on solar thermal technologies, including ocean thermal energy conversion and desiccant dehumidification. |

**Appendix 1 Making the Perfect Soil**

Soils are a crucial element of our survival and well-being. You have begun to learn about the importance of soil in your daily life. It is now your turn to make the perfect soil. You and your group will be working together to engineer the perfect soil. Remember there are several factors that you need to take into consideration including the type of plant you are trying to grow. Use the knowledge gained in class to help create the perfect soil. Happy Growing!

**Part 1: Brainstorming and Research**

1. Different types of plants need different types of nutrients in the soil. What type of seed is your group trying to grow? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What do you already know about this type of plant? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Research your type of plant and the nutrients/type of soil it grows best in. What did you learn? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 2: Planning the Perfect Soil**

Using the information you have learned from Part 1 it is now time to plan your “perfect” soil. List the amounts of each ingredient for each of your group’s soils. Remember that the directions need to be clear enough to be replicated exactly the way your group made it.

Soil 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Soil 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Soil 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Soil 4 (The Control- soil dug from the school yard)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 3:** **Creating the Perfect Soil**

Carefully follow your group’s directions to create your soils. Write a detailed description of what the soil looks like, feels like, and smells like. Take a picture of each soil to document your observations.

Soil 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Soil 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Soil 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Soil 4 (The Control- soil dug from the school yard)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 4: The observations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 1** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 2** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 3** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 4** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 5** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |
| **Day 6** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 7** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 8** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Day 9** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |
| **Day 10** | | | |
|  | Height of Plant (cm) | Number of Leaves | Observations |
| Soil 1 |  |  |  |
| Soil 2 |  |  |  |
| Soil 3 |  |  |  |
| Soil 4 |  |  |  |

**Part 5: Analyze the Results: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Part 6: Conclusion/Plan for Perfecting the Perfect Soil**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CATEGORY | **4** | **3** | **2** | **1** |
| **Research Sources** | Several reputable background sources were used and cited correctly. Material is translated into student\'s own words. | A few reputable background sources are used and cited correctly. Material is translated into student\'s own words. | A few background sources are used and cited correctly, but some are not reputable sources. Material is translated into student\'s own words. | Material is directly copied rather than put into students own words and/or background sources are cited incorrectly. |
| **Planning the Soil** | Procedures are listed in clear steps. Each step is numbered and is a complete sentence. | Procedures are listed in a logical order, but steps are not numbered and/or are not in complete sentences. | Procedures are listed but are not in a logical order or are difficult to follow. | Procedures do not accurately list the steps of the experiment. |
| **Observations** | Clear, accurate, dated notes are taken regularly. | Dated, clear, accurate notes are taken occasionally. | Dated, notes are taken occasionally, but accuracy of notes might be questionable. | Notes rarely taken or of little use. |
| **Analysis** | The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed. | The relationship between the variables is discussed and trends/patterns logically analyzed. | The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data. | The relationship between the variables is not discussed. |
| **Summary** | Summary describes the skills learned, the information learned and some future applications to real life situations. | Summary describes the information learned and a possible application to a real life situation. | Summary describes the information learned. | No summary is written. |
| **Participation** | Used time well in lab and focused attention on the experiment. | Used time pretty well. Stayed focused on the experiment most of the time. | Did the lab but did not appear very interested. Focus was lost on several occasions. | Participation was minimal OR student was hostile about participating. |