**The Garden Ecosystem…**

# The Science behind Grandmother’s Garden!!

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## Description

## We have all seen a garden before! Most of us have worked, or assisted in planting a garden before. Gardens have numerous benefits to society. A garden is a piece of land, usually near a home, where vegetables, shrubs, fruits, flowers, bushes, trees, and grasses can be grown.

## As a man-made landscape, a garden is a planned space, usually outdoors, set aside for the display, cultivation, and enjoyment of plants and other forms of nature. The garden can incorporate both natural and man-made materials. Depending on which part of the world we live in, gardens can be grown throughout the year or just during the warm months of the year. Gardens can also be very exciting outdoor laboratories where all aspects of science seamlessly function to create a beautiful habitat!

## Starting a garden can be daunting but exciting task. There are all kinds of decisions to make, but a little planning can go a long way toward making a garden you will enjoy working in as much as looking at.

## The goal of this lesson is to understand some of the fundamental sciences behind the creation and maintenance of gardens. It is also important to look at the ecosystem dynamics of gardens and the traditional and cultural aspects that most cultures attribute to gardens.

## Objectives

Students will be able to:

* Identify the Biotic and Abiotic components of gardens,
* Understand the concept of ecosystem sustainability as it applies to gardens.
* Identify the role of microbes in the functioning of garden ecosystems.
* Learn basic techniques for planning and starting a garden
* Demonstrate the environmental sustainability aspects of gardens

# North Dakota State Standards

9-10.2.6 Design and conduct a guided investigation

9-10.2.7 Maintain clear and accurate records of scientific investigations

9-10.2.8 Analyze data found in tables, charts, and graphs to formulate conclusions

11-12.1.2 Identify structure, organization, and dynamics of components within a system

11-12.8.1 Identify the criteria that scientific explanations must meet to be considered valid

# Next Generation Science Standards

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible, social, cultural, and environmental impacts.

HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints or interactions within and between systems relevant to the problems

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

RST.11-12.7- Integrate and evaluate multiple sources of information presented in diverse formats and media(e.g., quantitative data, video, multimedia in order to address a question or solve a problem

# Schedule

09:00-09:30 General Organization and Cultural Connection

09:30-10:00 PowerPoint Presentation

10:00-10:30 Activity 1: *Stuff in your garden*

10:30-11:15 Activity 2A: *Soil Organisms*

11:15-12:00 Activity 2B: Soil *Microscopy*

12:00-12:45 Lunch

12:45-01:45 Activity 3: *How to Start Seeds*

01:45-02:30 Activity 4: *Garden Planner*

02:30-02:50 Activity 5: *Edible Garden Soil Mosaic*

02:50-03:00 Wrap-up activity and Reflection questions

# Cultural Connection:

# Terminology to Note:

Garden

Biotic

Abiotic

Vegetable

Perennial

Annual

Ecology

Ecosystem

Habitat

Seed

Soil type

Potting mix

Shrub

Tree

Flower

Bed

Weed

Organism

Microorganism

Macro organism

Decomposition

Soil Fertility

Porosity

Microflora

Macroflora

Microfauna

Mesofauna

Macrofauna

Bacteria

Fungi

Actinomycetes

Algae

Virus

Protozoa

Nematode

Arthropod

Annelid

Insect

### Activity 1: *Stuff in your garden*

**Introduction**

Gardens are fun environments where fresh produces can be grown and harvested. They are also aesthetically pleasing environments. Most people garden as a hobby in our communities. Gardens come in different types, shapes, sizes, and are created for many different purposes. Components in a garden can also be classified in different ways. In ecology, ecosystems typically have living and non-living components which are interdependent and intricately linked for the survival of the system. Gardens usually have a great diversity of plants and animals using the area as a habitat. They also have other components which are essential for the growth of the garden ecosystem. The most important component of your garden is the soil! It is often said “Feed the soil and the plants will take care of themselves”.

In this activity we will identify the living (biotic) and non-living (abiotic) components of a garden. These components in ecology are typically considered natural components as opposed to man-made components usually found in gardens.

**Materials**

* Pen
* Lesson Plan
* Computer (optional to view garden pictures if you do not have a garden on campus)

**Procedure**

Take a trip to a nearby garden and observe every aspect of the garden. If there is no garden nearby, search for pictures of gardens online and observe them. Once you have completed your observation, fill out the table below and classify the garden components you observed. Make sure to also provide a reason for why you think they are important to the garden.

|  |  |
| --- | --- |
| **Living components (Biotic)** | **Importance in the Garden** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Non-Living components (Abiotic)** | **Importance in the Garden** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Questions**

1. What are some of the benefits we get from gardens?
2. What does a 3-sisters garden look like?
3. What does a medicine wheel garden look like?
4. Which important living component of the garden is not visible to the naked eye?

## Activity 2A: *Soil Organisms*

1. Please complete the following table below, using your computer as a resource.
2. Soil Organisms include:
   1. Microrganisms: Bacteria, Fungi, Actinomycetes, Virus, Protozoa
   2. Macrorganisms: Nematodes (round worm), Arthropods: insects, Annelids (segmented worms)
3. Activity (20-30 minutes) with discussion to follow.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Microorganisms Scientific Name** | **Common Name** | **Describe Shape** | **Function in Soil** | **Insert/Add/Draw a Picture** |
| Bacillus subtilis | Bacteria | Rod shaped | Inhabit the rhizosphere, which is the interface between plant roots and the surrounding soil. The plants roots and associated biofilm can have a significant effect on the chemistry of the soil, creating a unique environment. |  |
| Tabacco Mosaic |  |  |  |  |
| Streptomyces |  |  |  |  |
| Pseudomonas |  |  |  |  |
| Mucor |  |  |  |  |
| Chlorella |  |  |  |  |
| Euglena |  |  |  |  |
| Lumbricus |  |  |  |  |
| Pratylenchus |  |  |  |  |

**Questions**

1. Which soil organism is the most important organism in soil and why?
2. Do all of these organisms live in all types of soil?
3. If you went outside and dug up a teaspoon of soil, what soil organisms do you think that it would contain?

## Activity 2B: Soil *Microscopy*

**Introduction:**

The majority of soil organisms are microscopic organisms. They are so small that they cannot be seen with the human eye therefore, we must use a microscope which will allow us to view the microorganism. Using prepared slides from a biological supply company; students will observe a variety of microscopic soil organisms under the microscope and complete a worksheet.

**Objectives:**

1. Students will use a microscope to observe a variety of soil microorganisms
   1. Bacteria structure “morphology” varies by organism.
2. Work in groups of 3 per microscope: each student must observe each organism
3. Complete a soil organism microscopy worksheet.

**Materials:**

* Compound light microscope (view bacteria using microscopes at 20X to 40X Magnification)
* Link: How to use a microscope (4 minutes)

<https://www.youtube.com/watch?v=SUo2fHZaZCU>

* Prepared Slides of Soil Microorganisms (Biological Supply Company)
* Soil sample from the garden to prepare a slide for viewing
* Link: How to make wet and dry mount slides (6 minutes)

<https://www.youtube.com/watch?v=ZjQVQ8gT0A8>

**Procedure:**

1. Order Bacteria, Fungi, Actinomycetes, Algae, Protozoa in advance so that they arrive several days before classroom observation. Give each group (2) slides of each soil organism.
2. Review microscope use procedures with the class. Show video above
3. Have students observe bacteria, fungi, virus, protozoa under the microscopes. Using magnification (20X-40X)
   1. Items to note:
4. *Bacteria*
5. *Actinomycetes*
6. *Fungi*
7. *Algae*
8. *Protozoa*
   1. *Flagellates*
   2. *Amoebae*
   3. *ciliates*
9. During observation, the teacher should circulate around the room, checking for completion of worksheet and, assisting with microscope usage, etc.

**Questions:**

1. What organisms did you find the most interesting?
2. What shapes of microorganisms were you able to see under the microscope?
3. Can you classify some of the organisms that were seen today?

**Soil Microorganisms through a Microscope:**

*Bacteria, Actinomycetes, Fungi, Algae, Protozoa: Flagellates (F), Amoebae (A), Ciliates(C)*

|  |  |  |
| --- | --- | --- |
| **Microorganism Name** | **Classify: Bacteria, Fungus, Algae,**  **Protozoa: F,A, C, Actinomycetes** | **Draw a Picture** |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |

### Activity 3: *How to Start Seeds*

**Six Steps, from Seed to Garden**

<https://www.gardeners.com/how-to/how-to-start-seeds/5062.html>

1. Find the right containers  
You can start seeds in almost any type of container, as long as it's at least 2-3 " deep and has some drainage holes. If you are the DIY type, you might want to grow seedlings in yogurt cups, milk cartons or paper cups or [trays that are made especially for seed starting](https://www.gardeners.com/buy/seed-starting-and-lights/seed-starting-kits/). It's easy to fill the trays, the watering system ensures consistent moisture

2. Prepare the "potting soil"  
Choose potting soil that's made for growing seedlings. Do not use soil from your garden or re-use potting soil from your houseplants. Start with a fresh, sterile mix that will ensure healthy, disease-free seedlings.

Before filling your containers, use a bucket or tub to moisten the planting mix. The goal is to get it moist but not sopping wet; crumbly, not gloppy. Fill the containers and pack the soil firmly to eliminate gaps.

Remember that most mixes contain few, if any, nutrients, so you'll need to feed the seedlings with [liquid fertilizer](https://www.gardeners.com/search?q=liquid%20fertilizer) a few weeks after they germinate, and continue until you transplant them into the garden.

3. Start planting  
Check the seed packet to see how deep you should plant your seeds. Some of the small ones can be sprinkled right on the soil surface. Larger seeds will need to be buried. For insurance, plant two seeds per cell (or pot). If both seeds germinate, I snip one and let the other grow. It's helpful to make a couple divots in each pot to accommodate the seeds. After you've dropped a seed in each divot, you can go back and cover the seeds.

Moisten the newly planted seeds with a mister or a small watering can. To speed germination, cover the pots with plastic wrap or a plastic dome that fits over the seed-starting tray. This helps keep the seeds moist before they germinate. When you see the first signs of green, remove the cover.

4. Water, feed, repeat  
As the seedlings grow, use a mister or a small watering can to keep the soil moist but not soggy. Let the soil dry slightly between waterings. Set up a fan to ensure good air movement and prevent disease. A fan that's plugged into the same timer as my grow lights. Remember to feed the seedlings regularly with [liquid fertilizer](https://www.gardeners.com/search?q=liquid%20fertilizer), mixed at the rate recommended on the package.

5. Light, light, light!  
Seedlings need a lot of light. If you're growing in a window, choose a south-facing exposure. Rotate the pots regularly to keep plants from leaning into the light. If you're growing under lights, adjust them so they're just a few inches above the tops of the seedlings. Set the lights on a [timer](https://www.gardeners.com/search?q=timer) for 15 hours a day. Keep in mind that seedlings need darkness, too, so they can rest. As the seedlings grow taller, raise the lights.

6. Move seedlings outdoors gradually  
It's not a good idea to move your seedlings directly from the protected environment of your home into the garden. You've been coddling these seedlings for weeks, so they need a gradual transition to the great outdoors. The process is called hardening off. About a week before you plan to set the seedlings into the garden, place them in a protected spot outdoors (partly shaded, out of the wind) for a few hours, bringing them in at night. Gradually, over the course of a week or 10 days, expose them to more and more sunshine and wind. A [cold frame](https://www.gardeners.com/search?q=Cold%20frame) is a great place to harden off plants.

**Questions**:

1. What is it called when a seed sprouts or opens up?
2. What will your seed produce and will it grow and produce in the area that you live?
3. What does a seed need in order to sprout?

### Activity 4: *Garden Planner*

**Introduction**

## Starting a garden can be daunting but exciting task. There are all kinds of decisions to make, but a little planning can go a long way toward making a garden you will enjoy working in as much as looking at.

The three most important questions to keep in mind when starting a garden are:

* How do you plan to use the space (entertaining, play area, grow food...)?
* What do you envision in your mind?
* How much resources can you devote to it ( usually time and money)?

To have a successful garden, you need to choose a good site. The amount of sun exposure and access to water will play a big part in what plants you'll be able to grow. You also need to identify the right type of soil and soil nutrients fora new garden. Plant selection is the next step and it is highly dependent on your soil type! Ultimately, plants you chose will depend on what you like and want!

Then designing considerations have to be made. It is an ongoing process and is half the fun of gardening. There are no fixed so called "design rules", and there are no garden police to enforce them. Most gardens are a mix of plants that are always growing and changing. Even so, there are some basic principles that will get you started off right.

The Garden Planner is a software that allows you to plan the perfect garden based on your site characteristics, plant preferences, plant nutrient requirements, aesthetic preferences, and synergistic interactions in the garden. In this activity we will use the Garden planner software to design our individualized ideal garden.

**Materials**

Computer with speakers

Link to the online software program: <http://gardenplanner.almanac.com/>

Video tutorial link: [http://gardenplanner.almanac.com/gardenplanner/gardenplanner.html#](http://gardenplanner.almanac.com/gardenplanner/gardenplanner.html)

**Procedure**

* Download the garden planner almanac on to your computer
* Follow the quick easy video tutorial
* Open the planner on your computer screen and explore all its components
* Design an ideal garden for your home, adding all your preferred plants!
* Once you have completed your design, print the design

**Questions**

1. **Describe the design of your garden?**
2. **What were some of the major considerations you wanted included in your garden?**
3. **Does the row size influence the number of crops you can plant in a row?**
4. **What are the cultural significance of some of the crops you included in your designed garden?**
5. **Lookup the planting time range for the following crops in the garden**

[**http://www.thegardenhelper.com/vegtips.html**](http://www.thegardenhelper.com/vegtips.html)

|  |  |  |
| --- | --- | --- |
| Garden Produce | When to plant in soil (Month) | How long before harvest |
| Carrots: |  |  |
| Radishes: |  |  |
| Lettuce: |  |  |
| Tomatoes: |  |  |
| Green beans: |  |  |
| Okra: |  |  |
| Eggplants: |  |  |
| Cucumbers: |  |  |
| Onions: |  |  |
| Peppers: |  |  |
| Raspberries: |  |  |
| Broccoli: |  |  |
| Squash: |  |  |
| Potatoes: |  |  |
| Peanuts: |  |  |

### Activity 5: *Edible Garden Soil Mosaic*

**Introduction and Background Information:**

Soil takes many years to form from a starting point of bedrock or parent material, a layer of rock upon which soil accumulates. As years pass, good quality soil will develop four or more distinct layers. At the surface is the O horizon, a layer of organic material, usually partly decomposed, also called residue or leaf litter. Next is the A horizon, also called topsoil. Most plant roots grow in this layer and it holds most of the soil’s nutrients. The B horizon (subsoil) contains sand and silt, and perhaps some nutrients that have dripped through (leached) from the layers above. The C horizon is partially broken down bedrock. The last layer, the R horizon, is bedrock. Some classification schemes add other layers, but this is a simple one. The deeper the O and A layers are, the richer the soil is. Soil profiles vary greatly.

**Materials**

* clear plastic cups for each student
* spoons
* candy coated chocolate
* 2 -3 boxes of chocolate pudding (prepared)
* gummy worms
* ½ cup+ colored sprinkles
* chocolate sandwich cookies, crushed
* ½ cup coconut
* yellow, brown or green food coloring
* labels/paper:
  + Parent Material
  + Subsoil
  + Topsoil
  + Organisms
  + Residue or Leaf litter
  + Earthworms or red wigglers

**Getting Ready:**

1. Prepare the pudding according to the directions on the package.
2. Place chocolate sandwich cookies into a sealed plastic bag and crush using a rolling pin. Alternatively, use a food processor to crush the cookies.
3. Add a couple of drops of food coloring to the coconut in a plastic container or baggy. Shake for 30 to 45 seconds. Pour coconut onto paper towels to dry (about an hour).

**Procedure**

* + - For simplicity in this activity we use the terms: parent material, subsoil, topsoil, and residue or leaf litter.
    - Follow the attached diagram available for review.Place each soil layer ingredient by its appropriate label:
* Candy coated chocolate = ‘Parent Material’
* Chocolate pudding = ‘Subsoil’
* Crushed chocolate sandwich cookies = ‘Topsoil’
* Colored sprinkles = ‘Organisms’
* Coconut = ‘Residue’
* Gummy worms = ‘Earthworms’ label.
* Place spoons with each of the soil horizon/layer ingredients.
* Put a spoonful of candy-coated chocolates into the bottom of an individual cup;
* Repeat this procedure with the pudding (Subsoil), followed by cookie crumbs (Topsoil), sprinkles (Organisms), coconut (Residue) and finally a gummy worm (Earthworms).



**Discussion:**

1. What are the layers of soil?
2. What types of organisms live in soil and aid in soil production?