Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.1 Summarize the characteristics that all organisms share (including the obtainment and use of resources for energy, the response to stimuli, the ability to reproduce, and process of physical growth and development).
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In kindergarten (K-2.2), students identified examples of organisms and nonliving things. Students have explored the basic needs (food, shelter, water, space, and shelter) of plants in 1st grade and of animals in 2nd grade.

It is essential for students to know the characteristics that separate living organisms from non-living things. All living organisms share the following characteristics:

They obtain and use resources for energy
- All organisms must obtain resources, such as food, oxygen, and water, which provide required energy to perform the basic processes of life, such as growing and developing, or repairing injured parts.
- *Autotrophs* (for example plants) provide their own food for energy through the process of *photosynthesis*, while *heterotrophs* (for example animals) must find an external source for food.
- Energy is released from food in most organisms through the process of *respiration*.

They respond to stimuli
- A *stimulus* is any change in an organism's surroundings that will cause the organism to react.
- Examples of environmental stimuli may be changes in the amount of light present, changes in temperature, sound, amount of water, space, amounts or types of food, or other organisms present.
- The reaction to the stimulus is called a *response.* It can be an action or behavior performed by the organism.

They reproduce
- Organisms have the ability to reproduce, or produce offspring that have similar characteristics as the parents. There are two basic types of reproduction:
  - *Asexual reproduction*: a reproductive process that involves only one parent and produces offspring that is identical to the parent.
  - *Sexual reproduction*: a reproductive process that involves two parents. The egg (female reproductive cell) and sperm (male reproductive cell) from these two parents combine to make an offspring that is different from both parents.

They grow and develop
- *Growth* is the process whereby the organism becomes larger.
- *Development* is the process that occurs in the life of the organism that results in the organism becoming more complex structurally.
- Organisms require energy to grow and develop.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

It is not essential for students to know about the origins of life, mitosis or meiosis, or the chemical equations for photosynthesis and respiration.

Assessment Guidelines:
The objective of this indicator is to *summarize* characteristics that all organisms share; therefore, the primary focus of assessment should be to generalize the major points about characteristics that all organisms share. However, appropriate assessments should also require student to *recall or exemplify* the characteristics of organisms; or *compare* how organisms obtain food or reproduce.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.2 Recognize the hierarchical structure of the classification (taxonomy) of organisms (including the seven major levels or categories of living things—kingdom, phylum, class, order, family, genus, and species).
Taxonomy level: 1.1-A Remember Factual Knowledge

Previous/Future knowledge: In 4th grade (4-2.1), students classified organisms into two major groups: plants and animals according to their physical characteristics. There will be additional study about protists and bacteria in 7th grade.

It is essential for students to know that to study all of the organisms on Earth, biologists have devised ways of naming and classifying them according to their similarities in structures.

- The study of how scientists classify organisms is known as *taxonomy*.
- The modern classification system uses a series of levels to group organisms.
- An organism is placed into a broad group and is then placed into more specific groups based its structures.
- The levels of classification, from broadest to most specific, include: kingdom, phylum, class, order, family, genus, and species.
- The more classification levels an organism shares with another, the more characteristics they have in common.

Kingdom

- While scientists currently disagree as to how many kingdoms there are, most support a five-kingdom (Plants, Animals, Fungi, Protists, Monerans) system.
- Organisms are placed into kingdoms based on their ability to make food and the number of cells in their body.

Phylum (pl. phyla)

- In the Plant Kingdom, phyla are sometimes referred to as *divisions*.
- Plants are normally divided into two groups: vascular and nonvascular.
- In the Animal Kingdom, there are 35 different phyla. These phyla can be divided into two groups: vertebrates and invertebrates.

Class, Order, Family

- These levels become even more specific and will include fewer organisms that have more in common with each other as they move down the levels.

Genus (pl. Genera)

- Contains closely related organisms.
- The genus is used as the first word in an organism's scientific name.

Species

- Consists of all the organisms of the same type which are able to breed and produce young of the same kind.
- The species is used as the second word in an organism's scientific name.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

Scientific name

- The scientific name of an organism is made up of its genus and species.
- It is written in italics (*Genus species*) with the genus capitalized.
- For example, *Canis lupus* is the scientific name for the wolf and *Pinus taeda* is the scientific name for a loblolly pine.

It is not essential for students to know any more detail about fungi, protists, or Monerans beyond the major characteristics listed above. Students will study in detail the structures, processes and responses in plants (6-2) and animals (6-3). Students do not need to use binomial nomenclature to determine the scientific name of an organism.

Assessment Guidelines:

The objective of this indicator is to *recognize* the hierarchical structure of the classification of organisms; therefore, the primary focus of assessment should be to remember the classification scheme for organisms. However, appropriate assessments should also require students to *recall* characteristics of each level of organization that determines which organisms are placed within it*;* or *identify* an appropriate example of a scientific name.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.3 Compare the characteristic structures of various groups of plants (including vascular or nonvascular, seed or spore-producing, flowering or cone-bearing, and monocot or dicot).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the study of plants in previous grades. In 4th grade (4-2.1), students classified organisms as flowering or nonflowering plants. Students will not revisit this concept in high school, as the focus will be on the cellular level of organisms.

It is essential for students to know that organisms in the Plant Kingdom are classified into groups based on specific structures. All plants are included in this kingdom, which is then broken down into smaller and smaller divisions based on several characteristics, for example:
- How they absorb and circulate fluids – vascular or nonvascular;
- How they reproduce – spores or seeds;
- Method of seed production – cones or flowers;
- Type of seed leaf – monocot or dicot.

Plants are commonly classified into two major groups based on their internal structures. These two groups are vascular and nonvascular.

Vascular Plants
- This is the largest group in the Plant Kingdom.
- These plants have a well-developed system for transporting water and food; therefore, they have true roots, stems, and leaves.
- Vascular plants have tube-like structures that provide support and help circulate water and food throughout the plant.
- *Xylem* transport water and minerals from the roots to the rest of the plant.
- *Phloem* transport food from the leaves to the rest of the plant.
- Examples include trees and many shrubs with *woody* stems that grow very tall and grasses, dandelions, and tomato plants with soft *herbaceous* stems.

Nonvascular Plants
- These plants do not have a well-developed system for transporting water and food; therefore, do not have true roots, stems, or leaves.
- They must obtain nutrients directly from the environment and distribute it from cell to cell throughout the plant. This usually results in these plants being very small in size.
- Examples include mosses, liverworts, and hornworts.

The following classifications can also be used to group plants.

Seed-producing

- Seed-producing plants are plants that reproduce through seeds. Seed plants make their own seeds.
- Seeds contain the plant *embryo* (the beginnings of roots, stems, and leaves) and stored food (*cotyledons)* and are surrounded by a seed coat. From those seeds, new plants grow.
- There are two major groups of seed-producing plants: cone-bearing plants and flowering plants.

Spore-producing

- Spore-producing plants are plants that produce spores for reproduction instead of seeds.
- Spores are much smaller than seeds.
- Almost all flowerless plants produce spores.
- Examples include mosses and ferns.

Flowering Plants

- Flowering plants differ from conifers because they grow their seeds inside an ovary, which is embedded in a flower.
- The flower then becomes a fruit containing the seeds.
- Examples include most trees, shrubs, vines, flowers, fruits, vegetables, and legumes.

Cone-bearing Plants

- Most cone-bearing plants are evergreen with needle-like leaves.
- Conifers never have flowers but produce seeds in cones.
- Examples include pine, spruce, juniper, redwood, and cedar trees.

Monocot

- A seed with one food storage area is called a *monocotyledon,* or *monocot*.
- Flowers of monocots have either three petals or multiples of three.
- The leaves of monocots are long and slender with veins that are parallel to each other.
- The vascular tube structures are usually scattered randomly throughout the stem.
- Examples include grass, corn, rice, lilies, and tulips.

Dicot

- A seed with two food storage areas is called a *dicotyledon,* or *dicot*.
- Flowers of dicots have either four or five petals or multiples of these numbers.
- The leaves are usually wide with branching veins.
- The vascular tube structures are arranged in circular bundles.
- Examples include roses, dandelions, maple, and oak trees.

It is not essential for students to know specific structures of nonvascular plants or the stages of reproduction in spore-producing plants. The terms gymnosperm and angiosperm need not be used at this time. Students do not need to know the origin or evolution of the plant kingdom.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

Assessment Guidelines:

The objective of this indicator is to *compare* the characteristic structures of various groups of plants; therefore, the primary focus of assessment should be to detect similarities and differences between the various groups (including vascular and nonvascular, seed and spore-producing, flowering and cone-bearing, and monocot and dicot). However, appropriate assessments should also require student to *identify* the different plant groups and their characteristics; *classify* plants into the various groups based on their characteristics; or *exemplify* various groups of plants based on their characteristics.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.4 Summarize the basic functions of the structures of a flowering plant for defense, survival, and reproduction.
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-2.4), students summarized the life cycle of plant, which included flowers and seeds. In 3rd grade (3-2.2), students explained how physical and behavioral adaptations (for example structures for defense) allowed organisms to survive.

It is essential for students to know that flowering plants have special structures that function for defense, survival, and reproduction.

Structures for Defense
Plants have structures for defense that protect them from threats and without these defenses the plant might die. Examples of natural defenses that plants have developed over time may be

- thorns that can defend the plant from being eaten by some animals
- fruits and leaves with poisons so that they are not eaten by animals
- the ability to close its leaves when touched (*thigmotropism*)

Structures for Survival
Plants have structures that allow them to survive in their habitats when the conditions are not suitable. Examples of parts of flowering plants that function for survival may be:

- Leaves function as the site of photosynthesis, respiration, and transpiration in plants.
- Stems support the plant and hold the leaves up to the light. Stems also function as food storage sites.
  - The *xylem* in the stems transports water from the roots to the leaves and other plant parts.
  - The *phloem* in the stems transport food made in the leaves to growing parts of the plant.
- Roots help anchor the plant in the ground.
  - They also absorb water and nutrients from the soil and store extra food for the plants.
  - The more surface area on the root that is available, the more water and nutrients it can absorb.
  - *Root hairs* help to increase this surface area.
- There are two types of roots: fibrous roots and taproots.
  - *Fibrous roots* consist of several main roots that branch off to form a mass of roots. Examples are grass, corn, and some trees.
  - *Taproots* consist of one large, main root with smaller roots branching off. Examples are carrots, dandelions, or cacti.
- Seeds have special structures that allow them to be dispersed by wind, water, or animals.
- The seeds coat helps protect the embryo from injury and also from drying out.

Structure for Reproduction
Parts of the flowering plant that function in reproduction include:
Flowers

- Flowers produce seeds.
- Many flowers contain both male and female parts needed to produce new flowers.
- Flower petals are often colorful or have a scent to attract insects and other animals.

Stamen

- The male part of a flower that has an *anther* on a stalk (*filament*).
- The anther produces the pollen that contains the sperm cells.

Pistil

- The female part of the flower that contains
  - The *ovary*, which contains the ovules where the egg cells are produced,
  - the *stigma*, which is the sticky top where pollen grains land, and
  - the *style*, which is a stalk down which the pollen tube grows after pollination has taken place

Seed

- The ovule that contains the fertilized egg (embryo) from which new plants are formed.
- A fruit that is formed from the ovary often protects them.

It is not essential for students to know the cell layers of leaf structures or other structures of roots or stems.

Assessment Guidelines:
The objective of this indicator is to *summarize* the basic functions of the structures of flowering plants; therefore, the primary focus of assessment should be to generalize points about the various structures needed for defense, survival, and reproduction. However, appropriate assessments should also require student to *identify* the parts of a flower used for reproduction; *identify* structures in plants used for defense, survival, or reproduction; *illustrate* a flower or plant structures using words, pictures, or diagrams; or *classify* a structure based on its function for defense, survival, or reproduction.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.5 Summarize each process in the life cycle of flowering plants (including germination, plant development, fertilization, and seed production).
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-2.4), students summarized the life cycle of plants (including germination, growth, and the production of flowers and seeds). In 3rd grade (3-2.1), students illustrated the life cycle of seed plants.

It is essential for students to know that all flowering plants have similar life cycles. These life cycles include distinct stages. These stages include:

Germination
- When seeds are dispersed from the parent plant, they can either lay dormant or they can begin to grow immediately given the right conditions.
- This early stage of seed growth is called *germination*.
- The roots begin to grow down, while the stem and leaves grow up.

Plant development
- Over time the seed grows into a mature plant with the structures necessary to produce more plants.

Fertilization
- When pollen, which is produced in the stamen of a flower, transfers from stamen to pistil (*pollination*) and then enters the ovule, which is located in the ovary of a flower, *fertilization* occurs.

Seed production
- Once the ovule is fertilized it develops into a seed.
- A fruit (fleshy, pod, or shell) then develops to protect the seed.
- Seeds are structures that contain the young plant surrounded by a protective covering.

It is not essential for students to know how reproduction occurs in nonvascular plants, cone-bearing plants, or spore-producing plants. Differences in the time to complete a plant's life cycle, such as annual, biennial, or perennial, are interesting but not essential. Plant meiosis is also not essential.

Assessment Guidelines:
The objective of this indicator is to *summarize* each of the processes in the life cycle of flowering plants; therefore, the primary focus of assessment should be to generalize the major points about the life cycle of seed plants (including germination, plant development, fertilization, and seed production). However, appropriate assessments should also require student to *identify* the individual stages; *illustrate* the life cycle stages using words, pictures, or diagrams; or *classify* by sequencing the stages of the life cycle.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.6 Differentiate between the processes of sexual and asexual reproduction of flowering plants.

Taxonomy level: 4.1-B Analyze Conceptual Knowledge

Previous/Future knowledge: This is the first time that students have been introduced to the terms sexual and asexual reproduction. They have studied the process of reproduction in flowering plants in 1st and 3rd grades.

It is essential for students to know the difference between sexual and asexual reproduction in flowering plants.

Sexual reproduction

- A process of reproduction that requires a sperm cell (in pollen) and an egg cell (in the ovule) to combine to produce a new organism.
- All flowering plants undergo sexual reproduction.

Asexual reproduction

- A process of reproduction that involves only one parent plant or plant part and produces offspring identical to the parent plant.
- Many plants can grow new plants asexually from their plant parts.
- If a plant is cut or damaged, it can sprout new growth from the stems, roots, or leaves.

Plants use a variety of parts to produce new plants such as:

Tubers, bulbs

- These are all types of underground stems.
- The "eyes" or buds of tubers, for example potatoes, grow into roots and shoots to produce a new plant.
- Bulbs, for example onions, are big buds made of a stem and special types of leaves.

Runners

- These are all types of stems that run along the ground.
- New strawberries or some ivy grow from the tips of runners.
- Many lawn grasses grow from runners.

Stem Cuttings

- When a piece of cut stem is planted, roots may form from the cutting, and then a full plant develops.
- Sugar cane and pineapple are examples of plants grown from stem cuttings.

Roots

- Some fruit trees and bushes send up "suckers" or new shoots from the roots.
- Some plants have roots that can produce new plants from root pieces, such as a sweet potato.

Leaves

- Some houseplants produce little plants right on their leaves.
- For example, African violets can produce plants from leaves placed on top of soil.

It is not essential for students to know how reproduction occurs in nonvascular plants, cone-bearing plants, or spore-producing plants.

Assessment Guidelines:
The objective of this indicator is to *differentiate* between sexual and asexual reproduction in plants*;* therefore, the primary focus of assessment should be to distinguish between processes and structures that result in asexual reproduction from those that result in sexual reproduction in plants. However, appropriate assessments should also require student to *identify* the requirements for sexual reproduction in flowering plants; *exemplify* asexual reproduction in plants; or *identify* structures that allow asexual plant reproduction to take place.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.7 Summarize the processes required for plant survival (including photosynthesis, respiration, and transpiration).
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In kindergarten, 1st grade, and 3rd grade, students studied the resources needed by plants in order to survive. Students have not studied the specific processes of photosynthesis, respiration, and transpiration.

It is essential for students to know that plants are organisms that perform certain processes necessary for survival.

Photosynthesis
- Plants are organisms that make their own food, a simple sugar, for survival.
- The process by which they make this sugar is called *photosynthesis*.
- *Chloroplasts*, found in the cells of the leaf, contain *chlorophyll*, a green pigment that absorbs light energy.
- During this process, plants use carbon dioxide gas from the air (taken in through openings, or *pores*, in the leaf called *stomata*) and water (taken in through the roots) to make sugar (food) in the leaves.
- During the process of photosynthesis, oxygen is also produced. The oxygen is released into the air through the stomata.
- Photosynthesis is the process that provides the oxygen in the atmosphere that most living organisms need.

Respiration
- The food (sugar) created through the process of photosynthesis is used to provide energy needed by the plants to perform life functions.
- To obtain the energy from the food it produces, plants must break down the sugar in the cells throughout the plant in a process called *respiration*.
- In this process, oxygen from the air (taken in through the stomata) combines with the sugar, which is then broken down into carbon dioxide and water.
- During this process, energy is released. This energy can now be used by the plant to perform life functions.
- The carbon dioxide and water that are formed are then given off through the stomata in the leaves.

Transpiration
- Some of the water taken in through the roots of plants is used in the process of photosynthesis.
- However, plants lose most of the water through the leaves. This process is called *transpiration*.
- Without a way to control transpiration, plants would wither up and die. Fortunately, plants are able to slow down transpiration.
- *Guard cells*, mostly on the underside of the leaf, open and close the stomata.
- When the stomata are closed, water cannot escape from the leaf.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

It is not essential for students to know the chemical formulas for photosynthesis and respiration. The light and dark dependent reactions of photosynthesis as well as the steps for respiration are not essential. Students do not need to know the internal leaf structural layers.

Assessment Guidelines:
The objective of this indicator is to *summarize* plant processes necessary for survival; therefore, the primary focus of assessment should be to generalize the major points about the processes of photosynthesis, respiration, and transpiration. However, appropriate assessments should also require student to *identify* the component plant parts necessary for photosynthesis, respiration, and transpiration; *illustrate* the movement of water, oxygen, carbon dioxide, and food through the plant; *compare* photosynthesis and respiration in terms of starting materials and what is produced; or *recall* the function of these processes in plants.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.8 Explain how plants respond to external stimuli (including dormancy and the forms of tropism known as phototropism, gravitropism, hydrotropism, and thigmotropism).

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/future knowledge: In 3rd grade (3-2.4), students studied how plants respond to changes in their environments, specifically their response to light. Students in 3rd grade also studied the concept of gravity as a pull on an object. In 4th grade (4-2.4), students studied plant behaviors in response to light, water, touch, and gravity in the environment.

It is essential for students to know that plants respond to changes in their environments. These responses (the reply to the change in the environment, or stimulus) vary depending on the specific environmental stimulus (a change in the environment that causes a response or a reaction).

Under certain conditions, when a mature plant or seed becomes or remains inactive, it is said to be *dormant*.

- *Dormancy* is a period of time when the growth or activity of a plant or seed stops due to changes in temperature or amount of water.
- Dormancy allows various species to survive in particular environments.
- It helps to ensure that seeds will germinate when conditions are favorable for survival of the small seedlings.
- For example, leaves fall from trees prior to the conditions of winter and the leaf buds do not open again until conditions are favorable in the spring.

Plants respond to changes in the environment by growing or moving their stems, roots, or leaves toward or away from the stimulus. This response, or behavior, is called a *tropism*. Examples of plant tropisms include:

Phototropism

- The way a plant grows or moves in response to light

Gravitropism

- The way a plant grows or moves in response to gravity; also called *geotropism*

Hydrotropism

- The way a plant grows or moves in response to water

Thigmotropism

- The way a plant grows or moves in response to touch

It is not essential for students to know other tropisms, negative or positive tropisms, or the internal causes for tropisms.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

Assessment Guidelines:

The objective of this indicator is to *explain* how plants respond to external stimuli; therefore, the primary focus of assessment should be to construct a cause-and-effect model of plants responding to external stimuli through dormancy or tropisms. However, appropriate assessments should also require student to *identify* the responses of plants including dormancy and tropisms; *exemplify* tropisms in plants; or *illustrate* the forms of tropism using words, pictures, or diagrams.

Structures, Processes, and Responses of Plants

6-2 The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-2.9 Explain how disease-causing fungi can affect plants.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/future knowledge: In 5th grade (5-2.4), students identified the roles of organisms as they interact and depend on one another through food chains and food webs in an ecosystem, including decomposers (microorganisms, termites, worms, and fungi). Students have not previously been introduced to the concept of diseases or their affects on other organisms.

It is essential for students to know that fungi are a kingdom of organisms that do not make their own food.

- Many types of fungi must grow in or on other organisms, such as plants.
- These fungi, for example grain mold, corn smut, and wheat rust, cause diseases in those plants that result in huge crop losses.
- Diseases caused by fungi may also affect other important crops, such as rice, cotton, rye, and soybeans.
- If a fungus infects a tree, fruit, or grass, it can eventually kill the plant.

NOTE TO TEACHER: Students should know that even though fungi can be harmful to plants, they are also helpful as decomposers, as a source of penicillin (medicine), and as food.

It is not essential for students to know about fungi that cause diseases in humans (including Athlete's foot) as this will be studied further in 7th grade.

Assessment Guidelines:
The objective of this indicator is to *explain* the effects of disease-causing fungi on plants; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the ways that plants are affected by fungi. However, appropriate assessments should also require students to *recognize* fungi that cause disease in plants; or *recall* that not all fungi are harmful.