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## II. HOW DO PLANTS GROW?

Life is a miracle. Daily living is filled with miracles, but you must have the “eyes” and the interest to “see” many of the day-to-day miracles often taken for granted. Plant growth is such a miracle. Some growth is spectacular, taking place very rapidly in a matter of minutes or hours. Other growth is unnoticed even over the period of months or years. But whether fast or slow, the question still lingers, “How do plants grow?”

Anyone who has ever planted a seed in the ground, watered it, and waited patiently to see the first tiny leaf push through the soil must surely have been amazed. How does a tiny, dry, seemingly lifeless seed grow and develop into a plant just like its parent? Scientists are still asking how and why. Hundreds of years of dedicated study have not unlocked the mysteries of the Creator’s miracle of growth.

### SECTION OBJECTIVES

**Read these objectives.** When you have completed this section, you should be able:

8. To discuss plant growth.
9. To distinguish between monocots and dicots.
16. To express an appreciation for God’s purpose and design in plants.

### VOCABULARY



**Study these words** to enhance your learning success in this section.

annual	endosperm	perennial
bark	entropy	sigmoid curve
cotyledon	enzyme	tropism
dicotyledon (dicot)	meristem	vascular cambium
differentiation	monocotyledon	wood
elongation	(monocot)	

### DEVELOPMENTAL MORPHOLOGY

Developmental morphology is a study of the developmental characteristics of plant forms and structures. This section will help you to compare and contrast the form and structure of various groups of plants.

**Seedlings.** When a gardener or farmer grows a crop of plants, he often starts with the seeds. The seed is a conveniently packaged miniature plant. It contains the embryonic plant with a supply of specially formulated food and a protective cover called a *seed coat* that ensure getting the young plant off to a good start. All that is needed is a little water and a little care. Then watch it grow!

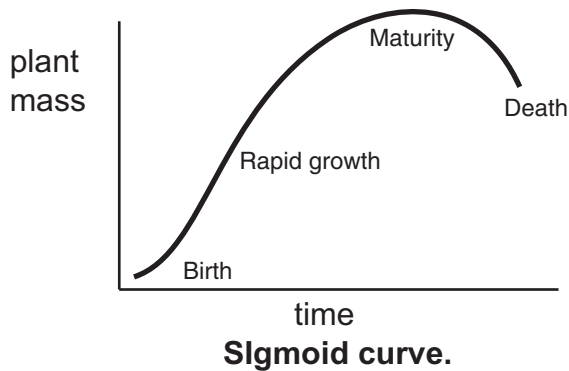
**Seed germination.** The increasing complexity and the careful organization observed as a seed germinates (or sprouts) and develops

into a mature plant is especially interesting. Starting from a small, dry chunk of tissue, a living plant emerges. It possesses a variety of different parts with distinct shapes, sizes, colors, and odors. Life and growth are miraculous phenomena that overcome **entropy**. Life and growth processes lead to an increased level of organization and volume, but only when energy is introduced to build up end products or to prolong aging.

Because of man’s sin, the universe is under the Creator’s judgment and is subject to the physical law of entropy. Like a giant clock that was wound up at the beginning, it is thought the universe is running down, degenerating, and therefore subject to entropy. Overcoming of entropy in living things is temporary. There is a tremendous amount of energy expended as an organism grows and develops. This energy is changed into usable life and growth energy, giving birth to a new plant.

As soon as a seed germinates, however, it begins to show signs of dying (entropy). At the moment of germination, the newly wound clock begins to run. As the new plant grows and tissues are organized, root cells are sloughed off, tissue dies, older leaves die, and new leaves appear. After producing seed, the entire plant dies—some in a month, a year, two years, or many years. The long lives of even the giant sequoias and the tenacious bristlecone pines are numbered. These ancient clocks will someday run down.

**Sigmoid curve.** The life phenomenon of birth, growth, maturity, and death can be illustrated by the **sigmoid curve**. This curve applies to all life. The sigmoid curve may also



be used to show what happens to populations of living things in a *closed system* (i.e., set limits of space, air, and food, as shown in a terrarium). The beginning phase of growth (rather slow) is followed by a rapid increase in growth (increased size or increased numbers of plants). Growth finally slows down and levels off. The leveling-off period may be short, as in an **annual** plant, which grows rapidly, produces flowers and seeds, and dies all in one year; or it may be long, as is evident for **perennials**, which show slow uniform growth for many seasons before death. Some perennials, especially ornamental garden plant varieties, may die back during cold winter then re-grow in spring.

In an *open system* more growth may occur before the leveling off occurs or entropy begins to take effect. This added growth happens when additional space, air, or food becomes available. The human population is at or very near the phase of the growth curve where an increase in one or more of these limiting factors must occur to support more people.

God designed the environment with open possibilities. Man has been given the ingenuity to manage the environment, for the benefit of all God's creation. But problems do arise. Waste and pollution place stress on our

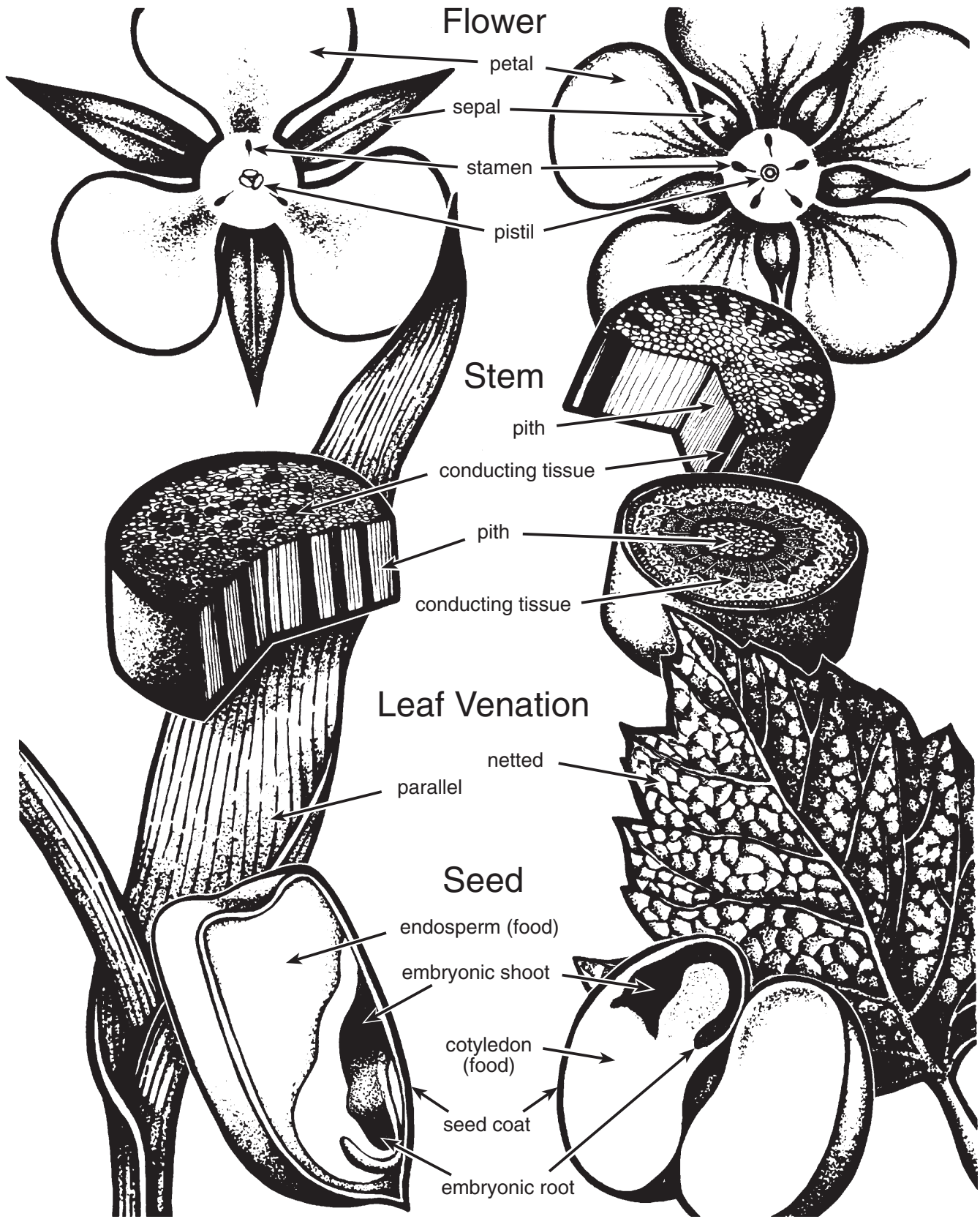


**Complete these activities.**

△ 2.1 Draw a sigmoid curve and label these parts: *birth, rapid growth, maturity, and death.*

△ 2.2 Draw the four life stages of an organism, using a single green plant as an example.

**a. birth**
**b. rapid growth**
**c. maturity**
**d. death**



MONOCOT PLANT

DICOT PLANT

Figure 7: Comparison of a Monocot and a Dicot

environment and damage life in general, often hampering food production and making the environment unsuitable for animals and plant life. Living with only immediate benefits in mind results in exploitation and waste of resources in the present, making them unusable for tens or even hundreds of years in the future. As stewards of God's creation, we should diligently accept the responsibility to better manage the environment for ourselves and future generations until the Lord returns.

**Monocots and dicots.** The embryo plant is basically an axis with a root-growing point at one end and a shoot-growing point at the other end. The shoot tip consists of tiny plumule leaves that later expand into the first true leaves of the plant. The axis is attached near the center to one or two **cotyledons** or seed leaves. Grasses are examples of **monocotyledons** (having *one* seed leaf) and beans are an example of **dicotyledons** (having *two* seed leaves). The food for the monocot embryo is stored in the surrounding tissue, the **endosperm**; the food for the dicot embryo is stored in cotyledons. The endosperm of some monocots is of importance to people because it is high in starch content and is suitable for

grinding into flour.

Flowering plants, or angiosperms (Class *Angiospermae*), are grouped into the two main subclasses, monocots and dicots, for taxonomic purposes. One of the main differences between them is seed leaf number. As the plants grow, other differences become pronounced. You will be able to recognize and classify many of these plants almost immediately into one of the two major groups. Compare the table below with Figure 7. It will help you compare and contrast some of the characteristics of monocots and dicots.

	MONOCOT	DICOT
<b>Seeds</b>	One cotyledon One seed leaf	Two cotyledons Two seed leaves
<b>Leaves</b>	Parallel veins	Netted veins
<b>Roots</b>	Usually fibrous	Usually a taproot
<b>Stems</b>	Scattered vascular tissue	Vascular tissue bundles form a ring
<b>Flowers</b>	Flower parts in multiples of three	Flower parts in multiples of four or five

**Comparison Table**



**Complete these statements.**

- 2.3 A plant that germinates, grows, produces flowers and seeds, and dies in a year or less is called a/an \_\_\_\_\_ .
- 2.4 A plant that may die back but continues to live for many years is called a/an \_\_\_\_\_ .
- 2.5 A prepackaged miniature plant is a good description for a/an \_\_\_\_\_ .
- 2.6 The sigmoid curve is used in \_\_\_\_\_ studies.
- 2.7 The physical law of \_\_\_\_\_ describes the process of increasing disorganization, deterioration, and degeneration in a closed system.
- 2.8 Two long-living plants are the (a) \_\_\_\_\_ and the (b) \_\_\_\_\_ .
- 2.9 The food for the embryo plant comes from either the (a) \_\_\_\_\_ or (b) \_\_\_\_\_ .



**Complete these statements.**

- 2.10 Define entropy: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

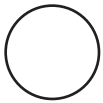
- 2.11 Distinguish between a monocot and a dicot in:
- leaf structure. \_\_\_\_\_
  - seed structure. \_\_\_\_\_
  - stem structure. \_\_\_\_\_
  - flowers. \_\_\_\_\_



**Complete this investigation.** It will take about two weeks.

**Materials needed:**

- magnifier tripod, 10x
- razor blade (single-edged)
- soil mixture (potting soil and sand)
- at least four of two types of monocot seeds (corn, wheat, grasses)
- at least four of two types of dicot seeds (lima, kidney or pinto bean, oak, pea)
- four Styrofoam cups
- water
- tray



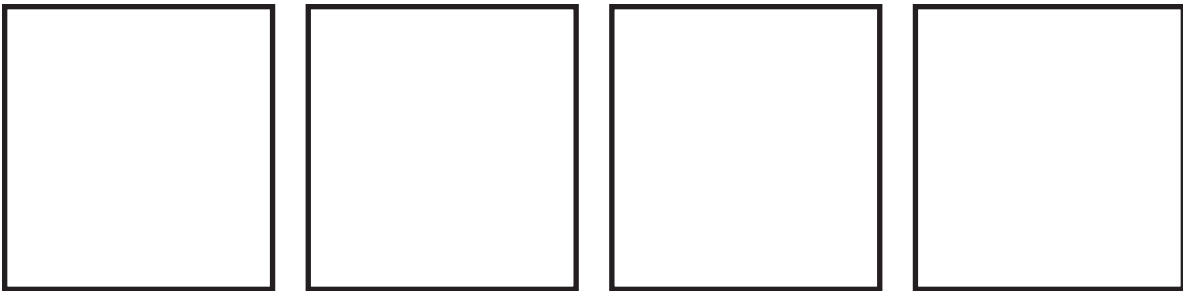
**Procedure.** Check the boxes as you complete each step.

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- Soak all of the seeds overnight in some water in a Styrofoam cup.
- Open one of each kind of seed with a razor blade.
- Use a magnifying glass to study the opened seeds.

△ 2.12

Make drawings of each opened seed. Label the following seed parts: *seed coat*, *shoot tip*, *root tip*, and the *cotyledons* or *endosperm*.



**Corn**

**Bean**

\_\_\_\_\_

\_\_\_\_\_

- 
- 
- 
- 
- 

- Fill each cup 3/4 full of soil mixture.
- Plant each of the four types of seeds in a different, labeled cup. Plant at least three seeds per cup, *no deeper than a quarter inch into the soil*.
- Make a drainage hole in the bottom of each cup.
- Place each cup on a tray.
- Water each plant as needed to keep the soil moist.