

Plants II

Objectives:

1. Describe the life histories of cycads, conifers and angiosperms and indicate which is the dominant generation in each division.
2. Compare and contrast the gametophyte of a fern, a conifer and an angiosperm.
3. Give reasons why gymnosperms persisted, even though angiosperms became dominant.
4. Describe the adaptations present in angiosperms but not in gymnosperms that made angiosperms so successful.
5. List the important features that distinguish monocots and dicots.
6. Given a plant specimen or description, place it correctly in one of these groups: Coniferophyta, Cycadophyta, or Anthophyta.

Introduction

There are two divisions of plants that produce seeds – gymnosperms (“naked seed”) and angiosperms (“hidden seed”). Gymnosperms include the cycads, which resemble palm trees but have cones (Cycadophyta), *Ginkgo* (Gingkoophyta), *Gnetum* and its relatives (Gnetophyta), and the familiar conifers (Coniferophyta). Angiosperms are placed in the division Anthophyta, which includes all flowering plants.

These plants have solved the problem of reproducing on land by doing away with flagellated sperm altogether. The male spores are retained within the parent plant and develop into immature male gametophytes called pollen grains. These are resistant to dehydration and can be spread in large numbers by the wind. Additionally, the young sporophyte embryo does not develop into a mature sporophyte immediately but can survive as a dormant seed until environmental conditions are favorable. The production of pollen and seeds allowed these plants to reproduce in the absence of water and major reason for their success.

Gymnosperms such as conifers have continued to survive in spite of the success of angiosperms because they are better adapted to poor, rocky soils and extreme cold. Their needles (evergreen leaves) allow them to carry out photosynthesis all year round even in extreme cold conditions. Many land plants, particularly conifers, have formed symbiotic relationships with fungi

called mycorrhizae. The fungi associate with the roots and significantly increase the surface area for absorption of minerals from poor soils.

Angiosperms are characterized by their flowers and their highly efficient vascular tissues. The rapid uptake of water and minerals by the root system (below ground) and their distribution to the shoot system (above ground) allow an angiosperm to maintain large leaves with broad surface areas. The higher rate of photosynthesis carried on by these leaves allows the plant to grow much more quickly than a gymnosperm, and it may reach reproductive maturity in a few weeks.

Most plant growth is indeterminate and stops only when the plant dies. Not all parts of the plant undergo cell division, however. Only certain tissue, called meristem, contains actively dividing cells. Meristematic tissue is found at the tip of the shoot (the part above the ground growing upward) and the tip of the root (the part underground growing downward). Growth occurs there due to the actively dividing cells of the apical meristem.

Plants may survive for 1, 2, or many years. The annuals die after a season's growth and allow their seeds to continue the species the following spring. Biennials reproduce after two seasons and then die. Perennials live on for many years. The body of an annual grows mainly in length, from the tips of its shoot system and from the tips of its roots where the actively dividing apical meristem is found. This type of growth is called primary growth. Some annuals and most perennials also increase in size sideways. This growth in girth by the addition of new cells is called secondary growth and is due to lateral meristem. The stem of some perennials—the trunk of a tree, for example—continues to increase in diameter year after year. Other perennials, such as the chrysanthemum and bulb-forming plants, die back each year and produce little or no secondary growth.

When secondary growth occurs, large amounts of secondary xylem called wood may be formed. This tissue gives great strength to the stems and roots of woody plants. Plants that do not form wood are called herbs. Secondary phloem is also produced.

Angiosperm plants show great diversity, but they fall into two main groups: the monocots and the dicots. These names are derived from the structure of the seed. A monocot has one seed leaf (cotyledon), whereas a dicot has two. The characteristics of the roots, stems, and leaves are also different. Monocots are usually herbs, whereas dicots include both herbs and woody plants.

In this exercise you will be examining representatives of the plant divisions whose members produce seeds. Using prepared slides and, in some cases, fresh tissue, you will learn to identify the major seed plant divisions based on their anatomy and morphology. As you examine the slides and plant material, attempt to identify the adaptations in the morphology and lifecycle of gymnosperms and angiosperms that have made them so successful in a terrestrial environment. Finally, at the end of the laboratory, you will learn how to distinguish between the two classes of angiosperms based in their anatomy and morphology.

Group: Vascular plants with seeds - Gymnosperms (naked seeds)

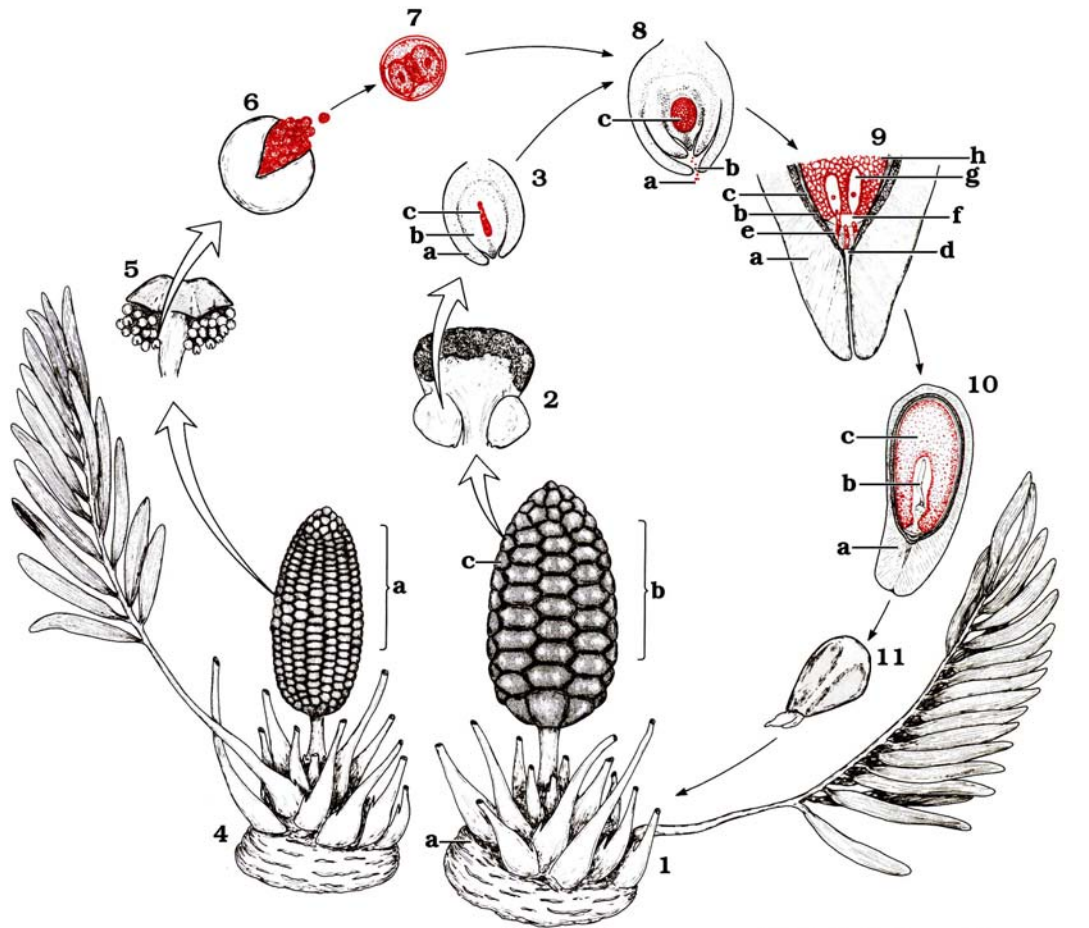
- Over 760 species.
- Woody trees, shrubs, and a few vines.
- Usually cones as reproductive structures.
- Seeds are borne exposed on scales of cones.
- Normally wood (xylem) lacks vessels, has only tracheids for water conduction.

Division: Cycadophyta

- Cycads.
- About 100 species, important phylum during the Triassic period (248 million years ago).
- Dioecious, meaning that seed cones and pollen cones are on two separate plants.
- They are tropical and subtropical plants with trunk-like stems and compound leaves.
- They are popular as ornamentals.
- *Zamia pumila* is the only U.S. native cycad.
- Examples: False king sago, and coontie (*Zamia pumila*).

Examine the potted specimen, if available. These palm-like plants are gymnosperms as they produce cones. In some species, both male and female plants produce cones, while in others only the male bears cones (the female reproductive structure is more leaf-like in these species). Examine the cone specimens available in lab and see if you can determine which is which.

ZAMIA LIFE CYCLE



- 1. Sporophyte, ovulate
 - a. Tuberous stem
 - b. Strobilus
 - c. Megasporophyll
- 2. Megasporophyll with ovules
- 3. Ovule, sec.
 - a. Integument
 - b. Nucellus (megasporangium)
 - c. Megaspore tetrad
- 4. Sporophyte, staminate
 - a. Strobilus

- 5. Microsporophyll
- 6. Microsporangium, dehiscent
- 7. Microspore with microgametophyte (pollen)
- 8. Ovule at pollination
 - a. Pollen
 - b. Micropyle
 - c. Megagametophyte
- 9. Ovule at fertilization
 - a. Outer integument
 - b. Stony integument

- c. Inner integument
- d. Pollen chamber
- e. Microgametophyte
- f. Archegonial chamber
- g. Archegonium
- h. Megagametophyte
- 10. Seed, sec.
 - a. Old sporophyte
 - b. Embryo (new sporophyte)
 - c. Megagametophyte
- 11. Germinating seed

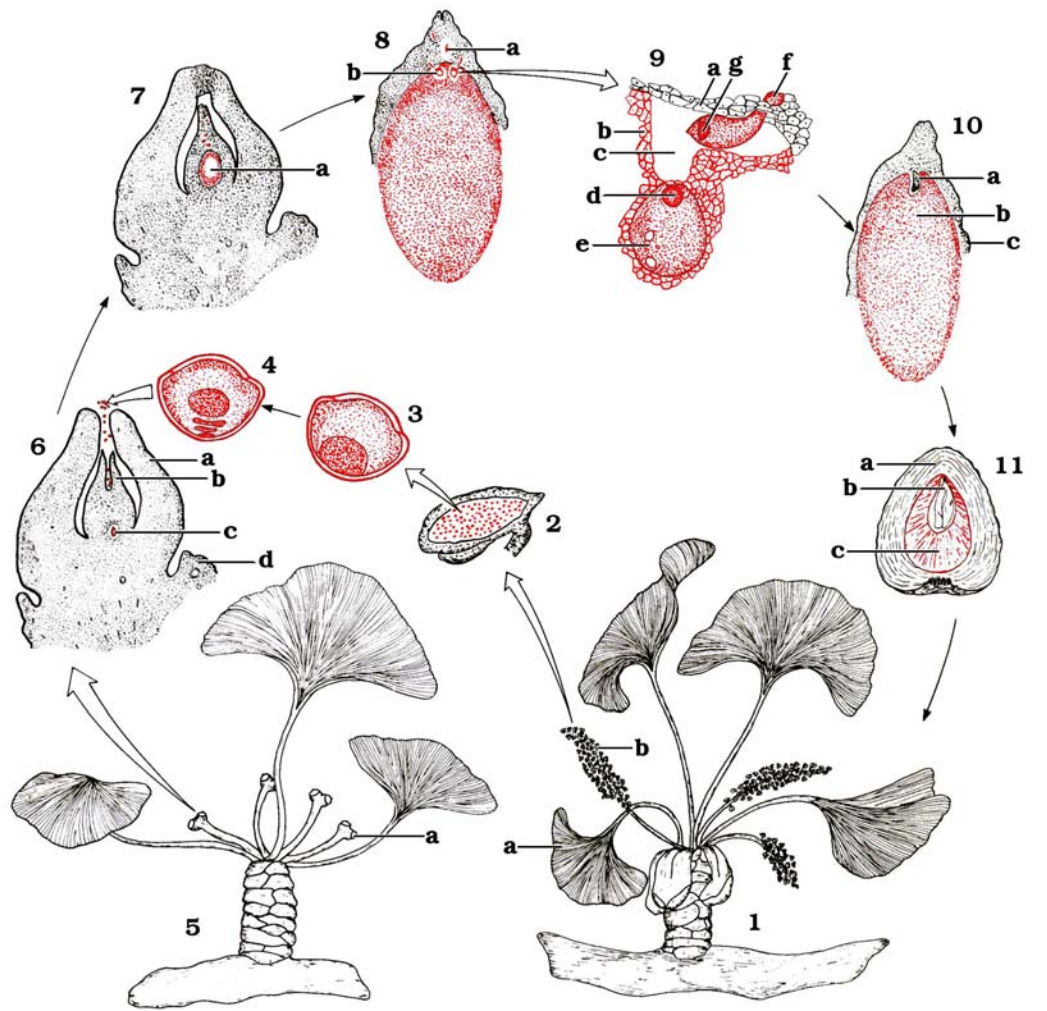
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Division: Ginkgophyta

- Only 1 species left, a native of Eastern China.
- It is the oldest species of living tree; the other ginkgoes went extinct 200 million years ago.
- Deciduous (shed leaves), with seeds completely exposed (no cone).
- Important medicinal plant enhancing neurological functions such as memory in geriatric patients.
- Seeds are eaten in China.
- Example: *Ginkgo biloba*.

GINKGO LIFE CYCLE



- | | | |
|---|---|---|
| <p>1. Staminate spur shoot a. Dichotomous venation b. Microstrobilus</p> <p>2. Microsporophyll, l.s.</p> <p>3. Microspore</p> <p>4. Mature microspore with microgametophyte (pollen)</p> <p>5. Ovulate spur shoot a. Ovule</p> <p>6. Ovule at pollination, l.s. a. Integument b. Megasporangium</p> | <p>c. Megaspore tetrad d. Collar (megasporophyll)</p> <p>7. Ovule, l.s. a. Free-nuclear megagametophyte</p> <p>8. Megagametophyte, l.s. a. Pollen tube b. Archegonium</p> <p>9. Archegonium near fertilization a. Megasporangial tissue</p> | <p>b. Megagametophyte c. Archegonial chamber d. Egg nucleus e. Archegonium f. Pollen tube g. Sperm nucleus</p> <p>10. Embryo, meristematic, l.s. a. Embryo (new sporophyte) b. Megagametophyte c. Megasporangium</p> <p>11. Seed, l.s. a. Old sporophyte b. Embryo (new sporophyte) c. Megagametophyte</p> |
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Division: Gnetophyta

- About 70 species
- Possess more efficient water-conducting cells (vessel elements) in their xylem. The other gymnosperms usually do not have vessels (angiosperms have these vessel elements too). Include tropical shrubs and vines. Some found in deserts and other dry regions.
- Believed to be most closely related to flowering plants
- Examples: *Ephedra* and *Welwitschia*.

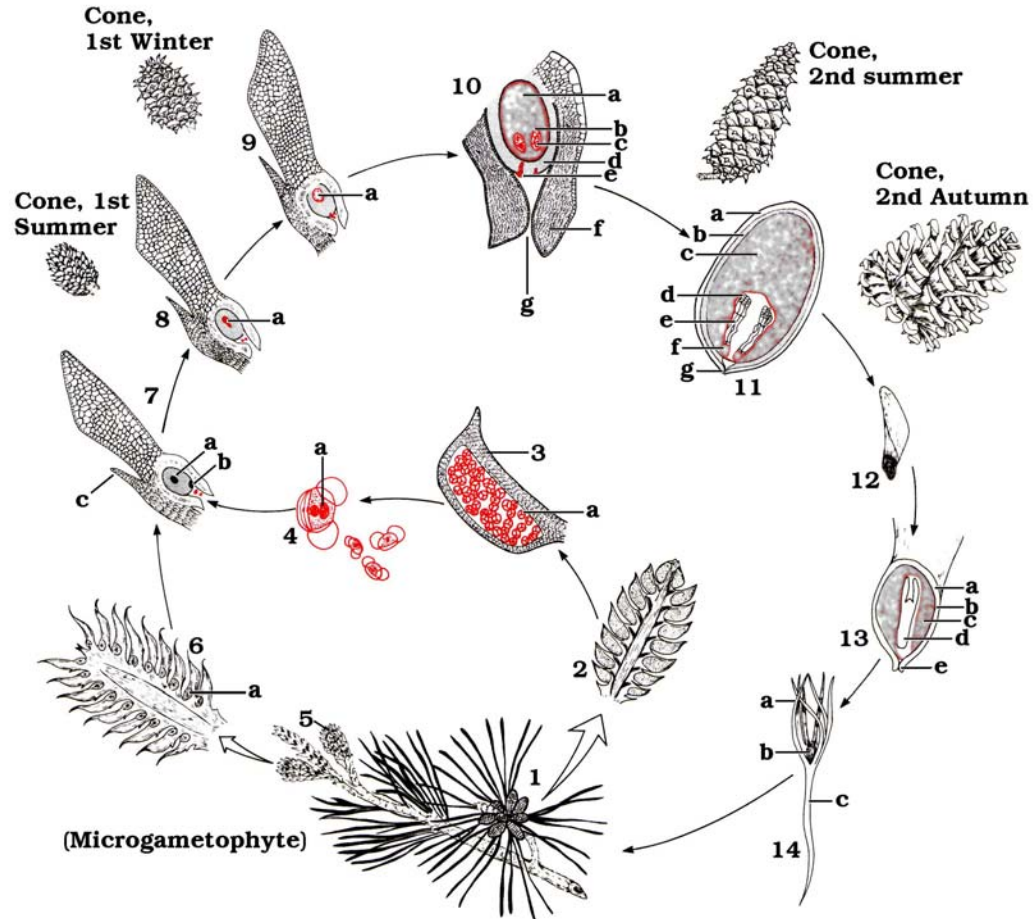
Division: Coniferophyta (Latin *Conus*, cone; *ferre*, to carry)

- Pines, spruces, hemlocks, and firs
- About 550 species.
- Woody trees or shrubs that produce secondary xylem every year (wood and bark).
- Possess long and narrow leaves called needles, and produce resin.
- Usually monoecious, meaning that seed cones and pollen cones are on the same plant.
- Ecologically important for providing shelter and food to animals and for preventing soil erosion (roots), lumber, paper, and medicine (taxol).
- Examples: Longleaf pine, Slash pine, Sand pine, Pond pine, Bald cypress (*Taxodium distichum*), and Pond cypress (*Taxodium acendens*).

Examine the cones available in the lab and identify the staminate and ovulate cones. Draw a diagram of the pine life cycle, indicating which structures are haploid and which are diploid. Examine prepared slides (if available) of conifer pollen, evergreen leaves (needles) and cones. Draw diagrams of your observations and use these to answer the following questions:

1. You may have noticed that the pollen of conifers appears to be winged. What is the function of the wings on the pollen grain?

PINE LIFE CYCLE



1. Staminate strobilus (spring)
2. Staminate strobilus, l. s.
3. Microsporophyll, l. s.
 - a. Microsporangium
4. Mature pollen (microspore)
 - a. Microgametophyte
5. Ovulate strobilus (spring)
6. Ovulate strobilus, l. s.
 - a. Ovule
7. Megasporophyll, l. s.
 - a. Megaspore mother cell
 - b. Megasporangium
 - c. Bract
8. Megasporophyll, l. s.
 - a. Megaspore tetrad
9. Megasporophyll, l. s.
 - a. Free-nuclear megagametophyte

10. Ovule (13 months)
 - a. Megagametophyte
 - b. Archegonium
 - c. Egg nucleus
 - d. Megasporangium
 - e. Germinated pollen
 - f. Integument
 - g. Micropyle
11. Ovule (14 months)
 - a. Integument
 - b. Megasporangium
 - c. Megagametophyte tissue
 - d. Embryos

- e. Suspensor
- f. Archegonium
- g. Micropyle
12. Megasporophyll
13. Mature ovule, l. s.
 - a. Integument
 - b. Megasporangium
 - c. Megagametophyte tissue
 - d. Embryo
 - e. Micropyle
14. Seedling
 - a. Cotyledon
 - b. Plumule
 - c. Radicle

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Group: Vascular plants with seeds - Angiosperms (seeds enclosed within a fruit)

- Over 250,000 species
- Woody or herbaceous.
- Flowering plants that produce flowers, fruits, and seeds.
- Seeds are enclosed within a fruit.

Division: Anthophyta

- Largest group of plants.
- Heterosporous, bear flowers, and seeds enclosed in a fruit.
- Two classes based on the seed leaf of the plant embryo, called cotyledon.

Class: Liliopsida

- True monocot.

Class: Magnoliopsida

- True Dicots.
- Example: Slides of maize caryopsis (corn seed) showing scutellum i.e. cotyledon, coleoptile, coleorhiza, epicotyl, and hypocotyl; endosperm, and ovary wall. Also *Capsella* (shepherd's purse) showing cotyledons, epicotyl, hypocotyl, and seed coats.

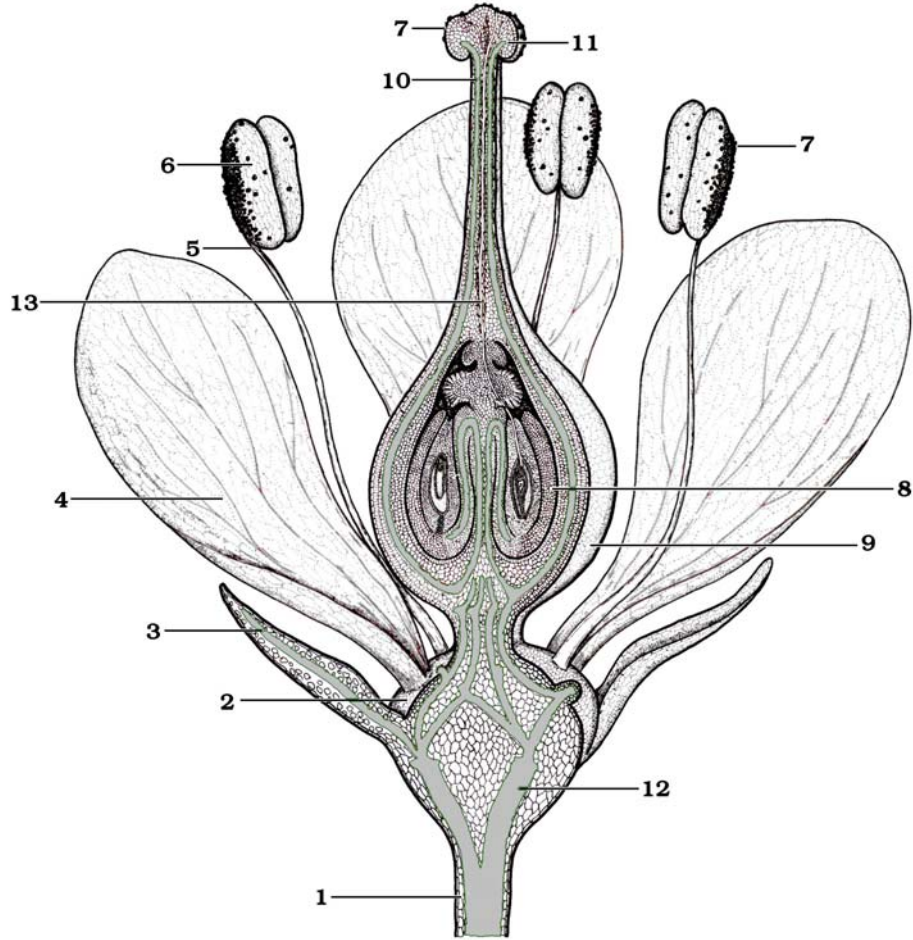
In this part you will learn the difference between monocots and dicots (examine the appropriate specimens and slides), the basic plant anatomy, various terms for different fruits, modified stems, and roots. You will need to be able to identify these differences.

Complete the following exercises and answer the accompanying questions:

1. Use the following diagram, which illustrates the anatomy of a typical flower, identify and label the following structures:
 - a. pedicel
 - b. receptacle
 - c. sepals
 - d. petals

- e. stamen, including the filament and anther
- f. pistil (carpel) containing the stigma, style and ovary
- g. ovule

TYPICAL FLOWER Dicot



- | | |
|------------------|-------------------|
| 1. _____ | 7. _____ |
| 2. _____ | 8. _____ |
| 3. _____ | 9. _____ |
| 4. _____ } _____ | 10. _____ } _____ |
| 5. _____ } _____ | 11. _____ } _____ |
| 6. _____ } _____ | 12. _____ |
| | 13. _____ |

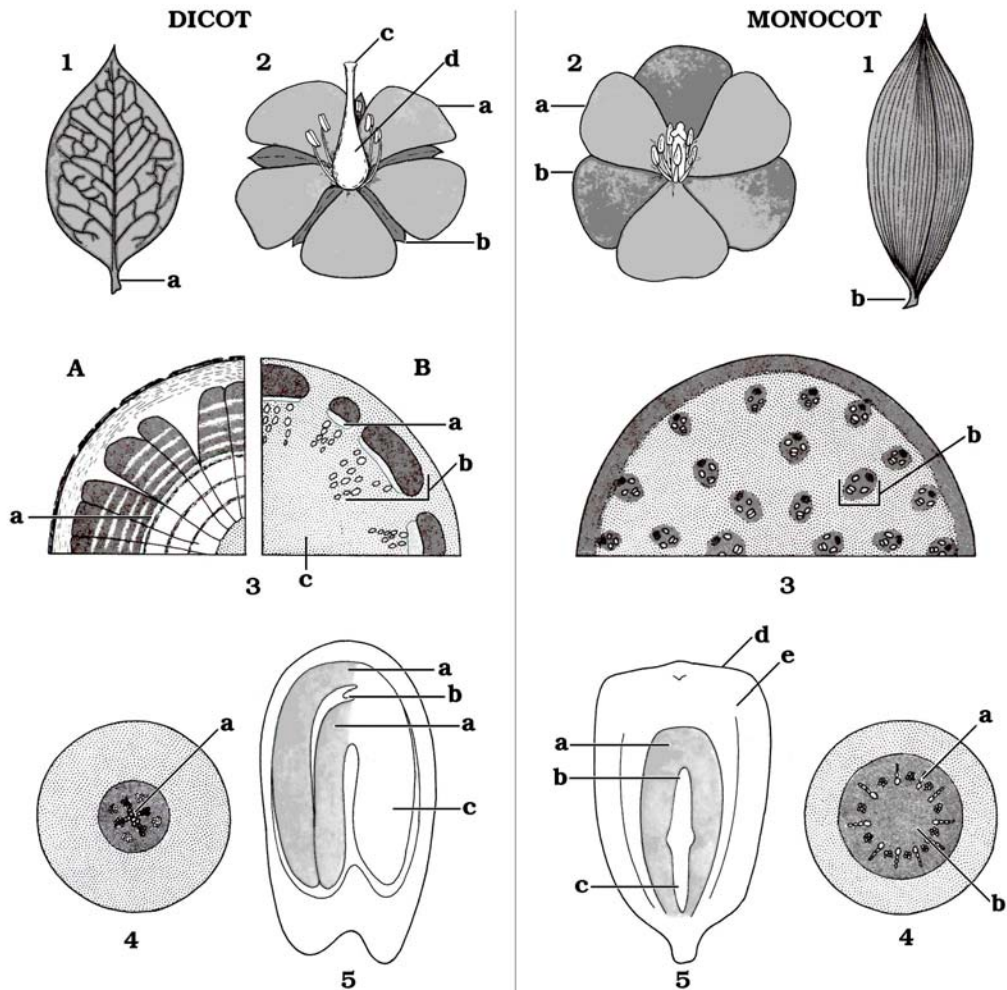
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2. Draw a diagram outlining the life cycle of a typical angiosperm. Indicate which structures are diploid and haploid.

3. Complete the following table that compares the class Monocotyledonae (monocot) and the class Dicotyledonae (dicot). Examine the available angiosperm specimens and classify each as either a monocot or a dicot.

| Feature | Monocotyledonae | Dicotyledonae |
|---------------------------------|------------------------|----------------------|
| Number of cotyledons | | |
| Multiples of flower parts | | |
| Vein pattern in leaves | | |
| Arrangement of vascular bundles | | |
| Type of root system | | |
| Examples | | |

DICOT AND MONOCOT COMPARISON



1. Leaf
 - a. Petiole
 - b. Leaf sheath
2. Flower
 - a. Petal
 - b. Sepal
 - c. Pistil
 - d. Stamen
3. Stem (cross section)
 - A. Woody
 - B. Herbaceous
 - a. Cambium
 - b. Vascular bundle
 - c. Pith

4. Root
 - a. Vascular tissue
 - b. Pith
5. Seed
 - a. Cotyledon
 - b. Epicotyl
 - c. Hypocotyl
 - d. Fruit wall
 - e. Endosperm

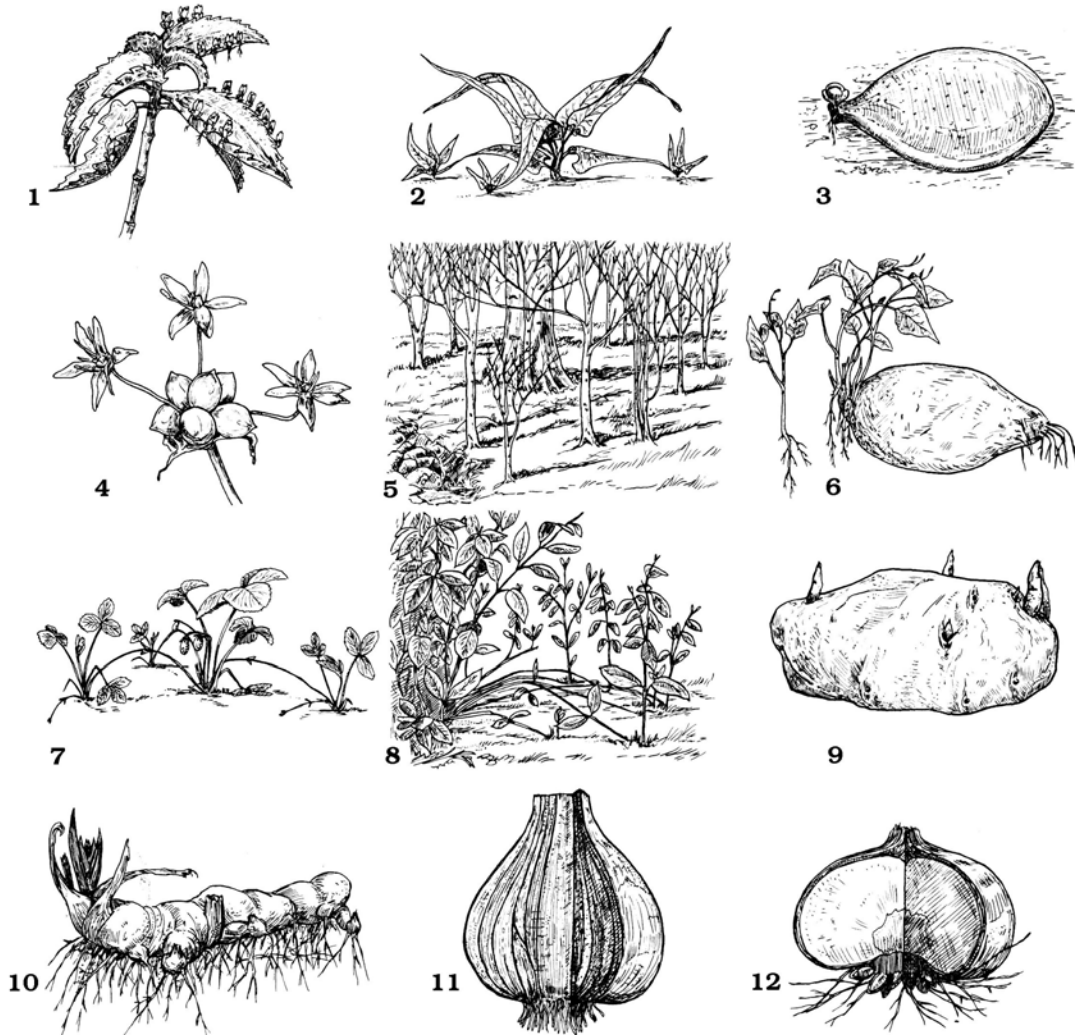
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4. Angiosperm stems (the ascending portion of the plant) not only produce and support leaves and flowers, and transport water and nutrients, but can be modified for a number of specializations. The table below lists five of the most common stem modifications. Define each of these modified stems and give at least one example of each.

| Stem modification | Definition/description | Example |
|--------------------------|-------------------------------|----------------|
| Tuber | | |
| Rhizome | | |
| Tendrils | | |
| Bulb | | |
| Corm | | |

PLANT REPRODUCTION

Vegetative



I. Leaves

1. Marginal plantlets (Kalanchoe)
2. Tip layering (walking fern)
3. Petiolar plantlet (jade plant)

II. Flowers

4. Aerial bulbs (onion)

III. Roots (by adventitious budding)

5. Horizontal (beech)
6. Fleshy (sweet potato)

IV. Stems (by adventitious rooting)

7. Stolons (strawberry)
8. Tip layering (Forsythia)
9. Tuber (Irish potato)

V. Stems (by division)

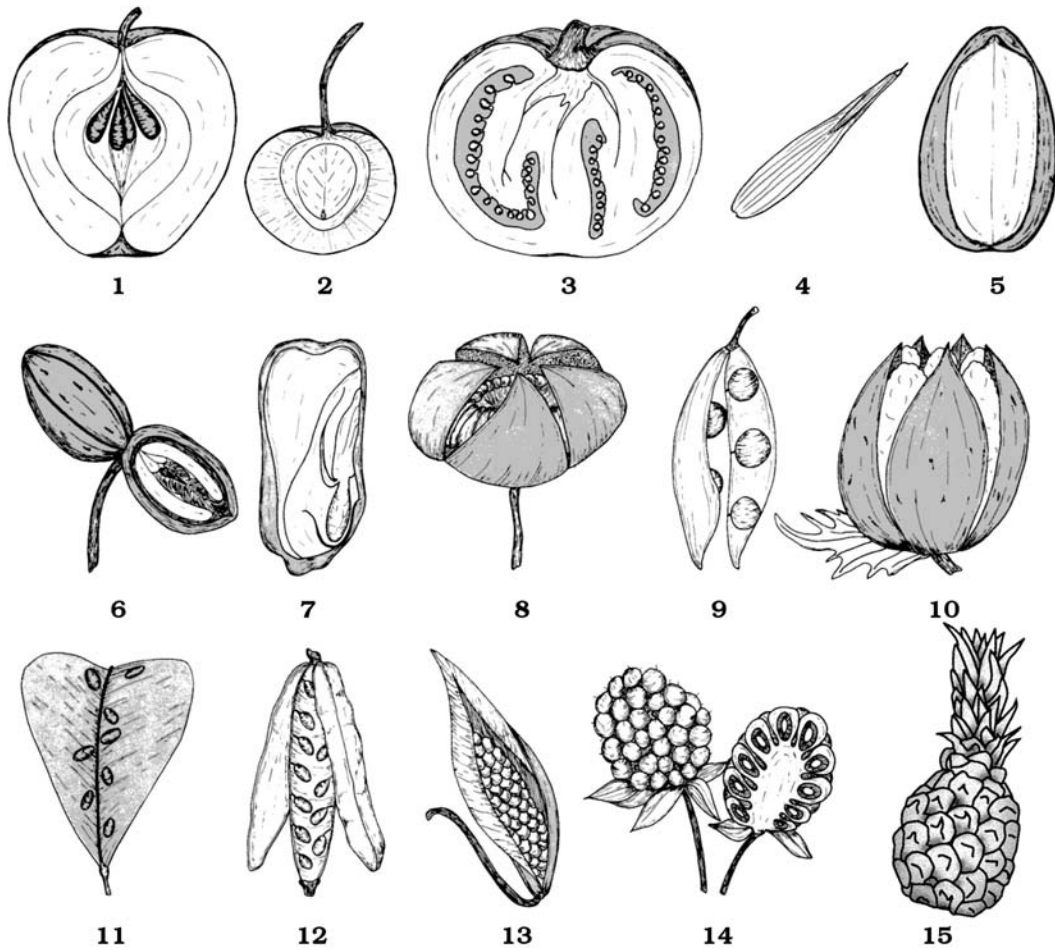
10. Rhizome (iris)
11. Bulb (onion)
12. Corm (Crocus)

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5. Seed dispersal in angiosperms is accomplished by the use of fruits. Ten different types of fruit are recognized by plant biologists and descriptions of each type are included in the table below. Using these descriptions, examine the examples of angiosperm fruits provided and list it in the table in the box next to the correct description. (Hint: Not all fruit types may be present, some may be used more than once)

| Category | Fruit Type | Description | Example |
|--------------------------|-----------------|--|---------|
| Simple fruits | | | |
| Dry fruits (at maturity) | Achene | Ovary wall and seed coat are fused, one seed | |
| | Nut | Ovary wall hard or woody but can be separated from seed, one seed | |
| | Capsule | Ovary has several cavities in cross-section, several to many seeds | |
| | Legume | Ovary has one cavity that opens along both sides, many seeds | |
| | Follicle | Ovary has one cavity that opens along one side, many seeds | |
| Fleshy fruits | Drupe | Ovary with one seed surrounded by very hard seed, outer covering of seed formed from inner ovary wall | |
| | Berry | Mature ovary tissue soft and fleshy, surrounding flower tissue does not develop into fruit, many seeds | |
| | Pome | Fleshy fruit develops in part from surrounding flower tissue (base of sepals and petals), ovary wall forms "core" around seeds, many seeds | |
| Compound fruits | | | |
| more than one ovary | Multiple fruit | Fruit formed from ovaries of many flowers | |
| | Aggregate fruit | Fruit formed several ovaries in one flower | |

FRUIT TYPES



SIMPLE FRUIT

Fleshy

- 1. _____
- 2. _____
- 3. _____

Dry, indehiscent

- 4. _____
- 5. _____
- 6. _____
- 7. _____
- 8. _____

SIMPLE FRUIT

Dry, dehiscent

- 9. _____
- 10. _____
- 11. _____
- 12. _____
- 13. _____

COMPOUND FRUIT

- 14. _____
- 15. _____

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6. Identify the function of each of the following structures found in seed plants. Consider their function in the land environment.

a. pollen grain

b. microsporangium

c. flower

d. carpel

e. seed

f. fruit

g. endosperm

7. As a way of summarizing what you have learned about land plants in the last two weeks, complete the following table that compares the important characteristics of land plants.

| Features | Moss | Fern | Conifer | Flowering plant |
|----------------------------------|-------------|-------------|----------------|------------------------|
| Dominant generation | | | | |
| Vascular tissue (+/-) | | | | |
| Seed (+/-) | | | | |
| Fruit (+/-) | | | | |
| Water required for fertilization | | | | |
| Pollen grain (+/-) | | | | |
| Homosporous or heterosporous | | | | |
| Examples | | | | |