PLANT ANATOMY, GROWTH AND DEVELOPMENT

AG 510 - F

UNIT OBJECTIVE

After completion of this unit, students should be able to match terms and definitions, identify the parts of a plant and match functions and plant parts. Students should also be able to select requirements for good seed germination and list factors that cause poor germination. This knowledge will be demonstrated by completion of the unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

 1. Match terms associated with plant growth and development to the correct definitions.

 2. Name the three stages of plant growth and development.

 3. Name three requirements for good seed germination.

 4. Label a drawing showing the parts of a monocot and dicot seed.

 5. Arrange in order the stages of germination for a monocot and dicot seed.

 6. Select factors that cause poor seed germination.

 7. Label a drawing showing the four primary parts of a plant.

 8. Match functions of plant parts to the correct part.

 9. Name two types of root systems.

 10. Label a drawing showing the parts of a stem.

 11. Label a drawing showing the plant tissues in a monocot and dicot stem.

 12. Match stem modifications with the correct description.

 13. Select conditions affecting the vegetative growth of crop plants.

 14. Name the three vegetative growth stages of small grains.

 15. Name the four vegetative growth stages of corn.

 16. Describe sexual reproduction in plants.

 17. Describe asexual reproduction in plants.

 18. Arrange in order the life cycle of a flowering plant.

 19. Label a drawing showing the parts of a complete flower.

 20. Match the type of flower to the correct description.

 21. Match the types of pollination to the correct description.

 22. Name three ways pollen is moved.

 23. Explain the process of fertilization in plants.

 24. Define the two basic types of plant tissue.

25. Identify the correct types of meristematic and permanent tissues when given a description of each.

 26. Study cells.

 27. Study cell parts.

 28. Describe how animal cells differ from plant cells.

 29. Discuss how monocot stems differ from dicot stems.

 30. Examine roots and stems.

 31. Examine root growth.

 32. Observe the structure and function of flowers.

 33. Study flower functions in reproduction.

 34. Observe the development of seed parts into young plants.

 35. Observe plant growth.

 36. Study plant reproduction without seeds.

 37. Grow a bean plant.

 38. Grow plants from seeds.

 39. Produce rooted cuttings.

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SUGGESTED ACTIVITIES

 I. Suggested activities for instructor

 A. Order materials to supplement unit.

 1. Literature

a. *Agronomy Curriculum Materials Packet*, 232 pages; available from IAVIM, 208 Davidson Hall, Iowa State University, Ames, Iowa 50011; approximate cost $10.00; order no. 214.

b. *Crop Production*, 15 transparency masters; available from IAVIM, 208 Davidson Hall, Iowa State University, Ames, Iowa 50011; approximate cost $2.25; order no. 517.

 2. Filmstrips, slideshows, etc.

a. *Agronomy,* computer program; available from IAVIM, 208 Davidson Hall, Iowa State University, Ames, Iowa 50011; approximate cost $15.00; order no. 902.

 B. Make transparencies and necessary copies of materials.

 C. Provide students with objective sheet and discuss.

 D. Provide students with information sheets and laboratory exercises.

E. Discuss information sheets and demonstrate procedures outlined in laboratory exercises.

 F. Review and give test.

 G. Reteach and retest if necessary.

 II. Instructional materials

 A. Objective sheet

 B. Suggested activities

 C. Information sheet

 D. Transparency masters

 1. TM 1--A Corn Grain and Its Parts

 2. TM 2--A Bean Seed and Its Parts

 3. TM 3--Stages in Germination and Emergence of Corn

 4. TM 4--Stages in Germination and Emergence of a Bean Seed

 5. TM 5--Primary Parts of a Plant

 6. TM 6--Functions of Leaves, Stems, Roots and Flowers

 7. TM 7--Types of Root Systems

 8. TM 8--Parts of the Stem

 9. TM 9--Arrangement of Tissue in Stems

 10. TM 10--Above Ground Stem Modifications

 11. TM 11--Below Ground Stem Modifications

 12. TM 12--Conditions Affecting the Vegetative Growth of Crop Plants

 13. TM 13--Comparison of Utilization of Sunlight by Crop Plants

 14. TM 14--Plant Growth Variance With Temperature Change

15. TM 15--Rate of Photosynthesis and Respiration as Affected by Temperature

16. TM 16--Approximate Pounds of Water Required to Produce One Pound of Dry Matter

 17. TM 17--Vegetative Growth Stages of Wheat

 18. TM 18--Vegetative Growth Stages of Corn

 19. TM 19--The Life Cycle of a Flowering Plant

 20. TM 20--Parts of a Complete Flower

 21. TM 21--Self-pollination and Cross-pollination

 22. TM 22--Plant Meristems

 23. TM 23--Epidermal Cells

 24. TM 24--Parenchyma Tissue

 25. TM 25--Collenchyma Tissue

 26. TM 26--Schlerenchyma Tissue

 27. TM 27--Phloem Tissue

 E. Instructor notes for laboratory exercises

 F. Laboratory exercises

 1. LE 1--What Are Cells?

 2. LE 2--Studying Cell Parts

 3. LE 3--Animal and Plant Cell Differences

 4. LE 4--How Monocot Stems Differ From Dicot Stems

 5. LE 5--Examining Roots and Stems

 6. LE 6--Root Growth

 7. LE 7--Observing the Structure and Function of Flowers

 8. LE 8--Flower Functions in Reproduction

 9. LE 9--Development of Seed Parts into Young Plants

 10. LE 10--Plant Growth

 11. LE 11--Plant Reproduction Without Seeds

 12. LE 12--Growing a Bean Plant

 13. LE 13--Plant Propagation From Seed

 14. LE 14--Produce Rooted Cuttings

 G. Answers to laboratory exercises

 H. Test

 I. Answers to test

 III. Unit references

A. Cooper, Elmer L., *Agriscience Fundamentals and Applications*, Delmar Publishers, Inc., Albany, New York 12212, 1990.

B. Delorit, R.J., et al., *Crop Production*, 5th edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1984.

C. Fridline, C.R., *Plant Growth and Development*, Ohio State University, Ohio Agricultural Education Curriculum Materials Service, Columbus, Ohio, 1980.

D. Fridline, C.R., *Seed Production of Corn, Small Grains and Soybeans*, Ohio Agricultural Education Curriculum Materials Service, Columbus, Ohio, 1977.

E. Hartmann, Hudson T., et al., *Plant Science - Growth, Development, and Utilization of Cultivated Plants*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632, 1988.

F. Janick, J., et al., *Plant Science*, 2nd edition, W.H. Freeman and Co., San Francisco, California, 1974.

G. Otto, James H., Towle, Albert*, Modern Biology*, Holt, Rinehart and Winston, New York, 1985.

H. Raven, P.H., et al., *Biology of Plants,* 3rd edition, Worth Publishers, Inc., New York, New York, 1981.

I. Slesnick, Irwin, L., et al., *Biology*, Scott, Foresman and Company, Glenview, Illinois, 1985.

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INFORMATION SHEET

 I. Terms and definitions

 A. Node--The part of a stem where a leaf is attached

 B. Internode--The part of a stem between two nodes

 C. Bud--An embryonic shoot of a plant

 D. Leaf scar--A scar left on the stem when a leaf falls

E. Vascular bundle scar--A spot within a leaf scar left by the vascular bundles when a leaf falls

 F. Monocot--Plant having one seed leaf (cotyledon) as in cereals and corn

 G. Dicot--Plant having two seed leaves (cotyledons) as in beans and peas

H. Vascular bundle--A strand of tissue containing xylem and phloem enclosed by a sheath of cells

I. Xylem--Vascular tissue that transports water and minerals from the root system to the leaves

J. Phloem--Vascular tissue that conducts food from the leaves to regions of growth or storage

 K. Pistil--Seed bearing organ of a flower, composed of the ovary, style and stigma

L. Stamen--Part of the flower which produces the pollen; composed of the filament and anther

 M. Fertilization--Union of the male (pollen) nucleus with the female (egg) cell

 N. Pollination--Transfer of pollen from the anther to the stigma

 O. Embryo--The young plantlet within the seed; the germ

 P. Radicle--The embryonic root

 Q. Hypocotyl--The part of an embryo between the cotyledons and the radicle

R. Epicotyl--The part of the embryo above the cotyledons and below the next leaves

 II. Stages of plant growth and development

 A. Seed germination and seedling growth

 B. Vegetative

 C. Reproduction

 III. Requirements for good seed germination

 A. Proper temperature

(Note: This requirement varies for different crops. Cereals will show some germination at 32oF, while corn will not show any germination until 48oF.)

 B. Sufficient moisture

(Note: This requirement varies for different crops. Cereals will germinate when their moisture content is about 50%. Soybeans will not germinate until their moisture content is about 75%. The range is 26% to 75% for most agronomic crops.)

 C. Ample supply of oxygen

(Note: Germination will not occur if oxygen is not available for crops like small grains and peas. Rice seed can germinate in the absence of oxygen.)

 IV. Parts of the seed

 A. Monocot (Transparency 1)

 1. Epicotyl

 2. Hypocotyl

 3. Radicle

 4. Cotyledon

 5. Coleoptile

 6. Endosperm

 7. Seed coat

 B. Dicot (Transparency 2)

 1. Epicotyl

 2. Hypocotyl

 3. Radicle

 4. Cotyledons

 5. Seed coat

V. Stages of germination

 A. Monocot (corn, small grains) (Transparency 3)

 1. Absorption of water and oxygen into the seed

2. The seed coat ruptures and the primary root (radicle) begins to grow downward

3. The epicotyl elongates, the coleoptile piercing the soil as it grows upward

 (Note: The leaves of the coleoptile are rolled into tight pointed buds.)

 4. The coleoptile emerges

(Note: When the coleoptile emerges, the first node on the stem is still underground. It is from this node that the secondary root system develops.)

 5. The coleoptile unfolds

(Note: When the leaves of a seedling emerge above the soil surface and unfold, the plant is then capable of manufacturing its own food.)

 B. Dicot (beans, peas) (Transparency 4)

 1. Absorption of water and oxygen into the seed

2. The seed coat ruptures and the primary root (radicle) begins to grow downward

3. The hypocotyl curves into a loop and pushes through the soil, pulling the cotyledons toward the soil surface

 4. Emergence of seedling occurs

(Note: The curve in the hypocotyl straightens out immediately after emergence so the plant will stand correctly.)

5. The cotyledons spread apart and the stem tip is exposed to air and sunlight

(Note: When the first pair of leaves has emerged, the plant is then capable of manufacturing its own food.)

 VI. Factors that cause poor seed germination

 A. Mechanical injury to seed (cracked grain)

 B. Disease

 C. Storage conditions

(Note: Temperature and humidity are important considerations for storage of crop seeds.)

 D. Age of seed

 (Note: Germination percentages will decrease as the age of the seed increases.)

 E. Soil temperature too cold

 F. Hard seed coat

(Note: Some plants (hard-seeded legumes) produce seeds with a hard seed coat. The seed coat will not allow moisture and oxygen to enter the seed and bring about germination.)

 G. Soil moisture insufficient

 H. Planting too deep

 I. Chemical damage

(Note: Reduced germination percentages may result if seeds come in contact with chemicals such as fertilizers.)

 J. Crusting of soil

 VII. Primary parts of a plant (Transparency 5)

 A. Roots

 B. Stem

 C. Leaves

 D. Flowers

 VIII. Functions of plant parts (Transparency 6)

 A. Roots

 1. Absorb water and nutrients

(Note: Most of absorption takes place through root hairs. The rate at which water is absorbed depends on (1) the rate at which water is lost from leaves (transpiration), (2) the amount of water in the soil, and (3) the amount of root surface in contact with soil particles.)

 2. Anchor and support plants

(Note: The roots must anchor the plant to the extent that wind, etc., cannot knock it down.)

 3. Store food

(Note: Some plants store foods they have manufactured in the roots. Examples are radishes, carrots, sweet potatoes and sugar beets.)

 B. Stem

 1. Supports leaves, flowers, fruit and seeds

 2. Conducts water, nutrients and food

(Note: The stem conducts water and minerals in solution from the root system through the xylem tissue to the leaves. It also conducts food made in the leaves through the phloem tissue to the parts of the plant where it is growing or food is being stored.)

 3. Stores food

(Note: Examples of plants that store food in the stem include potatoes and asparagus.)

 C. Leaves

 1. Manufacture food for the plant

(Note: Photosynthesis is the process by which leaves make food from carbon dioxide and water in the presence of sunlight.)

 2. Necessary for transpiration

 3. Store food

(Note: Examples of plants that store food in the leaves include lettuce, cabbage, celery, rhubarb and onions.)

 D. Flowers

 1. Serve as site of reproduction

 2. Store food

(Note: Examples of plants that store food in flowers include grains, fruits, nuts, berries, broccoli and cauliflower.)

 IX. Types of root systems (Transparency 7)

 A. Tap root system

(Note: In this system, one root is larger than the rest. Examples of plants with tap root systems include alfalfa, sugarbeets, beans, carrots and radishes.)

 B. Fibrous root system

(Note: In this system, all roots are approximately the same size. Examples of plants with fibrous root systems include all the grasses and cereal grains.)

 X. Parts of the stem (Transparency 8)

 A. Node

 B. Internode

 C. Terminal bud

 D. Lateral bud

 E. Leaf scar

 F. Vascular bundle scar

 XI. Tissues in a stem (Transparency 9)

 A. Monocots

(Note: Vascular tissue, which consists of the xylem and phloem, is evenly distributed throughout the pith. With some monocots, the stem is hollow. Examples include wheat and oats.)

 1. Epidermis

 2. Pith

 3. Vascular bundles

 B. Dicots

 (Note: Vascular tissue forms in a single ring near the outside of the stem.)

 1. Epidermis

 2. Cortex

 3. Vascular bundles

 4. Pith

 XII. Stem modifications (Transparency 10)

 A. Above ground

1. Crown--Appears just above or just below ground level from which modified stems grow. This type of growth is common in small grains

2. Stolon--Runners that grow along top of soil surface. This type of growth is common in strawberry plants and clover

3. Spur--Modified stem growth that appears laterally on branches of fruit trees and bears fruit

 B. Below ground (Transparency 11)

1. Rhizome--Underground stems that grow horizontally below soil surface. This type of growth is common to bluegrass, brome grass, quackgrass and canada thistle

2. Tuber--Enlarged fleshy parts found at the tip of a rhizome. This type of growth is common to potatoes

3. Corm--Fleshy, short underground stems with very few buds. This type of growth is common to timothy and gladiolus

4. Bulb--Short disc-shaped stem surrounded by leaf-like scale structures. This type of growth is common to onion and garlic

 XIII. Conditions affecting the vegetative growth of crop plants (Transparency 12)

 A. Climate

 1. Sunlight (Transparency 13)

(Note: Sunlight is the energy source for photosynthesis. More efficient use of sunlight by a crop plant will result in higher yields, if other factors are not limiting.)

 2. Temperature (Transparencies 14, 15)

(Note: The temperature of both air and soil affects the rates at which the different plant processes take place. Air temperature affects the rate of photosynthesis, respiration and transpiration. Soil temperature has an effect on respiration and absorption by the roots.)

 3. Water (Transparency 16)

(Note: Water can be a severe limiting factor in the growth of crop plants. The availability of water, either by precipitation or irrigation, influences crop yield more than any other factor. Water is a requirement for food manufacture, a solvent for mineral nutrients and a part of the transpiration process.)

 B. Soil features

 1. Nutrient availability

 2. Moisture storage

 3. Soil compaction

 a. Reduced water infiltration

 b. Reduced root penetration

 4. Amount of erosion

 C. Crop pests

 1. Disease

 2. Insects

 3. Weeds

 D. Crop being produced

 E. Economics

(Note: Economics is the least controllable of all variables affecting crop production. In many cases the point of maximum yield is not the same as maximum profit point. Crops should be managed to reach the point of maximum profit.)

XIV. Vegetative growth stages of small grains (Transparency 17)

 A. Tillering

 B. Jointing

 C. Boot

 XV. Vegetative growth stages of corn (Transparency 18)

 A. Two-leaf stage

 B. Six-leaf stage

 C. Ten-leaf stage

 D. Fourteen-leaf stage

 XVI. Sexual reproduction in plants

 A. Reproduction by seed

1. Involves the combination of two different sets of genes to create offspring with a new genetic makeup

2. Often the most efficient and economical method for reproducing annual bedding plants and some biennials and perennials

3. The function of the seed is to produce a new plant

a. A seed is produced by the combination of nuclear material in the process of fertilization

 b. Results in zygote formation

B. Sexual reproduction usually used for annuals and on plants which grow quickly from seed and produce a plant similar to the parents

(Note: The end result of sexual reproduction in plants is the seed. Seeds are of importance in production of a new crop and as food for both people and livestock.)

 XVII. Asexual reproduction

 A. Reproduction by vegetative propagation

 1. Uses plant parts such as leaves, roots and stems to start new plants

2. No new genetic material introduced--the offspring will be identical to parents

 B. Methods

 1. Cuttings

 a. Stem cuttings using a tip (straight) cutting

b. Leaf cuttings using a leaf section, leaf petiole or by cutting the veins

 c. Root cuttings using a cutting of the root and planting it

 2. Layering--Rooting a stem at the node

(Note: Grape layering to replace a vine or strawberries' natural runners are examples of layering.)

3. Separation--Removing corms or bulbets from the parent bulb plant (for example: an iris)

 4. Division--The removal of new shoots with some root from below

 (Note: This is used on dahlias.)

5. Grafting--Involves the transfer of wood with buds from one plant and matching up its cambium layer to another plant. The ends then grow together, resulting in a plant having desirable qualities of both parent plants

 XVIII. The life cycle of a flowering plant (Transparency 19)

 A. Seed germination and seedling growth

 B. Vegetative growth

 C. Flower formation

 D. Pollination

 E. Fertilization

 F. Seed development

 XIX. Parts of a complete flower (Transparency 20)

 A. Pistil--Female part where egg cell originates

 1. Stigma--Upper part of pistil that catches pollen

 2. Style--Supports stigma

 3. Ovary--Produces ovules which develop into seeds

 B. Stamen--Male part of flower

 1. Filament--Supports anther

 2. Anther--Bears the pollen

 C. Accessory organs

 1. Corolla--Petals of the flower

 2. Calyx--Sepals of the flower

 3. Pedicel--Stalk of an individual flower

 XX. Types of flowers

A. Complete--Has stamens, pistils, petals and sepals on same flower; common to dicots

B. Incomplete--Has stamens and pistils, but no petals or sepals; common to monocots

 C. Perfect flower--Has both stamens and pistils on the same flower

 D. Imperfect flower--Has either stamens or pistils, but not both on the same flower

 E. Staminate--Has only male flower parts

 F. Pistillate--Has only female flower parts

G. Monoecious--Staminate and pistillate flowers found on the same plant

(Examples: Corn, cucumbers, squash, melons and pumpkins)

H. Dioecious--Staminate and pistillate flowers found on separate plants

(Examples: Holly, date, palm, spinach and asparagus)

 XXI. Types of pollination (Transparency 21)

A. Self-pollination--Transfer of pollen from the anthers to the stigma of the same flower on the same plant

B. Cross-pollination--Transfer of pollen from the anthers of one plant to the stigmas of another plant

(Note: Cross-pollination usually requires an insect or bee to transfer the pollen from one plant to the other.)

 XXII. Pollen is moved by

 A. Gravity

 B. Wind

 C. Insects

 D. Birds

 E. Man

XXIII. Fertilization--After a pollen grain alights on the surface of the stigma, it forms a pollen tube. The pollen tube grows down the style to the ovary. It penetrates the ovary and the male cell unites with the ovule. This is called fertilization, the union of the male and female cells. The result is a zygote. Cell division takes place and the zygote becomes the embryo of the seed

 XXIV. Plant tissues

A. Large groups of organized cells of similar structure that perform a collective function

 B. Basic types

 1. Meristem (meristematic tissue)

a. Comprised of actively dividing cells that develop and differentiate into other tissues and organs

 b. Cells have thin walls and dense protoplast

 2. Permanent

 a. Develops from the meristems

b. Non-dividing differentiated cells

 XXV. Meristematic tissue (Transparency 22)

 A. Apical meristems

 1. Shoot meristems

 a. Found in the tops of the shoots

b. Responsible for producing new buds and leaves in a uniform pattern at the end of the stem and laterally along stems

 2. Root meristems

 a. Growing points for the root system

 b. Found at the various ends of the roots

 B. Lateral meristems

 1. Account for girth and growth of woody stems

 2. Composed of cellulose and pectin

 3. Provide mechanical support for plant

 4. Vascular cambium--Produces new xylem and phloem

5. Cork cambium--Produces bark (the protective covering of old stems and roots)

 6. Number of growth rings indicates tree's age

 C. Intercalary meristems

1. Active tissues that have been separated from the shoot terminal meristem by regions of more mature or developed tissue

 2. Found near the nodes of grasses

 3. Reason for continuous growth after mowing grasses

 XXVI. Permanent tissues

 A. Simple tissue--Uniform, composed of only one type of cell

 1. Epidermis tissue (Transparency 23)

a. Single, exterior layer of cells that protects stems, leaves, flowers and roots

b. Outside surface of epidermal cells usually covered with cutin--a waxy substance that reduces water loss

2. Parenchyma tissue (Transparency 24)

a. Living, thin-walled cells with large vacuoles and many flattened sides

b. Most common and abundant plant tissue making up the fleshy part of the in food and water

 3. Collenchyma tissue (Transparency 25)

 a. Elongated cells with unevenly thickened primary walls

 b. Gives support to young stems, petioles and leaf veins

 4. Schlerenchyma tissue (Transparency 26)

 a. Thick-walled cells

 b. Common in stems and bark

 c. Found as stone cells in pear fruits and walnut shells

 d. Nonliving when mature

 5. Cork tissue

 a. Bark of maturing stems, tree trunks and potato skins

 b. Cells walls are waterproofed with suberin (waxy material)

 c. Die soon, but retain shape

B. Complex tissue--Composed of combinations of simple and specialized cells and tissues

 1. Xylem

 a. Constitutes the majority of wood

 b. Principal conductor of water and dissolved nutrients

 2. Phloem (Transparency 27)

 a. Main conducting tissue for dissolved food material

b. Basically composed of cells called sieve elements arranged into sieve tubes