FIGURE 15–1 The structure of a tulip bulb—an example of a tunicate laminate bulb. Longitudinal section representing stage of development shortly after the bulb is planted in the fall.
FIGURE 15-2  (a) Bulb with tunicate covering and adventitious roots (arrow). (b) Cross section of bulb showing basal plate, bulb scales and flower axis.
FIGURE 15–3 Propagation by offset bulbs. Aerial bulblets or bulbils of (a) *Lilium* and (b) sword lily (*Watsonia*). (c) Bulblets (arrow) from bulb scale cutting of *Lilium*.
FIGURE 15–6  (a) Tunicate bulbs of tulip. (b,c) nontunicate, scaly bulb of lily [Lilium hollandicum] with adventitious roots.
FIGURE 15–7 Left: Outer appearance of a scaly bulb of lily (*Lilium hollandicum*). Right: Longitudinal section of a bulb of *L. longiflorum* ‘Ace,’ after flowering stage, showing old mother bulb scales and new daughter bulb scales. Bulb obtained in fall near digging time [12]
FIGURE 15–8  (a) Contractile roots (arrow) attached to a lily bulb, and (b) a dropper (arrow) of trout lily (*Erythronium*), which is a new bulb that forms at the end of a stolon.
Figure 15-9.
Commercial rooting room for the greenhouse bulb forcing market. (a) Rooting room initially warm enough (9 °C) to allow bulb rooting, (b) later reduced to 5 °C to promote breaking dormancy of bulbs, reduced growth and slowed stem elongation, (c,d) later moved to greenhouse for forcing.
In the production of a lily crop, (a) producers count leaf emergence from potted bulbs (pot and soil removed) and use this as a gauge to speed up or slow down the production cycle, in (b) timing flowering plants for certain market periods. (Photograph ‘a’ courtesy A.E. Nightingale).
Figure 15-11 Easter lily propagation is exclusively done in the U.S. Pacific Northwest. Individual scales are directly planted into raised beds. Each scale (arrow) produces multiple plants in (a, b) dense rows.
FIGURE 15–12 Propagation by separation of smaller, offset bulbs (arrows) in (a) narcissus, (b) tulip, and (c) lily.
Figure 15-13 Mechanical digging and harvesting tunicate bulbs in U.S. Pacific Northwest. (a) Mechanized digger harvesting bulbs. (b) Dug bulbs are then transferred up to truck to be hauled to the processing area. (c) Harvesting process with workers trailing to collect missed bulbs.
FIGURE 15-14  Commercial propagation of tunicate bulbs in the Netherlands. (a) Flowers are cut to eliminate disease and competition to the bulbs. (b) Bulbs are dug and left to dry in the field. (c) Bulbs are further dried in open storage racks. (d, e) Grading bulbs into salable grades and offset grades for next season’s production. (f) Storage of graded bulbs.
Propagation of lily by scaling. (a) Adventitious bulblets form at base of scale (arrow), and (b) plantlet formed from bulb scale. (Photograph courtesy R. A. Criley).
Figure 15-17. Propagation of Crinum. (a) Mother bulb and single offset daughter bulblet (arrow). (b) Tri-scales with attached basal plate and elongating bulblets (arrow). (c) New bulblets will be divided, subcultured and multiplied via tissue culture (81).
Figure 15-18
FIGURE 15–19 Twin-scale propagation of Narcissus (daffodil) cut from whole bulbs and kept at 22° C in moist vermiculite for two months.
Figure 15–20 Gladiolus corm. (a) External appearance. (b) Longitudinal section showing solid stem structure.
Figure 15–21. (a) Stage of gladiolus corm development during the latter part of the growing season. The remnants of the originally planted corm (white arrow) are evident just below the newly formed corms (blue arrow). A small white cormel has formed (black arrow). (b) Emerging flower stem of gladiolus (arrow). (Photograph b courtesy R.A. Criley).
Figure 15–22 Tubers of potato (*Solanum tuberosum*) showing their development from (a) white stolons arising from stem tissue; roots are darker, thinner; the tuber is attached to the stolon at the tuber’s morphological basal (proximal) end (arrow). (b) Tuberization (tuber formation) is characterized by the hook “gancho” at the subapical portion of the stolon (arrows) and subsequent tuber enlargement.
Incan site of Machu-Picchu in Southeastern Peru
Birthplace of First Irish white Potato
PATTEN: MURDOCK: WHITE
The First Irish Potatoes grown in North America were planted HERE during the spring of 1719 by the Early Settlers of Nutfield (Londonderry) now Derry, N.H., on the Common Field bordering West Running Brook.
1719 “Irish Potato” brought to New Hampshire

Post 1550 – Pizarro & Conquistadores conquer the Incas of Peru
SAN JOSE DE AYMARA, Huancavelica, PERU

3,900m (13,000 feet)
Figure 2. A) Field location; B) Planting; C) Formononetin Application; D) Harvest.
Mycorrhiza — "fungus root"

- The symbiotic association between specific fungi with the fine roots of higher plants.
- The majority of plants, strictly speaking, do not have roots; they have mycorrhizas.
Figure 15–24 Tubers of potato (*Solanum tuberosum*). (a) “Seed potato” which is a vegetative propagule made of a diced, suberized tuber. The axillary buds (“eyes”) later form shoots (arrow) and the root system arises from the newly forming shoot. (b) Minituber (arrow) produced from tissue culture which facilitates rapid multiplication and exportation of disease-free propagules.
FIGURE 15-23  Stolon (black arrow) and tuber (red arrow) production in *Cucurma* (ginger, Thai tulip) and *Phlomis* (Jerusalem sage).
Figure 15–25 Types of fleshy and tuberous roots and shoots. (a) Sweet potato fleshy root showing adventitious shoots. (b) Dahlia during early stages of growth. The old tuberous root piece will disintegrate in the production of the new plant; the new roots can be used for propagation. (c) A tuberous begonia stem, showing its vertical orientation. This type continues to enlarge each year.
Figure 15-26. (a) Fleshy root of sweet potato with adventitious shoots or “slips” (arrow), (b) tuberous roots of dahlia attached to crown (arrow), and (c) each separate tuberous dahlia root must have a section of the crown (arrow) bearing a bud which elongates into a shoot.
Figure 15-27 A tuberous stem in cyclamen. (a) Tuber ready for transplanting. (b,c) Tuberous stems.
Figure 15–28 Structure and growth cycle of lily-of-the-valley (Convallaria Mamalis).
Right: Section of rhizome as it appears in late spring or early summer with one-, two-, or three-year-old branches. A new rhizome branch begins to elongate in early spring and terminates in a vegetative shoot bud by the fall. The following spring, leaves of the bud unfold; food materials manufactured in the leaves by photosynthesis are accumulated in the rhizome. Growth the second season is again vegetative. Early in the third season a flower bud begins to form, and at the same time a vegetative growing point forms in the axil of the last leaf.
Top left: Section of the three-year-old branch showing terminal flower bud and lateral shoot bud enclosed in leaf sheaths. Such a section is sometimes known as a pip or crown and is forced for spring bloom. In the early spring the flowering shoot expands, blooms, and then dies down, and the shoot bud begins a new cycle of development. (Redrawn from Zweede [93].)
Figure 15–29  (a,b) Mother-in-law's tongue (Sansevieria spp.) and (c) Johnson grass (Sorghum halepense) are rhizomous plants that regenerate themselves clonally through rhizomes (arrows) from which shoots arise. (Photo c courtesy R.A. Criley)
Figure 15–30 Rhizome of the tropical ginger plant (*Zingiber officinale*). This is easily propagated by division of the thickened rhizome, which is the source of commercial ginger. The axillary buds (arrow) will develop into the shoot system.
Plantlets on leaves -
*Bryophyllum crenatodaigremontianum*
Figure 15–33 Pseudobulbs (arrows) facilitate survival of orchids during adverse environmental conditions and can be divided-up and used as propagules with species such as (A) Gongora quinquenervis, (B) Oncidium longifolium, and (C) Laelia anceps.
Figure 15-34 Commercial propagation of cymbidium orchids from pseudobulbs. (a,b) Back and (c) green pseudobulbs.