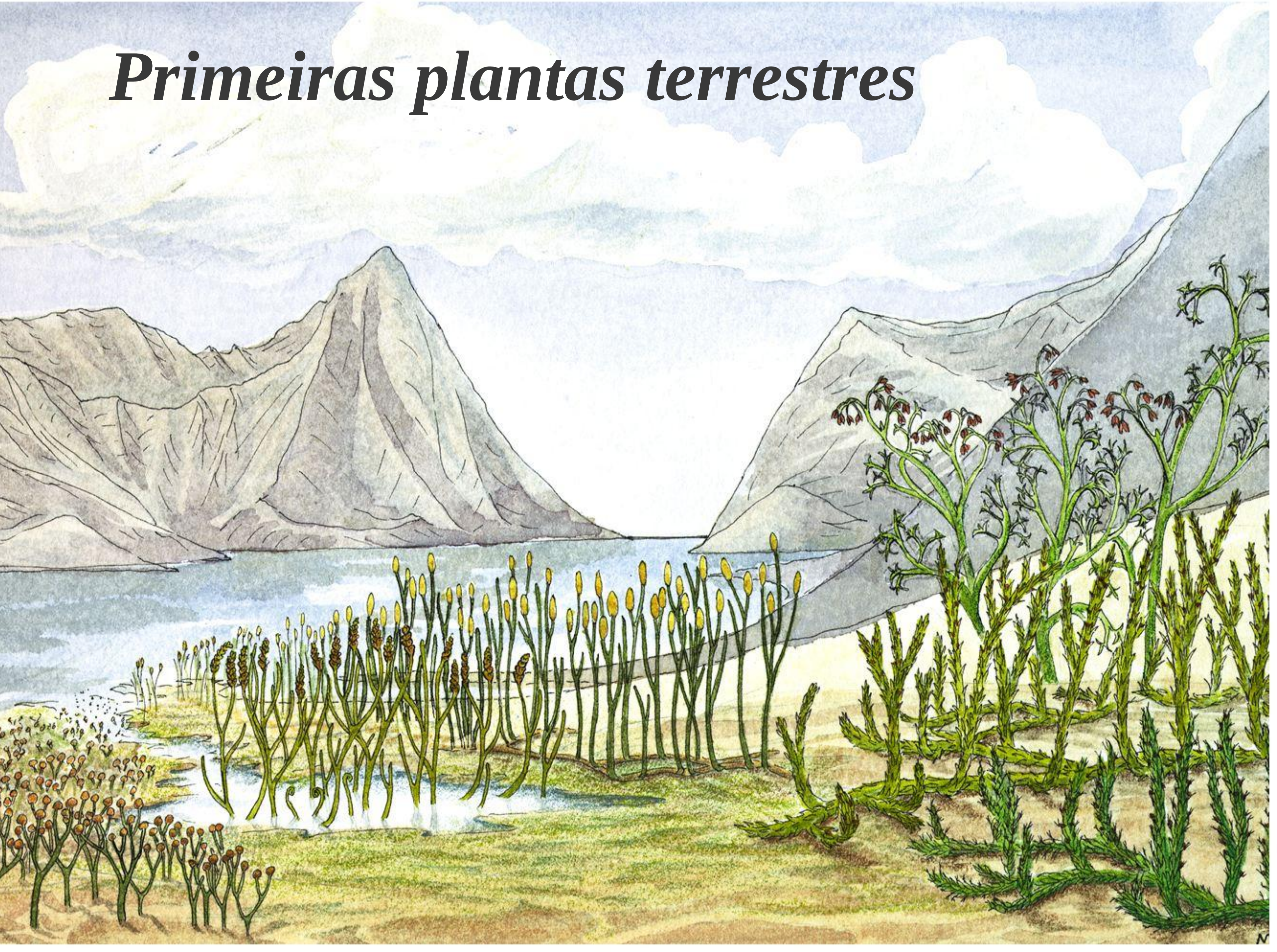
Anatomia Vegetal

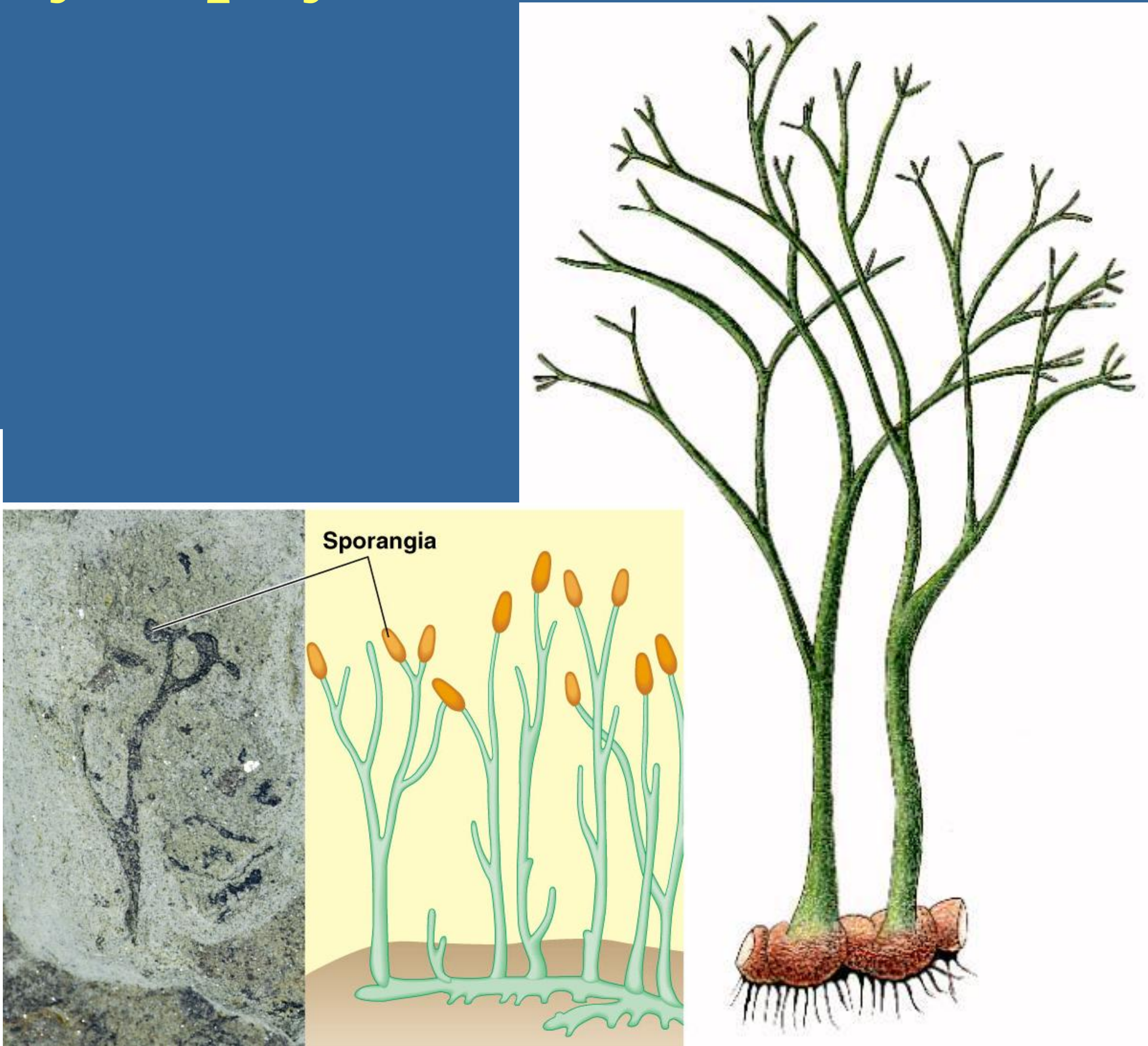
Aula 4

Raiz

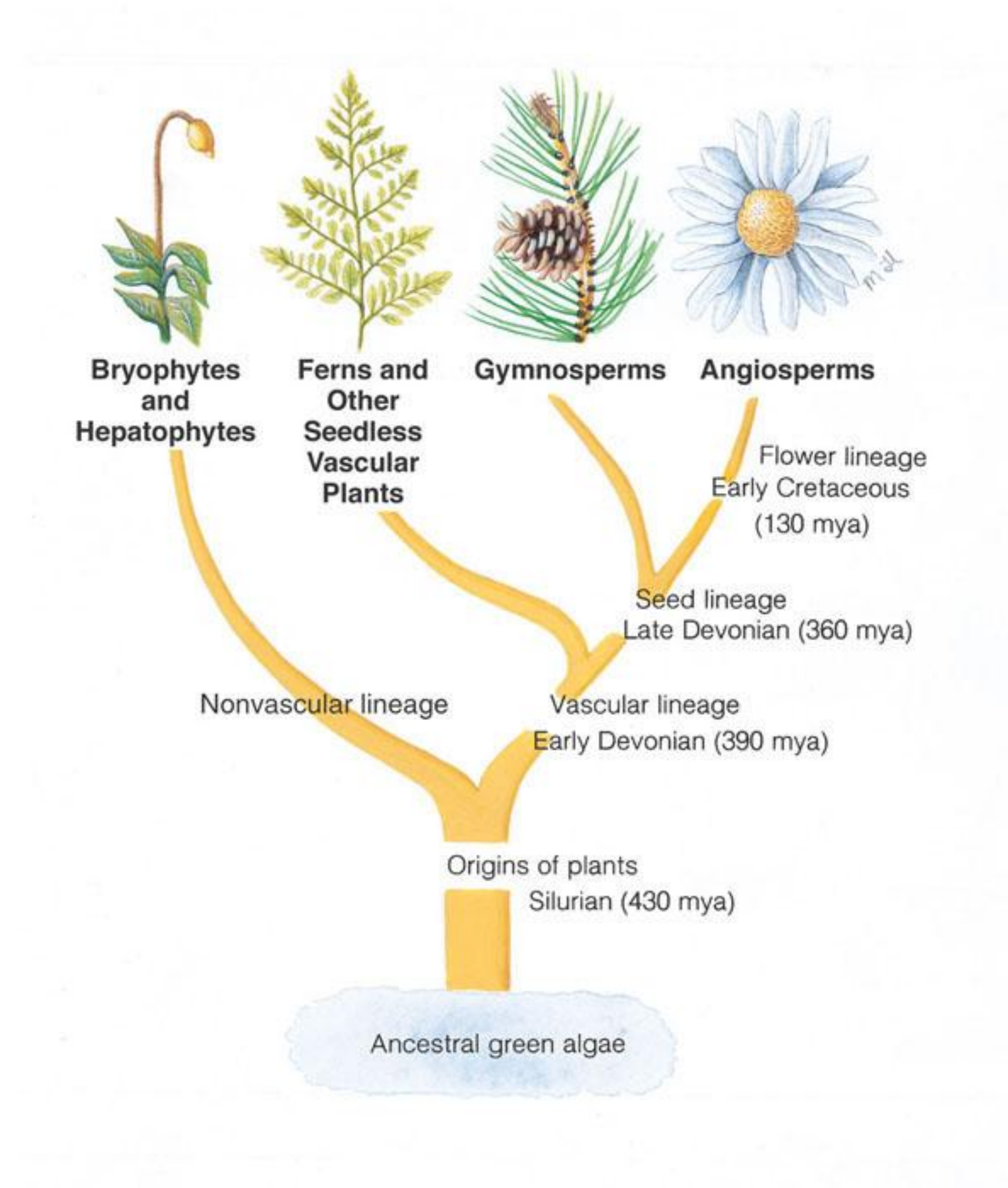
Primeiras plantas terrestres



Rhyniophyta

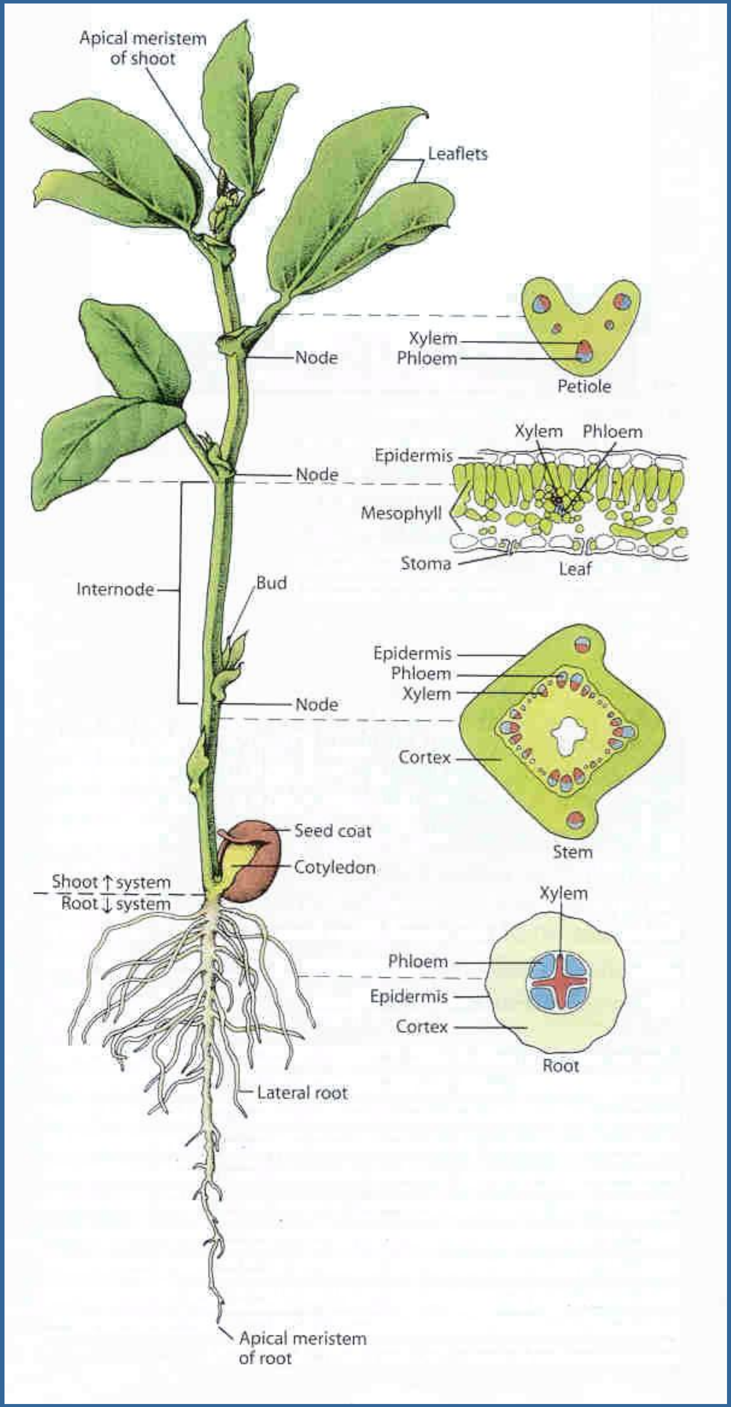


Filogenia das plantas terrestres


Bryophytes and Hepatophytes
Ferns and Other Seedless Vascular Plants
Gymnosperms
Angiosperms
Flower lineage
Early Cretaceous (130 mya)
Seed lineage
Late Devonian (360 mya)
Nonvascular lineage
Vascular lineage
Early Devonian (390 mya)
Origins of plants
Silurian (430 mya)
Ancestral green algae

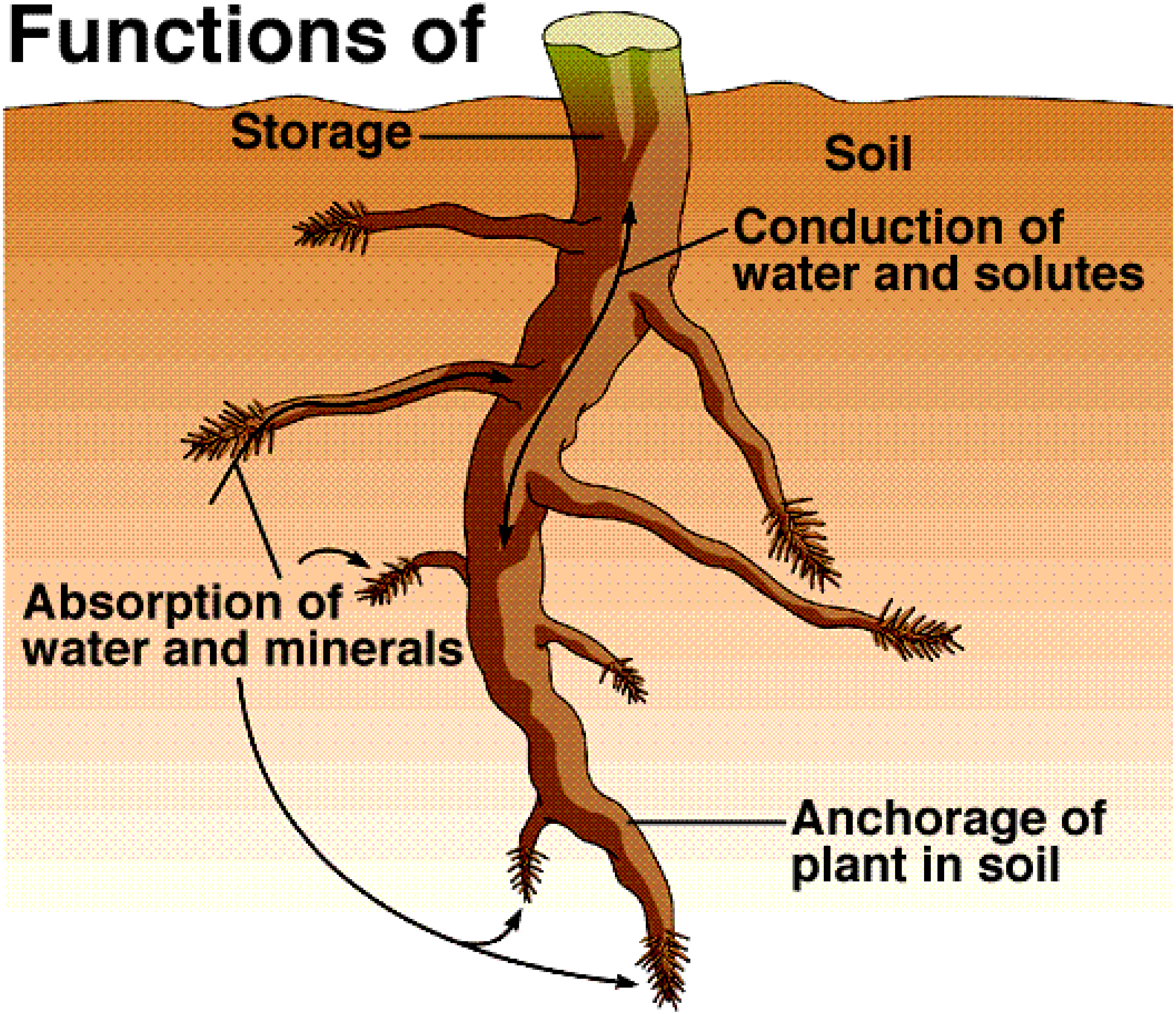
Raiz

- Funções:
  - Fixação
  - Absorção
  - Condução
  - Armazenamento
  - Aeração

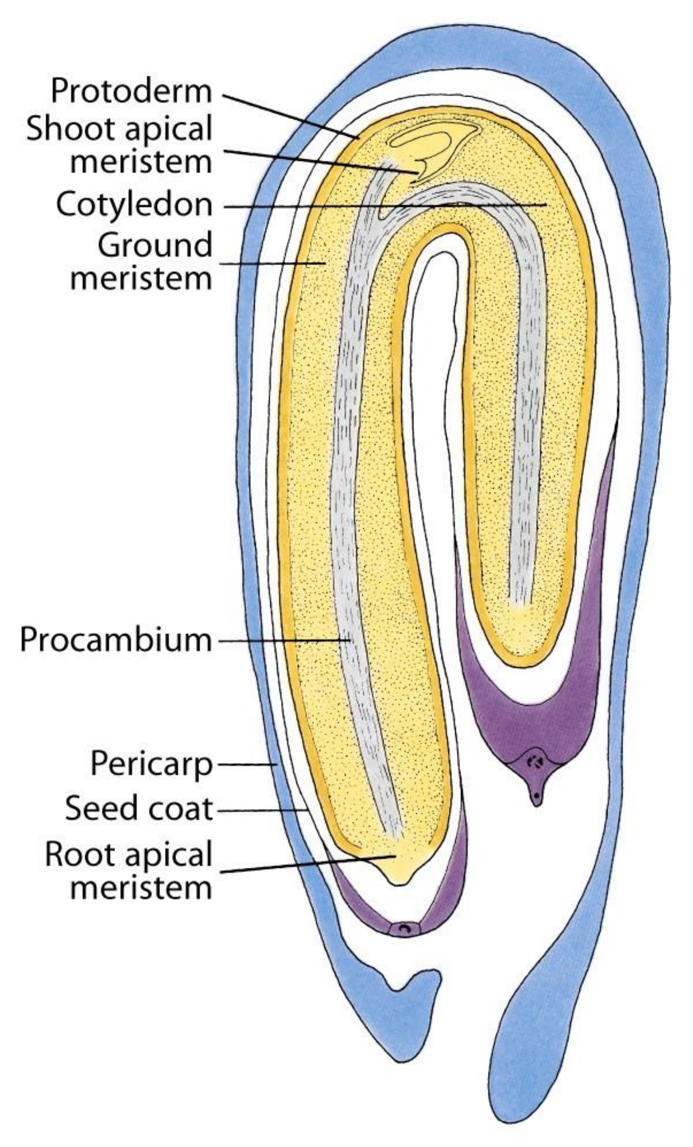

Apical meristem of shoot
Leaflets
Node
Xylem
Phloem
Petiole
Xylem
Phloem
Epidermis
Node
Mesophyll
Stoma
Leaf
Internode
Bud
Epidermis
Phloem
Xylem
Node
Cortex
Stem
Seed coat
Cotyledon
Shoot ↑ system
Root ↓ system
Xylem
Phloem
Epidermis
Cortex
Root
Lateral root
Apical meristem of root

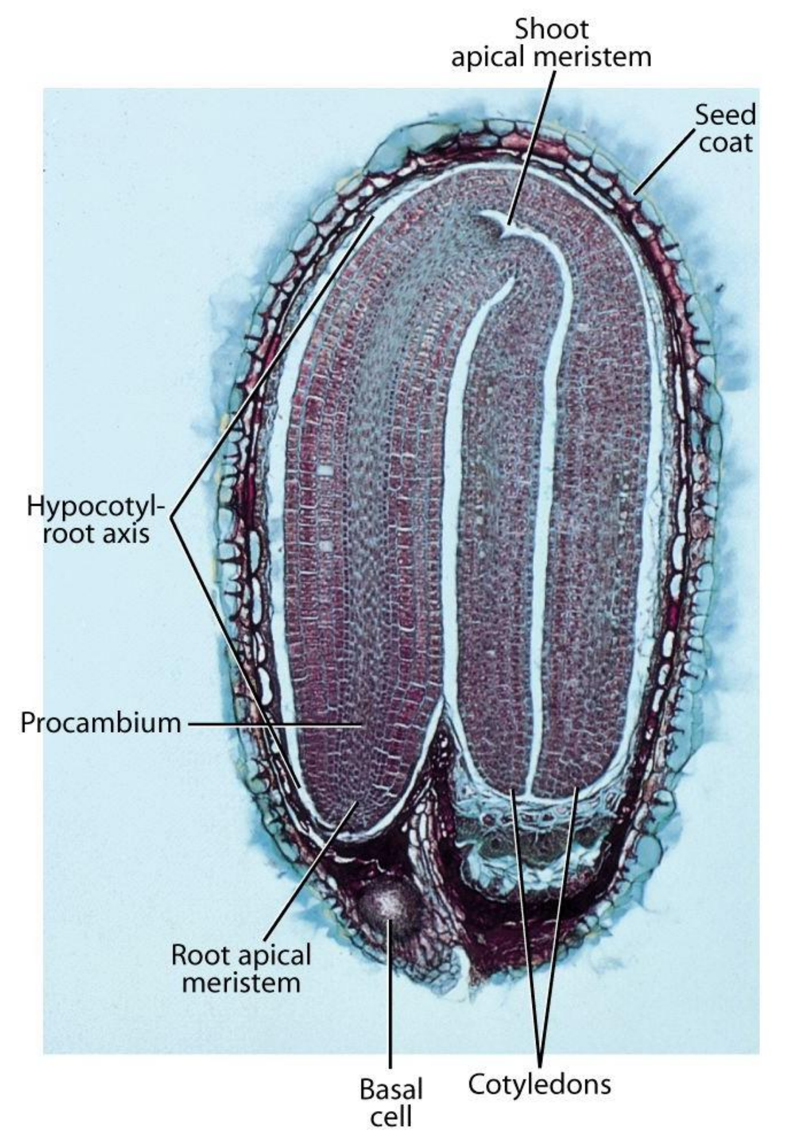
Randy Moore, Dennis Clark, and Darrell Vodopich, Botany Visual Resource Library © 1998 The McGraw-Hill Companies, Inc. All rights reserved.

Major Functions of Roots


Storage
Soil
Conduction of water and solutes
Absorption of water and minerals
Anchorage of plant in soil

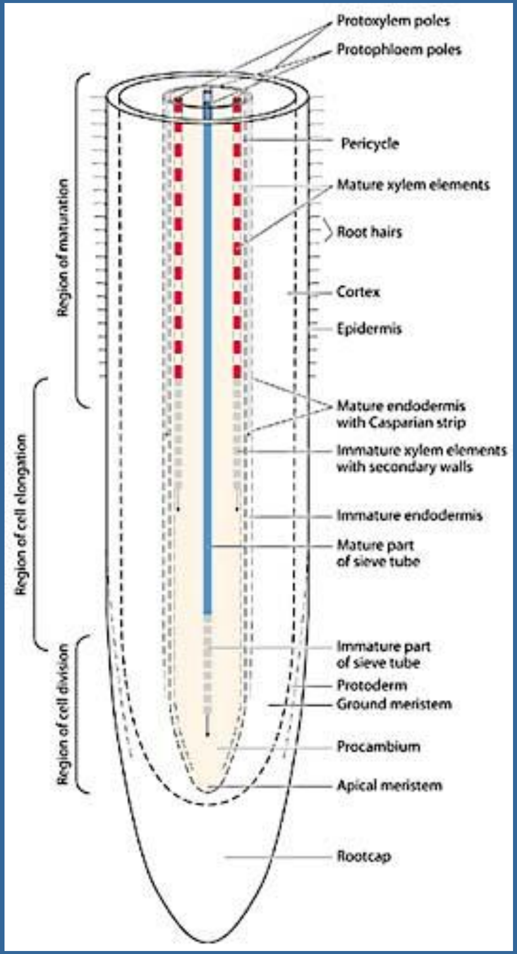
Formação do corpo primário

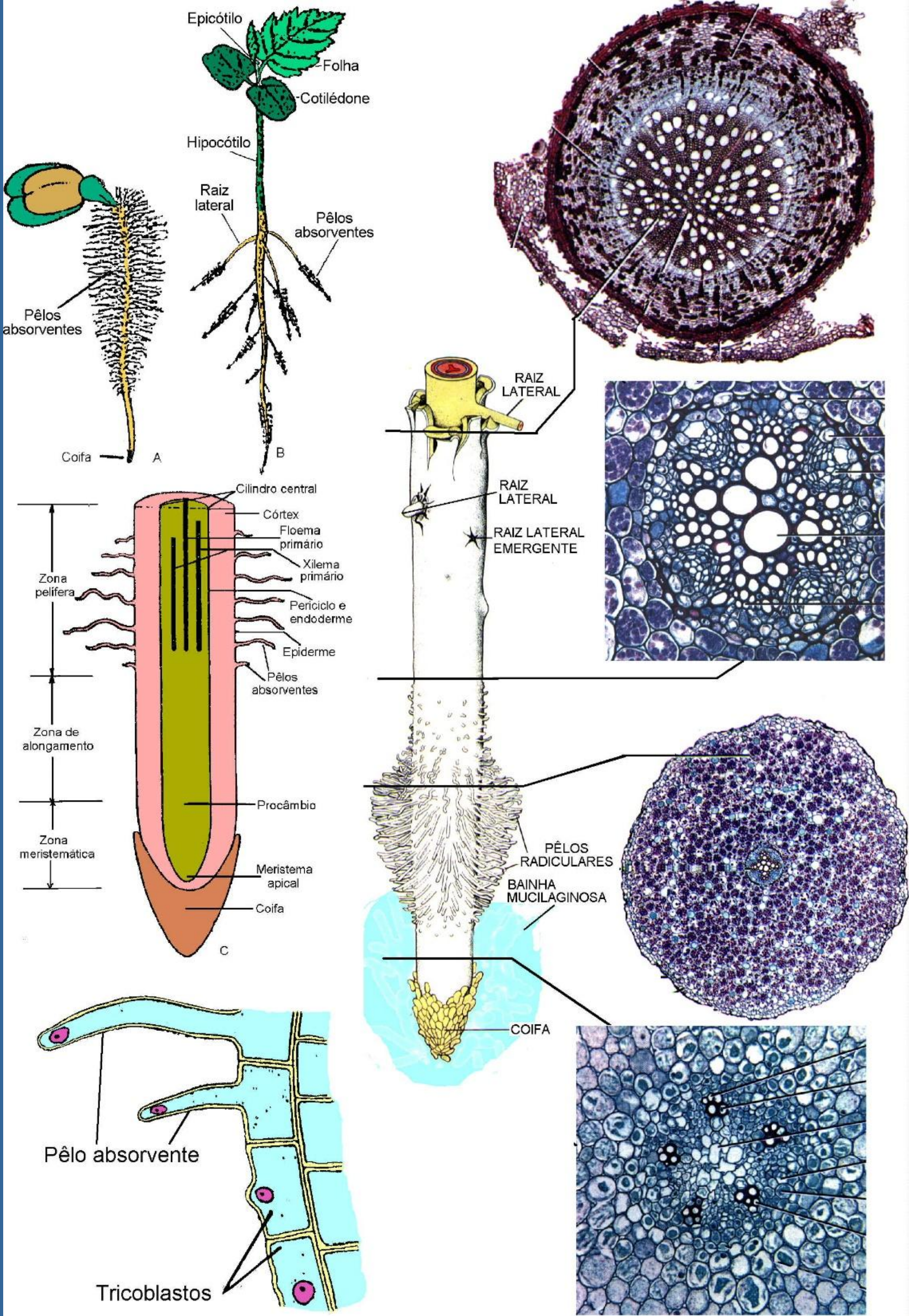

Protoderm
Shoot apical meristem
Cotyledon
Ground meristem
Procambium
Pericarp
Seed coat
Root apical meristem


Shoot apical meristem
Seed coat
Hypocotyl-root axis
Procambium
Root apical meristem
Basal cell
Cotyledons

Raiz

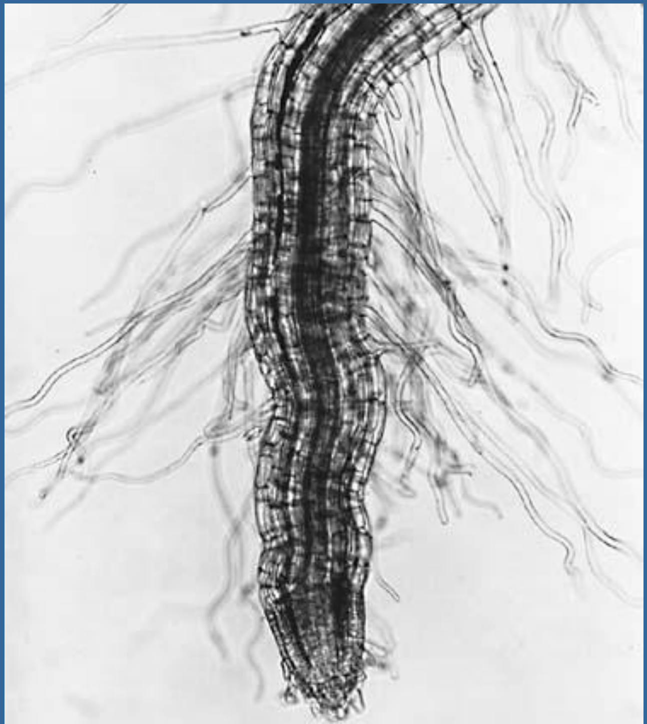
- 3 regioes:
  - Meristematica
  - Alongamento
  - Maturação

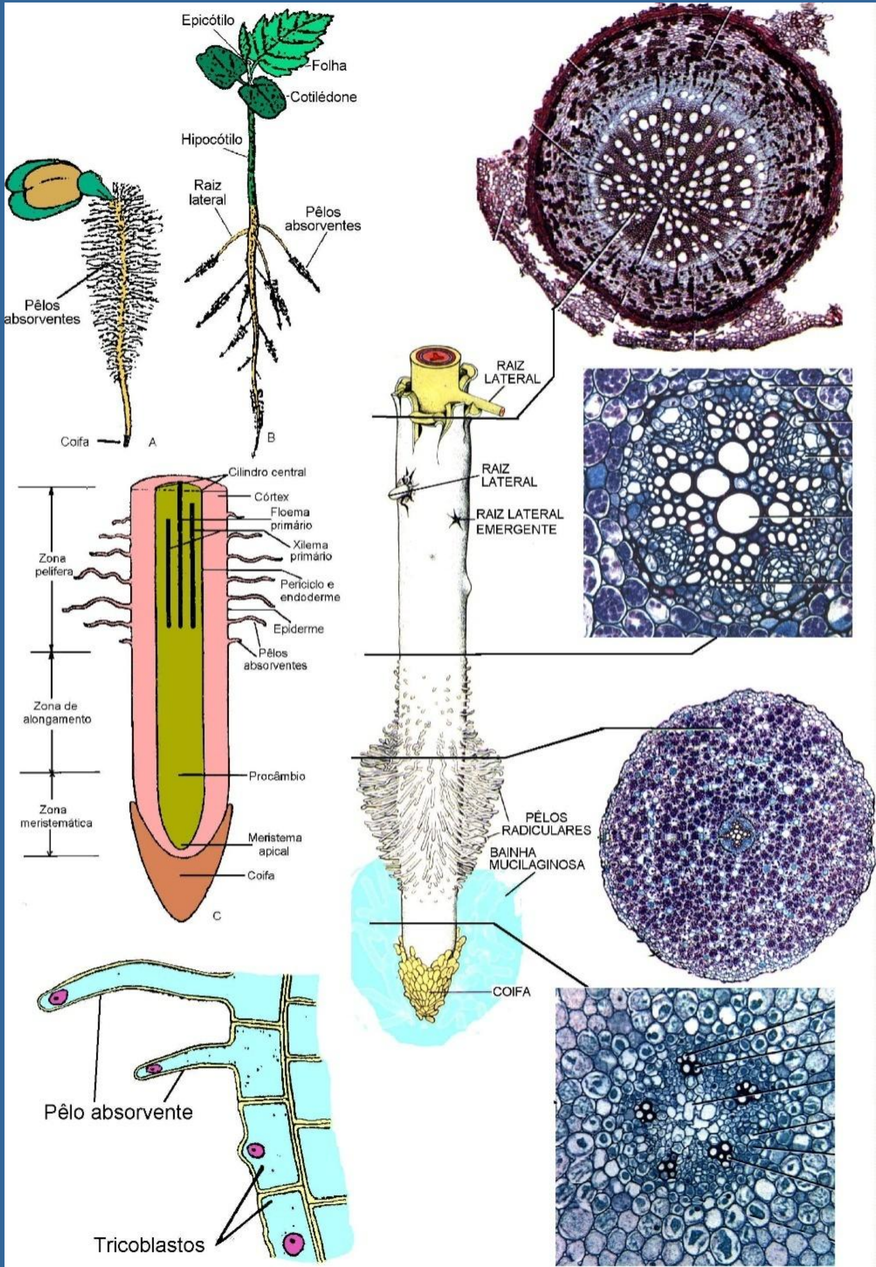

Protoxylem poles
Protophloem poles
Pericycle
Mature xylem elements
Root hairs
Cortex
Epidermis
Mature endodermis with Casparian strip
Immature xylem elements with secondary walls
Immature endodermis
Mature part of sieve tube
Immature part of sieve tube
Protoderm
Ground meristem
Procambium
Apical meristem
Rootcap
Region of maturation
Region of cell elongation
Region of cell division


Epicótilo
Folha
Cotilédone
Hipocótilo
Raiz lateral
Pêlos absorventes
Pêlos absorventes
Coifa
A
B
Cilindro central
Córtex
Floema primário
Xilema primário
Periciclo e endoderme
Epiderme
Pêlos absorventes
Zona pelífera
Zona de alongamento
Zona meristemática
Procâmbio
Meristema apical
Coifa
C
RAIZ LATERAL
RAIZ LATERAL
RAIZ LATERAL EMERGENTE
PÊLOS RADICULARES
BAINHA MUCILAGINOSA
COIFA
Pêlo absorvente
Tricoblastos

Pelos radiculares

- Região de maturação
  (zona pilífera)
- ↑ Superficie absorção
- Efêmeros




Epicótilo
Folha
Cotilédone
Hipocótilo
Raiz lateral
Pêlos absorventes
Pêlos absorventes
Coifa
A
B
Cilindro central
Córtex
Floema primário
Xilema primário
Periciclo e endoderme
Epiderme
Pêlos absorventes
Zona pelífera
Zona de alongamento
Zona meristemática
Procâmbio
Meristema apical
Coifa
C
RAIZ LATERAL
RAIZ LATERAL
RAIZ LATERAL EMERGENTE
PÊLOS RADICULARES
BAINHA MUCILAGINOSA
COIFA
Pêlo absorvente
Tricoblastos

Raiz

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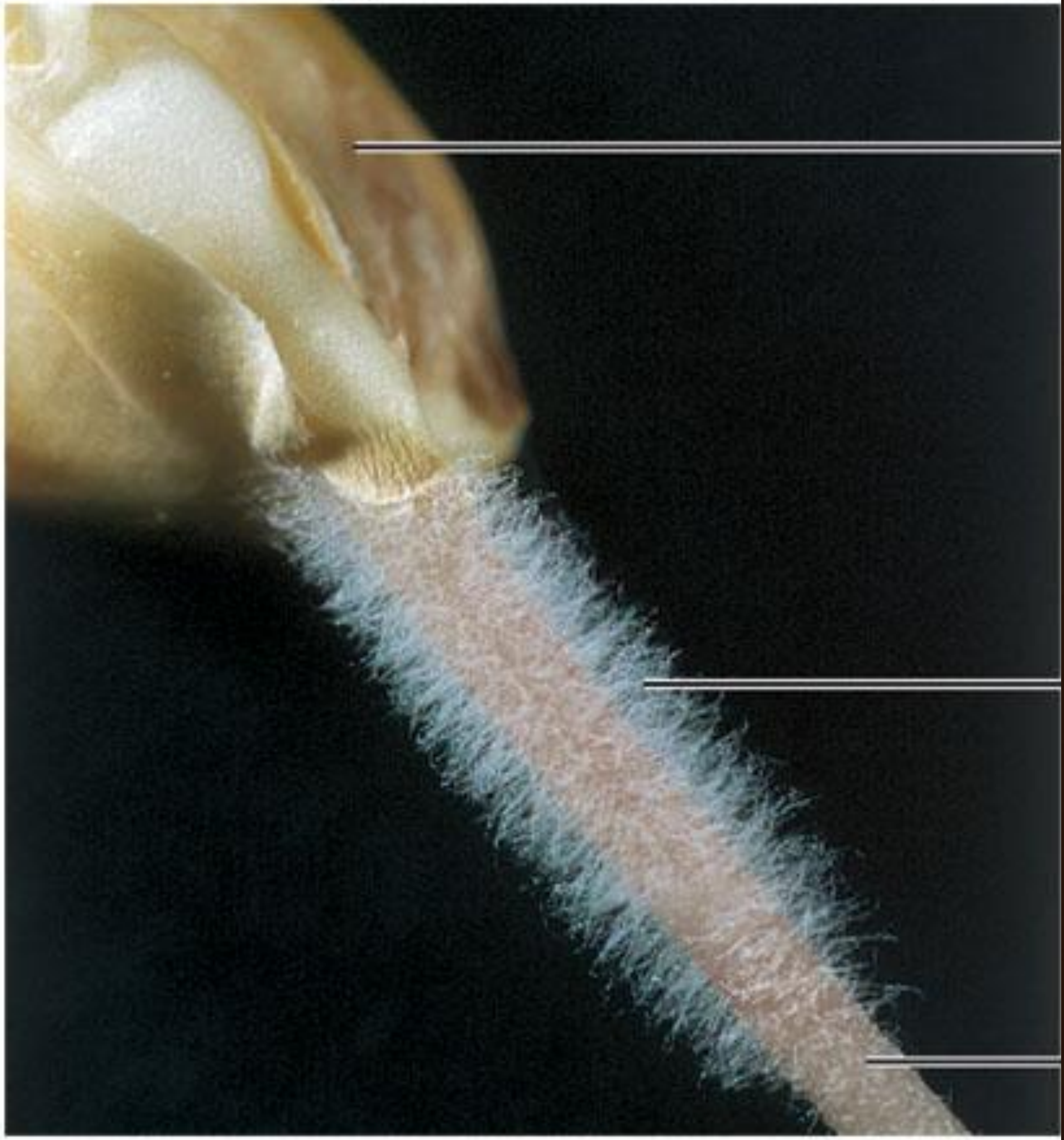
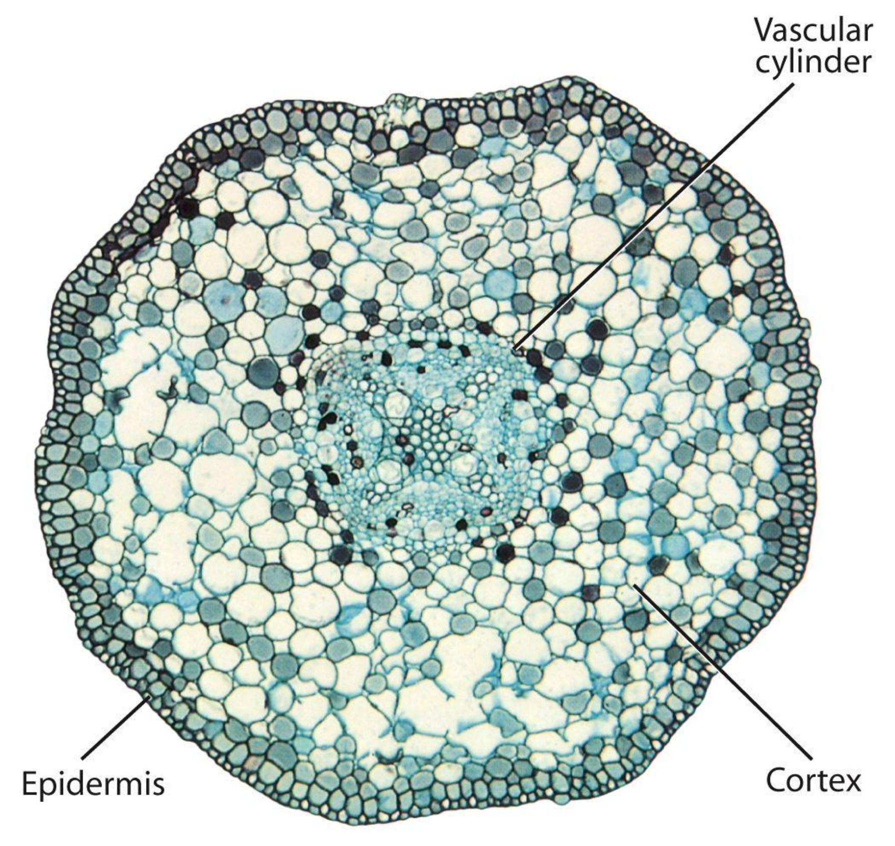


a. Root hairs

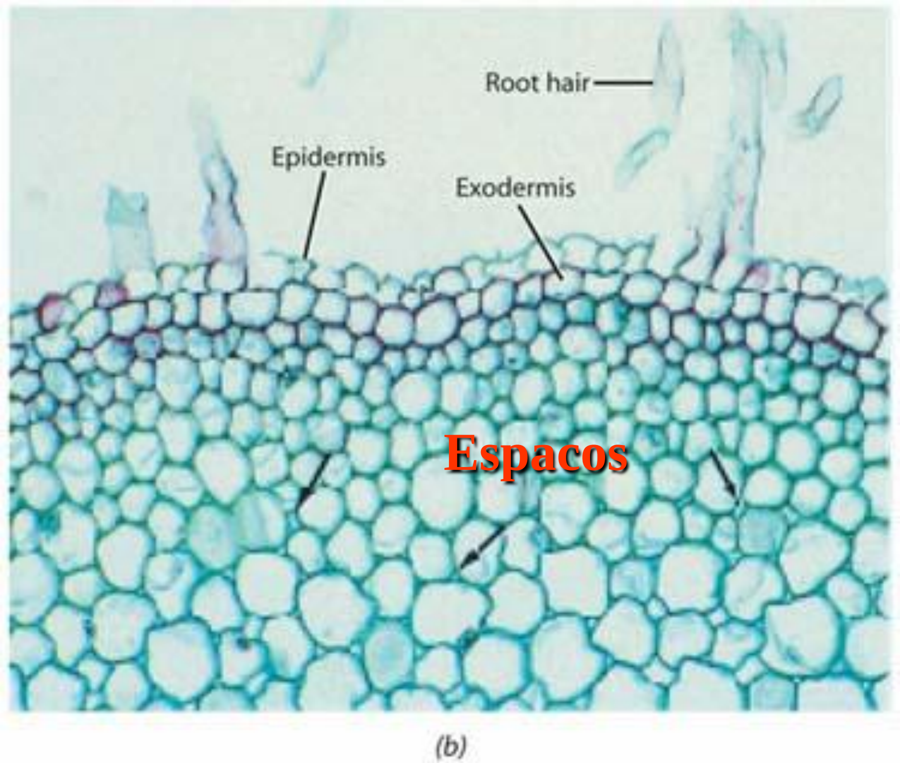
Estrutura primária

- 3 sistemas de tecidos:
    - Dérmico (epiderme)
    - Fundamental (cortex)
    - Vascular (tecidos vascu


Vascular cylinder
Epidermis
Cortex

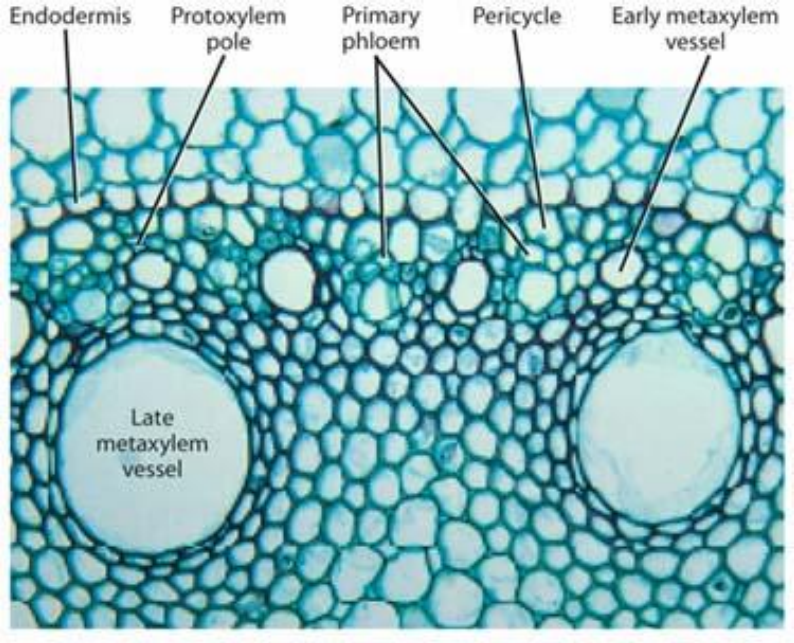
Córtex

- Maior parte do corpo
- Geralmente armazenam amido
- Espaços intercelulares (aeração)
- Camada mais interna: endoderme
  - Estrias de Caspary

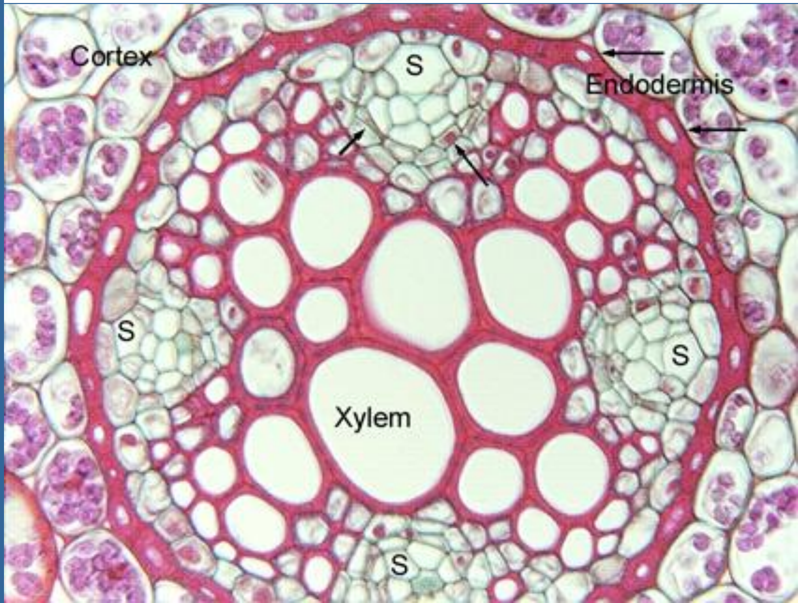

Root hair
Epidermis
Exodermis
Espacos
(b)

Sistema vascular

- Cilindro vascular
  - Tecidos vasculares primários
  - Periciclo (células parenquimáticas)
- Periciclo:
  - Surgimento de raízes secundárias
  - Formação do câmbio vascular
  - Formação do felogênio

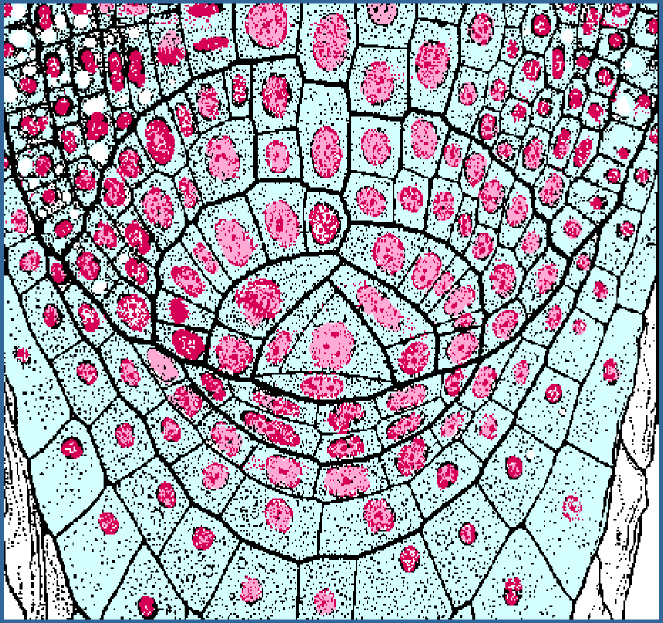

Endodermis
Protoxylem pole
Primary phloem
Pericycle
Early metaxylem vessel
Late metaxylem vessel

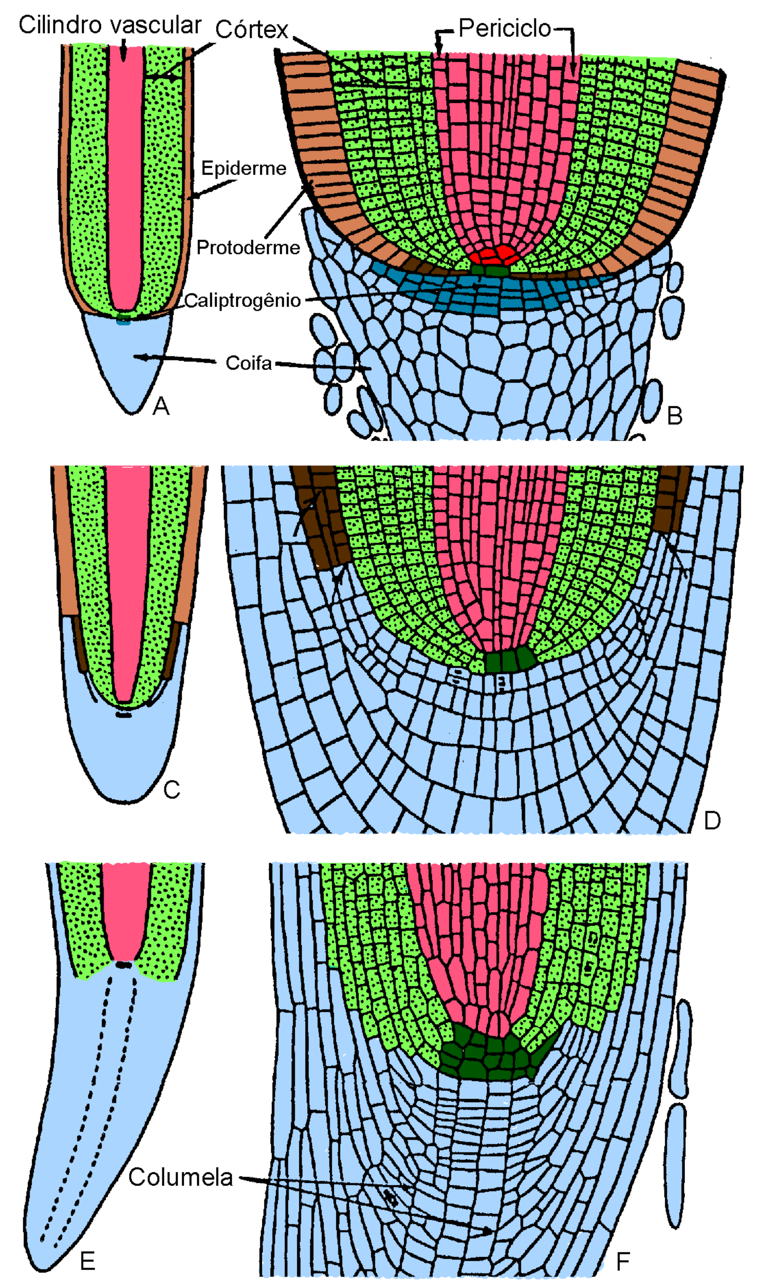
(d)


Cortex
S
Endodermis
S
S
Xylem
S

Ápice radicular

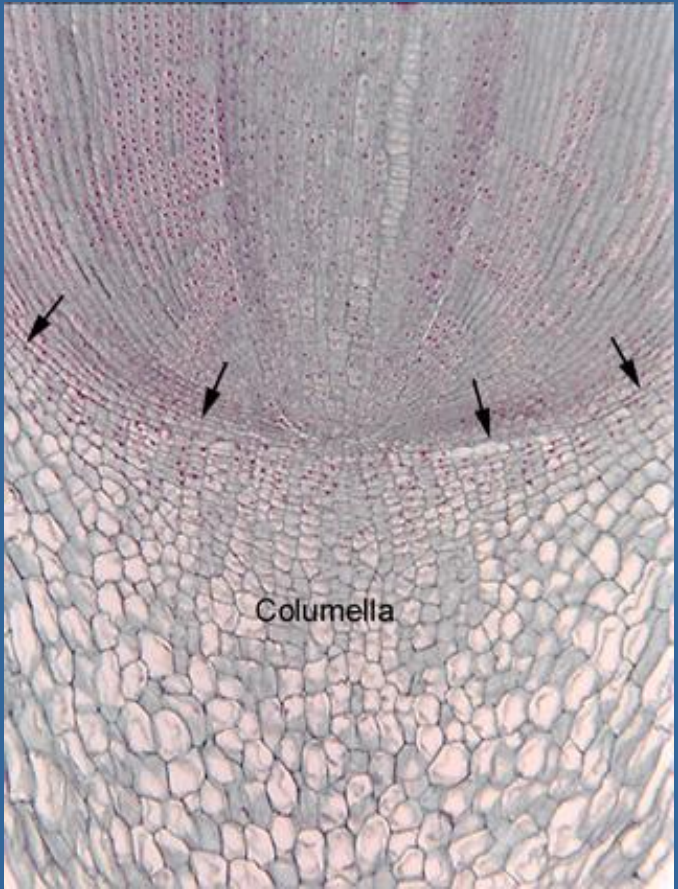
- 3 grupos de iniciais
  - Cortex, cilindro vascular e coifa
    - Camadas distintas
- 1 grupo de iniciais
  - Cortex, cilindro vascular e coifa
    - Origem em comum
    - Caliptrogênio

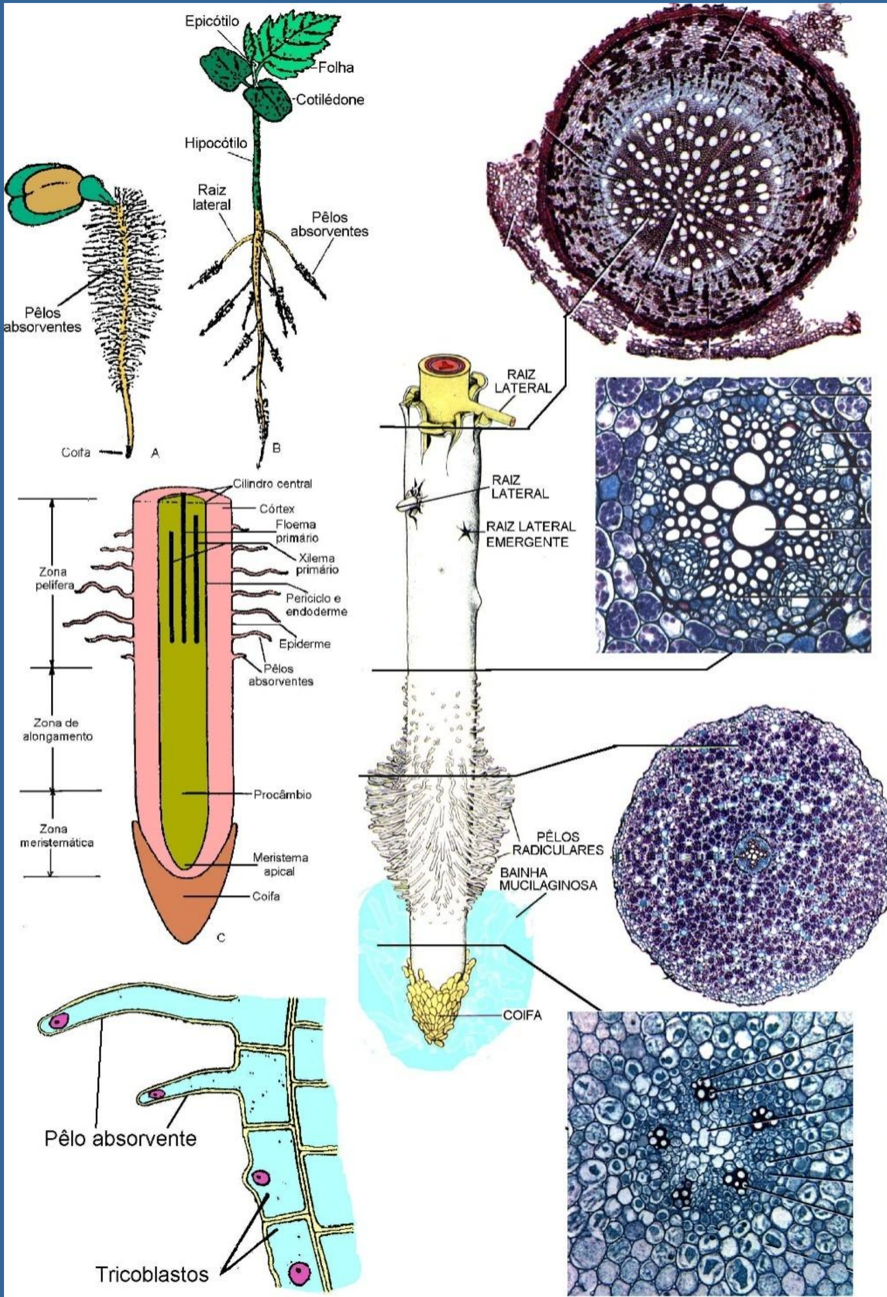



Cilindro vascular
Córtex
Periciclo
Epiderme
Protoderme
Caliptrogênio
Coifa
A
B
C
D
Columela
E
F

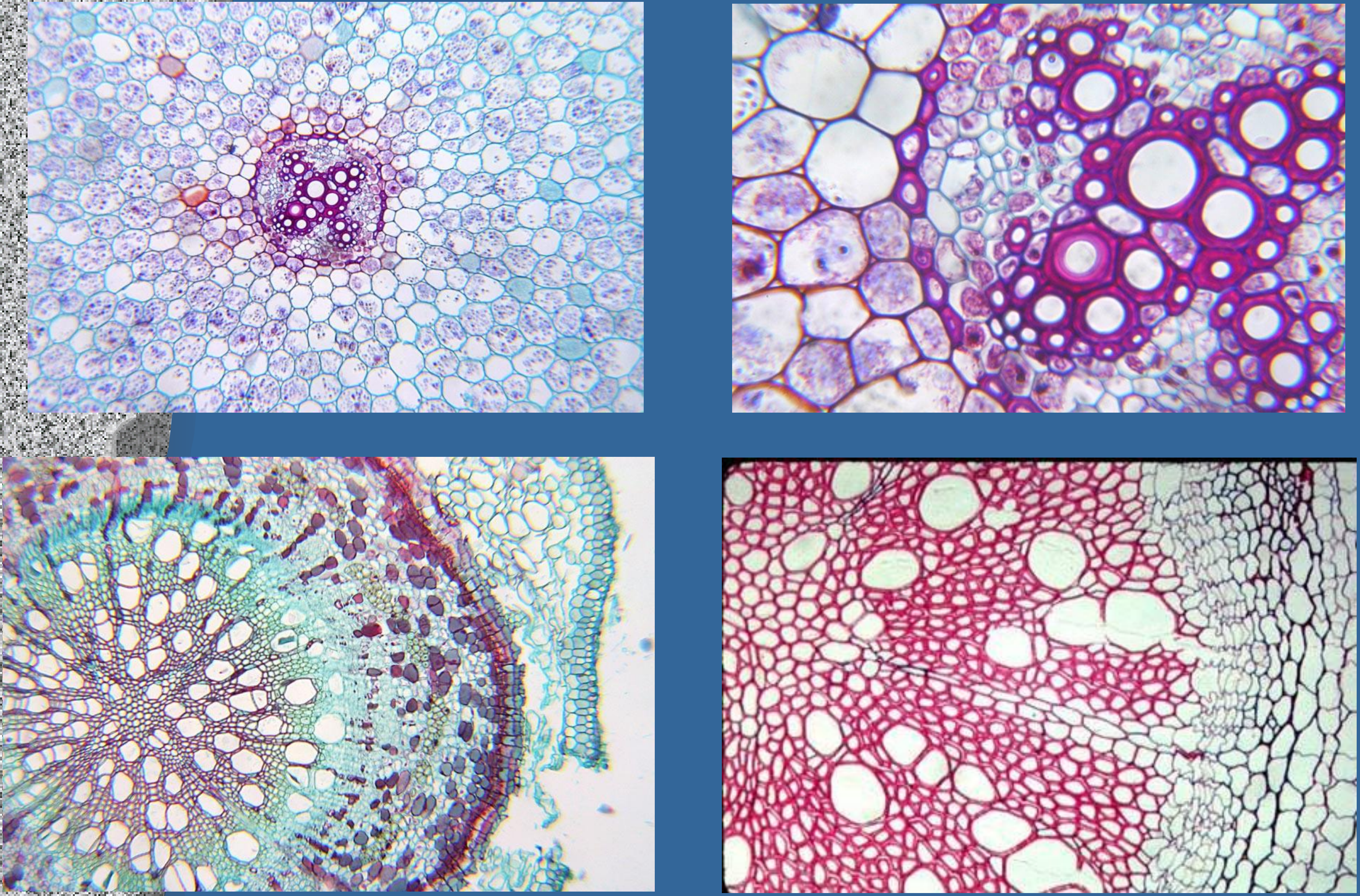
Coifa

- **Proteção do ápice radicular**
- **Mucilagem (Polissacarídeo)**
- **Penetração no solo**
- **Presença de amido**
  - **(Gravitropismo)**

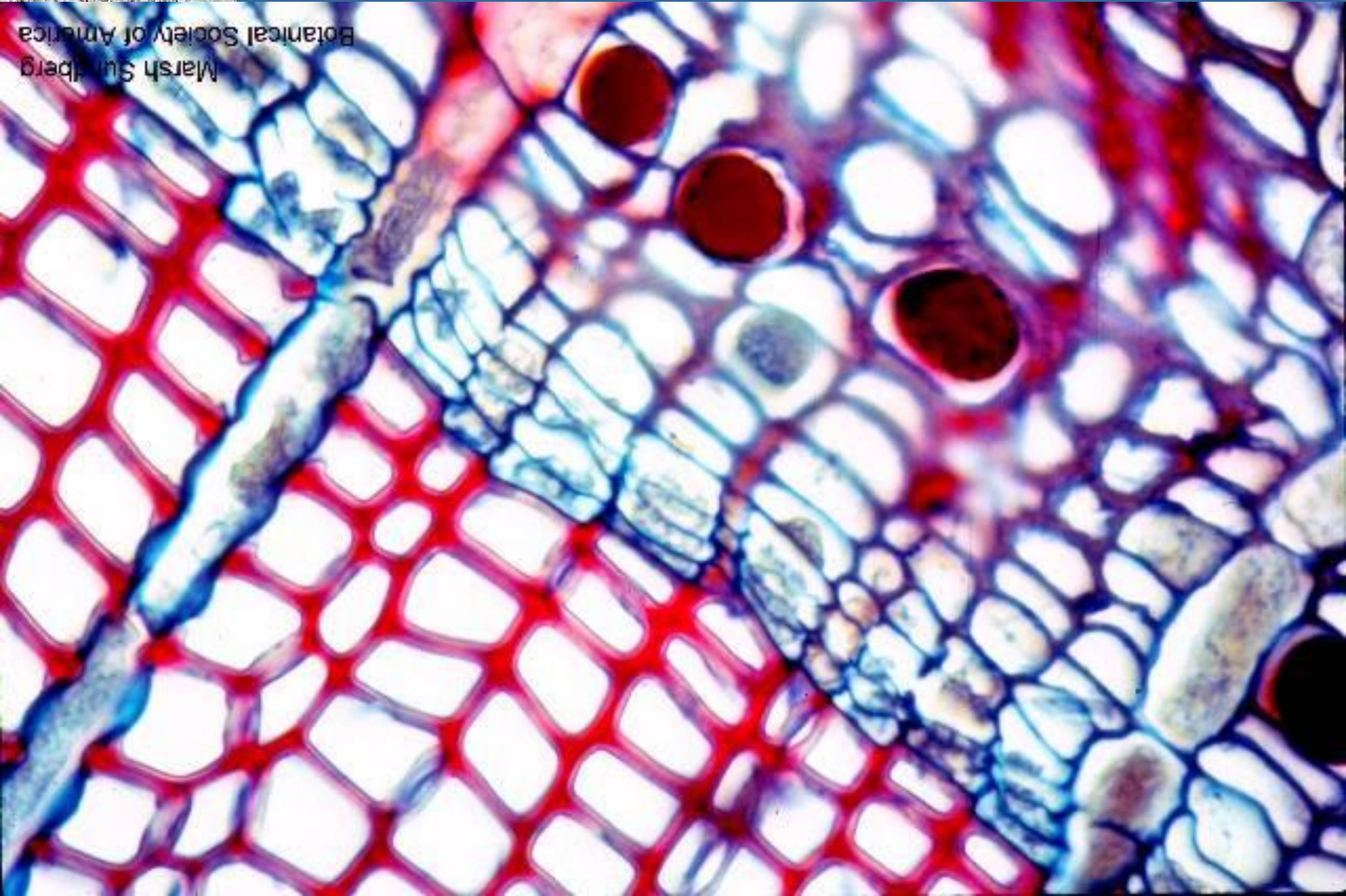



Epicótilo
Folha
Cotilédone
Hipocótilo
Raiz lateral
Pêlos absorventes
Pêlos absorventes
Coifa
A
B
Cilindro central
Córtex
Floema primário
Xilema primário
Periciclo e endoderme
Epiderme
Pêlos absorventes
Zona pelífera
Zona de alongamento
Zona meristemática
Procâmbio
Meristema apical
Coifa
C
RAIZ LATERAL
RAIZ LATERAL
RAIZ LATERAL EMERGENTE
PÊLOS RADICULARES
BAINHA MUCILAGINOSA
COIFA
Pêlo absorvente
Tricoblastos

Desenvolvimento secundário em raízes



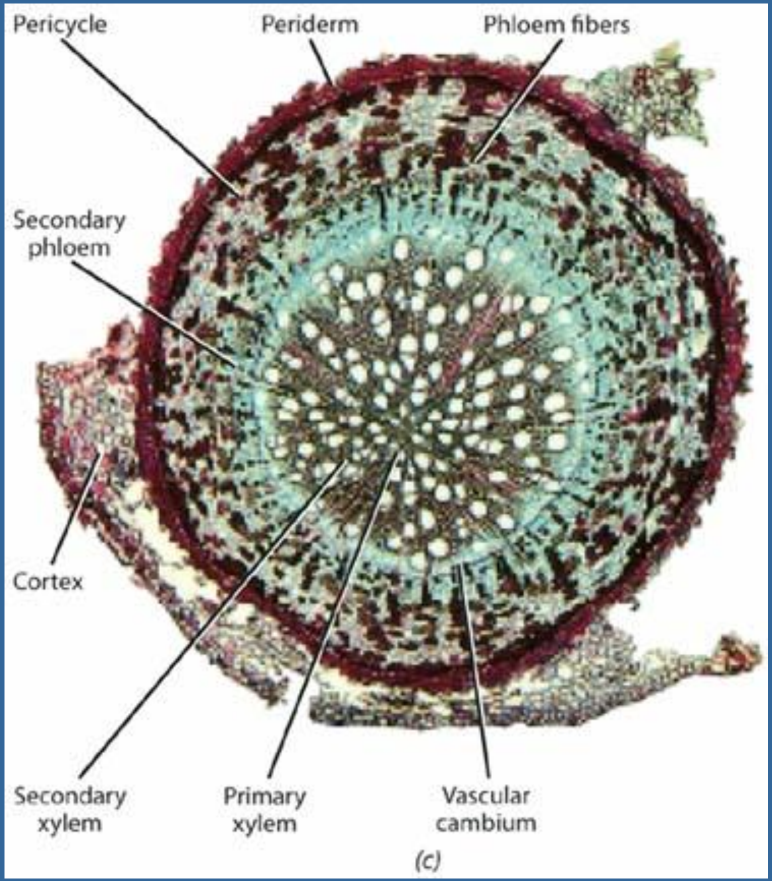
Cambio vascular

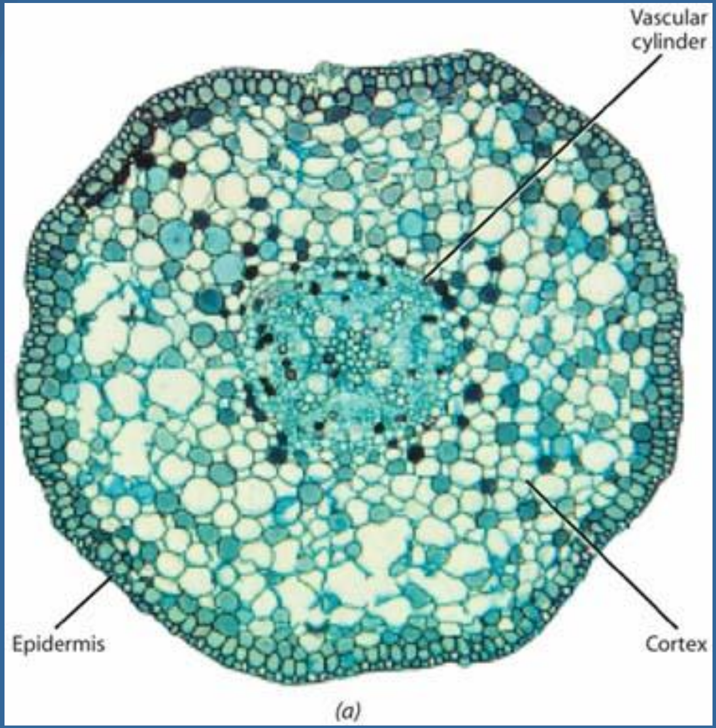


Botanical Society of America
Marsh Sundberg

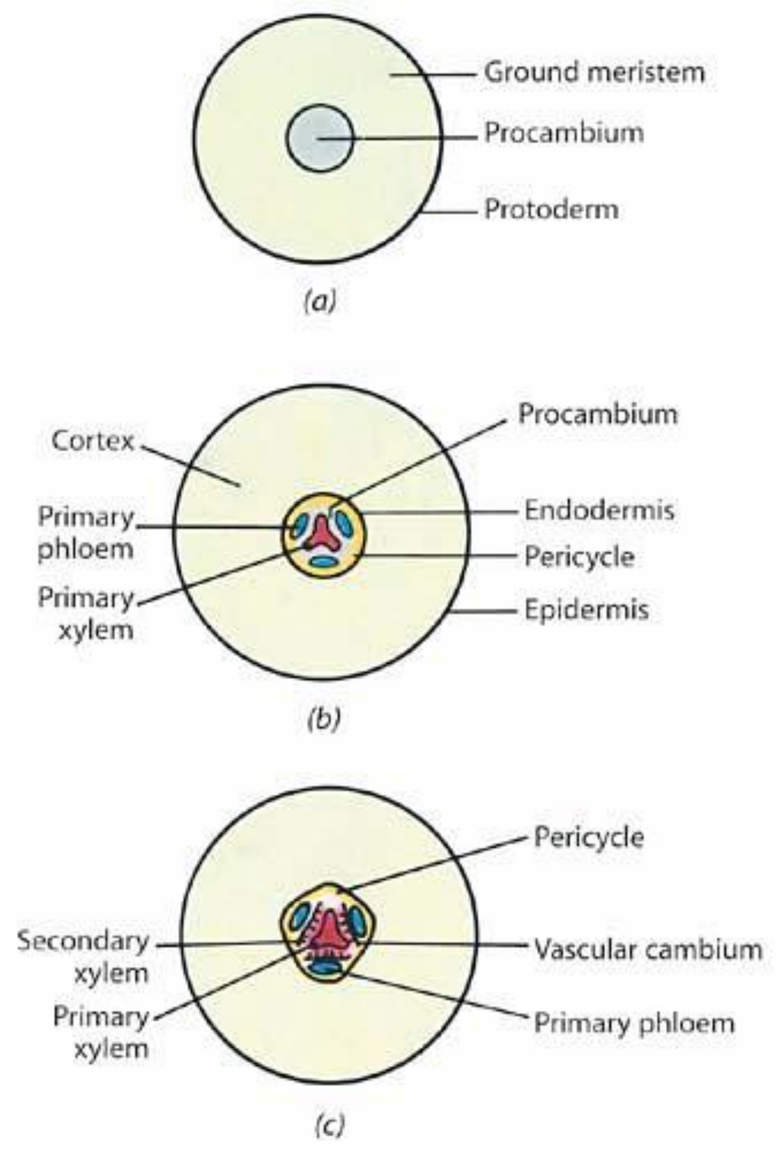
Crescimento secundário

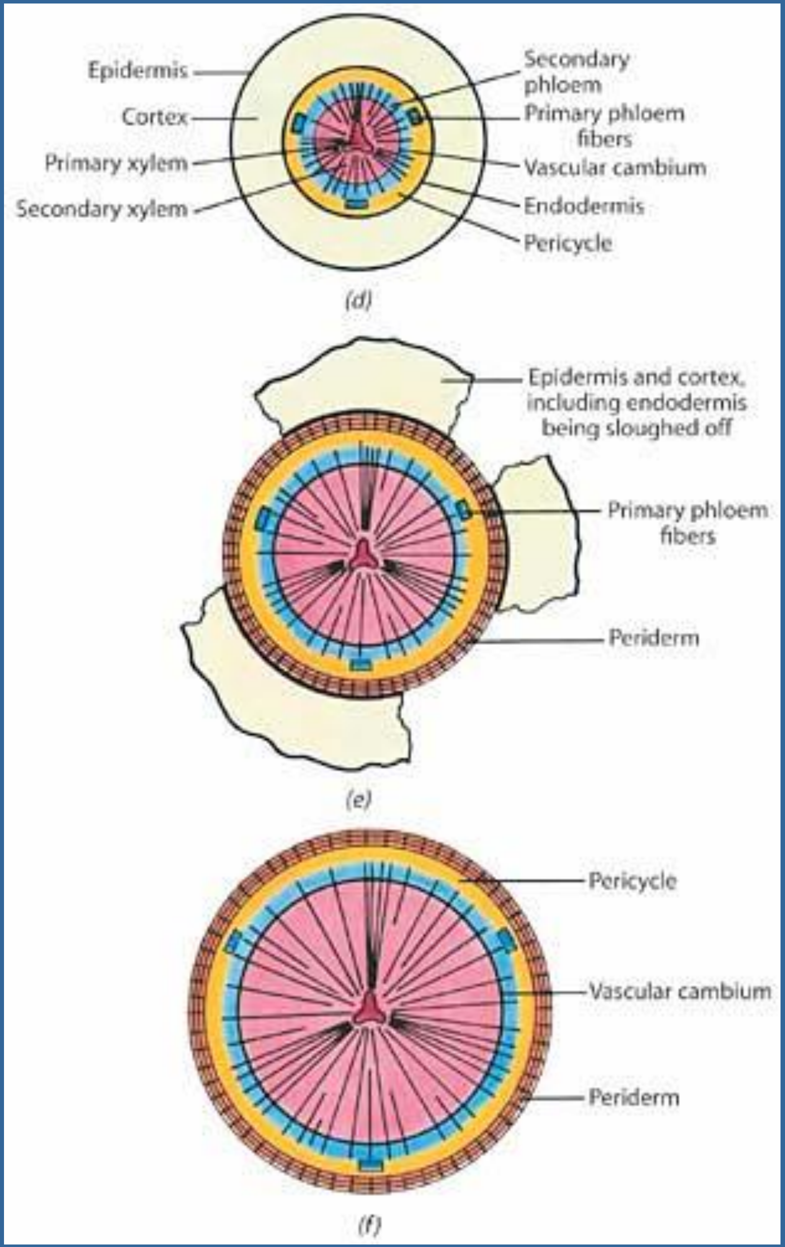
- **Formação de tecidos secundários:**
  - **Xilema e floema secundários (a partir do câmbio vascular)**
  - **Periderme (a partir do felogênio)**

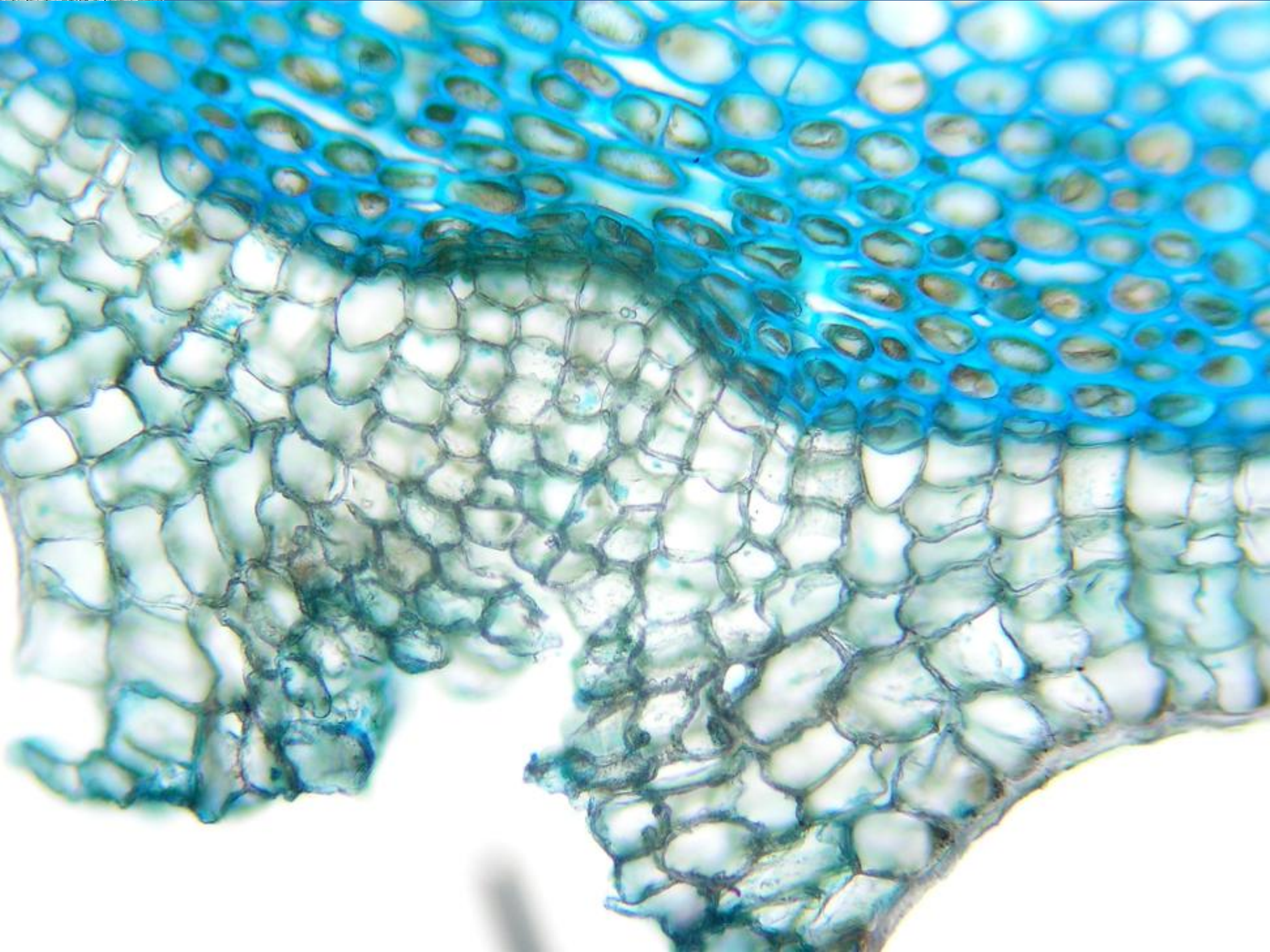

Pericycle
Periderm
Phloem fibers
Secondary phloem
Cortex
Secondary xylem
Primary xylem
Vascular cambium
(c)


Vascular cylinder
Epidermis
Cortex
(a)

Desenvolvimento secundário em raízes

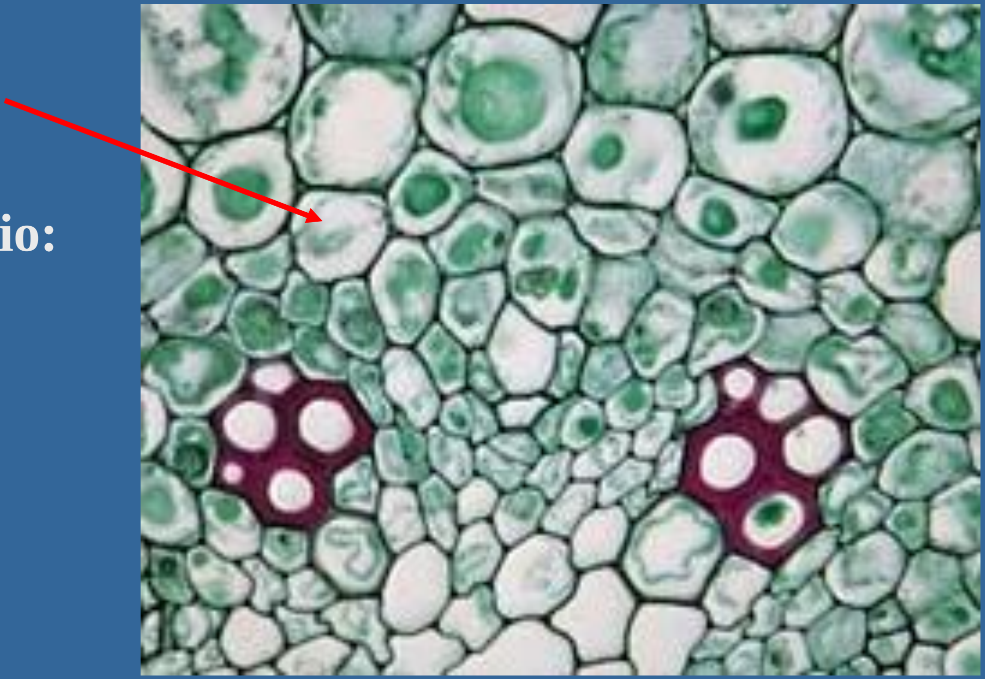

Ground meristem
Procambium
Protoderm
(a)
Cortex
Procambium
Primary phloem
Endodermis
Pericycle
Primary xylem
Epidermis
(b)
Pericycle
Secondary xylem
Vascular cambium
Primary xylem
Primary phloem
(c)


Epidermis
Cortex
Primary xylem
Secondary xylem
Secondary phloem
Primary phloem fibers
Vascular cambium
Endodermis
Pericycle
(d)
Epidermis and cortex, including endodermis being sloughed off
Primary phloem fibers
Periderm
(e)
Pericycle
Vascular cambium
Periderm
(f)

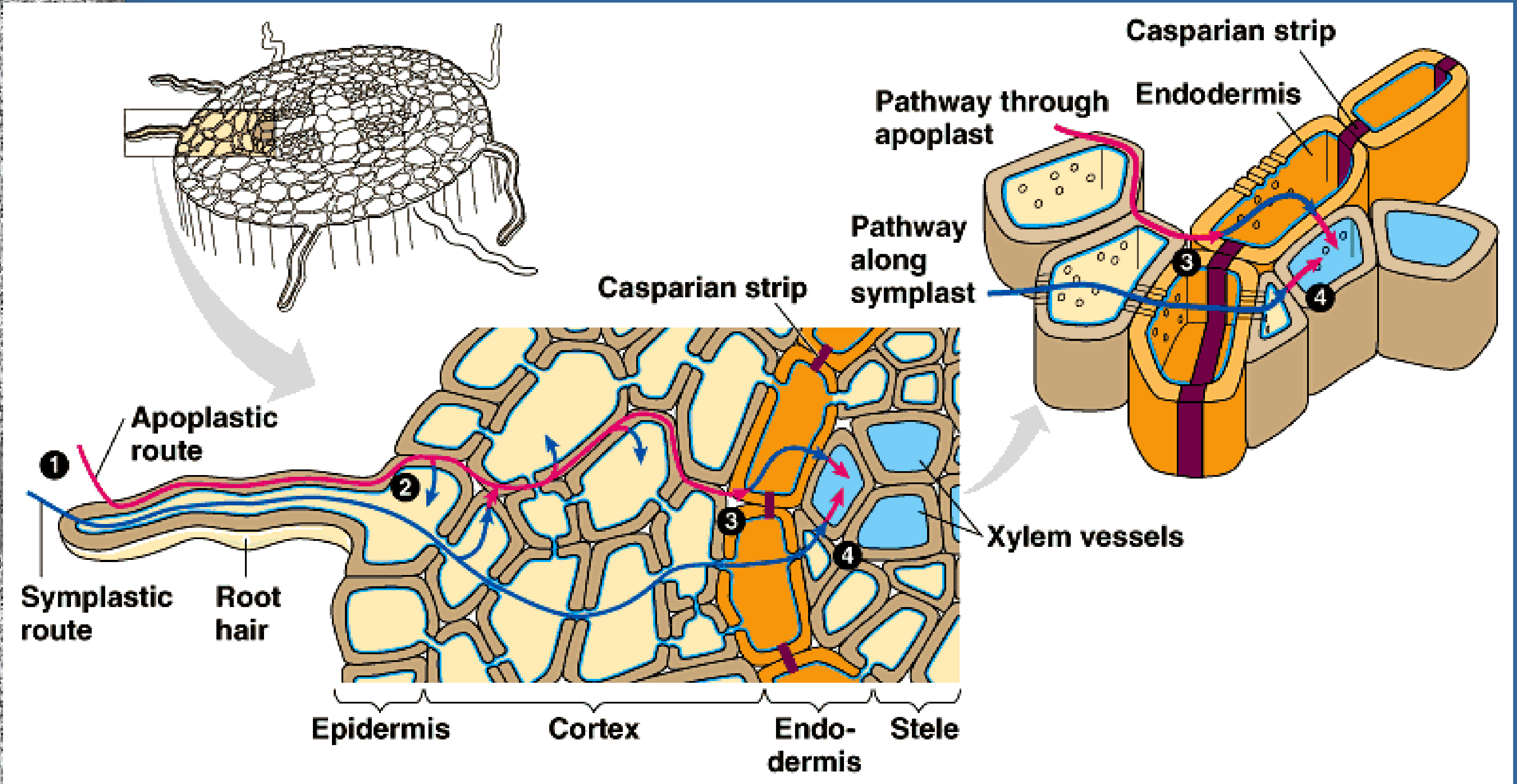


Endoderme

- Estrias de Caspary: impermeáveis
  - Via simplasto
- Crescimento secundário: perda do córtex e da endoderme
- Células de passagem
- Exoderme



Estrias de Caspary


Casparian strip
Endodermis
Pathway through apoplast
Pathway along symplast
Casparian strip
Apoplastic route
Symplastic route
Root hair
Xylem vessels
Epidermis
Cortex
Endo-dermis
Stele
❶
❷
❸
❹

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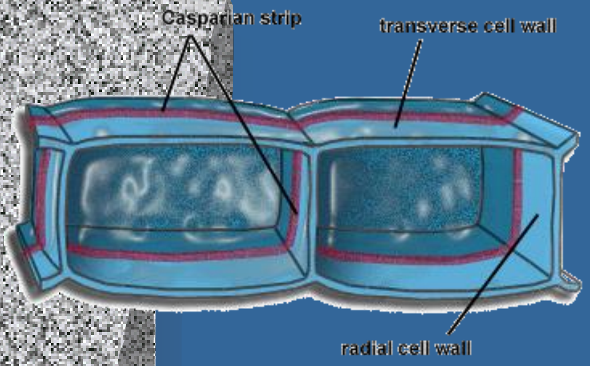
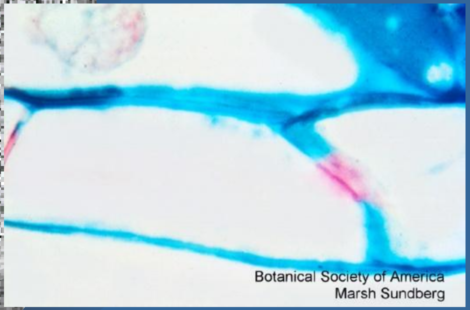
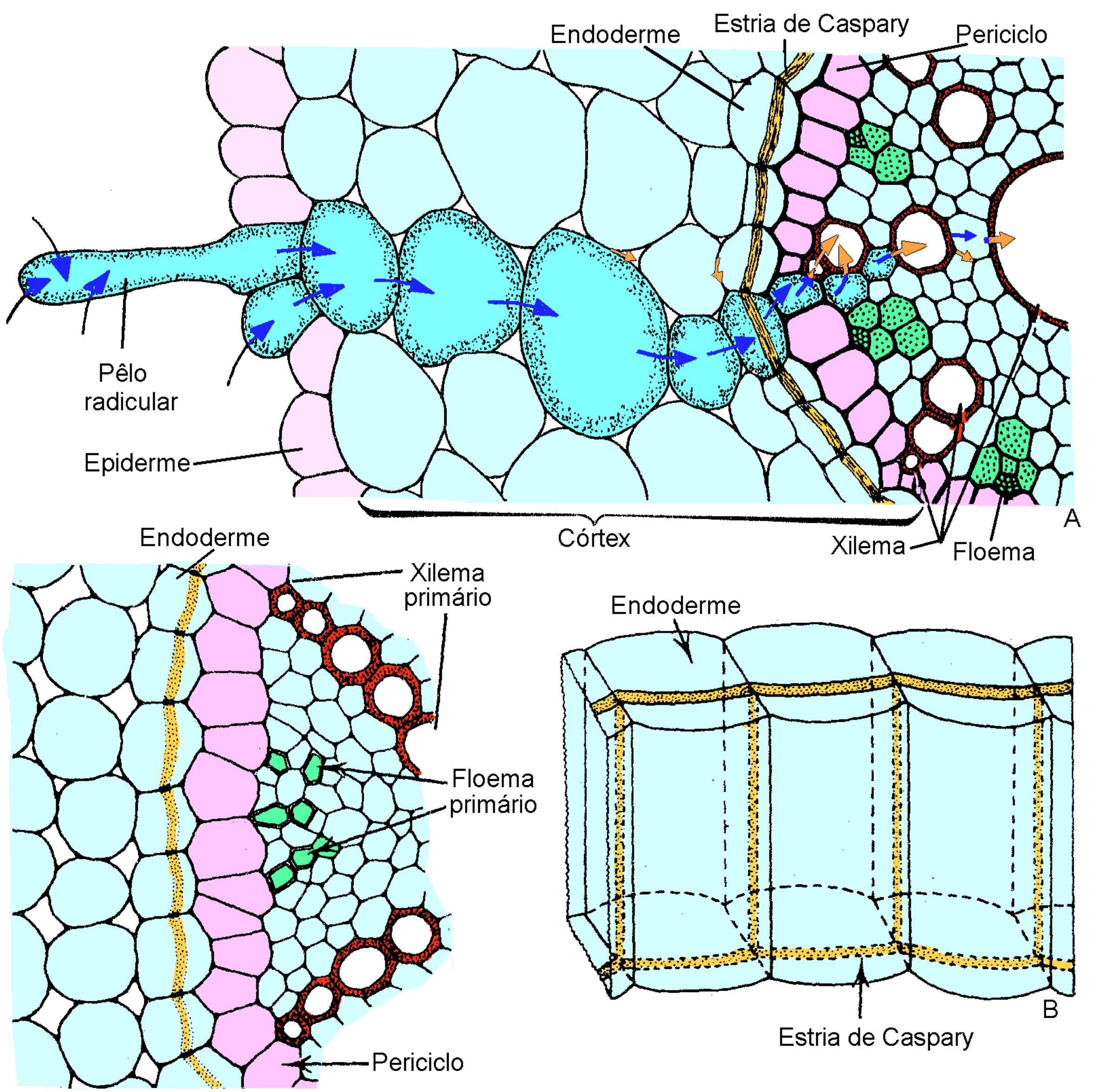
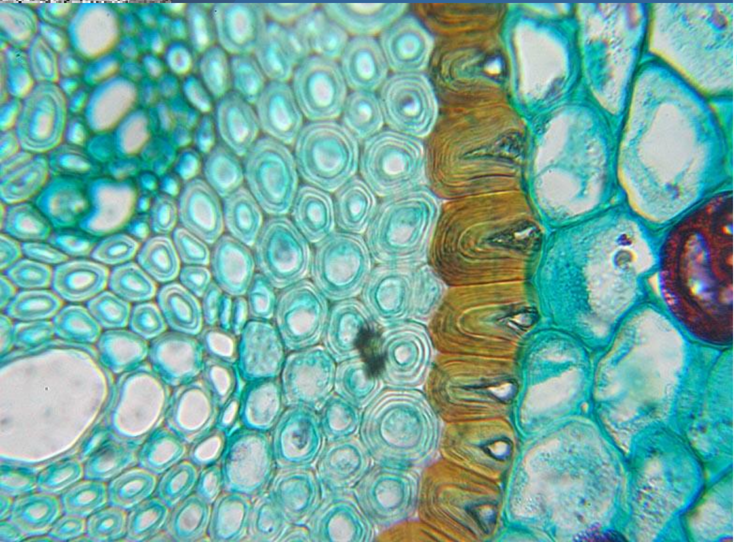
Estrias de Caspary

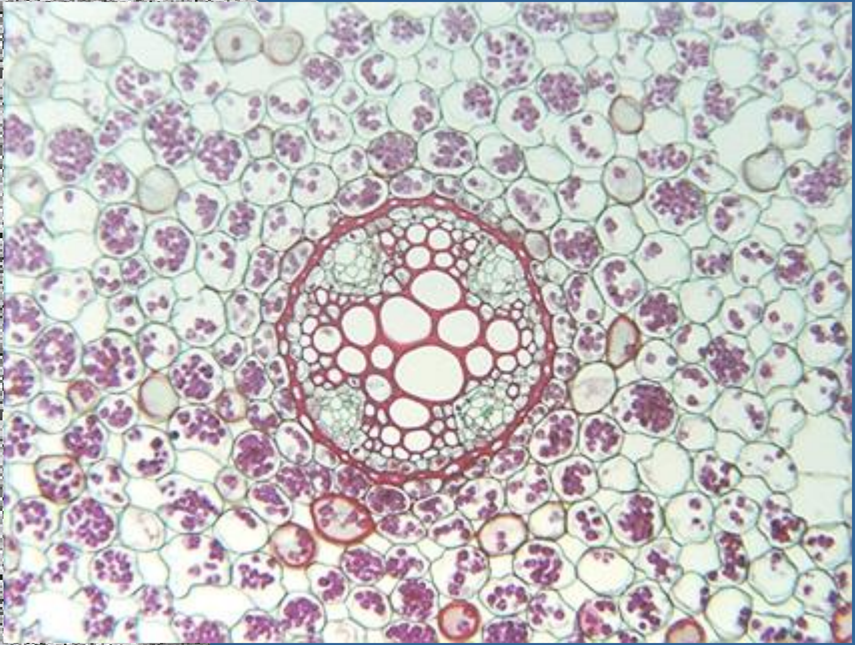

Casparian strip
transverse cell wall
radial cell wall

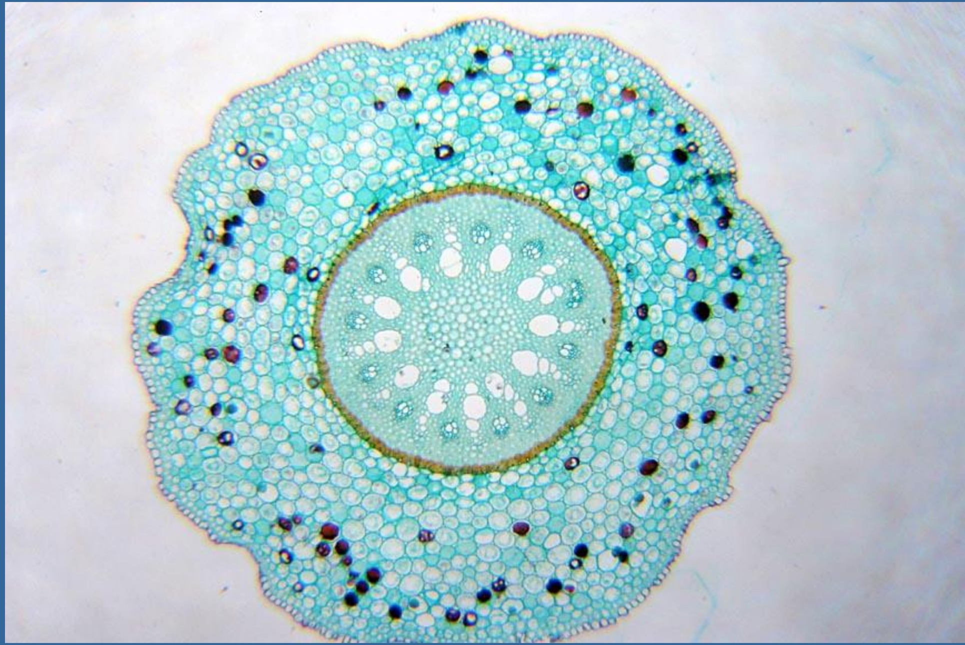

Botanical Society of America
Marsh Sundberg

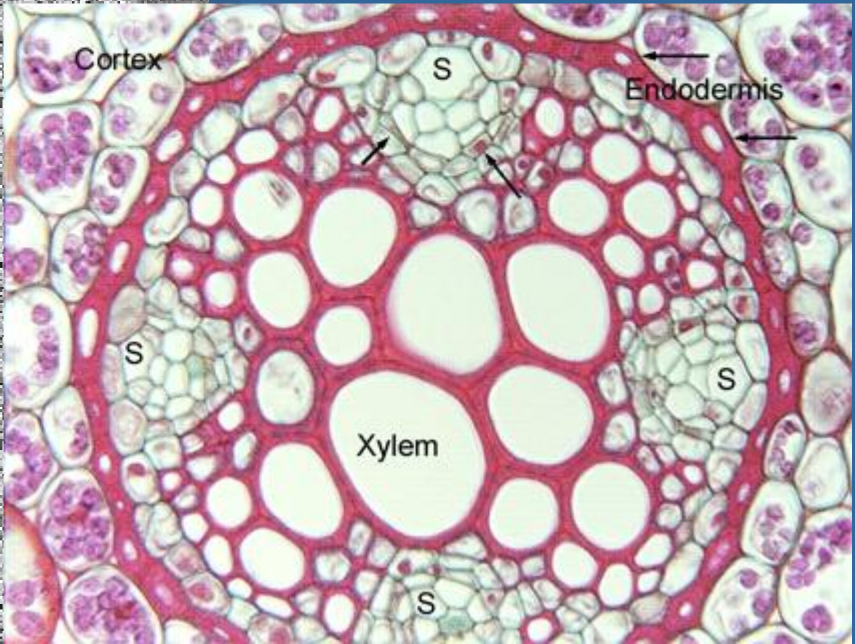

Endoderme
Estria de Caspary
Periciclo
Pêlo radicular
Epiderme
Córtex
Xilema
Floema
A
Endoderme
Xilema primário
Floema primário
Periciclo
Endoderme
Estria de Caspary
B

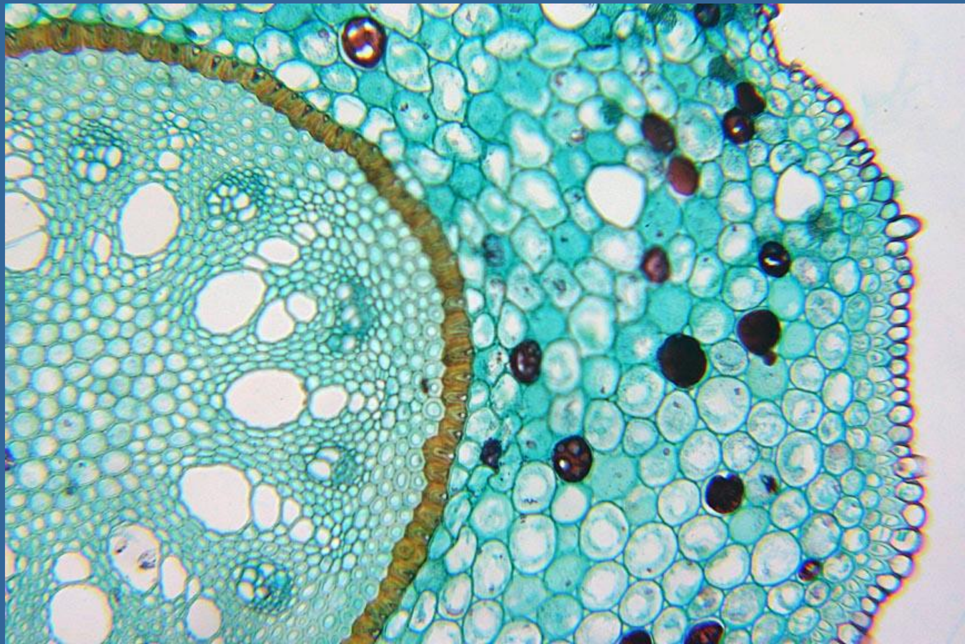


Dicotiledôneas X Monocotiledôneas



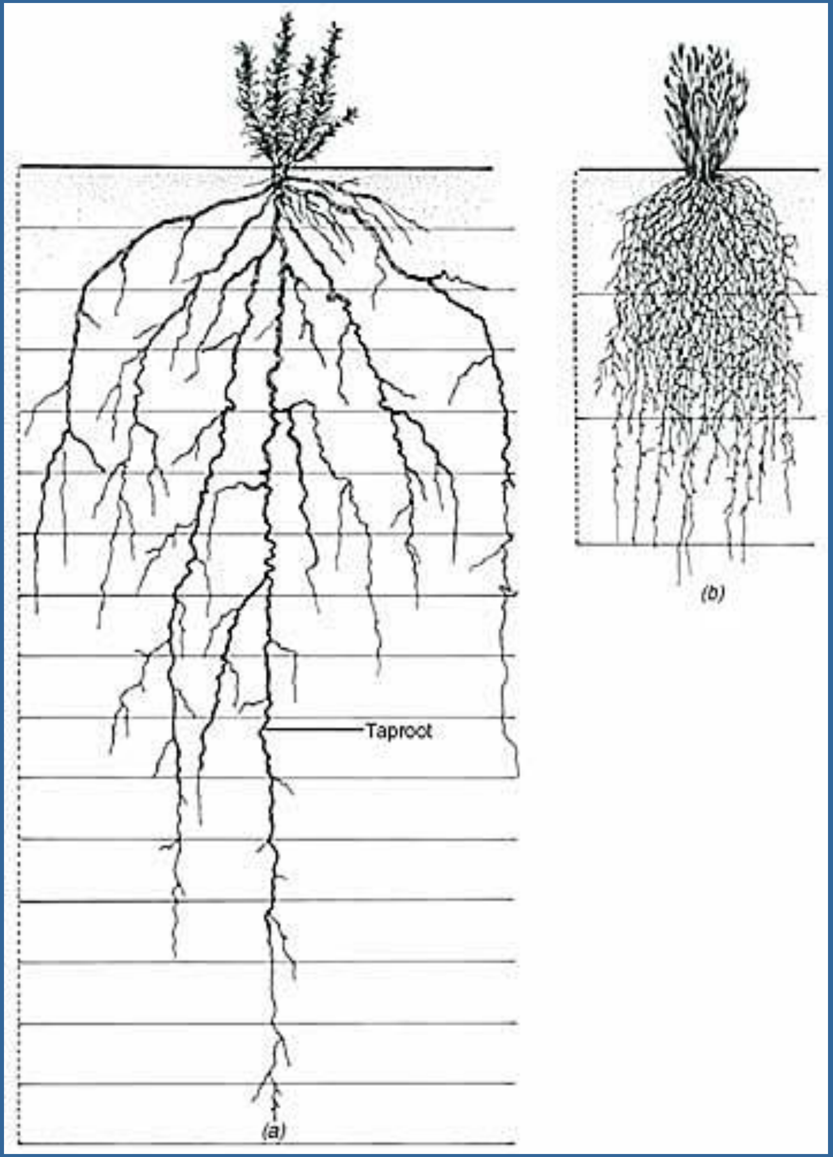


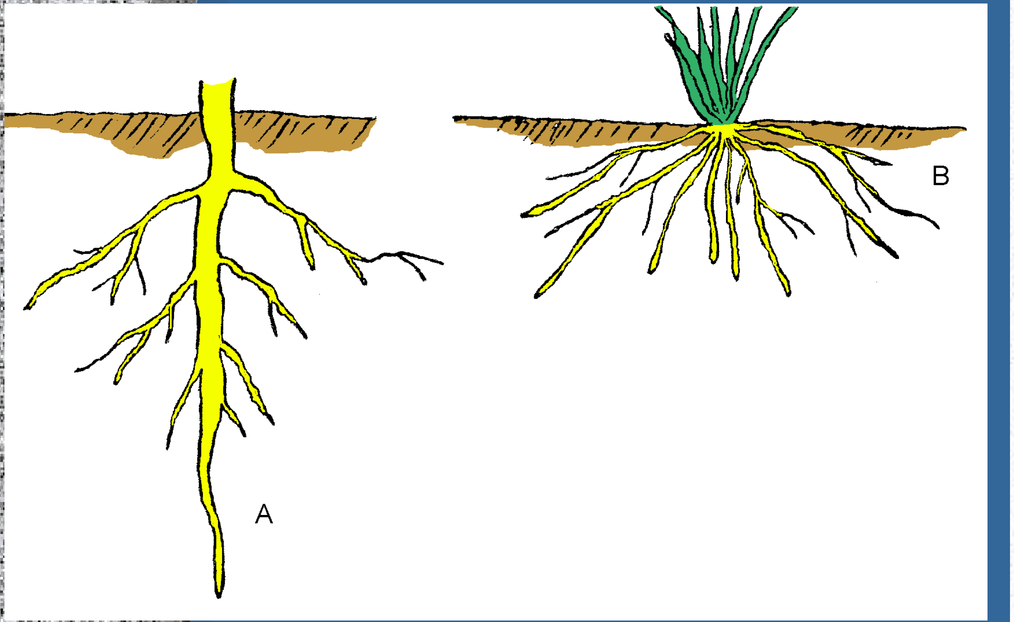

Cortex
S
Endodermis
S
S
Xylem
S



Sistemas radiculares

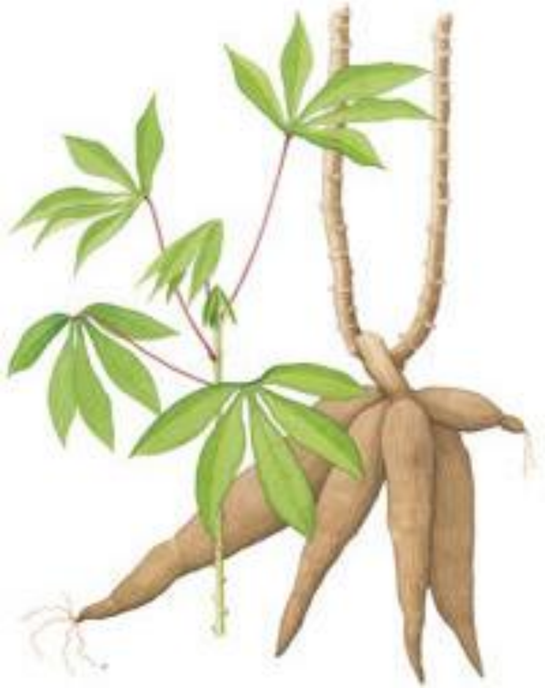
- A = Pivotante
- B = Fasciculado

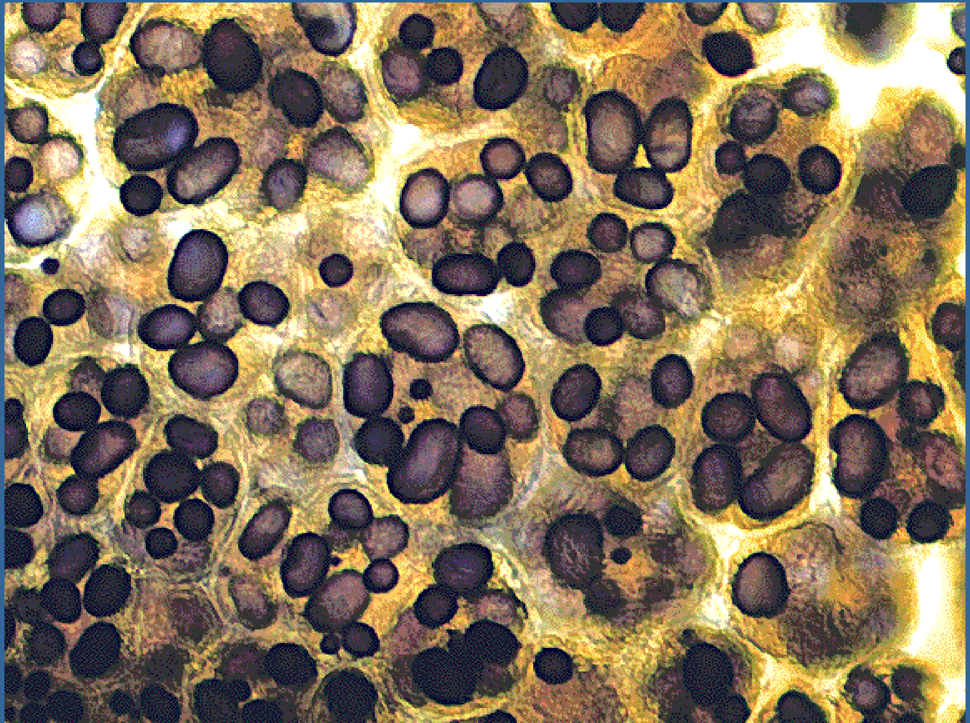




Raizes tuberosas

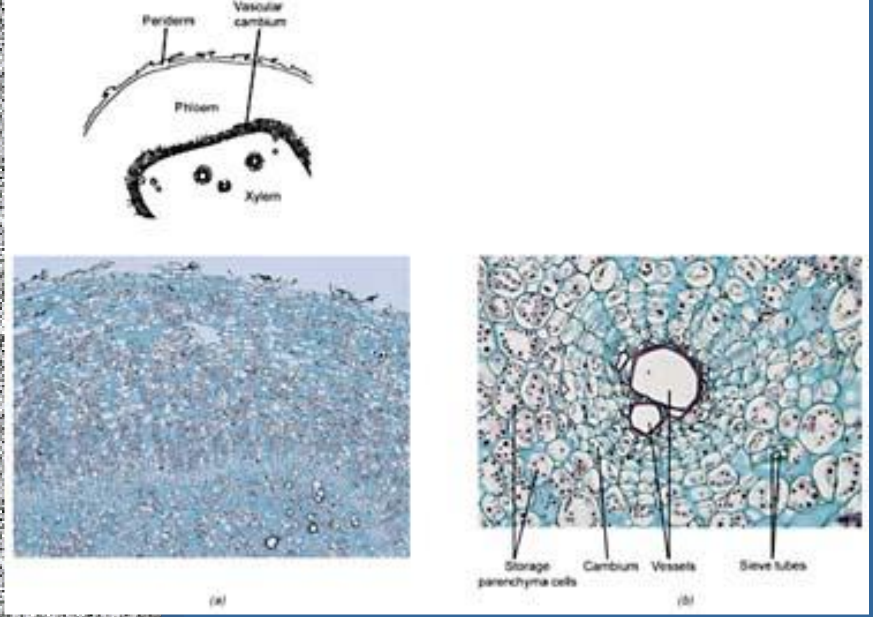
- Órgãos de armazenamento
- Parênquima de reserva
- Amiloplastos





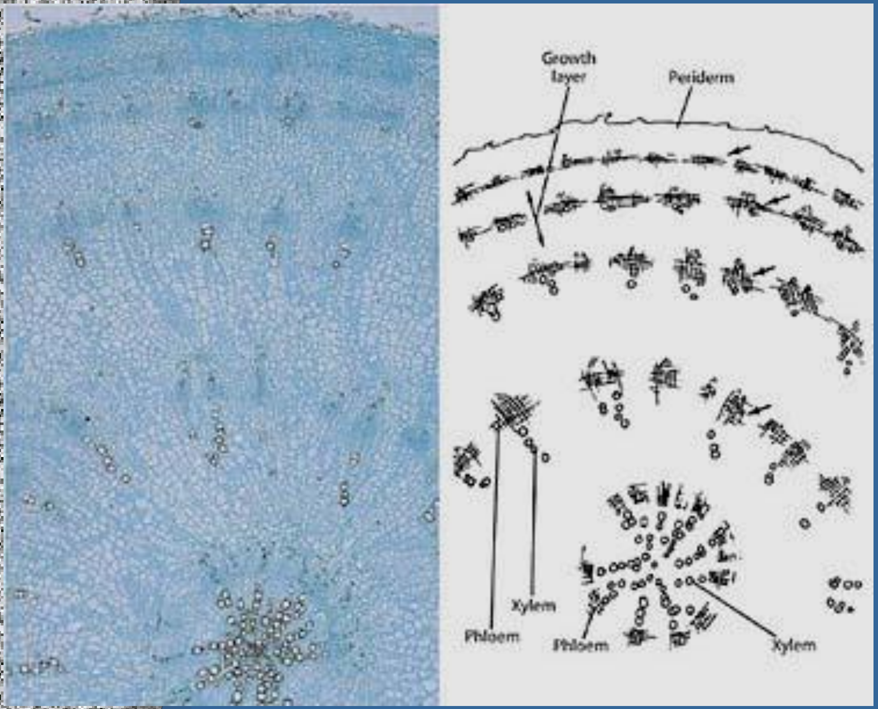
Raízes tuberosas

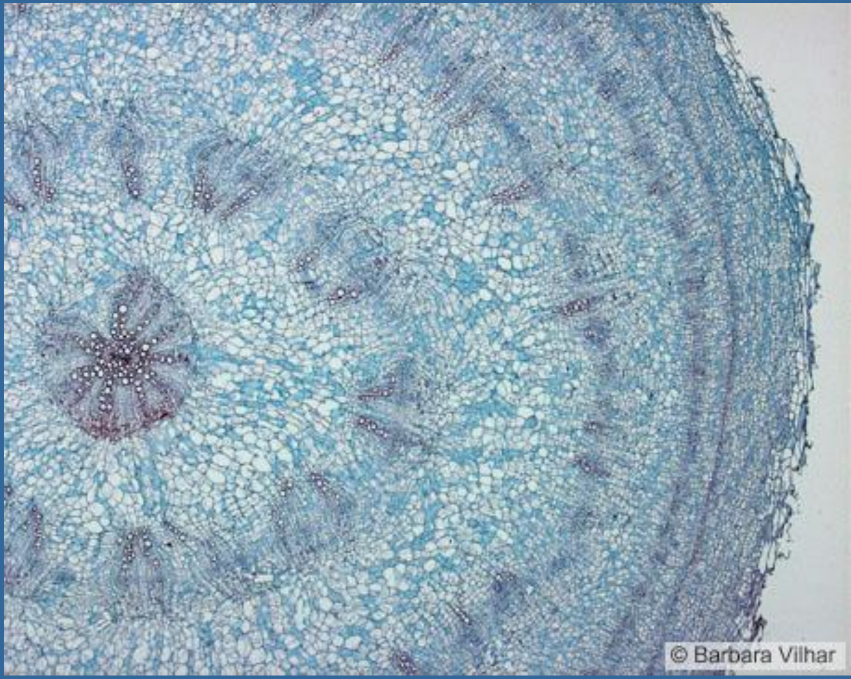
- Órgãos de armazenamento
- Parênquima de reserva
- *Daucus carota* - cenoura
- *Ipomoea batatas*: câmbios vasculares adicionais


Periderm
Vascular cambium
Phloem
Xylem
Storage parenchyma cells
Cambium
Vessels
Sieve tubes
(a)
(b)

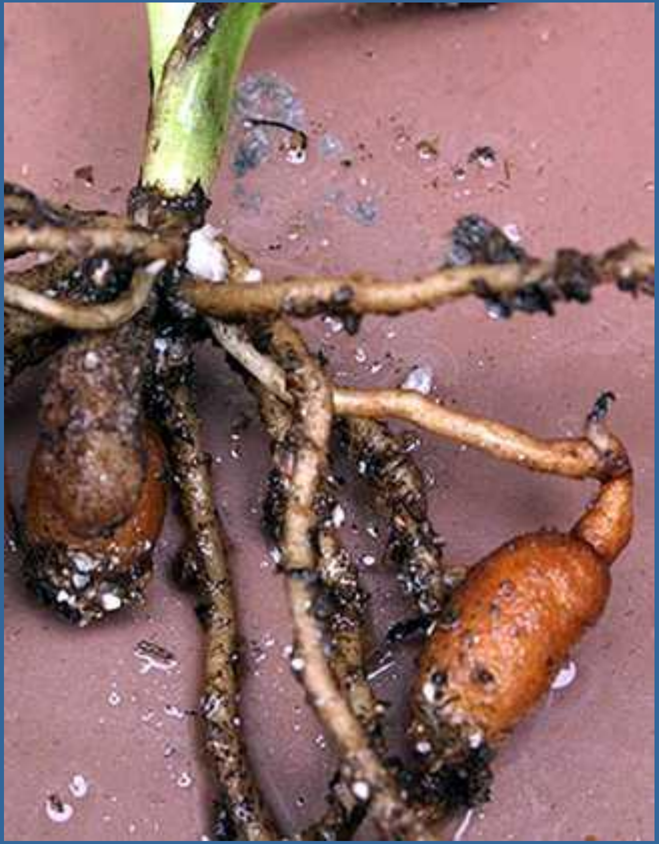
Raízes tuberosas

- *Beta vulgaris*: câmbios supranuméricos

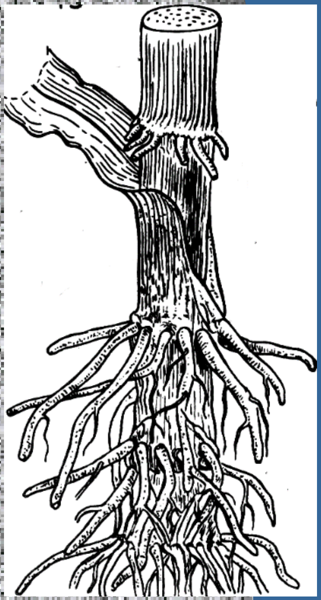

Growth layer
Periderm
Xylem
Phloem
Phloem
Xylem

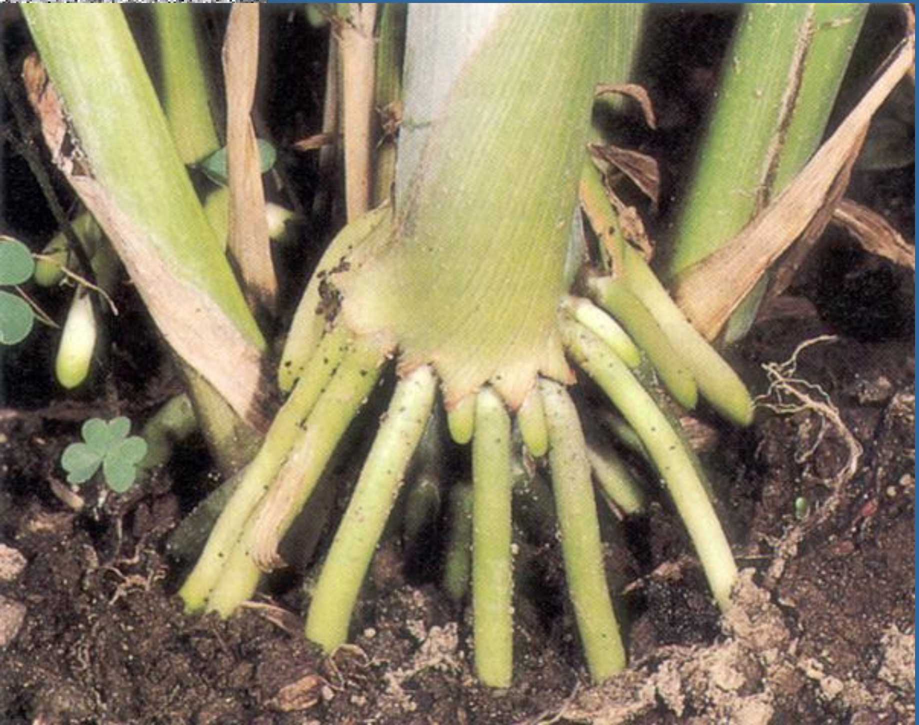

© Barbara Vilhar

Raízes tuberosas

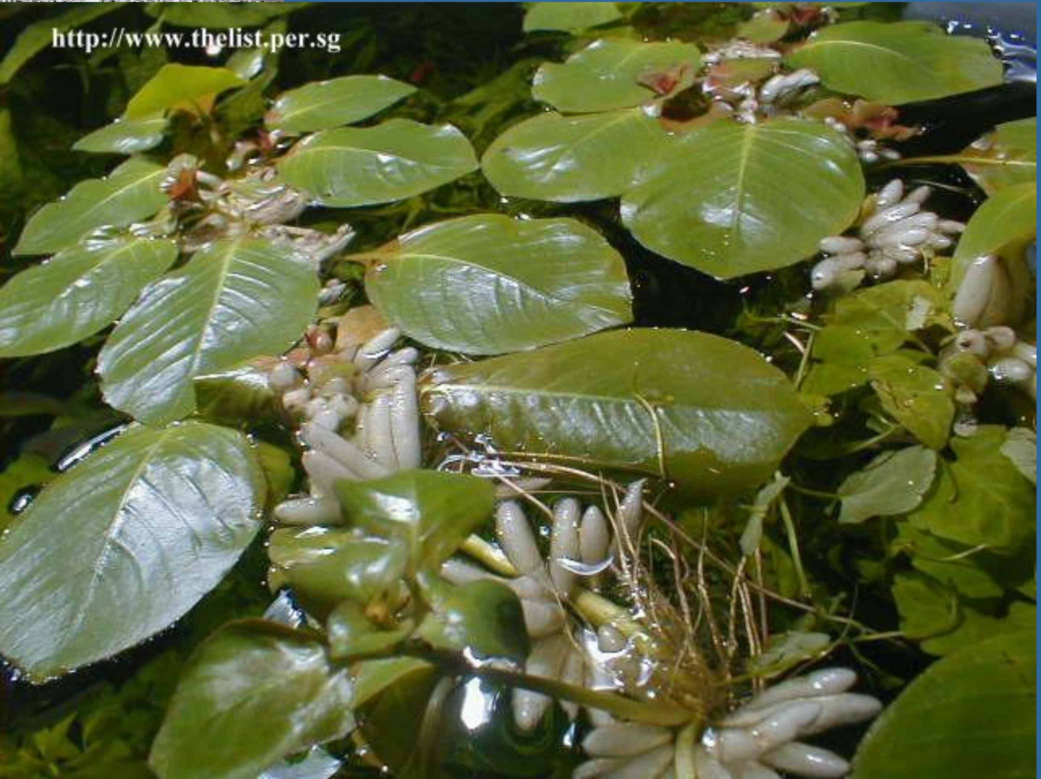


Raízes escora e suporte

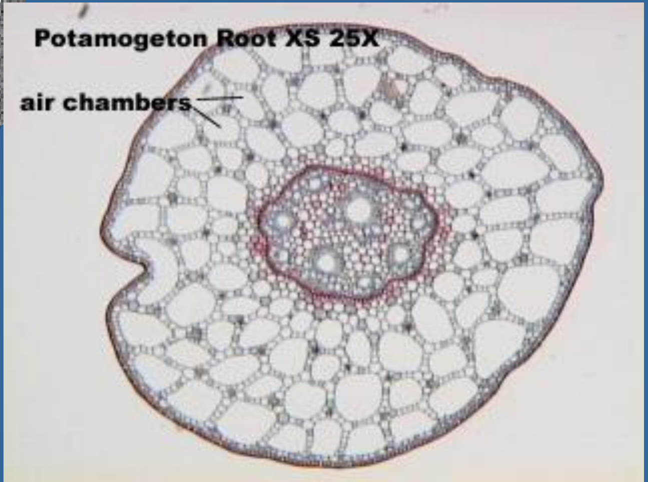


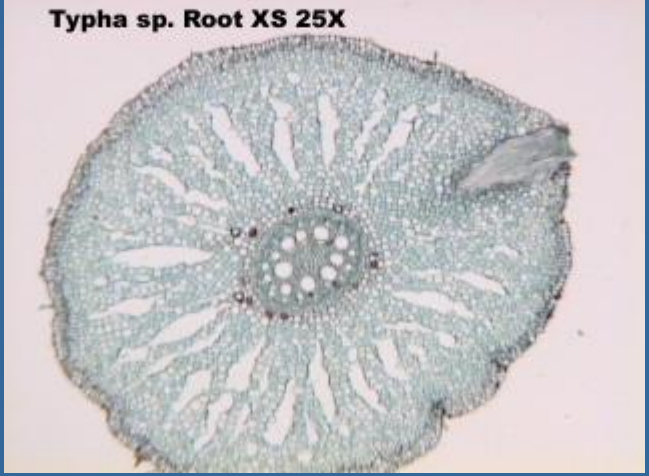


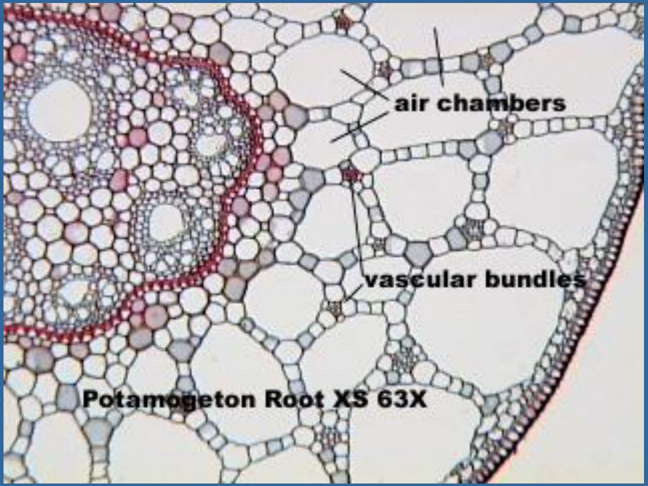
Raízes respiratórias

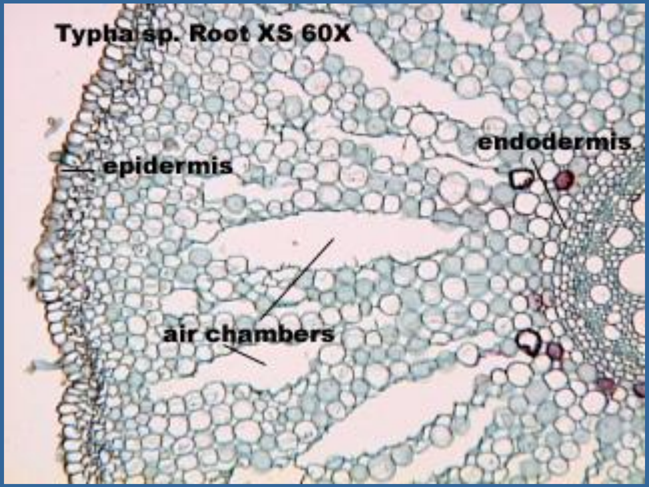

http://www.thelist.per.sg

Raízes de plantas aquáticas

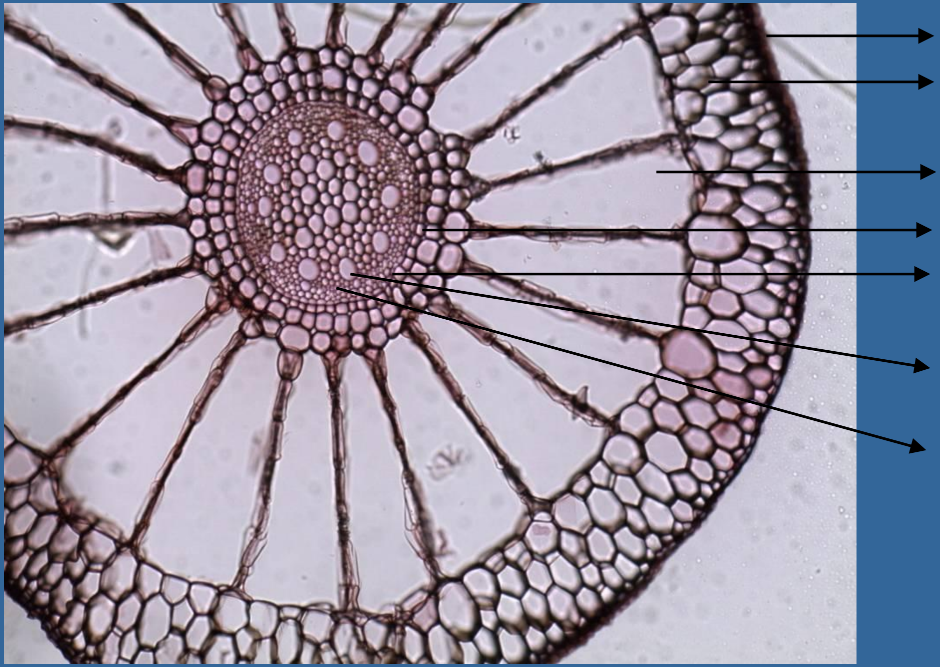

Potamogeton Root XS 25X
air chambers


Typha sp. Root XS 25X


air chambers
vascular bundles
Potamogeton Root XS 63X

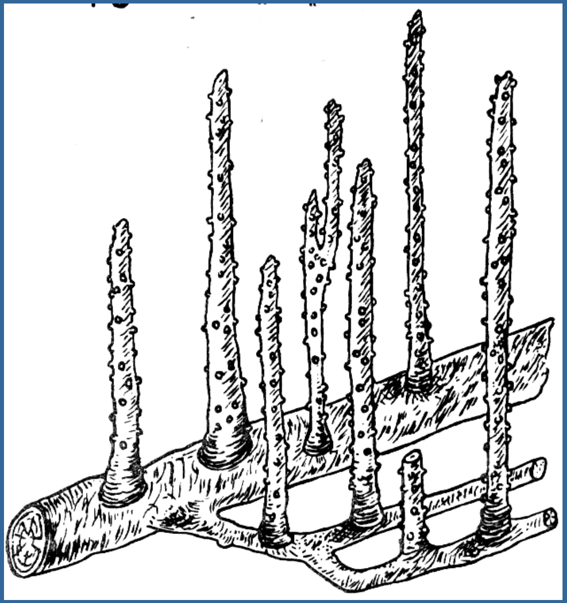

Typha sp. Root XS 60X
endodermis
epidermis
air chambers

Pistia stratiotes



- **Epiderme**
- **Parênquima cortical**
- **Aerênquima**
- **Endoderme**
- **Periciclo**
- **Xilema**
- **Floema**

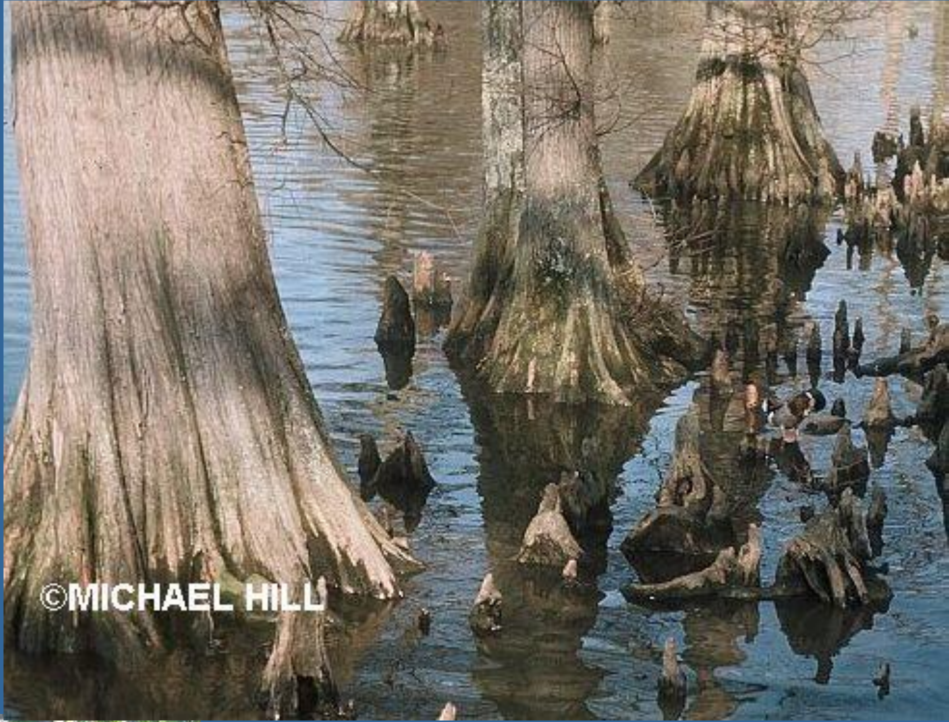
Raízes respiratórias



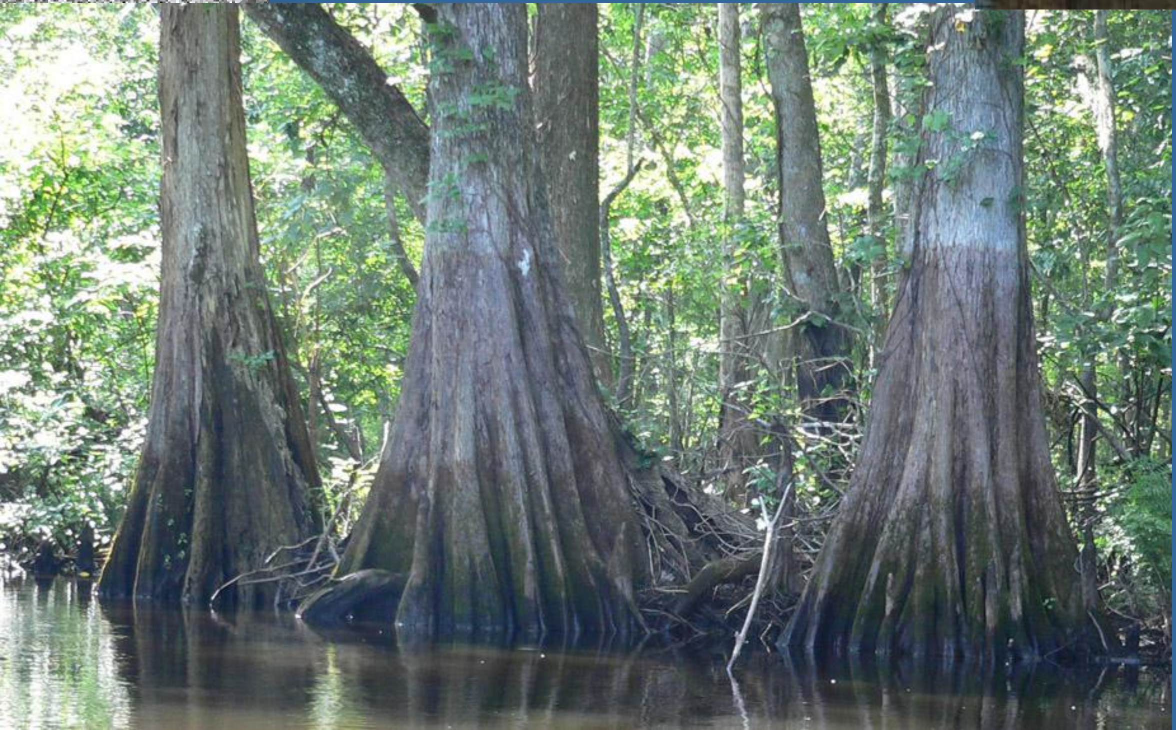
- Pneumatoforos
  - Espécies arbóreas ou arbustivas
  - Areas alagadas
  - Deficiência de oxigênio

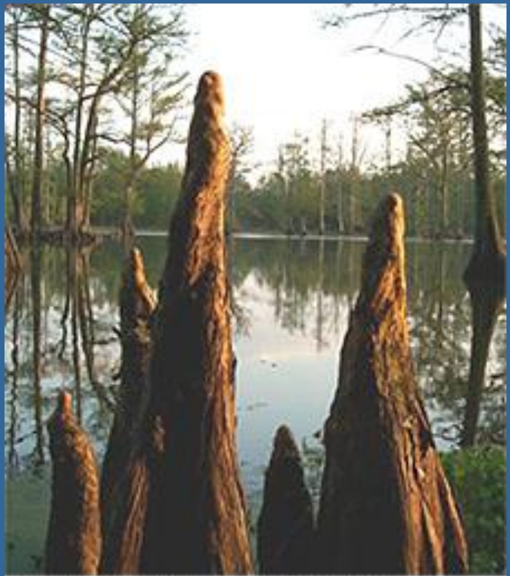
Pneumatophore

Taxodium



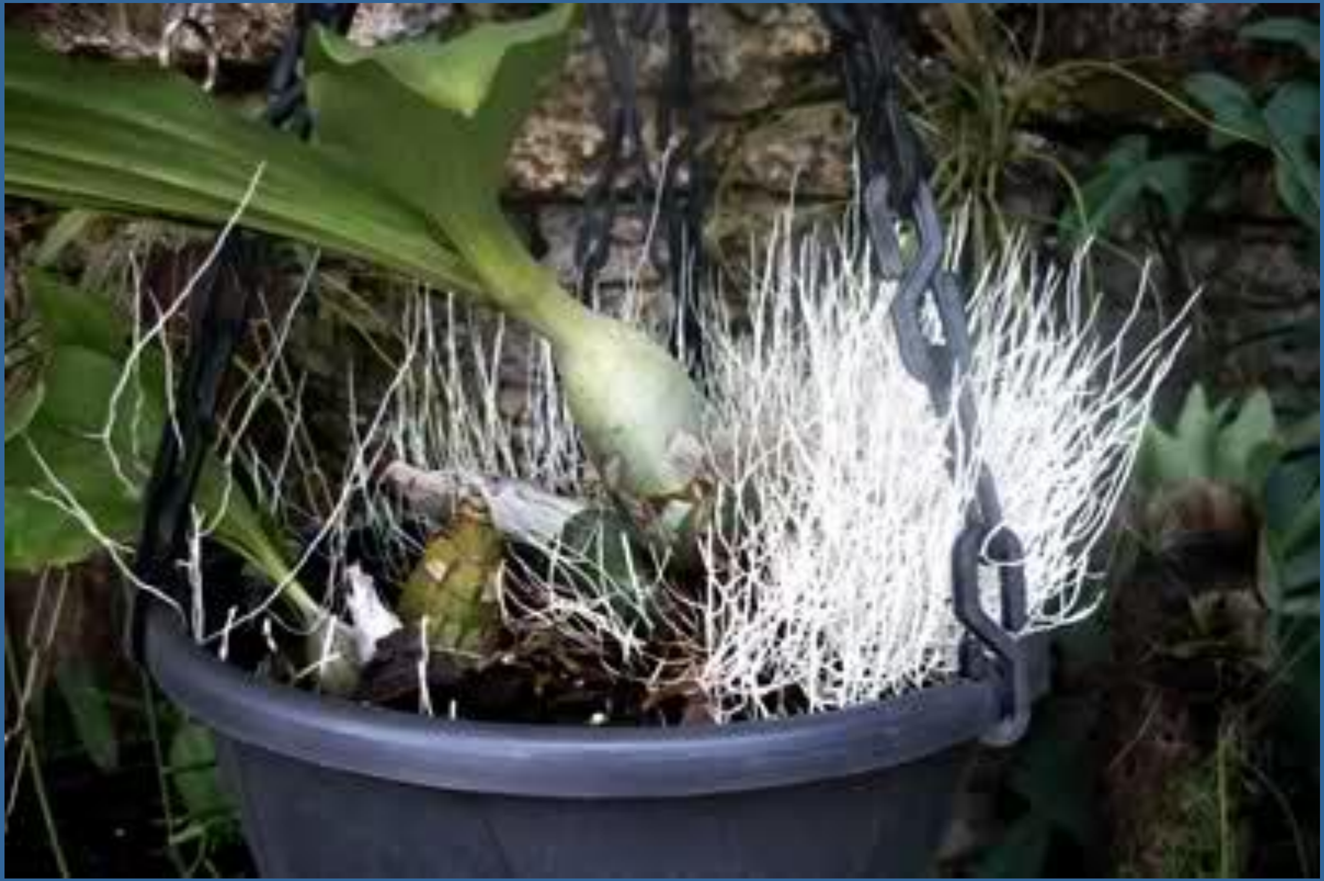
©MICHAEL HILL

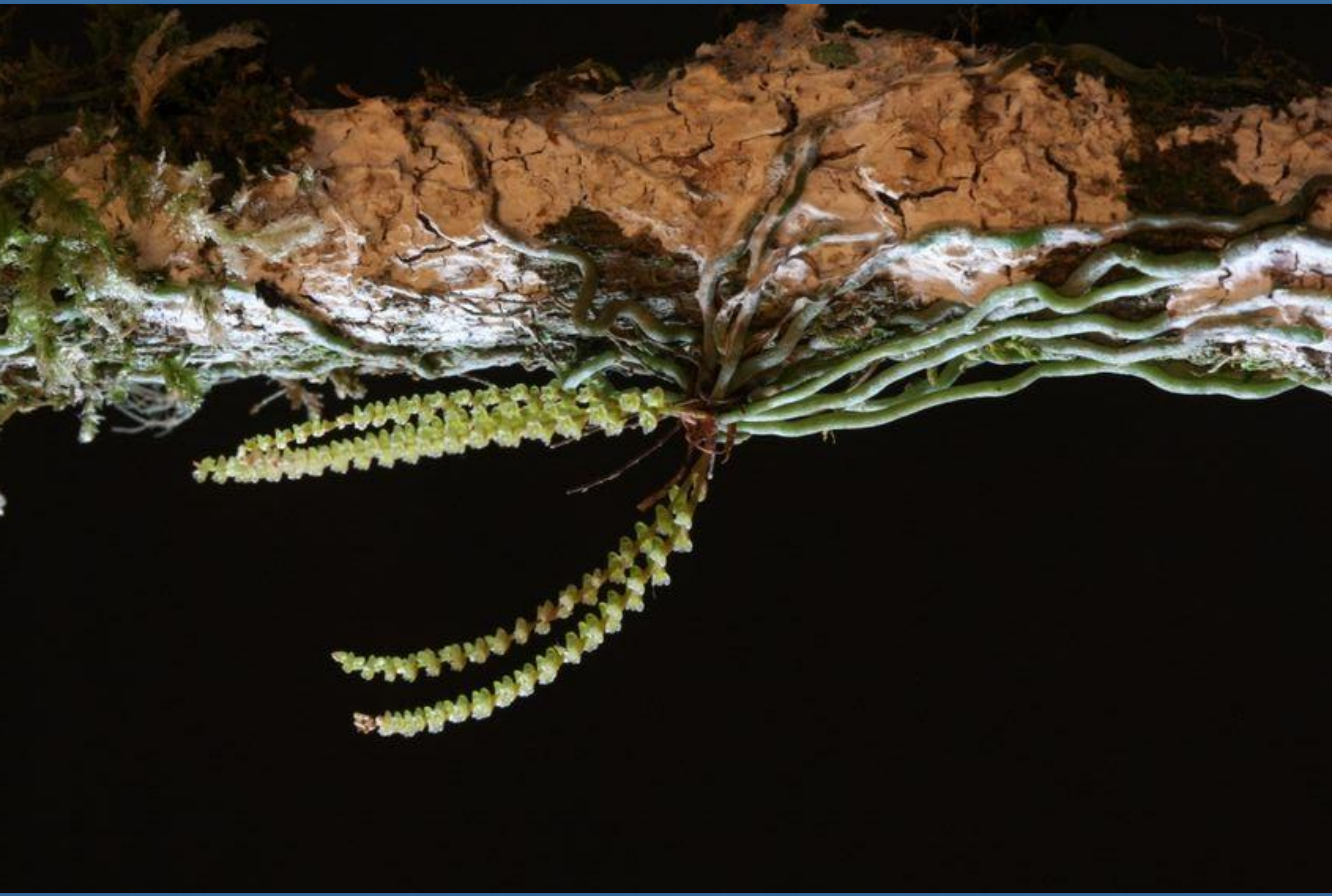




Cypress knees. (Photo: Steve Twaddle)

Raízes fotossintetizantes





Raízes fotossintetizantes

Raízes contrácteis

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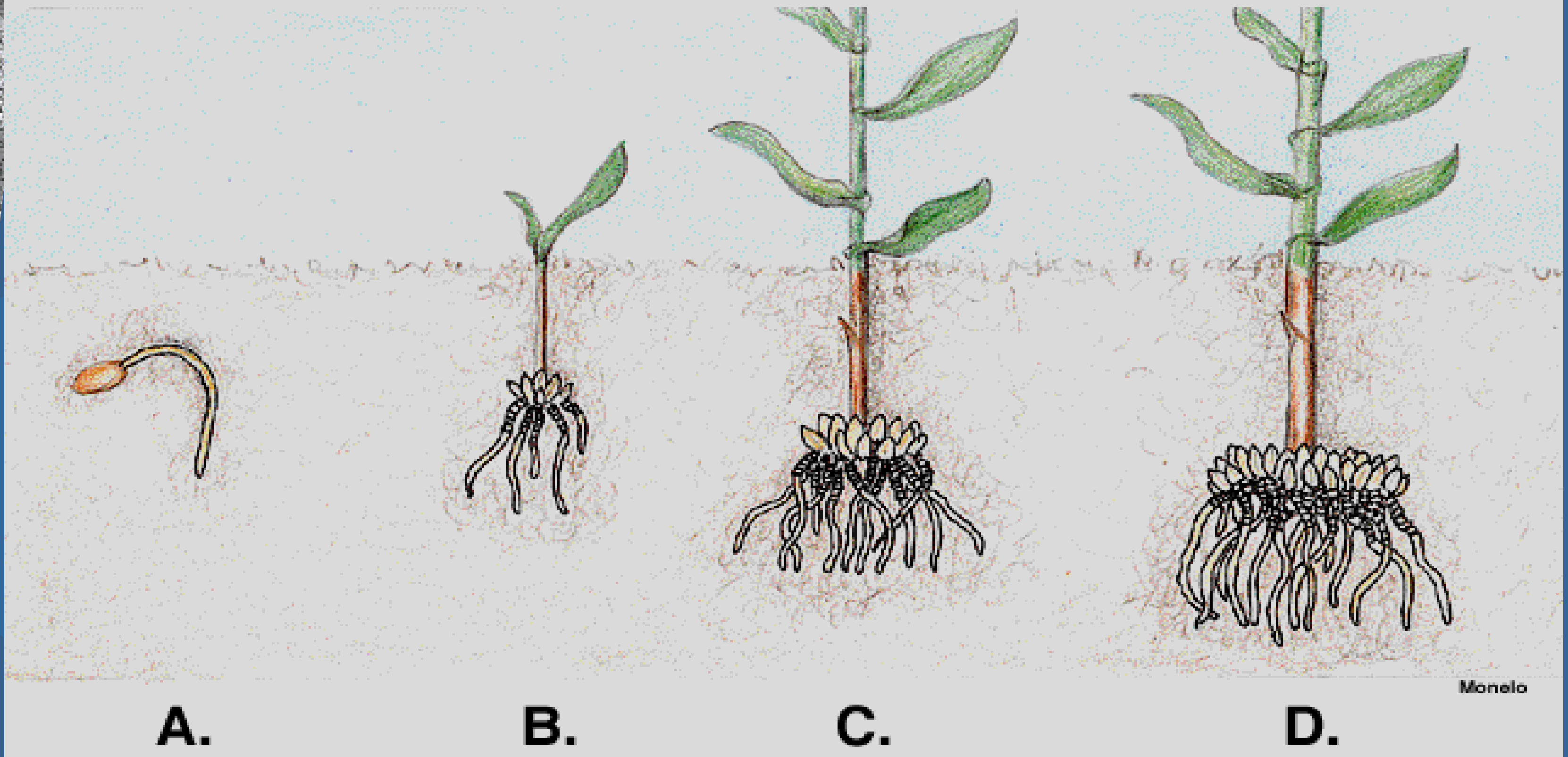
Action of Contractile Roots



Raízes grampiformes

- Plantas volúveis
- Fixação

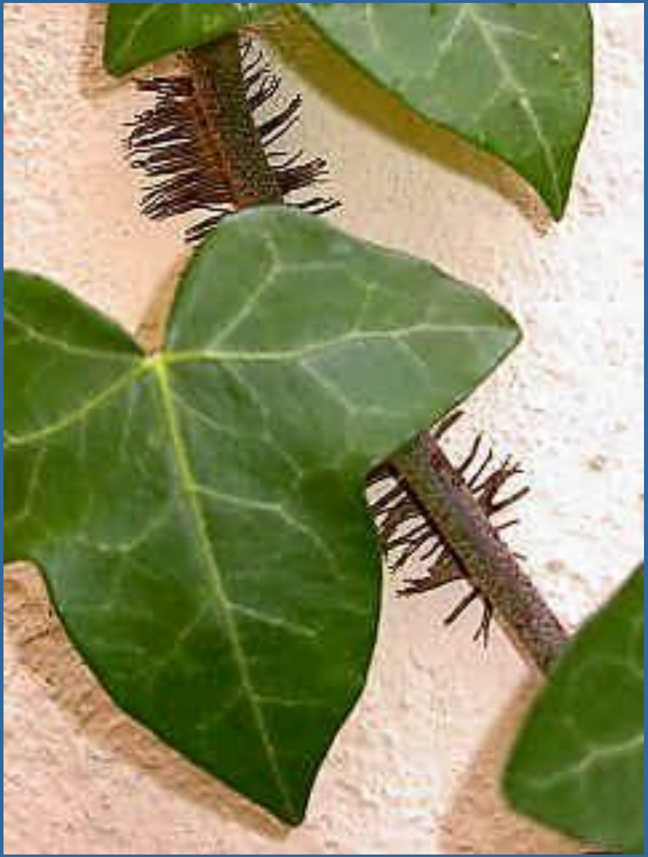
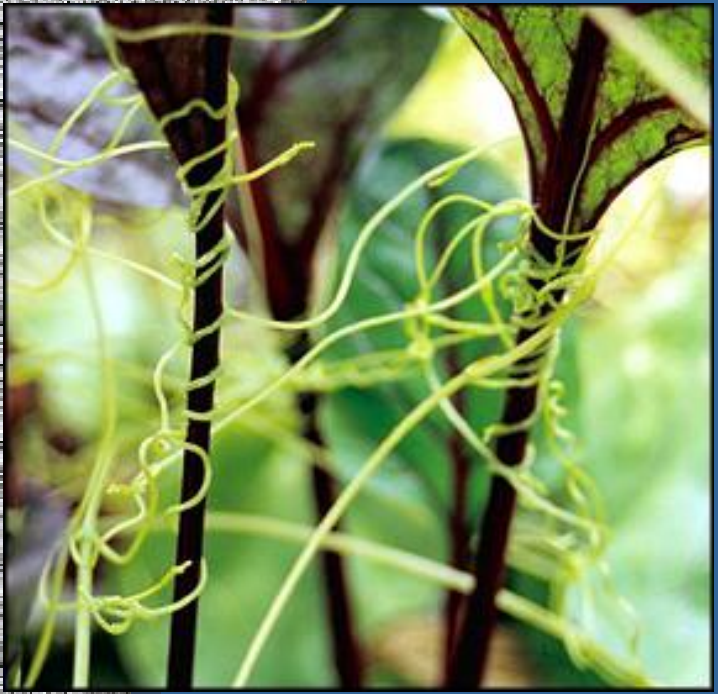
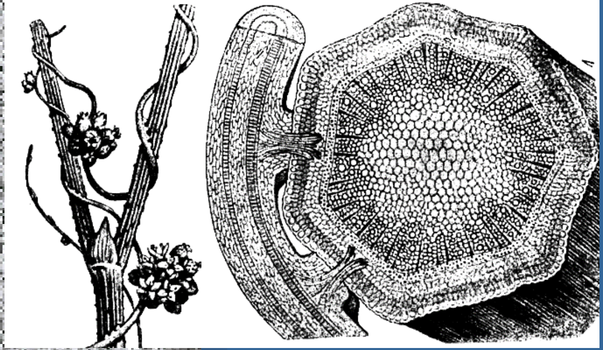


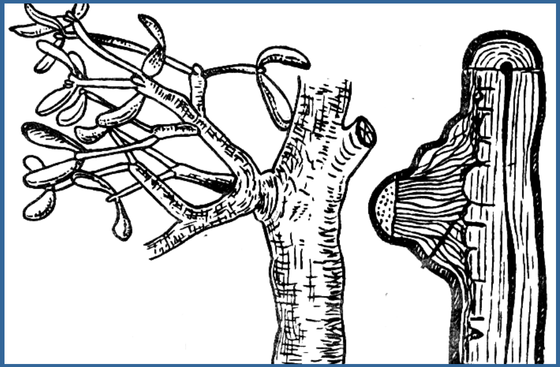
Foto: Arne Anderberg

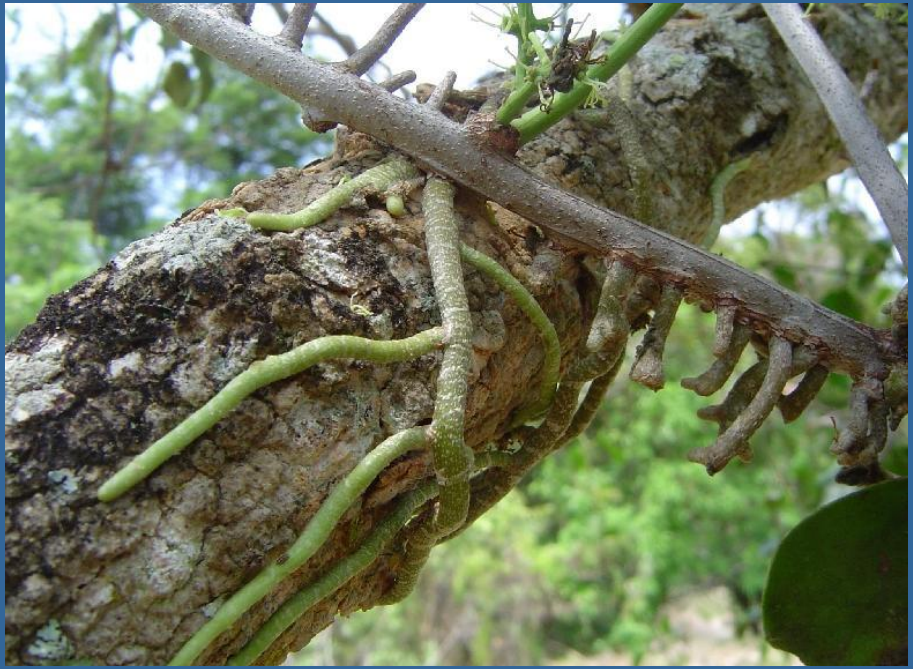
Raízes sugadoras - haustórios





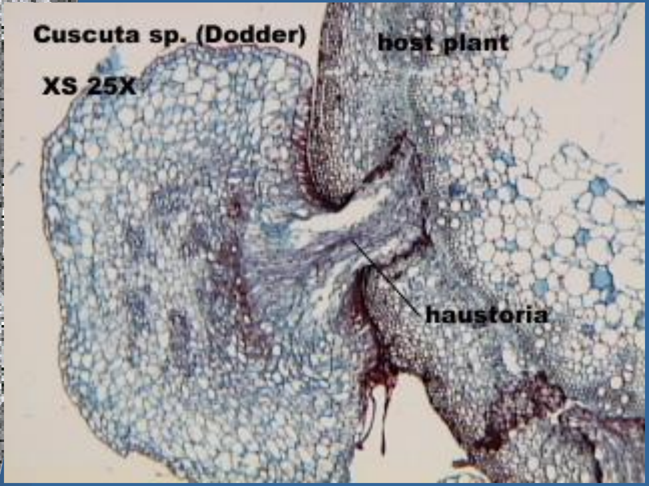
- **Holoparasitas**

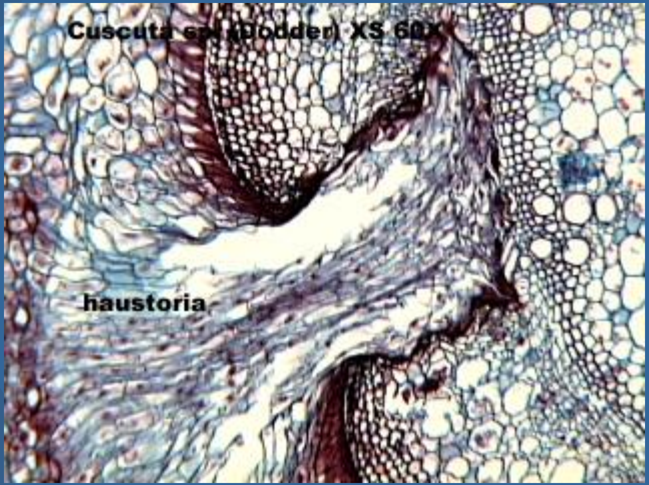


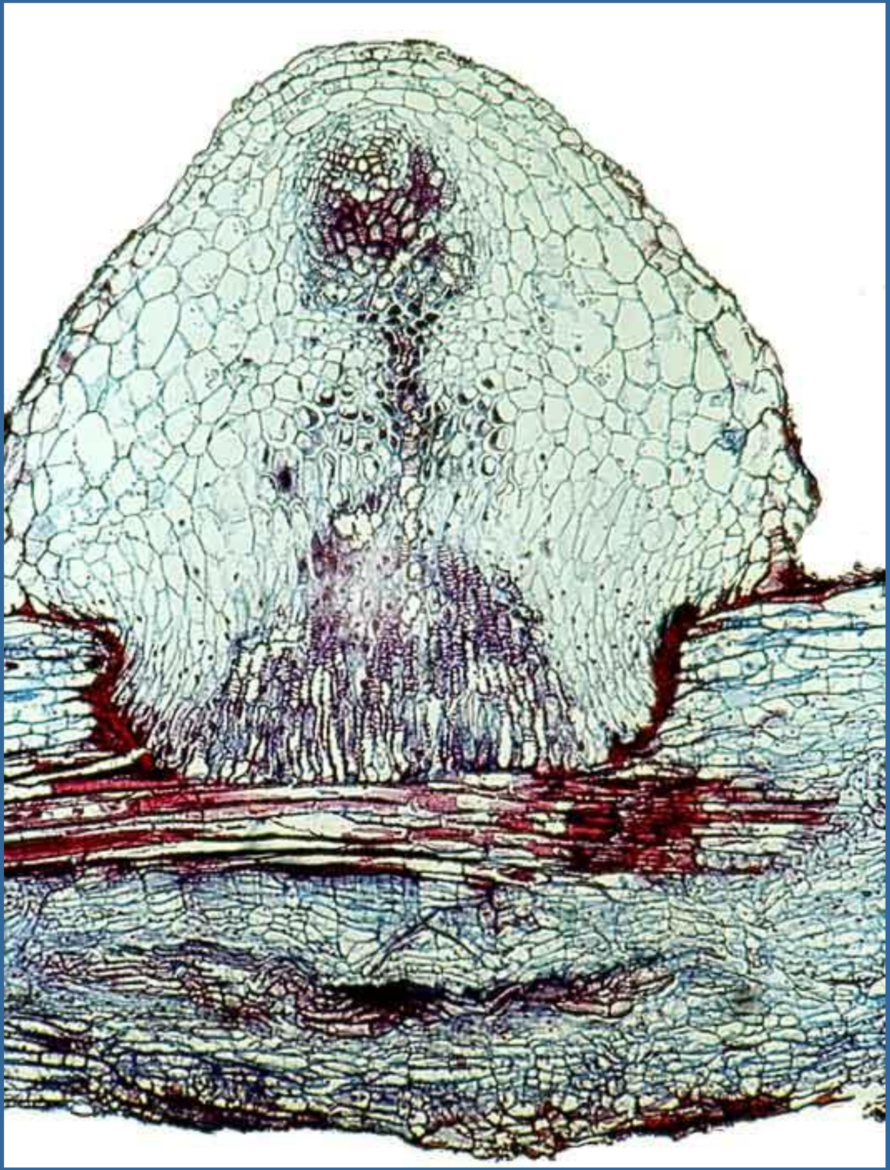


- **Hemiparasitas**

Raízes sugadoras - haustórios

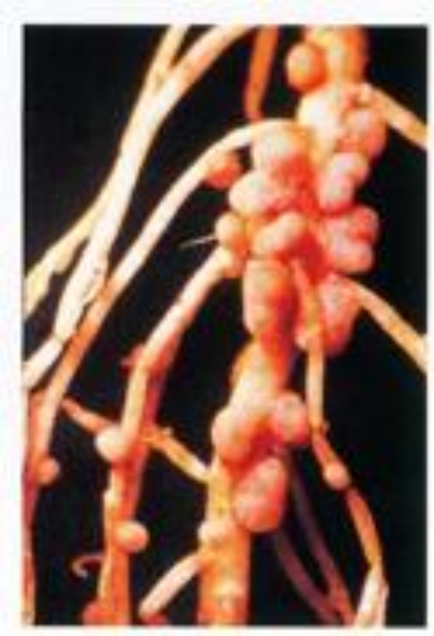

Cuscuta sp. (Dodder)
XS 25X
host plant
haustoria


Cuscuta sp. (Dodder) XS 60X
haustoria

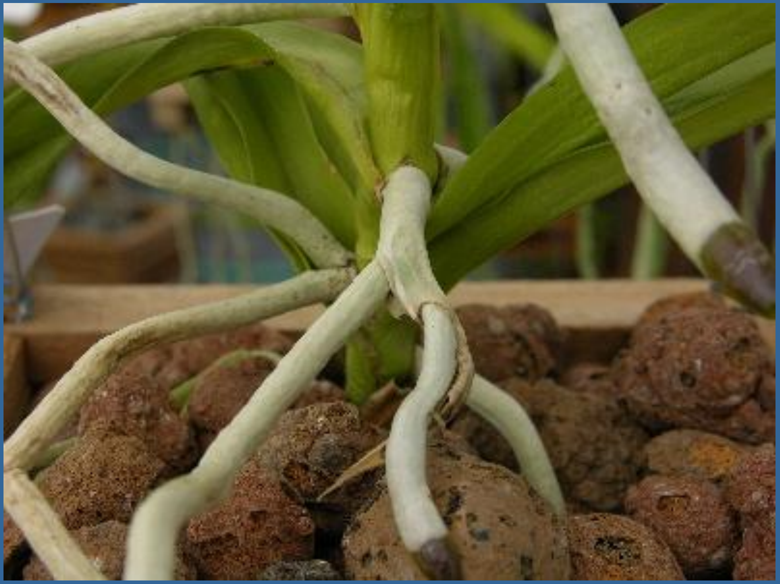


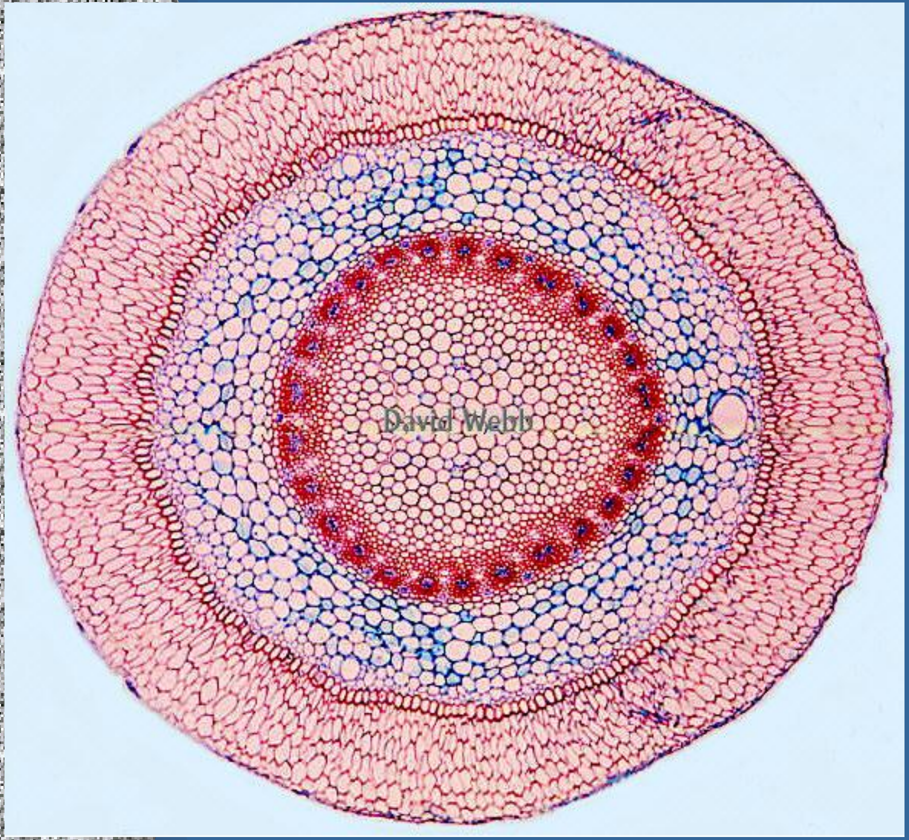
Raízes nodulares

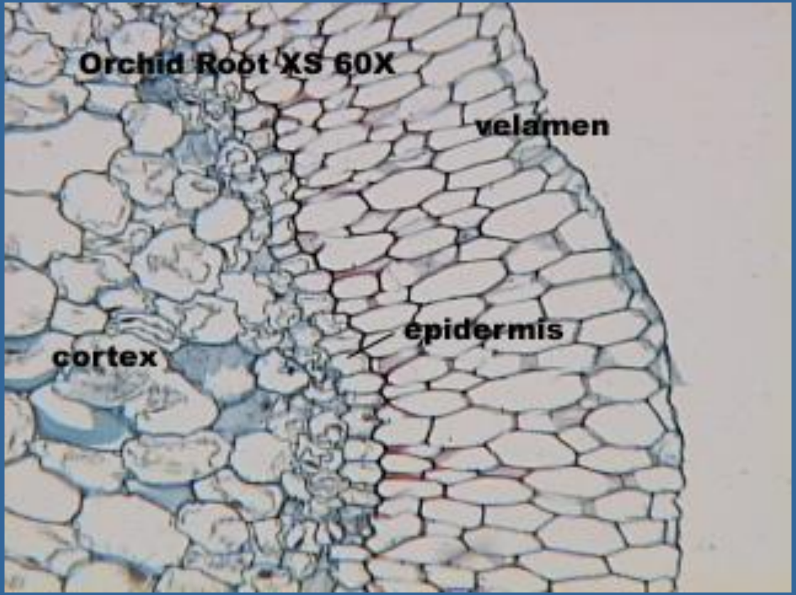
- Associação com *Rizobium* (bacteria)
- Fixação de nitrogênio
- Nitrogênio - Amônia



Raízes aéreas






Orchid Root XS 60X
velamen
epidermis
cortex

Micorrizas - Ectomicorrizas

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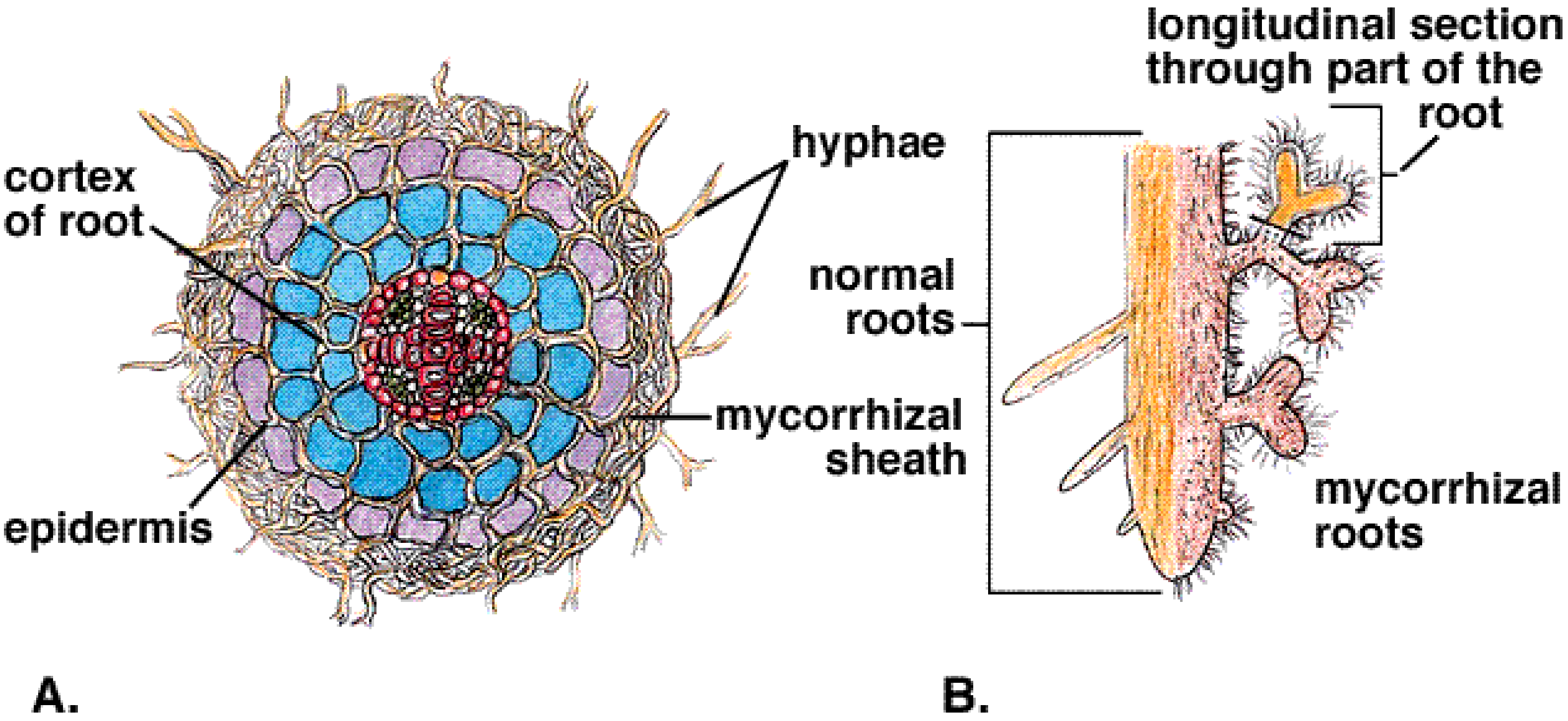
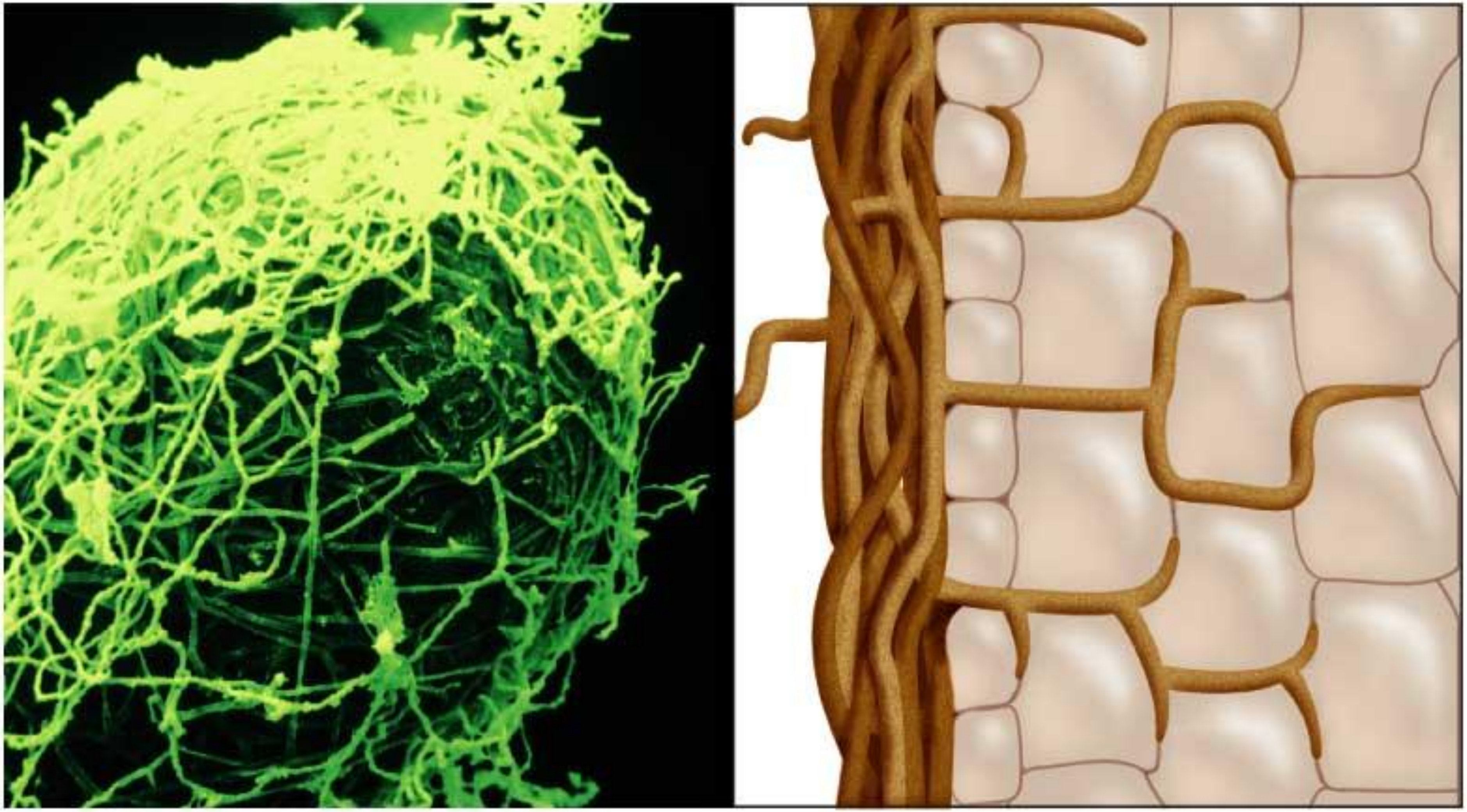
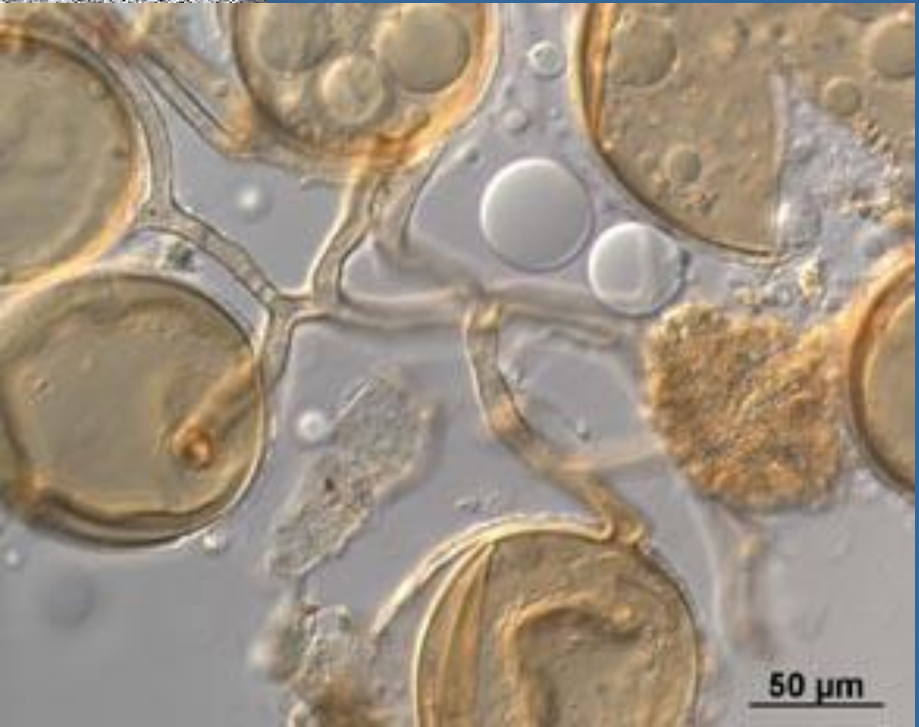
Mycorrhizae—Cross-section of a Root with Ectomycorrhizae

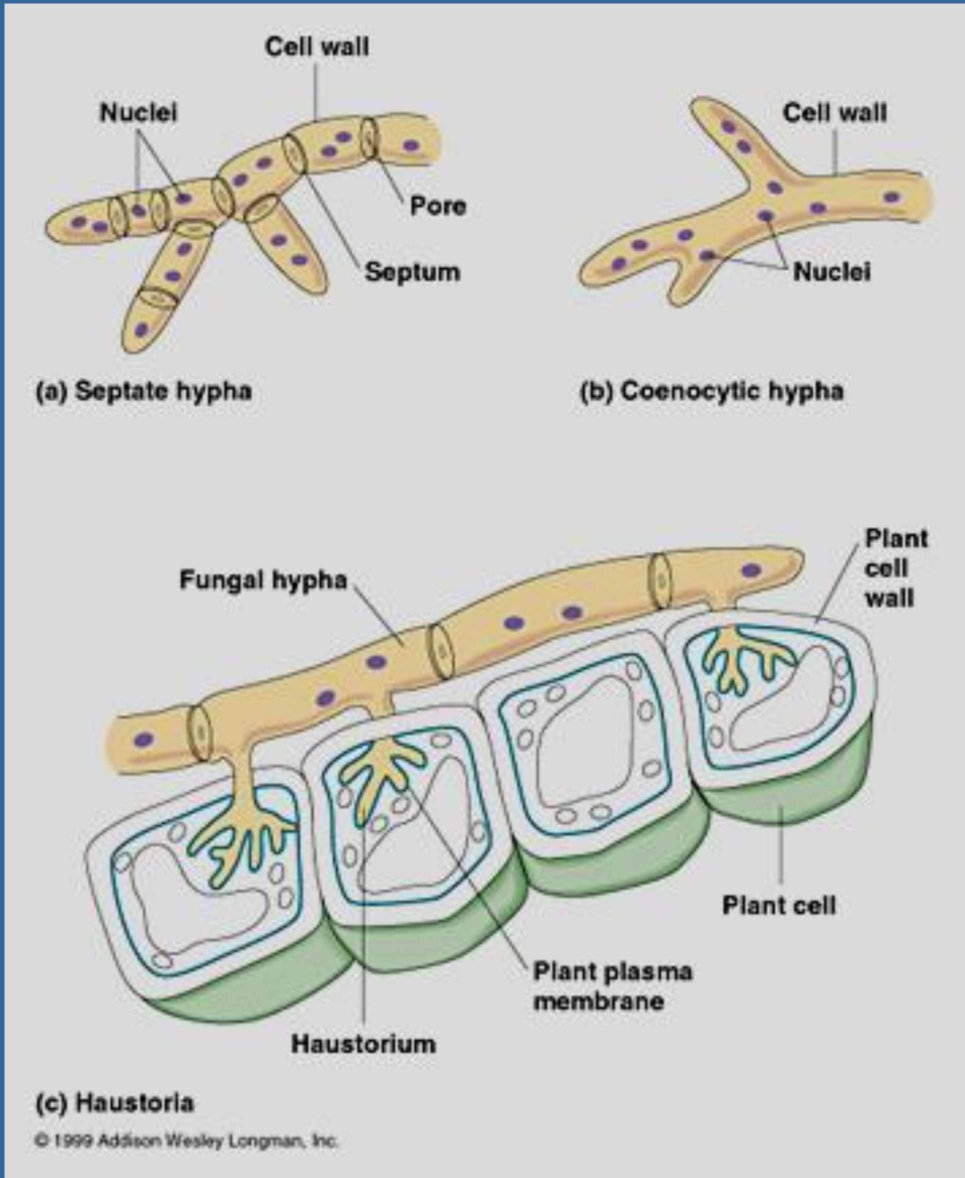

cortex of root
epidermis
hyphae
mycorrhizal sheath
A.
longitudinal section through part of the root
normal roots
mycorrhizal roots
B.

Micorrizas - Ectomicorrizas

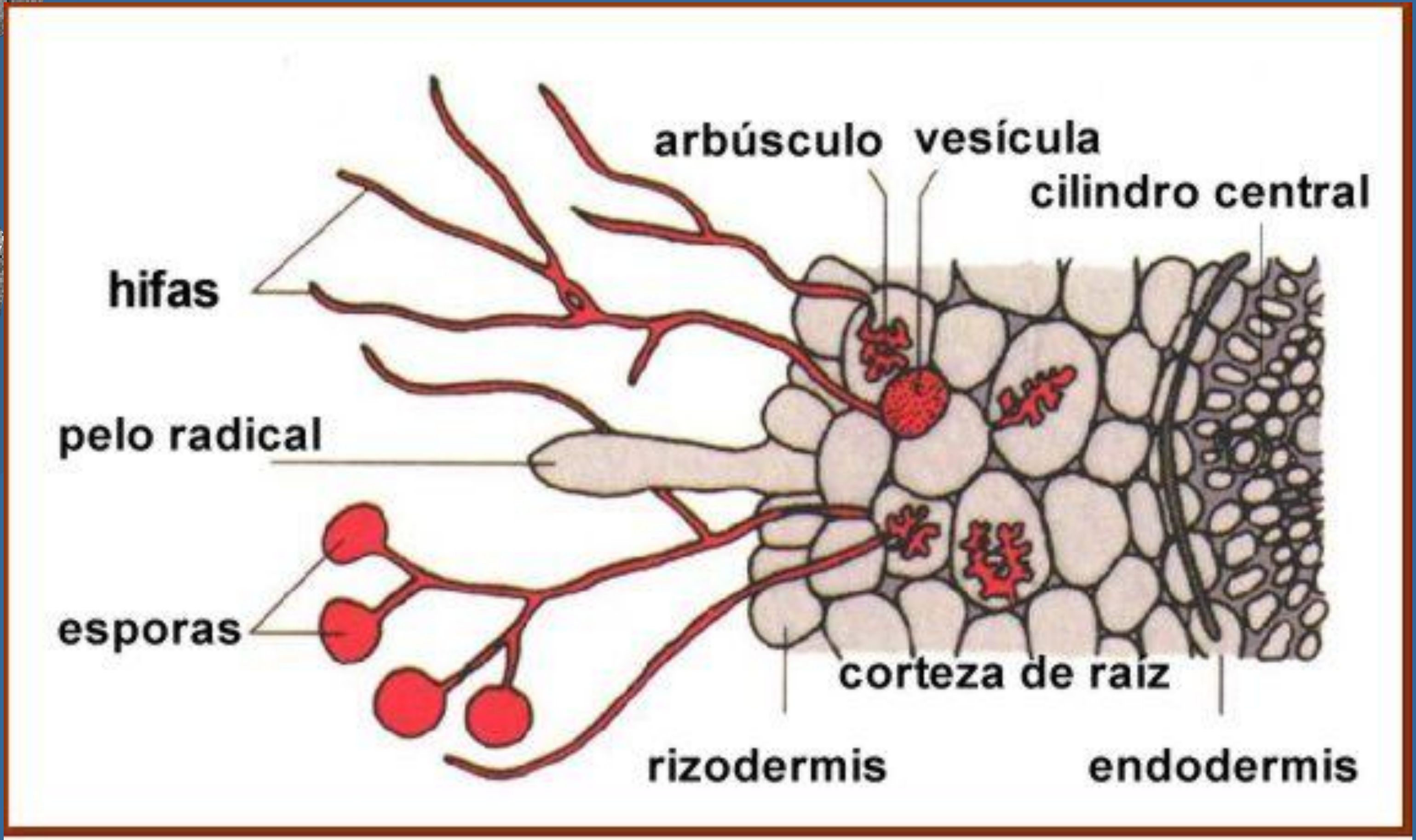


Micorrizas – Endomicorrizas




Cell wall
Nuclei
Pore
Septum
(a) Septate hypha
Cell wall
Nuclei
(b) Coenocytic hypha
Fungal hypha
Plant
cell
wall
Plant cell
Plant plasma
membrane
Haustorium
(c) Haustoria
© 1999 Addison Wesley Longman, Inc.

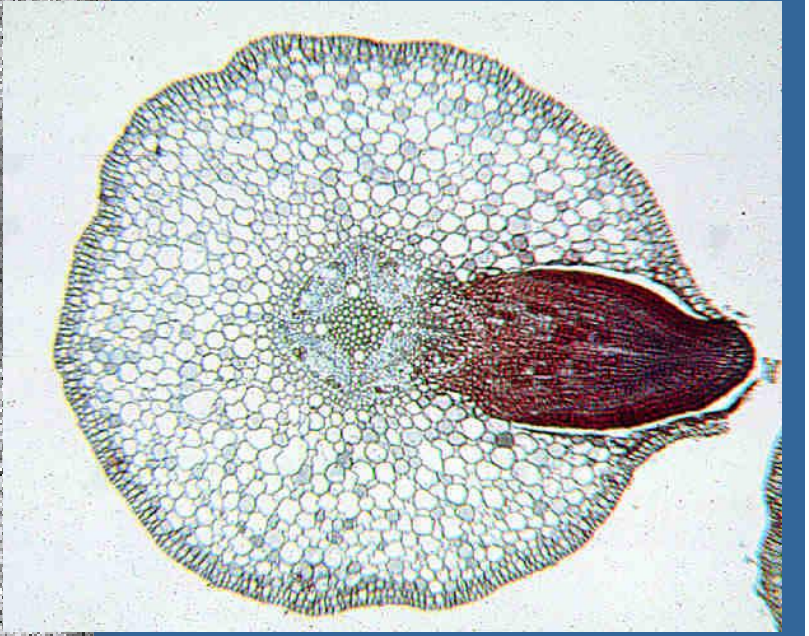
Micorrizas – Endomicorrizas

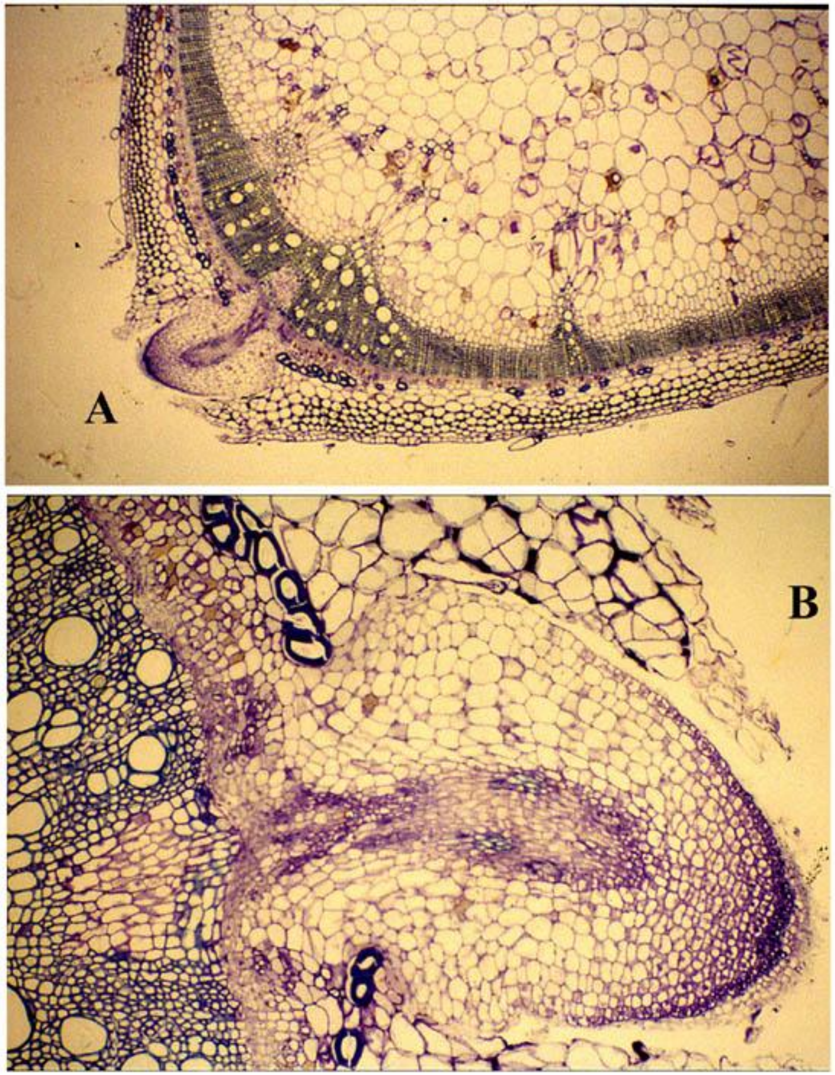

arbúsculo
vesícula
cilindro central
hifas
pelo radical
esporas
corteza de raíz
rizodermis
endodermis

(Gisi, U. Bodenoekologie, Georg Thieme Verlag Stuttgart 1997, S. 220)

Raízes laterais

- Origem: periciclo
- Endógenas: origem interna
- Primórdio de raiz: digestão de células corticais para crescer





Tav.13 - Sezione trasversale di una "talea "(porzione di fusto) di Pomodoro effettuata nella zona in cui si è formata la radice avventizia che sta emergendo all'esterno. Particolare in B