Plant Structures and Function
Meristematic Tissue

(Embryonic-can develop into different cells)
## Types of Buds

<table>
<thead>
<tr>
<th>by Location</th>
<th>by Status</th>
<th>by Morphology</th>
<th>by Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal</td>
<td>Accessory</td>
<td>Scaly</td>
<td>Vegetative</td>
</tr>
<tr>
<td>Axillary</td>
<td>Pseudoterminal</td>
<td>Covered</td>
<td>Reproductive</td>
</tr>
<tr>
<td>Adventitious</td>
<td>Dormant</td>
<td>Hairy</td>
<td>Mixed bud</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naked</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Structure</td>
<td>Function</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| Apical Meristem      | • At root tip & buds of shoots  
• Found in herbaceous plants, young shoots or youngest parts of woody plant | • Unspecialized plant tissue  
• From which all primary tissues (dermal, vascular, ground) are derived  
• Responsible for **primary growth (in length)** |
| Lateral Meristem     | • 2 types: **vascular cambium** (produce vascular tissue and ground tissue) & **cork cambium** (produce cork)  
• Cylinders of cells extending along length of roots and shoots  
• Never in leaves  
• In mature parts of woody plants (e.g. base of tree branch) | • Responsible for **secondary growth (in width/diameter/girth)**  
• Adds strength to plant structure  
• Accounts for formation of woody rings in tree trunks |
Vascular Cambium in the vascular bundle (between xylem and phloem)
**Vascular Cambium** cells divide and form **secondary xylem** towards the inside & **secondary phloem** towards the outside. Seasonal climates produces growth rings because cells grow faster and are larger in the spring than later in the growing season.
Dermal, Vascular, and Ground Tissues

Dicot Root Cross-section
<table>
<thead>
<tr>
<th>Type</th>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidermis</td>
<td>• Flat rectangular cells</td>
<td>• Waterproofing (cuticle)</td>
</tr>
<tr>
<td></td>
<td>• <em>Layer is 1 cell thick</em></td>
<td>• protection</td>
</tr>
<tr>
<td></td>
<td>• Outer layer</td>
<td>• Prevent from infection</td>
</tr>
<tr>
<td></td>
<td>• <em>Surface covered with waxy layer (cutin/cuticle)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In leaves and herbaceous roots/stems</td>
<td></td>
</tr>
<tr>
<td>Cork</td>
<td>• <em>Dead and hollow cells</em></td>
<td>• Waterproofs roots and stems</td>
</tr>
<tr>
<td></td>
<td>• Covers surface of roots and stems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Replaces epidermis during secondary growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In roots/stems of woody plants</td>
<td></td>
</tr>
</tbody>
</table>
Vascular Tissue

**Xylem**
- Perforation plates
- Tracheids
- Vessel member

**Phloem**
- Sieve plate
- Companion cell
- Sieve areas
- Sieve element
## Vascular Tissue (conductive)

### Xylem

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 2 types: vessel elements (only in angiosperm) and tracheids</td>
<td>• Transport of water and dissolved minerals from root to leaves</td>
</tr>
<tr>
<td>• Long thin cylindrical cells</td>
<td></td>
</tr>
<tr>
<td>• Dead and hollow</td>
<td></td>
</tr>
<tr>
<td>• Perforated side and end walls</td>
<td></td>
</tr>
<tr>
<td>• End-to-end arrangement of cells</td>
<td></td>
</tr>
</tbody>
</table>

• Why dead cells? The cells need to be hollow to facilitate water flow, → cytoplasm dies and the cell has empty space, also the plant saves energy to maintain them.
# Phloem Structure and Function

<table>
<thead>
<tr>
<th>Long cylindrical cells</th>
<th>• Transport manufactured food from leaves to roots for storage and other parts for use</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Living, contains cytoplasm, no nucleus,</td>
<td>• Transport hormones</td>
</tr>
<tr>
<td>• Perforated end (cytoplasm connected)</td>
<td>• Require energy from cellular respiration</td>
</tr>
<tr>
<td>• Companion cell adjacent to phloem, responsible for control activity in phloem</td>
<td></td>
</tr>
</tbody>
</table>

- Phloem is the transport system in plants that moves food from leaves to roots, as well as hormones throughout the plant.
## Ground Tissue (Fundamental)

<table>
<thead>
<tr>
<th>Type</th>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex</td>
<td>Root and stem</td>
<td><strong>Storage of starch</strong> <em>(root)</em>, structural support <em>(stem)</em></td>
</tr>
<tr>
<td>Pith</td>
<td>Only in stem</td>
<td><strong>Storage of water</strong> <em>(stem)</em></td>
</tr>
<tr>
<td>Mesophyll</td>
<td>Leaf: palisade &amp; spongy mesophyll cells</td>
<td>Varies depending on cell type</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Photosynthesis</strong></td>
</tr>
</tbody>
</table>
Ground Tissue — cortex (root & stem) and pith (in stem)
Roots – Utah Canyons
Roots – Hawaii
Root Composition

- 3 main roles of roots:
  - anchor plant to ground
  - absorb water and nutrients from soil
  - starch storage

- 3 types of tissues that make up the root from outer layer to the core:
  - epidermis (dermal tissue)
  - cortex (ground tissue)
  - Vascular tissue (xylem/phloem)
Root

• Function of the root hairs:
  - absorption of water and minerals
  → many hairs increase the surface area

• Cells in the epidermis cannot perform photosynthesis as they do not possess chloroplasts

• Instead, epidermal cells undergo cellular respiration to obtain energy The GLUCOSE comes from the starch in the cortex of the root
  • \( \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy} \)
4 Zones of the Root

1. **Zone of maturation**: cells differentiate into different types of cells.

2. **Zone of elongation**: allows the root to get deeper within the soil.

3. **Zone of Cell Division (Meristematic region)**: rapid mitosis of undifferentiated meristematic cells.

4. **Root cap**: protects the meristematic region.
- Storage of starch in:
  - the cortex (ground tissue, under epidermis)
  - the vacuole of each cell (cell organelle)
- Vascular tissues are clustered in the centre of the roots
Root Types
Advantages of the Two Types of Root System

- **Fibrous root:**
  1) larger surface area for absorption
  2) Holds topsoil in place

- **Tap root:**
  1) Firm anchor
  2) Food storage
  3) Locate water source far below ground

Ex) carrots, beets
Roots

- **Adventitious roots (monocot)**: emerge from tissues other than root (stem & leaf)

- **Endodermis (= innermost layer of the cortex)**
  - surrounds the vascular tissue
  - structure: thin continuous ring of cells

  - function: filters materials entering vascular tissue (which will be transported to the rest of plant) with selectively permeable membrane (selects only desired molecules)

  - textbook figure 14.36 p.544
The STEM
Stem - Logging
Stem - Hawaii
Stem - Grafting
Stem Structure:

[Diagram showing the structure of a stem, including epidermis, cortex, pith, cambium, xylem, and phloem.]
Stem Composition

- **Epidermis:**
  - Protective layer
  - Contains chloroplasts, cuticle, stomata
  - Allows for photosynthesis to take place

- **Cortex:**
  - Layer of tissue surrounding the pith.
  - Rigid tissue, structural support
  - Also stores water and some nutrients

- **Pith:**
  - Found in the center of the stem
  - Contains air spaces (spongy tissue)
  - Stores water and some nutrients.

- **Vascular tissue**
  - Xylem and phloem
Stem Composition

- 2 main roles of stems:
  1) structural support
  2) Water and nutrient transport

- **An axillary bud**: bud that has a potential to form a new stem →
- **A terminal bud** (apical bud): bud located at the tip of a plant stem (dominant in a young shoot),

- **Apical dominance**: terminal buds inhibit growth of axillary buds → plant concentrates on growing taller for more light exposure

- Ex) when gardeners prune trees, they remove terminal buds which remove inhibition on axillary bud → axillary buds break dormancy and grow into new branches
Stem
Modified stems

- stolons (strawberries)
- rhizome (ginger)
- tuber (potato)
- bulb (onion)
cactus - vertical stem (stores water)
Stem- Stolon

- Surface of ground
- Horizontal growth
- Buds can develop into stems of new plants
- Ex) strawberry
Stem - Rhizome

- Underground
- Horizontal growth
- Buds can develop into stems
- Ex) ginger
- Why aren’t these roots? → main function of roots is absorption and roots do not have buds
Stem-tuber

- Swollen ends of rhizomes
- For food storage
- Buds can grow into new shoots above ground
- Ex) potato
Stem- bulb

- Underground
- Small stem
- Has paper-like cover
- Surrounded by layers of modified leaves
- Ex) onion, tulip
The Leaf

• The main role of the leaf: **photosynthesis**
  (to convert solar energy into chemical energy)

• Parts of the Leaf:
  - Epidermis
  - Palisade layer (mesophyll)
  - Spongy layer (mesophyll)
  - Vascular Tissue
  - Stoma and guard cells
Zea Mays (Maize Corns)
Cuticle

- Function: protection, prevent water loss
- Structure: waxy coating

* Epidermal cells and cuticle are transparent to allow light to go through
Monocot Leaf (Zea)
Leaf
Palisade Cells

- Function: **photosynthesis**
- Structure: long, thin cells packed up
- How is its structure related to its function?
  - Top end of cell is exposed to light.
  - Bottom end is exposed to the gases (CO$_2$) in the spongy layer.
- Pack cells into upper surface of leaf
  - Maximizes collection of light
Spongy layer

- Contain mesophyll cells for photosynthesis
- Cells are not packed
- Has air space (contains CO2, O2, water vapour)
Stoma (in lower epidermis)

- from the Greek word “mouth”.
- Structure: pore-like openings in the plant’s epidermis.
- Function: to permit gas exchange between the leaf’s interior and external environment.
- The larger the opening, the faster the gas exchange.
- opening is controlled by two guard cells.
Leaves - Stomata
Guard Cells

- **Structure:** paired, thick inner wall, has microfibrils
- **Function:** controls the size of the stomata, the rate of gas exchange
How Guard Cells Work

- **To open:**
  - Water flows into the guard cells, pushing out on the cell membrane → rings prevent increase of cell in diameter → cell increases in length → but **outer wall is more flexible and bulges outwards** → **inner wall is pulled** and stoma opens
Guard Cells

- **To Close:**
  - Water flows out → guard cells return to the resting position → inner walls relieved → stoma closes

- [http://www.bcb.uwc.ac.za/ecotree/leaves/stomata.htm](http://www.bcb.uwc.ac.za/ecotree/leaves/stomata.htm)
Vascular Tissue
Add row to your table

• The VEINS – made up of xylem and phloem which are bundled together in thin strands.
• Think back to the veins in a dicot and monocot flower. Which veins are parallel and which are net-like?
• They allow the movement of water and nutrients

Movement of Water
http://www.youtube.com/watch?v=J1PqUB7Tu3Y
Practice leaf(ing)
Leaf – Cross section
Roots – Mangrove