Plant Kingdom

Characteristics
• Eukaryotic
• Photosynthetic
• Multicellular
• Sexually reproducing
• Life History involves an alternation of a haploid phase (Gametophyte) with a diploid phase (Sporophyte)

Classification
Artificially grouped into Nonvascular or Vascular Plants

Non Vascular Plants – "Bryophytes"
• Disperse by spores
• Require H₂O for sexual fertilization
• Small
• No vascular tissue
• Grow in clumps or masses
• Many capable of prolonged dehydration
• Most lack cuticle (protective surface layer)
• Three Divisions of Bryophytes

Three Phyla
Bryophyta – Mosses
Hepatophyta – Liverworts
Anthocerophyta – Hornworts

Vascular Plants
• Vascular tissue
• Cutin or suberin on aerial parts
• Body an axis (stern)
• Large surface/volume ratio common
• Much survival value for terrestrial habitat with water deficit – increase in size by conducting tissue – especially xylem
• Many subdivision and classes
• Each textbook varies, but – patterns are visible as increase in complexity of body structure
• Vascularization (Microphylls vs megaphylls in leaves)
• Dispersal {spore (Single cell) vs seed}
• Sperm transport H₂Ovs pollen grain
Lower (spore-dispersing) Vascular Plants
Mostly predominant in fossil eras
Important in coal-formation

Fossil Phyla
  Rhyniophyta
  Zosterophyllophyta
  Trimerophytothyta

Extant Phyla
  Lycophyta (Lycopodiophyta) – Ground Pines, Club Mosses and Quillwort
    Three Extant Classes (Orders) (Families)
      Lycopodiae (Lycopodiaes) (Lycopodiaceae)
      Selaginellae (Selaginellales) (Selaginellaceae)
      Isoetae (Isoetales) (Isoetaceae)

Monilophyta or Pteridophyta
  Ferns (Pterophyta)
    Five Orders
      Ophioglossales – Eusporangiate
      Marattiales – Eusporangiate
      Filicales – Homosporous and Leptosporangiate
      Salviniales – Heterosporous and Leptosporangiate
      Marsileales – Heterosporous and Leptosporangiate

Horsetails or Equisetum – One Order
  Equisetales (Sphenophyta)

Whisk Ferns – One Order
  Psilotales (Psilotophyta)
Higher (seed-dispersing) Vascular Plants
- Disperse by multicellular seeds
  - Embryo head-start in seed package
- Transport sperm in pollen grain
  - Freedom from \( \text{H}_2\text{O} \) for fertilization

Two Broad Groups plus the Fossils
Fossil Phyla
Progymnospermophyta
- Pteridospermales – Fossil Seed Ferns
- Cordaitales – Primitive Conifer-like
- Bennettitales – Fossil Cycadeoides

Extant Phyla
Gymnosperms – Seed not protected by a fruit
- Four Phyla
  - Cycadophyta: Cycads
  - Coniferophyta: Conifers (e.g., Pine, Spruce, Fir, Hemlock, Yew)
  - Ginkgophyta: Ginkgo
  - Gnetophyta: Gnetum, Ephedra, Welwitschia

Angiosperms (Flowering plants) – Seed protected by a fruit (the ovary)
- One Phylum Anthophyta – Flowering Plants
  - Two Classes comprise 97% of Angiosperms
    - Eudicotyledones (Dicots)
    - Monocotyledones (Monocots)
  - Additional Groups comprise 3% of the more primitive Angiosperms
    - Magnoliidae, including several orders
    - Nymphaeales – Water Lilies
    - Illiciales – Star Anise
    - Amborellales
    - Archaeafructales – Earliest Anthophyte Fossil
Characteristics of the Plant Groups

Non-Vascular Plants

The Bryophytes (Mosses, Hornworts and Liverworts)
- Multicellular
- Non-vascular
- Haploid generation dominant, assimilative phase
- Mostly terrestrial, of moist habitats
- Water necessary for sexual reproduction
- Flagellated sperm cells
- Archegonium - female sex organ
- Antheridium - male sex organ
- All small!

Phylum – Hepatophyta (Liverworts)
- Two groups
  - Thallose
    - Leafy (resemble mosses, but lack a midrib on the "leaves", and have dorsal-ventral symmetry
- Dorsal-ventral symmetry
- Vegetative reproduction by
  - Fragmentation
  - Gemmae
- Sporangium simple

Phylum – Bryophyta (Mosses)
- Radially symmetrical
- Gametophyte phyllodes ("leaves") have a midrib (costa)
- Sporangium a capsule elevated by a stalk or seta above the gametophyte

Phylum – Anthocerophyta (Hornworts)
- Rounded thallose-like gametophyte
- Vegetative reproduction by
- Fragmentation
- Sporophyte "horn-shaped" growing from a basal sheath beneath the surface of the gametophyte thallus. The sporophyte continues to grow from a basal meristem, producing spores clustered around a central stalk. The sporophyte tip splits releasing spores
- Less common than liverworts or mosses
Vascular Plants

Phylum - Lycophyta (Lycopodiophyta) (Club mosses)
- True roots, stems and leaves (Microphylls)
- Sporangia borne in a strobilus
- May be Homosporous (One type of sporangium) or Heterosporous (Produce megasporangia and microsporangia)
- Strobili may be axillary or terminal
- Examples
  - Lycopodium
  - Selaginella
  - Isoetes

Phylum - Monilophyta or Pterophyta (Ferns, Whisk Ferns and Horsetails)

Ferns
- Sporophyte generation dominant
- Both gametophyte and sporophyte independent
- Underground rhizome typical (Stem)
- Fertile and sterile fronds (Leaves {Megaphylls})
- Spores produced in sporangia located in a sorus which usually has a protective indusium
  - Sori located on underside of fertile fronds
- Several Orders
  - Ophioglossales – Eusporangiate
  - Marattiales – Eusporangiate
  - Filicales – Homosporous and Leptosporangiate
  - Salviniales – Heterosporous and Leptosporangiate
  - Marsileales – Heterosporous and Leptosporangiate

Order – Equisetales (Sphenophyta) (Horsetails and Scouring rushes)
- Stems silica impregnated
- Branches whorled
- Stems jointed
- Leaves microphylls and often non-photosynthetic
- Homosporous (Archegonia and Antheridia on same plant)
- Spores have elaters for dispersal
- One Genus
  - Equisetum

Order – Psilotales (Psilotophyta)
- No true roots or leaves
- Phyllodes present
- Sporangia borne in axils, in clusters
- Determined to be a degenerate group related to ferns
- Examples
  - Psilotum
  - Tmesipteris
Phylum – Progymnospermophyta
Order – Pteridospermales (Pteridospermophyta) (Seed Ferns)
- All fossils
- Important as the probable progenitors of today's seed plants

Phylum - Cycadophyta (Cycads)
- 9 genera, 100 species
- Tropic and subtropical
- Vegetative characteristics:
  - Stem unbranched, short or columnar
  - Terminal crown of long, leathery, compound leaves (Palm-like)
  - Less than 6 feet tall (mostly)
- Reproduction
  - All Dioecious (Male and Female Strobili on separate plants)
  - Pollen sacs on scalelike microsporophylls in compact cones (Microsporangia)
  - Megasporophylls also in cones (some up to 3 ft in length)
  - Pollination by wind, but male gamete motile
  - Largest motile gametes with up to 20,000 flagella
- Examples
  - *Cycas revoluta* (Sago palm)
  - *Zamia*

Phylum - Ginkgophyta (Ginkgo or Maidenhair tree)
- One living species *Ginkgo biloba*
- Deciduous tree with fan-shaped leaves
- Reproduction
  - Sexual cycle like cycads
  - Male strobilus in short pendant paired microsporophylls
  - Female Ovules develop into yellowish, cherry-like seeds
  - Seed coat decomposes at maturity for dispersal

Phylum - Gnetophyta
- Do not produce flowers
- Seeds not protected by a fruit (ovary)
- Xylem contains vessels
- Oldest fossils just 50 million years BP
- Three representatives (All distinctive)
  - *Gnetum*
  - *Ephedra*
  - *Welwitschia*
Phylum - Coniferophyta (Conifers)
• Dominant vegetation of the Taiga regions
• Major source of paper and lumber
• Strobili modified into cones
• Cone scales are modified sporophylls
• Xylem contains tracheids but no vessels

Reproduction
• Male and female gametophytes produced in separate cones
• Female cones contain Megasporangia
  o Each megasporangium produces an ovule with an integument
  o Meiosis produces a megaspore, retained within the cone that develops into the female gametophyte with archegonium containing an egg
• Male cones (Microsporangia in strobilus) contain Microspores that develop into the pollen grains (male gametophytes)
• Wind pollination – Water unnecessary for fertilization
• Seeds unprotected by sterile tissue

Examples
Pinus  Pseudotsuga  Metasequoia
Abies  Tsuga  Taxus
Picea  Thuja  Juniperus

Phylum - Anthophyta (Flowering Plants)

Reproduction
• Reproductive organs within a flower rather than a cone
• Ovule embedded in sporophyte tissue (ovary)
• Gametophytes greatly reduced
• Fertilization "double"
  o One sperm with the egg:
  o One sperm with polar nuclei to form a nutritive endosperm
• Seeds enclosed in a fruit (ovary)

Two Major Classes (Distinguished Anatomically)

<table>
<thead>
<tr>
<th>Monocotyledones (Monocots)</th>
<th>Eudicotyledones (Dicots)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flower parts in 3's</td>
<td>Flower parts in 5's (4's)</td>
</tr>
<tr>
<td>Leaves with parallel veins</td>
<td>Leaf venation palmate or pinnate</td>
</tr>
<tr>
<td>No true cambium</td>
<td>Cambium usually present</td>
</tr>
<tr>
<td>One cotyledon</td>
<td>Two cotyledons</td>
</tr>
<tr>
<td>Scattered vascular bundles</td>
<td>Vascular bundles in a ring (cylinder)</td>
</tr>
<tr>
<td>Nonocolpate pollen</td>
<td>Tricolpate Pollen</td>
</tr>
<tr>
<td>Sheathing leaf bases</td>
<td>Leaves usually have a petiole</td>
</tr>
</tbody>
</table>

Additional Groups of more primitive Angiosperms
Magnoliidae, including several orders
Nymphaeales – Water Lilies
Illiciales – Star Anise
Amborellales
Archaefructales – Earliest Anthophyte Fossil