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Acknowledgments

Special thanks to Vickie Azcuenaga, Rick Abrahamson, Barbara Laschkewitsch, and Louise Heinz for their contributions and technical assistance in the preparation of this lab manual.
1. GENERAL INFORMATION
   a. Instructors: Dr. Chiwon William Lee, Professor
      Office: Room 266-F, Loftsgard Hall
      Phone: 701-231-8062, fax 701-231-8474, cell 701-361-9411
      E-mail: <chiwon.lee@ndsu.edu>

      Craig Carlson, teaching assistant
      Phone 701-361-9466, e-mail <craig.carlson@ndsu.edu>

      Whitney Harchenko, teaching assistant
      Phone 701-212-3915, e-mail <whitney.harchenko@ndsu.edu>

   b. Class Hours: Section 1: 1:00-2:50 p.m. Mon
      Section 2: 3:00-4:50 p.m. Mon
      Section 3: 1:00-2:50 p.m. Wed
      Section 4: 3:00-4:50 p.m. Wed

   c. Place: Horticulture Greenhouse Classroom

   d. Web Site: http://www.ndsu.nodak.edu/instruct/chlee/plsc211/

   e. Related Course: PLSC 210-Horticulture Science (3 Credits)
      General education class
      10 a.m. Mon, Wed, Fri (Loftsgard Hall 114)
      (http://www.ndsu.nodak.edu/instruct/chlee/plsc210/)

2. OBJECTIVES
   a. Rationale

      Horticulture enriches our lives by providing such basic requirements as nutritious food, esthetic
      environment, and emotional well-being. Gardening and other horticultural practices have long
      been considered as the most favorite leisure activities in American life. This class is designed to
      provide first-hand experiences in basic horticulture to students interested in the subject.

   b. Goals

      Upon completion of this class, students will have the basic knowledge and skills in horticulture.
      With practical experience, students will be familiar with a wide range of subject matter
      including plant identification, propagation, controlled environment production, horticulture
      information retrieval system, pruning, and lawn care, plants for interior uses, and fruits and
      vegetables.

3. WHO SHOULD TAKE THIS COURSE
   a. Horticulture Majors

      This course is required for all incoming horticulture majors. Students majoring in horticulture
must complete this class before taking other horticulture courses in the Department of Plant Sciences. Transfer students who completed a similar course from a two-year technical college or other institution must consult the instructor to determine whether this course can be waived.

b. **Non-Majors**

This class is available to all students interested in the subject matter for the general education requirement in science and technology. This course is designed to provide a broad range of training in practical horticulture to any student who likes to work with plants.

4. **TEXTBOOK**


5. **COURSE CONTENT**

   a. **Introduction** - General introduction to the field of horticulture and horticulture greenhouse facility
   b. **Local greenhouse tour** - Two-hour field trip to a local greenhouse
   c. **Plant identification** - Nomenclature, classification, identification of selected horticultural plants
   d. **Sexual propagation** - Plant propagation by seed, germination test, scarification, stratification
   e. **Asexual propagation** - Plant propagation by cuttings, layering, grafting, tissue culture, division, underground storage organs such as bulbs and corms
   f. **Horticulture internet** - Horticulture websites, writing internet articles using web-authoring programs
   g. **Plant nutrition** - Macro- and micronutrients, fertilizer calculation, nutrient deficiency symptoms
   h. **Flower garden design** - Garden design for annual and perennial flowering plants
   i. **Greenhouse production** - Environmental control, facility, culture, light measurements, hobby greenhouses
   j. **Landscape design** - Landscape design principles, landscape installation and maintenance
   k. **Pruning and training** - Basic and practices of tree training and pruning
   l. **Lawn care** - Identification of warm-season and cool-season turfgrasses, care lawns for homes, golf courses, and other recreational facility
   m. **Interior plants** - Identification of foliage plants, cultural requirement, interior landscaping
   n. **Exercise on fruits** - Classification and identification, cultural requirements, tasting of various fruits and nuts
   o. **Plant growing** - Practical experience in propagating and growing selected greenhouse crops

6. **LAB REPORTS**

Seven lab reports are submitted throughout the semester. Each is worth 20 points.

7. **EXAMINATIONS**

There will be one mid-term exam and a final exam (lab practical). One-third of the final exam is comprehensive covering old materials. Each exam is worth 65 points.
8. **GRADING**

<table>
<thead>
<tr>
<th>Points</th>
<th>Grading Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>A  90-100%</td>
</tr>
<tr>
<td>30</td>
<td>B  80-89%</td>
</tr>
<tr>
<td>65</td>
<td>C  70-79%</td>
</tr>
<tr>
<td>65</td>
<td>D  60-69%</td>
</tr>
<tr>
<td></td>
<td>F  &lt;60%</td>
</tr>
</tbody>
</table>

**Total** 300

9. **STUDENT OUTCOMES ASSESSMENT**

You are required to take a pre-test for the course material during the first week of class and complete the post-test during the last week of semester. These tests are administered via an internet website (http://www.ndsu.nodak.edu/instruct/chlee/plsc211/). Those who participate in both the pre- and post-tests will receive 10 extra points toward their final grades.

10. **ADDITIONAL INFORMATION**

   a. **Class Attendance**

   Regular attendance of classes is required. In case of sickness or other emergencies, students should contact the instructor so that make-up lab exercise can be arranged.

   b. **Students with Special Needs**

   Any student with disabilities or other special needs, who needs special accommodations in this course, is invited to share these concerns or requests with the instructor as soon as possible.

   c. **Office Hours**

   Office hours for the instructor: 8:30 a.m.-12:00, Tues and Thurs. Please put your name on the appointment calendar on the door (Room 266F, Loftsgard Hall) for office visits. You may also arrange for an appointment by e-mail (chiwon.lee@ndsu.edu) or telephone (office 701-231-8062, mobile 701-361-9411).
<table>
<thead>
<tr>
<th>Week</th>
<th>Lab No.</th>
<th><strong>Sections I, II</strong> (Mon)</th>
<th><strong>Sections III, IV</strong> (Wed)</th>
<th>Lab Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wk 1</td>
<td>-</td>
<td>Aug 31</td>
<td>Sep 2</td>
<td>Plant Identification</td>
</tr>
<tr>
<td>Wk 2</td>
<td>-</td>
<td>(Sep 7)*</td>
<td>Sept 9</td>
<td>Local Greenhouse Tour</td>
</tr>
<tr>
<td>Wk 3</td>
<td>Lab 1</td>
<td>Sep 14</td>
<td>Sep 16</td>
<td>Sexual Propagation</td>
</tr>
<tr>
<td>Wk 4</td>
<td>Lab 2</td>
<td>Sep 21</td>
<td>Sep 23</td>
<td>Asexual Propagation</td>
</tr>
<tr>
<td>Wk 5</td>
<td>Lab 3</td>
<td>Sep 28</td>
<td>Sep 30</td>
<td>Horticulture Publication (IACC 114)</td>
</tr>
<tr>
<td>Wk 6</td>
<td>Lab 4</td>
<td>Oct 5</td>
<td>Oct 7</td>
<td>Plant Nutrition</td>
</tr>
<tr>
<td>Wk 7</td>
<td>Lab 5</td>
<td>Oct 12</td>
<td>Oct 14</td>
<td>Gardening (<em>Midterm Exam</em>)</td>
</tr>
<tr>
<td>Wk 8</td>
<td>Lab 6</td>
<td>Oct 19</td>
<td>Oct 21</td>
<td>Greenhouses</td>
</tr>
<tr>
<td>Wk 9</td>
<td>Lab 7</td>
<td>Oct 26</td>
<td>Oct 28</td>
<td>Landscape Design</td>
</tr>
<tr>
<td>Wk 10</td>
<td>Lab 8</td>
<td>Nov 2</td>
<td>Nov 4</td>
<td>Pruning and Training</td>
</tr>
<tr>
<td>Wk 11</td>
<td>Lab 9</td>
<td>Nov 9</td>
<td>(Nov 11)</td>
<td>Local Greenhouse Tour</td>
</tr>
<tr>
<td>Wk 12</td>
<td>Lab 10</td>
<td>Nov 16</td>
<td>Nov 18</td>
<td>Interior Plants</td>
</tr>
<tr>
<td>Wk 13</td>
<td>Lab 11</td>
<td>Nov 23</td>
<td>Nov 25</td>
<td>Lawn Care</td>
</tr>
<tr>
<td>Wk 14</td>
<td>Lab 12</td>
<td>Nov 30</td>
<td>Dec 2</td>
<td>Fruits and Nuts</td>
</tr>
<tr>
<td>Wk 15</td>
<td>Lab 13</td>
<td>Dec 7</td>
<td>Dec 9</td>
<td>Reviews and Free Lab</td>
</tr>
<tr>
<td>Wk 16</td>
<td>Lab 14</td>
<td>Dec 14</td>
<td>Dec 16</td>
<td><em>Final Exam</em></td>
</tr>
</tbody>
</table>

Dates for lab exercises are subject to change. *No classes (holidays)
Lab Exercise 1

PLANT IDENTIFICATION

Objectives:

1. To introduce plant nomenclature and classification.
2. To become familiar with basic plant morphology.
3. To begin to identify plants using morphological characteristics.

Introduction

Plants can be identified by observing certain distinguishing morphological characteristics. Some plants are closely related, which is shown by the similarity of their flower structures. These plants are placed into a specific plant family. A herbaceous example of a family that is based on similarity of flower parts would be Asteraceae, the aster family, of which marigolds and zinnias are members. An example of a woody plant family would be Aceraceae to which maples belong.

Within each family there are members that are more closely related than others. This relationship is demonstrated by the similarity of basic morphological traits like leaf shape or arrangement. These plants are placed in a group called a genus. Maples belong to the genus Acer, while marigolds are placed in the genus Tagetes.

Members of a plant genus are again subdivided, according to their similar morphological characteristics, into a grouping called a species. For example, each different type of maple belongs to a different species (see list below).

The Binomial Plant Classification System, which we have just described, gives each plant a scientific name using the genus and species.

Examples of scientific names:

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer saccharinum</td>
<td>Silver maple</td>
</tr>
<tr>
<td>Acer platanoides</td>
<td>Norway maple</td>
</tr>
<tr>
<td>Tagetes erecta</td>
<td>African marigold</td>
</tr>
<tr>
<td>Tagetes patula</td>
<td>French marigold</td>
</tr>
</tbody>
</table>

When botanists group plants, they use flower parts as their primary guide because the flower is the least affected by growing conditions. In this lab we will be looking at leaf characteristics to help us identify plants because they are more likely to be available to you.
Plant Classification Lecture Outline

A. Plant Nomenclature

1. Binomial classification system
   a. Two Latin names:
      genus - the first letter is capitalized
      species - all lower case
   b. Varieties and cultivars:
      Variety -
      Cultivar -
   c. Importance:

B. Morphological Characteristics

1. Plant types
   a. Woody
      1) deciduous
      2) evergreen
   b. Herbaceous
      1) annual
      2) perennial
      3) biennial

2. Leaf types (we will study this in detail in lab)
3. Fruit types
   a. pod                b. silique            c. capsule
   d. samara             e. schizocarp        g. achene
   h. nut (acorn)        i. berry              j. pome
   k. pepo               l. cone               m. hesperidium
   n. aggregate fruit    o. multiple fruit

4. Inflorescence
   Flowers are borne on structures called inflorescence, which is a collection of individual flowers arranged in a specific order or form.
   a. spike             b. catkin
   c. raceme            d. corymb
   e. umbel             f. compound umbel
   g. cyme              h. panicle
   i. head              j. solitary flower

5. Other characteristics
PLANT MORPHOLOGY

In order to successfully identify woody plants it is necessary for an individual to have a keen awareness (working knowledge) of taxonomic terminology and concise mental pictures of leaf, bud, stem, flower, and fruit morphology.

LEAF MORPHOLOGY

ANGIOSPERM LEAF TYPES

Simple Leaf vs. Compound Leaf

The position of the bud determines whether the leaf is simple or compound. In the case of the single leaf the bud is found in the axil of the leaf and stem. If the bud is located in the axil of a structure containing more than one leaf it is termed compound. Compound leaves may have from three to 1500 leaflets. Ex: *Acer* with three or *Albizia julibrissin* with 400 to 1500 leaflets.

![Simple Leaf vs. Compound Leaf Diagram](image)

Variation in Compound Leaves

<table>
<thead>
<tr>
<th>Palmate</th>
<th>Odd Pinnate</th>
<th>Even Pennate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex: <em>Acanthopanax</em>, <em>Parthenocissus</em></td>
<td>Ex: <em>Acer negundo</em>, <em>Fraxinus</em></td>
<td>Ex: <em>Gleditsia</em></td>
</tr>
</tbody>
</table>
Bipinnately Compound Leaves

Bipinnately compound leaves are twice divided. What was considered the leaflet of the pinnately compound leaf is now another leaf-bearing axis to which additional leaflets are attached. The new leaf bearing axes are referred to as pinnae. Each pinna has a certain number of leaflets. Ex: *Gymnocladus, Albizia, Gleditsia* (in certain instances).

![Bipinnately Compound](image)

Ex: *Gleditsia triacanthos*, Honey-locust

ANGIOSPERM LEAF TYPES

Cone-bearing or naked seeded plants often display different leaf types than those associated with angiosperm plants. Not all conifers (or cone-bearers) have evergreen foliage (exceptions include *Taxodium, Metasequoia, Larix, and Pseudolarix*).

<table>
<thead>
<tr>
<th>Leaf Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awl-like</td>
<td>The needles (leaves) are shaped like an awl. They are usually very sharp to the touch. Many <em>Juniperus</em> (Junipers) exhibit awl-shaped foliage. This character is manifested in juvenile forms of juniper, however, there are many species and cultivars (<em>Juniperus communis, J. Procumbens, J chinensis</em> ‘Pyramidalis’ to name a few) which possess the awl-like of needle foliage in youth and old age.</td>
</tr>
<tr>
<td>Scale-like</td>
<td>Scale-like foliage overlaps like the shingles on a roof or the scales on a fish. This type of foliage is relatively soft to the touch. <em>Thuja, Chamaecyparis, Cupressus, Calocedrus</em> and many <em>Juniperus</em> species exhibit this type of foliage.</td>
</tr>
<tr>
<td>Needle-like</td>
<td>Needle-like foliage is typical of several evergreen genera and species. The drawing depicts the foliage of a 5-needled pine. In the genus <em>Pinus</em> the leaves (needles) are usually contained in fascicles of 2, 3, 2 and 3, or 5. Other species such as <em>Abies, Picea, Cedrus, Pseudotsuga, and Taxus</em> have the needles borne singly or in clusters along the stem. The needles may be relatively flat (2-sided) or angular (often quadrangular) in cross-section.</td>
</tr>
</tbody>
</table>
ARRANGEMENT OF LEAVES

Many vegetative keys employ the arrangement of leaves and buds as a basis for separation. The use of the four categories by the student allows him/her to categorize plants into groups and assists in eliminating many plants from consideration in the process of positive identification.

**Opposite**
Leaves and buds directly across from each other on the stem. Ex: *Acer, Lonicera, Deutzia, Viburnum*.

**Alternate**
Leaves and buds are spaced in alternating fashion along the axis of the stem and seldom, if ever, are seated directly across from each other. Ex: *Betula, Fagus, Quercus, Celtis, Ulmus, Carya, Juglans*.

**Subopposite**
Subopposite refers to a condition where the leaves and buds are not spaced sufficiently far apart to be considered alternate nor are they perfectly opposite, hence, the term subopposite. Ex: *Rhamnus cathartica, Cercidiphyllum japonicum, Chionanthus virginicus*.

**Whorled**
Whorled refers to a condition when three buds and leaves (or more) are present at a node. Ex: *Catalpa, Hydrangea paniculata 'Grandiflora', Cephalanthus occidentalis*. 
LEAF VENATION

Pinnate
The leaf has a prominent central vein (often termed the midrib) which extends from the base, where the petiole attaches to the blade, to the apex of the leaf. If the interveinal areas were removed the overall effect would be that of a fishbone. Pinnate venation occurs in the leaves of many plant types. The elm (*Ulmus*) and oak (*Quercus*) are classic examples.

Palmate
There are several main veins all of approximately equal size which extend from the base of the leaf to the apex of the lobe or margin of leaf. Ex: *Acer, Platanus, Cercis.*

Dichotomous
A very limited type of venation, the most familiar representative of which is *Ginkgo biloba.* The basal veins extend for a distance and then branch forming a “Y” type pattern.

Parallel
Typical of many monocotyledonous plants. The veins run essentially parallel to each other along the long axis of the leaf. Ex: *Zea* (corn), *Ruscus, Danae.*
LEAF SHAPES

The tremendous quantity of terminology related to leaf shapes can be confusing. Association of the following pictures with the terms will help to alleviate the burden of strict terminology. This also applies to leaf bases, margins, and apices.

<table>
<thead>
<tr>
<th>Ovate</th>
<th>Lanceolate</th>
<th>Cordate</th>
<th>Elliptical</th>
<th>Spatulate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obovate</td>
<td>Oblanceolate</td>
<td>Obcordate</td>
<td>Oblong</td>
<td>Linear</td>
</tr>
<tr>
<td>Peltate</td>
<td>Cuneate</td>
<td>Reniform</td>
<td>Hastate</td>
<td></td>
</tr>
</tbody>
</table>
### LEAF BASIS

<table>
<thead>
<tr>
<th>Cuneate</th>
<th>Acute</th>
<th>Rounded</th>
<th>Cordate</th>
<th>Oblique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagitate</td>
<td>Hastate</td>
<td>Truncate</td>
<td>Auriculate</td>
<td></td>
</tr>
</tbody>
</table>

### LEAF MARGINS

<table>
<thead>
<tr>
<th>Entire</th>
<th>Serrate</th>
<th>Serrulate</th>
<th>Doubly-Serrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dentate</td>
<td>Crenate</td>
<td>Incised</td>
<td>Sinuate</td>
</tr>
<tr>
<td>Undulate</td>
<td>Lobed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**LEAF APICES**

<table>
<thead>
<tr>
<th>Mucronate</th>
<th>Cuspidate</th>
<th>Acuminate</th>
<th>Acute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtuse</td>
<td>Truncate</td>
<td>Emarginate</td>
<td>Obovate</td>
</tr>
</tbody>
</table>

16
Lab 1. List of Plants for Identification

This list is representative of the plants commonly found in landscapes. You will be responsible for identifying some or all of them on the exam.

**Woody Plants:**
1. American Elm  *Ulmus americana*
2. Green Ash  *Fraxinus pennsylvanica*
3. Flowering Crabapple  *Malus sp.*
4. Bur Oak  *Quercus macrocarpa*
5. Colorado Spruce  *Picea pungens*
6. Ponderosa Pine  *Pinus ponderosa*
7. American Linden  *Tilia americana*
8. Creeping Juniper  *Juniperus horizontalis*
9. Silver Maple  *Acer saccharinum*

**Herbaceous Plants:**
1. Petunia  *Petunia hybrida*
2. Zinnia  *Zinnia elegans*
3. Geranium  *Pelargonium hortorum*
4. African Marigold  *Tagetes erecta*
5. French Marigold  *Tagetes patula*
Plant Identification Key

A. Woody Plants

#1 Name
Plant type_____________Leaf arrangement___________Leaf type_____________
Leaf margin_________tip__________shape_________Fruit type_____________
Other characteristics:

#2 Name
Plant type_____________Leaf arrangement___________Leaf type_____________
Leaf margin_________tip__________shape_________Fruit type_____________
Other characteristics:

#3 Name
Plant type_____________Leaf arrangement___________Leaf type_____________
Leaf margin_________tip__________shape_________Fruit type_____________
Other characteristics:

#4 Name
Plant type_____________Leaf arrangement___________Leaf type_____________
Leaf margin_________tip__________shape_________Fruit type_____________
Other characteristics:
#5 Name

Plant type_________ Leaf arrangement__________ Leaf type___________
Leaf margin_________ tip___________ shape___________ Fruit type___________
Other characteristics:

#6 Name

Plant type_________ Leaf arrangement__________ Leaf type___________
Leaf margin_________ tip___________ shape___________ Fruit type___________
Other characteristics:

#7 Name

Plant type_________ Leaf arrangement__________ Leaf type___________
Leaf margin_________ tip___________ shape___________ Fruit type___________
Other characteristics:

#8 Name

Plant type_________ Leaf arrangement__________ Leaf type___________
Leaf margin_________ tip___________ shape___________ Fruit type___________
Other characteristics:

#9 Name

Plant type_________ Leaf arrangement__________ Leaf type___________
Leaf margin_________ tip___________ shape___________ Fruit type___________
Other characteristics:
B. **Herbaceous Plants**

#1 Name

- Plant type ____________________ Leaf arrangement ________________________
- Leaf margin ___________________ tip __________________ shape ______________
- Flower characteristics: 
- Other characteristics: 

#2 Name

- Plant type ____________________ Leaf arrangement ________________________
- Leaf margin ___________________ tip __________________ shape ______________
- Flower characteristics: 
- Other characteristics: 

#3 Name

- Plant type ____________________ Leaf arrangement ________________________
- Leaf margin ___________________ tip __________________ shape ______________
- Flower characteristics: 
- Other characteristics: 

#4 Name

- Plant type ____________________ Leaf arrangement ________________________
- Leaf margin ___________________ tip __________________ shape ______________
- Flower characteristics: 
- Other characteristics: 

#5 Name

- Plant type ____________________ Leaf arrangement ________________________
- Leaf margin ___________________ tip __________________ shape ______________
- Flower characteristics: 
- Other characteristics: 


1. What are three identifying characteristics of a dicot? **Give an example.**

2. What are three identifying characteristics of a monocot? **Give an example.**

3. What are the differences between annual and perennial plants? **Give an example of each.**

4. Why are scientific nomenclature and plant classification important?

5. What are the differences between deciduous and evergreen trees?
Lab Exercise 2
SEXUAL PROPAGATION OF PLANTS

A seed is formed when a pollen grain lands on the stigma of the flower, and sends down a pollen tube which releases a sperm cell into the ovule. This fertilization or joining of the sperm cell and ovule forms a cell called a zygote. The zygote then develops into an embryo. The embryo along with the food storage organs, cotyledons and/or endosperm, and the seed coat or testa make up what is called the seed.

The embryo is a diminutive plant and under the proper conditions it will grow into a plant. This new plant will have characteristics from both of its parents. The embryo has two basic parts: the radicle, which grows into the root or below ground portion of the plant and the plumule, which grows into the above ground portion of the plant. The seed also contains food stored as either starch (wheat), fats (sunflower), protein (beans), or a combination of all three. The food storage gives the growing embryo and developing seedling energy until its leaves can begin photosynthesizing.

The process of seed germination is much more complicated than it would appear. Germination is a biochemical process that involves the activation of many chemical reactions. This happens in three stages.

The first stage of seed germination involves the uptake of water. This is called imbibition. During imbibition the protein synthesizing systems are activated and various enzymes are synthesized. These enzymes catalyze reactions used in the second stage of germination.

The second stage of germination involves the breakdown of the stored energy rich compounds of the cotyledons and endosperm. The second stage is a period of readying the embryo for rapid growth during the third stage.

During the third stage of germination, cell division begins and the embryo grows into a seedling. The first growth occurs in the radicle, and the root system is established. This is followed by the emergence of the plumule. Once the seedling has formed leaves it becomes a self sufficient plant.
Lab 2. Lecture Outline

A. What is sexual propagation?
   1. Definition
   2. Advantages over asexual propagation
   3. Disadvantages

B. Which method should you use?
   1. depends on:
      a.
      b.
      c.

C. Uses
   1.
   2.
   3.

D. Factors affecting germination
   1. Seed viability
   2. Germination is affected by:
      a.
      b.
3. Seed dormancy

4. Treatments to overcome dormancy
   a. Scarification
      1) Mechanical
      2) Hot water
      3) Acid treatment
   b. Stratification
      1) Moist chilling
      2) Warm moist followed by cold moist

5. Environmental conditions needed for germination
   a. Moisture
   b. Aeration
   c. Light
   d. Temperature
Lab 2. Sexual Propagation
Lab Exercises

I. Objective
To learn seed structure, viability test, and treatments to overcome seed dormancy.

II. Materials
Bean seeds (old, new, water-soaked, TTC-treated), razor blades, petri dish, paper towels, sand a paper or file.

III. Procedures

1. Seed Anatomy
Cut through a soaked bean seed and observe the internal structure. Sketch and label the parts of the seed.

2. Seed Viability
Bean seeds have been soaked overnight in TTC (triphenyltetrazolium chloride). This changes living tissue to a red color. Uncolored spots will indicate poor viability. Cut open several seeds and sketch your observations. Based on your observations how would you describe their viability? Why?

3. Seed Germination Tests
Seed has been divided into "old" and "new" lots. Count out 10 seeds from each lot and plant according to instructor's directions. Record the number of seeds that germinated for each group and calculate corresponding germination percentages.

4. Seed Scarification
This exercise will evaluate scarification techniques and their effect on germination percentages. Select 10 seeds for each of the four treatments and plant in the four different containers provided.

   a. Treatment 1- Control (no scarification)
   b. Treatment 2- Seeds soaked in hot water
   c. Treatment 3- Seeds soaked in acid (sulfuric acid)
   d. Treatment 4- Mechanical scarification (use sandpaper, file, or clippers)

IV. Results
Obtain seed germination data for the steps 3 and 4 above for your group and the entire class. Use this information for your lab report.
Bean Seed

Structure of Bean Seed

Germination and seedling development of bean
Epigeous germination of cherry seed (endocarp removed)

Hypogeous germination of peach seed (endocarp removed)
LAB 2 - Sexual Propagation of Plants
Lab Report

Name ___________________________    Lab Section __________________

1. Define seed scarification and stratification.

   Scarification:

   Stratification:

2. Summarize results of the seed scarification experiment (Procedure # 4).

   Plant species 1 ____________________  Plant species 2 ____________________

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total no. seeds</th>
<th>No. seeds germinated</th>
<th>% germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Control</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
<tr>
<td>b. Hot water</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
<tr>
<td>c. Acid</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
<tr>
<td>d. Mechanical</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
</tbody>
</table>

   Species 1

   Species 2

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total no. seeds</th>
<th>No. seeds germinated</th>
<th>% germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Control</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
<tr>
<td>b. Hot water</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
<tr>
<td>c. Acid</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
<tr>
<td>d. Mechanical</td>
<td>______________</td>
<td>________________</td>
<td>______________</td>
</tr>
</tbody>
</table>

   Comments:

3. What is the function of the cotyledon?

4. What is the difference between endosperm and embryo?

5. Why is water necessary for seed germination?

6. What are three factors that affect seed viability?
Lab Exercise 3
ASEXUAL PROPAGATION OF PLANTS

Asexual propagation is used to reproduce or multiply many horticultural plants. Plants that are propagated asexually are genetically the same as the mother plant. This is also called cloning. Although cloning is being talked about a lot today, it is not a recent development. Farmers have been cloning crop plants since before recorded history. One of the oldest clones in existence is Thompson seedless grapes. The plant with the largest number of daughter plants is the navel orange. All clones originate from a single plant and all of the plants that are propagated from it, asexually, are genetically the same.

Some asexually propagated crops that are grown extensively are: tree fruits, cane fruits, strawberries, sugar cane, potatoes, sweet potatoes, cassava, cranberries, and most herbaceous and woody ornamental plants. Almost all the flower crops and green plants grown as greenhouse crops are also propagated asexually.

Plants are propagated asexually for the following reasons:

1. to preserve the genetic characteristics of a particular plant;
2. to propagate plants that do not produce viable seeds (bananas, pineapple, seedless grape, etc.);
3. to propagate plants that produce seed that is difficult to germinate or has a very short storage life (cotoneaster, willow);
4. to bypass the juvenile stage of plant growth when the plants will not flower and bear fruit (apple).

By far the most important of these is the first. This is the main reason that many horticulture plants are propagated asexually.

Asexual propagation may be done by making cuttings from the stem, root or leaves of the desired plant. Stem cuttings are made by removing a small branch or twig from the plant. This cutting will usually contain two or more buds, one of which will grow into the top of the plant. With proper treatment, adventitious roots will be produced on the end of the cutting that was closest to the root of the original plant. Root cuttings are made in a similar fashion, but produce an adventitious stem on the end of the cutting that was nearest to the stem of the original plant. Leaf cuttings produce both roots and stems when the leaf is placed under proper conditions. *adventitious [not properly belonging to]- Referring to a structure arising from an unusual place, such as buds at other places than leaf axils, or root growing from stems or leaves.

Grafting is another type of asexual propagation. In the process of grafting, a part of the stem of one plant is mechanically joined to the stem or root of another plant. If the graft is to be successful, the stem (scion) and the root (stock) must be closely related taxonomically. Grafting is used primarily for woody plants and most tree fruits are propagated in this manner. The scion may be a single bud (budding), or it may have several buds (grafting).

Some plants can be propagated asexually by dividing clumps of the plants. This is called division and is used for such plants as iris, some lilies, orchids, many house plants and perennials. In division, the clumps are cut or torn apart and the individual plants replanted. These will then make another clump which can be divided to keep the process going.

Plants can also be asexually propagated by layering. The process of layering is as if you rooted a cutting while it was still attached to the plant. There are several different ways to layer a plant, but generally the process involves placing a part of the plant stem under conditions favorable for rooting.
Once roots have formed the new plant is separated from the mother plant and established in a new location.

Over the last several years tissue culture propagation has been perfected as a way to propagate plants asexually. Tissue culture uses very small cuttings that are sterilized and grown in test tubes under aseptic conditions. In some instance the cutting can be as small as a single cell isolated from various plant tissues. Once the cutting (explant) is established in a test tube, the medium on which the explant is to grow can be modified to promote the production of numerous stems or roots. Usually the culture is first manipulated to produce many stems. These stems are then placed under cultural conditions to promote rooting. Plants can be reproduced very rapidly using tissue culture methods. A single bud from a potato plant can be multiplied a million times in a single year.
Notes - Plant Propagation Video

A. Specialized Plant Parts

Bulbs

Corms

Tubers

Tuberous roots

B. Propagation by Division

What

How

C. Micropropagation

Explants

Sterile medium

Controlled environment

Advantages
  1.
  2.
  3.
  4.

Disadvantages
  1.
  2.
  3.
ASEXUAL PROPAGATION BY VEGETATIVE PARTS

A. Propagation by Cuttings

1. Four main groups of stem cuttings:
   a. Hardwood - dormant
   b. Semi-hardwood - late summer
   c. Soft wood - late spring or early summer
   d. Herbaceous - when actively growing

2. Sanitation

3. Environment

4. Transplanting

5. Harden-off

B. Layering

C. Air Layering

D. Grafting and Budding

1. Scion

2. Stock

3. Union

4. Cambium
Lab Exercise 3
ASEXUAL PROPAGATION - CUTTINGS

Objective: a) To acquaint the student with some of the basic techniques used in propagating plants using cuttings, and b) to test a hypothesis that a temperature differential between root zone and ambient air in mist room promotes root initiation and quality.

Materials Needed: Stock plants, knives, pruning shears, cell packs to hold rooting medium, rooting hormone (IBA powder or solution), pot labels, marking pens.

Procedures:

1. Preparation of cuttings: Swedish Ivy (*Plectranthus australis*), Indin Laurel (*Ficus benjamina*).
   a. Select growing shoot tips that are 8-10 cm long and contain at least 2 nodes. Cut the tips from the stock plant. Remove leaves from the basal 4-5 cm. Make the cuttings as uniform as possible.
   b. Each group will make 80 cuttings of one species.
      Label plant materials with treatment, date, your name and lab section. Use pencil or waterproof marking pen.
   c. Divide the cuttings into 4 groups of 20 cuttings each.
      Treat each group as follows:
      
      Group 1: No rooting compound - bottom heat.
      Group 2: Rooting compound - bottom heat.
      Group 3: No rooting compound - no bottom heat.
      Group 4: Rooting compound - no bottom heat.
      
      To treat cuttings in rooting compound, dip in water, shake off excess water and dip into rooting powder. Then place in rooting media in packs.

2. Take cuttings from any of the additional plants provided.
   
   Iron Cross Begonia (*Begonia masoniana*) - leaf cutting
   Snake Plant (*Sansevieria trifasciata laurentii*) - leaf sections
   African Violet (*Saintpaulia ionantha*) - leaf cutting
   Giant Dumbcane (*Dieffenbachia amoana*) – canes (5 cm segments), lay horizontally on media
   Peperomia (*Peperonia obtusifolia*) - stem, leaf cutting
   Other materials will also be provided.

3. Check progress of plants after 7 and 14 days. Hand in results with your recommendation of the best treatment for propagating the plant you worked with. The additional cuttings are for your information only and may take longer to root.
LAB 3 - Asexual Propagation of Plants
Lab Report

Name ________________________________________  Lab Section _________________

1. Obtain data on the rooting of cuttings after 7 and 14 days. Using the data obtained after 14 days, discuss the outcome of your experiment (part 3, lab exercise #3) and draw a conclusion whether higher root-zone temperature in relation to ambient temperature actually promoted root initiation and quality.

   a. Experimental results:

   Species #1 (Herbaceous plant)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total no. of cuttings planted</th>
<th>No. of cuttings rooted</th>
<th>% rooting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Control, no bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Control, bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) IBA, no bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) IBA, bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   Species #2 (Woody plant)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total no. of cuttings planted</th>
<th>No. of cuttings rooted</th>
<th>% rooting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control, no bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Control, bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. IBA, no bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. IBA, bottom heat</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   b. Conclusion and discussion:

2. Define asexual propagation. How does it differ from sexual propagation?

3. What are three reasons why plants are propagated asexually?

4. What is the purpose of using IBA (indolebutyric acid) in cutting propagation?

5. List 4 environmental factors that are important in rooting of cuttings.
Lab Exercise 4
HORTICULTURE ARTICLE FOR INTERNET

I. Introduction

During this lab, we will use the internet as a source of information on horticultural topics. This information can be applied to other areas as well. We will study the basic fundamentals of surfing, using search engines, and linking to other sites. You are required to write a horticulture article about a topic of your choice.

Keyword - a word that describes a subject area (i.e., carnation).
Link - a clickable area on a page that will lead to another page.
Page - a document on the internet.
Search engine - a site that lists other sites and can be used to find information.
URL - an Internet address (eg. http://www.ndsu.nodak.edu).

II. Objectives

This lab exercise is designed to acquaint the students with various horticulture web sites. Specific objectives are to: a) obtain information on selected horticultural topics of student’s choice, b) learn how to use the HTML language, and c) write a horticulture article of your interest for placement on a web site.

III. Procedure

A 30-minute lecture will cover how to a) assemble information, b) design a web-page, c) introduce pictures and graphic files, and d) establish links to other articles, using the web-authoring programs (i.e., DreamWeaver). Students may be able to turn in a draft copy of a web-article by the end of the class.

IV. Assignment

a. Select a horticultural topic of your choice,
b. Find information from horticultural web sites by surfing,
c. Write a horticulture article that will be placed on the class home page.
d. Cite references for web sites as source of information and further reference. (These web sites must be listed at the end of your article as links so that readers can visit the specific sites as needed)
e. Turn in: a hard copy of your article and a diskette containing your article. All graphic files must be placed in your folder. The folder name should include the initial of your first name and full last name.

V. Grading of Article

Articles submitted will be graded on the basis of: a) information content, b) originality, c) organization, d) artwork and appearance, and e) appropriateness in citation and references. Sources for the pictures and graphs used in the article must be shown with proper labeling and permission from the original publisher. A total of 30 possible points is given.
I. General Introduction

All living organisms require certain elements for their survival. Plants are known to require carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), calcium (Ca), sulfur (S), potassium (S), and magnesium (Mg), which are called **Macronutrients**, because they are needed in larger amounts. Plants also need large amounts of carbon (C), hydrogen (H), and oxygen (O) for growth and development. Plants absorb these elements through air and water, they are not usually applied as fertilizers.

**Micronutrients** which are needed in very minute quantities are: iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), and chlorine (Cl). There is no "most important element" since all are required for life, growth and reproduction. They are therefore called **essential elements**.

Plant tissues also contain other elements (Na, Se, Co, Si, Rb, Sr, F, I) which are not needed for the normal growth and development.

<table>
<thead>
<tr>
<th>Element</th>
<th>Chemical symbol</th>
<th>Atomic weight</th>
<th>Ionic forms absorbed by plants</th>
<th>Approximate dry tissue concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macronutrients</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>14.01</td>
<td>NO$_3^-$, NH$_4^+$</td>
<td>4.0 %</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>30.98</td>
<td>PO$_4^{3-}$, HPO$_4^{2-}$, H$_2$PO$_4^-$</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>39.10</td>
<td>K$^+$</td>
<td>4.0 %</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>24.32</td>
<td>Mg$^{2+}$</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Sulfur</td>
<td>S</td>
<td>32.07</td>
<td>SO$_4^{2-}$</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca</td>
<td>40.08</td>
<td>Ca$^{2+}$</td>
<td>1.0 %</td>
</tr>
<tr>
<td><strong>Micronutrients</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>Fe</td>
<td>55.85</td>
<td>Fe$^{2+}$, Fe$^{3+}$</td>
<td>200 ppm</td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn</td>
<td>54.94</td>
<td>Mn$^{2+}$</td>
<td>200 ppm</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>65.38</td>
<td>Zn$^{2+}$</td>
<td>30 ppm</td>
</tr>
<tr>
<td>Copper</td>
<td>Cu</td>
<td>63.54</td>
<td>Cu$^{2+}$</td>
<td>10 ppm</td>
</tr>
<tr>
<td>Boron</td>
<td>B</td>
<td>10.82</td>
<td>BO$_3^{2-}$, B$_4$O$_7^{2-}$</td>
<td>60 ppm</td>
</tr>
<tr>
<td>Molybdenium</td>
<td>Mo</td>
<td>95.95</td>
<td>MoO$_4^{2-}$</td>
<td>2 ppm</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl</td>
<td>35.46</td>
<td>Cl$^-$</td>
<td>3000 ppm</td>
</tr>
<tr>
<td><strong>Essential But Not Applied</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon</td>
<td>C</td>
<td>12.01</td>
<td>CO$_2$</td>
<td>40 %</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>H</td>
<td>1.01</td>
<td>H$_2$O</td>
<td>6 %</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>16.00</td>
<td>O$_2$, H$_2$O</td>
<td>40 %</td>
</tr>
</tbody>
</table>

Under most agricultural and horticultural conditions, only **nitrogen**, **phosphorus**, and **potassium** are depleted from the soil to the extent that growth and development are interrupted. These are the fertilizer elements. Modern agriculture depends on the addition of these elements to the soil to ensure optimum yields of food crops. Soil tests are used to determine the levels of the elements available to the crop and the quantities that must be added as fertilizer to get profitable yields. Deficiencies of other elements such as sulfur, zinc and copper may occur in some soils. These deficiencies can be corrected by the addition of small amounts of these elements to the soil or as sprays to the plant. Under some
conditions the soil may contain adequate supplies of the element, but because of soil pH (acidity or alkalinity) the element is unavailable to the plant. This occurs with iron in high pH (alkaline) soils. Many plants growing in these soils will have yellow (chlorotic) leaves. All species of plants do not react the same under these conditions. Some will show the deficiency symptom, while others are apparently able to extract the iron from the soil.

II. Fertilizer Concentration Calculations

A. Units Used

ppm = parts per million  
mM = milli molar  
meq/l = milliequivalent per liter

B. Conversion Factors (metric vs. British system)

1 ounce = 28.35 g  
1 pound = .45 kg  
1 gallon = 3.78 liters  
1 g = .035 ounce  
1 kg = 2.205 pounds  
1 acre = 43,560 ft²  
1 liter = 1 kg

C. Fertilizer Concentrations

a. Parts per million (ppm)

The term, parts per million, is an expression of concentration used often to describe very dilute solutions. The term states how many parts of solute there are in a million parts of the whole solution. Parts per million almost always expresses concentrations on a mass basis. For example, a 10 ppm solution is one in which every million grams of solution contains 10 grams of solute. The ppm designation is most often applied to dilute solutions in water. For example, 1 kilogram (1000 gram) of water contains 1 million milligrams of water; thus

\[
1 \text{ kg} = 1 \text{ kg} \times 1000 \text{ g/kg} \times 1000 \text{ mg/g} = 1,000,000 \text{ mg}
\]

At normal temperatures, 1 liter of a dilute water solution has a mass of approximately 1 kilogram. If we have 10 mg of solute in 1 liter of solution, it will be 10 ppm.

\[
\frac{10 \text{ mg solute}}{1 \text{ liter solution}} = \frac{10 \text{ mg solute}}{1,000,000 \text{ mg solution}} = 10 \text{ ppm}
\]

Thus when we say that the concentration of nitrogen in water is 200 ppm, we mean that 1 liter of the solution contains 200 milligrams of nitrogen. The important thing to remember is:

1 kg = 1,000,000 mg  
1 liter water = 1 kg  
therefore, 1 liter water = 1,000,000 mg
b. **Milli-molar (mM)**

One millimolar (mM) concentration refers to a solution containing one-thousandth of molecular weight (g) of the solute per liter of water. One molar (M) concentration equals 1000 millimolar (mM) concentration.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Molecular or atomic weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>14.01</td>
</tr>
<tr>
<td>K⁺</td>
<td>39.10</td>
</tr>
<tr>
<td>NH₄NO₃</td>
<td>80.05</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>18.01</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>62.01</td>
</tr>
<tr>
<td>Ca²⁺</td>
<td>40.08</td>
</tr>
<tr>
<td>Mg²⁺</td>
<td>24.32</td>
</tr>
<tr>
<td>S</td>
<td>32.07</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>96.07</td>
</tr>
<tr>
<td>MgSO₄·7H₂O</td>
<td>246.50</td>
</tr>
</tbody>
</table>

1 mM NH₄NO₃ = 80.05 mg per liter (mg/l)
1 mM NO₃⁻ = 62.01 mg/l
1 mM SO₄²⁻ = 96.07 mg/l
1 mM MgSO₄·7H₂O = 246.5 mg/l

c. **Milliequivalent per liter (meq/l)**

Milliequivalent per liter (meq/l) concentrations are often used to show the strength of fertilizer ions (anion or cation) in a solution. Since one equivalent weight is the molecular weight divided by valence, one meq/l refers to the ionic concentration of a solution that contains one millimole/valence per liter of water.

\[\begin{align*}
\text{NH}_4\text{NO}_3 & \quad \rightarrow \quad \text{NH}_4^+ + \text{NO}_3^- \\
(80) & \quad \rightarrow \quad (18) + (62) \\
\text{MgSO}_4\cdot7\text{H}_2\text{O} & \quad \rightarrow \quad \text{Mg}^{2+} + \text{SO}_4^{2-} \\
(246.5) & \quad \rightarrow \quad (24.3) + (96.1)
\end{align*}\]

1 meq/l NH₄NO₃ = 80 mg/l
1 meq/l NH₄⁺ = 18 mg/l
1 meq/l NO₃⁻ = 62 mg/l
1 meq/l MgSO₄·7H₂O = (246.5 mg/2)/l = 123.3 mg/l
1 meq/l Mg²⁺ = (23.3 mg/2)/l = 11.6 mg/l
1 meq/l SO₄²⁻ = (96.1 mg/2)/l = 48.0 mg/l

D. **Fertilizer Analysis**

a. **Commercial Analysis**

Commercial analysis is given by the percentages of nitrogen (N), phosphorus (P₂O₅), and potassium (K₂O) in that order. For example, Peters 20-16-20 fertilizer contains 20% N, 16% P₂O₅, and 20% K₂O by weight.
b. **Elemental Analysis**

Elemental analysis is used for more technical and scientific purposes. It is expressed as percent weights of elemental nitrogen (N), phosphorus (P), and potassium (K) in that order.

c. **Conversion of Commercial Analysis to Elemental Analysis**

By using the ratios of elemental to oxides for phosphorus and potassium, the commercial analysis can be converted to elemental analysis.

- Nitrogen - always expressed as elemental N
- Phosphorus - \( \frac{P_2}{P_2O_5} = 0.44 \), or \( \frac{P_2O_5}{P} = 2.99 \)
- Potassium - \( \frac{K_2}{K_2O} = 0.83 \), or \( \frac{K_2O}{K} = 1.20 \)

Thus, Peters 20-16-20 commercial analysis fertilizer can be labeled as a 20-7.04-16.6 elemental analysis fertilizer.

\[
20\% \text{ N} - 16\% \frac{P_2O_5}{P} - 20\% \frac{K_2O}{K} = 20\% \text{ N} - 7.04\% P - 16.6\% K
\]

For example, if you want to apply 200 ppm nitrogen to your plants and were going to mix up 1 liter of solution you then would have to put 1000 mg or 1 gram of fertilizer into the liter of water.

1 liter water = 1,000,000 mg, therefore, 200 mg of N are needed. However, the fertilizer is only 20% N. So:

\[
\frac{200}{0.20} = \frac{x}{1.00} \quad x = 1000 \text{ mg} = 1 \text{ g.}
\]
III. Problems

1) You wish to prepare 5 gallons of a 100 ppm nitrogen (N) fertilizer. How much 15-10-5 commercial analysis fertilizer will you need to add to 5 gallons of water to get the desired concentration?

2) You are mixing 5 gallon of concentrate fertilizer to apply with a hose-on (1:15 proportion), and you want the final concentration to be 200 ppm nitrogen (N). What amount of fertilizer, if you are using 20-20-20 commercial analysis fertilizer, do you need to add to 5 gallon of water?

3) What would be the concentrations of phosphorus and potassium in the fertilizer solution above? (see #2)

| Nitrogen   | = | 200   | ppm N |
| Phosphorus | = | ______ | ppm P₂O₅ | = | __________ ppm P |
| Potassium  | = | ______ | ppm K₂O | = | __________ ppm K |

4) The fertilizer bag says add 5 oz. to 100 gallons of water. What ppm N, P, K will this solution be, assuming the fertilizer has a commercial analysis of 20-20-20?
DEMONSTRATION OF NUTRIENT DEFICIENCIES
Lab Experiment

A. Objective

Plants require large quantities of macronutrients (N, P, K, Ca, Mg, S). Of these macronutrients, deficiency symptoms of nitrogen, phosphorus, and potassium can be visually detected on plants grown under an artificially controlled culture system. The objective of this study is to artificially induce and characterize deficiency symptoms of nitrogen, phosphorus, and potassium on selected plants. During the course of this study, students will observe and characterize abnormal symptoms of plants lacking nitrogen, phosphorus, or potassium.

B. Materials and Method

*Plant Materials*

Three species of plants (corn, bean, leaf lettuce) will be used. Corn and bean will be grown in perlite, whereas leaf lettuce will be grown hydroponically.

*Nutrient Solutions*

Five different solutions containing the complete combinations of macronutrients lacking one of the three macronutrients N, P, and K. All solutions will contain the standard concentrations of micronutrients (a modification of Hoagland Solution):

- Treatment 1 --- Complete fertilizer
- Treatment 2 --- Lacking nitrogen (-N)
- Treatment 3 --- Lacking phosphorus (-P)
- Treatment 4 --- Lacking potassium (-K)
- Treatment 5 --- Lacking calcium (Ca)
- Treatment 5 --- Lacking all macronutrients

C. Procedures

Germinate seeds of the three species on an inert medium (rockwool, perlite, sand, etc.) using deionized water. When the seedlings start developing true leaves, plant them in 6-inch plastic pots containing perlite (corn and bean). For lettuce, place the seedlings on a styrofoam board which will float on top of a hydroponic solution contained in a plastic tub. Observe plant growth and development of deficiency symptoms for 8 weeks.

D. Observations

Observe the growth of plants with each of the four treatments. Characterize the growth and development of nutrient deficiency symptoms for nitrogen, phosphorus, and potassium in 8 weeks of observation. Using the findings of the experiment, complete your lab report.
PREPARATION OF HOAGLAND SOLUTION

1. Preparation of Nutrient Solutions: Method A, for Amateurs

Either one of the solutions given in Table 1 may be tried. Solution 2 may often be preferred because the ammonium salt delays the development of undesirable alkalinity. The salts are added to the water, preferably in the order given. To either of the solutions, add the elements iron, boron, manganese, and in some cases, zinc and copper, which are required by plants in minute quantities. There is danger of toxic effects if much greater quantities of these elements are added than those indicated later in the text. Molybdenum and possibly other elements required by plants in minute amounts will be furnished by impurities in the nutrient salts or in the water, and need not be added deliberately.

Table 1. Composition of nutrient solutions (amounts given are for 25 gallon solutions).

<table>
<thead>
<tr>
<th>Salt</th>
<th>Grade of salt</th>
<th>Approximate amount, in ounces</th>
<th>Approximate amount, in level tablespoons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution 1*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium phosphate (monobasic)</td>
<td>Technical</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>Fertilizer</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Calcium nitrate</td>
<td>Fertilizer</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Magnesium sulfate (Epsom salt)</td>
<td>Technical</td>
<td>1.5</td>
<td>4</td>
</tr>
<tr>
<td>Solution 2*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonium phosphate (monobasic)</td>
<td>Technical</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>Fertilizer</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>Calcium nitrate</td>
<td>Fertilizer</td>
<td>2.5</td>
<td>6</td>
</tr>
<tr>
<td>Magnesium sulfate (Epsom salt)</td>
<td>Technical</td>
<td>1.5</td>
<td>4</td>
</tr>
</tbody>
</table>

*To either of these solutions, supplements of elements required in minute quantity must be added; see directions in the text.

a. Boron and Manganese Solution - Dissolve 3 teaspoons of powdered boric acid and 1 teaspoon of chemically pure manganese chloride (MnCl₂·4H₂O) in a gallon of water. (Manganese sulfate could be substituted for the chloride.) Dilute 1 part of this solution with 2 parts of water, by volume. Use a pint of the diluted solution for each 25 gallons of nutrient solution.

The elements in group a are added when the nutrient solution is first prepared and at all subsequent changes of solution. If plants develop symptoms characteristic of lack of manganese or boron, solution a, in the amount indicated in the preceding paragraph, may be added between changes of the nutrient solution or between addition of salts needed in large quantities. But care is needed, for injury may easily be produced by adding too much of these elements.

b. Zinc and Copper Solution - Ordinarily this solution may be omitted, because these elements will almost certainly be supplied as impurities in water or chemicals, or from the containers. When it is needed, additions are made as for solution a. To prepare solution b, dissolve 4 teaspoons of chemically pure zinc sulfate (ZnSO₄·7H₂O) and 1 teaspoon of chemically pure copper sulfate (CuSO₄·5H₂O) in a gallon of water. Dilute 1 part of this solution with 4 parts of water. Use 1 teaspoon of the diluted solution for each 25 gallons of nutrient solution.

c. Additions of Iron to Nutrient Solution - Generally, iron solution will need to be added at frequent and regular intervals, for example, once or twice a week. If the leaves of the plant tend to become yellow, even more frequent additions may be required. However, a yellowing or mottling of leaves can also arise from many other causes.

The iron solution is prepared as follows: Dissolve 1 teaspoon of iron tartrate (iron citrate or iron sulfate can be substituted, but the tartrate or citrate is often more effective than the sulfate) in 1 quart of water. Add 1/2 cup of this solution to 25 gallons of nutrient solution each time iron is needed.
2. Preparation of Nutrient Solutions: Method B, for Schools or Technical Laboratories

For experimental purposes, the use of distilled water and chemically pure salts is recommended. Molar stock solutions (except when otherwise indicated) are prepared for each salt, and the amounts indicated below are used.

### Solution 1
- 1M KH$_2$PO$_4$, potassium acid phosphate: 1 cc
- 1M KNO$_3$, potassium nitrate: 5 cc
- 1M Ca(NO$_3$)$_2$, calcium nitrate: 5 cc
- 1M MgSO$_4$, magnesium sulfate: 2 cc

### Solution 2
- 1M NH$_4$H$_2$PO$_4$, ammonium acid phosphate: 1 cc
- 1M KNO$_3$, potassium nitrate: 6 cc
- 1M Ca(NO$_3$)$_2$, calcium nitrate: 4 cc
- 1M MgSO$_4$, magnesium sulfate: 2 cc

To either of these solutions, add solutions a and b below.

#### a. Supplementary Solution
Prepare a supplementary solution which will supply boron, manganese, zinc, copper, and molybdenum, as follows:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Grams dissolved in 1 liter of H$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td>H$_2$BO$_3$, boric acid</td>
<td>2.86</td>
</tr>
<tr>
<td>MnCl$_2$.7H$_2$O, manganese chloride</td>
<td>1.81</td>
</tr>
<tr>
<td>ZnSO$_4$.5H$_2$O, zinc sulfate</td>
<td>0.22</td>
</tr>
<tr>
<td>CuSO$_4$.5H$_2$O, copper sulfate</td>
<td>0.08</td>
</tr>
<tr>
<td>H$_2$MoO$_4$.H$_2$O, molybdic acid</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Add 1 cc of this solution for each liter of nutrient solution, when solution is first prepared or subsequently changed, or at more frequent intervals if necessary.

This will give the following concentrations:

<table>
<thead>
<tr>
<th>Element</th>
<th>Parts per million of nutrient solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
<td>0.5</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.5</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.05</td>
</tr>
<tr>
<td>Copper</td>
<td>0.02</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.05</td>
</tr>
</tbody>
</table>

#### b. Iron Solution
Add iron in the form of 0.5 per cent iron tartrate solution or other suitable iron salt, at the rate of 1 cc per liter, about once or twice a week or as indicated by appearance of plants. The reaction of the solution is adjusted to approximately pH 6 by adding 0.1 N H$_2$SO$_4$ (or some other suitable dilution).

### Molar Solutions

The concentrations of stock solutions of nutrient salts used in preparation of nutrient solutions are conveniently expressed in terms of molarity. A molar solution is one containing 1 gram-molecule (mol) of dissolved substance in 1 liter of solution. (In all nutrient-solution work, the solvent is water.) A gram-molecule or mol or a compound is the number of grams corresponding to the molecular weight.

Example 1, how to make a molar solution of magnesium sulfate: The molecular weight of magnesium sulfate, MgSO$_4$.7H$_2$O is 246.50. One mol of magnesium sulfate consists of 246.50 grams. Hence to make a molar solution of magnesium sulfate, dissolve 246.50 grams of MgSO$_4$.7H$_2$O in water and make to 1 liter volume.
Example 2, how to make a one-twentieth molar (0.05 M) solution of monocalcium phosphate, Ca\((\text{H}_2\text{PO}_4)_2\cdot\text{H}_2\text{O}\) (used in deficiency studies, below): The molecular weight of monocalcium phosphate, Ca\((\text{H}_2\text{PO}_4)_2\cdot\text{H}_2\text{O}\) is 252.17. Hence 0.05 mol of Ca\((\text{H}_2\text{PO}_4)_2\cdot\text{H}_2\text{O}\) is 525.17 grams/20 = 12.61 grams. Therefore, to make a 0.05 M solution of monocalcium phosphate, dissolve 12.61 grams of Ca\((\text{H}_2\text{PO}_4)_2\cdot\text{H}_2\text{O}\) in water and make to 1 liter volume.

3. Nutrient Solutions for Use in Demonstrating Mineral Deficiencies in Plants

In any experiment to demonstrate mineral deficiencies in plants, solution 1 or solution 2 should be used as a control to show normal growth in a complete solution. Below are given six solutions, each lacking in one of the essential elements. Distilled water should be used in making these solutions.

<table>
<thead>
<tr>
<th>cc in a liter of nutrient solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Solution lacking nitrogen</td>
</tr>
<tr>
<td>0.5 M K(_2)SO(_4)</td>
</tr>
<tr>
<td>1 M MgSO(_4)</td>
</tr>
<tr>
<td>0.05 M Ca((\text{H}_2\text{PO}_4)_2)</td>
</tr>
<tr>
<td>0.01 M CaSO(_4)</td>
</tr>
<tr>
<td>b. Solution lacking phosphorus</td>
</tr>
<tr>
<td>1M Ca((\text{NO}_3)_2)</td>
</tr>
<tr>
<td>1M KNO(_3)</td>
</tr>
<tr>
<td>1M MgSO(_4)</td>
</tr>
<tr>
<td>c. Solution lacking potassium</td>
</tr>
<tr>
<td>1M Ca((\text{NO}_3)_2)</td>
</tr>
<tr>
<td>1M MgSO(_4)</td>
</tr>
<tr>
<td>0.05M Ca((\text{H}_2\text{PO}_4)_2)</td>
</tr>
<tr>
<td>d. Solution lacking calcium</td>
</tr>
<tr>
<td>1M KNO(_3)</td>
</tr>
<tr>
<td>1M MgSO(_4)</td>
</tr>
<tr>
<td>1M KH(_2)PO(_4)</td>
</tr>
<tr>
<td>e. Solution lacking magnesium</td>
</tr>
<tr>
<td>1M Ca((\text{NO}_3)_2)</td>
</tr>
<tr>
<td>1M KNO(_3)</td>
</tr>
<tr>
<td>1M KH(_2)PO(_4)</td>
</tr>
<tr>
<td>0.5M K(_2)SO(_4)</td>
</tr>
<tr>
<td>f. Solution lacking sulfur</td>
</tr>
<tr>
<td>1M Ca((\text{NO}_3)_2)</td>
</tr>
<tr>
<td>1M KNO(_3)</td>
</tr>
<tr>
<td>1M KH(_2)PO(_4)</td>
</tr>
<tr>
<td>1M Mg((\text{NO}_3)_2)</td>
</tr>
</tbody>
</table>
LAB 5 - PLANT NUTRITION
Lab Report

Name ________________________________  Lab Section _________________________

1. Describe the functions of macronutrients nitrogen (N), phosphorus (P), potassium (K), and calcium (Ca) in plants.

2. Write the chemical forms (ions) of nitrogen (N), phosphorus (P), potassium (K), and calcium (Ca) that are actually absorbed by plants.

3. Why is an inert growing medium used to grow plants for detecting nutrient deficiencies?

4. Describe macronutrient deficiency symptoms that you have observed in each species, and provide comments on your findings.

   **Symptoms:**

   Nitrogen (N) deficiency:

   Phosphorus (P) deficiency:

   Potassium (K) deficiency:

   Calcium (Ca) deficiency:

   **Conclusion:**
Lab Exercise 6
DESIGNING A FLOWER GARDEN

Notes from video:

A. Where to put it

View from 3 locations

B. Zone you live in. Fargo is zone 3 (some of the more hardy zone 4 plants may be considered in sheltered places.)

C. Light

1. light each day - morning, afternoon, evening
2. light each season
3. Four classifications of areas by light
   a. full sunlight - some heat stress
   b. part sunlight - 5-6 hr. of full sun
   c. part shade - dappled sun
   d. full shade - not good for blooming plants

D. Many types - rock gardens, wall gardens, water gardens etc.

1. Decorative Home Garden
   a. mix of flowers and shrubs

   b. advantages -
      1) 
      2) 
      3) 

2. Herbaceous Border Garden
   Made up of a mixture of annuals, perennials, and spring bulbs
E. Planning and Designing

1. Curved shapes

2. Plan from background to foreground

3. Three levels - each 1/3 of bed depth
   a. Avoid step look

4. Plant flowers in groups
   a. Annual and perennials in groups up to 6 plants
      (odd numbers in groups look best)
   b. Spring bulbs - 6 to 12 in a group - 20 is max
   c. Keep in scale

5. Keep texture and shape varied

6. Color - beginners should start with 3-5 colors
   a. Contrast - not touching on the color wheel
   b. Harmonious - next to each other on the wheel

7. **Objective** is to have some color blooming in each level at all times
   a. Two perennials to each annual
      - Perennials usually bloom about 3 weeks
      - Annuals bloom most of the summer
   b. Choose perennials to bloom in late spring, summer, and fall in each of the three areas of the border.
   c. Make 3 lists, one for annuals, one for perennials, and one for bulbs. (See Lab 6 Worksheet)
      Start by listing your favorites in each category, making sure they will grow here.
   d. Background plants should be tall; a rule of thumb: as tall as 2/3 the width of the bed.
   e. Middle plants should be 12 - 36" tall.
   f. Foreground plants should be 12" or under
F. Preparing the flower bed.
   1. add organic matter
   2. till or dig
      a. mix in organic matter
      b. improve drainage
      c. make more oxygen available for the roots

G. Water systems
   1. emitter drip irrigation
   2. porous hose type
   3. drip irrigation
      a. saves 30 - 40% on water
      b. no evaporation or runoff
      c. reduces water on leaves and therefore reduces disease
      d. reduces compaction

H. Mulch
   1. weeds compete for nutrients and water
   2. one way to control is with 2-4" of mulch
      a. reduces weeds, evaporation, and compaction
      b. mulch should: allow air through, resist wind, hold moisture, and look good
   3. types:
   4. winter mulch 4- 6" deep helps protect plants from frost heave

I. Compost
   1. active or passive

J. Maintenance
LAB 6 - FLOWER GARDEN DESIGN
Lab Report

Name ___________________________________________ Lab Section ___________________

Assignment. Design a flower garden using the principles you saw in the video. This may be for an existing yard or you may make up an area with a flower garden about 8 ft x 25 ft. Please turn in these lists as well as the design, which should be drawn to scale. Be original but adhere to the basic precepts given in the video.

<table>
<thead>
<tr>
<th>Plant name (Scientific preferable)</th>
<th>Bloom</th>
<th>Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Period</td>
<td>Color</td>
</tr>
</tbody>
</table>

**List 1 - Perennials**

1
2
3
4
5
6
7
8
9
10
11
12

**List 2 - Annuals**

1
2
3
4
5
6
7

**List 3 - Bulbs and Corms**

1
2
3
4
5
6
7
Lab Exercise 7
GREENHOUSE PRODUCTION

In this lab we will look at the basic components of a greenhouse and the specific needs of three
different types of greenhouses: hobby, research, and commercial.

No matter what the use of a greenhouse the environment must be maintained for the health of the plant.
The components of that environment are: temperature, light, humidity and air movement.

Temperature is provided to the greenhouse by the energy of the sun's rays, or when that isn't sufficient,
by supplemental heat. Different plants need different temperature ranges. Most will do well in
temperatures from 50 to 70 degrees. Tropical plants need temperatures in the 70 to 80 degree range.
The heat in the greenhouse must be maintained at a more or less constant temperature during the day
with a 10 degree drop at night. There are four ways to maintain the temperature at the desired level:
prevent heat loss, store heat, add heat and vent out excess heat. We will discuss this in more detail later.

Light is measured in two areas, quality and quantity. Quality refers to the brightness of the light.
Quantity refers to duration. A plant needs a certain length of light. If quality is low a small amount can
be made up by adding quantity. In the greenhouse the glazing is the covering that lets the light in.
Examples of glazing are: glass, plastic, acrylic (Exolite) and fiberglass. Each has advantages and
disadvantages.

Glass lets 90% of the light through but it loses a lot of heat. Plastic, especially double inflated plastic,
is inexpensive and is used extensively in bedding plant production. Its major drawback is that it lasts
only 2-3 years before recovering is necessary. Exolite, polycarbonate rigid sheets, is being used widely.
It allows excellent light penetration, and it is also fuel efficient. Fiberglass is rarely used anymore,
because it is a fire hazard and has a great reduction in light penetration over time. The invention of heat
curtains and the ability to line glass with a thin sheet of plastic is making glass gain ground as the most
popular covering for large commercial greenhouses. This is because glass is still the best at letting in
light.

Humidity is the measure of the amount of water that is carried in the air at a given temperature. The
ideal humidity for the greenhouse is 50 - 60%. If the humidity is too high the environment will be just
right for diseases to attack the plants. If the humidity is too low the plants suffer from water stress.
You can control humidity by watering in the morning and venting out the moist air. Never water in the
evening.

Air movement is a necessity in a greenhouse. When a plant is outdoors the air is constantly moving
providing the plant with fresh air next to its leaves so is can replenish the oxygen and carbon dioxide it
uses. In the greenhouse air movement must be supplied through fans. Air movement also helps keep
relative humidity down and keep the temperature even throughout the greenhouse.

Hobby greenhouses have all the needs listed above, but they must be carried out in a small space. Heat
can be stored or released into the home to double its usefulness.

Commercial greenhouses also have the needs listed above and many more besides. The basic need is to
make a profit, to do this a commercial greenhouse must be efficient at providing environments to the
plants. The light and temperature needs must be very strictly controlled, computers are now being
widely used to provide these controls. Heat must not be wasted; new systems of curtains, which are
pulled out at night and rolled back in the morning, have reduced heat losses up to 50%. Movement of
plants is another area seeing great strides in efficiency. Benches that move to allow isles, or move from
head house to greenhouse and then out to be loaded onto a truck without human hands ever lifting the
plants, are now a reality.
How have all these inventions come to pass? One basic answer is research. The research greenhouse, like those here on campus, meets the basic four needs of light temperature, humidity control and air movement like the other greenhouses do. However they do so in small divided spaces. This is not efficient like the commercial greenhouses but it is efficient for research. Small areas can be kept rigidly controlled and separate from each other. Research is very important to all of us in horticulture.

**Soils Used in Plant Propagation and Greenhouse Production**

Soil Makeup: Solid - Sand, Clay, Humus, Silt  
Liquid - Water (Solution containing minerals)  
Gas - Air (Oxygen, Nitrogen, CO₂)

Soil Texture: Related to solid portion, i.e., sand, clay, organic materials

Most greenhouse soils are mixtures of two or more of the following:

- Field Soil - not used much
- Sand - washed quartz sand
- Peat - decomposed plant materials deposited in bags. Sphagnum peat usually used.
- Sphagnum Moss - dried and ground sphagnum moss
- Vermiculite - micaceous mineral that has been heated to 2000°F
- Perlite - Silica material of volcanic origin heated to 1400°F, very porous
- Compost - composted leaves or other organic materials - usually "well rotted"
- Shredded Bark & Sawdust - wood product wastes used in mixing soils. May or may not be composted, depending on tree species.
Environment and Growing Media

Light

Light is essential for photosynthesis. House plants are classified into 3 general light-requirement categories.


Medium Light: 200-500 foot-candles. Light from a north window, or indirect light from a south, east, or west window. Begonia, peperomia, African violet, piggyback plant.

Bright Light: 500-1000 foot-candles. Direct or filtered sunlight from an east, west, or south window. Cacti, dieffenbachia, sansevieria, geraniums and many others.

A foot-candle is the illumination of a surface one foot from the light of a standard candle. Light meters measure light intensity in foot-candles, luxes, or micro-Einsteins.

pH

The pH of a soil is a measure of its acidity or alkalinity. A pH of 7 is neutral, above 7 is alkaline (basic) and below 7 is acidic. Most House plants prefer slightly acid conditions (pH 6.5-7.0), especially orchids and African violets. A few do better in mildly alkaline soils, such as most succulents and geraniums. The following is a list of the pH of some common substances.

<table>
<thead>
<tr>
<th>Substance</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemon juice</td>
<td>2</td>
</tr>
<tr>
<td>Tomato juice</td>
<td>4.5</td>
</tr>
<tr>
<td>Blood</td>
<td>6.6</td>
</tr>
<tr>
<td>Soap</td>
<td>9</td>
</tr>
<tr>
<td>Household ammonia</td>
<td>12</td>
</tr>
</tbody>
</table>

Soluble Salts

Soluble salts are defined as the total of all dissoluble mineral residues in the soil. This includes sodium, magnesium, potassium and calcium. Monitoring soluble salts is important because if they are too low, it may indicate inadequate fertility. If they are too high, water passes out of the root system instead of into the plant, causing dehydration and starvation.
TROUBLE SYMPTOMS FOR FOLIAGE PLANTS AND POSSIBLE CAUSES

1. Lower leaves turn yellow and drop off easily.
   a. over-watering
   b. insufficient light

2. Burned margins or brown tips on leaves.
   a. accumulated salts in soil
   b. drought or low humidity

3. Pale leaf color, long internodes, loss of vigor, dropping lower leaves.
   a. lack of sufficient light

4. Growing tips chlorotic or growth slow.
   a. accumulated salts in soil
   b. too high a soil pH

5. Brown spots on leaves no pathogen present.
   a. excessive light
   b. water spotting

6. Interveinal chlorosis.
   a. iron (Fe) deficiency
   b. high pH

7. Poor flowering.
   a. insufficient light intensity
   b. vegetative growth encouraged (N fertilizers, too large pot, improper photoperiod)

8. Lower leaf drop, yellowing and/or dieback, roots brown and rotting (lower stems may be soft).
   a. excessive watering
   b. poor drainage
   c. accumulated salts (over fertilization)
   d. root rot caused by pathogens: *Pythium*, *Rhizoctonia*, *Phytophthora*
Lab 7 - Greenhouse Production Lab Exercises
Soil pH and Salinity

1. Measure pH and electrical conductivity (EC) of the following solutions using a portable pH meter and an EC meter. Estimate the concentration of total dissolved salts (TDS) for each solution.

<table>
<thead>
<tr>
<th>Water or soil sample</th>
<th>pH</th>
<th>Electrical conductivity</th>
<th>TDS (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. RO water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Bottled water (Aquafina)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Tap water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Fertilizer water (greenhouse)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. House plant soil extract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Sunshine mix extract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Peat extract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Pointsettia pot soil extract</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Why and how electrical conductivity (EC) is used to estimate salt concentrations in solutions?

3. Establish relationship between NaCl concentration and electrical conductivity.

<table>
<thead>
<tr>
<th>Solution no.</th>
<th>ppm NaCl</th>
<th>g L⁻¹</th>
<th>EC (µmho/cm)</th>
<th>EC (mmho/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2,000</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4,000</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6,000</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>8,000</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>10,000</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Using the data above, plot the EC readings NaCl concentration on a graph
   (x = ppm NaCl, y = mmho/cm).

b. Derive regression equations for estimating salinity using EC readings:

1) \( y = \frac{1}{x} \)  
2) \( x = \frac{y}{1} \), where \( y = \) electrical conductivity in mmho/cm
   \( x = \) parts per million (ppm) salt

3) 1 mmho/cm = \________________________ ppm NaCl
    1 µmho/cm = \________________________ ppm NaCl

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Lab 7 - Greenhouse Production Lab Exercises
Light Measurements

Name ___________________________________ Lab Section ___________________

1. Light Intensity Measurements

This exercise is designed to familiarize you with one method of determining light intensity. A knowledge of light intensities, which are commonly associated with the direction a window faces, can help you choose an appropriate plant, or place plants you already have in a better environment.

Light measurements will be taken at five different locations in the greenhouse.

North

1  2

3

4  5

<table>
<thead>
<tr>
<th>Location</th>
<th>Foot-candle</th>
<th>Lux</th>
<th>µmol m⁻² s⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
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<td></td>
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<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% reduction</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:
1. List five environmental factors that affect plant growth in the greenhouse and briefly explain how these factors can be regulated.

2. What kinds of plant problems can occur with following greenhouse conditions?
   a. Excessive heat
   b. Lack of ventilation
   c. High humidity
   d. Low water pH
   e. High water pH
   f. High soil salinity

3. Should you water the plants in a greenhouse just before you go home at night or wait until the next morning? Why?

4. What percentage of sunlight is transmitted into the greenhouse according to your measurements? Show calculations.

5. What is the optimum soil pH range for most greenhouse crops?

6. Why is high salinity of growing media detrimental to plant growth?
Lab Exercise 8
LANDSCAPE DESIGN

I. Benefits of a well planned landscape
   A. Personal benefits
   B. Conservation
   C. Economic
   D. Aesthetic

II. Landscape Design
   Profession, Art, Science, Process
   A. Profession
      1. Landscape Architect
      2. Landscape Designer
   B. An Art
      1. Principles of landscape design
         a. Unity
         b. Repetition
         c. Balance
         d. Dominance
         e. Scale
      2. Elements of Landscape Design
         a. Form
         b. Line
         c. Texture
         d. Color
C. A Science

1. Know plants
2. Construction
3. Soils
4. Irrigation systems
5. Drafting and graphic presentation technique

D. A Process

1. Site Analysis
   a.
   b.
   c.
   d.
   e.
   f.

2. Design Program
   a.
   b.
   c.
3. Schematic Diagram or Bubble Diagram
   a. 
   b. 
   c. 

4. Plan Development
   a. Preliminary Plan
   b. Final Plan

5. Project Installation
   a. 
   b. 
   c. 
Lab Exercise 9
PRUNING AND TRAINING

General Recommendation

1. Remove all limbs and branches that obstruct walks and drives.
2. Prune back to clear all doors and windows.
3. Remove all broken, diseased, or dead branches from all trees and shrubs.
4. Go back to prune your plants for form, shape, vigor, and beauty!
5. It is usually best to prune deciduous trees and shrubs during early spring before full leaf.
6. Evergreens, especially shrubs, should where practical, be encouraged to grow and branch to the ground. This not only gives a more healthy plant, but in most cases a much better looking plant.

Purposes of Pruning

1. To control habit of growth.
2. To remove all dead, broken, or diseased plant parts.
3. To produce desired shape and form.
4. To improve flowering and fruiting.
5. To improve chances of survival (usually at transplanting).

Some Pruning Tools

1. Hand Shears (7-1/2 inches long)
2. Pruning Loppers (26 inches long)
3. Pruning Saw (folding)
4. Pole Tree Saw (10 foot handle)

Botany of Pruning

Trees grow, above the ground, primarily from two areas:
1. Branches elongate from buds.
2. Branches increase in diameter from the cambium.

Water and mineral nutrients travel up from the roots through the wood or xylem into the leaves. Here, in the leaves, food is manufactured and sent back through the phloem out to feed all parts of the plant, twigs, buds, flowers, roots, etc.

If the terminal buds are removed, or twig end cut off side branching is induced, and a more compact habit of growth is obtained. If side branches or laterals are removed, a more upright form results.
Where to Cut

**IN RELATION TO BUDS.**
- Good
- Too much
- Stub
- Too Close
- Surface
- Too Long To Bud

**IN RELATION TO TWIGS.**
- Right
- Wrong

**BUILD YOUR TREE!**
- Cut to outside buds
  - For spreading growth.
- Save inside buds
  - For erect growth.

Grow your plants by choice, not by chance.
General Pruning

On all “heavy cuts,” make removal in three steps:

1. Under Cut
2. Over-cut off
3. Stub removal at shoulder ring

Keep all diseased, dead, and broken branches pruned out of your trees at all times.

Avoid weak crotch branching and remove “cross over” or “interfering” branches.

Prune to side branches, laterals, or main trunks. Never leave stubs, snags, or ragged cuts.

Big Cuts

Tight-weak crotch

Proper cut line. Cut at “shoulder ring,” area of rapid growth and heal over.
Directional Pruning (Trees)

All cuts to side branches
All cuts to clean
Stay as near as possible to natural form

Top work to reduce size, clear lines, etc.

Good

Stub pruning causes “bird nesting”

Prune to Side Branches

Shouler Ring
Cut to leave small surface area

Excessive flush cut
Too much surface
Slow heel over

Prune Limbs to Shoulder Rings
Deciduous Shrubs
Prune for Form

NOTE: When shrubs get old and leggy - one of three things may be done.

1. Consider rejuvenation. Remove at least half of the existing old canes at ground level. Dormant pruning is best for this. Next year remove remaining canes. As new growth comes up - keep terminal growth pinched back to induce side branching and compact growth.
2. In a few cases you may wish to cut all growth back. Thus allowing all growth to come up new.
3. Complete removal and replanting may be the most practical and economical solution.
Prune with a purpose on Junipers

**Discipline:** “Training which corrects, molds, strengthens, or perfects” (Webster)

Start when plants are young, if possible! Strive for a disciplined form. Avoid neglect and abuse.

<table>
<thead>
<tr>
<th>Prune “deep” enough to hide all cuts</th>
<th>The form to achieve on uprights is with a single-center trunk, and a “controlled” natural look.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut “Back In” to a top growing twig!</td>
<td>Neglect (left), disciplined (center), abuse (right)</td>
</tr>
</tbody>
</table>
| Be careful not to leave unsightly “Holes” | In maintaining spreading junipers, strive for the “disciplined” look. Avoid “butch” cut and “scalp jobs”.

**Avoid Sheared and Ugly Ends!**

<table>
<thead>
<tr>
<th>Make a cut deep enough to avoid the look of truncation. Remove a stem at the branching point.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neglect (left), disciplined (center), abuse (right)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Much of your pruning can be done by pinching back the new, young shoot growth as it develops each season! This stops terminal growth and avoids stringy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neglect (left), disciplined (center), abuse (right)</td>
</tr>
</tbody>
</table>
Building a Hedge

Prune when planted and each year after

Stakes and tight guide wires or ropes insure a more even surface. Make sure wire is tight and not misplaced by twig.

Overhanging top edges shade sides, which soon lose their leaves and become leggy.

SOME GOOD HEDGE PLANTS

<table>
<thead>
<tr>
<th>Low hedge (2 to 4 feet)</th>
<th>Large hedge (over 6 feet, continued.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pygmy Peashrub</td>
<td>Medora Juniper</td>
</tr>
<tr>
<td>Alpine Current</td>
<td>Chinese Lilac</td>
</tr>
<tr>
<td>Fritsch Spirea</td>
<td>Fragrant Sumac</td>
</tr>
<tr>
<td>Dakota Sunset Potentilla</td>
<td>Siberian Arborvitae</td>
</tr>
<tr>
<td>Little Giant Arborvitae</td>
<td>Bergeson Compact Dogwood</td>
</tr>
<tr>
<td>Hetz Midget Arborvitae</td>
<td>Wayfaring Tree Viburnum</td>
</tr>
<tr>
<td>Emerald Carousel Barberry</td>
<td></td>
</tr>
<tr>
<td>Dwarf Gooseberry</td>
<td></td>
</tr>
<tr>
<td><strong>Medium hedge (4 to 6 feet)</strong></td>
<td><strong>Screening (over 10 ft tall)</strong></td>
</tr>
<tr>
<td>Globe peashrub</td>
<td>Eastern Red Cedar</td>
</tr>
<tr>
<td>Threelobe Spirea</td>
<td>Medora Juniper</td>
</tr>
<tr>
<td>Triumph Potentilla</td>
<td>Grizzly Bear Juniper</td>
</tr>
<tr>
<td>Globe Arborvitae</td>
<td>Miss Canada Late Lilac</td>
</tr>
<tr>
<td>Miniglobe Honeysuckle</td>
<td>Embers (or Redwing) Amur Maple</td>
</tr>
<tr>
<td>Palibin Dwarf Lilac</td>
<td>Siberian Peashrub (Caragana)</td>
</tr>
<tr>
<td><strong>Large hedge (over 6 feet)</strong></td>
<td>Black Hills Spruce</td>
</tr>
<tr>
<td>Miss Kim Lilac</td>
<td>Colorado Spruce</td>
</tr>
<tr>
<td>Minuet Lilac</td>
<td>Pyramidal Arborvitae</td>
</tr>
<tr>
<td></td>
<td>Bailey Compact Amur Maple</td>
</tr>
<tr>
<td></td>
<td>Techny Arborvitae</td>
</tr>
</tbody>
</table>
LAB 9 - PRUNING AND TRAINING
Lab Report

1. Diagram the procedure for removing a large limb from a tree. Explain why large limbs are removed in this way.

2. Why are narrow crotches undesirable in a tree? What are two ways to deal with them?

3. List three ways to deal with overgrown shrubs. What would be the result of each treatment?

4. If you have an old apple tree in the yard of the house you just bought, how are you going to decide which branches to prune?
1. **Lawn Grass**

   By definition, a lawn is “a plot of closely mown grasses.” Actually, a lawn is composed of thousands of individual plants crowded and forced into a very unnatural growth habit. To achieve the desired results for an attractive turf, we should know a few of other facts:

   a. Lawns must have irrigation water.
   b. Lawns must have fertilizer.
   c. Lawns must have light.
   d. Lawns must have desirable soil conditions.
   e. Lawns must be mowed regularly.
   f. Lawns must have adequate top growth.

   ![Diagram of Naturally grown grass](image1)

   ![Diagram of Grasses in the lawn](image2)

   Naturally grown grass

   Grasses in the lawn

   Not just the lawn collectively, but each plant in this actual “forest” needs to be supplied with all of these in proper amounts, and at all times to some degree. Many factors tend to restrict or prevent full use of these things, even when they are available.

   Lawns need fertilizers to grow properly. Fertilizers are not “food” but raw materials used in the manufacturing of foods by the plants. Sugars, starches, proteins, etc. are the real foods. Both made and used by the plant for growth and production.

2. **The Turfgrasses**

   a. Growth characteristics

      Bunch-type,
      Rhizome-forming
      Stolon-forming
b. Temperature requirement

Cool-season grasses

Transitional zone grasses

Warm-season grasses
3. **General Lawn Care**

1. Mow often enough that you never remove more than one-third of the total height at any one cutting.

2. If and when irrigation is needed - water deep. Roots cannot get water or nutrients out of dry soil. In areas where tree and shrub roots compete with the lawn, extra deep irrigation can be of great worth.

3. Do not starve your lawn. But do not overfeed either. A good lawn is judged by its color and density, not by how often it has to be mowed. The even cut tops, not the closeness of cut, gives a lawn a more tailored look.

4. Soil compaction should be avoided where practical. Healthy grass can do much to avoid problems and resist compaction. Dry soils compact less than wet soils. If heavy use is expected for a special occasion try to have the lawn on the “dry side”, even if it requires an extra irrigation in your schedule. Avoid the use of lawn rollers, in most cases rollers do more damage then good. Lawns should be left to grow a little long before times of heavy use. Extra top growth gives extra padding and encourages better root condition.

5. Leave the clippings on your lawn if they are short enough to sift into the grass. However, any clippings that remain on the top after an hour or so should be removed.

6. Rake all leaves and debris from the lawn to avoid “burned” and “smothered” spots.

7. Compaction problems can be relieved by aeration and soil conditioning.

8. Aeration can be done with one of many tools. For general use, the tool found easiest and most practical is the common garden digging fork.

   a. Water the area.

   b. Insert fork into the soil six to eight inches holding the fork in a near vertical position (figure 1).

   b. Pull handle back twelve to eighteen inches (figure 2). If condition is not too bad remove fork. Repeat every eight to twelve inches over the compacted area.

   c. If compaction is severe or soil is very heavy, push handle forward and fill with a mixture of 50% peat moss and 50% sand. Remove fork.

   Note: This process breaks plant roots and may necessitate supplemental irrigation.
I. EVALUATING
   Problems
   1.
   2.
   3.

   Tests to evaluate lawn:
   1. Visual
   2. Thatch
   3. Conditions beneath soil
   4. Compaction
   5. Earthworms
   6. Soil test

II. SEED

   Two questions to ask before deciding on type of seed:
   1. Which grasses work for your area of the country?
   2. How old is existing lawn?

   Other factors in determining type of grass seed:
   1. Three growing areas:

      a. cool season:
         Bluegrass-Kentucky bluegrass
         Perennial rye
         Fescue-fine fescue

      b. warm season:
         Bermudagrass
         Zoysiagrass
         Buffalo grass
         St. Augustine grass

      c. transitional:

   2. Shade vs. sun
   3. Time
   4. Decoration or recreation
III. PREPARING LAWN

Renovate or Redo?
Renovation best done in early spring or early fall
1. scalp
2. remove thatch
3. aerate soil-1/4"deep
4. fertilize and lime if needed

Special steps for bare spots:
1. remove debris and rocks
2. add organic matter to depth of 6-8"
3. rake smooth

IV. SEEDING

Best done in early spring or early fall
If overseeding use half recommended rate
Water in thoroughly
Roll it
flattens
increases contact between seed and soil

Bare spot/brand new lawn:
1.
2.
3.
4.
5.

V. SODDING

VI. MOWING
Frequency:
Height:
Taller grass:
1.
2.
3.
Seasonal Mowing:
Summer:
Fall:
Final mowing:
Shady areas:

Proper Maintenance:
VII. WATERING

Best Way:
Best Time:

VIII. FEEDING

Only need to fertilize once or twice a season
Timing:
  Warm season:
  Cool season:
Results:
  Fall fertilizing:
  Spring fertilizing:
North area:
NOTE: Clippings return 50% of N back into soil.
Types of nutrition:

IX. PEST/DISEASE CONTROL

Backyard Pest Management
  1.
  2.
Insects:
  1. Above soil:
     Cinchbugs, armyworm, sod webworm
  2. Below Soil:
     Billbug grub, white grub
Method to check for bugs:
Contact Insecticides include Safer's Insecticidal Soap and Pyrethrums
Weeds:
  Compacted Soil
  Improper watering or fertilizing
  1. Annual Weeds:
     Crabgrass, chickweed, knotweed
  2. Perennial Weeds:
     Dandelions, thistle, plantain, buckhorn
# Lab Exercise 10
## PLANTS FOR INTERIORS

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Family</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beloperone guttata</td>
<td>Acanthaceae</td>
<td>Shrimp Plant</td>
</tr>
<tr>
<td>Dracaena marginata</td>
<td>Agavaceae</td>
<td>Dragon Tree of Madagascar</td>
</tr>
<tr>
<td>Sansevieria trifasciata</td>
<td>Agavaceae</td>
<td>Snake Plant</td>
</tr>
<tr>
<td>Dieffenbachia amoena</td>
<td>Araceae</td>
<td>Giant Dumbcane</td>
</tr>
<tr>
<td>Philodendron scandens oxycardium</td>
<td>Araceae</td>
<td>Heart-leaf Philodendron</td>
</tr>
<tr>
<td>Epipremnum aureum</td>
<td>Araceae</td>
<td>Golden Pothos</td>
</tr>
<tr>
<td>Spathyphyllum clevelandii</td>
<td>Araceae</td>
<td>Peace Lily or White Flag</td>
</tr>
<tr>
<td>Brassia arboricola</td>
<td>Araliaceae</td>
<td>Hawaiian Schefflera</td>
</tr>
<tr>
<td>Hedera helix</td>
<td>Araliaceae</td>
<td>English Ivy</td>
</tr>
<tr>
<td>Araucaria heterophylla</td>
<td>Araucariaceae</td>
<td>Norfolk Island Pine</td>
</tr>
<tr>
<td>Begonia masoniana</td>
<td>Begoniaceae</td>
<td>Iron Cross Begonia</td>
</tr>
<tr>
<td>Aechmea fasciata</td>
<td>Bromeliaceae</td>
<td>Silver Vase</td>
</tr>
<tr>
<td>Mammillaria albilanata</td>
<td>Cactaceae</td>
<td>Mammillaria Cactus</td>
</tr>
<tr>
<td>Crassula argentea</td>
<td>Crassulaceae</td>
<td>Jade Plant</td>
</tr>
<tr>
<td>Euphorbia splendens</td>
<td>Euphorbiaceae</td>
<td>Crown-of-Thorns</td>
</tr>
<tr>
<td>Euphorbia trigona</td>
<td>Euphorbiaceae</td>
<td>African Milktree</td>
</tr>
<tr>
<td>Saintpaulia ionantha</td>
<td>Gesneriaceae</td>
<td>African Violet</td>
</tr>
<tr>
<td>Plectranthus australis</td>
<td>Lamiaceae</td>
<td>Swedish Ivy</td>
</tr>
<tr>
<td>Chlorophytum comosum 'Vittatum'</td>
<td>Liliaceae</td>
<td>Variegated Spider Plant</td>
</tr>
<tr>
<td>Asparagus densifloris ‘Sprengeri’</td>
<td>Liliaceae</td>
<td>Sprenger Asparagus</td>
</tr>
<tr>
<td>Ficus benjamina</td>
<td>Moraceae</td>
<td>Weeping Fig</td>
</tr>
<tr>
<td>Ficus elastica</td>
<td>Moraceae</td>
<td>Rubber Plant</td>
</tr>
<tr>
<td>Cattleya spp.</td>
<td>Orchidaceae</td>
<td>Cattleya Orchid</td>
</tr>
<tr>
<td>Peperomia obtusifolia variegata</td>
<td>Piperaceae</td>
<td>Variegated Peperomia</td>
</tr>
<tr>
<td>Nephrolepis exaltata 'Dallas'</td>
<td>Polypodiaceae</td>
<td>Dallas Fern</td>
</tr>
<tr>
<td>Platycerium bifurcatum</td>
<td>Polypodiaceae</td>
<td>Staghorn Fern</td>
</tr>
</tbody>
</table>
Lab 10: Guidelines for Completing Plant ID Sheets

Names:
Family Name:  
Origin:  
Scientific Name:  
Common Name:  
Cultivar:  

Environmental Requirements:
1. Temperature:  
   Cool (C) ................. 50-60 F  
   Medium (M) .............. 60-70 F  
   High (H) ................ 70-80 F  

2. Light:  
   Low (L) ................. Minimum 50 fc (recommended 70-150 fc)  
   Medium (M) ............. Minimum 100 fc (recommended 200 fc)  
   High (H) ................. Minimum 200 fc (recommended 500 fc)  
   Very High (VH) ........ Minimum 500 fc (recommended 1000+ fc)  

3. Moisture:  
   Dry (D) .................. Let dry completely between watering  
   Moist (M) ............... Keep uniformly moist but not wet  
   Wet (W) .................. Never let soil dry out  

4. Humidity:  
   Low (L) .................. Up to 40% RH  
   Medium (M) ............. 60-70% RH  
   High (H) .................. 70-80% RH  

5. Medium:  
   Heavy (H) ............... High in soil for wet conditions  
   Medium (M) ............. Well drained, moist conditions  
   Light (L) ............... Dry, sandy conditions  

Plant Characteristics:
1. Plant Type:  
   Tree (Single-stem, Multi-stem) (Tr)  
   Shrub (Shr)  
   Ground Cover (GC)  
   Vine (V)  

2. Shape/Form:  
   Upright (Up) ............. Oval (Ov)  
   Spreading (Spr) ........... Round (R)  
   Cascading or Weeping (Cas) Irregular (Ir)  
   Climbing (Cl) ............. Pyramidal (Py)  

3. Plant Size:  
   Very Tall (VT) .......... Greater than 6 feet  
   Tall (T) ................. 4-6 feet  
   Medium (M) ............. 2-4 feet  
   Short (S) ................. 1-2 feet  
   Creeping (C) ............. Shorter than 1 foot  

4. Growth Rate:  
   Slow (S)  
   Medium (M)  
   Fast (F)  

5. Leaf Texture:  
   Pubescent (P), Waxy (W), Dull (D), Thick (T)  

6. Plant Texture:  
   Fine (F), Medium (M), Coarse (C)
1. **Shrimp Plant** *Beloperone guttata* (also *Justicia brandegeana*)  
   Family - Acanthaceae  
   250 Genera of dicots-herbs or shrubs-perfect flowers  
   Temp. Medium  
   Light High  
   Moist. Dry  
   Pests-Dis  
   Prop. Cutting  
   Notes Keep plants on dry side. Cut back 1/3 of plants in the spring.

2. **Dragon Tree of Madagascar** *Dracaena marginata*  
   Family - Agavaceae  
   20 Genera of monocots - leaves mostly narrow  
   Temp. Med  
   Light Medium  
   Moist Moist  
   Pests-Dis  
   Prop. Tip cutting  
   Notes Pointed leaves, sensitive to fluoride

3. **Snake Plant** *Sansevieria trifasciata*  
   Family - Agavaceae (also found it listed in Liliaceae family in two references)  
   Temp. Cool to high  
   Light low to high  
   Moist. Dry to medium dry  
   Pests-Dis. Mealybug, root rot if too wet  
   Prop. Division, leaf cutting  
   Notes Excellent low light plant; used for terrarium, dish garden, atrium; slow-growing; durable; does best in peat containing soil.

4. **Giant Dumbcane** *Dieffenbachia amoena*  
   Family - Araceae - Arum or Philodendron family  
   13 genera of monocots - herbs -stemless or erect and climbing stems; inflorescence spadix usually subtended by a spathe; genera include *Anthurium* plus others listed.  
   Temp. Medium to high  
   Light Medium  
   Moist. Moist  
   Pests-Dis. Mealybug, root rot and stem rot  
   Prop. Tip cutting, stem cutting  
   Notes Can be tall (15 ft); susceptible to cold (at 55 °F); produces oxalic acid crystals that are toxic to skin (causes inflammation).

5. **Heart-leaf Philodendron** *Philodendron scandens oxycardium*  
   Family - Araceae  
   Temp. Medium to high  
   Light Low to medium  
   Moist. Medium  
   Pests-Dis. Mealybug, root rots  
   Prop. Tip or nodal cuttings  
   Notes Very tolerant to all indoor conditions including low light; most comon of all philodendrons.

6. **Golden Pothos** *Epipremnum aureum*
7. **Peace Lily or White Flag** *Spathiphyllum clevelandii*
   - Family: Araceae
   - Temp.: Medium to high
   - Light: Low to medium
   - Moist.: Moist
   - Pests-Dis.: Mealybug, root rot
   - Prop.: Tissue culture, division
   - Notes: Very tolerant to low light conditions; use well-drained medium.

8. **Hawaiian Schefflera** *Brassaia arboricola*  
   (also *B. actinophylla, Schefflera arboricola* )
   - Family: Araliaceae
   - Temp.: Cool to medium
   - Light: Medium to high
   - Moist.: Medium
   - Pests-Dis.: Spider mite, scale, root rot
   - Prop.: Seed, cutting
   - Notes: More bushy and compact than *B. actinophylla*; attractive shrub.

9. **English Ivy** *Hedera helix*
   - Family: Araliaceae
   - Temp.: Cool to medium
   - Light: Medium to very high
   - Moist.: Medium
   - Pests-Dis.: Spider mite, scale
   - Prop.: Tip cutting, nodal cuttings
   - Notes: Used as for hanging basket, dish gardens; terrariums; does poorly in low light

10. **Norfolk Island Pine** *Araucaria heterophylla*
    - Family: Araucariaceae
    - Temp.: Medium
    - Light: High
    - Moist.: Moist
    - Pests-Dis.: Spider mite
    - Prop.: Tip cuttings, seed
    - Notes: Used for specimen, atrium, terrarium; seasonal use as Christmas tree

11. **Iron Cross Begonia** *Begonia masoniana*
    - Family: Begoniaceae
    - Temp.: High
    - Light: Medium to high
    - Moist.: Moist
12. **Silver Vase** *Aechmea fasciata*

*Family - Bromeliaceae - Pineapple Family*

- 44 genera of monocots; mostly epiphytic; stiff leaves which are colored toward base; leaves basal or rosette forming to hold water
- **Temp.** Cool to medium
- **Light** Medium to high
- **Moist.** Dry
- **Pests-Dis.** No insect problem, root rot
- **Prop.** Tissue culture, division
- **Notes** Floral accent, pot plant; flowers last 4 -6 months, easy to grow

13. **Mammillaria Cactus** *Mammillaria albilanata*

*Family - Cactaceae - Cactus Family*

- 50 to 150 genera of dicots; succulents found in drier regions of tropical areas; leaves reduced to spines; flowers showy and solitary
- **Temp.** High
- **Light** Very high
- **Moist.** Dry
- **Pests-Dis.** Mealybug, root rot
- **Prop.** Seed, division
- **Notes** Very attractive; used for dish garden and as a pot plant; keep dry during winter months.

14. **Jade Plant** *Crassula argentea*

*Family - Crassulaceae - Orpine Family*

- 35 genera of succulent herbs or undershrubs; annuals or perennials; includes *Sedum*, *Sempervivum*, *Kalanchoe*
- **Temp.** Cool, medium, high
- **Light** Medium to very high
- **Moist.** Dry
- **Pests-Dis.** Mealybug, scale aphid, spider mite; root and stem rot
- **Prop.** Stem cuttings
- **Notes** Very tolerant of all conditions; prefers high light; sensitive to salty soil; used for bonsai, specimen.

15. **Crown of Thorns** *Euphorbia splendens (E. mili splendens)*

*Family - Euphorbiaceae - Spurge Family*

- 290 genera of dicots with often milky sap; herbs, shrubs and trees; frequently cactus-like
- **Temp.** Medium to high
- **Light** High to very high
- **Moist.** Medium
- **Pests-Dis.** Mealybug, root rot
- **Prop.** Stem cuttings
- **Notes** Thorny; very good indoor plant for warm sunny areas

16. **African Milk Tree** *Euphorbia trigona*

*Family - Euphorbiaceae*

- **Temp.** Medium to high
17. **African Violet** *Saintpaulia ionantha*
   
   **Family** - Gesneriaceae
   
   moist tropical herbs and creepers; leaves frequently colored above or below and hairy
   
   **Temp.** Medium to high
   
   **Light** Very high
   
   **Moist.** Medium
   
   **Pests-Dis.** Spider mite, cyclamen mite, root and stem rot
   
   **Prop.** Tissue culture, seed, leaf cuttings
   
   **Notes** Most popular flowering house plant; avoid chilling.

18. **Swedish Ivy** *Plectranthus australis*
   
   **Family** - Lamiaceae - Mint Family
   
   180 genera of dicots with square stems; aromatic
   
   **Temp.** Medium to high
   
   **Light** Low to high
   
   **Moist.** Moist
   
   **Pests-Dis.** Mealybug, spider mite, root rot
   
   **Prop.** Tip cutting; nodal cutting
   
   **Notes** Very easy to grow, does not like chilling; sap stains skin and clothing orange.

19. **Variegated Spider Plant** *Chlorophytum comosum 'Vittatum'*
   
   **Family** - Liliaceae - Lily Family
   
   335 genera of monocots; herbaceous perennials; flowers often showy; grow from rhizomes, corms or bulbs; includes lily, daylily, tulip, onion, daffodil, hyacinth
   
   **Temp.** Cool to high
   
   **Light** Medium to high
   
   **Moist.** Medium
   
   **Pests-Dis.** Scale, mealybug, spider mite
   
   **Prop.** Division, stolons; tissue culture
   
   **Notes** Good for hanging basket; sensitive to fluoride damage.
20. **Sprenger Asparagus** *Asparagus densiflorus 'Sprengeri'*
   - Family: Liliaceae
   - Temp.: Cool to high
   - Light: High to very high
   - Moist.: Dry
   - Pests-Dis.: Spider mite
   - Prop.: Seed
   - Notes: Used for hanging baskets and cut foliage; very durable; easy to grow; does best under high light conditions.

21. **Weeping Fig** *Ficus benjamina*
   - Family: Moraceae - Mulberry Family
     - 53 genera of dicots; trees and shrubs - rarely herbs; milky sap
   - Temp.: Cool to high
   - Light: Medium to very high
   - Moist.: Medium
   - Pests-Dis.: Spider mite, mealybug, scale
   - Prop.: Tip cutting, air layering
   - Notes: Most common indoor tree; used as specimen, bonsai, pot plant; avoid drying, drafts, low lights; requires acclimatization; grow up to 70 feet.

22. **Rubber Plant** *Ficus elastica*
   - Family: Moraceae
   - Temp.: Cool to high
   - Light: Medium to very high
   - Moist.: Moist
   - Pests-Dis.: Scale, mealybug
   - Prop.: Air-layering, tip cuttings; tissue culture
   - Notes: Many different cultivars; used as specimen, pot plant; can be used for exterior.

23. **Cattleya Orchid** *Cattleya sp.*
   - Family: Orchidaceae - Orchid Family
     - 735 genera of monocots; herbaceous perennials; epiphytic, saprophytic, or terrestrial; stem often with pseudobulbs and aerial roots; one of the largest families of flowering plants
   - Temp.: High
   - Light: Very high
   - Moist.: Medium
   - Pests-Dis.: Scale, spider mite, mealybug
   - Prop.: Division, protocorm culture; seed
   - Notes: Flower initiation takes place at 2000-3500 fc; a large number of hybrids exists; used for flowering pot or corsages; slow growing.

24. **Variegated Peperomia** *Peperomia obtusifolia 'Variegata'*
   - Family: Piperaceae
     - Tropical herbs and vines; small flowers without petals or sepals
   - Temp.: Medium to high
   - Light: High to very high
   - Moist.: Medium to dry
   - Pests-Dis.: Mealybug, spider mite, root and stem rot
   - Prop.: Tip cuttings, leaf cuttings
   - Notes: Used for terrarium, dish gardens.
25. **Dallas Fern** *Neptholepis exaltata* 'Dallas'
   Family - *Polypodiaceae* - Ferns (Pteridophytes)-Common Fern Family
   most common ferns; no distinct trunk; nonflowering plants reproducing from spores
   Temp. Medium to high
   Light High to very high
   Moist. Medium
   Pests-Dis. Spider mite, mealybug, scale, whitefly, root rot
   Prop. Division, tissue culture
   Notes Used for hanging basket, pot plant; burns in direct sun; more compact than the Boston fern.

26. **Staghorn Fern** *Platycerium bifurcatum*
   Family - *Polypodiaceae*
   Temp. Medium to high
   Light Medium to very high
   Moist. Medium
   Pests-Dis. Spider mite, scale, root rot
   Prop. Spore, division
   Notes Used for hanging basket or slab; epiphytic; attractive fronds.
# PLANTS FOR INTERIORS

## LISTING BY PLANT FAMILIES

### ACANTHACEAE
- **Aphelandra squarrosa** (Zebra Plant)
- **Beloperone guttata** (Shrimp Plant)
- **Crossandra infundibuliformis** (Crossandra)
- **Fittonia minima** (Miniature Silver Nerve Fittonia)
- **Fittonia verschaffeltii 'Pearlei'** (White Nerve Fittonia)
- **Fittonia verschaffeltii 'Argyoneura'** (Pink Nerve Fittonia)
- **Graptophyllum pictum** (Caricature Plant)
- **Hemigraphis 'Exotica'** (Purple Waffle Plant)
- **Hypoestes sanguinolenta** (Polka Dot Plant or Freckle Face)
- **Pachystachys lutea** (Lollipop Plant)
- **Jacobinia carnea** (Pink Lollipop Plant)
- **Pseuderanthemum atrropurpureum tricolor** (Tiger Plant)

### AGAVACEAE
- **Agave americana** (Century Plant)
- **Agave angustifolia marginata** (Variegated Caribbean Agave)
- **Agave attenuata** (Dragon Tree Agave)
- **Beaucarnea recurvata** (Ponytail or Elephant-Foot Tree)
- **Cordyline terminalis** (Baby Doll Dracaena)
- **Cordyline stricta** (Cordyline)
- **Dracaena craigii 'Compacta'** (Compact Dracaena)
- **Dracaena deremensis 'Bausei'** (Striped Dracaena)
- **Dracaena deremensis 'Janet Craig'** (Janet Craig Dracaena)
- **Dracaena deremensis 'Warneckii'** (Warneckii Dracaena)
- **Dracaena fragrans 'Massangeana'** (Corn Plant)
- **Dracaena godseffiana 'Florida Beauty'** (Gold Dust Dracaena)
- **Dracaena marginata** (Dragon Tree of Madagascar)
- **Dracaena marginata 'Tricolor'** (Tricolor Dragon Tree)
- **Dracaena sanderiana** (Ribon Plant)
- **Dracaena thalioides** (Lance Dracaena)
- **Pleomele reflexa** (Pleomele)
- **Pleomele reflexa 'Variegata'** (Song of India Pleomele)
- **Sansevieria intermedia** (Pygmy Bowstring)
- **Sansevieria trifasciata** (Snake Plant)
- **Sansevieria trifasciata 'Golden Hahnii'** (Golden Birdnest Sansevieria)
- **Sansevieria trifasciata laurentii** (Variegated Snake Plant or Birdnest Sansevieria)
- **Yucca elephantipes** (False Agave)

### AIZOACEAE
- **Lithops lesii** (Living Stones)

### AMARANTHACEAE
- **Alternanthera versicolor** (Joseph's Coat)
- **Iresine herbstii 'Aurco-reticulata'** (Clown Plant)
- **Iresine lindenii** (Bloodleaf or Achyranthus)
- **Iresine lindenii formosa** (Bloodleaf or Achyranthus)

### AMARYLLIDACEAE
- **Clivia miniata** (Kaffir Lily)
- **Eucharis grandiflora** (Eucharis Lily)
- **Hippeastrum spp.** (Amaryllis)
- **Nerine bowdenii** (Naked Lady Lily)
APOCYNACEAE
Mandevilla splendens
Mandevilla sanderi 'Rosea'
Nerium oleander

ARACEAE
Aglaonema commutatum maculatum
Aglaonema commutatum 'Pseudo bracteum'
Aglaonema commutatum 'Treubii'
Aglaonema crispum
Aglaonema modestum
Anthurium scherzerianum
Caladium spp.
Diffenbachia amoena
Dieffenbachia 'Exotica'
Dieffenbachia oerstedii 'Variegata'
Dieffenbachia maculata
Dieffenbachia maculata 'Rudolph Roehrs'
Epipremnum aureum
Epipremnum aureum 'Marble Queen'
Monstera deliciosa 'Variegata'
Monstera deliciosa
Monstera guttifera
Monstera friedrichshalii
Philodendron bipennifolium
Philodendron x 'Burgundy'
Philodendron camifolium
Philodendron hastatum
Philodendron scandens oxycardium
Philodendron micans
Philodendron mortianum
Philodendron panduriforme
Philodendron selloum
Philodendron squamiferum
Scindapsus pictus 'Argyraeus'
Spathiphyllum clevelandii
Syngonium auritum
Syngonium podophyllum
Syngonium podophyllum 'White Butterfly'
Zamioculcas zamiifolia

ARALIACEAE
Brassaia actinophylla
Brassaia arboricola
Dizygotheca elegantissima
Fatsia japonica
Fatshedera x lizei
Hedera canariensis
Hedera canariensis variegata
Hedera helix
Hedera helix 'Glacier'
Hedera helix 'Golddust'
Hedera helix 'Needlepoint'
Hedera helix 'Scutfolia'
Polyscias balfouriana
Polyscias balfouriana marginata
Polyscias fruticosa
Polyscias guilfoylei 'Victoriae'
Tupidanthus calyptatus

ARUCARIACEAE
Araucaria bidwillii
Araucaria heterophylla

APOCYNACEAE
Alice DuPont Mandevilla
Rose Dipladenia
Oleander

ARACEAE
Silver Chinese Evergreen
Golden Chinese Evergreen
Variegated Chinese Evergreen
Painted Droptongue
Chinese Evergreen
Flamingo Flower
Caladium
Giant Dumbcane
Dumbcane
Velvet Dumbcane
Spotted Dumbcane
Gold Dieffenbachia
Golden Pothos
Marble Queen Pothos
Variegated Split-Leaved Philodendron
Split-Leaved Philodendron
Angel Winged Philodendron
Windowleaf Philodendron
Horsehead Philodendron
Purple Prince Philodendron
Flask Philodendron
Spade-Leaf Philodendron
Heart-Leaf Philodendron
Velvet-Leaf Philodendron
Giant Philodendron
Fiddle-Leaf Philodendron
Tree Philodendron
Red Brizly Philodendron
Satin Pathos
Peace Lily or White Flag
Five Fingers Syngonium
Arrowhead or Nephthytis
White Butterfly Nephthytis
ZZ Plant

ARALIACEAE
Schefflera or Umbrella Tree
Hawaiian Schefflera
False Aralia
Japanese Aralia
Tree Ivy, Botanical Wonder
Algerian Ivy
Variegated Algerian Ivy
English Ivy
Glacier Ivy
Golddust Ivy
Needlepoint Ivy
Sweetheart Ivy
Balfour Aralia
Variegated Balfour Aralia
Ming Aralia
Lace Aralia
Tupidanthus

ARUCARIACEAE
Monkey Puzzle, Bunya Bunya Tree
Norfolk Island Pine
**ARECACEAE**
- Caryota mitis
- Caryota obtusa
- Chamaedorea elegans 'bella'
- Chamaedorea seifrizii
- Chamaerops humilis
- Chrysalidocarpus lutescens
- Howea forsteriana
- Phoenix roebelenii
- Rhapis excelsa

Cluster Fishtail Palm
Fishtail Palm
Neanthe Bella Palm
Bamboo Palm
European Fan Palm
Areca Palm, Butterfly Palm
Kentia Palm
Pigmy Date Palm, Dwarf Date Palm
Lady Palm

**ASCLEPIADACEAE**
- Ceropegia ampliata
- Ceropegia woodii
- Hoya bella
- Hoya carnosa
- Hoya carnosa rubra
- Hoya carnosa 'Tricolor'
- Hoya carnosa 'Variegata'
- Hoya compacta
- Hoya compacta 'Variegata'
- Hoya keyssii
- Hoya 'Silver Pink'
- Stapelia gigantea
- Stephanotis floribunda

Lantern Flower
String of Hearts
Miniature Wax Plant
Wax Plant
Tricolor Wax Plant
Variegated Wax Plant
Hindu Rope
Variegated Wax Plant
Queensland Wax Plant
Silver Pink Hoya
Giant Toad Plant
Stephanotis, Wedding Flower

**ASTERACEAE**
- Gynura aurantiaca
- Gynura sarmentosa
- Senecio macroglossus variegatus
- Senecio mikaoides
- Senecio herreianus
- Senecio rowleyanus
- Senecio serpens

Velvet Plant
Trailing Velvet Plant
Variegated Wax Ivy
Parlor Ivy, German Ivy
String of Beads
String of Pears
Blue Chalksticks

**BEGONIACEAE**
- Begonia bowerii
- Begonia 'Chantilly Lace'
- Begonia foliosa
- Begonia masoniana
- Begonia rex
- Begonia semperflorens 'Charm'

Eyelash Begonia
Angelwing Begonia
Iron Cross Begonia
Rex Begonia
Charm Begonia

**BIGNONIACEAE**
- Radermachera sinica

China Doll

**BUXACEAE**
- Buxus microphylla japonica

Japanese Little Leaf Boxwood

**CACTACEAE**
- Astrophytum myriostigma
- Cephalocereus senilis
- Cereus peruvianus 'Monstrosus'

Bishop's Cap
Oldman's Cactus
Giant Club
| **Echinocactus grusonii** | Golden Barrel |
| **Epiphyllum ackermannii** | Red Orchid Cactus |
| **Epiphyllum cooperi** | White Orchid Cactus |
| **Ferocactus lastispinus** | Devil's Tongue |
| **Gymnocalycium mihanovichii** | Plain Chin Cactus |
| **Mammillaria celsian** | Gold Star |
| **Mammillaria elongata** | Bunny Ears |
| **Opuntia basilaris** | Red Bunny Ears |
| **Opuntia microdasys 'Albispina'** | Eve's Pin Cactus |
| **Opuntia microdasys rufida** | Coral Cactus |
| **Opuntia subulata** | Christmas Cactus |
| **Rhipsalis cereuscula** | Thanksgiving Cactus |
| **Schlumbergera bridgesii** | **CELASTRACEAE**
| **Schlumbergera truncata** | Euonymus japonicus
| **Euonymus japonicus variegatus** | Variegated Euonymus |
| **CLUSIACEAE** | Clusia rosea
| **EUONYMUS JAPONICUS** | Fat Pork Tree |
| **COMMELINACEAE** | Callisia elegans
| **Callisia elegans** | Striped Inch Plant
| **Cyanotis kewensis** | Teddy Bear Plant
| **Rheo spathaceae** | Moses on a Raft
| **Setcreasea purpurea** | Purple Heart |
| **Tradescantia albiflora 'Albo-Vittata'** | Giant White Inch Plant
| **Tradescantia fluminensis 'Variegata'** | Variegated Wandering Jew
| **Tradescantia multiforma** | Tahitian Bridal Veil
| **Tradescantia silamontana** | White Velvet Tradescantia
| **Zebrina pendula** | Wander Jew |
| **CORNACEAE** | Aucuba japonica 'Variegata'
| **Aucuba japonica 'Variegata'** | Gold Dust Tree |
| **CRASSULACEAE** | Aeonium arboreum 'Atropurpureum'
| **Aeonium arboreum 'Atropurpureum'** | Tree Aeonium
| **Aeonium haworthii** | Pinwheel
| **Crassula arborescens** | Silver Dollar
| **Crassula argentea** | Jade Plant |
| **Crassula argentea 'Variegata'** | Variegated jade Plant |
| **Crassula flacata** | Propeller Plant |
| **Crassula tetragona** | Miniature Pine Tree |
| **Echeveria 'Doris Taylor'** | Wooly Rose |
| **Echeveria 'Doris Taylor'** | Green Mexican Rose |
| **Echeveria glava** | Plush Plant |
| **Echeveria pulvinata** | Ghost Plant, Mother-of-Pearl |
| **Graptoptetalum paraguayense** | Dragon Flower |
| **Gasteria huernia spp.** | Velvet Leaf |
| **Kalanchoe beharensis** | Maternity Plant |
| **Kalanchoe daigremontiana** | Pen Wiper |
| **Kalanchoe marmorata** | Panda Bear Plant |
| **Kalanchoe tomentosa** | Chandelier Plant |
| **Kalanchoe tubiflora** | Moonstones |
| **Pachyphytum oviferum** | Burro Tail |
| **Sedum morganianum** | **CYCADACEAE**
| **Cycas circinalis** | Fern Palm |
| **Cycas revoluta** | Sago Palm |
| **Cyperaceae** | **CYPERACEAE**
| **Cyperus alternifolius** | Umbrella Plant |
| **Cyperus papyrus** | Papyrus |
EUPHORBIACEAE
Acalypha hispida
Acalypha wikesiana macafeana
Codiaeum variegatum pictum 'Bravo'
Euphorbia mammilaris
Euphorbia pseudocactus
Euphorbia pulcherrima
Euphorbia splendens prostrata
Euphorbia tirucalli
Euphorbia trigona
Pedilanthus tithymaloides 'Variegatus'

FARBACEAE
Mimoso pudica

GESNERIACEAE
Aeschynanthus lobbianus
Aeschynanthus marmoratus
Chrysothemis folgens
Columnnea microphylla
Episcia cupreata
Nautilocalyx lynchii
Saintpaulia ionantha
Sinningia speciosa
Streptocarpus rexii
Streptocarpus saxorum

LAMIACEAE
Coleus blumei
Plectranthus australis
Plectranthus coleoides 'Marginatus'
Plectranthus oertendahii
Plectranthus purpuratus

LEEACEAE
Leea coccinea

LILIACEAE
Aloe aristata
Aloe barbadensis
Aloe variegata
Asparagus densiflorus 'Meyeri'
Asparagus densiflorus 'Sprengeri'
Asparagus setaceus
Aspidistra elatior
Aspidistra elatior 'Variegata'
Chlorophytum comosum
Chlorophytum comosum 'Variegatum'
Chlorophytum comosum 'Vittatum'
Haworthia cspidata
Haworthia fasciata
Haworthia marginifera
Haworthia reinwardtii

MALVACEAE
Abutilon x hybridum
Abutilon x hybridum 'Souvenir de Bonn'
Abutilon megapotamicum
Abutilon pictum 'Thompsonii'
Hibiscus rosa-sinensis
Hibiscus rosa-sinensis cooperi

FARBACEAE
Mimoso pudica

GESNERIACEAE
Aeschynanthus lobbianus
Aeschynanthus marmoratus
Chrysothemis folgens
Columnnea microphylla
Episcia cupreata
Nautilocalyx lynchii
Saintpaulia ionantha
Sinningia speciosa
Streptocarpus rexii
Streptocarpus saxorum

LAMIACEAE
Coleus blumei
Plectranthus australis
Plectranthus coleoides 'Marginatus'
Plectranthus oertendahii
Plectranthus purpuratus

LEEACEAE
Leea coccinea

LILIACEAE
Aloe aristata
Aloe barbadensis
Aloe variegata
Asparagus densiflorus 'Meyeri'
Asparagus densiflorus 'Sprengeri'
Asparagus setaceus
Aspidistra elatior
Aspidistra elatior 'Variegata'
Chlorophytum comosum
Chlorophytum comosum 'Variegatum'
Chlorophytum comosum 'Vittatum'
Haworthia cspidata
Haworthia fasciata
Haworthia marginifera
Haworthia reinwardtii

MALVACEAE
Abutilon x hybridum
Abutilon x hybridum 'Souvenir de Bonn'
Abutilon megapotamicum
Abutilon pictum 'Thompsonii'
Hibiscus rosa-sinensis
Hibiscus rosa-sinensis cooperi

Chenille Plant, Foxtail
Copper Leaf
Croton
Indian Corncob
Poinsettia
Crown of Thorns
Pencil Tree
African Milk Tree
Redbird Cactus, Devil's Backbone
Sensitive Plant
Lipstick Plant
Black Pagoda
Sunset Plant
Miniature Lipstick Plant
Flame Violet
Purple Shrub Violet
African Violet
Gloxinia
Cape Primrose
False African Violet
Coleus
Swedish Ivy, Creeping Charlie
Candle Plant
Prostrate Charlie
Moth King
West Indian Holly
Lace Aloe
Aloe Vera, Medicine Plant
Tiger Aloe
Plume Asparagus Fern
Sprenger Asparagus
Asparagus Fern
Cast Iron Plant
Variegated Cast Iron Plant
Spider Plant
Inside-Out Spider Plant
Variegated Spider Plant
Star Window Plant
Fairy Washboard
Pearl Plant
Chinese Lantern
Variegated Flowering Maple
Hanging Chinese Lantern
Flowering Maple
Chinese Hibiscus, Rose of China
Variegated Hibiscus
<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Common Name</th>
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<tbody>
<tr>
<td><strong>MARANTACEAE</strong></td>
<td>Calathea clossonii</td>
<td>Rattlesnake Plant</td>
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<td>Calathea insignis</td>
<td>Peacock Plant</td>
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<td>Calathea makoyana</td>
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<td>Calathea picturata 'Argentea'</td>
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<td>Calathea roseo-picta</td>
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<td>Maranta leuconeura 'Erythroneura'</td>
<td>Red-veined Prayer Plant</td>
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<td>Maranta leuconeura kerchoveana</td>
<td>Prayer Plant</td>
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<tr>
<td><strong>MORACEAE</strong></td>
<td>Ficus benjamina</td>
<td>Weeping fig</td>
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<td>Ficus benjamina 'Exotica'</td>
<td>Javan Fig</td>
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<td>Ficus deltoidea</td>
<td>Mistletoe Fig</td>
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<td>Ficus elastica 'Decora'</td>
<td>Rubber Plant</td>
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<td>Ficus elastica 'Honduras'</td>
<td>Variegated Rubber Plant</td>
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<td>Ficus elastica 'Variegata'</td>
<td>Variegated Rubber Tree</td>
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Peperomia obtusifolia  
Peperomia obtusifolia variegata  
Peperomia rubella  
Peperomia sandersii  
Peperomia scandens  
Peperomia scandens 'Variegata'  
Peperomia viridis  

**Pittosporaceae**  
Pittosporum tobira  
Pittosporum tobira 'Variegata'  

**Poaceae**  
Oplismenus hirtellus 'Variegatus'  

**Podocarpaceae**  
Podocarpus macrophylla  
Podocarpus macrophyllus 'Maki'  
Podocarpus gracilior  

**Polygonaceae**  
Coccoloba latifolia  

**Polypodiaceae**  
Adiatum cuneatum  
Adiatum micophyllum  
Alsophila australis  
Asplenium nidus  
Asplenium bulbiferum  
Crytomium falcatum 'Rochefordianum'  
Davallia fejeensis  
Davallia trichomanoides  
Nephrolepis exaltata bostoniensis  
Nephrolepis exaltata 'Florida Ruffles'  
Nephrolepis exaltata 'Fluffy Ruffles'  
Nephrolepis exaltata 'Whitmanii'  
Pellaea rotundifolia  
Phlebodium aureum  
Platycerium wilhelminae reginae  
Polystichum tsas-simense  
Pteris cretica  
Pteris ensiformis 'Victoria'  
Stenochlaena palustris  

**Portulacaceae**  
Portulacaria afra  
Portulacaria afra 'Variegata'  

**Primulaceae**  
Cyclamen percicum  

**Rubiaceae**  
Gardenia jasminoides  
Ixora spp.  
Coffee arabica  

**Rutaceae**  
Citrus mitis  

**Saxifragaceae**  
Saxifraga stolonifera  
Saxifraga stolonifera 'Tricolor'  
Tolmiea menziesii  

Felted Peperomia  
Baby Rubber Plant  
Variegated Baby Rubber Plant  
Pepe Peperomia  
Watermelon Peperomia  
Philodendron Peperomia  
Variegated Philodendron Peperomia  
Mock Orange  
Variegated Mock Orange  
Ribbon Grass  
Buddhist Pine  
Japanese Yew Pine  
Fern Pine  
Sea Grape  
Delta Maidenhair Fern  
Maidenhair Fern  
Australia Tree Fern  
Birdnest Fern  
Mother Fern  
Rochford Holly Fern  
Rabbit's Foot Fern  
Squirrel's Foot Fern  
Boston Fern  
Florida Ruffles Fern  
Dwarf Feather Fern  
Feather Fern  
Button Fern  
Hare's Foot Fern  
Staghorn Fern  
Leather Fern  
Table Fern  
Victoria Table Fern  
Climbing Fern  
Elephant Bush  
Variegated Elephant Bush  
Cyclamen  
Gardenia  
Jungle Geranium  
Coffee Plant  
Calamondin  
Strawberry Begonia  
Variegated Strawberry Begonia  
Piggy-back Plant
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<td>Pilea 'Moon Valley'</td>
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<td>ZAMIACEAE</td>
<td>Zamia furfuracea</td>
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PLANTS FOR HIGH-LIGHT SITUATIONS

These plants will tolerate or excel in situations with an interior light level of 1000 Foot Candles or more. Remember that temperature levels are not a consideration for this list.

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<th>Plant Name</th>
<th>Common Name</th>
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Polyscias quilfoylei 'Victoriae'
Portulacaria afra
Portulacaria afra 'Variegata'
Sansevieria intermedia
Sansevieria trifasciata
Sansevieria trifasciata 'Golden Hahnii'
Sansevieria trifasciata hahnii
Sansevieria trifasciata laurentii
Sedum morganianum
Senecio macroglossus variegatus
Senecio mikaioides
Senecio rowleyanus
Senecio serpens
Strelitzia reginae
Syngonium podophyllum
Tupidanthus calyptratus
Vanda spp.
Yucca elephantipes

PLANTS FOR LOW-LIGHT SITUATIONS

These plants will tolerate light levels of less than 300 Foot Candles. Usually in these situations, plants will grow very slowly or not at all, and care should be taken not to apply too much water or fertilizer.

Aechmea rhodocyanea
Aglaonema commutatum 'Psuedo bracteum'
Aglaonema commutatum 'Treubii'
Aglaonema commutatum maculatum
Aglaonema crispum
Aglaonema modestum
Aspidistra elatior
Aspidistra elatior 'Variegata'
Aucuba japonica variegata
Chlorophytum comosum
Clivia miniata
Epipremnum aureus
Epipremnum aureus 'Marble Queen'
Ficus elastica 'Decora'
Maranta leuconeura kerchoveana
Monstera deliciosa
Peperomia obtusifolia
Philodendron cannifolium
Philodendron oxycardium
Rhoeo spathaceae
Spathiphyllum clevelandii

Coralberry
Golden Chinese Evergreen
Silver Chinese Evergreen
Chinese Evergreen
Cast Iron Plant
Variegated Cast Iron Plant
Gold Dust Tres
Spider Plant
Golden Pothos
Marble Queen Pothos
Rubber Plant
Prayer Plant
Split-Leaved Philodendron
Baby Rubber Plant
Flask Philodendron
Heart-Leaf Philodendron
Moses on a Raft
Peace Lily or White Flag
PLANTS FOR HIGH TEMPERATURE SITUATIONS

These plants will withstand average temperatures between 80° and 95° Fahrenheit. Remember that at approximately 95°F, plant metabolism stops for most plants, and cooler night temperatures are necessary for survival. With average temperatures over 100°F, few plants, if any, can be expected to survive.

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agave americana</td>
<td>Century Plant</td>
</tr>
<tr>
<td>Agave angustifolia marginata</td>
<td>Variegated Caribbean Agave</td>
</tr>
<tr>
<td>Agave attenuata</td>
<td>Dragon Tree Agave</td>
</tr>
<tr>
<td>Agave victoriae-reginae</td>
<td></td>
</tr>
<tr>
<td>Asparagus sprengeri</td>
<td>Sprenger Asparagus</td>
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<tr>
<td>Astrophytum myriostigma</td>
<td>Bishop’s Cap</td>
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<tr>
<td>Bougainvillea glabra</td>
<td>Bougainvillea</td>
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<tr>
<td>Caryota mitis</td>
<td>Cluster Fishtail Palm</td>
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<tr>
<td>Caryota obtusa</td>
<td>Fishtail Palm</td>
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<tr>
<td>Cephalocereus senilllis</td>
<td>Oldman’s Cactus</td>
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<td>Cereus peruvianus 'Mostrosus'</td>
<td>Giant Club</td>
</tr>
<tr>
<td>Coldiaeum variegatum pictum 'Bravo'</td>
<td>Croton</td>
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<tr>
<td>Crassula argentea</td>
<td>Jade Plant</td>
</tr>
<tr>
<td>Crassula argentea 'Variegata'</td>
<td>Variegated Jade Plant</td>
</tr>
<tr>
<td>Echinocactus grusonii</td>
<td>Golden Barrel</td>
</tr>
<tr>
<td>Ferocactus lastispinus</td>
<td>Devil’s Tongue</td>
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<td>Ficus benjamina</td>
<td>Weeping Fig</td>
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<tr>
<td>Ficus benjamina 'Exotica'</td>
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<tr>
<td>Ficus deltoides</td>
<td>Mistletoe Fig</td>
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<td>Ficus rubignosa</td>
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<td>Hibiscus rosa-sinensis</td>
<td>Arabian Jasmine</td>
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<tr>
<td>Jasminum sambac</td>
<td>Velvet Leaf</td>
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<tr>
<td>Kalanchoe beharensis</td>
<td>Panda Bear Plant</td>
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<tr>
<td>Kalanchoe tomentosa</td>
<td>Living Stones</td>
</tr>
<tr>
<td>Lithops lesii</td>
<td>Veitch Screw Pine</td>
</tr>
<tr>
<td>Pandanus veitchii</td>
<td>Mock Orange</td>
</tr>
<tr>
<td>Pittosporum tohira</td>
<td>Variegated Mock Orange</td>
</tr>
<tr>
<td>Pittosporum tohira 'Variegatum'</td>
<td>Burro Tail</td>
</tr>
<tr>
<td>Sedum morganianum</td>
<td>False Agave</td>
</tr>
<tr>
<td>Yucca elephantipes</td>
<td></td>
</tr>
</tbody>
</table>
PLANTS FOR COOL SITUATIONS

These plants will tolerate average temperatures of 50°F to 65°F. They will also do well in normal interior temperature ranges but are good for placement near cooler windows and entryways.

Abutilon hybridum 'Fireball'
Abutilon pictum 'Thompsonii'
Adiantum cuneatum
Adiantum microphyllum
Ardisia crispa
Asparagus meyeri
Asparagus plumosus
Asparagus sprengeri
Aspidistra elatior
Aspidistra elatior 'Variegata'
Asplenium nidus
Aucuba japonica variegata
Beloperone guttata
Brassaiia actinophylla
Brassaiia arboricola
Calathea crousii
Calathea insignis
Calathea makoyana
Calathea picturata 'Argentea'
Calathea roseo-picta
Ceropogia woodii
Chlorophytum comosum
Chlorophytum comosum 'Variegatum'
Chlorophytum comosum 'Vittatum'
Cycas revoluta
Cyclamen percicum
Cyrtomium falcatum 'Rochefordianum'
Davallia fejeensis
Davallia trichomanoides
Dizygotheca elegansissima
Dracaena deremensis 'Janet Craig'
Dracaena deremensis 'Warneckei'
Dracaena fragrans massangeana
Dracaena godseffiana 'Florida Beauty'
Dracaena marginata
Epiphyllum ackermannii
Epiphyllum coooperi
Euonymus japonicus
Fatshedera lizei
Fatsia japonica
Hedera canariensis variegata
Hedera helix
Hedera helix 'Goldust'
Hedera helix 'Needlepoint'
Hedera helix 'Scutifolia'
Helxine soleirolia
Hippeastrum spp.
Hoya carnosa
Hypoestes sanguinolenta
Leea coccinea
Maranta leuconeura 'Erythronium'
Maranta leuconeura kerchoveana
Mimosa pudica
Musa acuminata
Nephrolepis exaltata 'Florida Ruffles'
Nephrolepis exaltata 'Fluffy Ruffles'
Nephrolepis exaltata 'Whitemani'
Nephrolepis exaltata bostoniensis
Opilamenus hirtelis 'Variegatus'
Oxalis regnellii 'Rubra Alba'

Chinese Lantern
Flowering Maple
Delta Maidenhair Fern
Maidenhair Fern
Coral Berry
Plume Asparagus Fern
Plumosa Fern
Sprenger Asparagus
Cast Iron Plant
Variegated Cast Iron Plant
Birdsnest Fern
Gold Dust Tres
Shrimp Plant
Schefflera or Umbrella Tree
Hawaiian Schefflera
Rattlesnake Plant
Peacock Plant
String of Hearts
Spider Plant
Inside-Out Spider Plant
Variegated Spider Plant
Sago Palm
Cyclamen
Rochford Holly Fern
Rabbit's Foot Fern
Squirrel's Foot Fern
False Aralia
Janet Craig Dracaena
Warneckei Dracaena
Corn Plant
Gold Dust Dracaena
Dragon Tree of Madagascar
Red Orchid Cactus
White Orchid Cactus
Euonymus
Tree Ivy
Japanese Aralia
Algerian Ivy
English Ivy
Goldlust Ivy
Needlepoint Ivy
Sweetheart Ivy
Baby's Tears
Amaryllis
Wax Plant
Polka-Dot Plant or Freckle Face
West Indian Holly
Red-Veined Prayer Plant
Prayer Plant
Sensitive Plant
Dwarf Banana
Florida Ruffles Fern
Dwarf Feather Fern
Feather Fern
Boston Fern
Ribbon Grass
Oxalis
Oxalis rubra
Passiflora caerulea
Pellaea rotundifolia
Pellionia pulchera
Phlebodium aureum
Pilea 'Moon Valley'
Pilea 'Silver Tree'
Pilea cadierei
Pilea depressa
Pilea involucrata
Pilea microphylla
Pilea spruceana 'Norfolk'
Pittosporum tobira
Pittosporum tobira 'Variegatum'
Platycerium wilhelminae reginae
Plectranthus australis
Podocarpus macrophylla
Podocarpus macrophylla maki
Polystichum tsus-simense
Pteris cretica
Pteris ensiformis 'Victoria'
Sansevieria trifasciata
Sansevieria trifasciata laurentii
Saxifraga stolonifera
Saxifraga stolonifera 'Tricolor'
Stenochlaena palustris
Tolmiea menziesii
Tradescantia albiflora 'Albo-Vittata'
Tradescantia fluminensis 'Variegata'
Tradescantia multiflora
Tupidanthus calypratus
Zamia furfuraceae
Zebrina pendula
Pink Oxalis
Passion Flower
Button Fern
Satin Pellonia
Hare's Foot Fern
Moon Valley Pilea
Silver Tree Pilea
Aluminum Plant
Creeping Pilea
Friendship Plant
Artillery Plant
Norfolk Pilea
Mock Orange
Variegated Mock Orange
Staghorn Fern
Swedish Ivy or Creeping Charlie
Buddhist Pine
Japanese Yew Pine
Leather Fern
Table Fern
Victoria Table Fern
Snake Plant
Snake Plant
Strawberry Begonia
Variegated Strawberry Geranium
Climbing Fern
Piggy-back Plant
Giant White Inch Plant
Variegated Wandering Jew
Tahitian Bridal Veil
Tupidanthus
Cardboard Palm
Wandering Jew
PLANTS WITH LOW WATER REQUIREMENTS

These plants tolerate low water situations and are valuable for hard to reach or low water areas.

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aechmea chantinii</td>
<td>Coralberry</td>
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<tr>
<td>Aechmea fulgens discolor</td>
<td>Silver Urn Plant</td>
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<tr>
<td>Aechmea rhodocyanea</td>
<td>Tree Aeonium</td>
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<tr>
<td>Aeonion arboreum 'Atropurpureum'</td>
<td>Century Plant</td>
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<tr>
<td>Aeonion hawarthii</td>
<td>Variegated Caribbean Agave</td>
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<tr>
<td>Agave americana</td>
<td>Dragon Tree Agave</td>
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<tr>
<td>Agave angustifolia</td>
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<tr>
<td>Agave attenuata</td>
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<tr>
<td>Agave victoriae-reginae</td>
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<tr>
<td>Aloe aristida</td>
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<tr>
<td>Aloe barbadensis</td>
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<tr>
<td>Aloe variegata</td>
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<td>Ananas comosus</td>
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<tr>
<td>Ananas comosus variegatus</td>
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<tr>
<td>Asparagus densiflorus 'Myers'</td>
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<tr>
<td>Asparagus densiflorus 'Sprengeri'</td>
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<tr>
<td>Asparagus setaceus</td>
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<tr>
<td>Aspidistra elatior</td>
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<tr>
<td>Aspidistra elatior 'Variegata'</td>
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<tr>
<td>Astrophytum myriostigma</td>
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<td>Beaucarnea recurvata</td>
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<td>Bilbergia nutans</td>
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<tr>
<td>Brassia arboricola</td>
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<td>Cephalocereus senilis</td>
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<td>Cereus peruvianus 'Mostrosus'</td>
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<tr>
<td>Cerepegia woodii</td>
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<tr>
<td>Chamaedorea elegans 'Bella'</td>
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<tr>
<td>Chamaerops humilis</td>
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<tr>
<td>Chlorophytum comosum</td>
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<td>Chlorophytum comosum 'Variegatum'</td>
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<tr>
<td>Chlorophytum comosum 'Vittatum'</td>
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<td>Cordyline terminalis</td>
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<td>Crassula arborescens</td>
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<td>Crassula argentea 'Variegata'</td>
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<td>Crassula falcata</td>
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<td>Crassula tetragona</td>
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<td>Cryptanthus roseus pictus</td>
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<td>Cycas revoluta</td>
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<td>Dracaena craigii 'Compacta'</td>
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<tr>
<td>Dracaena deremensis 'Bausei'</td>
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<tr>
<td>Dracaena deremensis 'Janet Craig'</td>
<td></td>
</tr>
<tr>
<td>Dracaena deremensis 'Warneckeii'</td>
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</tr>
<tr>
<td>Dracaena fragrans massangeana</td>
<td></td>
</tr>
<tr>
<td>Dracaena godseffiana 'Flordia Beauty'</td>
<td></td>
</tr>
<tr>
<td>Dracaena marginata</td>
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</tr>
<tr>
<td>Dracaena marginata 'Tricolor'</td>
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</tr>
<tr>
<td>Dracaena sanderiana</td>
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</tr>
<tr>
<td>Dracaena thalioides</td>
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<tr>
<td>Echeveria 'Doris Taylor'</td>
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<tr>
<td>Echeveria gilva</td>
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<tr>
<td>Echeveria pulvinata</td>
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<tr>
<td>Echinocactus grusonii</td>
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<tr>
<td>Epiphyllum ackermannii</td>
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<tr>
<td>Epiphyllum cooperi</td>
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<td>Euphorbia mammilaris</td>
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<td>Euphorbia tirucalli</td>
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<td>Ferocactus lastispinus</td>
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<td>Graptotpetalum paraguavense</td>
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<tr>
<td>Gymnocalycium mihanovichii</td>
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<tr>
<td>Haworthia cuspidata</td>
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</tbody>
</table>

96
Haworthia fasciata  
Fairy Washboard
Haworthia margaritifera  
Pearl Plant
Haworthia reinwardtii  
Hoya 'Silver Pink'
Hoya bella  
Miniature Wax Plant
Hoya carnosa  
Wax Plant
Hoya carnosa rubra  
Tricolor Wax Plant
Hoya carnosa variegata  
Variegated Wax Plant
Hoya compacta  
Hindu Rope
Hoya keyi  
Dragon Flower
Huerina  
Velvet Leaf
Huerina spp.  
Maternity Plant
Kalanchoe beharensis  
Pen Wiper
Kalanchoe daigremontiana  
Panda Bear Plant
Kalanchoe marmorata  
Chandelier Plant
Kalanchoe tomentosa  
Living Stones
Kalanchoe tubiflora  
Golden Star
Lithops leslii
Mammillaria celsian
Mammillaria collinsii
Mammillaria elongata
Neoregelia carolinae tricolor
Opuntia basilaris  
Bunny Ears
Opuntia microdasys 'Albispina'  
Red Bunny Ears
Opuntia microdasys rufida  
Eve's Pin Cactus
Opuntia subulata  
Moonstones
Pachyphytum oviferum  
Veitch Screw Pine
Pandanus veitchii  
Redbird Cactus or Devil's Backbone
Pedilanthus tithymaloides 'Variegatus'
Phoenix roebelenii  
Pigmy Date Palm or Dwarf Date
Palm
Pleomele angustifolia honoriae
Narrow-Leaved Pleomele
Polyscias balfouriana
Balfour Aralia
Polyscias balfouriana marginata
Variegated Balfour Aralia
Polyscias fruticosa
Ming Aralia
Portulacaria afra  
Elephant Bush
Portulacaria afra 'Variegata'
Variegated Elephant Bush
Rhipsalis cereuscula
Coral Cactus
Sansevieria intermedia  
Pygmy Bowstring
Sansevieria trifasciata  
Snake Plant
Sansevieria trifasciata 'Golden Hahnni'
Christmas Cactus
Sansevieria trifasciata hahnii  
Thanksgiving Cactus
Sansevieria trifasciata laurentii  
Burro Tail
Schlumbergera bridgesii
Giant Toad Plant
Schlumbergera truncata  
Stephanotis
Sedum morganianum  
Bird of Paradise
Stapelia gigantea
Yucca elephantipes
Stephanotis floribunda
Cardboard Palm
Strelitzia reginae
Yucca elephantipes
Zamia furfuraceae
PLANTS FOR SMALL SPACES

These plants will keep a low bushy shape in most situations.

Adiantum cuneatum
Adiantum microphyllum
Aechmea rhodocyanea
Aglaonema commutatum 'Pseudo-bracteum'
Aglaonema commutatum 'Treubii'
Aglaonema commutatum maculatum
Aglaonema crispum
Aglaonema modestum
Asparagus meyeri
Aspidistra elatior
Aspidistra elatior 'Variegata'
Asplenium nidus
Aucuba japonica variegata
Buxus microphylla japonica
Calthea insignis
Calthea makoyana
Chlorophytum comosum
Chlorophytum comosum 'Variegatum'
Chlorophytum comosum 'Vittatum'
Cissus rhombifolia
Cissus rhombifolia 'Danica'
Clivia miniata
Cordyline terminalis
Crassula argentea
Crassula argentea 'Variegata'
Cycas revoluta
Dieffenbachia 'Exotica'
Dracaena craigii 'Compacta'
Dracaena deremensis 'Warneckei'
Echinocactus grusonii
Fatsia japonica
Ficus pumila
Kalanchoe tomentosa
Maranta leuconeura 'Erythroneura'
Maranta leuconeura kershoveana
Nephrolepis exaltata bostoniensis
Peperomia astrid
Peperomia caperata 'Emerald Ripple'
Peperomia griseoargentea
Peperomia griseoargentea 'Blackie'
Peperomia incana
Peperomia obtusifolia
Peperomia obtusifolia variegata
Peperomia rubella
Peperomia sandersii
Peperomia scandens
Peperomia scandens 'Variegata'
Peperomia viridis
Philodendron cannifolium
Rhoeo spathaceae
Sansevieria trifasciata
Sansevieria trifasciata laurentii
Schlumbergera bridgesii
Schlumbergera truncata
Scindapsis aurerus
Scindapsis aurea 'Marble Queen'
Spathiphyllum clevelandii

Delta Maidenhair Fern
Maidenhair Fern
Coralberry
Golden Chinese Evergreen
Silver Chinese Evergreen
Chinese Evergreen
Plume Asparagus Fern
Cast Iron Plant
Variegated Cast Iron Plant
Birdsnest Fern
Gold Dust Tres
Japanese Little Leaf Boxwood
Rattlesnake Plant
Peacock Plant
Spider Plant
Inside-Out Spider Plant
Variegated Spider Plant
Grape Ivy
Oak-Leaf Grape Ivy
Cafir Lily
Baby Doll Dracaena
Jade Plant
Variegated Jade Plant
Sago Palm
Dumbcane
Compact Dracaena
Warneckei Dracaena
Golden Barrel
Japanese Aralia
Creeping Fig
Panda Bear Plant
Red Veined Prayer Plant
Prayer Plant
Boston Fern
Emerald Ripple Peperomia
Silver Leaf Peperomia
Dark Silver Leaf Peperomia
Felted Peperomia
Baby Rubber Plant
Variegated Baby Rubber Plant
Pepe Peperomia
Watermelon Peperomia

Flask Philodendron
Moses on a Raft
Snake Plant
Snake Plant
Christmas Cactus
Thanksgiving Cactus
Golden Pothos
Marble Queen Pathos
Peace Lily or White Flag
PLANTS FOR USE IN SITUATIONS REQUIRING HEIGHT

These plants, in general, can be easily purchased in sizes that allow for a five foot plant or taller.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Araucaria bidwilli</td>
<td>Monkey Puzzle</td>
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<tr>
<td>Araucaria heterophylla</td>
<td>Norfolk Island Pine</td>
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<tr>
<td>Bougainvillea glabra</td>
<td>Bougainvillea</td>
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<tr>
<td>Brassaia actinophylla</td>
<td>Schefflera or Umbrella Tree</td>
</tr>
<tr>
<td>Brassaia arboricola</td>
<td>Hawaiian Schefflera</td>
</tr>
<tr>
<td>Caryota obtusa</td>
<td>Fish-tail Palm</td>
</tr>
<tr>
<td>Chamaedorea seifrizii</td>
<td>Bamboo Palm</td>
</tr>
<tr>
<td>Chrysalidocarpus hulcencs</td>
<td>Areca Palm or Butterfly Palm</td>
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<tr>
<td>Coffea arabica</td>
<td>Coffea Plant</td>
</tr>
<tr>
<td>Coldiaeum variegatum pictum 'Bravo'</td>
<td>Croton</td>
</tr>
<tr>
<td>Dizygotheca elegantissima</td>
<td>False Aralia</td>
</tr>
<tr>
<td>Dracaena fragrans massangeana</td>
<td>Corn Plant</td>
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<tr>
<td>Dracaena marginata</td>
<td>Tricolor Dragon Tree</td>
</tr>
<tr>
<td>Ficus benjamina</td>
<td>Weeping Fig</td>
</tr>
<tr>
<td>Ficus benjamina 'Exotica'</td>
<td>Weeping Fig</td>
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<tr>
<td>Ficus elastica 'Decora'</td>
<td>Rubber Plant</td>
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<tr>
<td>Ficus elastica 'Honduras'</td>
<td>Variegated Rubber Plant</td>
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<tr>
<td>Ficus elastica variegata</td>
<td>Variegated Rubber Plant</td>
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<tr>
<td>Ficus lyrata</td>
<td>Fiddle Leaf Fig</td>
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<tr>
<td>Ficus retusa nitida</td>
<td>Indian Laurel</td>
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<td>Gardenia jasminoides</td>
<td>Gardenia</td>
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<td>Hibiscus rosa-sinensis</td>
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Lab Exercise 12
EXERCISE ON FRUITS AND NUTS

I. FRUIT TYPES

Botanically speaking, the fruit of a flowering plant may be defined as a matured ovary and its contents, together with other flower parts that may sometimes adhere to it.

The ovary wall, known as the pericarp, consists of three layers in fruits: the exocarp, or outer layer, which is often the skin; the mesocarp, or middle layer, which may become fleshy; and the endocarp, or inner layer, which is sometimes modified in various ways.

The following is a list of the types of fruits we'll consider:

**Achene** - a dry, simple fruit that does not dehisce when ripe. (*Example: sunflower*)

**Aggregate** - a cluster of fruits derived from a single flower. The flower consists of many pistils on a common receptacle. The individual fruits of the aggregate may be drupes or achenes. (*Example: strawberry*)

**Berry** - a simple fruit in which the entire pericarp is fleshy. It may contain one or more seeds. (*Example: tomato*)

**Drupe** - a simple, fleshy fruit with a single seed enclosed in a stony endocarp or pit. The skin of these fruits is the exocarp; the fleshy edible portion is the mesocarp. (*Example: peach*)

**Hesperidium** - A type of berry in which the rind is made up of exocarp and mesocarp; the "edible" portion is the endocarp. (*Example: orange*)

**Legume** - a simple dry, dehiscent fruit usually splitting along two sutures. (*Example: pea*)

**Multiple Fruit** - a fruit which is derived from many separate but closely clustered flowers. (*Example: pineapple*)

**Nut** - a simple, dry indehiscent fruit with a bony shell. (*Example: chestnut*)

**Pepo** - a berry with a hard rind made up of exocarp and receptacle tissue. (*Example: muskmelon*)

**Pome** - a simple, fleshy fruit in which the inner portion of the pericarp forms a dry paper-like "core". (*Example: apple*)

Note the following fruit types:

**Dehiscent fruits** are those which split apart when ripe.
**Indehiscent fruits** are those which do not split apart when ripe.
**Simple fruit** are those which are composed of a single ovary.
EDIBLE FRUITS

1. **Kumquat.** A small tropical citrus used for marmalade and for table decorations. They are rather bitter even after made into marmalade.

2. **Kiwifruit** (*Actinidia chinensis*). Imported from New Zealand. New Zealand has a law that their import-export ratio must balance so in order to sell them refrigerators and cars, etc., we must purchase something. The kiwi has caught the fancy of the Americans and most who taste it, like it. The small trees are now being planted in California.

3. **Grapefruit.** So called because the original "wild" type or Pomelo, bears its fruit in large bunches. The fruit is a citrus or hesperidium, a special type of berry. Note that it is divided into sections and that the pulp or juice is compartmented into large cell-like structures within the sections. The grapefruit is subtropical though it is often produced in more tropical areas. It is best when some cold weather is involved in its development. The trees are evergreen and develop in alternate "growth flushes" and "rest periods." It may be easily damaged while in a growth flush but may withstand 25-26°F for considerable periods if in rest. The grapefruit is called the "wake up" fruit and is a favorite for breakfast. It has just a hint of bitterness if you think it is too sour, you are probably eating too much sugar laden food.

The best grapefruit comes from Texas and the Indian River area of Florida. Look for smooth skin, slightly flattened, symmetrical shape, heavy for its size. Do not buy if light or has a sheep-nose shape. Scale insects on the surface should not affect the internal quality, nor should a russetted surface. Pits on the surface with a brown color indicate exposure to chilling temperatures and such fruit should be avoided.

4. **Mango.** A truly tropical fruit with a large flat seed. They generally are chilled to the point where they will rot before they ripen and develop their characteristically bright flavor. They are really good, so do not judge them by their "Fargo flavor".

5. **Mandarins.** Oranges with a particular bright flavor, generally very juicy and thin skinned. A different species from the true "orange." Mandarins include the Tangerine, King, Satsuma, etc., and usually cost more than oranges because they require special handling and have a short shelf life.

6. **Pineapple.** Native to Mexico and Central America. Now grown in Hawaii. They are easily chilled so are seldom good when purchased at Fargo stores. When imported by boat or from Mexico by train or truck, they may be picked very green if not chilled, they will ripen satisfactorily. Or they may be picked almost ripe and flown in, in which case they are very expensive and usually delicious. Even when fully ripe, they should not be chilled below 45°F. When green, they will chill at temperatures under 60°F. Each section appearing on the surface is a fruit, all are fused together in a giant multiple fruit.

7. **Pear.** A pome fruit. Note the structure of the core. Till recent years, pears were seasonal fruits, seen only for a week or two in the stores each year. Now they are harvested in a green mature condition and placed in a "controlled atmosphere" (CA) storage where the carbon dioxide is raised to about 3% and the oxygen is lowered to about 5% which puts the living tissue into a suspended state. They may be held this way for several months in almost perfect condition, then packed and sent to distant stores, they are still green and will stay "asleep" for two or three weeks. Take them
home and expose them to room temperatures till they turn yellow. Eat then when they become just slightly soft and be sure to eat the core and the seeds too. (In CA they are also kept cold, about 32°F.) What is the ambient concentration of CO₂ and O₂ in the atmosphere? If the CA is made to the specifications above, what material composes the remainder? The most popular and best tasting pear is the Bartlett, however, it does not store as well as the d'Anjou which is usually larger. The pears on exhibit may include a variety that is russetted, the Bosc.

8. **Tangelo.** A cross between the grapefruit (Pomelo) and the tangerine (Mandarin). There are many types. One called the Mineola has a characteristic sheep-nose. What kind of fruit is the Tangelo Hybrid?

9. **Temple Orange.** A cultivar with a bright flavor much like a Mandarin and highly colored and thin skinned, too.

10. **Nuts.** Define the nut as a type of fruit! Some of the nuts on exhibit may include the Coconut, English Walnut, Pecan, Almond, Brazil Nut and Filbert or Hazelnut. There are some trees of a wild Hazelnut that grow in North Dakota. Their nuts are very small and are not sold commercially. Acorns may be eaten, too, but sometimes must have their tannins extracted to avoid poisonous consequences. No other nut crops are produced in North Dakota. (Peanuts are not nuts, what are they?)

11. **Coconuts.** Grow on very tall "fan" palms. The white meat inside is the copra of commerce from which the oil is extracted. Inside is a liquid endosperm called "milk" because it is rich in vitamins and growth factors. Outside the copra is a hard shell which makes the best quality charcoal absorbent for use in gas masks. Surrounded the nut is a strong fibrous coating that enables the nut to survive falling from the 150 foot high trees or floating across the salty oceans.

   Open the coconut by first driving a nail into two eyes and draining the milk before smashing the shell with a hammer.

12. **Banana.** A berry (seeds embedded in the pulp) but the seeds in the popular fruit are mere remnants. The banana seen in our stores is a bland icky fruit that is almost flavorless compared to many good bananas. But so it is that it was so chosen you will have to go to the tropics yourself to partake of the heavenly goodness. As you see it, the fruit is sent here completely green and ripened when desired by exposure to ethylene gas. Bananas are easily chilled by putting them in the refrigerator where they will quickly blacken. If they are already ripe, it won't harm them internally, however. Bananas belong to the genus Musa. A similar plant of this genus is the source of Manilla Hemp.

13. **Lemons.** The variety most popular is the Eureka which normally has two puffy pointed ends. The Eureka is yellow, but all varieties are not. Lemons are tropical, injured by light frosts, so limited in the US to California. Highly acid, rich in Vitamin C. Recent research demonstrated that the Vitamin C is lost rapidly when the lemon is juiced, even when the juice is stored in cold temperatures! Vitamin C is water soluble, therefore, your body needs a daily supply.

14. **Honeydew Melon.** A pepo berry. The honeydew is very popular with the Semite peoples, but increasing in use by others as it becomes more available. Remember that it will not be good until it becomes soft. Put it out at room temperature and wait for it to
soften which may take 2 days to 2 weeks; be patient. There is a variety that will mature in North Dakota's short season. Of the melon fruits that can be produced in North Dakota include the muskmelon and the watermelon.

15. **Dried fruits.**

An old method of food preparation being revived. Fruits are the most easily prepared because they contain larger amounts of sugar than vegetables and meats. Drying was once done in the sun, but the task can be accomplished faster and with less loss of flavor and nutritious vitamins when forced air dried. The dried fruits on exhibit are those popularly sold in the grocery such as raisins (dried grapes), currants (miniature raisins), apricots, pears, apples, plums (prunes), peaches, figs and dates (fruit of a frond palm).

Drying removes the moisture and leaves the remaining fruit pulp which is very concentrated. Use care not to eat very much at one time, it is not natural to consume such highly concentrated foods. You may be surprised at the price of dried fruits, but if you could the numbers of fruits instead of thinking of it as weight or quantity, the price is rational. There is some savings in shipping costs of dried food, but it probably is not enough to balance the cost of drying. Some of the dried fruit is first sulfured by exposing the fresh material to sulfur dioxide fumes. This preserves the color, makes the fruit a little more tart, and preserves the vitamins, which ordinarily are lost in the drying process. There is no indication that sulfuring is deleterious to health, but some health food "purists" suggest that this might be a possibility.

16. **Limes.**

Small citrus, very sour, distinctive taste, high in vitamin C. Long before Vitamin C was understood, the British Navy rationed limes to their sailors to prevent them from becoming diseased from scurvy. This enables them to compete against the navies of the world and become superior in sea faring it also gave the British people the name of "Limey". Purchase limes when they are green. When they begin to ripen to a yellow color, they begin to dry and lose their juice. Do they lose their Vitamin C, too?

17. **Figs.**

Seldom seen fresh this far north. Dried figs have been in common use for ages though. The fig is another "Multiple Fruit". But different from the pineapple which has its stigmas facing inward. There is a small hole at the bottom of the fig through which a small wasp can fly to reach the pollen and stigmas and pollinate them. Considered a tropical fruit, figs can be grown in northern Texas.

18. **Apples.**

Pome fruits in shades of yellow, red and green. One of the more important tree fruits which can be grown in North Dakota. Haralson is the favorite variety. It is fairly tart and stays crisp for a considerable period. Haralson is excellent for cooking. Commercially the variety Delicious is sold most. Delicious is lovely to look at with its characteristic elongated cheeks on the blossom end.

19. **Quince.**

A pome of ancient history. Fruit which has merited little or no improvement. Used for cooking, jellies, preserves.

20. **Papaya.**

A tropical American fruit with some of the appearance of a small melon. If the sweetmushy flavor is objectionable to you, try adding some lemon juice or even salt and pepper or sugar. Papayas contain papain, an enzyme similar to pepsin, which is used to tenderize meat. The papaya is a giant herbaceous plant, 25-30 feet high and is grown in Florida, Texas, California and of course Hawaii from seed.
21. **Strawberry.** An aggregate in which the individual fruits are the achenes which are consumed along with the pulpy mass of receptacle tissue. Strawberries are being produced in North Dakota gardens, but are seldom sold in stores because of the high cost of harvesting. Commercial growers harvest by allowing the consumer to pick (PYO), then charging only a fraction of the cost that would be due a supermarket. The varieties grown most in North Dakota, Ogallala and Redcoat, are extra hardy. Strawberries contain more Vitamin C than oranges.

22. **Red Raspberry.** Another fruit being produced commercially in North Dakota. Raspberry fruits are aggregates of tiny drupes. Most popular variety is the Boyne because it withstands the winter and is disease resistant. Raspberries are customer picked and bring about twice the price of strawberries.

23. **Sweet Orange.** The most popular of the citrus fruits. Orange juice is fed to babies, often their first food after milk. It is high in Vitamin C. The most flavorsome varieties are the Blood (not seen in the USA), the Valencia, the Washington Navel, and the Temple. Other less flavorsome varieties are called "juice" oranges and their quality or soluble solids content is markedly lower.

24. **Gooseberry.** A fruit that is produced in North Dakota gardens but hasn't the popularity of raspberries and strawberries. Perhaps the most popular variety in the U.S. is "Pixwell" which originated at NDSU. Pixwell gooseberry fruits hang on long stems well below the thorny stems.

25. **Persimmon.** Native species are found in the southern states, generally with several seeds. They are very astringent and pucker your mouth when green. Kakis or Oriental species are much improved and considered by the Japanese to be one of their best fruits. The Khaki should be eaten when at the consistency of custard.

26. **Peach.** Very popular drupe fruit, seen in North Dakota stores in season but seldom of good quality because it is picked green for the long distance shipment.

27. **Cranberry.** A favorite at Thanksgiving and Christmas. They are grown in highly specialized bogs, areas where water for irrigation and flooding can be controlled and the soil is acid. Massachusetts, Wisconsin, and Washington State.

28. **Blueberry.** A more recent introduction to commerce. Blueberries are produced on acid soils. One of the top berry crops of Michigan but giving way to the Carolinas.

29. **Plantain (Musa paradisiaca).** Also known as the Cooking Banana and is not suitable to eat without cooking for its flesh is firm and not so sweet as the common banana.

30. **Avocado.** Contains up to 18% vegetable oil so considered more as a main course food than as a dessert. Most commonly used as a salad with the addition of salt, pepper, or lemon juice. The seed is not bony hard and so evaluation of the avocado as a drupe is not clear. Most texts dodge this issue and do not classify it.