Leaf Classification
Materials
You will need:

✓ Demo leaf photo sheet
You will need:

✓ Demo leaf photo sheet
✓ Seven Simple Steps to Binning Leaves
You will need:

- Demo leaf photo sheet
- Seven Simple Steps to Binning Leaves
- Binning Chart
You will need:

✓ Demo leaf photo sheet
✓ Seven Simple Steps to Binning Leaves
✓ Binning Chart
✓ Leaf Classification Worksheet
You will also need:

Ruler with centimeter scale (1 centimeter equals 10 millimeters, so each tick mark on the ruler is equal to 1 millimeter)

Calculator

Scrap paper

Paper clips

Pencil, or pen
Leaf Basics

Words you will need to know.
Leaf parts 1

**Petiole**: the leaf stalk or stem

**Lamina**: the fleshy portion of the leaf connected to the petiole containing a network of veins

**Base**: the lower quarter of the lamina nearest the petiole

**Margin**: the edge of the lamina
Leaf parts 2

**Midvein**: a primary vein running through the center of the lamina; generally the thickest vein

**Lateral secondary veins**: veins branching outward from the midvein, other primaries, or secondaries like limbs on a tree

**Apex**: the upper quarter of the lamina where the midvein ends
Veins in leaves are classified first to seventh order. In most photographs the fourth to seventh order veins are not visible.

Vein orders are based on gauge (thickness or diameter). The leaf’s thickest veins are first order.

First order = Primary vein or veins
Second order = Secondary veins
Third order = Tertiary veins
Leaf veins 2

First order (primary)

Second order (secondary)

Third order (tertiary)
Leaf Classification

Steps to Binning
Where does the petiole connect to the lamina?
Peltate

The petiole connects in the interior of the lamina.
Marginal

The petiole connects at the margin.
Step 1

- Dicot
- Peltate (12)
- Marginal

- Go to Step 4
- Go to Step 2
Is the leaf unlobed or lobed?
What is a lobe?

A **lobe** is a finger-like projection of the leaf margin. A **sinus** is an indentation in the leaf margin. To be lobed, the sinus must cut inward at least 25% of the distance from the projection’s tip to the midvein.
A leaf with no lobes
Lobed

A leaf with two or more lobes
Step 2

- Marginal
- Unlobed
  - Go to Step 3
- Lobed
  - Go to Step 3
How many primary veins does the leaf have?
What is a primary vein?

**Primary veins** are the thickest order of veins. The midvein is always a primary vein. Any other vein that is at least 75% of the midvein’s thickness, and branches from it at or near the base is also considered a primary vein.
A leaf with only one primary vein

Pinnate
Palmate

A leaf with two or more primary veins.
Step 3

Unlobed

Pinnate

Go to Step 4

Palmate

Go to Step 4

Lobed

Pinnate 13

Go to Step 4

Palmate 14

Go to Step 4
Is the leaf toothed or untoothed?
What is a tooth?

A tooth is a vein-bearing projection of the margin. It has a sinus that cuts inward less than 25% of the distance from the projection’s tip to the midvein.
What does a tooth look like?

dentate  Serrate  crenate
Toothed

A leaf with one or more teeth
A leaf without a tooth

Untoothed
Step 4

Pinnate

Toothed
Go to Step 5

Untoothed
Go to Step 5

Toothed
Go to Step 5

Palmate

Untoothed
Go to Step 5
Does the leaf have agrophanic veins?
What are agrophic veins?

Agrophic veins are a comb-like arrangement of second order veins branching from a lateral primary or secondary vein. An agrophic vein is not paired with a second order vein on the opposite side of the lateral vein it branches from.
What do agrophics look like?

simple agrophics  compound agrophics
A leaf having agrophic veins
A leaf having no agrophic veins.
Step 4

Toothed

Agrophics

Go to Step 6

Untoothed

No Agrophics

Go to Step 6

Agrophics

Go to Step 6

No Agrophics

Go to Step 6
What path do the secondary veins take?
What are secondary veins?

Secondary veins are laterally branching second order veins. With the primary veins they form a framework that gives the leaf its structural integrity.

If the leaf were a tree, the midvein and other primaries would be its trunk or trunks. The secondaries would be the largest limbs branching from the trunk.
There are four basic secondary vein pathways

Craspedodromous (Crasp)
Semicraspedodromous (Semicrasp)
Eucamptodromous (Eucampt)
Brochidodromous (Brochid)
In a *craspedodromous* leaf, the secondary vein ends at the margin almost always in a tooth, or at a marginal vein.
In a **semicraspedodromous** leaf, the secondary vein branches near the margin; one branch ends in a tooth and the other joins with a nearby secondary.
In a **eucamptododromous** leaf, the secondary vein never reaches the margin. It loses gauge as it nears the margin. No longer a second order vein, it curves away from the margin and links to a nearby secondary as a tertiary vein.
In a **brochidodromous** leaf, the secondary vein never reaches the margin, but curves to join with a nearby secondary vein forming second order loops and arches.
Step 6: Craspedodromous

- Pinnate
  - Toothed
    - Agrophics
    - Crasp 17
    - Go to Step 7
  - Untoothed
    - Agrophics
    - No Agrophics
    - Crasp 27
    - No Agrophics
    - Crasp 28
Step 6: Craspedodromous (continued)
Step 6: Semicraspedodromous

- Pinnate
- Palmate
- Toothed

- Agrophics
- No Agrophics
- Agrophics
- No Agrophics
- Semicrasp 15
- Semicrasp 16
- Semicrasp 31
- Semicrasp 32
Step 6: Eucamptodromous

- Pinnate
- Palmate
- Untoothed

Agrophics

Eucampt 29

No Agrophics

Eucampt 30

Agrophics

Eucampt 39

No Agrophics

Eucampt 40
Step 6: Brochidodromous

- **Pinnate**
- **Palmate**
- **Untoothed**

Agrophics

Brochid

No Agrophics

Brochid

Agrophics

Brochid

Brochid

No Agrophics

Go to Step 7
What shape is the leaf?
Leaf Shape:

Ovate

The widest part of the leaf is in the bottom 2/5 of the lamina (nearer the base).
Leaf Shape:

Elliptic

The widest part of the leaf is in the middle 1/5 of the lamina (nearer the middle).
Leaf Shape:

Oblong

The margins through the middle 1/3 of the lamina are nearly parallel.
Leaf Shape:

Obovate

The widest part of the leaf is in the upper 2/5 of the lamina (nearer the apex).
Step 7: Leaf Shape

- Pinnate
- Toothed
- No Agrophics
- Crasp

Ovate 18
Elliptic 19
Oblong 20
Obovate 21
Step 7: Leaf Shape (continued)

- Pinnate
- Untoothed
- No Agrophics
- Brochid

Ovate 23
Elliptic 24
Oblong 25
Obovate 26
Leaf Area

How to calculate the surface area of a leaf and assign a size class
Estimating Leaf Area

To estimate the surface area of the leaf, measure the length and width of the lamina.

Use the fossil leaf photograph labeled **Actual Size** to make the measurements of leaf length and width.

Some fossil leaves are not complete. Measure only what you can see.
Measuring Length

Measure the length of the lamina parallel to the midvein in millimeters. Do not include the length of the petiole in your measurement.
Measuring Width

Measure the width of the lamina perpendicular to the midvein in millimeters.
Calculating Leaf Area

The surface area of a rectangle is calculated by multiplying length times width. Given that leaves are not rectangular, the surface area of a leaf is estimated using the formula:

Leaf Area (mm$^2$) = Length (mm) x Width (mm) x 0.75
Assigning a Size Class

After estimating the leaf area, use the Raunkiaer-Webb Size Class Chart to assign the leaf a size class.

<table>
<thead>
<tr>
<th>Raunkiaer-Webb Size Class Chart</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf area (mm²)</td>
<td>Size class</td>
</tr>
<tr>
<td>Less than 25 mm²</td>
<td>leptophyll</td>
</tr>
<tr>
<td>25-225 mm²</td>
<td>nanophyll</td>
</tr>
<tr>
<td>225-2025 mm²</td>
<td>microphyll</td>
</tr>
<tr>
<td>2025-4500 mm²</td>
<td>notophyll</td>
</tr>
<tr>
<td>4500-18,225 mm²</td>
<td>mesophyll</td>
</tr>
<tr>
<td>18,225-164,025 mm²</td>
<td>macrophyll</td>
</tr>
<tr>
<td>Greater than 164,025 mm²</td>
<td>megaphyll</td>
</tr>
</tbody>
</table>