Plant do not passively exist in their environment, but are actively responding to changes and signals from the environment. For a plant to persist and reproduce, it must constantly cope with the changing physical characters of their habitats. Plants must have mechanisms to determine up from down to produce roots and shoots in the correct orientation. Plants also must have mechanisms to measure time in that they as they must produce flowers at the right time of year, become seasonally dormant and even determine night from day. Light is an important environmental cue to which plants are especially sensitive. Different levels of light will stimulate dramatic differences in growth pattern and leaf size and shape. In many cases different qualities of light are need for specific plant responses. For example, a red light absorbing receptor helps plants measure day length; a blue light receptor is used for morphological changes. The growth response towards or away from a light source is termed phototropism.

Thigmotropism is another growth response found in some plant organs. Thigmotropism is a growth in response to touch. Organs like tendrils are thigmotropic and are able to sense an object on to which it can grow around to anchor the plant. Many climbing vines and lianas have well developed tendrils.

Growth in response to gravity in called gravitropism. Most plants are strongly gravitropic with their roots demonstrating positive gravitropism (towards the force of gravity) and their shoot demonstrating negative gravitropism (their shoots grow away from the force of gravity). Phototropism, thigmotropism and gravitropism in plants are controlled by a combination of morphological, biochemical and molecular mechanisms working together to coordinate a plant’s growth in response to its environment.

In today’s lab you will be investigating a number of plants responding to the environment. You will not only see examples of tropisms, but also other ways in which plants are measuring and reacting to environmental signals.

1. Hormones

**Auxin:** One of the many affects auxin has on plant growth and development is the maintenance of apical dominance. Apical dominance is when the apical or terminal bud on a shoot inhibits the development of axillary buds below it. It results from the production of auxin in the terminal bud, which diffuses down the stem and keeps the axillary buds in dormancy. By removing the terminal bud, the auxin source is also removed and the axillary buds will develop.

*Look at the plants on display in lab today. Some of the plants have had their terminal buds removed, other have their terminal buds intact. In the space below record the difference in axillary bud development in plants with the terminal bud removed.*
Measure the total length (mm) of the axillary buds in the first two nodes and compare that to the controls.

<table>
<thead>
<tr>
<th>species</th>
<th>Terminal bud intact</th>
<th>Terminal bud removed</th>
<th>Difference (removed- intact mm)</th>
</tr>
</thead>
</table>

Can you detect a difference in the development of the axillary buds growth between the two groups? How might this difference affect the shape of a plant? What environmental feature might mimic this effect?

**Ethylene:** Another plant hormone is ethylene. Ethylene is a gas produced in ripening fruit and aging or senescing shoots. It can have several physiological and developmental effects on a plant. One affect is the stimulation of fruit ripening. The saying “one bad apple can ruin the whole barrel” has some validity in that a ripening apple can stimulate ripening in all the fruit at once. This is not a desirable effect when storing fruit and great expense is taken to reduce ethylene levels in fruit storehouses. Another physiological effect of ethylene is the hastening of leaf fall and the onset of dormancy in deciduous plants. This is a natural response in plants and is important in plants which must loose their leaves and prepare their shoots for a cold winter period. Other effects attributed to ethylene are the induction of flowering in bromeliads, cell growth patterns and sex expression in cucurbits (which have male and female flowers).

*In today’s lab is a demonstration of the effects of ethylene. We have taken advantage of the production of ethylene in ripening fruit to demonstrate leaf abscission on the evergreen holly. Look at the display in class today. In the space below describe the effect of ethylene on holly. Although evergreen, would ethylene be important to leaf abscission in holly?*
2. Tropisms

Gravitropism is the growth response to gravity.

*Observe the experiment in lab today with corn seedlings. Corn seed oriented differently in respect to gravity have been arranged in a large Petri dish to demonstrate the plant’s ability to sense up from down. In one seed the root cap has been removed. What was the effect? In the space below sketch the different responses to gravity.*

Phototropism is the growth in response to light.

*Observe the experiment in today’s lab on orientation of plant growth to light. A dark grown pot of wheat is exposed to different qualities of light (red, green and blue). Carefully lift the black box to observe which color of light the wheat grew towards.*

What color do wheat plants grow towards? What information does that give you in regards to the light receptor responsible for phototropism?

Solar Tracking is a reversible movement of leaves synchronized to the movement of the sun. Some plants are diaheliotropic (leaf surfaces remain perpendicular to suns rays) and others are paraheliotropic (leaf surfaces remain parallel to suns rays).

*In today’s lab there is a demonstration set up with bush lupines, which are a common small shrub along the Oregon coastline.*

Is the bush lupine heliotropic (i.e. solar tracking)? Are they diaheliotropic or paraheliotropic? Can you first come up with an explanation for solar tracking and then explain the possible differences between the two responses (diaheliotropism and paraheliotropism)? How does the bush lupine fit into your explanation?
Thigmotropism is the growth in response to touch.

In today’s lab there are examples of plants with thigmotropic structures: tendrils. Tendrils are modified leaves or petioles designed for grabbing and allowing a plant to climb or use another structure for support.

Look at the plants on display today. In the space below sketches a tendrils that are attached to a structure and tendrils still unattached.

Sensitive plants are one of a few plant species that will have a rapid (but reversible) response to touch. This technically is not a tropism because growth does not occur. Instead sensitive plants will change their turgor pressure in tissues in a specialized structure at the base of the leaflets and petiole called the pulvinus. The pulvinus is stimulated to suddenly lose its’ water be a weak electrical signal produced by touching the plant. In some cases the signal will transmit down the plant to other leaves causing them to close as well even though they were not touched.

In today’s lab you will do a simple experiment to try to time the rate often electrical signal transmitted down a sensitive plant. Using a sharp stimulus often works better than touching with your fingers. Use a lighted match to gently heat (do not scorch) the tip of a fully open plant. Slowly wave the match below the tip of the uppermost fully developed leaf just until the leaflets began to close. Time the rate at which the stimulus travels down the leaf and the petiole drops. Wait a few moments to see if the stimulus is transmitted to other leaves on the plant. After the plant has responded, record the time and not how long it takes for the plant leaf to open again. Repeat your experiment by running two or three trials. Use the table below to organize your results.

<table>
<thead>
<tr>
<th>trial</th>
<th>Time to leaflet closes</th>
<th>Time to petiole drops</th>
<th>Time to next leaf affected</th>
<th>Recovery time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Light effects on Growth and Physiology

Finally in lab today you will be studying two very different responses to light: shoot elongation and stomatal aperture.

*Observe plants grown in the dark and in the light. What is the general morphological difference between them (growth pattern)? Is there a functional explanation for this response?*

*From your observations, what can you say about the relationship of light and chlorophyll production?*

*Compare stomatal peels from the creeping charley plants that have been kept in light and in darkness. Look for stomata in the epidermal peels and make rough sketches of them in the space below.*

*What is the difference in their stomatal aperture (i.e. open or closed)?*

*How is the aperture related to photosynthesis and transpiration (i.e. carbon gain and water loss)?*

*Can you explain the observed difference in aperture from the perspective of light, photosynthesis and transpiration?*