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PLANT ROOTING STRATEGIES

What do plants need to survive? They need light (to photosynthesize), carbon dioxide (for photosynthesis), water (for photosynthesis and other cellular processes), and other nutrients like nitrogen (to build chlorophyll, proteins, and other structures). Plants use their leaves to capture light and take in carbon dioxide, but most plants cannot take in large amounts of water or other nutrients this way. Roots are the specialized plant structures that enable most plants to access the water and nutrients necessary for survival. Roots also serve as an energy storage area so that plants have access to energy during times when they are unable to produce enough new energy. A plant's roots can also provide stability so that the plant does not fall over.

Rooting strategy is the term we use to describe the method that has evolved for a particular plant to anchor itself, collect water and nutrients, and store energy. Plants in the cloud forests of Monteverde, Costa Rica, exhibit a wide variety of interesting rooting strategies. Let's use the *Canopy in the Clouds* site to take a closer look!

Background

Before you view any videos, it will be helpful to know several terms. Use the *Canopy in the Clouds* glossary to define the following terms. Write the definitions on the lines provided.

- epiphyte:_____
  _____
- hemi-epiphyte: _____
  _____
- bromeliad: _____
  _____
- bryophyte: _____
  _____

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Plants in the canopy provide an interesting place to explore roots. They only have limited soil (formed by decomposing leaves and detritus that gets caught on branches) on which to root, unlike plants that root in the soil on the ground. As a result, they have a wide variety of strategies. Here are a few examples:

(1) Bryophytes only have root-like structures, but not actual roots.

(2) Bromeliads have roots, but they primarily serve to anchor the plant, as opposed to taking up water and nutrients.

(3) Hemi-epiphytes have roots that slowly grow down to the ground and eventually become the trunk of the tree.

(4) Even plants on the ground have a variety of strategies. One researcher identified at least 25 different rooting strategies for tropical trees alone!

<u>Plants in the Canopy</u>

Lets navigate up to the canopy in any panorama and locate an epiphyte. (There are thousands of epiphytic plants from which to choose, but if you are uncertain, visit Panorama #3, and look right above hotspot 1 up in the canopy.). Describe what you see:

_____

_____

_____

Now go to Panorama #2, head up to the canopy, and click on hotspot 5. Before reading the text here, look at the picture and try to count the number of plant species that are growing on this branch.

How many different plant species can you count? _____

Read the text box to learn about how these plants got to the canopy.

List three different ways in which plants can end up growing up in the canopy rather than on the ground.

- _____
- _____
- _____

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Visit Panorama #3, canopy hotspot 3, to learn about the hemi-epiphytic plant *Didymopanax*. After watching this clip, visit canopy hotspots 4 and 5 at this site to read about two other plants that live in the canopy.

How can a plant grow without being rooted in soil? Watch Panorama #3, hotspot 2 to find out.

How do aerial plants get the nutrients they need to survive?

_____

_____

_____

Terrestrial Plants and Root Biomass

Terrestrial plants rely on their roots for water and other nutrients. However, understanding plant rooting patterns while the plant is still living in the soil presents many challenges. As a result, scientists have developed other ways to learn about the roots of terrestrial plants. One such method is measuring root biomass. Biomass is the weight of living material. In this case, scientists took a soil sample every 10 cm and separated the roots from the soil. Each soil sample was the same size. After drying the roots in an oven (so that the water in the roots didn't change the results), they weighed each sample. Here are the results from three different soil pits in the low elevation site (see panorama #1, video #3). All results are dry weight of roots in grams:

Sample Depth (cm)	Soil Pit #1 (g)	Soil Pit #2 (g)	Soil Pit #3 (g)	Average (g)
0-10	2.9	2.7	1.0	
10-20	1.8	2.5	0.4	
20-30	1.5	0.8	2.6	
30-40	0.3	0.8	3.3	
40-50	0.1	1.2	2.4	

After reviewing the data, prepare a bar graph of average root biomass versus soil depth. Place soil depth (the independent variable) along the x-axis and root biomass (the dependent variable) along the y-axis. Your graph should fill at least half of the page. Be sure to include units, label your axes, and give your graph a clear title.

Use the data and your completed graph to answer the following questions.

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(1) Describe any patterns or trends that you observe on your graph.

_____

_____

_____

(2) Did all of the soil pits follow the same pattern? Why is it important to use an average value of three soil pits and what information do you lose by just looking at the average and not the data?

_____

_____

_____

(3) Based on what you see in your graph, what is the rooting strategy of plants in the low elevation site (with regard to depth)?

_____

_____

_____

(4) Make a sketch of a low elevation site plant (or several plants) and the root system it might possess. Include a vertical scale to show soil depth below the surface.

Low elevation site plant and potential root system

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(5) Provide a possible explanation for this rooting strategy.

_____

_____

_____

(6) If you were to view nutrient data for this site, you would find that many nutrients are concentrated near the surface, with less nutrients deeper in the soil. How might this help explain the rooting strategy of plants in the low elevation site?

_____

_____

_____

(7) How might the root biomass data be different if water and nutrients were distributed several meters deeper into the soil? Explain.

_____

_____

_____