

wrong	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
right	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	
score	100	97.8	95.6	93.3	91.1	88.9	86.7	84.4	82.2	80.0	77.8	75.6	73.3	71.1	68.9	66.7	64.4	62.2	60.0	57.8	55.6	

# Light and Growth

Name \_\_\_\_\_

**Observation:** Plants usually grow in lighted areas.

**Question:** Can plants grow without light?

**Hypothesis:** Plants cannot grow without light for photosynthesis.

**Prediction:** If the hypothesis is true, then pea plants will be smaller than light-grown controls, when germinated inside a box (without light).

**Experiment:** You planted seeds of the dwarf 'Little Marvel' cultivar of pea (*Pisum sativum*) some time ago. One pot of plants was left in the greenhouse and a second pot was placed in a dark box for growth. These have been watered as needed over the subsequent weeks and have grown under the lighted and dark conditions. You will now observe the plants and measure their growth.

**Height of shoots.** Make sure that each pot has the same number of seedlings (5). Cut at soil level and **completely discard** any extras from a pot. You must do this or all your efforts go down the drain!!! Measure the height of the five shoots remaining from each pot. For this, measure each shoot to the **nearest whole centimeter** and then calculate the mean.

Dark: \_\_\_\_\_ Mean: \_\_\_\_\_ cm

Light: \_\_\_\_\_ Mean: \_\_\_\_\_ cm

**Size of leaf.** Your instructor will tell you which leaf to measure: Leaf # \_\_\_\_\_.

Measure the length of this leaf **to the nearest cm** on each plant and calculate an average leaf length for each treatment. During your observations of the leaves, note the color of the leaves. CAUTION: The leaves are compound and may end in a tendril!

Dark: \_\_\_\_\_ Mean: \_\_\_\_\_ cm Leaf Color: \_\_\_\_\_

Light: \_\_\_\_\_ Mean: \_\_\_\_\_ cm Leaf Color: \_\_\_\_\_

**Number of leaves.** Your instructor will demonstrate the various types of leaves on the pea plant. Count the number of leaves on each plant from base to tip and calculate an average number of leaves for each treatment.

Dark: \_\_\_\_\_ Mean: \_\_\_\_\_

Light: \_\_\_\_\_ Mean: \_\_\_\_\_

**Fresh weight of shoot.** Using a razor blade, cut the shoots from each pot just above the cotyledons. Take care not to damage the cotyledons. **IMMEDIATELY** fold the shoots gently and place them squarely on the balance pan. Weigh each collection of shoots as accurately as possible.

Fresh Weight of shoots:                      Light A: \_\_\_\_\_.\_\_\_\_\_ g      Dark A: \_\_\_\_\_.\_\_\_\_\_ g

Place the shoots on a labeled sheet of aluminum foil to be baked dry.

**Fresh weight of cotyledon.** Locate both fresh cotyledons from the plants. Be sure to remove all soil, the seed coat, and other attachments. Weigh each collection of cotyledons as accurately as possible.

Fresh Weight of cotyledons:                      Light B: \_\_\_\_\_.\_\_\_\_\_ g      Dark B: \_\_\_\_\_.\_\_\_\_\_ g

Place the cotyledons on a labeled sheet of aluminum foil to be baked dry.

**Dry weight of shoot.** Remove the shoots from the foil and reweigh each collection of shoots as accurately as possible. Be sure the balance is zeroed when the pan is clean, dry, and empty.

Dry Weight of shoots:                      Light C: \_\_\_\_\_.\_\_\_\_\_ g      Dark C: \_\_\_\_\_.\_\_\_\_\_ g

**Dry weight of cotyledon.** Remove the cotyledons from the foil and reweigh each collection of cotyledons as accurately as possible. Be sure the balance is zeroed when the pan is clean, dry, and empty.

Dry Weight of cotyledons:                      Light D: \_\_\_\_\_.\_\_\_\_\_ g      Dark D: \_\_\_\_\_.\_\_\_\_\_ g

Discard the dried shoots, cotyledons and foil into the trash. Clean and put away the balance.

## Analysis:

On average, under which treatment do **shoots** have... (Neither means <5% difference!)

more height?	Light	Dark	Neither	longer leaves?	Light	Dark	Neither
more internodes?	Light	Dark	Neither	greener leaves?	Light	Dark	Neither
longer internodes?	Light	Dark	Neither	more fresh weight?	Light	Dark	Neither
more leaves?	Light	Dark	Neither	more dry weight?	Light	Dark	Neither

On average, under which treatment do **cotyledons** have... (Neither means <5% difference!)

more shriveled appearance?	Light	Dark	Neither
more fresh weight?	Light	Dark	Neither
more remaining dry weight?	Light	Dark	Neither

Did the plants growing in light produce any solid matter by photosynthesis? To crudely assess this question, calculate the total plant dry weights, and calculate the ratio of dry weight in light to the dry weight in the dark.

Combined dry weight of shoots and cotyledons (C+D): Light \_\_\_\_\_ g Dark \_\_\_\_\_ g

Ratio of dry weight of plants in light to plants in dark (Light  $\div$  Dark): \_\_\_\_.

(YES! You must divide it out and round to two decimal places.)

Calculate the % Increase (+) or Decrease (-) in weight ((Ratio - 1)  $\times$  100 ): \_\_\_\_\_%

Did Photosynthesis result in at least a 5% increase in dry matter?  yes  no

Did the shoots grow by merely taking up water? To analyze for this question, you must calculate the percent water in each shoot. This is done by comparing difference between the fresh weight (part A) and dry weight (part C) for the shoots, and compare the difference to the total weight (fresh weight).

Water found in shoots (A-C): Light \_\_\_\_\_ g Dark \_\_\_\_\_ g

Percent water in shoots [= 100  $\times$  (A - C)  $\div$  A ]: Light \_\_\_\_\_% Dark \_\_\_\_\_%

Under which treatment do the plants have at least 5% more water

content than do those under the other treatment?  light  dark  neither

Since we pooled our shoots in the weighing operation, we cannot carry out any kind of statistical test to determine whether the differences you have calculated are statistically significant or not. There would be no degree of freedom to carry out the test. However, your instructor may collect the Percent Water in Shoots information from each team in the class and subject the several calculated results to a t-test to help determine whether the differences observed in the class as a whole are statistically significant.

**Decision:** The hypothesis, "Plants cannot grow without light for photosynthesis"

is  cannot be  rejected.