INTRODUCTION

Plants have always been a source of fascination to me. I have worked in the garden with my mom my whole life. We have always sought different ways to better grow our plants, whether it was with more fertilizer, a different type of soil, or a different location. My science projects of the past were of plants, too, and they were always about improving the quality of plants in different environments. In biology class, we discussed the necessity of light for photosynthesis and what occurred when there was no light. So if a plant had more than the usual 12 or so hours of light, would it become a �super plant?� Would it be unusually tall, or large?

GERMINATION:

All types of seeds need these three things to grow: a proper temperature, moisture, and oxygen. Seeds receive all the moisture they need from the soil they live in. The moisture softens the seed�s coat, allowing its growing parts to break through. The moisture also helps to prepare certain materials in the seed for their part in the seed�s growth. If the seed receives too much water, it may begin to rot. If it receives too little, germination may take place slowly or not at all. The seed needs oxygen for the changes to take place within it during germination (Mandell and Walker)

Conditions needed for germination include abundant water, an adequate supply of oxygen, and proper temperatures. When a seed begins to grow, it absorbs large amounts of water. This water causes many chemical changes inside the seed. It also causes the seed�s internal tissues to swell and break through the seed coat. Temperature requirements for germination vary. Species that germinate in the summer require higher temperatures than those that germinate in spring. Many seeds require a cold period before they can germinate. Some types of seeds also need light to germinate. These seeds tend to sprout during the spring, when the number of daylight hours increases.

FACTORS AFFECTING PLANT GROWTH:

Its heredity and its environment determine the plant�s growth. The plant�s heredity determines its characteristics, such as its flower color and its general size. These characteristics are passed from generation to generation. Some environmental factors are sunlight, climate, and the soil condition (Mandell and Walker).

Substances that are made within the plant may also affect the plant�s growth. These hormones control these activities: the growing of the roots and the production of flowers and fruit. Other growth hormones, called gibberellins, make the plant grow larger, cause blooming, and speed seed germination. Another hormone, the cytokinins, makes the plant�s cells divide.

All plants need light, a suitable climate, and an ample supply of water and minerals from the soil. But some types of plants grow best in the sun, while others love the shade. Plants are also different in the amount of water they need and in the temperature they need to survive. Plants growing in the shade experience a low red to far-red light ratio, and many plants will undergo extension growth as a response to growing in red light depleted shade (Peer, Briggs, and Langenheim 640). These environmental factors affect the rate of growth, the size, and the reproduction of plants.

PHOTOSYNTHESIS:

Photosynthesis is the process of converting energy from sunlight to energy in chemical bonds. It takes place in the chloroplasts of the plants. Its general equation is:

Light + 6H2O + 6CO2 --> C6H12O6 + 6O2

C6H12O6 is called glucose. The plant uses it to complete its cycle in producing energy. Photosynthesis begins when pigments in the plant cells absorb light and the energy excites and electron, energizing it. The electron gives off the energy it just received and another electron in a nearby pigment molecule is excited. This process continues until a chlorophyll a molecule, P680, absorbs the energy. The P680 stands for the maximum wavelengths of light that can be absorbed. This molecule forms photosystem II and another molecule called P700 forms photosystem I (Pack 63).

A process called Noncyclic Photophosphorylation produces ATP, an energy molecule, from ADP using energy from light. It begins with photosystem II, in which as mentioned before, electrons are energized by light. The energized electrons go to a primary electron acceptor and pass through an electron transport chain. The chain is composed of proteins that pass electrons from one protein to the next, causing the electrons to lose energy. The energy lost is used to create ATP molecules. When the electrons reach photosystem I they are energized by sunlight again and passed to another primary electron acceptor. At the end of the chain, the electrons combine with NADP+ and H+ to form NADPH, a coenzyme and an energy-rich molecule. The electrons that came from photosystem II are now part of NADPH and the loss of the electrons is replaced when H2O is split into two electrons, 2 H+ and � O2. This process is called photolysis. All of the reactions in Noncyclic Photophosphorylation are often called the light reactions because they require light.

Another cycle, the Calvin Cycle, produces glucose (C6H12O6). An enzyme called RuBP Carboxylase, or rubisco, works to merge CO2 and RuBP to produce phosphoglycerate (PGA), which contains 3 carbon atoms. Then the ATP and NADPH from the light reactions are used to convert the PGA into PGAL, or phosphoglyceraldehyde, an energy rich molecule. The used ATP and NADPH, now ADP and NADP+, are reincorporated into noncyclic photophosphorylation where they are energized again. The whole cycle will end up repeating itself 6 times in order to produce 1 molecule of glucose. Most of the PGALs produced are combined with ATP to produce RuBP, allowing the cycle to continue. This cycle is also called the dark reactions because light is not directly used by the cycle. The cycle cannot occur in the dark, however, because the much needed ATP and NADPH are only produced in the light during photophosphorylation.

At night, the process of photosynthesis can no longer occur and a different process begins. This process is called respiration. Rubisco is the most common protein on earth (Pack 70). But along with its ability to work with CO2, it is also able to fix oxygen. This leads to problems. The CO2-fixing efficiency is reduced because instead of just fixing CO2, oxygens get in there as well. And when oxygen is used instead of CO2, specialized organelles, the peroxisomes, which are near the chloroplasts, begin to break down photorespiration products (Pack 70). This means that the plant releases CO2 without the production of ATP or NADPH and undoes the work of photosynthesis (Raven and Johnson 194). Plants that carry out this process are called C3 plants.

EXPERIMENTS WITH LIGHT AND PLANTS

Wendy A. Peer, Winslow R. Briggs, and Jean H. Langenheim studied the shade avoidance responses in two coastal redwood forest species in different light quality environments. "Many studies have indicated that phyB-like phytochromes are involved in modulating various parameters of the shade-avoidance and end-of day far-red responses" (Peer, Briggs, and Langenheim 644). They studied how different species were affected by the amount of light and found that some responded as sun-adapted plants, while others as shade-tolerant. The shade-avoidance response is thought to be an adaptive feature of some plants to enable seeds that germinate beneath the soil surface to rapidly emerge and in shade to grow away from areas of low R:FR light through hypocotyl and stem extension (Peer, Briggs, Langenheim 642). If the plant had just sunlight, and no shade, it would flourish rapidly.

[Lourens Poorter and Marinus J.A. Werger](http://www.amjbot.org/cgi/content/full/86/10/1464?JOURNALCODE&TITLEABSTRACT=light&FIRSTINDEX&SEARCHID=QID_NOT_SET&RESULTFORMAT&hits=10&gca=86/10/1464&sendit=Get+All+Checked+Abstract(s)&)  studied the affects of light on the architecture of plants in the rain forest. They found that sun plants had a similar crown area, a deeper crown, and a higher leaf area index compared to shade plants and their leaves were more evenly distributed along the stem. This suggests that differences in leaf layering are found between plants growing in different light environments, rather than between species differing in shade tolerance (Poorter and Werger). "...it can be argued that light-demanding species should invest more in horizontal crown expansion to increase light interception in the light-limited understory" (Poorter and Werger). Their results showed that plants in the shaded area had a larger height than plants in the sun.

Etsushi Kato and Tsutom Hiura experimented with the effect of light availability, display size, and local floral density on fruit sets. Earlier studies have examined pollen limitation and resource limitation, but there are areas where even mature individuals may not reach the canopy layer and cannot receive sufficient light for the maturation of fruits (Kato and Hiura 495). Therefore, the fruit set is limited by light availability, not pollen. They discovered that light availability had no effect on fruit initiation, but was "positively related to mature fruit set" (Kato and Hiura 499).

RADISHES:

A radish is an annual plant grown for its edible root. Radish roots vary in shape, size, and color, according to its variety. Gardeners usually plant radishes in the spring, but in mild, cool climates, radishes may grow throughout the year. The roots are ready to harvest in four or five weeks (MacGillivray). The variety that I will be using produces a large, globe-shaped radish that is about 1 �" across and has a crimson skin and mild white flesh. It is ready in about 29 days. In the Pacific Coast areas, they should be sown from fall to early spring and seedlings emerge in 7-10 days depending on the environment. They thrive in cool weather and become large without becoming hollow or pity.

SUNFLOWERS

Sunflowers grow to be 4-12 feet tall, with either one single large bloom, or smaller blooms in clusters. They have a tolerance to high temperatures and plenty of sunlight. Sunflowers have blossoms composed of yellow petals that circle around disks, with smaller yellow or brown petals. They have the ability to track the sun because of auxin in the shady part of the stem. The auxin causes that region of the stem to elongate, bending the flower towards the sun.

Sunflowers are grown for their seeds and oil. Refined sunflower-seed oil is edible and considered by many equal in quality to olive oil. Cruder sunflower oil is used for making soap and candles (Encarta). The seeds are consumed by both humans and animals.