LESSON 2: LIGHTING

There are basically four requirements for plant life;
Water, Nutrition, light and climate.

In lesson 1 we covered the different types of systems and some basic theory on how hydroponics works, now we're going to start finding out why hydroponics works. In this lesson we are going to learn about photosynthesis and how plants need light to grow.

If your garden is outdoors or in direct sunlight then proper lighting isn't something you should need to worry about. The plants should get the complete spectrum of light that they need from the sun.

If growing indoors lighting can be a concern. While it may be in sunlight such as a windowsill it may not be getting the light enough hours of the day, and may be underperforming. You may need to add some supplemental lighting to extend the hours of light the plant needs.

It is very possible to grow in an enclosed space with the right artificial light, but not all light sources are created equal, and there is the additional cost of powering the lights.

Do you know the difference between types of lights? Did you know that for proper growth, just any old bulb won't work? There are major differences between light bulb types so we'll start with the type that everyone will be familiar with; the incandescent.

INCANDESCENT

This oldie was first experimented with in the early 1800's. It was continually refined and Thomas Edison's design in the late 1800's has remained almost unchanged today. That should tell you something about the efficiency of these bulbs. While they are cheap to buy, they use considerably more electricity than any other type of light bulb for the amount of light produced.

Another downside for using them as grow lights are that the amount and colour of the light isn't ideal for plant production. That's not to say it won't work, but the results will be far less impressive than if actual grow lights were used.

Incandescents also have a habit of throwing off a lot of heat. If your grow room isn't sufficiently ventilated excess heat and moisture can lead to unwanted mold that will be bad for your health, your plants health, and your property resale value!

This golden glowing oldie is cheap and readily available, but it's on its way out in favour of more energy efficient types of lighting .

FLUORESCENT

with roots almost as old as the incandescent bulb, but far more refined, fluorescent bulbs are much more efficient than Incandescents. Fluorescent lights have efficiency of about %22 percent of the energy used is converted to light (incandescent is about %10). Recent changes in technology have allowed many of the drawbacks of fluorescent bulbs to be overcome.

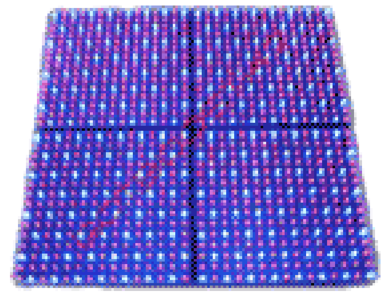
While they are more efficient than incandescent lights, they do have problems. They require a ballast to provide a controlled flow of electricity. Without such a ballast they would very quickly self destruct. They also have a low light density, meaning a fluorescent light would need to be physically bigger to put out the same amount of light. This is great for the first 2 weeks of plant growth, but afterwards the intensity is simply too low for best results.

As grow lights they can do a decent job but won't provide the best possible results. They are better for growing than incandescent because they can provide a wider color spectrum, and they do not emit nearly as much heat as a normal bulb. Newer style fluorescent lights use an electronic ballast, rather than an older-style electromagnetic one. By using these they flicker less, come on instantly, and don't give off an annoying humming noise.
Recently Compact fluorescent bulbs have come on the market incorporating a ballast into the base and tube(s) to contain the gas inside. One interesting development is certain CFL grow lights can have separate tubes in different light spectrums to have a near complete amount of each color light from one bulb.

LIGHT EMITTING DIODE

Two individual LEDs

An LED grow Panel



The concept for this type of light goes back to 1907, and commercially viable LED's became available sometime around the late 1960's. Unfortunately these LEDs were pretty dim, and were only in one colour; Red.

As time went on, the light output was increased, and more colours became available, but were still costly to implement, or too dim to be useable. In the early 90's a very bright blue LED became available and by the end of the twentieth century they were widely used. Bright blue LEDs are significant because plant growth requires mainly the red and blue spectrum of light and with this advancement growing with LED became viable.

LEDs can be very efficient with the lower end LEDs being about twice as efficient as incandescent bulbs, and the higher end LEDs have an efficiency just above the most efficient fluorescent lights. Recently specialized LED grow lights have come on the market with a balance of red/blue light for proper growth.

Besides being efficient LED have several benefits over other methods of lighting. LEDs are very durable, they are solid state and are very hard to break by force, drop one from the ceiling and it should be fine… unlike a glass bulb. The lifetime of LEDs is significantly longer too, from 35,000 hours to 50,000 hours of useable performance, instead of 2000 for incandescent and 30,000 fluorescent, and even then they still give off light, but it has dimmed. It's rare for LEDs to simply not give off light.

Growlight LEDs may be more costly initially, but have higher output and don't degrade when turned on (like fluorescent) and don't need a "cool-down" period like some HID lighting systems.

HIGH INTENSITY DISCHARGE

The norm for hydroponic lighting, this type of light offers increased efficiency and light density than fluorescent or incandescent lights, and has a lower initial cost than LED lighting.

These bulbs also require a ballast like a fluorescent bulb, but are usually made with a quartz bulb, and the pressurized gas inside varies depending on what type of light is needed. The most common two are High Pressure Sodium (HPS) used for flowering, and metal Halide (MH) used for vegetation growth.Unfortuneately they also give off the largest amount of heat.

These lights are what you will find in most hydroponics supply stores, they can be tailored for specific applications, areas and growth stages.

Did You Know?

These types of High Intensity Discharge (HID) lamps are known as "arc lamps".
They are called this because they produce light by electricity jumping or "arcing" from one electrode to another. It was originally named "arching" due to the shape, but was shortened around the late 1800s.

PHOTOSYNTHESIS & TRANSPIRATION

Plants require a constant supply of energy to grow and this energy comes from light. In nature, plants receive light from the sun but if you're in a classroom, you may need to add artificial light so your plants have an adequate amount of light to grow.

Transpiration and photosynthesis are the two major processes that are carried out by green plants that use energy from the sun. Both of these processes use large amounts of light energy but only in photosynthesis is a significant amount of energy from light actually stored for future use. Light influences other processes such as flowering, seed germination, certain growth stages and pigment production but, in these cases, only very small amounts of energy from light are used.

During the transpiration process, plants draw in carbon dioxide from the air through their pores and water from their roots and give off oxygen and water vapor. Energy from the sun evaporates water from the plant cell walls. Although this results in a movement of water in the plant tissue (xylem) this energy is neither stored nor used to bring about vital reactions involved in the synthesis of foods, in assimilation, growth or reproduction.

In photosynthesis, which literally means "putting together (synthesis) by means of light (photo)," water is drawn up through the stem from the roots and into the leaf tissue where the chloroplasts, containing chlorophyll (a green pigment) can be found. There the water encounters carbon dioxide which entered the leaf from the air through minute breathing pores (stomata) located abundantly on the underside of the leaves. The stomata also permits the outflow of water vapor and oxygen. The light, carbon dioxide and water produce carbohydrates which are stored in the plant and later released as energy for other vital plant functions.

Energy stored as chemical energy in foods (carbohydrates, fats, proteins) is continually released in living cells during the process of respiration. Basically, photosynthesis stores energy and respiration releases it enabling cells to perform the work of living. By releasing energy, respiration provides the energy needed for all other plant functions.
Everything we know ultimately depend on photosynthesis because it is the method by which all basic food is created.

You know how plants use the light, but what role do the different coloured lights play?

White light, as it comes from the sun, is composed of waves of red light, through successively shorter waves to violet light. The band of colors that compose the visible spectrum of light (that which we can see) include, starting with the longest rays, red, orange, yellow, green, blue, indigo and violet. The visible spectrum represents only a part of the radiant energy that comes from the sun and only a part of the visible spectrum is effective in photosynthesis.

Wavelengths that cannot be seen by the naked eye also exist. Beyond the red rays are still longer rays called infrared and beyond the violet rays are even shorter rays called the ultraviolet.
The fact that chlorophyll is green to the eye is evidence that some of the blue and red wavelengths of white light are absorbed, leaving proportionally more green to be transmitted, reflected and seen.

If your plants aren't getting enough light they can let you know. Here is what to look for if your plants aren't getting what they need.

•The plants may stretch and grow towards the light source, and have elongated stems
•The plant may become deformed and odd shaped- and may not be flowering or fruiting due to lack of light.

If your garden is outdoors or in direct sunlight then proper lighting isn't something you should need to worry about. The plants should get the complete spectrum of light that they need from the sun.
If growing indoors, lighting can be a concern. While it may be in sunlight such as a windowsill it may not be getting the light enough hours of the day, and may be underperforming. You may need to add some supplemental lighting to extend the hours of light the plant needs.

It is very possible to grow in an enclosed space with the right artificial light, but not all light sources are created equal, and there is the additional cost of buying and powering the lights. Specialty lights such as the ones we discussed previously can provide a close approximation of sunlight, but no artificial light can provide the entire spectrum.

Placement
The intensity of the light is directly proportional to the distance of the light source. Closer is better as the

plants will recieve more light this way, but when using fluorescent, incandescent or a HID arc lamp, if you place them too close to the plant, it will burn the plant.

LED's have an big advantage here as they give off very little heat and the plant can be touching the light with no ill effects.

TEACHERS' TIP

If you plan to set-up a hydroponics system in your classroom, most likely you wont have proper lighting, or a budget to accommodate it. If this is the case there are certain plants that do not require as much light as others, and may perform better.

A tomato plant is an example of a plant that has a high light requirement.

The following plants have a low light requirement and thus should perform better in a classroom setting.
Beets • Carrots • Lettuce • Cabbage • Radishes • Spinach • Onions • Peas