

Personal Photo-BioReactor (PPBR) Kit Instructions

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Welcome to the wonderful world of home-grown spirulina! This (evolving) guide is written to help you grow up the bottle of spirulina culture included with your kit into a thriving tankful that can be harvested often for a highly nutritious superfood unavailable any other way!

Important statement about liability:

While I have no reason to think that there is any danger involved in growing and consuming spirulina that you grow yourself, this is a new process which we are still learning about, and hazards to your health cannot be ruled out. **In particular, follow these instructions TO THE LETTER** and do not eat your spirulina if pH is low (<10), color is off (anything but deep blue-green), or you have any other reason to think that anything might be amiss with your culture. I also recommend getting a microscope and monitoring your culture to make sure that no other algae (or other organisms) are growing there.

OK, so here's what you'll need to grow your own Spirulina (see pic below).



Figure 1: The kit. Buckets and beaker not included.

A full kit, with all the below components, is available at AlgaeLab.org :

- **A tank**, or other container to hold the culture. 10 gallons is a good size to start with, and inexpensive 10-gallon aquariums (as shown in the pictures) work well. Keep in mind that you will need to be able to clean it out thoroughly from time to time;
- **Live Spirulina**. You can order a liter bottle from AlgaeLab.org (these instructions assume this), or buy much smaller amounts at higher cost from culture libraries such as UTex or CCMP;
- **A heater**, capable of maintaining the tank at around 97 degrees F. 100W is a good size for a 10-gallon tank;

- **Aquarium thermometer;**
- **Plug timer**, for heater;
- **Air pump** of a size appropriate for the tank;
- **3' aquarium air tubing;**
- **Diffusers/bubblers** sufficient to run around the inside edges of the tank;
- **4 Clothespins** or other clips;
- **3/4"+ dia. Tubing** for harvest;
- **pH strips** capable to measuring a range of 7-11 pH;
- **Harvest cloth** screen printing fabric with 40-50 micron openings;
- **Nutrients** – see Appendix at end of this document. Pre-mixed nutrients can be bought from AlgaeLab.org, and are provided with the kits.

More information about how to use each of these components is below. In addition to the kit, you'll want one or two 2.5 or 5 gallon buckets, and some thin clear plastic to cover the tank (more about these items below). Also note that we're assuming that you're using one of our 10-gallon tanks; if you're not, scale the amount of culture you make accordingly...

General Instructions About Growing Spirulina:

To grow, Spirulina, like any algae, needs light, water, carbon dioxide, and the right amounts of nutrients.

Light:

When your culture is growing well and fairly thick, it will grow best when exposed to maximum sunshine – the more the better. This is an important factor for choosing where to put the algae tank. A greenhouse is ideal, next best is a south-facing window that gets a lot of sun.

However, a lot of direct sunshine (or other bright light) can hurt the algae when they are otherwise stressed (e.g. immediately after putting your starter into your tank, or when pH is high, temperature is low, or nutrients are off). Also, a lot of sunshine can cause the tank temperature to climb too high (see below). If this starts happening, shade your algae a little (thin white fabric is best, to ensure that not too much light is lost), then give them sun again when the problem is fixed for maximum productivity.

Temperature:

Temperature is also very important. These algae (*Arthrospira Platensis* from the CCMP culture collection) seem to prefer temperatures around 97 Fahrenheit. Above about 102F they tend to clump up and turn yellowish, indicating stress. If this happens, strain out the clumps, add in nutrients as if you just harvested, and they will bounce back and turn blue-green again. If high temperatures continue too long, the algae will die; this is one of the most common ways in which cultures have been lost so far. This is a particular concern on especially sunny days, when the heat of the sun can raise the temperature unexpectedly high.

Low temperatures are not harmful -- in fact, because they slow down the algae's metabolism, they can help keep them alive without feeding/mixing, if live spirulina need to be stored for a few days (or longer) -- but they won't grow well.

Carbon Dioxide:

There is a (growing) amount of carbon dioxide in the atmosphere. This is more than adequate for good growth. If you have a very high-sunshine setup that is growing well, and you desire higher growth, you may want to experiment with carbon dioxide supplementation to increase the growth further. Look on the website AlgaeLab.org for details of how to do this.

Nutrients:

The algae need the right combination of ingredients in the water (the “medium”) to grow well. These are supplied by the included nutrient mixes – the “Starter” mix to make new medium, and the “Make-Up” mix to replace nutrients lost when the algae are harvested. If you want to make your own medium instead of using our pre-mixed powders, the recipe is at the end of this document.

To keep the medium from getting too concentrated, replace any water evaporated from the tank with fresh water.

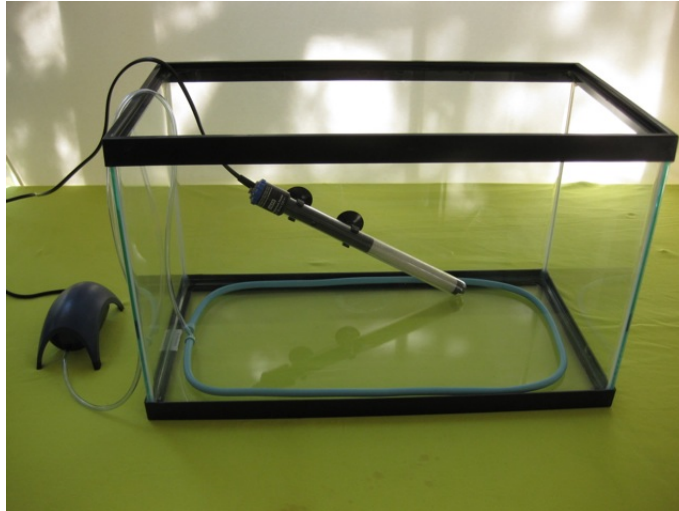
Try to prevent any culture contamination. While the high pH of the culture should prevent anything deleterious from growing in it, hygiene is still a good idea. Minimize contact with the culture, and wash your hands carefully if you have to touch it. Keep the PPBR covered.

How to measure culture density:

This is expressed in terms of how far through the culture you can see a high-contrast item. The best thing is to print out a 2x2 black and white checkerboard pattern on a square 3"x3", seal the whole thing up with clear packing tape, and attach it to a piece of wire that has centimeter marks on it. If you don't have a printer, use something white in place of the checkerboard pattern. Then you can stick it in your tank and see at what depth it "disappears". It is a surprisingly consistent and useful measurement. For example, if the depth is more than 4cm, it's better to leave the culture before harvesting; if it is 4cm or less, go ahead and harvest. As you watch your tank, you'll develop an “eye” for when the density is high enough...

How to Grow Your Spirulina: Step by Step Instructions**Taking Care of the Spirulina Starter (Inoculum):**

When transporting your bottle of starter Spirulina, keep the lid on tight to keep it from spilling (obvious?). But as soon as you can, put it in a spot that has plenty of light but no direct sunlight, remove the cap, and if possible fill the mouth of the bottle with a cotton ball or two so it can breathe without becoming contaminated. If you have an air pump and a little hose, run bubbles through the culture to keep it mixed. If not, swirl it gently to re-suspend the algae (making a uniform green soup with minimal splashing, it only takes a few seconds) as often as possible, at least once a day. Start the culture as described below as soon as possible; the algae can survive this way for a few weeks, but they'll grow better if this period is kept to a minimum.



Starting the Culture:

To start the culture, position the PPBR so that it will get plenty of light, but not direct sunlight. Use a white sheet or other thin white fabric to shade it if it has to sit in a sunlit place. Once it has become dense (< 4 cm visibility), give it as much sun as possible; move it to a brighter place if necessary. You'll see that it grows better on sunnier days, though a lot of sun can also raise the temperature too high; keep an eye on this in the summer...

Put the bubbler wand in the tank as shown above, running along the edge of the tank; this is a good position for the bubbler because the turbulence created by the bubbles will help prevent algae from clumping and sticking to the walls. Attach the bubbler to the air pump, inserting the check valve into the line to prevent culture from running back into the air pump. Blow into the check valve to make sure you're inserting it in the right direction, so that air can flow. Attach the heater to the lower part of the side of the tank. Plug the heater into the plug timer included with the kit. The Spirulina grow best when they are cool at night, so set the timer to turn off the heater at dusk, and to turn on the heater about three hours before dawn. Instructions for how to set up the timer are attached to the end of this document.

Important note about What Water To Use:

Using the wrong water will kill your Spirulina! To make the medium in which the Spirulina will grow, you'll need a good water source. The best source we have found is tap water, filtered through a filter medium such as activated carbon or ceramic (i.e. a Brita, Pur, Berkey, or other common water filtration systems). The only thing the filter has to do is remove the chlorination. Unchlorinated well or spring water should work as well. The two things to avoid are chlorination, and water from which all minerals have been removed.

To use chlorinated water: If you do not have a water filter, and the water source you have is chlorinated (e.g. tap water), you can dechlorinate the water as you would for an aquarium; any pet store will sell dechlorination kits.

To use mineral-free water: If you want to use distilled water, rain water, or water that has been filtered using reverse osmosis, or if you live in a place with extremely "soft" water, you will need to add some extra minerals into the water to make up for what is missing from your water. This would be 0.1 g/L magnesium sulfate, 0.5 g/L potassium sulfate, and/or 0.1 g/L calcium chloride (or lime or plaster); the first two may not be necessary if the water is merely "soft".

Do not use "alkalized" water (e.g. from "Kangen" filters, etc.), the pH is totally wrong for the Spirulina. If you don't know what this is, don't worry about it.

Mix up 10 liters of medium by combining 10 liters of water (chosen according to the guide above) with 15 tablespoons (that's one cup minus one tablespoon) of the "starter" mix, plus 2 squeezes of the Algae Iron solution in the brown bottle.

This ratio -- 7 1/2 tablespoons of starter powder and 1 squeeze of iron solution per 5 liters of water - is what to use whenever starting or expanding a culture.

Angle the heater so that its top comes out of the water (anything above the max level mark must be dry for your safety), where it can be more easily adjusted and read. Plug in the bubbler. Mark the level of the water on the side of the tank with an erasable marker.

It is a good idea to only pour in half of your bottle of starter, keeping the second half in reserve in case something goes wrong. It will grow up faster, though, if you use the whole bottle.



Using the thermometer, watch the temperature and make sure it doesn't go above 102F – which is especially likely to happen after it's gotten a few hours of direct sunlight. Adjust the heater to get a temperature around 97F. Every few days, add in fresh water to make up for evaporation, keeping the water level constant.

You may want to put some kind of clear plastic cover over the top of the tank to lessen evaporation and to keep out dust, etc. Plastic wrap or clear plastic bags held in place by clothespins or gravity works fine.

Be patient! This stage can take a few weeks. If you check the pH at this stage (optional), it will start at around 8.5 and slowly rise as the days go by.

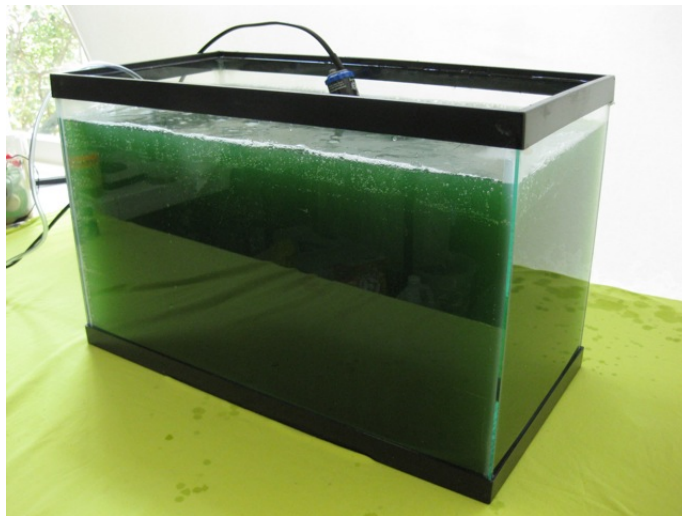


Growing Up the Culture:

When the culture density gets high (<4 cm visibility), expand it by adding more fresh medium -- 7 1/2 tablespoons of starter powder and 1 squeeze of iron solution per 5 liters of water. Add enough medium to double the volume of the culture – for the first doubling, this amounts to 10 liters of water, 15 tablespoons of starter mix, and 2 squeezes of iron solution.

Adjust the heater position to keep its top above water! Re-mark the water level so you can keep it constant by adding fresh water as before.

Wait until the culture is dense again, before doubling again. Keep going until the tank is full.

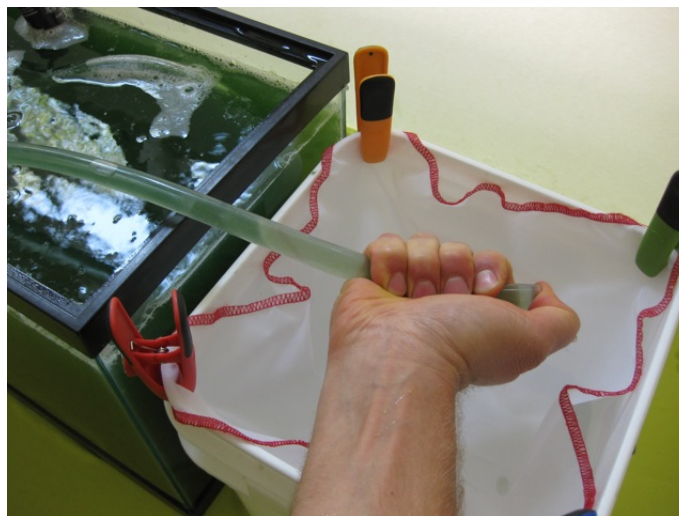


Harvesting:

When the PPBR is full and density is high (<4 cm visibility), it is time to harvest. Check the pH; if it is below 10, don't harvest yet. If it is 11 or above (which won't happen for months after the first grow-up), you will want to replace the medium (see below). pH should rise over time, but only very slowly (over months) after reaching 10+.



Set up a small bucket next to the PPBR, making sure its lip is at or slightly above the PPBR culture level. The process goes faster (and you can harvest more Spirulina) if the bucket can be placed lower than the tank. Use clips to secure the harvest filter cloth across the open top of the bucket, allowing it to droop down by 3 inches or more as seen above.



Use the larger tube as a siphon by immersing it in the culture, plugging one end with your thumb, then pulling that end out while keeping the other end immersed. Keeping it plugged, place the tube end into the lowest part of the filter cloth and let go. If this end of the tube is below the culture level, this should form a siphon, which will draw the culture into the filter.



Although the height of the bucket lip will keep it from overflowing even if left alone, it is better to stop the flow before the medium level in the bucket hits the bottom of the filter cloth.



Gather the spirulina captured in the cloth together by raising the edges and gently shaking, forming a clump in the center. Gently squeeze this clump to release most of the remaining medium.



This can be repeated for larger harvest, but as a general rule, don't pass more than half the PPBR volume through the filter cloth at one time, or the remaining culture may be too thin to grow back quickly.



Assess the volume of the harvested spirulina. For every tablespoon of fresh spirulina harvested, mix 1 teaspoon of the "Make-Up" mix (MAKE SURE TO SHAKE & MIX IT WELL BEFORE USING!) with a liter or so of water and pour it into the PPBR (alternately, mix it with the culture medium that passed through the filter cloth). Also a squeeze of iron juice for every five liters of culture passed through the filter.



The harvested spirulina should be dark blue-green. If it is not, do not eat it.

Enjoy the spirulina! Put it in your smoothie, mix it in soup or sauces after cooking -- avoid exposure to high temperatures to maintain the nutrient content. Keep in mind that fresh spirulina is like raw eggs or raw meat, and spoils very quickly; do not touch it unless your hands are very clean. Excess spirulina can be frozen without losing nutrients, or dried.

The harvest cloth can be washed with warm water and a bit of soap, or it can be placed in the top rack of your dishwasher for cleaning.

Maintenance:

Add more fresh water occasionally to replace evaporated water and keep the level of the culture constant.

Floating clumps of spirulina can be scooped up with a strainer to separate them from the culture for disposal. If there are many, use the siphon to draw larger quantities of medium through a screen to capture the clumps. If the clumps are anything but dark blue-green do not eat them; compost them instead.

If excess clumps of spirulina can be seen at the bottom, the whole culture can be siphoned temporarily into buckets or other (clean!) containers while the PPBR inside is cleaned. This is a good thing to do every few months or so.

Add in "Make-Up" mix in proportion to the spirulina removed in this way -- 1 tsp powder, and a squeeze of iron juice, per two tablespoons of algae gunk removed. Mix it in some water before adding it to the If your tank isn't growing well, try adding some more.

Renewing the Culture

If the pH of the culture is 11 or above, or if you have any reason to think that the medium chemistry is off (i.e. the culture is yellowish and doesn't grow well), you will need to replace the medium.

Mix up twenty liters of medium, using 30 tablespoons of starter mix, 4 squeezes of iron juice, and 4 teaspoons of green tea. Move the heater in to the new medium to start equalizing the temperature. Run the entire culture through the harvest cloth; you'll have to do this in stages. After each run through the harvest cloth, put the harvested Spirulina immediately into the new medium. Pour the old medium into your compost pile.

If you have any questions, email us at questions@algaelab.org.

Finally, HAVE FUN!

Appendix: Mix Recipes

*** ALWAYS USE FOOD-GRADE CHEMICALS IN YOUR NUTRIENT MIXES! ***

Starter Mix Recipe:

All measurements are in grams per liter of fresh water.

Ingredient	Amount	Suggested Source
Sodium bicarbonate, also known as baking soda	16 g/L	Your local supermarket
Potassium Nitrate also known as saltpeter	2 g/L	http://store.theingredientstore.com/saltpetre-food-gradedpotassiumnitrate.aspx
Sea Salt	1 g/L	Your local supermarket or health food store.
Ammonium phosphate (see note below)	0.1 g/L	http://www.homebrewers.com
Strong green tea	1 mL/L	Your local supermarket or health food store.
Iron Sulfate	10 mg/L	http://www.healthwarehouse.com (use ¼ of a dropperful per liter of medium)

For measuring the green tea, the fact that 5 ml is almost exactly 1 teaspoon may be useful.

The ammonium phosphate can be monoammonium phosphate $(\text{NH}_4)\text{H}_2\text{PO}_4$, diammonium phosphate $(\text{NH}_4)_2\text{HPO}_4$, or monopotassium phosphate KH_2PO_4 .

Sodium nitrate can be substituted for the potassium nitrate, but then it is necessary to add 0.5/L of potassium sulfate so that the algae get enough potassium. If your water is very "soft", you must add 0.1g/L of lime, calcium chloride, or plaster to the mix. To grow in distilled water, rain water, or reverse osmosis water, add 0.1 g/L magnesium sulfate, 0.5 g/L potassium sulfate, and 0.1g/L of lime, calcium chloride, or plaster to the mix.

Make-Up Mix Recipe:

This makes enough for several months of harvesting. It is only used at harvest time.

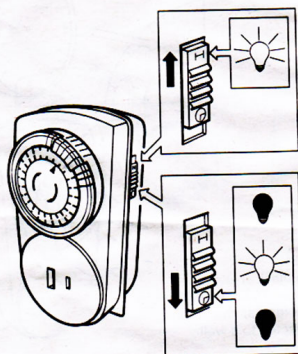
Ingredient	Amount	Suggested Source
Potassium Nitrate, also known as saltpeter	1.4 kg	http://store.theingredientstore.com/saltpetre-food-gradedpotassiumnitrate.aspx
Ammonium phosphate (see note)	50 g	http://www.homebrewers.com
Potassium sulfate	30 g	http://www.enasco.com
Magnesium sulfate, also known as Epsom Salt	20 g	Your local supermarket.

If your water is particularly "soft", add 10g of lime.

These recipes are adapted from the online pamphlet by Antenna Technologies, "A Teaching Module for the

Production of Spirulina" by J. Falquet, June 1999.

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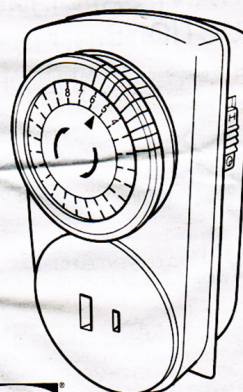


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**ENGLISH**

Only for indoor use.
Max. load: See type label.

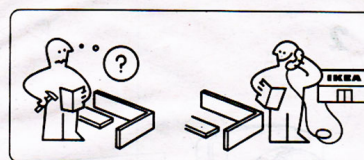
IMPORTANT SAFETY INSTRUCTIONS

This product has a polarized plug (one blade is wider than the other) as a feature to reduce the risk of electric shock. This plug will fit in a polarized outlet only one way. If the plug does not fit fully in the outlet, reverse the plug. If it still does not fit, contact a qualified electrician. **Never use with an extension cord unless plug can be fully inserted. Do not attempt to defeat the safety purpose of the polarized attachment plug. Do not alter the plug.**

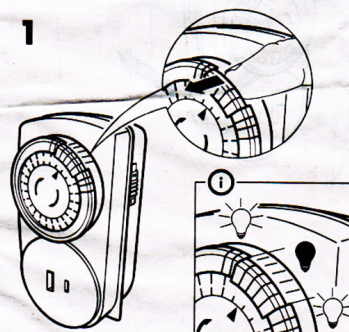
CAUTION: TO PREVENT ELECTRICAL SHOCK, MATCH WIDE BLADE OF PLUG TO WIDE SLOT, FULLY INSERT.

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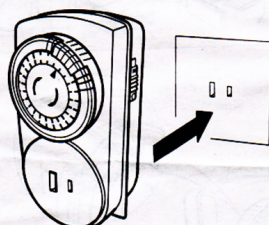


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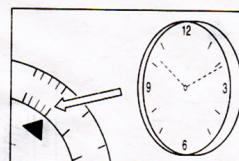


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**ENGLISH**

Set the black arrow to local time. The clock will work as long as the timer is connected to a wall socket.

FRANÇAIS

Placer la flèche noire sur l'heure locale. L'horloge fonctionnera tant que le minuteur est branché sur une prise murale.

ESPAÑOL

Pon la flecha negra en la hora local. El reloj funcionará siempre y cuando el temporizador esté conectado a la electricidad.

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