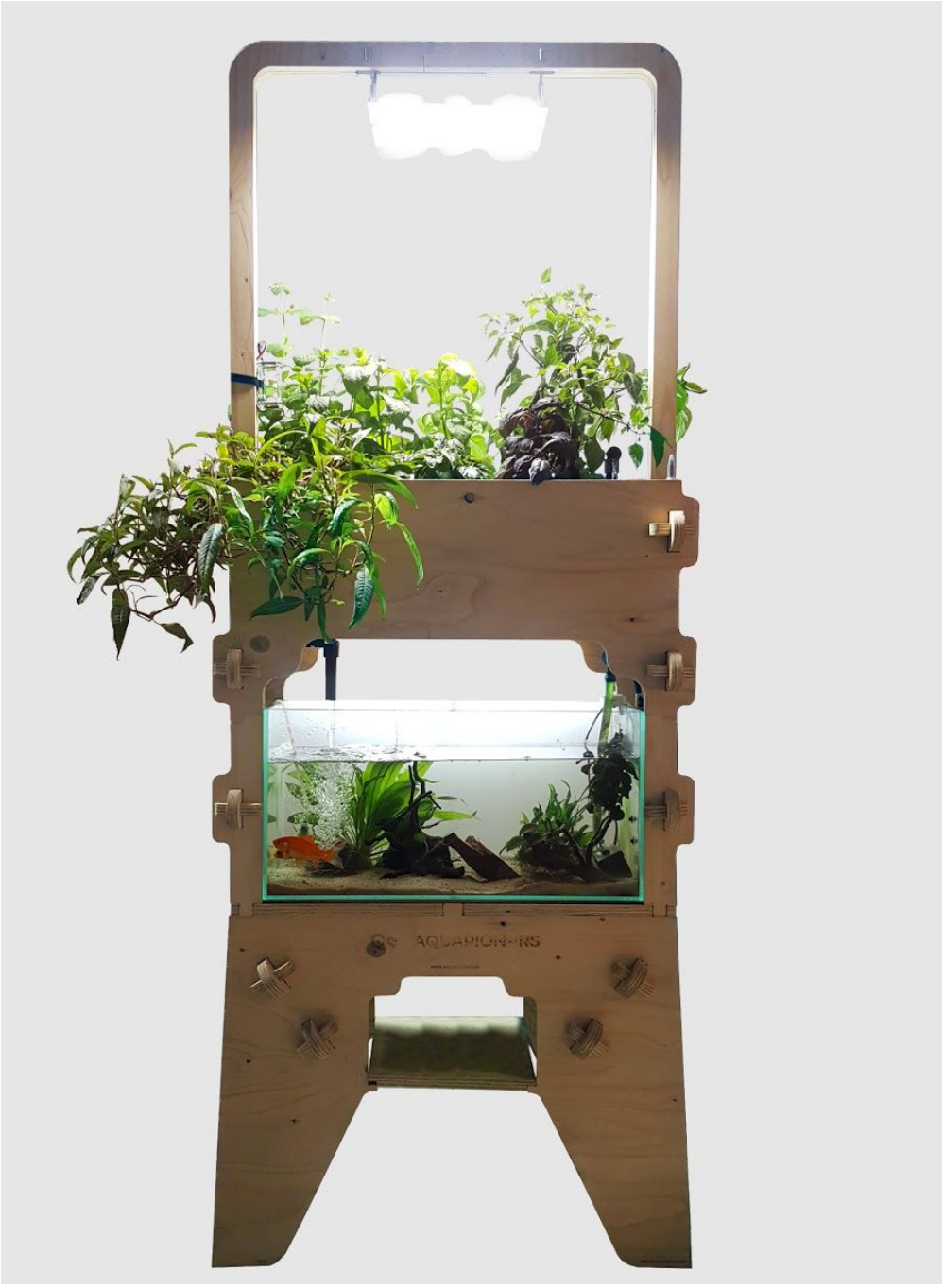
Download kit

Free documentation & blueprints for Aquapioneers Kit
Part IV - Biological System - The Life

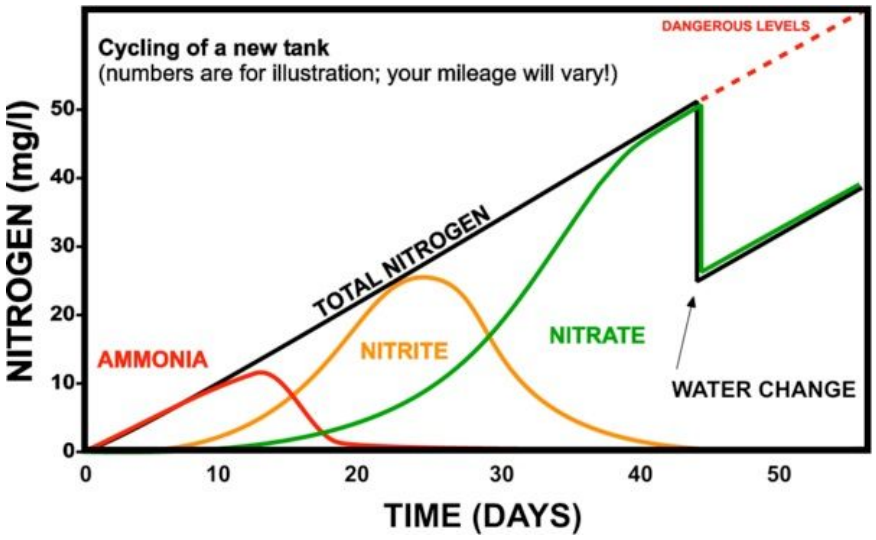
1. Almost ready to have your fresh aromatics all year round !

In less than two months, your Aquapioneers Kit could look likes something like the picture below. However there are some crucials biological steps to put in place before your aquaponics jungle takes place. In this section we will explain you how to kickstart the biological ecosystem and how to take car of it in order to grow with confidence.



2. Starting up (cycling) your ecosystem

An aquaponic system needs about **a month** to establish a biological equilibrium between plants, fish and bacteria. This is due to the fact that the bacteria which filter the fish waste grow very slowly on the filter material we put at their disposal. While these nitrifying bacteria are ubiquitous and do not need to be artificially introduced into the system, it is fundamental to introduce a source of ammonia (NH4), simulating fish waste, which they can "train" to decompose into the nitrate (NO3) fertilizer we are after. We should not introduce fish until the filter is properly established, since these might die by self-intoxication. The safest way to do this is to add controlled dosages of ammonium chloride, a cheap and harmless chemical available. Nitrite concentrations should be monitored. Over time, ammonia (NH4) will be degraded first into nitrite (NO2) and finally into nitrate (NO3), so that globally, if you measure all three components over time, you should get a graph similar to the something below:



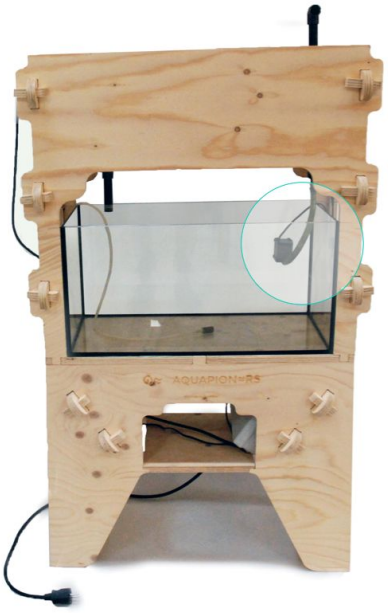
2.1 Bill of materials

For this you will need the following:

35 L of PH 7 clay pebble	Ammonium chloride (AC) powder	NH4 water test	NO3 water test	NO2 water test
				
Price: 10-15€	Price: 1€	Price: 10€	Price: 10€	Price: 10€

2.2 Start the water irrigation system

1



The entire electrical system is now in place, but “Do not plug your system to the mains power” until there is water in the fish tank, as this will run your water pump dry and possibly destroy it. To facilitate adding water to the aquarium you will remove the growbed for a while. To do so, first disconnect the flexible pipe to the water pump connector and the 12 Volts LED strip connector as well.

2

You will be able then to fill the aquarium. Tap water is OK.

3

Before adding the expanded clay pebbles to the Growbed, we advise you to clean them several times with tap water in another bucket. Why ? To remove all the dust that has been trapped inside the bag in which they come from. Ensure you've removed most of the water used to clean the clay pebbles before adding them to the grow bed.

4

Replace carefully the growbed filled with clay pebbles above the aquarium. You might need help

from a peer since it could be quite heavy.

5

Replace the water pump inside the aquarium by reconnecting it to the green flexible pipe. Add the air pump tube in the aquarium as well.

6

Last but no the least, you can add the lighting structure on top of growbed. *However, please note that till your ecosystem is not cycled and planted you will not need to use the growing light*. Before connecting your system to the main power, just make sure your electrical box is sealed. Then here you go !

2.3 Start cycling your ecosystem

1

With an Aquapioneers kit of 50 L, we recommend to introduce ammonium chloride (AC) powder and test for ammonia, nitrite and nitrate with the help of the table on the following page (**we recommend to print it and put it next to the kit to ease the follow up**). An "X" marks the days in which we recommend to carry out the corresponding water test. The number in the column "AC dosis (g)" corresponds to the amount of ammonium chloride chemical to introduce into your system on that day. This dosage increases over time as the bacteria community grows stronger and is able to process more waste, until it matches the amount of ammonia produced daily by the amount of fish we'd like to introduce into our system.

2

IMPORTANT: If you want to use this table on a system with different size and amount of fish, you will need to adapt the dosages you introduce to your system. Do do this, IF you follow the design principles in Annex II, just divide the number in column 3 by 50, and then multiply by the amount of liters in your system. For example, if your system has 600 liters as in the example in section 2, the first dosis of ammonium chloride you need to introduce will be 0.2 g / 50 liters * 600 liters = 2.4 grams of ammonium chloride (AC).

Notes:

- The test should be carried out before introducing a new ammonium chloride dosis.
- The kit is properly cycled (and safe for fish) once nitrite (NO2) levels remain below 0,15 mg / Lt after minimum 2 weeks of cycling.

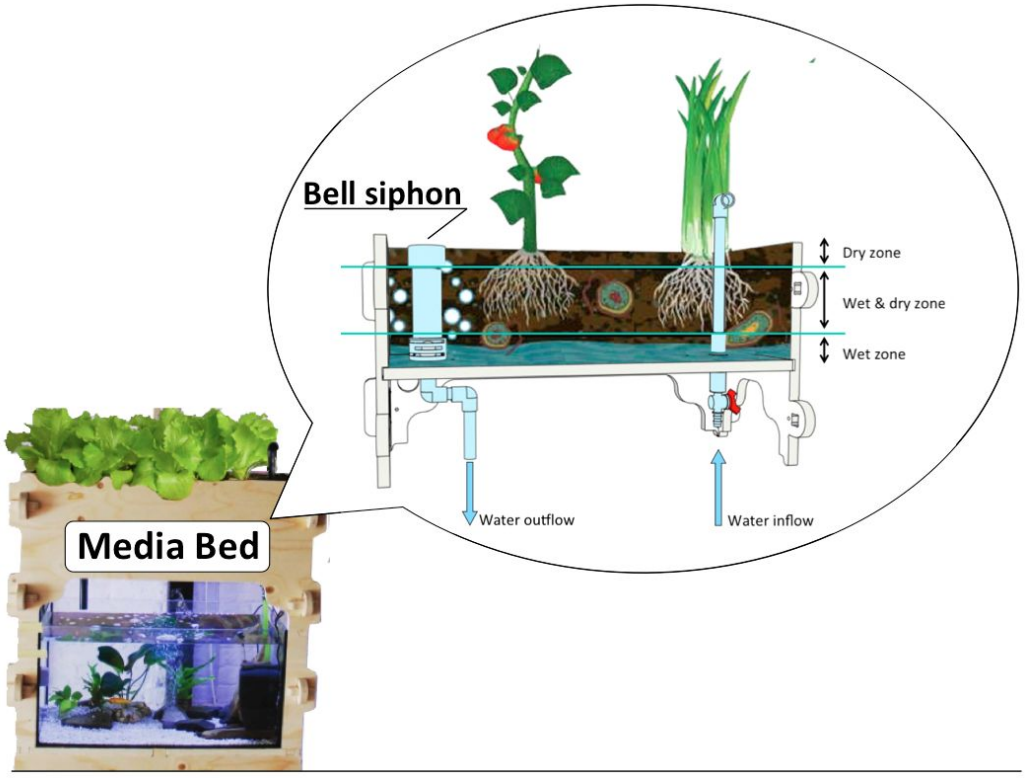
Guide to start the nitrogen cycle for the Aquapioneers kit

Day	Date	AC dosis (g)	NO2 test	Value	NO3 test	Value
1		0.2	X		X	
2						
3						
4						
5						
6						
7		0.2	X		X	
8						
9						
10						
11		0.2	X		X	
12						
13						
14						
15						
16						
17						
18		0.4	X		X	
19						
20						
21						
22						
23						
24		0.6	X		X	
25						
26						
27						
28						
29						
30		0.8	X		X	
31						
32						
33		0.8				
34						
35						
36		1.2	X		X	
37						
38						
39		1.2				
40						
41			X		X	

3. Troubleshooting

Once your system is running, you might “or not” encounter some mechanical or electrical issues. You will find the most common ones below with our troubleshooting approach.

3.1 The bell siphon

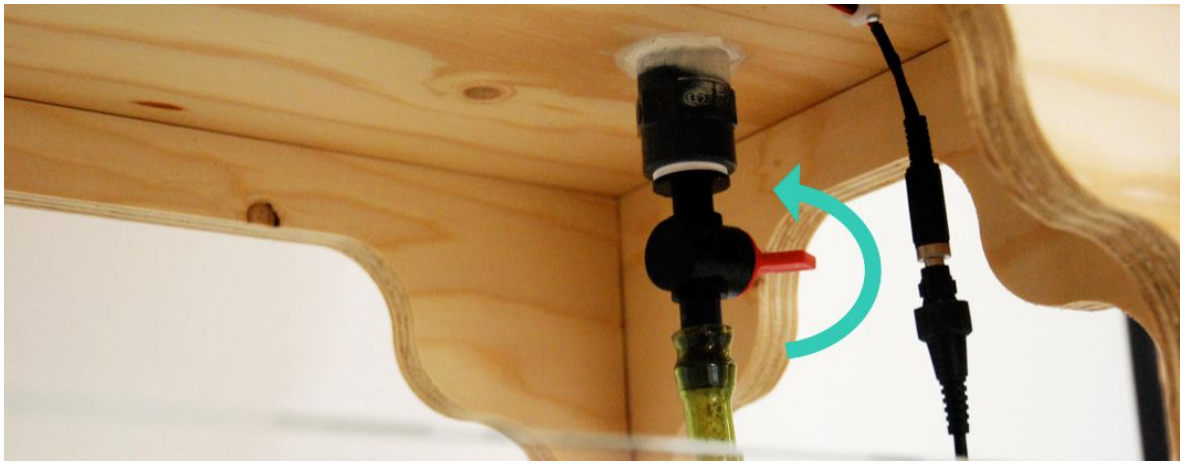


Media Bed technique that is used in the Aquapioneers kit, works with a Bell siphon which is a type of autosiphon that exploits a few physical laws of hydrodynamics and allows the media bed to flood and drain automatically, periodically, without a timer. This alternation ensures both high humidity and high oxygen levels in the Media Bed - exactly what your plant roots and nitrifying bacteria need! There is one downside to the bell siphon: Its proper function depends on the water flow of your pump. A correctly operating bell siphon drains the entire media bed water in less than a minute, then completely stops flowing until the media bed is full of water again, and the cycle starts anew.

If the water flow from the siphon is low (+/- the flow of the water inlet) and the water level remains constant, your Bell Siphon is not working correctly. If left unattended, in a matter of days this could mean the death of your fish. If you are not sure whether your bell siphon is working or

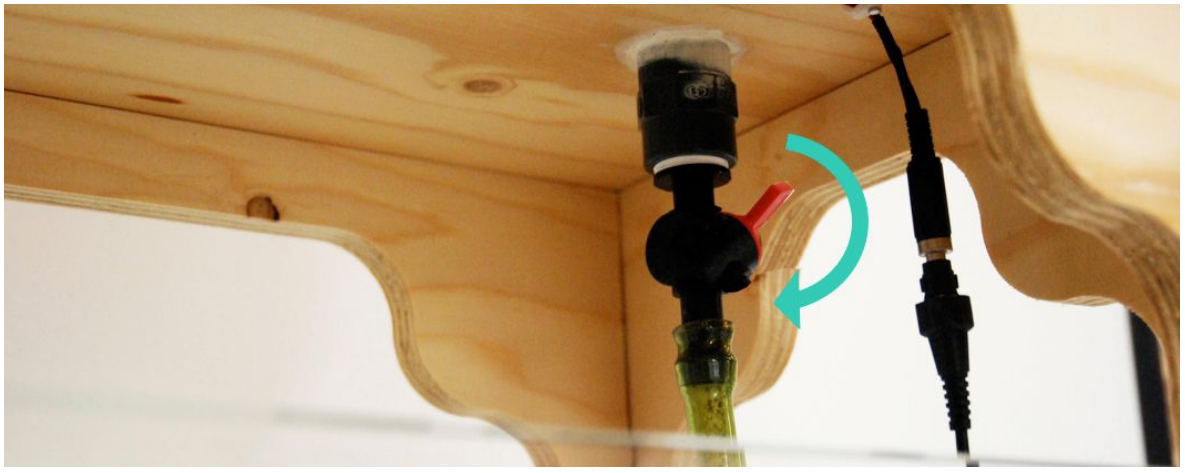
not, test your nitrite (NO2): After a day of malfunction, you will detect a nitrite increase in your system. If this is your case:

TROUBLESHOOTING 1: Your media Bed stays full



The water flow is too low. Use the valve to slightly increase the water flow. Wait a few minutes. If the problem persists, do this again. Repeat the process until the problem is fixed. Note: The siphon is very sensitive to the flow rate, only turn the valve as little as possible in order to avoid your flow becoming too high.

TROUBLESHOOTING 2 : Your media Bed stays empty

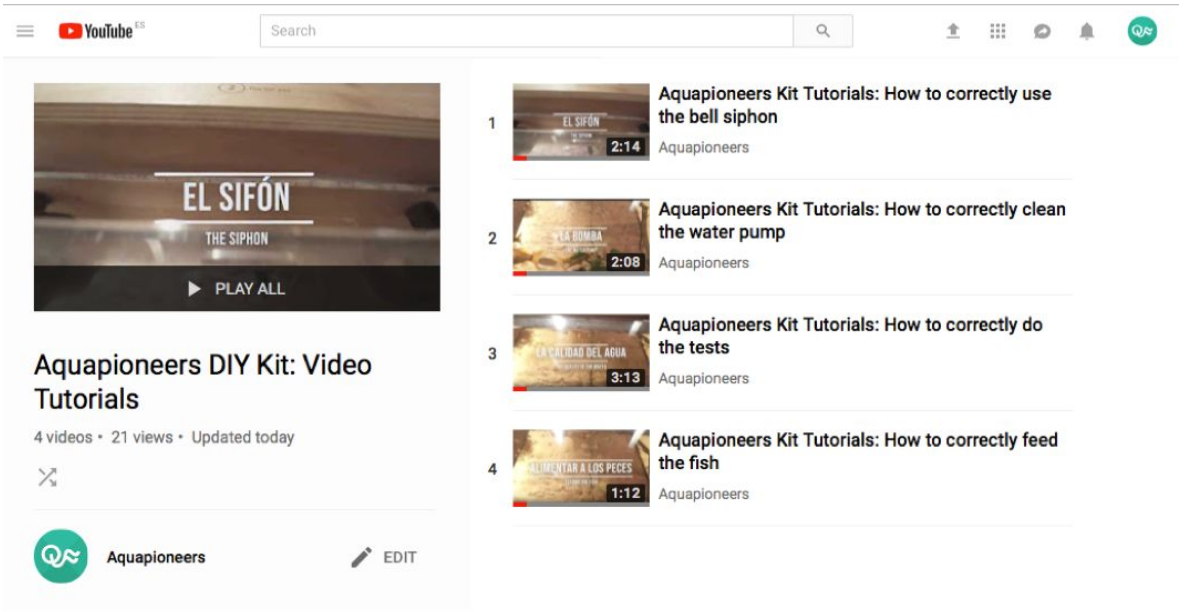


The water flow is too high. Use the valve to slightly reduce the water flow. Wait a few minutes. If the problem persists, do this again. Repeat the process until the problem is fixed. Note: The

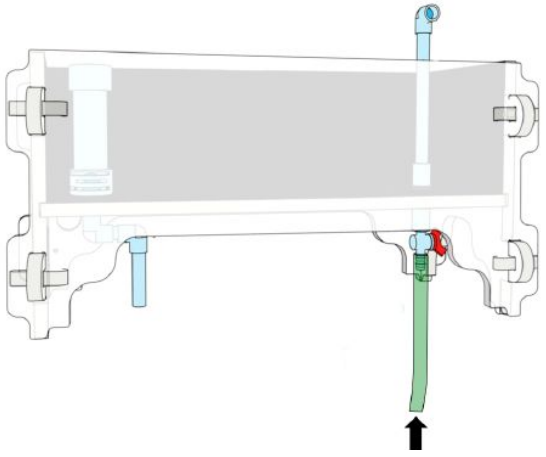
siphon is very sensitive to the flow rate, only turn the valve as little as possible in order to avoid your flow becoming too low.

VIDEO TUTORIAL on Youtube

If it is still not clear, we have created a video tutorial on this topic that can be watched on our Youtube channel : https://www.youtube.com/watch?v=m3OZn8t-0Q0&t=17s



3.2 The water inlet



The water inlet on top of your media bed delivers the aquarium water to the plants. The inlet is connected to the pump which is located at the bottom of the aquarium, via the transparent tube. A valve below the Media Bed regulates the flow of the water inlet. As the pump is simply connected to electricity, it should run whenever your kit is plugged in. Therefore the water inlet should supply water continuously. If no water is coming out of the inlet, follow the following steps to troubleshoot the issue. It is critical that the problem is resolved quickly, because a dry inlet means that your media bed is no longer filtering the fish water. If left unattended, your fish may die in a couple of days time!

TROUBLESHOOTING 1 : The electrical system is failing

In the event of an electrical failure, your pump will evidently stop working. You will easily identify this case since all your electrical components will stop working, such as the grow light and the air pump. If your other elements are working, move on to point 2) If all your electrical components are failing, walk through the following steps:

- Make sure the kit is connected to the power supply.
- Make sure your power supply has not been affected.
- If you have determined your electrical supply is working but not your kit, there might be an issue in the electrical system of your kit. We strongly encourage calling an electrician to resolve the problem. If you decide to debug it yourself, make sure to disconnect your kit from the power socket before you do!

TROUBLESHOOTING 2 : Your valve was closed by mistake

The valve controlling your inlet flow might be on the “closed” position. If it is the case, open it back to the position that enables the bell siphon to function correctly (see section on the bell siphon). Try to see if the valve is closed without touching it, because if you do, you might have to readjust the water flow (--> see section 2.1).

TROUBLESHOOTING 3 : Your pump is obstructed

The pump delivering the water to your plants might have been obstructed. This may occur if :

- Your pump inlet has been blocked by algae and bacteria. You can easily avoid this situation by cleaning your pump once a month.
- Debris from the aquarium has blocked the inlet.
- Debris from the aquarium is blocking the rotor inside the pump. THIS IS ESPECIALLY LIKELY TO OCCUR IF YOU USE COARSE SAND (~2-3 mm diameter) AS AQUARIUM DECORATION. Individual particles tend to enter the pump and block the rotors motion. Avoid this type of decoration.

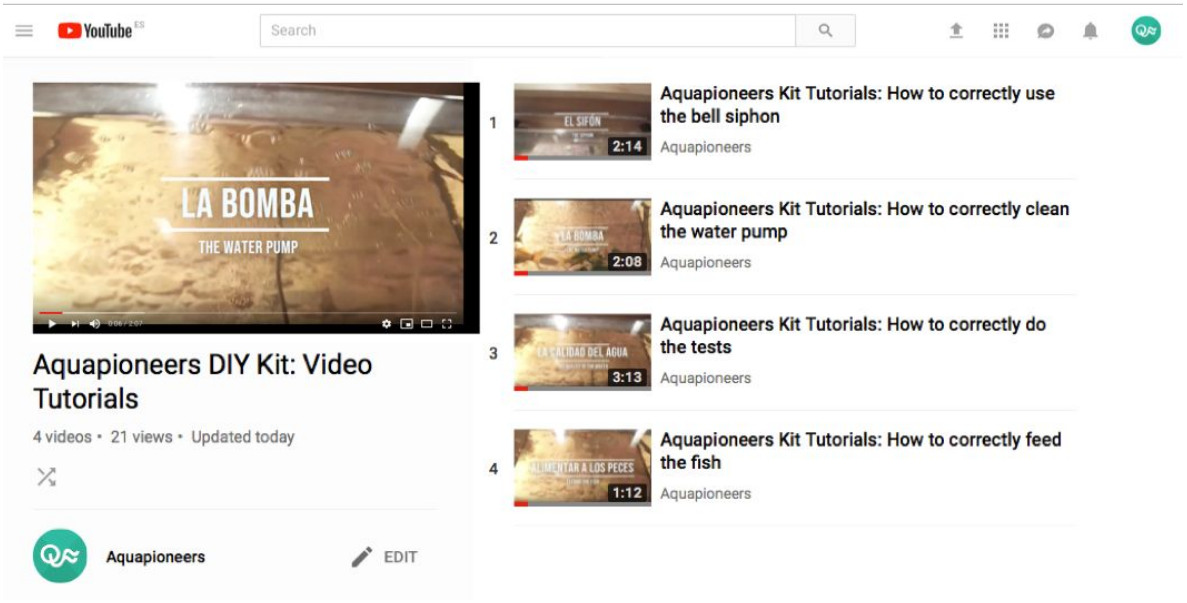
To resolve this issue, **unplug your kit from electricity**, then disconnect the pump from the transparent tubing in order to clean it.

Water pumps break if left to run dry = if air enters the pump. Never remove your pump from the water without disconnecting electricity! This would damage it irreparably.

Most pumps are easy to take apart for cleaning. **Before you set up your system**, make sure you know how to open your pump until the rotor comes out (the inner piece with blades which rotates)! Take it apart in the water and use a small brush to clean the parts. Remove any debris (or sand particles) and make sure the rotor can freely rotate before putting the pump back together. Once reassembled, put the pump back into the water. Connect the pump back to the transparent tubing and plug back the electricity. You should be good to go!

VIDEO TUTORIAL on Youtube

If it is still not clear, we have created a video tutorial on this topic that can be watched on our Youtube channel : https://www.youtube.com/watch?v=pN3SSN_O0qc&t=4s



4. Some species of fish that can inhabit your ecosystem

Congratulations on setting up your brand new Aquapioneers kit! Now starts the exiting time, introducing our lovely fish ! But the big question is which one ? and how many could live in a 50L aquarium respecting their well being. Below are just a few examples of freshwater fish available in almost every aquarium stores around the world. However, for the ones that don't have any previous experience with aquariums, we recommend to start with Goldfish !

GOLD FISH

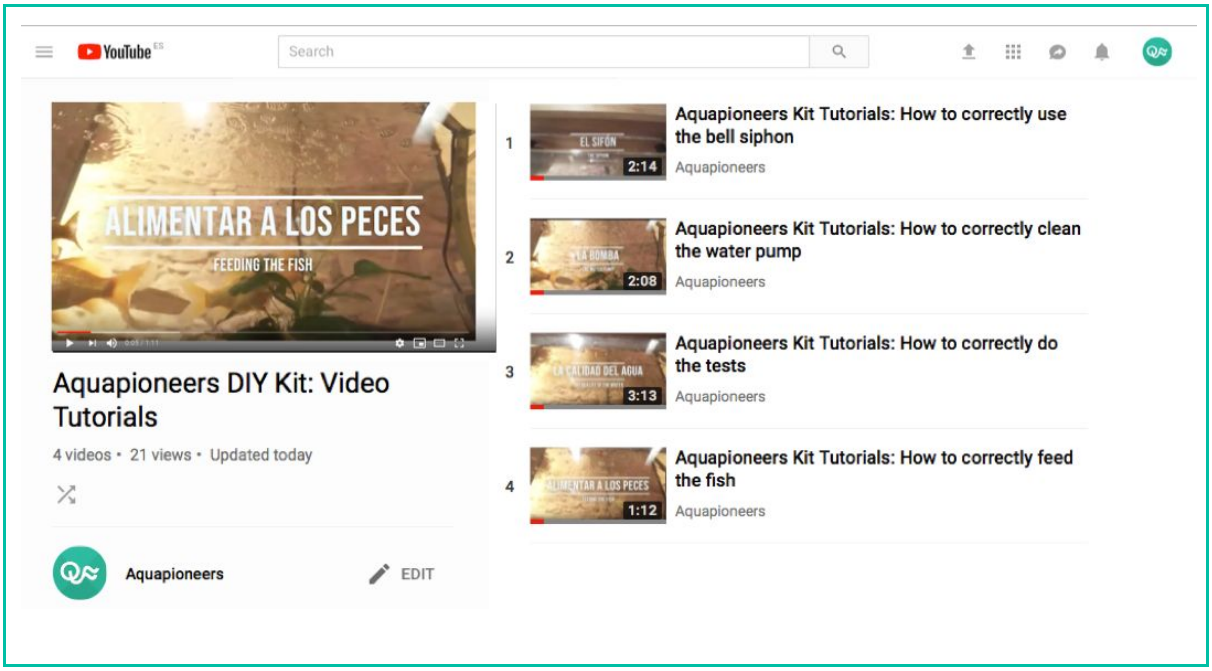
GUPPY

HEMICHROMIS

TETRA NEON

VIDEO TUTORIAL on Youtube

When it comes to feed them, we have created a video tutorial to guide you on our Youtube channel : https://www.youtube.com/watch?v=it17Tjr0Hbc



5. Some herbs and leafy greens you can grow

Below are just a few examples of aromatics and leafy greens you can grow in the Aquapioneers kit.

Based on our team experience and research at ValldauraLabs in Barcelona, we continuously update this wepage (http://aquapioneers.io/plants/) to provide you relevant information about what type of plants you can grow and what are the best conditions in terms of light, temperature, PH, etc you should take care to get the most of your kit. Here are some examples.

6. How to care for your kit

Congratulations on setting up your brand new Aquapioneers kit! In order to make sure your fish and plants grow healthy there are a few simple steps you need to regularly follow. While these tasks are quite simple, it is essential that you follow them as instructed, and when instructed, without which you could end up terribly frustrated.

6.1 Daily tasks

Probably the most important Keep an eye open on a daily basis. Ecosystems can be fragile, and sooner or later problems may arise. Most problems can be avoided by detecting the signs early.

As you get to know your ecosystem, the signs will become obvious to you. What you should be looking out for:

The Bell siphon rapidly drains all of the media bed water, then fully stops until the media bed is full of water again for the next cycle.

- The water inlet has a permanent and constant flow.
- The fish feed normally.
- The fish are active during the day.
- The light switches on and off according to the timer.
- The plants are growing, and have healthy green looking leaves (turn off the growlight for a better view)
- Fine air bubbles are coming out of the air diffuser (the diffuser should be near the bottom, not top, of the aquarium)
- The water is transparent.
- The kit is dry

To ease this daily follow up, we've prepared a printed version (following page) that can be added next to your kit

DAILY & WEEKLY TASKS

Actions	Elements	FAQs
Observe		The water inlet has a permanent and constant flow ?
		Fine air bubbles are coming out of the air diffuser ?
		The bell siphon rapidly drains all the media bed water, then fully stops until the media bed is full of water again for the next cycle
		When bell siphon stops, Is the water level in the aquarium less than 15 cm from the upper edge?
		The light switches on and off according to the timer ?
		The fish feed normally and everything you add in less than 10 min
		The fish are active during the day?
		The plants are growing and have healthy green looking leaves?
Feed		Add one distributed fish feed dose along the day
Analize		**Every week:** 1. Test your water and ensure: 20 < NO3 < 80; NO2 < 0,3 2. Refill your system with dechlorinated tap water (8L) + add an iron dosis 3. Clean the aquarium

If you answer **NO** to one of these questions, your system is not working properly. Please refer to troubleshooting section of Aquapioneers kit user manual.

6.2 Weekly tasks

Choose a day of the week to do your basic maintenance tasks to make sure you are regular in your care. Let's assume this day is saturday. Every saturday you will need to:

REFILL YOUR SYSTEM WITH DECHLORINATED WATER : to compensate for the water used by your plants

- Put around 8 L tap water in a container.
- Dechlorinate the water. In most countries tapwater contains chlorine which needs to be removed because it is toxic for the fish. You have 2 options:
    - If you want to be able to use it instantly, purchase a dechlorinating product from your nearest fishkeeping store. Dose it according to manufacturers instructions and mix it with the water you prepared.
    - Leaving the water in a bucket for 24h will let the chlorine evaporate and make your water safe to use without using chemicals!

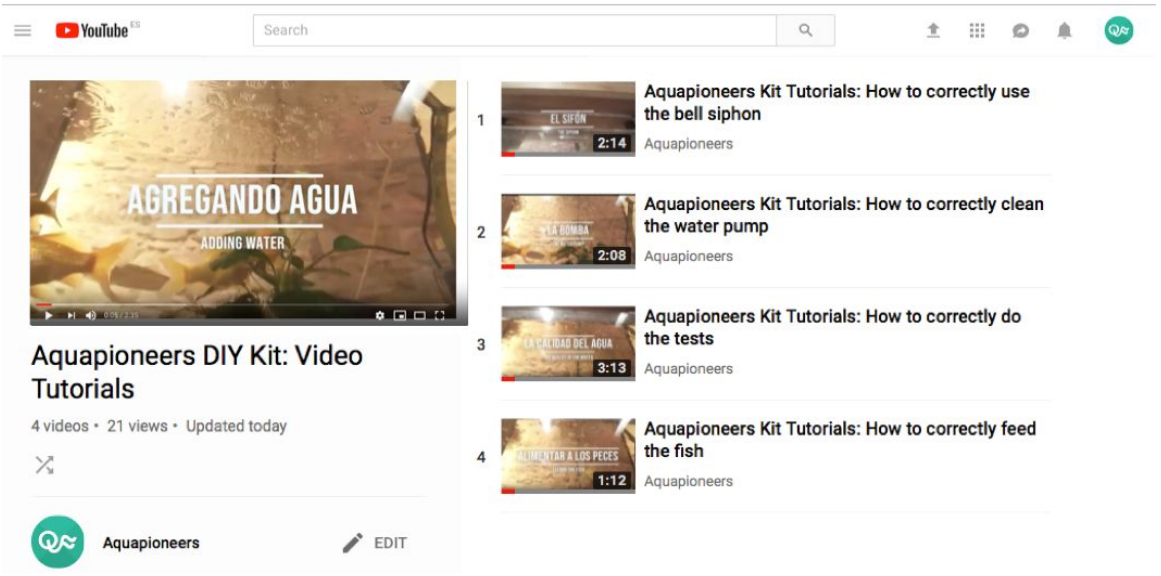
ADD IRON TO THE WATER FOR HEALTHIER PLANTS

In aquaponics, iron tends to be deficient. It can be added under the form of an iron chelate (we highly recommend the EDDHA type, make sure you get one that does not significantly colour your water at recommended dosages!) :

- Weigh out 0.4 g of iron chelate and dissolve it in the water you dechlorinated,
- OR
- You can purchase vials that were carefully weighed by our team. You just empty the vial into the water, and you're done.

VIDEO TUTORIAL on Youtube

If it is still not clear, we have created a video tutorial on these two topic that can be watched on our Youtube channel : https://youtu.be/BWA90jbF0Qo



CLEAN THE AQUARIUM

To keep your system beautiful and shiny, and avoid algae growth, you should clean your aquarium every week. We recommend to use magnetic sponges made for that purpose, which allow you to clean the tank easily and without getting wet!

TEST YOUR NITRITE AND NITRATE CONCENTRATION

This should be done twice a week, or every time you suspect your bell siphon / filter might not be working correctly. You may reduce testing frequency once you have become accustomed to your system and know how to detect the reasons behind nitrite accumulations. Nitrite (NO_2) is a toxic intermediate in the transformation of fish waste (ammonia NH_4^+) to plant fertilizer (Nitrate NO_3). Test kits are available in every fishkeeping store. In a well functioning system ammonia and nitrite are kept at very low levels by the essential nitrification bacteria living in the Media Bed.

If your Nitrite concentration is above 0.1 mg/L, this is a sign that :

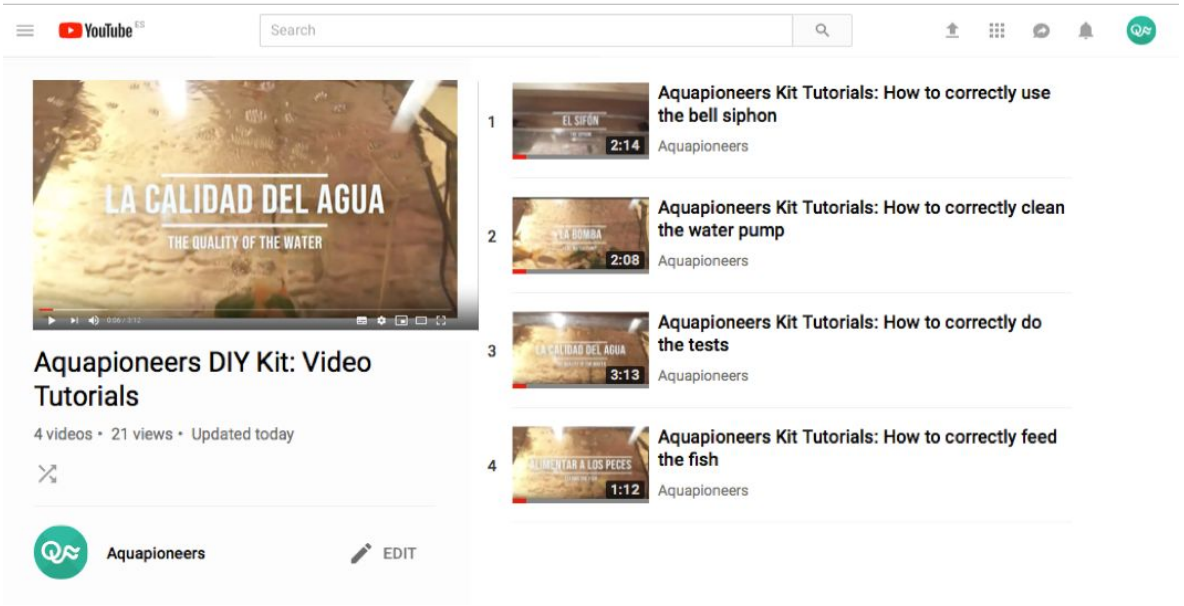
1. Your system has not finished the cycling process (see section "Setting up your aquaponics kit) and is NOT ready to host fish.
   OR
2. Your filter (= the Media Bed) is not functioning correctly.

The most common reasons for high Nitrite concentrations are:

- The bell siphon is not working properly (see the "bell Siphon infografic")
- A drastic change occurred in your system. Significant changes in Temperature, pH, oxygen levels can damage both your fish and your nitrifying bacteria. Avoid shocking your system in any way.

VIDEO TUTORIAL on Youtube

If it is still not clear, we have created a video tutorial on these two topic that can be watched on our Youtube channel :https://www.youtube.com/watch?v=LoWL6dGzlHY



INSPECT YOUR PLANTS CLOSELY to detect any bugs or unusual colors on the leaves. The earlier you detect pests the easier they are to remove.

ATTENTION!! Since your kit is an ecosystem, it is strictly prohibited to use conventional insecticides on your plants!! They might kill your fish and / or the vital microorganisms in your system!

Soft alternatives must be used, do your research carefully before attacking bugs that might find their way to your kit!

The team of Bright Agrotech did a great job with their blog (https://blog.brightagrotech.com/pesticides-for-aquaponics/) and youtube videos (Pest Controls for Aquaponics - YouTube) on the subject!

6.3 Ranges for water quality parameters

For aquaponics to work properly and avoid danger to its organisms, water quality needs to be monitored and controlled to fit into the following recommended ranges:

Physical parameters		How to increase	How to decrease
pH	6 < x < 8	Add plants, remove fish, decrease feed, change water source, add pH affecting chemicals (can be dangerous, not recommended!)	Remove plants, add fish, increase feed, change water source,add pH lowering chemicals (can be dangerous, not recommended!)
EC (mS / cm)	0.5 < x < 2	Remove plants, add fish, increase feed, change water source, add fertilizers	Add plants, remove fish, decrease feed, change water source, dilute with more fresh water
Temperatura (deg C)	16 < x < 28	Add water heating, improve insulation	Add water cooling, improve insulation, add shading material
Dissolved oxygen DO (ppm)	6 < x < 8.5	Add air diffusers, add water cascades	Not required, there is never too much oxygen
Chemical parameters (mg / L or ppm)		**How to increase**	**How to decrease**
NH4	< 0.25	Not required, should be as low as possible	Add plants, remove fish, decrease feed, add bacteria, add ammonia-removing substances
NO2	< 0.5	Not required, should be as low as possible	Fix filter issues, decrease feed, add bacteria, add nitrate-removing substances, remove fish
NO3	20 < x < 100	Increase feed, remove plants, add fish, add N fertilizer	Decrease feed, add plants, remove fish
PO4	0.2 < x < 10	Increase feed, remove plants, add fish, add P fertilizer	Decrease feed, add plants, remove fish
K	6 < x < 30	Increase feed, remove plants, add fish, change water source, add K fertilizer	Decrease feed, add plants, introduce fruiting plants (strawberries, tomatoes etc.) remove fish

Fe	0.5 < x < 3	Add iron chelate (EDDHA type), mineralize solid fish waste	Reduce iron supplementation

Notes:

a) These values are recommended values based on our experience in Aquapioneers. We have worked mostly with relatively tolerant fish species (tilapia, guppy, goldfish, carps). If you consider trying with other fish species, it is essential that you check toxicity values for these fish which may be lower than the values given here.

b) pH, EC, Temperature, DO, NH4 and NO2 are essential to fish health, while NO3, PO4, K and Fe generally are relevant to plant health only (unless they reach extreme values not generally encountered).

c) pH and EC can be measured with inexpensive electronic meters, dissolved oxygen monitoring is expensive and not usually necessary at small scale if the tanks are well aerated, but is a must for professional applications. The most inexpensive means of monitoring chemical parameters is to use chemical testing kits available in fish stores, as we did in the workshop.

Annex I : Aquaponic design ratios

An aquaponic system needs to be properly balanced between the 3 components: Fish, Plants & Bacteria. There have to be enough fish to generate the fertilizer needed by the plants, and there needs to be sufficient filtration (= Bacteria) to transform the produced fish waste into fertilizer. Steps:

a) Choose a given surface of plants
b) Calculate the amount of fish food needed (1 square meter of plants requires on average about 45 grams of fish food per day)
c) Calculate the filtration surface you need. For this, multiply the total daily amount of fish feed per day (in grams!) by 0.0657 to obtain the filtration surface you need to process the waste.
d) Calculate the volume of filter media you need. Many materials can be used as filtration media, and every media has a specific surface (how many meter squared of surface do I get for 1000 liters of material. For example, gardening Clay pebbles have about 250 m2 / 1000 liters of media. To obtain the volume of needed filter material in m3, divide the filtration surface you obtained in the previous step by the specific surface area (in this case, 250). To be safe, multiply this number by 1.5. Other examples of filtration materials, with their specific area, are given in the table below.

TABLE 4.1
Characteristics of different growing media

Media type	Surface area (m^2/m^3)	pH	Cost	Weight	Lifespan	Water retention	Plant support	Ease to work with
Volcanic gravel (tuff)	300–400	Neutral	Medium	Medium	Long	Medium–Poor	Excellent	Medium
Volcanic gravel (pumice)	200–300	Neutral	Medium–High	Light	Long	Medium	Medium–Poor	Easy
Limestone gravel	150–200	Basic	Low	Heavy	Long	Poor	Excellent	Difficult
Expanded clay (LECA)	250–300	Neutral	High	Light	Long	Medium–Poor	Medium	Easy
Plastic bottle caps	50–100	Inert	Low	Light	Long	Poor	Poor	Easy
Coconut fibre	200–400 (variable)	Neutral	Low–Medium	Light	Short	High	Medium	Easy

e) Calculate the total weight of fish you need to have in your system on average, knowing that generally fish in the growth stage feed on about 2 % of their bodyweight per day.
f) Calculate the size of your fish tank. In home systems, you should not exceed 20 kg of fish per cubic meter (1000 liter).

<u>EXAMPLE</u>

a) We'll choose a total surface of 5 square meter plants.
b) We'll need 5x 45 grams of feed per day = 225 grams per day.
c) Filtration surface needed = 225 grams per day x 0.0657 = 14.8 meter squared.

d) Volume of filtration material needed = 14.8 / 250 = 0.059 m3 = 59 liters. Introducing the safety factor of 1.5, we obtain a total of 1.5 x 59 = 89 liters of filtration material.
e) If the fish eat 225 grams per day equivalent to 2% of their body mass, it means we will have 225 grams / 0.02 = 11.25 kg of fish in our tank at full production levels.
f) Since we should not exceed 20 kg fish per cubic meter, we should have a fish tank that is at least 11.25 kg / (20 kg / m3) = 0.60 cubic meters large (or 600 L).

Annex II: Interesting Aquaponics links

a. A comprehensive document by the FAO (2014) on small-scale & low-cost aquaponic systems. Everything you need to know to design and care for home-grade systems. Building instructions included.
http://www.fao.org/3/a-i4021e.pdf

b. Iowa state university "how to do it yourself" 1 hour webinar (with US aquaculture association).
http://www.ncrac.org/video/aquaponics-how-do-it-yourself

c. Aquaponics resource compilation (pdf and videos) by US department of Agriculture.
https://www.nal.usda.gov/afsic/aquaponics

d. Aquaponics—Integrating Fish and Plant Culture, James Rakocy. Important facts and design figures.
http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-10215/SRAC-454web.pdf

e. Comprehensive youtube video series by Bright Agrotech LLC.
https://www.youtube.com/user/BrightAgrotechLLC/playlists

f. Aquapioneers kit design files & youtube video series on on how to care for the Aquapioneers kit.
http://aquapioneers.io/community-forum/