Chapter 2: How does aquaponics work?

Start Here

1

Take a look at the betta fish in your tank. It is very busy eating, breathing, swimming, and excreting waste (pooping). It breathes in dissolved oxygen from the water through its gills (they're like lungs for a fish!) and excretes ammonia (NH_3) through its gills and waste.

2

Any excess waste product becomes toxic if there is enough of it in the environment, but the waste is made up of elements that are needed by other organisms. Over time, the ammonia (NH_3) accumulates and becomes toxic to the fish, but it is exactly what nitrifying bacteria (our friends Somo & Bacter) like to eat!

3

The pump takes the ammonia-rich (NH_3) water and brings it up to the grow bed.

4

Somo (or nitrosomonos – the bacteria that absorbs ammonia (NH_3) and oxygen (O_2) to produce nitrite (NO_2-). This is a problem for our fish – nitrite is one of the most toxic substances on Earth for a fish!

5

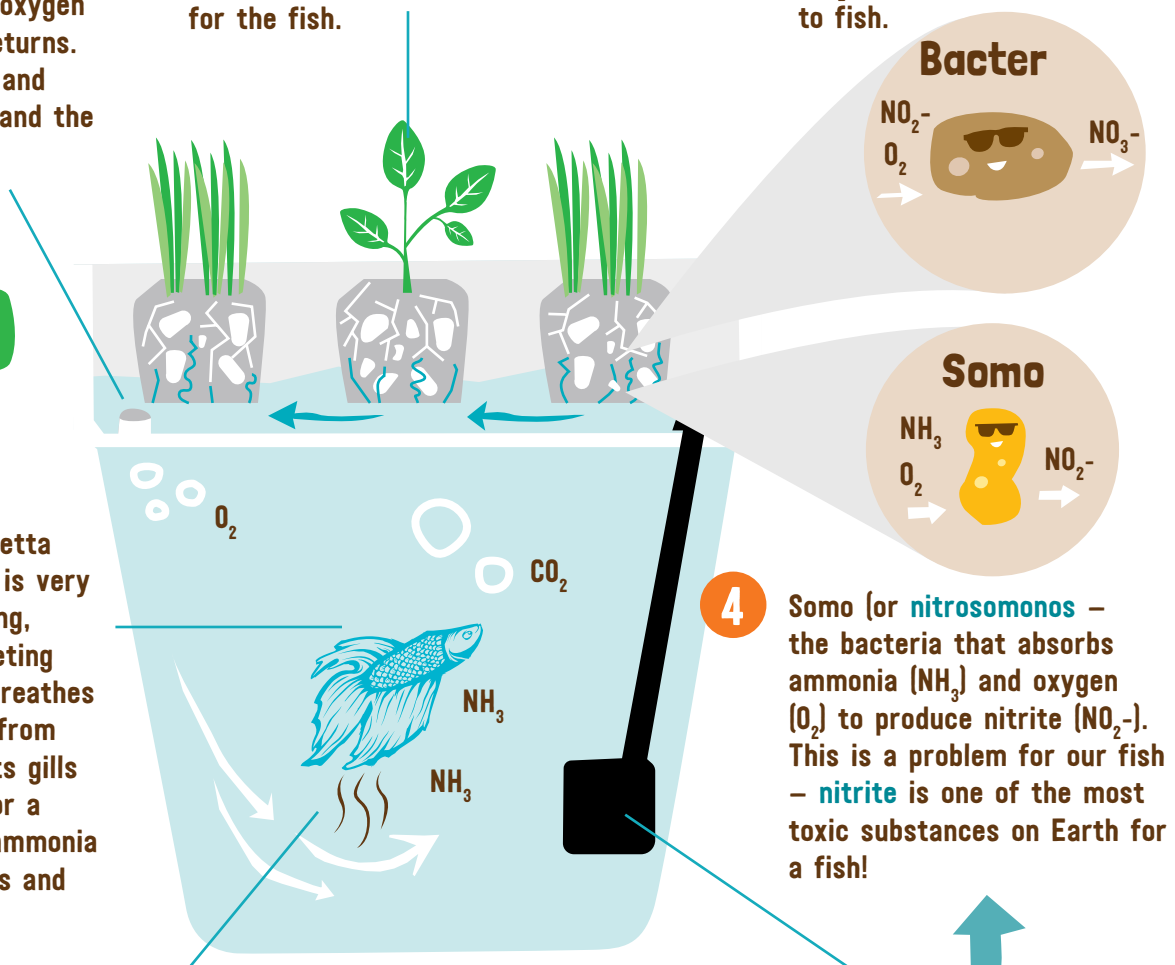
Luckily there is our other bacterial buddy, Bacto (or nitrobacter, the bacteria that absorbs nitrite) who loves nothing more than to take in as much nitrite (NO_2-), Nitrates can be toxic to fish.

6

Nitrate (NO_3-) is the useable form of nitrogen (N), one of the essential nutrients for plant growth. The plants absorb as much of it as they can out of the water flowing over their roots which, in turn, cleans the water, making it safe for the fish.

7

The clean water falls from the growbed back into the tank, bringing more oxygen from the air as it returns. This allows the fish and bacteria to breathe and the cycle continues!



FUN FACT: "Air" on Earth is 70% nitrogen. Nitrogren is one of the most essential nutrients for plants, but the nitrogen in the air is not in a form that is usable for them. It isn't until our bacterial buddies perform their function that it becomes nitrate.

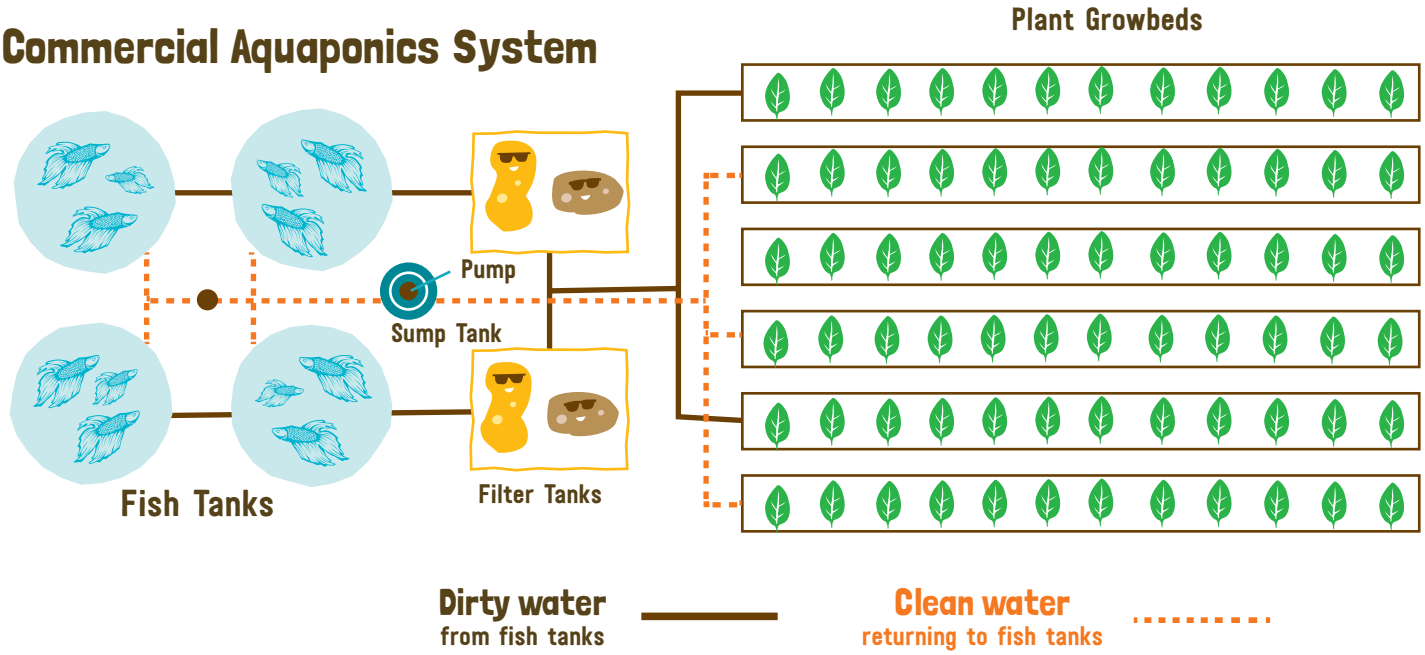
Chapter 2: How does aquaponics work?

Commercial Aquaponics

In a commercial system, four big fish rearing tanks are at the highest point, and they seperate fish of different ages, so the bigger fish don't eat the little guys.

The "dirty" water (full of fish waste) flows out into filter tanks which trap the solids and the house the nitrifying bacteria (Somo & Bacter!) who turn the ammonia into nitrates.

Commercial Aquaponics System



The water then flows out to long hydroponic grow tanks (similar to the growbeds in your Water Garden), which can be hundreds of feet long! Often these are full of floating rafts holding the plants, which pull the nitrates from the water.

The clean water flows down to the lowest point, called a sump tank which holds the cleanest water in the system. From here, the water is pumped back to the fish talks and the cycle continues!

The fish are harvested when they grow big enough to eat, while the plants are harvested weekly to be sold to restaurants, farmers markets, and grocery stores. Compare and contrast your classroom Water Garden and a commercial aquaponic system. How are they similar and how are they different? What are the benefits of each?

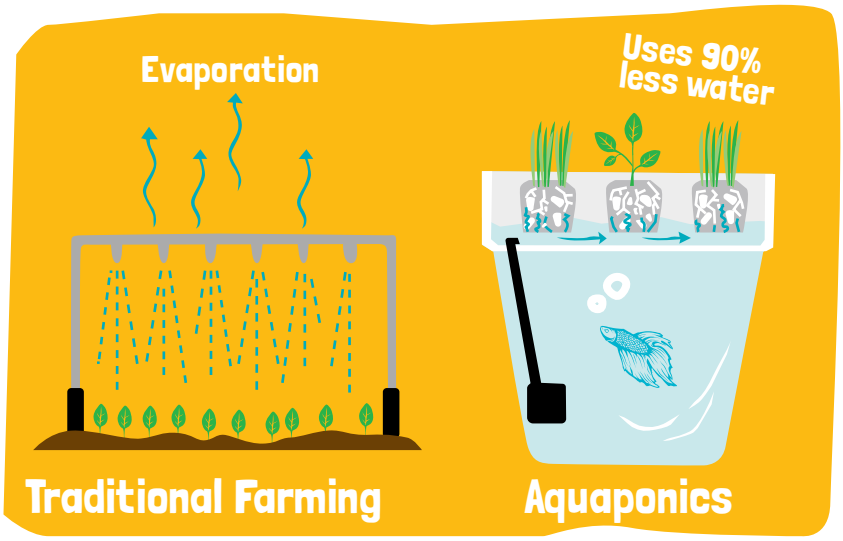
FUN FACT: One of the largest commercial aquaponic systems is in the United Arab Emirates. It produces 60,000 heads of lettuce each month and 20,000 pounds of fish each year!

Chapter 3: Why is aquaponics awesome?

1 Water Savings

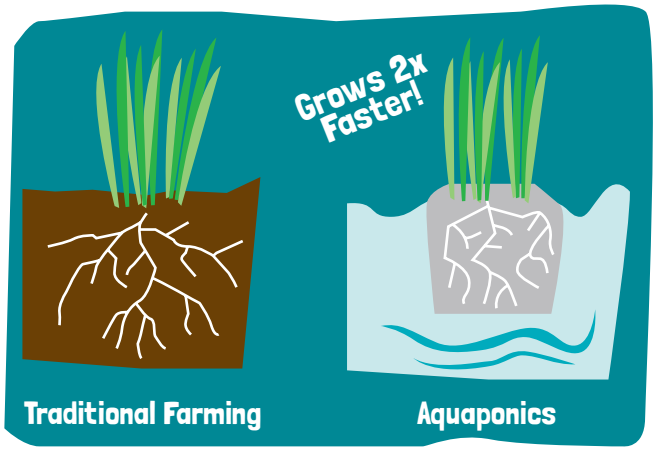
From Chapters 1 and 2, we've learned that irrigation is the key to agriculture. In traditional agriculture, many farmers use large sprinklers to spray water out over their fields. Some water goes to the crops, but a lot is lost to evaporation - the process of liquid water turning into a gas (test it out for yourself in the Activities section!). The higher the temperature the faster water evaporates, so this is especially bad in hot weather. Water is also absorbed into the soil and lost through runoff coming from the field.

In aquaponics, the water moves from the fish tanks through pipes to the growbeds holding the plants. There is no water lost to runoff or soil absorption, and in many systems there is less loss from evaporation!



2 Efficient Plant Growth

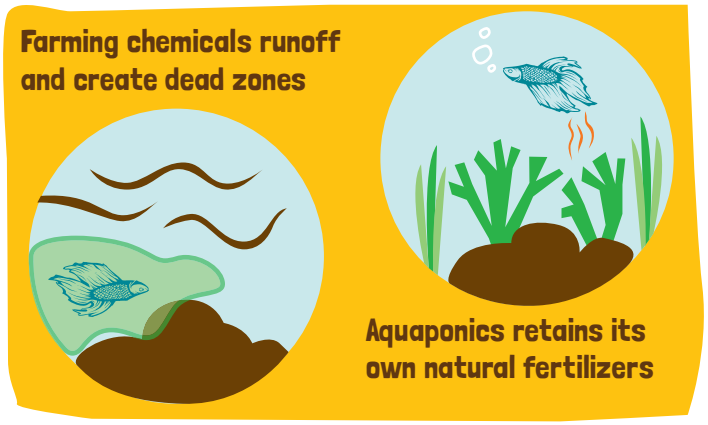
Plants use energy to grow what they need to survive. Each part of the plant has its role. Roots grow to seek out nutrients and water from the soil, whereas leaves absorb sunlight for energy, and fruit holds the seeds to reproduce. When the roots don't have to work hard to find what they need, more energy is available to grow leaves and fruit. Plants in aquaponics can grow more than twice as fast, and often much larger because the roots given all the water and nitrogen they need!



3 Beyond Organic

Aquaponic systems work because of their living components; therefore, aquaponic growers are held to a life standard beyond organic standards. In organic farming, there are approved pesticides, herbicides, and fertilizers that are used for killing pests, weeds, and promoting growth. In aquaponics, you cannot use the same chemicals because they would kill the fish and bacteria. The same is true for commerical aquaculture-the antibiotics that are commonly used to fight fish diseases cannot be used in aquaponic systems because they would kill the nitrifying bacteria.

Aquaponics creates and uses its own natural fertilizer (fish waste), and keeps it contained within the system. When farmers spray their fields with fertilizers those nutrients often seep into the groundwater and runoff into into streams, rivers, and eventually into the ocean.



When the fertilizers reach these bodies of water, they are consumed by plants-especially algae - a simple water plant- causing algal blooms, or the rapid growth of lots of algae. Bacteria loves to eat this algae, which depletes much of the oxygen in the water. There are areas where the algal blooms are so huge that the bacteria eating them use up all of the oxygen, leaving the water apoxic, or without oxygen. Fish are not able to survive in these areas, creating what scientists call "dead zones." This is an increasing problem in the world's oceans today, emphasizing the need for more sustainable farming methods like aquaponics! **How many dead zones do you think there are in the world? How might you be able to help?**

Vocabulary

Agriculture (ag•ri•kuhl•cher) Food production

Algae (al•guhl) A simple water plant that grows very quickly

Algal blooms (al•guhl blooms) A simple water plant that grows very quickly

Ammonia (uh•mohn•yuh) A chemical compound made up of nitrogen and hydrogen (NH3)

Apoxic (eh•pohx•ik) Without oxygen

Aquaculture (ak•wuh•kuhl-cher) Fish farming the study of ecosystems and their interactions

Chinampas (chi•nam•puhs) Rectangular plots in shallow waters of lakes to grow crops

Dead Zones (ded zohn) An area of water that does not have enough osygen for life to survive

Ecology (ih•kol•uh•jee) The study of ecosystems and their interactions

Evaporation (ih•vap•uh•rey•shuhn) The process of liquic turning into a gas

Fertile (fur•tl) Capable of producting life

Fertilizers (fur•tl•ahy•zer) A substance that increases plant growth

Herbicides (hur•buh•sayhd) A substance used to kill plants (specifically weeds)

Hydroponics (hahy•druh•pon•iks) Growing plants in nutrient-rich water

Inputs (in•poots) The resources a living thing needs in order to perform a function

Vocabulary

Irrigation (ir•i•gey•shuhn) Water systems for crops

Mesopotamia (mes•uh•puh•tey•mee•uh) The region where it is believed some of the first civilizations emerged, also know as the "Fertile Crescent"

Nitrate (nahy•treyt) The useable form of nitrogen for plants (NO3 -)

Nitrification Transforming ammonia (NH3) into nitrate (NO3); the useable form of nitrogen for plants

Nitrite (nahy•trahyt) A form of nitrogen that is toxic to fish (NO2)

Nitrobacter (nahy-truh-bak-ter) A bacteria that absorbs ammonia

Nitrogen (nahy-truh-juhn) A chemical element needed by all living things

Nitrosomonas (nahy-truh-suh-mohn-us) A bacteria that absorbs ammonia

Nutrient film technique (noo-tree-uhnt film tek-neek) A growing technique that runs nutrient-rich water over roots

Outputs (out·poot) Waste that a living thing produces

Organism (awr-guh-niz-uh m) Living things; a form of life

Periodic Table of Elements (pe•ri•od•ic ta•ble of el•e•ments) The system used to organize and chart the 118 chemical elements

Pesticides (pes·tuh•sahyd) A chemical used to kill plants or pests

Runoff (ruhn-awf) Water flowing from the fields