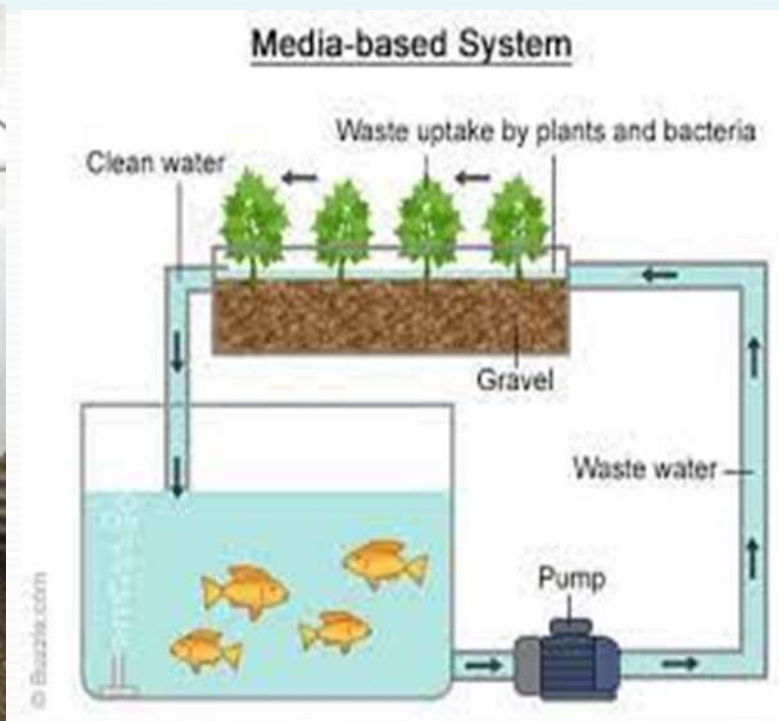


Advanced techniques in Aquaculture **Lecture 8**



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Aquaponics

Aquaponics is seen as highly efficient fish farming technique that addresses the multiple challenges of the conventional techniques. By using less water, reducing the need for synthetic fertilizers, and minimizing waste and producing food without damaging our environment.

What is Aquaponics?

Aquaponics is a sustainable farming method that combines aquaculture (the cultivation of aquatic organisms like fish) with hydroponics (the growing of plants in nutrient-rich water without soil). This combination creates biological processes that occur in both systems to create a closed-loop environment where fish and plants thrive together.

How Does Aquaponics Work?

In aquaponics, the plants are grown in the grow bed, and fish are placed in the fish tank. The nutrient-rich water from the fish tank that contains fish waste is fed to the grow bed, where billions of naturally occurring beneficial bacteria break the ammonia down into nitrites and then into nitrates.

Plants absorb these nitrates and other nutrients to help them grow. The plant's roots clean and filter the water before it flows back into the fish tank for the fish to live. The fresh, clean, and oxygenated water recirculates back to the fish tank, where the cycle will begin again.

The Aquaponic General Cycle



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The Nitrogen Cycle

In aquaponics, the nitrogen cycle is a fundamental process that transforms toxic ammonia from fish waste into less harmful nitrates. Fish excretes ammonia that accumulates in the water. Beneficial bacteria, specifically Nitrosomonas, convert ammonia into nitrites. Another type of beneficial bacteria, Nitrobacter, then converts nitrites into nitrates that serve as a valuable nutrient source for plants.

Role of Beneficial Bacteria in Converting Waste:

The presence of beneficial bacteria is essential for the nitrogen cycle to function. These bacteria colonize the surfaces of the grow beds and grow media, providing a substrate for their growth. Without these bacteria, the toxic ammonia produced by fish waste would accumulate and harm the fish. This is why the conversion of ammonia and nitrites into nitrates is essential to the aquaponics systems.

Fish and Plant Symbiosis

- **Fish Waste as a Nutrient Source:** Fish excrete waste that contains ammonia, a nitrogen-rich compound. Excessive ammonia levels can be harmful to fish, but this waste becomes a valuable resource for plant growth in aquaponics.
- **Nutrient Absorption by Plants:** As water from the fish tanks flows into the grow beds or PVC pipes plants absorb the nitrates through their root systems. These nitrates provide essential nutrients like nitrogen and phosphorus that promotes plant growth and development.
- **Purified Water Returning to the Fish Tanks:** The plants' uptake of nutrients fuels their growth and naturally filters the water. Purified water, now clean of excessive nitrates and other waste, is then recirculated back into the fish tanks, creating a closed-loop system.

Components of an Aquaponics System

A. Main Components:

1. Fish

To achieve maximum growth output from your fish, select the best fish for your system and know how to care for the fish in your system correctly.

What Fish Species are Best for Aquaponics?

The most common fish raised in aquaponics systems are:

1. **Edible fish:** tilapia, carp, catfish, trout, largemouth bass, salmon, yellow perch, bluegill, jade perch, barramundi
2. **Ornamental fish:** goldfish, koi, tetras, guppies
3. **Other aquatic animals,** such as shrimps

2. Plants

Choosing the best plants to grow in your aquaponics system is essential for your system's overall success. So select plants that are easy to grow and well suited to your location.

What Type of Plants Can You Grow in Aquaponics?

Almost all plants can be grown in aquaponics. However, plants also have different nutrient, space, and light requirements. So, to choose the best plants and achieve the optimum result from your aquaponic system, consider the factors mentioned above.

list of plants that grow best on a specific aquaponics method:

1. **Media Based Aquaponics System:** lettuce , tomatoes, ginger, eggplant, eggplant, cucumber, and any plants that will fit your grow bed.

2. **Raft System:** lettuce, basil, kale, cabbage, Swiss chard, mint, watercress, and other small rooting plants
3. **Nutrient Film Technique (NFT):** lettuce, strawberry, spinach, parsley, dill, and other small rooting plants.

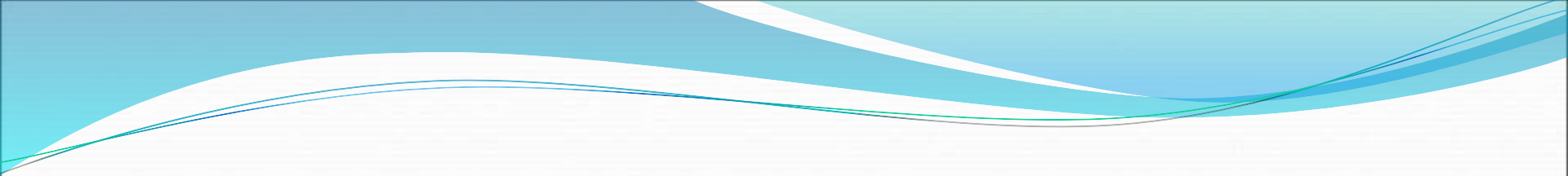
3. Bacteria

The bacteria in aquaponics systems can be present in the **biofilter**, grow beds, and fish tanks. Bacteria convert fish wastes into nutrients absorbed by the plants. So, it is essential to maintain a healthy bacterial colony in your system.

B. Secondary Components

- 1- **Fish Tank** : is the home of your fish and one of the most important materials of the aquaponics system.

- 2- **Grow Bed** : Will hold your plants and grow media. Depending on your system, the grow bed can be PVC pipes, floating rafts, or any food-grade containers.
- 3- **Grow Bed Support**: Frame that will support the weight of your grow bed.
- 4- **Sump Tank(Optional)**: Using a sump tank will depend on the design of your system.
- 5- **Plumbing Pipes and Fittings** : It depends on the type of your grow beds, system, and other factors.
- 6- **Bell Siphon** : is required for a flood and drains media bed.
- 7- **Water Pump**: The water pump size depends on your desired tank exchange rate, and several grow beds.
- 8- **Aerator and Air Stones**: These are used in the fish tank and media beds.
- 9- **Grow Lights (Optional)**: grow light are mainly used in indoor systems.

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- 10- **Heater (Optional)**: Using a water heater will depend on your location, fish species, and target water temperature.
 - 11- **Grow Media** : You can use clay pebbles, expanded shale, gravel, and other inert grow media for a media-based system.
 - 12- **Monitoring System (Optional)**: It depends on your situation and how you want to manage your system.
 - 13- **Timers and Controllers**: These are used for controlling the lighting, pumping, and temperature.

Types of Aquaponics System

There are the **four main types** of aquaponics systems:

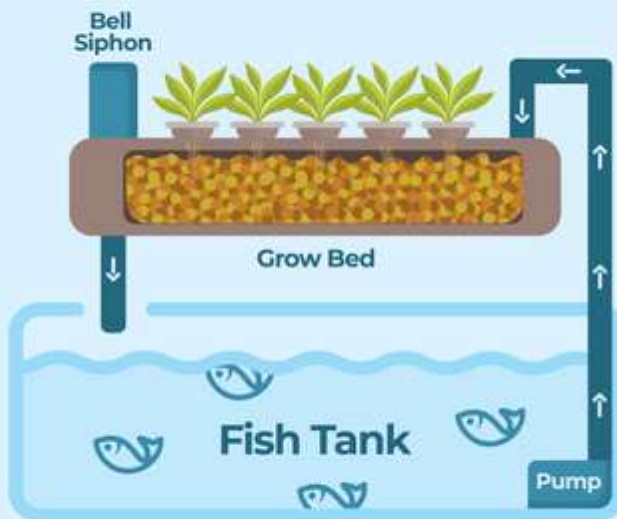
1- Media Based Aquaponics System

Media Based, or Flood and Drain is the most common aquaponics system. A media based uses a grow bed or container filled with grow media (usually gravel, lava rock, or clay pebbles) to plant the crops.

The grow bed is periodically flooded with water from the fish tank directly or through a bell siphon so that the plants can access the nutrients. The water drains back into the fish tank, where a new cycle begins.

All waste is broken down in the grow bed. Sometimes worms are added to the grow media to help break down all the waste. The media based uses the fewest components, and no additional filtration is needed, making it easy to operate.

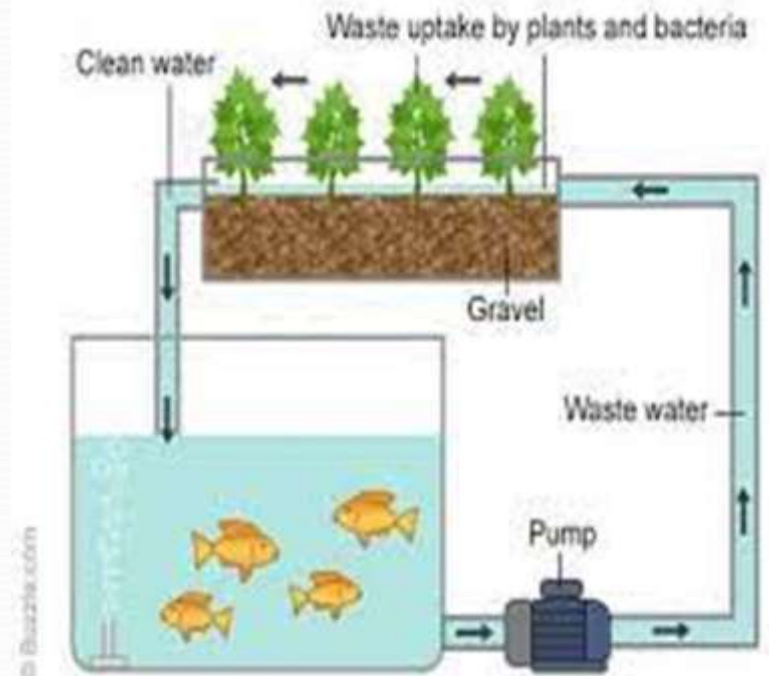
Media Based



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Media-based System



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2- Raft System

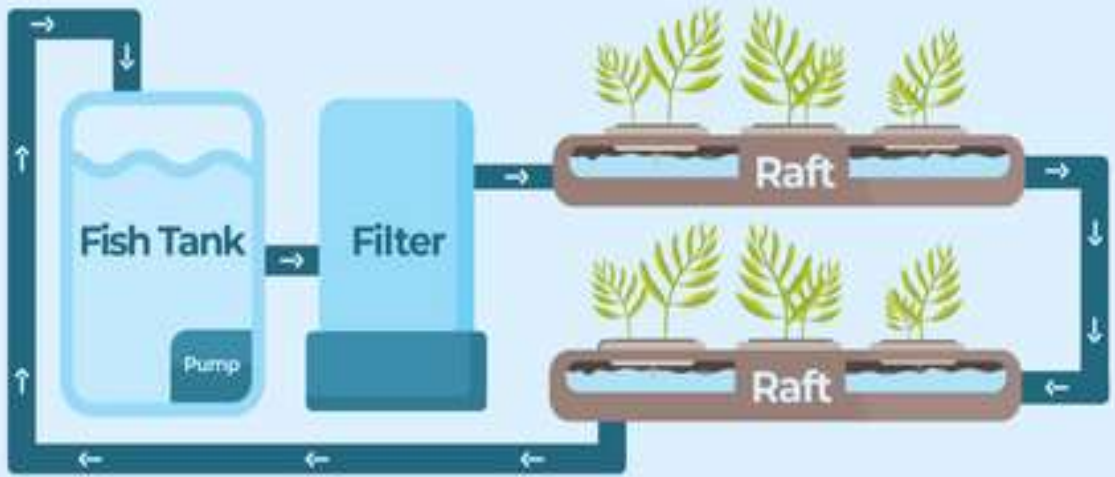
The raft system is also known as Deep Water Culture or Floating System.

In a raft system, the nutrient-rich water circulates through the long canals, usually at a depth of about 20 cm, while rafts (polystyrene or foam board) float on top.

The plants are grown on the raft boards supported within holes. Plant roots hang down in the nutrient-rich, oxygenated water, where they absorb oxygen and nutrients to thrive.

The nutrient-filled water flows continuously from the fish tank through the filtration process, then to the raft tank where the plants are grown, and finally back to the fish tank. Most often, the raft tank is separate from the fish tank.

Raft System



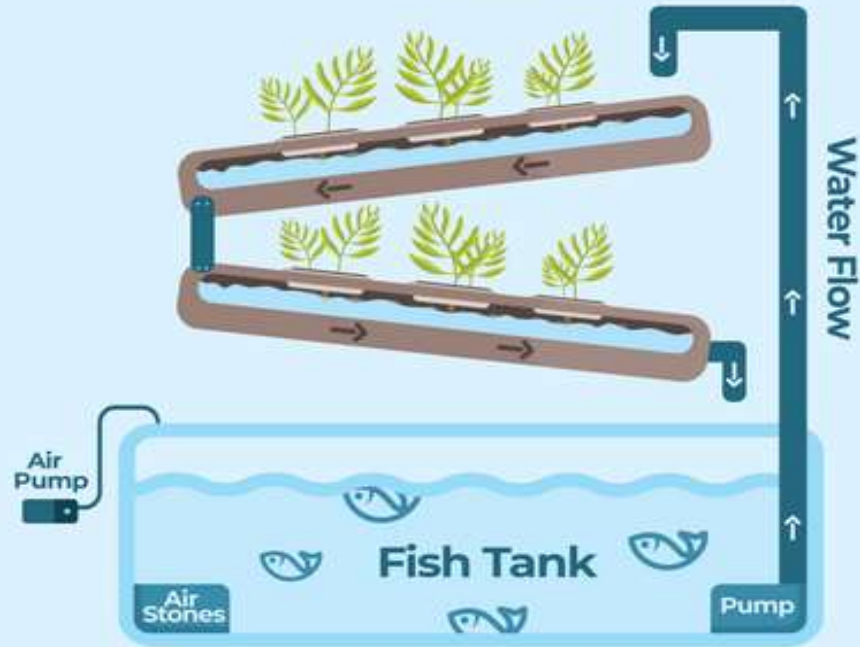
3- Nutrient Film Technique (NFT)

The Nutrient Film Technique (NFT) is a hydroponic growing technique adapted to aquaponics because of its simple yet effective design that works well in some environments.

In the NFT method, the plants are grown on long, narrow channels. A thin film of water continuously flows down each channel to provide plant roots with water, nutrients, and oxygen.

Like the raft system, the water flows from the fish tank through filtration components, through the NFT channels where plants are grown, and then back into the fish tank.

NFT



Benefits of Aquaponics

- 1- Sustainable Food Production: Aquaponics is a sustainable solution to the growing concern of food security. Integrating fish and plant cultivation maximizes resource efficiency while producing protein (fish) and produce (plants) in a single system.
- 2- Year-Round Cultivation: Aquaponics aren't confined by seasonal limitations. With controlled indoor aquaponics systems, crops can be grown year-round, ensuring a steady supply of fresh produce regardless of external weather conditions.
- 3- Minimal Environmental Impact: Traditional farming can contribute to soil erosion, water pollution, and excessive resource consumption. Aquaponics reduces these negative impacts by using less water, minimizing waste, and eliminating the need for synthetic fertilizers and pesticides.
- 4- producing healthy food (organic plants and fish).

Challenges of Aquaponics

1- Initial Setup Costs: Establishing an aquaponic system can be costly.

2- Technical Knowledge Required: Aquaponics involves understanding complex interactions between fish, plants, bacteria, and water chemistry. A solid understanding of these principles is crucial for the success of the system.



