



Topic 4: Self-Reliant Systems and Procedures

4.3 Soiless Cultivation Methods

Developed By:

NOVATEX
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Objectives

Objective 01

Understanding the definition and principles of Aquaponics.

Objective 02

Advantages of Aquaponics and the historical development.

Objective 03

Understanding water conservation, nutrient recycling and reduced environmental impact.

Objective 04

Describe the symniotic relationship between fish and plants and system design.

Objective 05

Develop strategies to prevent, monitor, and manage pests and diseases in Aquaponics.



Objectives

Objective 06

Understanding the definition and principles of Aeroponics.

Objective 07

Advantages of Aeroponics over traditional farming methods and the historical development.

Objective 08

Understanding aeroponic plant biology and physiology as well as aeroponic technology.

Objective 09

Introduce design management and integration including automation and control.

Objective 10

Develop strategies to prevent, monitor, and manage pests and diseases in Aeroponics.



Soiless Cultivation Methods

Aquaponics



Aeroponics



Hydroponics



What is Aquaponics?

- Aquaponics is a sustainable farming method that combines aquaculture (raising fish) and hydroponics (growing plants in water) in a symbiotic environment.
- In aquaponic systems, fish waste provides nutrients for plants, and the plants help to filter and clean the water for the fish. This creates a closed-loop system where both fish and plants benefit from each other's presence.



Benefits of Aquaponics



- They require less water compared to soil-based agriculture, as water is recirculated between the fish tanks and grow beds, minimizing wastage.
- Eliminates the need for synthetic fertilizers, pesticides, and herbicides, making it an environmentally friendly and sustainable food production method.
- Can be adapted to various scales, from small backyard setups to large commercial operations, providing flexibility for growers.



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Benefits of Aquaponics



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Benefits of Aquaponics Systems

Water Conservation

- Aquaponics systems use water very efficiently compared to traditional soil-based farming.
- The water in the system is continuously recirculated between the fish tanks and the plant beds, with minimal losses due to evaporation or runoff.
- This closed-loop system can reduce water usage by up to 90% compared to conventional agriculture.



Benefits of Aquaponics Systems

Nutrient Recycling

- Fish waste provides nutrients for the plants.
- Fish excrete ammonia, which is converted by bacteria in the system into nitrites and then nitrates, which are essential nutrients for plant growth.
- The plants uptake these nutrients, effectively filtering the water for the fish.
- This nutrient cycling process creates a symbiotic relationship between the fish and plants, reducing the need for external fertilizers.




Benefits of Aquaponics Systems


Reduced Environmental Impact

- Eliminates the need for synthetic fertilizers and pesticides, which can pollute waterways and harm ecosystems.
- By using natural processes to recycle nutrients and maintain water quality, aquaponics minimizes environmental pollution and contributes to healthier ecosystems.



History of Aquaponics Systems

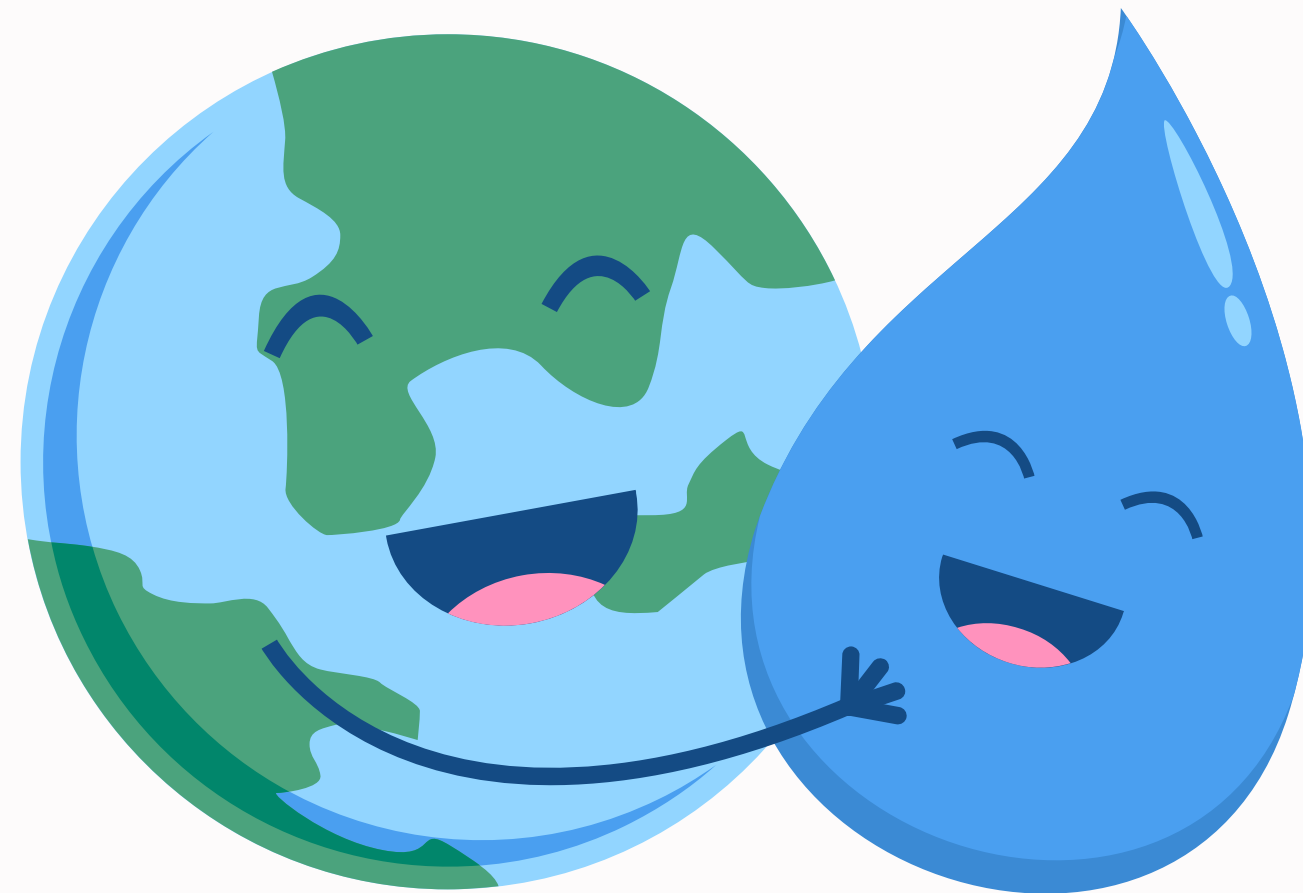
 While aquaponics may seem like a modern innovation, its roots can be traced back to ancient civilizations such as the Aztecs and Chinese, who practiced forms of integrated aquaculture and agriculture.

 In recent decades, advances in technology and understanding of aquatic ecosystems have led to the development of modern aquaponic systems.



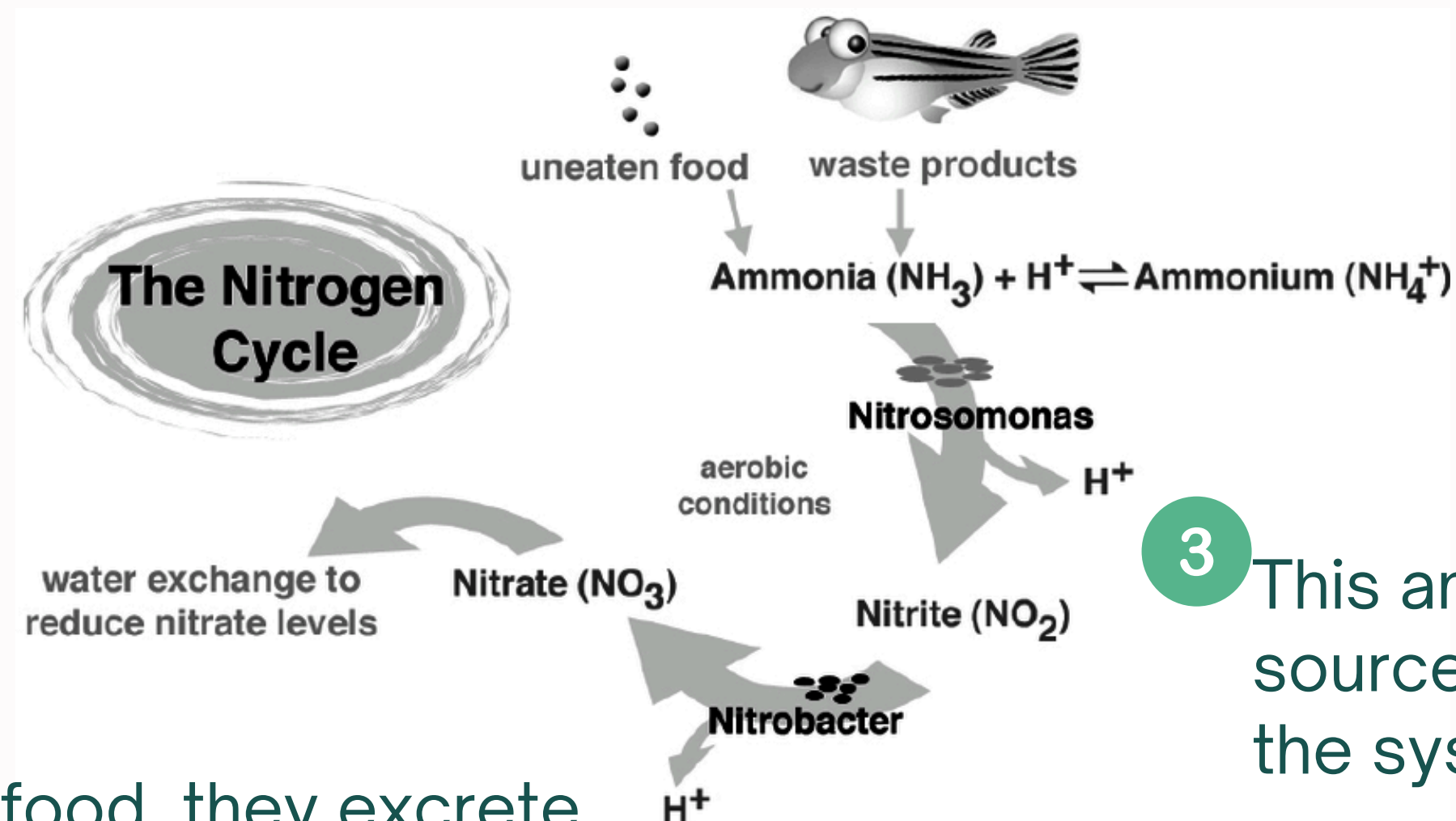
History of Aquaponics Systems

 Today, aquaponics is gaining popularity worldwide as a viable solution to food security and environmental sustainability challenges.



Fish Nutrition as a Nutrient Source

- 1 Fish in aquaponic systems are fed a balanced diet to meet their nutritional needs for growth and development.

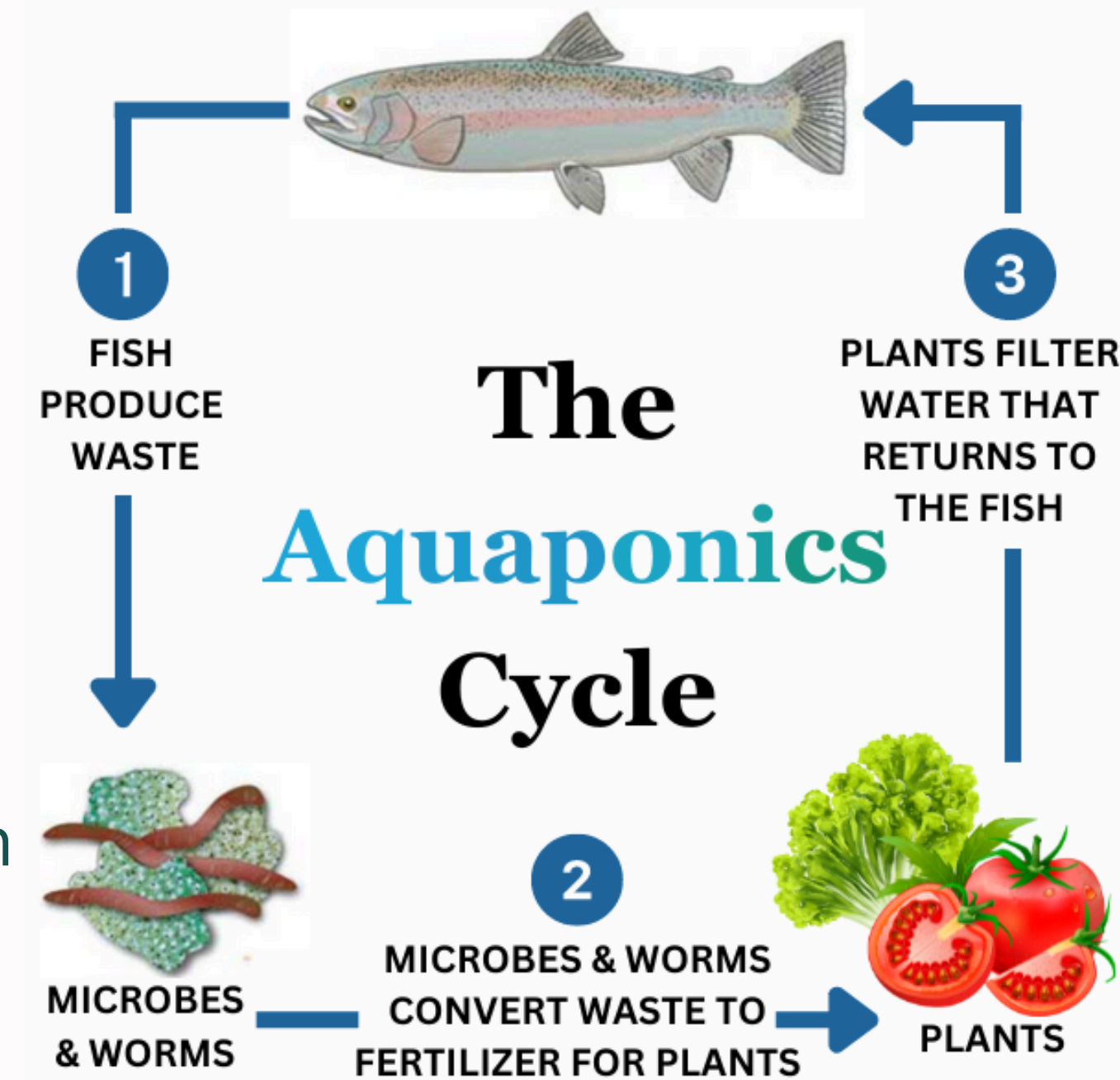


- 2 As fish digest their food, they excrete waste in the form of ammonia through their gills and excrement.

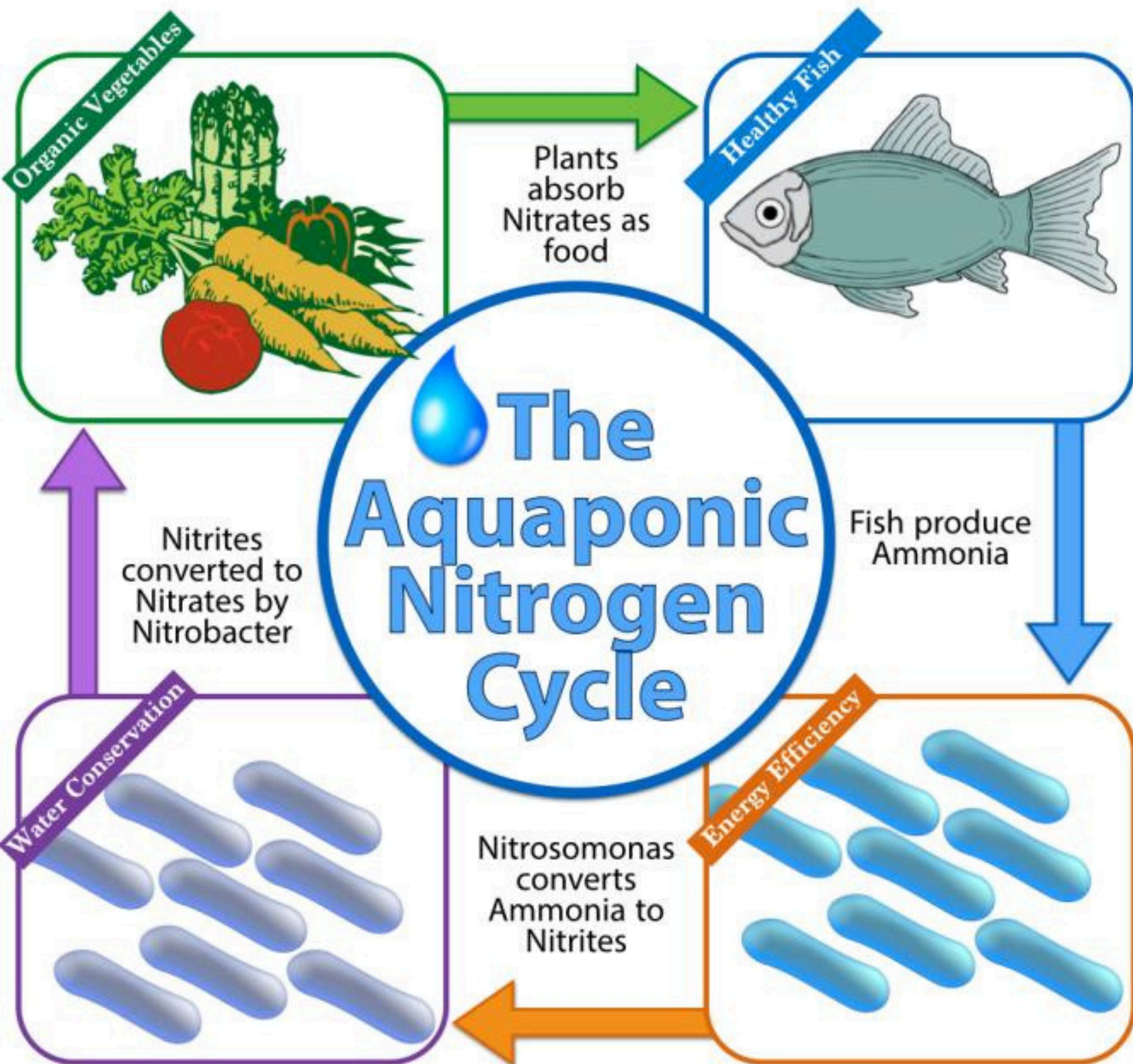
- 3 This ammonia is the primary source of nitrogen for plants in the system.

Nutrient Dynamic

- In aquaponic systems, nutrient cycling occurs continuously as fish waste is converted into plant-available nutrients by nitrifying bacteria.
- Plants uptake these nutrients from the water, helping to maintain water quality for the fish.
- This natural nutrient cycling process minimizes the need for external fertilizers and ensures a balanced ecosystem within the aquaponic system.



Nutrient Dynamics



Nitrosomonas bacteria convert ammonia into nitrite, and Nitrobacter bacteria further convert nitrite into nitrate, which is the primary form of nitrogen that plants can absorb and utilize for growth.

Symbiotics Relationships



Fish-Plant Interaction

- The relationship between fish and plants in aquaponic systems is mutually beneficial.
- Fish waste provides essential nutrients for plant growth, including nitrogen, phosphorus, and potassium.
- In return, plants help to purify the water by uptaking nutrients, thereby creating a healthy environment for the fish.
- This symbiotic relationship mimics natural ecosystems, where nutrient cycling is essential for ecosystem health and productivity.



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Symbiotics Relationships



Microbial Community

- Microorganisms, including **nitrifying bacteria**, beneficial microbes, and biofilms, play a vital role in maintaining the balance of nutrients and microbial activity in aquaponic systems.
- These microbial communities help to break down organic matter, convert ammonia into nitrate, and suppress harmful pathogens, contributing to overall system **health** and **productivity**.



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System Design

Components of Aquaponic Systems:

- Fish Tanks: Containers for raising fish, often made of materials like fiberglass or plastic.
- Grow Beds: Containers filled with growing media (e.g., gravel or clay pellets) where plants are cultivated.
- Pumps and Plumbing: Equipment for water circulation and distribution between fish tanks and grow beds.
- Filters: Devices for removing solid waste and maintaining water clarity.
- Oxygenation Systems: Aeration devices to ensure adequate oxygen levels for fish and plant roots.



System Design



Design Considerations:

- Location: Choosing a suitable site with access to water, sunlight, and electricity.
- Size: Determining the scale of the system based on available space and production goals.
- Layout: Arranging components to optimize water flow and accessibility for maintenance.
- Climate Control: Implementing measures to regulate temperature and humidity as needed.



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Plant species for Aquaponics



Leafy Greens:

- Lettuce
- kale
- spinach
- Swiss chard



Herbs:

- Basil
- cilantro
- parsley
- mint



Fruit-Bearing Plants:

- tomatoes
- peppers
- cucumbers
- strawberries

Transplanting and Maintenance:

- Seed Starting: Germinating seeds in a suitable growing medium before transplanting into grow beds.
- Transplanting: Carefully transferring seedlings into grow beds once they have developed roots.
- Crop Maintenance: Monitoring plant health, pruning, and providing necessary nutrients to support growth.
- Harvesting: Harvesting mature plants at the peak of freshness for consumption.



Maintenance:



Water Quality Management:

- **Monitoring Parameters:** Regularly testing water pH, ammonia, nitrite, and nitrate levels to ensure optimal conditions for fish and plants.
- **Nutrient Adjustment:** Adjusting feed rates and supplemental nutrient dosing as needed to maintain balanced nutrient levels.
- **Water Changes:** Periodically replacing a portion of the water to prevent accumulation of dissolved solids and maintain water clarity.



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Aquaponic System:

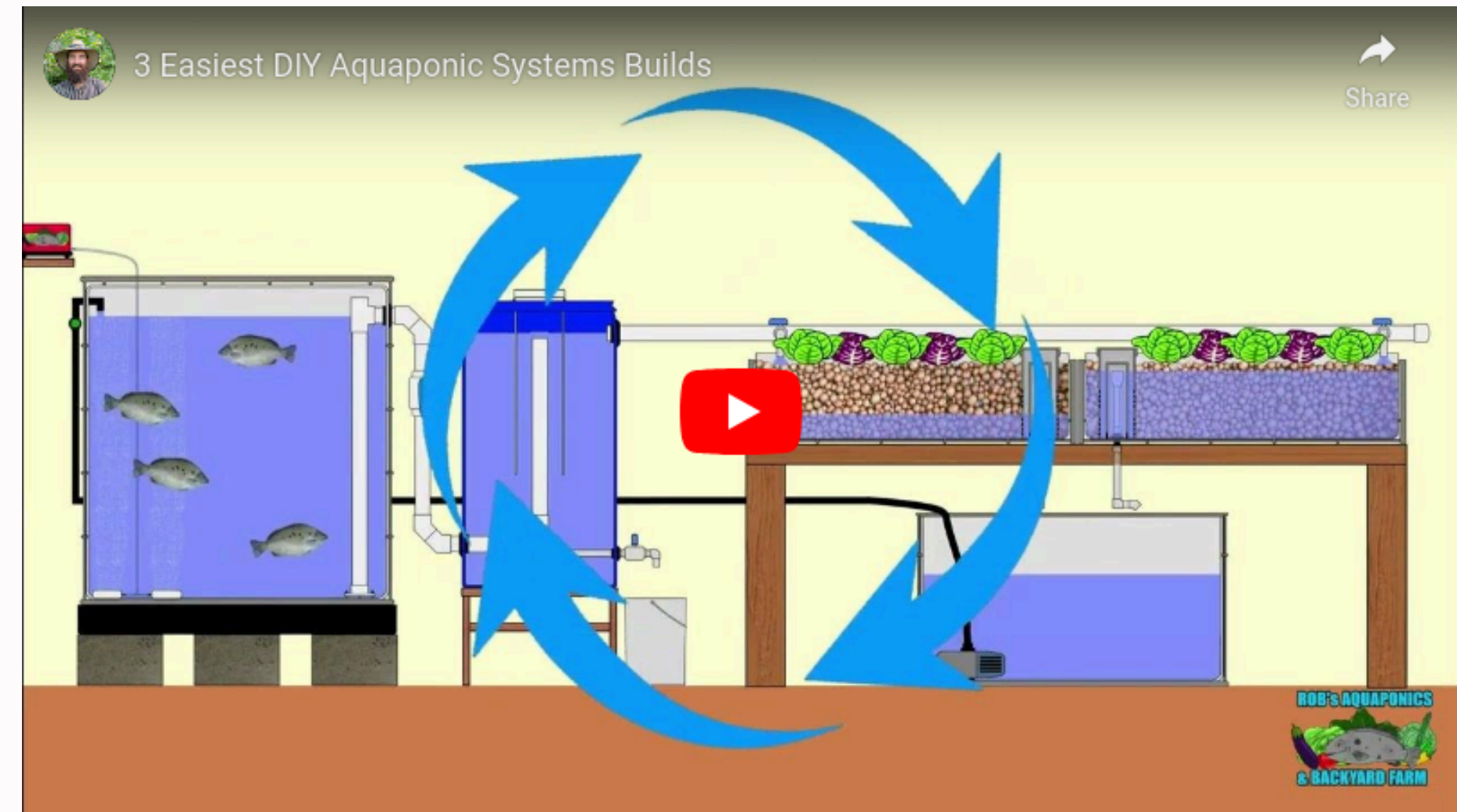


Aquaponic System:

Aquaponics System Design Video



Aquaponics System Design Video



What is Aeroponics?

- Aeroponics is an innovative method of cultivating plants that involves suspending the plant roots in an air or mist environment while delivering nutrients directly to them.
- Aeroponics relies on a misting or spraying mechanism to deliver a highly oxygenated nutrient solution to the plant roots, promoting rapid growth and efficient nutrient absorption.



Benefits of Aeroponic Systems



- Significantly conserve water compared to traditional farming methods, as they utilize a closed-loop system that recirculates nutrient solutions, minimizing water wastage.
- Reduces water consumption by up to 90% compared to traditional soil farming.
- Reduces agricultural runoff, mitigating the pollution of water bodies and preserving aquatic ecosystems.



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Benefits of Aeroponic Systems

- By eliminating the need for soil, aeroponics minimizes the risk of soil-borne diseases, promoting healthier plants and reducing the reliance on chemical pesticides.
- The precise control over nutrient delivery and environmental conditions in aeroponic systems leads to higher crop yields and superior produce quality.
- The scalability and adaptability of aeroponic systems make them ideal for urban agriculture, contributing to sustainable city planning and resilient food systems.



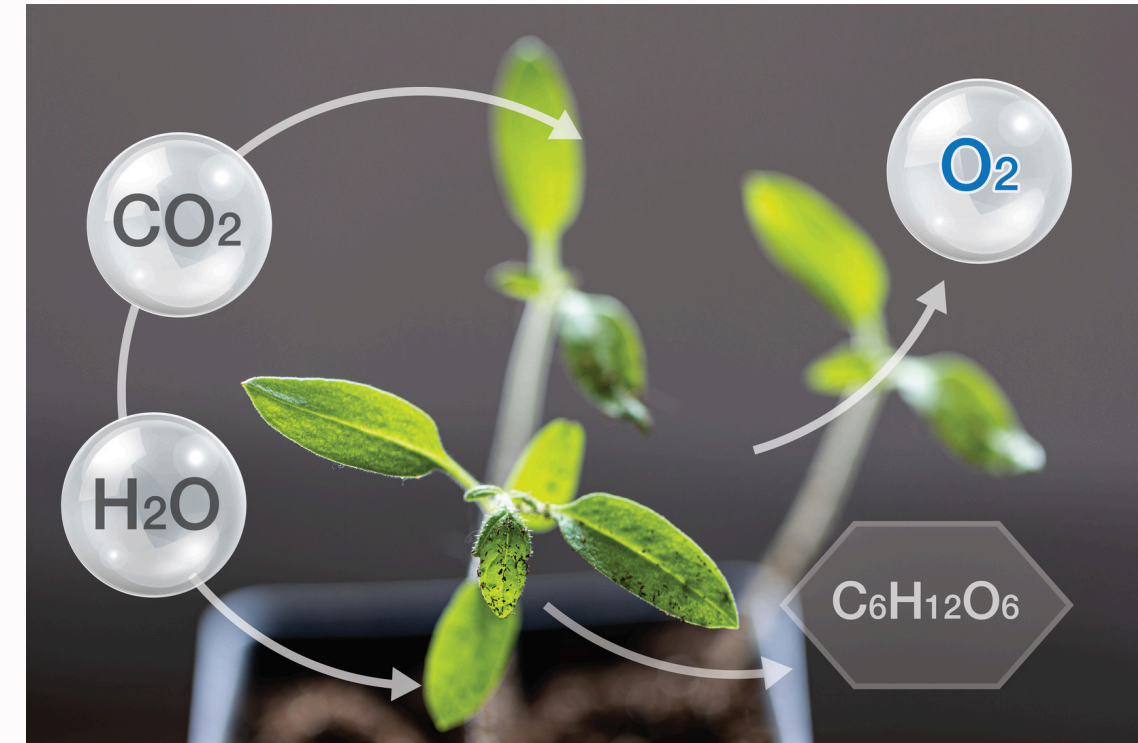
Benefits of Aeroponic Systems



Plant Biology and Physiology in Aeroponics

Plant Growth and Development:

- **Photosynthesis:** Aeroponic plants exhibit robust photosynthetic activity, utilizing light energy, carbon dioxide, and water to produce glucose and oxygen.

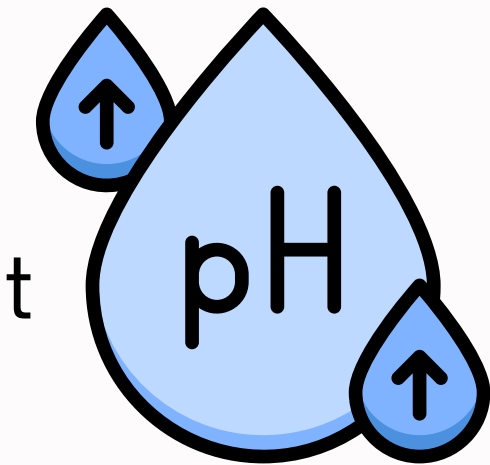


- **Growth Regulation:** Precise control over environmental factors and hormone levels in aeroponics promotes balanced growth and development, optimizing plant health and productivity.

Plant Health and Growth

Factors Affecting Plant Health:

- **Nutrient Balance:** Maintaining proper nutrient levels and pH in the nutrient solution is critical for healthy plant growth and development.



- **Disease Prevention:** Aeroponic systems minimize soil-borne pathogens, reducing the risk of disease outbreaks and promoting plant health.



Plant Health and Growth

Common Plant Disorders and Monitoring

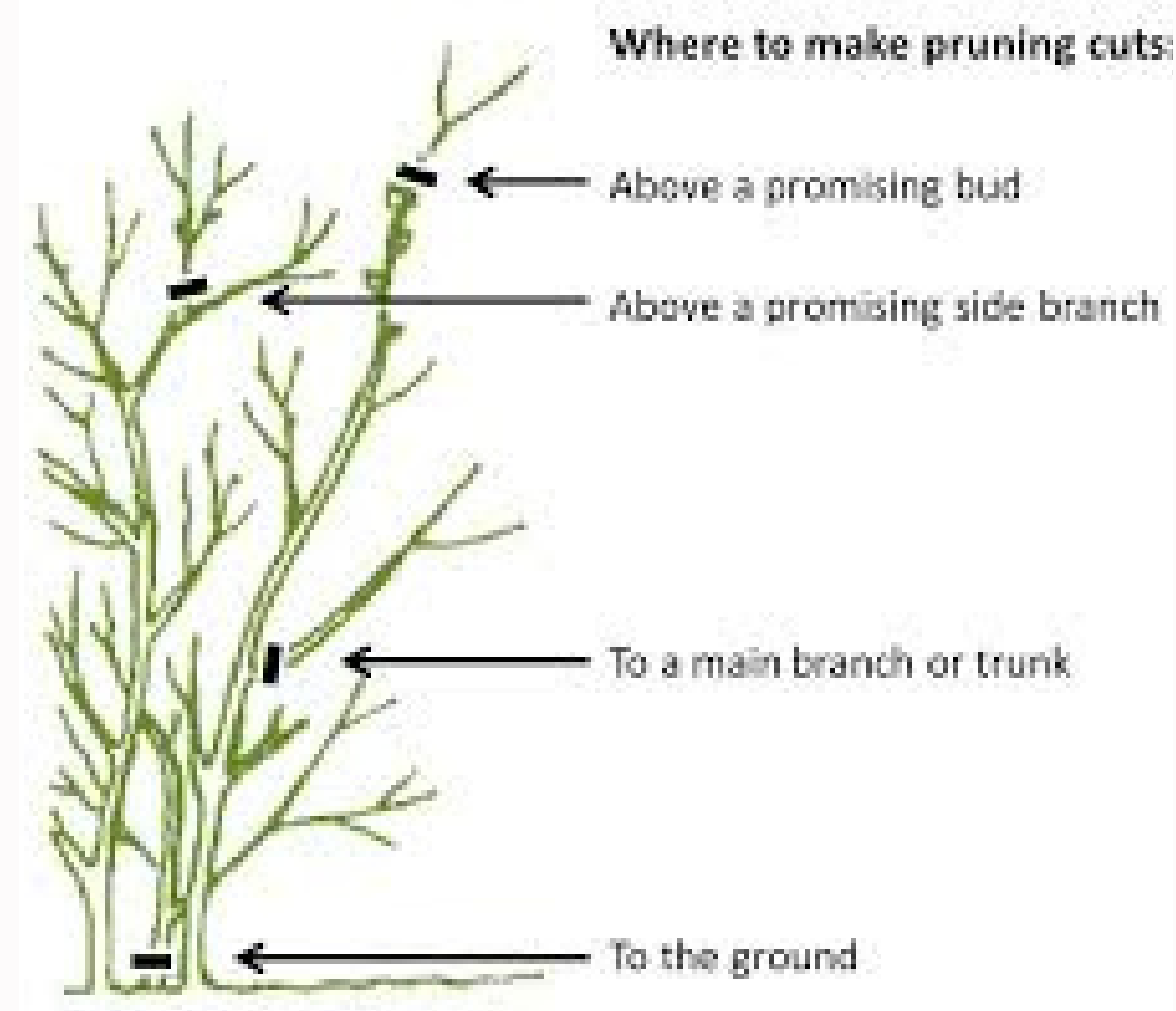
- **Nutrient Deficiencies:** Symptoms such as yellowing leaves or stunted growth indicate nutrient imbalances, requiring adjustments to the nutrient solution.
- **Environmental Stress:** High temperatures, humidity fluctuations, or improper light levels can stress plants, affecting their health and growth.



Plant Health and Growth

Maximizing Yield and Quality

- **Pruning and Training:** Proper pruning and trellising techniques optimize light penetration and airflow within the plant canopy, maximizing yield and quality.



Plant Health and Growth

Maximizing Yield and Quality

- **Harvesting:** Harvesting crops at peak maturity ensures superior flavor, texture, and nutritional content, enhancing overall crop quality and market value.



Plant Health and Growth

Maximizing Yield and Quality



System Design and Integration



Vertical Systems:

- Vertical aeroponic systems utilize vertical space efficiently
- Stacking multiple growing layers to maximize production capacity.
- This is ideal for urban farms, greenhouses, or indoor cultivation facilities with limited floor space.

Horizontal Systems:

- Horizontal aeroponic systems arrange plants in a single plane or staggered rows
- Spreading them across a horizontal surface.
- This is suitable for larger-scale commercial operations or outdoor installations where space is abundant.



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System Design and Integration



System Design and Integration

Components and Layout

- Nutrient Reservoir: Holds the nutrient solution to be delivered to the plants.
- Pump: The pump pressurizes and circulates the nutrient solution through the system, ensuring uniform distribution to all plants.
- Misting Devices: Misting nozzles or sprayers atomize the nutrient solution into fine droplets for root absorption.
- Root Chambers: Containers or racks where plant roots are suspended and exposed to the mist.
- Monitoring/Control Systems: Sensors and controllers regulate nutrient delivery, misting frequency, and environmental conditions.

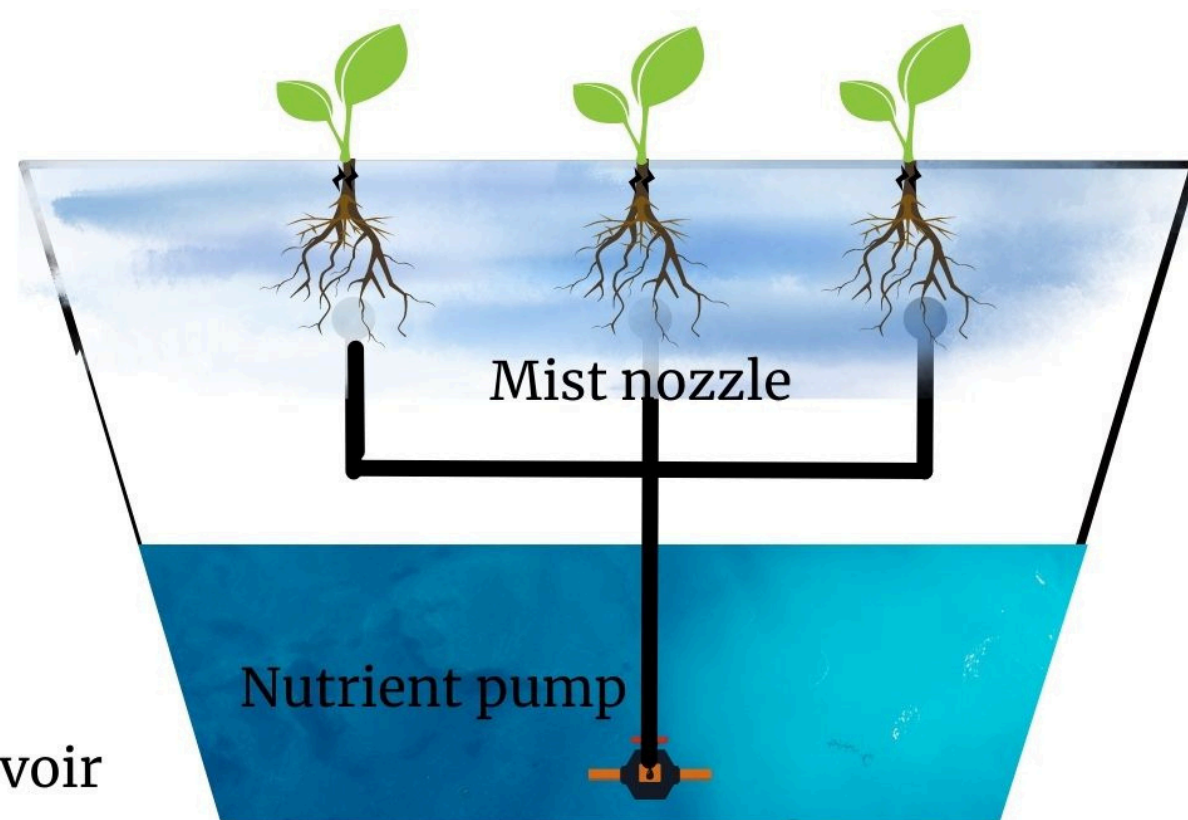


System Design and Integration

Nutrient Reservoir

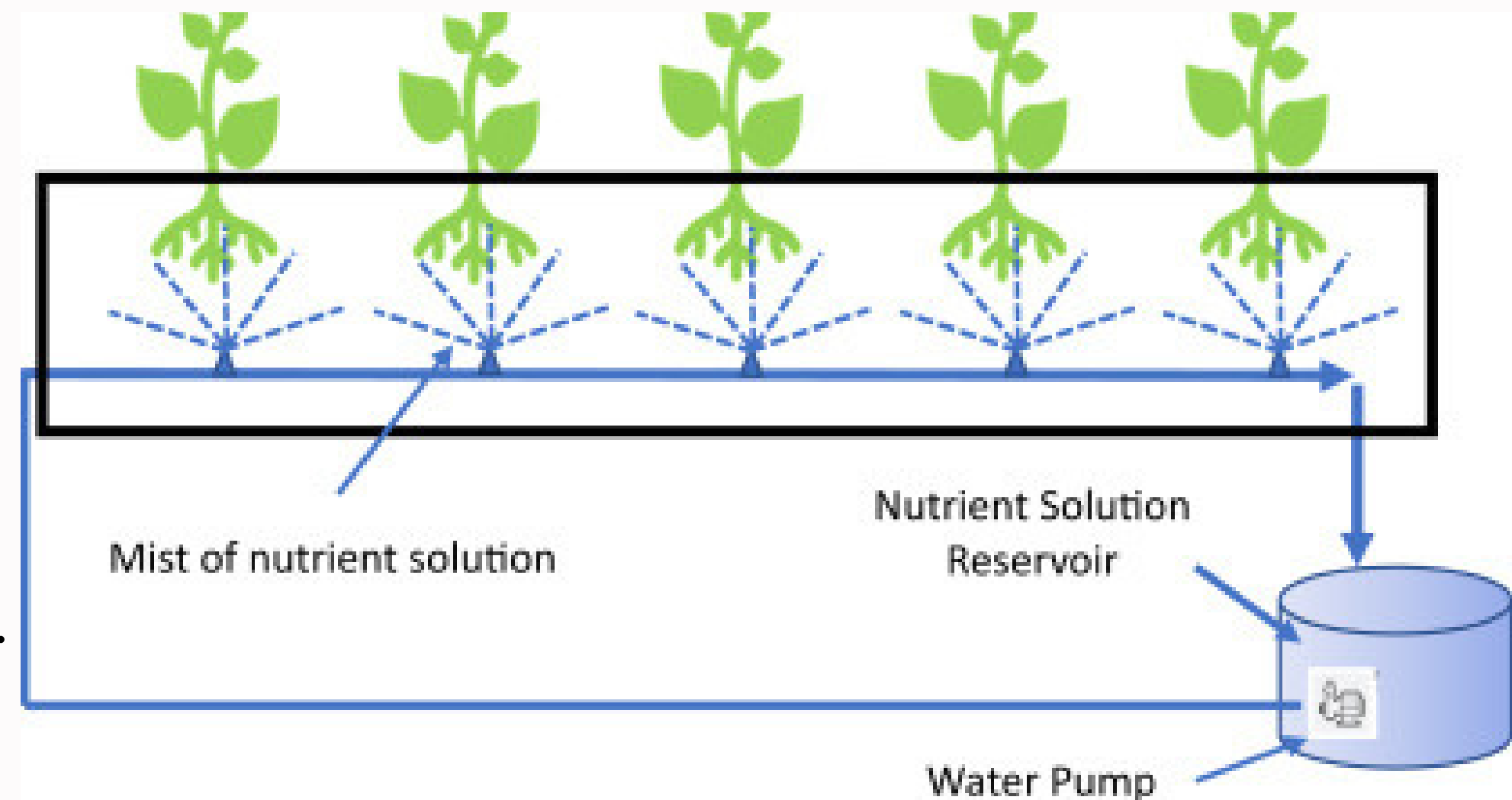
Misting Devices

Root Chambers



Pumping and Automization

- Pumps are used to pressurize and distribute the nutrient solution to misting nozzles or sprayers.
- Atomization is achieved by forcing the nutrient solution through small openings, creating a fine mist that envelops the roots.



System Design and Integration



Control and Automization

Timers and Sensors:

- Automated timers control nutrient delivery and misting intervals,
- while sensors monitor environmental parameters such as temperature and pH.

Feedback Systems: Automated feedback systems adjust nutrient delivery and environmental controls based on real-time data, optimizing growing conditions and plant health.



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System Design and Integration

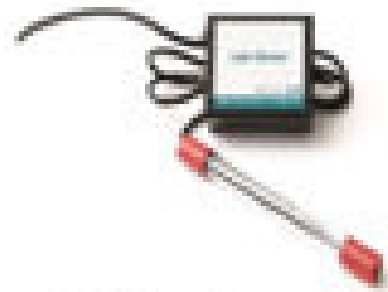
Control and Automization



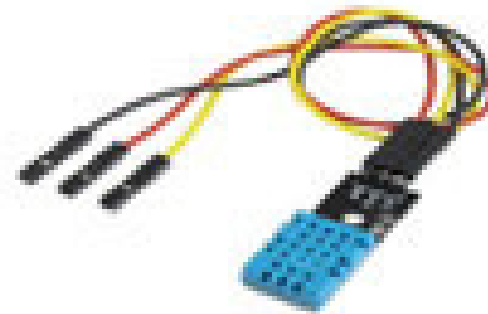
pH sensor



EC sensor



Light intensity sensor



Humidity sensor



CO₂ sensor



Water level sensor



Timer sensor



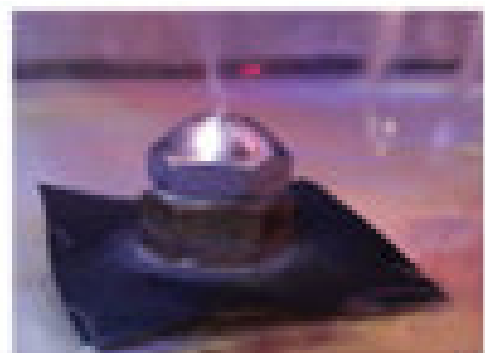
LED lights



CO₂ cylinder



Atomization fogger



Pressure atomization nozzle



Pressure pump



Ventilation fan



Air cooler



Warm air



System Design and Integration

Energy Efficiency and Scalability

LED Lighting:

- Energy-efficient LED grow lights provide the optimal spectrum and intensity of light for photosynthesis
- Promoting healthy plant growth and maximizing yields.
- LED fixtures consume less energy and generate less heat, reducing operating costs and environmental impact.



System Design and Integration



Energy Efficiency and Scalability

Insulation:

- Insulating growing chambers and reservoirs helps maintain stable temperatures and humidity levels, reducing heat loss and energy consumption.
- Proper insulation minimizes environmental fluctuations and ensures consistent growing conditions for optimal plant performance.

Renewable Energy:

- Integration of renewable energy sources such as solar panels or wind turbines can offset energy consumption and reduce reliance on grid electricity.
- Utilizing clean and sustainable energy sources aligns with environmentally friendly practices and enhances the overall sustainability of aeroponic systems.



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System Design and Management



Planning and Installation

- **Site Selection:** Choose a location with access to water, electricity, and suitable environmental conditions for aeroponic farming.
- **System Installation:** Proper assembly and testing of system components ensure functionality and efficiency before planting.



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Nutrient Management and Maintenance

- **Nutrient Formulation:** Prepare a balanced nutrient solution tailored to the specific requirements of crops being grown.
- **Maintenance Practices:** Regular cleaning, inspection, and calibration of system components are essential for preventing malfunctions and ensuring optimal performance.



Plant species for Aeroponics



Leafy Greens:

- Lettuce
- kale
- spinach
- Swiss chard



Herbs:

- Basil
- cilantro
- parsley
- mint



Fruit-Bearing Plants:

- tomatoes
- peppers
- cucumbers
- strawberries



Root Vegetables:

- raddishes
- carrots
- beets

Pest and Disease Management

Pest Prevention Strategies

- **Quarantine:** Inspect incoming plants for pests and diseases before introduction to the system to prevent contamination.
- **Sanitation:** Maintain cleanliness and hygiene to minimize pest breeding grounds and disease transmission.



Monitoring and Identification

- Regular monitoring of plants and growing environment for signs of pest infestation or disease symptoms is essential for early detection and intervention.
- Accurate identification of pests and diseases enables targeted control measures to minimize damage and prevent spread.



Pest and Disease Management



Aeroponics System

[Aeroponics System Design Video](#)

[Aeroponics System Design Video](#)





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