Name	Abeerah Jabran, Sarah Abdulmelik
Grade	8T
Project Title	Filtering The Future

<table>
<tr><th>Date</th><th>Information / Data / Accomplishments</th></tr>
<tr><td>November 14, 2024</td><td>
On this date, we finalized our project idea and selected our title, Filtering the Future. We also submitted the "Science Fair Part 1" and received approval for our project.
<table>
<tr><td>Group Members' Names</td><td>Abeerah Jabran, Sarah Abdulmelik</td></tr>
<tr><td>Project Title</td><td>Filtering The Future</td></tr>
<tr><td>Division (from list provided)</td><td>Consumer goods</td></tr>
<tr><td>Topics (up to 5)</td><td>Consumer goods, Life sciences, Pollution-Water</td></tr>
<tr><td>Summary of proposed project</td><td>In this project, we aim to create an affordable and easy-to-use water filtration system designed to provide clean drinking water for people living in areas with contaminated water sources. Using inexpensive, accessible materials, we will design a simple filtration cup that can be easily assembled and used in everyday homes. The goal is to remove harmful bacteria, debris, from water, improving its safety and quality without the need for expensive technology. By focusing on affordability, our project seeks to provide a solution for communities in need of clean water, helping to prevent waterborne diseases and improve public health.</td></tr>
<tr><td>What type of project would you like to work on (based on the rubric posted)?
Experimental project
Innovation project
Study project</td><td>Innovation Project</td></tr>
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We also began our research and identified key subtopics, as well as selected the initial basic materials for the filtration cup.

Info:

Materials

1. Cotton Balls
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- Purpose: Acts as a pre-filter to catch larger particles like dirt and debris.
- How it helps: Cotton balls trap particles and help to prevent clogging of finer filtration layers.

3. **Gravel**

- Purpose: Helps filter out larger debris and prevents clogging of finer materials.
- How it helps: Gravel is useful as the first layer to catch big particles before water flows through finer materials.

6. Coffee Filters

- Purpose: Used as a fine filter to catch small particles.
- How it helps: Coffee filters can catch smaller debris and particles that are too small for sand or gravel to filter out. They're great as the final layer.

12. Cotton Cloth or Old T-shirt

- Purpose: Used as a fine filter layer.
- How it helps: The fabric can filter out dirt and larger particles, and when combined with other materials, it helps make the filtration more effective.

Example of a Homemade Filter Setup:

You can layer these materials to create an effective filtration system. Here's an example of a simple multi-layer filter:

1. Layer 1: Old tshirt
2. Layer 2: add coarse sand
3. Layer 3: add gravel
4. Layer 4: Cotton balls
5. Layer 5 (Bottom): Coffee filters

Extra Tips:

- **Use clear plastic bottles or containers** to build your filter for visibility and easy assembly.
- **Experiment** with different combinations of these materials to see which ones work best for your filtration system.
- **Test your filter** with dirty water (you can add dirt, food coloring, or small debris to simulate polluted water) and then compare the water before and after filtration to show how effective your setup is.

Sub-Topics:

1. Understanding Water Contamination

	- Water contamination, in simple terms, means the pollution of water that causes the water to become unsuitable for cooking, drinking, and other uses. Agriculture, industrial chemicals, and overflowing sewers are three of the many causes of contamination. - When harmful substances,such as chemicals or microorganisms, enter a water source, it contaminates the water. Main causes are Agricultural runoff, industrial contamination, improperly treated water,natural disasters, and sewage leaks. - Here's an in-depth look at water contamination: **1. Types of Water Contaminants** Water contaminants are typically categorized into four main types, each with specific sources and effects: **A. Biological Contaminants** ● Definition: These include microorganisms like bacteria, viruses, protozoa, and parasites that can cause illness. ● Examples: ○ Bacteria: E. coli, Salmonella, and Vibrio cholerae, which can cause diseases such as diarrhea, cholera, and typhoid. ○ Viruses: Hepatitis A virus, Norovirus, and Rotavirus, which can lead to illnesses including hepatitis, gastroenteritis, and polio. ○ Protozoa: Giardia and Cryptosporidium, which cause severe gastrointestinal distress. ● Sources: Biological contaminants often come from human or animal waste, leaking septic tanks, or contaminated surface runoff entering water sources. **B. Chemical Contaminants** ● Definition: These are chemicals or compounds that can be toxic when ingested, even in small amounts. ● Examples: ○ Pesticides and Herbicides: Used in agriculture and can seep into groundwater or wash into streams. ○ Heavy Metals: Lead, mercury, and arsenic are highly toxic and can cause various health issues, including neurological damage and organ failure. ○ Industrial Chemicals: Pollutants from factories, like polychlorinated biphenyls (PCBs), solvents, and petrochemicals, which can cause cancers and developmental issues. ● Sources: Chemical contaminants often result from industrial activities, agricultural runoff, improper waste disposal, and even household products that leach into water systems. **C. Physical Contaminants** ● Definition: These are visible particles or suspended solids that can cloud water and indicate other potential contamination. ● Examples: ○ Sediments: Soil, sand, and silt from erosion, construction, or stormwater runoff. ○ Plastics and Microplastics: Small plastic particles that can enter water sources from consumer products, waste, and improper disposal. ● Sources: Physical contaminants usually come from erosion, construction, agricultural activities, and improper waste disposal.

D. Radiological Contaminants

- Definition: These are radioactive substances that can cause radiation exposure and long-term health effects.
- Examples:
  - Radon: A naturally occurring radioactive gas that can leach into groundwater.
  - Uranium and Radium: Naturally present in certain soils and rocks, these can dissolve in water, especially in certain geological areas.
- Sources: Radiological contaminants typically come from natural deposits in the earth but can also result from mining, industrial waste, and improper disposal of radioactive materials.

2. Sources of Water Contamination

Water contamination can stem from a variety of sources, including:

- Agricultural Runoff: Fertilizers, pesticides, and animal waste from farms can be washed into rivers, lakes, and groundwater, introducing chemicals, nutrients, and pathogens into water supplies.
- Industrial Discharges: Factories and industrial facilities often discharge wastewater containing hazardous chemicals, heavy metals, and other pollutants into nearby water bodies.
- Urban Runoff: In cities, stormwater can carry contaminants like oil, trash, and chemicals from roads, parking lots, and lawns into water bodies.
- Sewage and Wastewater: Improperly treated sewage or leaks from septic tanks can release bacteria, viruses, and chemicals into water sources.
- Landfills and Waste Dumps: Waste disposed of in landfills can leach harmful substances into the ground, potentially contaminating groundwater.
- Natural Sources: In some cases, contaminants are naturally occurring, such as arsenic in rocks, which can dissolve into groundwater, or salt intrusion into freshwater sources near coasts.

3. Impact of Water Contamination on Health and the Environment

- Human Health Impacts: Contaminated water can lead to waterborne diseases, affecting digestive, respiratory, and nervous systems. Common illnesses include cholera, hepatitis, and dysentery. Long-term exposure to contaminants like heavy metals or chemicals can cause cancer, neurological disorders, and reproductive issues.
- Environmental Impacts: Contaminants in water can disrupt aquatic ecosystems, harm fish and other wildlife, and degrade overall water quality, impacting biodiversity and the food chain.

4. Detection of Water Contaminants

- Testing for Biological Contaminants: Techniques like bacterial culture tests, polymerase chain reaction (PCR) for DNA analysis, and enzyme-based tests to identify pathogens.
- Chemical Testing: Involves chromatography, spectroscopy, and various chemical reagents to detect pollutants like heavy metals and pesticides.
- Physical Testing: Measures turbidity (cloudiness), color, and total suspended solids to assess physical water quality.

- Radiological Testing: Detects radioactive particles through specialized equipment such as Geiger counters or scintillation detectors.

5. Preventing and Managing Water Contamination

- Source Control: Reducing pollutants at the source, such as using less toxic alternatives in agriculture and industry, and properly disposing of waste.
- Wastewater Treatment: Treating sewage and industrial wastewater to remove harmful contaminants before it enters the environment.
- Filtration and Purification: Using water filtration systems to remove contaminants from water sources, making it safe for consumption.
- Education and Awareness: Educating communities on best practices for waste disposal, agricultural management, and the importance of water conservation.

6. Global and Local Impact of Water Contamination

- Developing Countries: In many parts of the world, lack of access to clean water contributes to high rates of illness and mortality, especially in children. Contaminated water exacerbates poverty by increasing healthcare costs and reducing productivity.
- Climate Change and Water Contamination: Climate change can worsen water contamination by causing floods, which spread contaminants, and droughts, which concentrate pollutants in dwindling water supplies.

7. Water Filtration Solutions

- Various water filtration methods can help make contaminated water safe for drinking:
    - Boiling: Effective against pathogens but doesn’t remove chemical contaminants.
    - Activated Carbon Filters: Good for removing certain chemicals and improving taste.
    - Ceramic Filters: Effective against bacteria and larger particles.
    - Solar Disinfection: Using sunlight to kill pathogens.
    - Reverse Osmosis: Advanced filtration for removing most contaminants, including heavy metals and chemicals.

8. Future Challenges and Innovations in Water Purification

- As industrialization and population growth continue, more innovative and sustainable water purification solutions are needed to address contamination. Recent advancements include nanotechnology for filtration, portable water purifiers for remote areas, and biodegradable filters.

By understanding these extensive details, you can better appreciate the complexities and dangers of water contamination and the importance of accessible, affordable water purification solutions for public health. This information could help structure your science fair project to show both the causes and solutions for water contamination.

2. Principles of Water Filtration

1. Physical Filtration (Filtering with a Screen)

- What It Does: This method removes dirt, sand, and larger particles from water.

- How It Works: Water passes through a filter with small holes (like a screen or mesh), and the dirt gets stuck in the filter while clean water passes through.
- Example: A mesh filter that removes sand from water.

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2. Adsorption (Sticky Filter)

- What It Does: It helps remove bad smells, chemicals, and harmful substances like chlorine.
- How It Works: Some filters, like activated carbon, have a surface that attracts and "sticks" to unwanted chemicals and particles, trapping them in the filter.
- Example: Activated carbon filters that improve the taste and smell of water.

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3. Chemical Filtration (Changing Chemicals)

- What It Does: This method removes harmful chemicals or metals (like lead or iron) from water.
- How It Works: Chemicals in the filter react with the contaminants in the water to either change them or make them easier to remove.
- Example: Special filters that remove heavy metals or chemicals from drinking water.

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4. Reverse Osmosis (Super Fine Filter)

- What It Does: It removes very tiny particles, salts, and other dissolved substances from water.
- How It Works: Water is pushed through a very fine filter (membrane) that only lets water molecules through. The tiny contaminants stay behind.
- Example: Reverse osmosis systems used to filter saltwater to make it drinkable.

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5. UV Filtration (Using Light to Kill Germs)

- What It Does: It kills bacteria, viruses, and other harmful germs in the water.
- How It Works: UV light is used to damage the DNA of harmful microorganisms, making them unable to grow or cause disease.
- Example: UV purifiers used in water treatment to disinfect the water.

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6. Sedimentation (Letting the Dirt Settle)

- What It Does: This method removes large particles like dirt and mud.
- How It Works: Water is allowed to sit still for a while, and the heavy particles settle at the bottom, leaving cleaner water at the top.

	• Example: In lakes or rivers, water often goes through this natural process before it's filtered. --- **7. Coagulation and Flocculation (Clumping Particles Together)** • What It Does: This process helps to remove tiny particles by clumping them together into larger "clumps" (called flocs), which are easier to filter out. • How It Works: Special chemicals are added to the water that cause small particles to stick together. Once clumped, they can be removed by other filtration methods. • Example: Used in water treatment plants to remove tiny particles that can't be filtered out easily. --- **Summary of Principles:** • Physical Filtration: Removes big particles (like dirt and sand). • Adsorption: Attracts and traps bad chemicals and smells. • Chemical Filtration: Removes harmful chemicals and metals. • Reverse Osmosis: Filters out very small particles and salts. • UV Filtration: Kills harmful germs with light. • Sedimentation: Allows heavy particles settle to the bottom. • Coagulation and Flocculation: Makes tiny particles clump together to be filtered out **References\Links:** - Water Contamination - Understanding Water Filtration
November 17, 2024	We have finalized the materials list and completed the design of the filtration system. Ethics And Due Care Form approved . **3. Materials Selection** **1. Structural Components:** - **Polypropylene (PVC Foam Board)** • Features: Lightweight, strong, and resistant to chemicals and water. Often used in food containers and reusable cups. • Applications in Filtration: Commonly used for structural components like casings or support layers in filtration systems. • Benefits: Affordable, easy to mold, and widely available. • Safety: Food-safe and non-toxic, making it ideal for water-related uses. - **BPA - Free Polycarbonate (1 liter Coke Bottle)** • Features: Exceptionally strong, lightweight, impact-resistant, and waterproof. • Common Uses: Used in shatterproof water bottles, safety goggles, and durable containers.

- Why It Works: Polycarbonate is nearly unbreakable, making it ideal for applications where durability is critical.
- Drawbacks: Slightly more expensive than other plastics.

1. Cotton Balls

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2. Gravel

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5. Coarse Sand

6. Liter Soda Bottle

7. Activated Charcoal Bricks

8. 3 Types of Nasty Water

4. Designing the Filtration System

a filtration system that mimics how natural filtration works by using various materials to remove contaminants from dirty water. This design will use a combination of physical, chemical, and adsorption filtration techniques to purify water and make it suitable for basic use.

Materials Needed:

- **Clear Plastic Bottle** (e.g., 1-liter soda bottle) – For visibility and easy assembly
- **Activated Charcoal Bricks** – For adsorption (removes chemicals and improves taste)
- **Cotton Balls** – For pre-filtration (catches large debris)
- **Gravel** – For larger debris filtration and to prevent clogging
- **Coarse Sand** – For finer filtration to trap smaller particles
- **Coffee Filters or Old T-shirt** – For fine filtration to catch the smallest particles
- **Polypropylene (PVC Foam Board)** – For structural support, if necessary

	• **Rice**- **Filtration Process:** This filtration system will use **multiple stages** to purify the water: **Step 1: Initial Filtering Layer (Cotton Balls)** • **Purpose:** To filter out large particles such as dirt, leaves, and debris. • **How:** Place cotton balls at the very top of the bottle opening. They will act as a **pre-filter**, trapping large debris before the water moves to the next stage. **Step 2: Coarse Gravel Layer** • **Purpose:** To catch larger debris and prevent the finer materials (sand and charcoal) from clogging. • **How:** Place a layer of **coarse gravel** directly beneath the cotton balls. This layer will allow water to flow freely while catching larger solids. **Step 3: Coarse Sand Layer** • **Purpose:** To trap smaller particles, such as silt, sand, and fine debris. • **How:** Add a thick layer of **coarse sand** on top of the gravel. The sand will act as a natural filter, trapping any smaller particles in the water. **Step 4: Activated Charcoal Layer** • **Purpose:** To adsorb harmful chemicals, chlorine, and bad odors, improving water taste and reducing toxins. • **How:** Place **activated charcoal bricks** on top of the coarse sand. The charcoal will trap chemical contaminants through the process of **adsorption**, where the contaminants stick to the surface of the charcoal. **Step 5: Fine Filtration Layer (Coffee Filters or Old T-shirt)** • **Purpose:** To catch the finest particles and complete the filtration process. • **How:** Place **coffee filters** or a piece of **old cotton cloth (T-shirt)** at the very bottom of the bottle. This final layer will filter out any remaining fine particles that were not caught in the previous layers. **Step 6: Collection of Clean Water** • **Purpose:** To collect purified water. • **How:** Place the cut-off bottom of the plastic bottle beneath the filtered water, allowing the clean water to drip through the filter and collect into a clean container. --- **Filtration System Setup and Assembly:** 1. **Prepare the Bottle:** Cut off the bottom of a 1-liter plastic bottle to create an opening for water to flow through.

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2. **Layer the Materials:** Insert each layer into the bottle starting from the top (cotton balls) and work down to the bottom (coffee filter).
3. **Secure the Filter:** You may need to secure the cotton balls, gravel, sand, and charcoal layers with an elastic band or tape to prevent them from shifting when water flows through.
4. **Test the Filter:** Fill the top of the filter with **dirty water** (you can add dirt, food coloring, or small debris to simulate polluted water). Collect the filtered water in a clean container and compare the results before and after filtration.

Expected Results:

- The **cotton balls** will trap large debris and prevent clogging.
- The **gravel** layer will filter out larger particles, allowing water to pass through the finer materials.
- The **coarse sand** will filter out small particles like silt.
- The **activated charcoal** will adsorb chemicals, odors, and other toxins from the water.
- The **coffee filter or old T-shirt** will provide a final layer of filtration, ensuring that smaller particles are removed.

Scientific Principles at Work:

1. **Physical Filtration:** The cotton balls, gravel, and sand remove larger particles through physical barriers.
2. **Adsorption:** Activated charcoal adsorbs chemicals and impurities, improving the water's taste and removing harmful toxins.
3. **Chemical Filtration:** The sand and charcoal layers help remove heavy metals or other dissolved chemicals.
4. **Fine Filtration:** Coffee filters and cotton cloth remove small particulate matter and debris.

Testing and Comparison:

After running the dirty water through the filter, compare the water before and after filtration to evaluate the effectiveness of your system. You can measure:

- **Turbidity:** The clarity of the water before and after.
- **Smell:** Does the filtered water smell better due to the activated charcoal?
- **Taste:** The charcoal will help improve the taste by removing chemical contaminants.
- **Physical debris:** How much dirt and particles were removed by the cotton, sand, and gravel layers?

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November 19, 2024

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Today, we successfully completed two additional subtopics: *Environmental Impact and Sustainability* and *Case Studies of Similar Low-Cost Filtration Systems.*

8. Environmental Impact and Sustainability

Environmental Impact:

1. **Reducing Pollution:** The water filtration system will help clean contaminated water, preventing harmful pollutants from entering natural water bodies. By filtering out chemicals, heavy metals, and debris from water, the system can reduce water pollution in communities with limited access to clean water.

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2. **Waste Reduction:** Using common, inexpensive materials like cotton, sand, gravel, and activated charcoal helps minimize waste. Your project can encourage the use of recyclable materials (like plastic bottles) for the filtration system, reducing the need for additional plastic production.
3. **Healthier Ecosystems:** Cleaner water means healthier aquatic ecosystems. By removing harmful contaminants, your filtration system can protect aquatic life and maintain biodiversity, contributing to better environmental balance in polluted areas.

Sustainability:

1. **Low-Cost and Reusable:** The filtration system is designed to be affordable, meaning it can be accessed by people in need, without the reliance on costly water purification methods. Also, because it uses materials that are easy to replace or maintain (like charcoal or sand), the system is sustainable for long-term use.
2. **Local Sourcing of Materials:** Many of the materials used, such as cotton, sand, and activated charcoal, are locally available and don't require complex industrial processes to produce. This reduces the environmental footprint of transporting raw materials or manufacturing expensive water purification technologies.
3. **Minimizing Harmful Chemicals:** The project promotes safe and non-toxic materials, like BPA-free plastic and natural substances like sand and charcoal, ensuring that it doesn't introduce new pollutants into the environment. This sustainable approach reduces the overall environmental impact.

Long-Term Environmental Benefits:

1. **Providing Clean Water for Communities:** Your filtration system has the potential to be a lasting solution in regions where clean water is scarce, ultimately helping communities thrive by providing access to safe drinking water, reducing waterborne diseases, and improving public health.
2. **Promoting Awareness and Education:** By introducing low-cost filtration systems, your project can raise awareness about water quality and encourage communities to adopt sustainable practices in water conservation and purification, which can have a lasting positive effect on both the environment and public health.

9. Case Studies of Similar Low-Cost Filtration Systems

Over the years, many low-cost water filtration systems have been developed to address the lack of clean water in underserved communities. Below are a few examples of these systems, along with a comparison to my own project.

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1. LifeStraw (Portable Water Filter)

- **Overview**: LifeStraw is a simple, portable water filtration device that removes bacteria, parasites, and microplastics from water. It's typically used by individuals in outdoor settings or in emergency situations where access to clean water is limited.
- **Key Features**:
    - Can filter up to 1,000 liters of water.
    - Removes 99.9999% of bacteria and 99.9% of parasites.

	○ Easy to use and designed for individual, portable use. ● **Comparison to My Project**: ○ **Similarity**: Like LifeStraw, my project focuses on improving water quality and accessibility by removing harmful contaminants. Both systems are designed to be easy to use and accessible to people in need. ○ **Difference**: While LifeStraw is a portable, single-use filter that targets biological contaminants, my system is intended for larger-scale community use and addresses a broader range of contaminants, including chemicals and heavy metals, using multiple layers of filtration like cotton, activated charcoal, and rice. --- **2. BioSand Filter (Household Water Filter)** ● **Overview**: The BioSand filter is a household water filtration system that uses layers of sand, gravel, and a biological layer to filter out pathogens and impurities. It is mainly used in homes or small community settings in developing regions. ● **Key Features**: ○ Removes pathogens through biological filtration. ○ Low-cost and requires minimal maintenance. ○ Treats up to 20 liters of water per day. ● **Comparison to My Project**: ○ **Similarity**: Both BioSand filters and my system are designed to be affordable, scalable, and easy to maintain, using locally available materials for filtration. ○ **Difference**: BioSand filters primarily focus on biological contaminants and rely on the growth of microorganisms to clean water, whereas my system uses a combination of physical filtration (cotton, rice), chemical adsorption (activated charcoal), and multi-stage filters to remove a broader spectrum of contaminants, including chemicals and heavy metals. --- **3. Sawyer Mini Water Filter** ● **Overview**: The Sawyer Mini is a compact, portable filter designed to remove bacteria, protozoa, and other microorganisms from water. It's mainly used by travelers, hikers, or in emergency scenarios where clean water is unavailable. ● **Key Features**: ○ Filters up to 100,000 gallons of water. ○ Removes 99.99999% of bacteria and protozoa. ○ Lightweight and easy to carry. ● **Comparison to My Project**: ○ **Similarity**: Both the Sawyer Mini and my system focus on providing affordable, accessible clean water to users in resource-limited settings. ○ **Difference**: The Sawyer Mini is designed for individual use and mostly addresses biological contaminants. In contrast, my system is a multi-layered filtration system that is reusable, scalable, and addresses a wider range of contaminants, such as chemicals, heavy metals, and particulate matter, in addition to biological ones. --- **4. Potters for Peace Ceramic Water Filter**

	• **Overview**: This is a simple, ceramic-based filter that works by allowing water to pass through the ceramic material, which traps bacteria and larger particles. It is commonly used in homes in developing countries to improve access to clean drinking water.
	• **Key Features**:
	  ○ Simple, durable, and low-cost.
	  ○ Filters out bacteria and larger particles.
	  ○ Local production is possible, helping keep costs down.
	• **Comparison to My Project**:
	  ○ **Similarity**: Both systems use locally sourced materials and are designed to be affordable and effective for people in low-income communities.
	  ○ **Difference**: The ceramic filter is focused on removing biological contaminants through physical filtration, while my system goes beyond biological filtration to include chemical and physical filtration techniques, such as the use of activated charcoal and multi-stage filtering, to address a wider range of water contaminants.
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	5. The Tippy Tap (Low-Cost Handwashing Station)
	• **Overview**: The Tippy Tap is a simple, hands-free handwashing station made with materials like plastic bottles, ropes, and wood. It's designed to help communities wash their hands without wasting water, particularly in areas with limited access to clean water.
	• **Key Features**:
	  ○ Uses gravity to dispense water from a plastic bottle.
	  ○ Affordable and easy to build with local materials.
	  ○ Promotes sanitation and hygiene in communities.
	• **Comparison to My Project**:
	  ○ **Similarity**: Both projects aim to improve public health by addressing water-related issues in low-income communities, using inexpensive, locally available materials.
	  ○ **Difference**: The Tippy Tap is focused on promoting hygiene through handwashing, while my project is focused on purifying water for drinking and consumption, using a broader range of filtration techniques to remove contaminants.
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	Summary Comparison:
	• **Similarities**:
	  ○ All of these systems, including mine, are designed to be affordable, accessible, and effective at providing clean water to communities in need.
	  ○ They all rely on simple, locally sourced materials to keep costs low and minimize the need for external resources.
	  ○ These systems aim to improve public health by making clean water more accessible in underserved regions.
	• **Differences**:
	  ○ My filtration system stands out by offering a more comprehensive approach to water purification. It combines multiple layers of filtration (cotton, rice, activated charcoal) to address a variety of contaminants, including chemicals, metals, and biological hazards.

	○ Unlike some of the systems mentioned, which are mostly for personal or household use (e.g., Sawyer Mini, BioSand filter), my system can be scaled up for use by communities, making it more adaptable to different needs. ○ While other systems focus on biological filtration or are designed for individual use, my project's multi-layer approach addresses a wider array of water quality issues, making it a more versatile solution for diverse water contamination challenges. In summary, my system builds upon the successes of these existing solutions but takes it further by providing a more holistic and scalable filtration method that can be used in a wider variety of settings, improving access to clean and safe water for entire communities.

November 20, 2024

3 new topics were completed.

12. Comparative Analysis of Traditional and Modern Filtration Techniques

1. People back then thought heat or boiling were the best forms of water purification. They also used crude straining methods of sand and gravel filtration. This showed that they thought if the water tasted good, it was purified which was wrong. They were not yet aware that even water that tasted pure could contain chemical contaminants or dangerous microorganisms.

2. Now in our project, we not only make the water taste good, but also is indicated to have no bacteria. Back then also, Hippocrates was the first to create a water filtration system with a cloth bag that the water would be poured through after being boiled. The cloth would trap any sediment in the water that were causing bad taste or smell, but that would mean there still could be bacteria. In our Filtering cup, We have several different water filters including cloth and san. Which would take out the bad smell or taste, and would get boiled after to remove the remaining bacteria.

13. Microbial and Pathogen Control in Low-Cost Filters:

1. **Physical Filtration**: Low-cost filters often use materials like sand, clay, or activated carbon to trap germs. These materials have small holes (pores) that stop harmful germs, like bacteria and viruses, from passing through.
2. **Chemical Methods**: Some filters use chemicals like chlorine, iodine, or silver to kill germs. Silver, for example, can be added to filters to help stop bacteria from growing. However, too much of these chemicals can be dangerous, so they need to be used carefully.
3. **UV Light (Ultraviolet Light)**: Some filters use UV light to destroy germs by changing their DNA, which makes them unable to cause illness. Solar-powered UV filters are also a cheap option in places with lots of sunlight.
4. **Biological Filtration**: Some filters allow helpful germs (called biofilms) to grow on the filter to fight harmful germs. These helpful germs break down bad substances and stop harmful germs from getting through. However, the biofilm needs to be managed so it doesn't become harmful itself.
5. **New Materials for Pathogen Control**: Researchers are working on creating new filter materials. Some materials attract germs to trap them, while others push them away. Ceramic filters can also be used to trap bacteria and other harmful organisms.
6. **Maintenance and Care**: Filters need to be cleaned regularly to keep them working well. If not cleaned, they can get clogged or become breeding

	grounds for germs. Some filters also need to be replaced after a while to keep working properly. 7. **Challenges:** ● Viruses: Filters are better at removing larger germs like bacteria, but they are not as good at catching viruses because viruses are much smaller. ● Water Quality: The type of water being filtered can affect how well a filter works. For example, dirty water with lots of particles might not be cleaned as well. ● Cost and Availability: Even though low-cost filters are affordable, getting them to remote places where people don’t have easy access to clean water can still be a challenge. 8. **Innovative Solutions:** ● Solar-Powered UV Filters: These use solar energy to power UV light, making them great for places that don’t have electricity. ● Ceramic-Activated Carbon Filters: These filters combine two methods—ceramic for blocking germs and activated carbon for improving taste and removing some chemicals. **15. Role of pH and Water Chemistry in Filtration Efficiency** 1. **What is pH, and How Does it Affect Filtration?** ● pH tells us how acidic or basic (alkaline) the water is. It can affect how well a filter works by changing the way certain substances behave in the water. ● Acidic water (low pH) can make metals like iron and copper dissolve more easily, which can make it harder to remove them with a filter. ● Alkaline water (high pH) can cause things like calcium (which makes water "hard") to form solid particles, which can actually be easier to filter out. ● How pH Affects Filters: ● Some filters work better at certain pH levels. For example, activated carbon filters work best in water that isn’t too acidic or too basic. If the pH is too high or low, the carbon might not work as well.

- The effectiveness of disinfectants like chlorine also depends on the pH. Chlorine works best in slightly acidic water. If the water is too alkaline, it’s not as good at killing germs.

2. **What is Water Chemistry, and How Does it Affect Filtration?**

- Water chemistry is all about the chemicals and particles that are dissolved in the water, like minerals, dirt, and other substances. These can affect how well a filter works.
  - Suspended solids (like dirt or sand) can clog filters and make them less effective. If the water is too cloudy (called turbidity), it might need to be treated before filtration to make the filter work better.
  - Ions are tiny charged particles like calcium, magnesium, and chloride. If there are too many of them, they can form deposits on filters, making them less effective over time. This is common in hard water, which has high levels of calcium and magnesium.

3. **How Can We Make Filtration More Efficient by Adjusting pH and Chemistry?**

- Sometimes, adjusting the pH of the water can help improve how well a filter works. For example:
  - If the water is too acidic or too basic, adjusting the pH can help remove certain chemicals more easily.
  - Acidic water can help remove metals and make disinfectants like chlorine work better.
  - Alkaline water can make minerals like calcium form solid particles, which are easier to filter out.
- Pre-Treatment: In places with hard water, it might help to soften the water before filtering. This is done by adding chemicals that replace calcium and magnesium with sodium, which helps prevent buildup in filters.

January 7, 2025	I have finalized the slides and simulation for the filtering process. Also completed the script. Created a QR code for the research. QR Code Filtering The Future Script Filtering The Future Slides