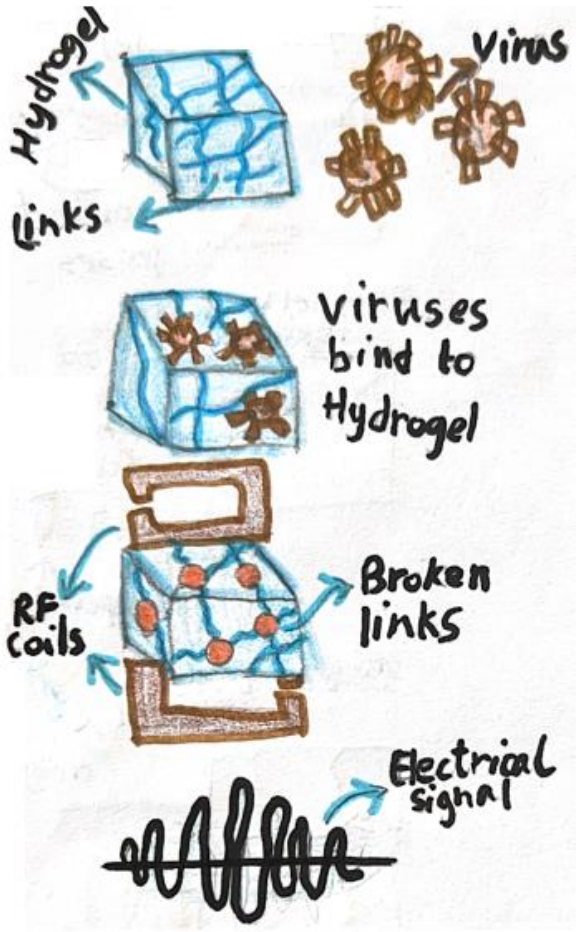
Grades K-3 Abstract

Many children get sick from colds and flu. In the U.S during the 2025 flu season, about 33% of children under 18 tested positive for Influenza and were hospitalized[1]. Around 36% of children under 5 are treated each year for common colds (rhino virus) and stomach bug (entero virus) [2]. Currently, viral infections are diagnosed using RT-PCR which detects the virus only after infection. our device "Buddy band" is a safe, wearable device for children. It features an air intake system, hydrogel-based virus detection, and an integrated computer chip for real-time alerts. The band continuously scans the environment and notifies when entering areas with high viral contamination, helping to reduce the risk of infection especially among school going children.

Grades K-3 Present Technology Section[3]



Scientists are currently researching and developing wireless sensor system that detects respiratory virus in air. In this method special antibodies are designed to detect specific viral antigens. These antibodies are embedded into ‘Hydrogel’ a soft, water rich polymer network.

How it works:

1. Hydrogel is exposed to a specific virus.
2. Virus binds to the Hydrogel.
3. Crosslink in the Hydrogel network break, causes Hydrogel to swell.
4. Radio Frequency (RF) coils detect change in shape and generate electrical signals within 10 minutes.

Limitations:

1. Detecting different types of viruses need different kinds of Hydrogels.
2. Don’t have real-time alerts and slower response time.
3. Hydrogels can dry out over time and
4. Hard to fit into wearable devices.

Grades K-3 History Section [4-6]

1894

The term "hydrogel" was first used to describe salt particles dispersed in a medium, forming a jelly-like substance.

1949

First biomedical use with Poly(vinyl alcohol) (Ivalon).

1960s: 1st generation

Crosslinked polymers were developed and later used in soft contact lenses (FDA approved in 1971).

1970s: 2nd generation

Stimulus-responsive hydrogels emerged, capable of changing their properties such as swelling in response to pH, temperature, or glucose.

Mid 1900s: 3rd generation

Third-generation hydrogels with high mechanical strength and self-healing properties were created.

2000-Present

Smart hydrogels are developed to sense and respond intelligently through crosslinking, with applications in biosensors, tissue engineering, and drug delivery.

Grades K-3 Future Technology – 1[7-9]

Buddy Band is a future wearable technology designed to detect early viral exposure from the surrounding air using safe, non-invasive sensing.

The system uses four coordinated steps that work together to sample air, detect viral particles, analyze data, and communicate results to the user in real time.

Step 1: Intelligent Air Intake and Particle Filtering

Air from the child's surroundings enters the band from all directions through a micro air-intake system.

A specialized filter layer is designed to allow only extremely small particles (such as viral-sized particles) to pass through, while diverting larger contaminants like dust and pollen.

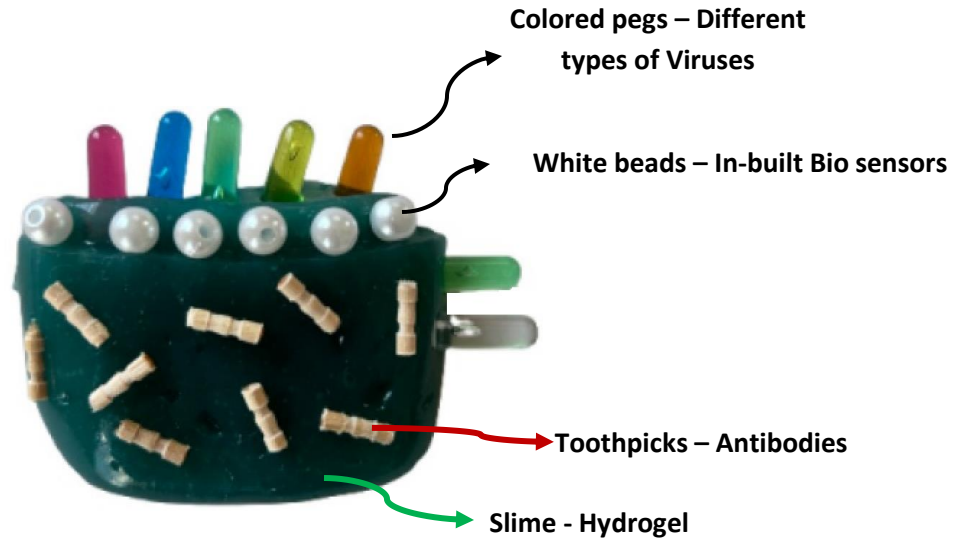
This system ensures that the band focuses on detecting potential viral exposure rather than general air pollution.

Grades K-3 Future Technology - 2

Step 2: Virus Capture Using Protected Hydrogel

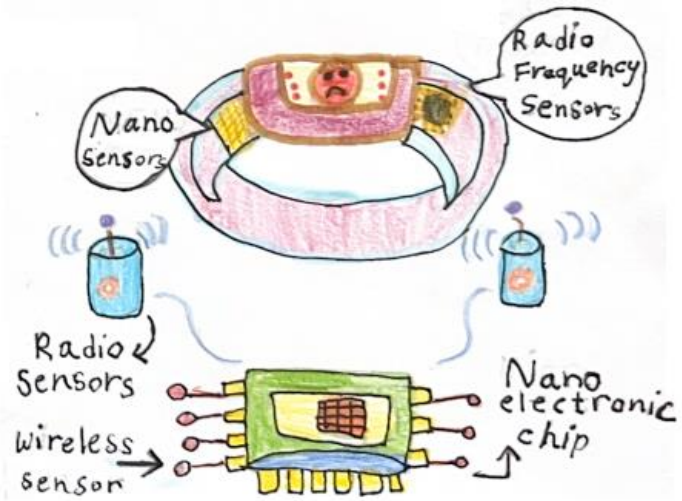
The filtered air then enters a protected hydrogel layer containing virus-specific antibodies. These antibodies bind only to matching viral antigens in the air. When binding occurs, it causes a physical change in the gel, indicating the presence of a specific virus.

For safe, continuous use, the hydrogel includes a neutralization system that weakens the virus, allowing the gel to reset and continue monitoring without releasing harmful particles.



Step 3: Detection and Data Processing Using Sensors

Nano electronic sensors continuously monitor the hydrogel for changes in the hydrogel shape. These changes are detected as electrical or Radio Frequency signals. The processing chips uses Artificial Intelligence (AI) to analyze this data and compare it with stored viral patterns to identify the type of viral particles present in real-time.



Grades K-3 Future Technology - 3

Step 4: Real-Time Alerts

Once the data on Virus type is processed, Buddy Band gives an alert as shown below:

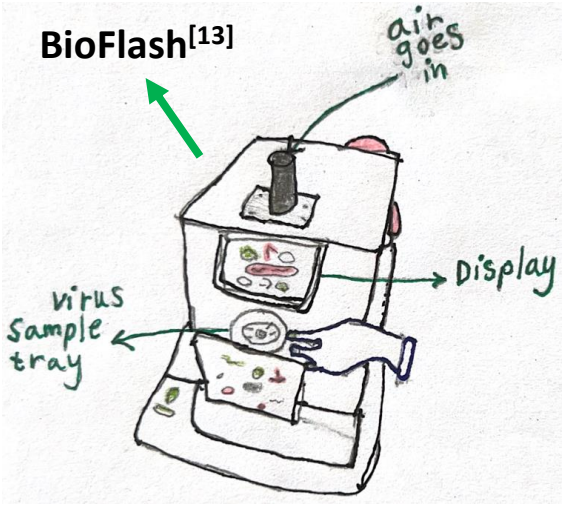
	Red Alert	Yellow Alert	Green Alert	App Notification
Watch Display				
Message	High Viral Contamination	Low Viral Contamination	No Viral Contamination	
Action needed	Move away immediately	Encouraged to take precautions such as wearing a mask, washing hands or use sanitizer	No action needed	

This easy-to-understand traffic light like alert system allows children, caregivers, and teachers to respond quickly and appropriately without needing medical knowledge.

Grades K-3 Breakthroughs – 1
Core breakthroughs needed for success[10-12]

- ✓ **Durability, drying and degradation of hydrogels**
  - A reusable hydrogel that selectively captures and safely neutralizes multiple viruses.
  - Develop biocompatible, breathable polymer coatings to protect the hydrogel from damage and drying.
- ✓ **Smart Viral Specific sensors**
  - Ultra-small, highly sensitive sensors capable of detecting airborne viruses in wearable devices.
  - Advances in nanotechnology and engineering enabling highly sensitive, low-power biosensors.
- ✓ **Accurate RF Signal Interpretation**
  - The device must detect subtle hydrogel changes caused by virus binding.
  - Improved RF sensing techniques paired with advanced signal processing.
- ✓ **Real-Time On-Device AI Processing**
  - Fast and accurate virus identification without relying on large computers or testing centers.
  - On-device smart chips to process data instantly without relying on the internet.

Grades K-3 Breakthroughs – 2
Buddy Band – Kids personal Germ Shield

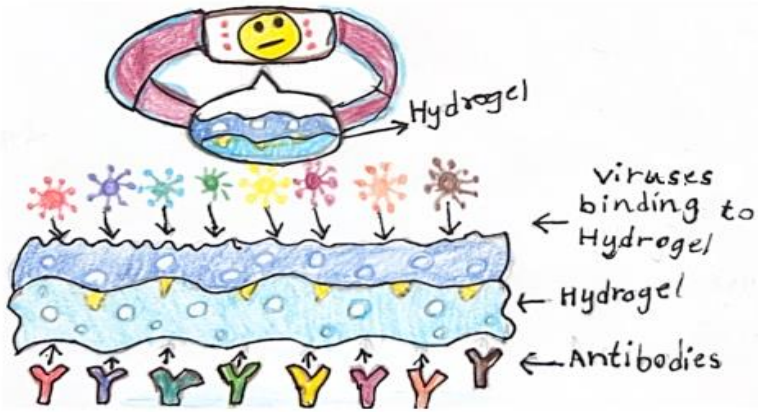


Why doesn't Buddy Band exist yet and **Why it matters for the future**?

Because the technology needed to safely detect viruses from the air in real time is still developing.

- Current viral detection devices (RT-PCR and Bio-Flash[13]) are **not small and sensitive enough to fit into a child-friendly wearable**.
- Combining biology, radio frequency sensing, and AI processing into one device is technologically very challenging.
- However, this technology is important for the future because **viruses spread before people know that they are exposed.**
- A device like Buddy Band could give **early warnings**, helping children and caregivers take simple actions to stay healthier and prevent outbreaks before they start.
- **Testing and Approvals**: Buddy Band would require extensive testing and regulatory approvals to ensure safety, accuracy, and reliability for children, which makes its development and public use challenging.

Grades K-3 Breakthroughs – 3[14-17]
How to test Hydrogel?



Buddy Band will detect different kind of viruses by embedding Hydrogel with viral specific antibodies.

Hydrogel testing procedures:

1. Place Hydrogel in a controlled lab environment.
2. Expose the Hydrogel to clean air sample.
3. Expose the Hydrogel to an air sample that has known virus.

Collect the following data:

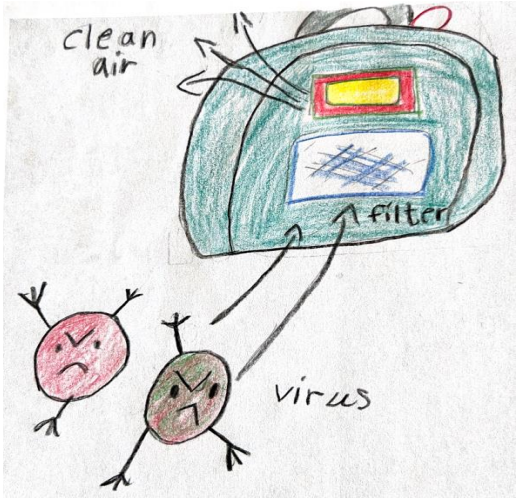
1. Collect data using RF sensors to monitor the hydrogel's swelling behavior in both clean air and virus-contaminated air samples.
2. Measure how much antibody binds to the specific antigen.
3. Measure how tightly the antibody binds to the antigen.
4. Measure how quickly the hydrogel reacts to the virus.
5. Repeat the process with another kind of viral antigen.

Grades K-3 Design Process – Idea 1[18-19]

Detect and neutralize Virus using Backpack

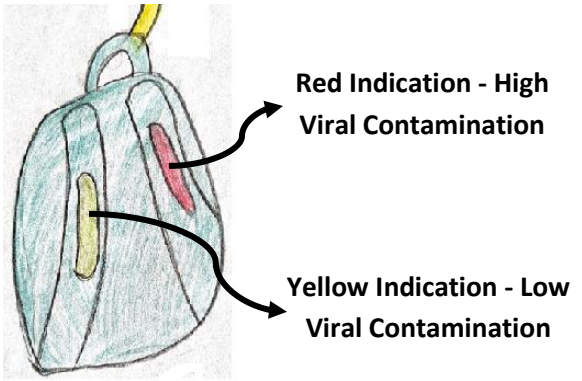
Idea 1:

Design a backpack that draws air in and then pass through nano air filters. Then the filtered air will be passed through UV-C (Ultra-Violet) light to neutralize (because Virus cannot be killed) the viruses. Filtered air will be returned to the environment.



Limitations:

1. Filters can get clogged and give false results; backpacks are not with the user all the time.
2. UV-C light if not handled properly can cause skin burns and corneal eye damage
3. UV-C light can produce Ozone gas which causes coughing, chest pain and harms vegetation and crops.



Buddy Band is better because:

1. No harmful radiation like UV-C light or Ozone gas are produced.
2. Can be worn by children all day which allows continuous monitoring.
3. Close contact provides immediate alert and faster response.

Grades K-3 Design Process – Idea 2

Clip-on Badge to filter out Viruses using Nanofibers

Idea 2:

Design a badge that attaches to clothing. Outer layer of the badge contains nanofibers which act as air filter. As the air passes through the nanofibers, biosensors underneath will detect the presence of different kinds of viruses.

Limitations:

1. Nano fibers can be damaged very easily as they are the outer layer.
2. All the germs not only viruses be trapped to the fiber which reduces the accuracy of Viral detection.
3. Might not get consistent air flow and higher chance of the badge being lost or misplaced.

Buddy Band is better because:

1. Key part of the Buddy Band, the Hydrogel lies underneath, so can't be damaged easily.
2. Air intake system can draw air consistently.
3. Different viruses can be detected by incorporating multiple virus-specific antibodies within the hydrogel.

Grades K-3 Design Process

NA

Grades K-3 Consequences

Positive Impact:

- New science idea in a kid friendly way.
- Public health officials can track patterns of commonly caused diseases in children especially in schools and play areas.
- Real time alerts – User gets alerts as soon as the air becomes risky, not after someone got sick.

Negative impact:

- App Hacking – Because of internet usage, information can be hacked.
- Safety – Potential for inaccurate or false readings that could delay emergency response or cause unnecessary panic.
- Future Research – Making hydrogels that can have selective antibodies still needs further research.
- Cost – Designing self-refreshable hydrogel crosslinks and flexible microelectronics might initially be expensive.

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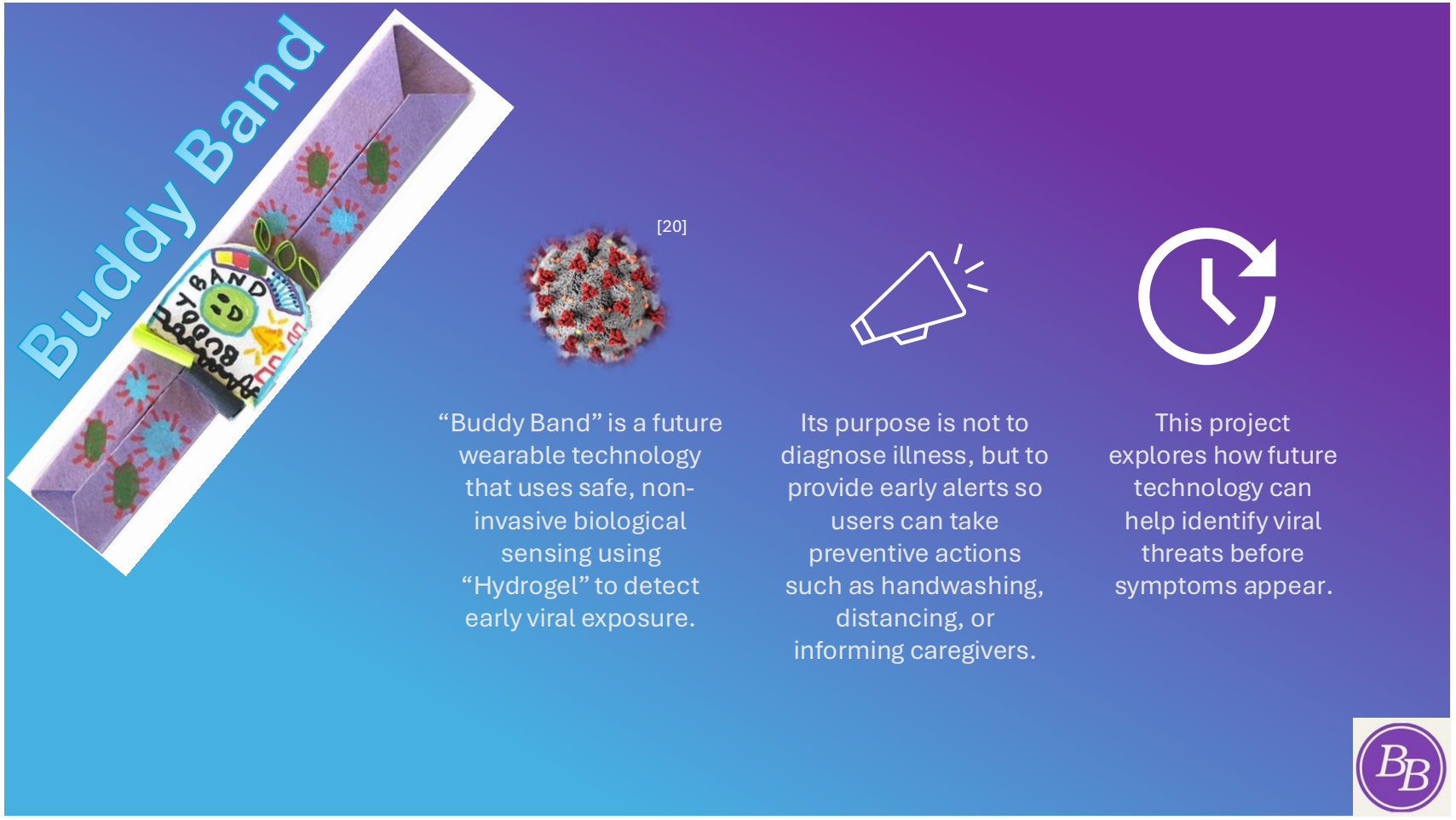
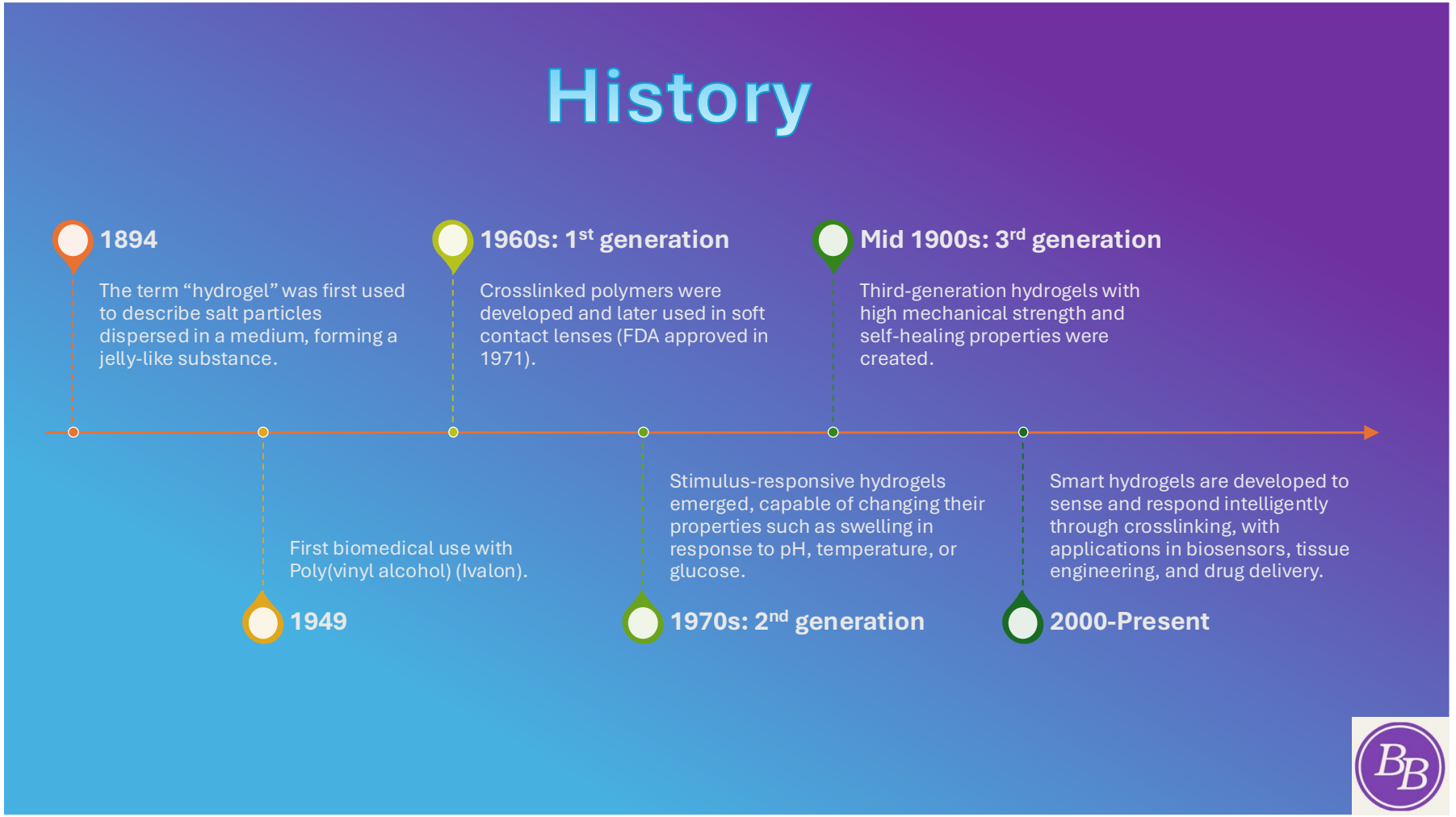
Sample Web Page - 1

Sample Web Page - 2



Sample Web Page - 3



Sample Web Page - 4

How “Buddy Band” works?

Micro air-intake system pulls air in

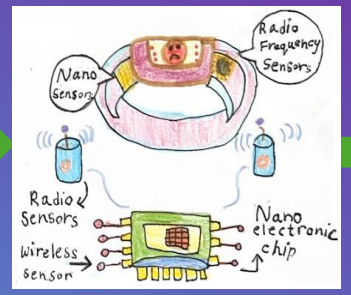
Special filter layer only allows Virus size particles

Divert large particles like dust and pollen

“Hydrogel” contains virus-specific antibodies

Viral antigens bind to the hydrogel

Hydrogel changes shape



Nano sensors detect shape changes

Changes converted to electrical signals

AI compares signals with stored vital patterns

Buddy band sends exposure alerts

Red: High
Yellow: Low
Green: None

Real-time alerts via phone app

Sample Web Page - 5

"Buddy Band" Impact on Society

- Reduced virus spread in schools
- Increased hygiene awareness in children
- Early preventative action by families
- Support public health initiatives
- Improved disease outbreak monitoring
- Ease of use by children, adults and healthcare workers