

Aspects of Drug Delivery Devices: Drug Release and Device Localization in the Body

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Abstract

Our aim for this research is to create a novel drug delivery device that can be retained long term in the human body for the duration of the treatment to automatically release the drug at the required timepoints. We are addressing the need for more effective drug delivery by making it easier for patients to take medication. In this research, there are two key aspects of drug devices that we are considering. The first aspect considered is the drug release mechanism, specifically sustained diffusion. To test this, we performed experiments using our device. We discovered that increasing the number of holes used for drug release will increase the diffusion rate. The second is determining proper localization of the device once it has entered the body while avoiding invasive procedures. We are researching the potential of magnetic sensors to determine locations of objects within the body. Hall effect sensors convert magnetic field inputs into voltage outputs. Since magnetic fields vary with distance, Hall effect sensors can be used as proximity sensors. We tested an A1324 sensor and determined that it has a certain range where we can estimate the distance between the sensor and a magnet due to a linear relation. These results can be used to consider a novel device prototype in the future.

Device Prototyping Aspects

Gastroretention is the ability to reside in the stomach long term. These are several examples of systems that allow for gastroretention²: 1) *High Density*: device can sink to the bottom of the stomach. 2) *Low Density*: buoyancy allows device to stay in the fundus. 3) *Mucoadhesive*: device binds to stomach wall. 4) *Swelling*: size increases in the stomach, it will not pass the pylorus.

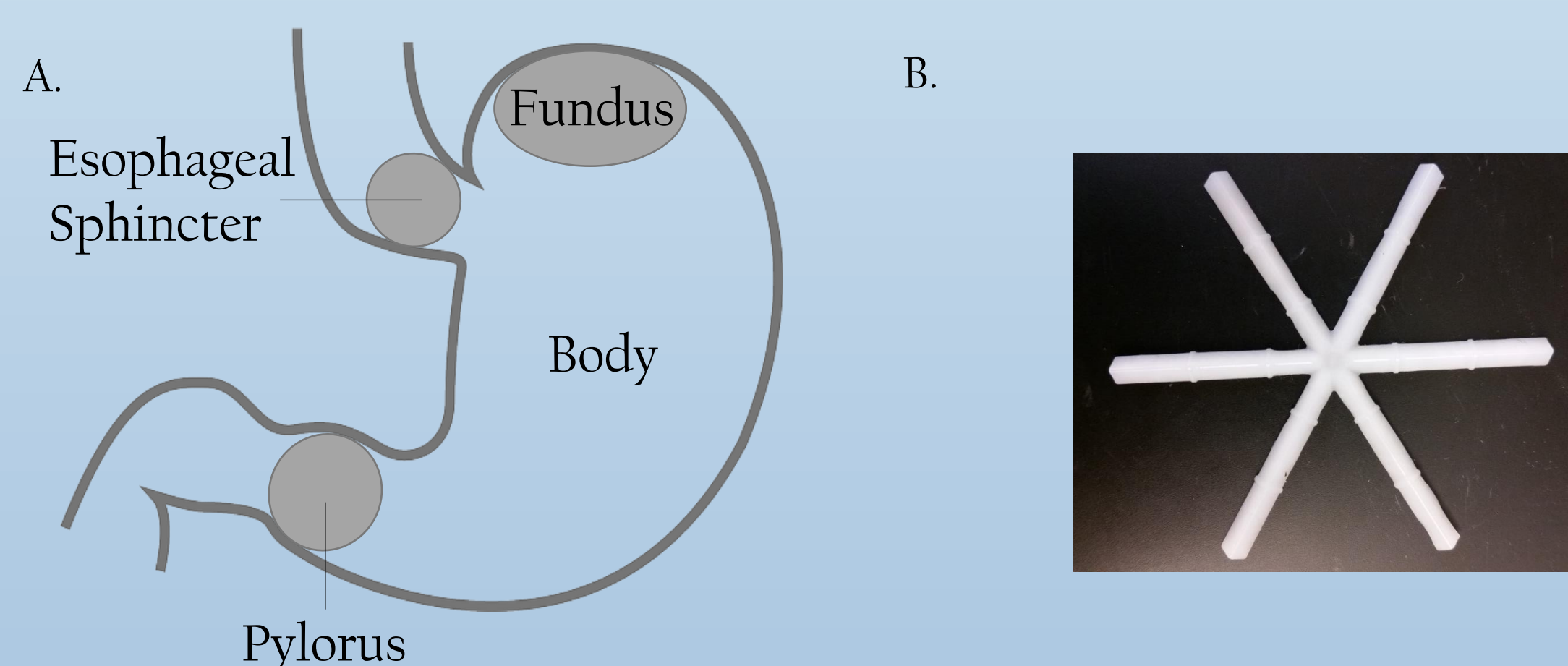


Figure 1. The location of device retention can vary based on the drug release mechanism and device localization in the body. (A) General anatomy of the stomach³ (B) Star Device used for gastroretention, one of the already made prototypes currently being refined for public use

Device Drug Release : Diffusion

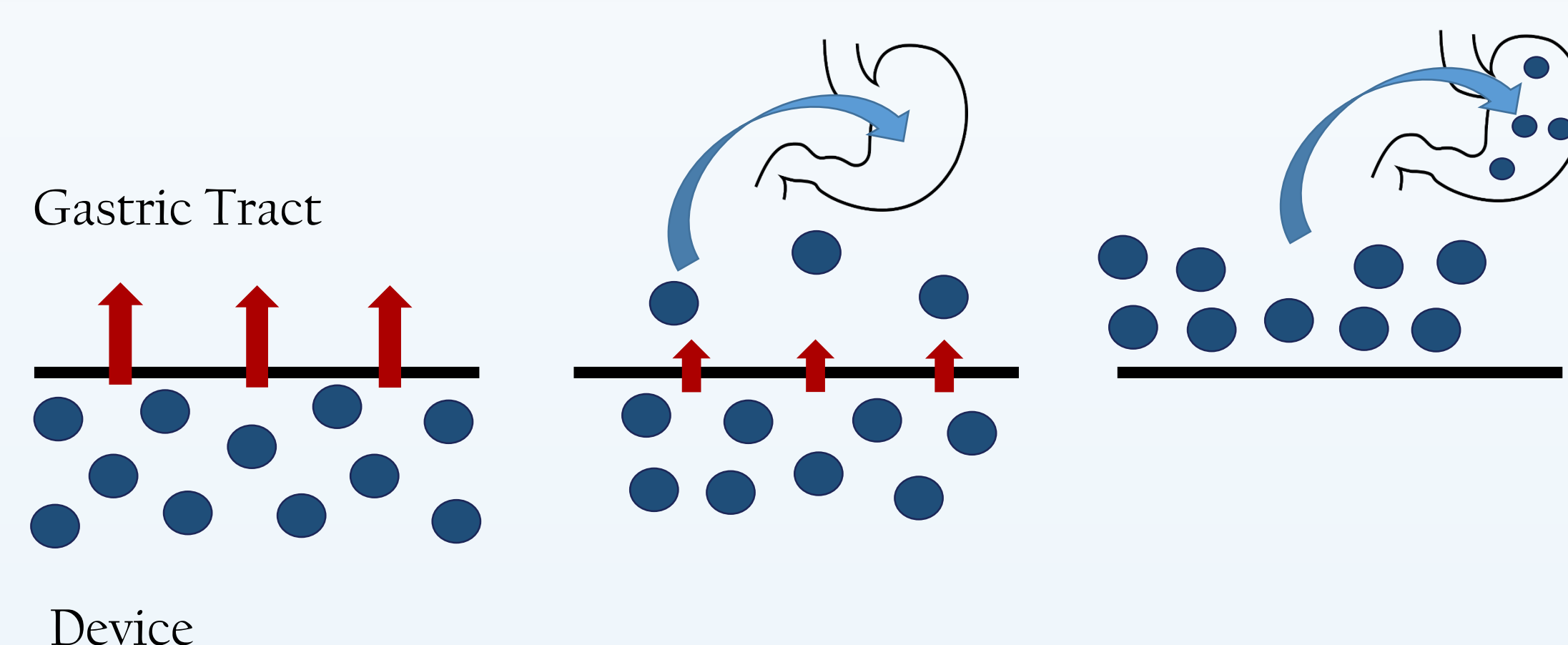


Figure 2. Sustained diffusion is the passive driving force as particles pass through a barrier due to an established gradient. This makes it an ideal drug release mechanism. Normally, once equilibrium is reached the change in particle concentration on both sides will stagnate. During drug release, when the gastric tract absorbs the drug the gradient is continuously reestablished. Thus, the drug will continue to release from the device.

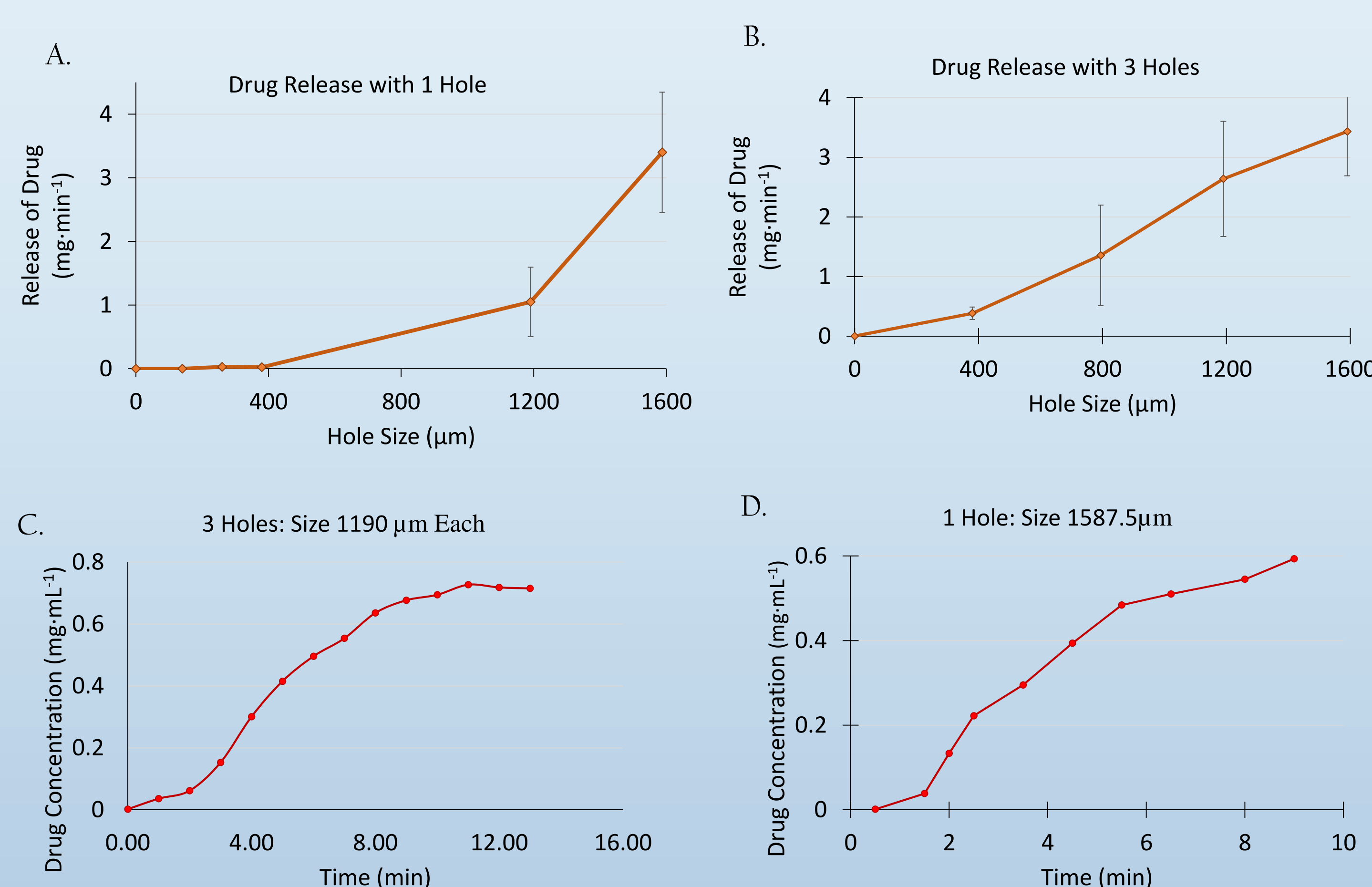


Figure 3. Several drug release devices were constructed in order to test the diffusion rates. Drug release (A) using one pore (B) using three pores. Drug concentration overtime (C) using one pore (D) using three pores.

Device Localization: Hall Sensor

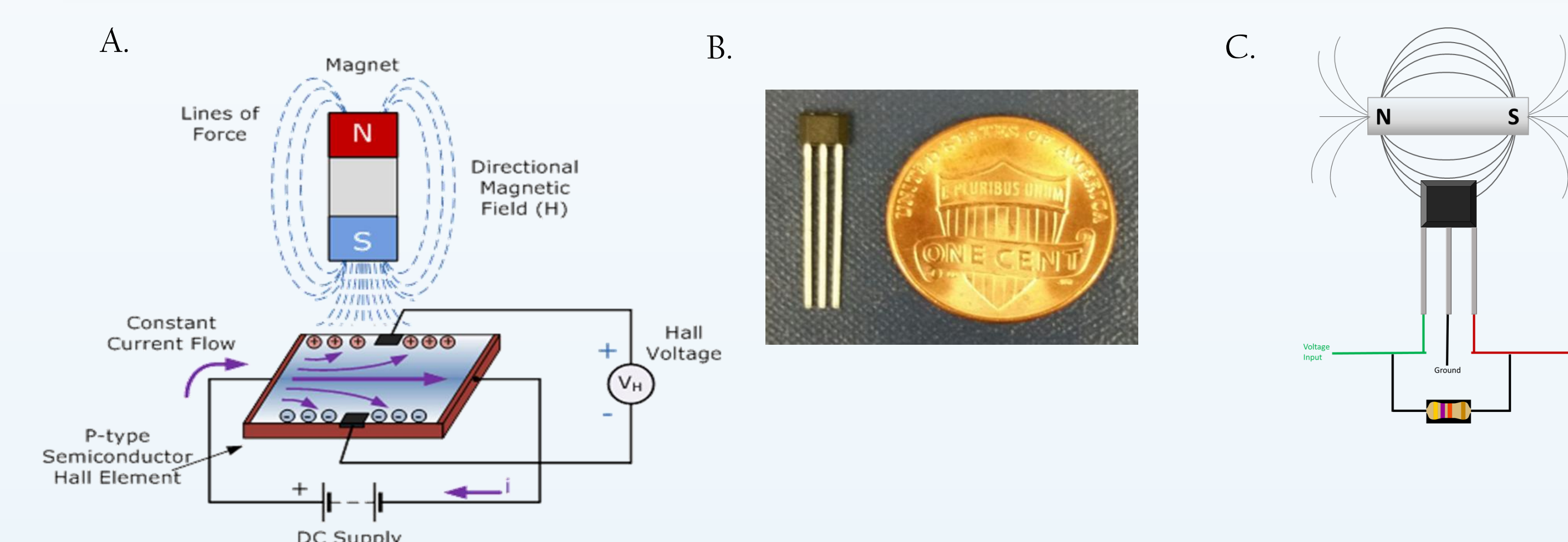


Figure 4. When the a magnet is placed near a current carrying metal, it will deflect the charges of electrons and protons until onto either side. This will create a voltage difference from the separation of charges. (A) This phenomenon is called the Hall Effect¹. Hall sensors that can then be used as proximity sensors since magnetic field varies by distance. (B) A picture of a hall sensor is depicted in. (C) The greater the magnetic force, the greater the voltage difference.

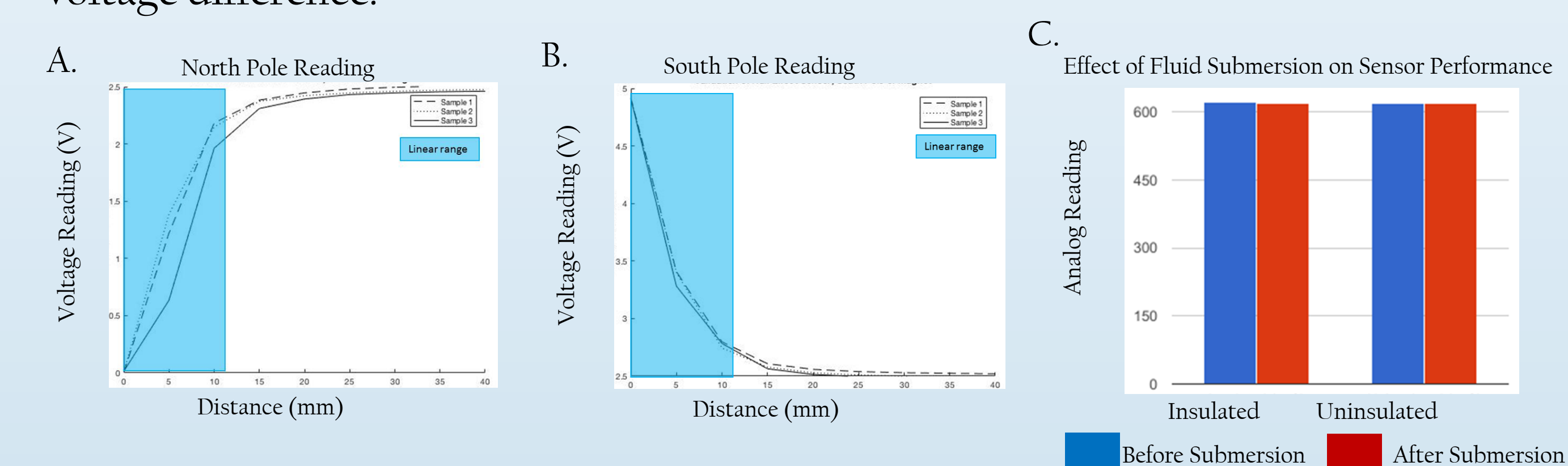


Figure 5. Voltage reading when magnet approaches from (A)North Pole. (B) South Pole. (C) Voltage reading after being submerged in fluid, insulated and uninsulated.

Discussion

Results show that sustained diffusion is a function of pore size and pore number. Increasing either pore size or pore number will increase the rate of drug release overtime. Pores increased with a more visible linear trend with three pore than one pore.. Saturation is seen because we do not reestablish the concentration gradient. Drug concentration does not saturate as quickly with one hole, since with only one hole there is less drug release

For the Hall sensor, the from the North Pole the voltage general increased with distance. From the South Pole, an opposite trend was formed. The sensor is durable enough that performance will not be affected by submersion in fluid. These results can be used for future prototyping for novel drug delivery devices that can be gastroretained.

Acknowledgements

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