Queen Elizabeth Prize for Engineering

Controlled Release Large Molecule Drug Delivery

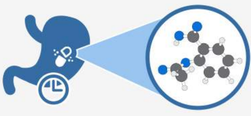
What is it?

Drug delivery is how we get medicine where it needs to go. It can take many forms, including pills, injections, and even implants. **Controlled release drug delivery** happens when a drug is dispersed at a specific rate in the body. For example, a pill of aspirin might dissolve in your gut and cross into your bloodstream, reaching the rest of the body. The speed at which it dissolves is the rate of drug delivery.

Take some aspirin for a headache

Pills dissolve

Aspirin molecules enter the bloodstream and reach the head



Timed RIease

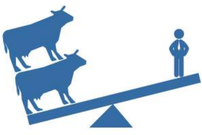
An Aspirin Molecule

Why do we need it?

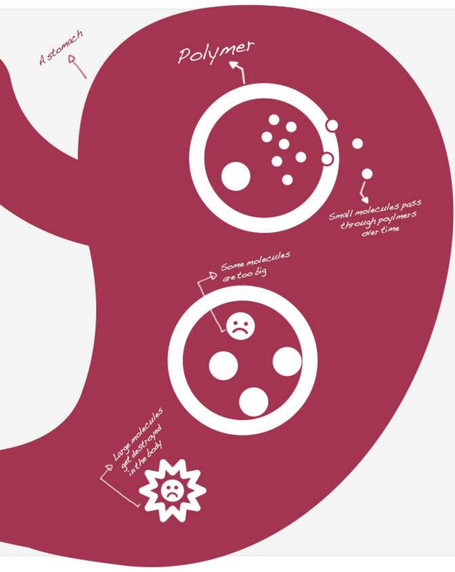
Controlled release drug delivery lets us give the same dose over a long period of time. This is important because a dose that is too high could be toxic, but a dose that is too low would be ineffective. Controlled release drugs can be taken less frequently than immediate-release versions of the same drug.

The difference between small and large molecules

Small molecules are stable in the body and can cross cell membranes without assistance, easily reaching the active areas inside cells. However, large molecules hold the key to tackling long-standing problems like cancer, mental illness, and diabetes. Unlike small molecules, they can attack specific cells and react in tailored circumstances.



If aspirin were the weight of an average European adult, the large molecule drug exenatide would be the weight of 2 cows



The Problem

Drug distribution systems existed prior to Langer's innovation, but researchers believed that slow, timed drug release was limited to small molecules.

1. Small molecules can rely on natural processes to move through polymers and into the bloodstream, but large molecules cannot be distributed the same way. They are too big to travel directly through polymers.
2. The structure that a large molecule takes is vital to its function, and large molecule drugs are vulnerable to deforming in the body's environment. Small molecules usually maintain their structure independently, even in the body

90%

of drugs use small molecule delivery due to these difficulties

The Solution

Robert Langer asked the engineering design question to solve this problem.

1. He engineered pathways through polymers that were of different sizes and lengths
2. He engineered polymers that were non-toxic, could last in the body, and enabled controlled release rates through the pathways

1. Fast Release

2. Slower release

3. Even Slower RIelease

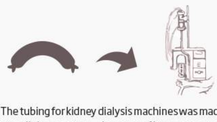
What else has changed?

Robert Langer changed the way that we use materials in medicine.

In the Past...

Materials in medicine were adopted from exisiting solutions

Artificial hearts were made from girdle material because it flexed like a heart... but when blood hits this material, it can form blockage-causing clots!



The tubing for kidney dialysis machines was made from cellulose acetate... because of its use as sausage casings!

NOW...

Thanks to Langer and other engneering revolutionaries, we can **design a solution that fits the problem.**

Langer's work has led to the creation of completely **new fields** including:

Tissue Engineering
and
Nano-Medicine

Actually it's a LOT more complicated and impressive than this.