# Get in My Body

## Drug Delivery

# Challenge Question

You are a doctor, physician assistant or nurse practitioner.

Your patient has a condition that requires her to keep constant levels of a medication in her body. However, she is unable to swallow.

*What are some other methods of administering a drug to her?*

*Remember*: She needs to take the drug at least twice a day for the rest of her life and to ensure patient compliance, the drug delivery method must be as simple as possible.

# Oral Administration

**Taken by mouth through the digestive tract – in liquid or pill form**

## Advantages:

- Easy, preferred by people
- Slow release of drugs; can extend the duration of action
- Drugs can be protected from harmful digestive tract enzymes and acids

## Disadvantages:

- Drugs are absorbed slowly
- Won’t work if vomiting profusely
- Unpredictable adsorption due to stomach acid and enzyme degradation

*Common usage*: aspirin, Advil®, Tylenol®, cough syrup, painkillers, steroids

# Injection

**By needle into the skin**


## Three methods:

Intravenous: infusion directly into the vein

Intramuscular: injection directly into muscle

Subcutaneous: injection into the cutis layer of the skin

# *Injection*: Intravenous

**Intravenous (IV): Infusion directly into a vein**

*Common usage*: blood transfusions, saline (for dehydration), painkillers, propofal (sleeping drug), anesthesia

## Advantages:

- Dependable and reproducible effects
- Entire administered dose reaches circulatory system *immediately*

## Disadvantages:

- Requires a cannula (IV line)
- More labor intensive and costly
- More prone to infections
- Distressing, especially to children

# *Injection*: Intramuscular & Subcutaneous


**Intramuscular: injection directly into muscle**

**Subcutaneous: injection into the cutis skin layer**

## Advantages:

- Good adsorption, especially for those with poor oral bioavailability
- Rapid effects
- Long duration of activity

## Disadvantages:

- Unpredictable adsorption
- Painful with bruising
- Not for needle-phobic people

*Common usage*: insulin (for diabetes), morphine, vaccines (hepatitis A, rabies, influenza), penicillin, diazepam (Valium)

# Topical

**Drug delivery directly to the site**


## Advantages:

- Easy, non-invasive
- High patient satisfaction

## Disadvantages:

- Very slow adsorption
- Difficult to control dosage
- Most drugs have a high molecular weight and low lipid solubility, causing them to not be adsorbed via skin or mucous membranes

*Common usage*: skin ointments and creams (for rashes, poison ivy), eye drops, ear drops (for infections), birth control (patches)

# Inhalation

**Medications taken into the blood stream via the lungs**

## Advantages:

- Rapid adsorption due to high surface area
- Fastest way to deliver drug to brain

## Disadvantages:

- Requires proper inhaler technique to get correct dosage
- Unpleasant taste; mouth irritation
- Bioavailability of drug depends on its size

*Common usage*: adrenocorticoid steroids (such as beclomethasone), bronchodilators (such as isoproterenol, metaproterenol, albuterol) and antiallergics (such as cromolyn)

# Suppository

**Drug delivery via rectum, vagina or urethra**

## Advantages:

- Good adsorption due to hemorrhoidal vein draining directly to inferior vein cava

## Disadvantages:

- Cannot be used after anal or rectal surgery
- Some people dislike and/or find the method uncomfortable

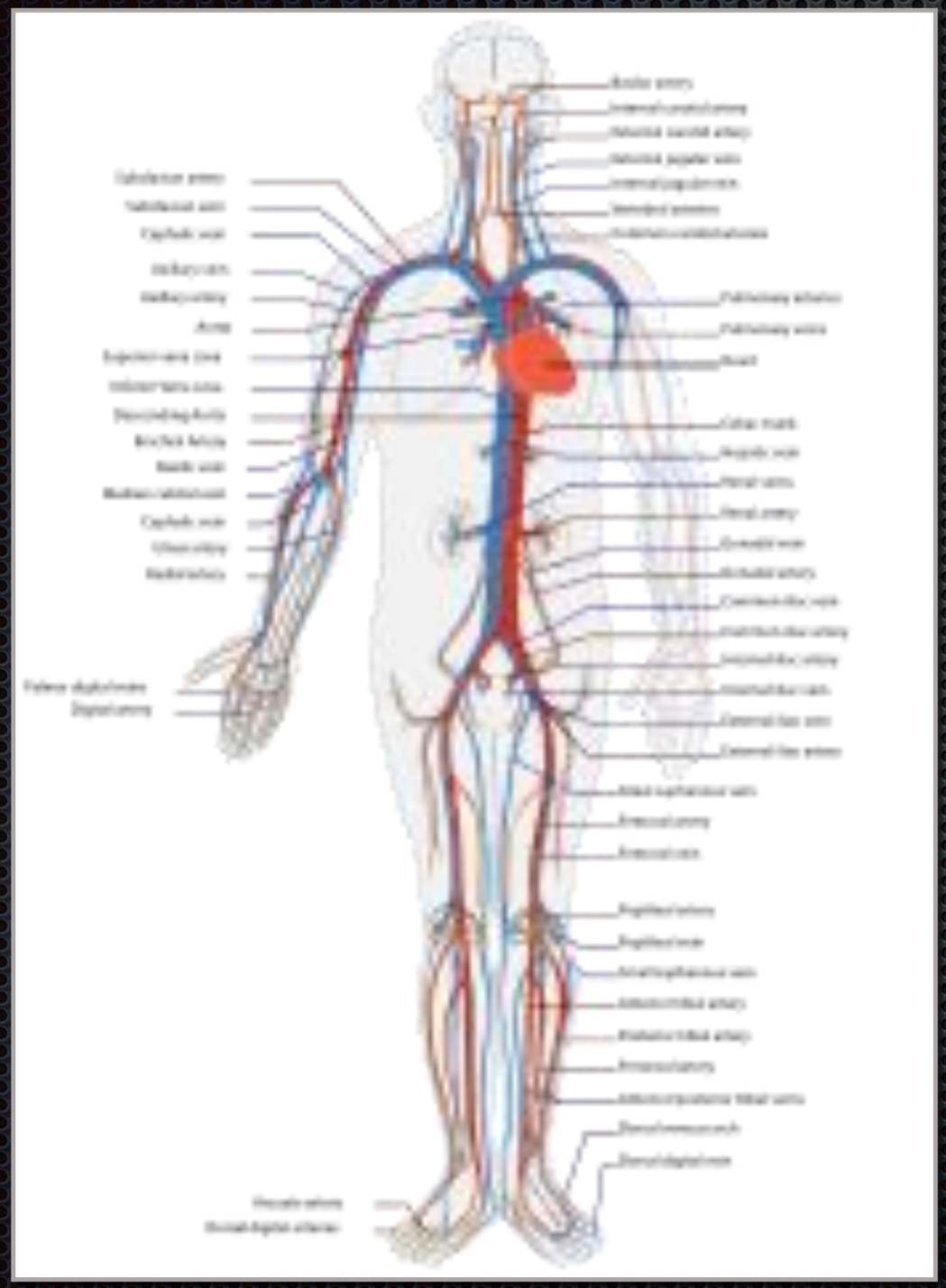
*Common usage*: laxatives, diclofenac (nonsteroidal anti-inflammatory drug), hemorrhoid medication treatment

# Design Considerations


- Toxicity
- Efficacy
- Drug size
- Solubility / bioavailability
- Drug release duration

# Circulatory System

**Circulatory system transports drugs to the organs of the body**

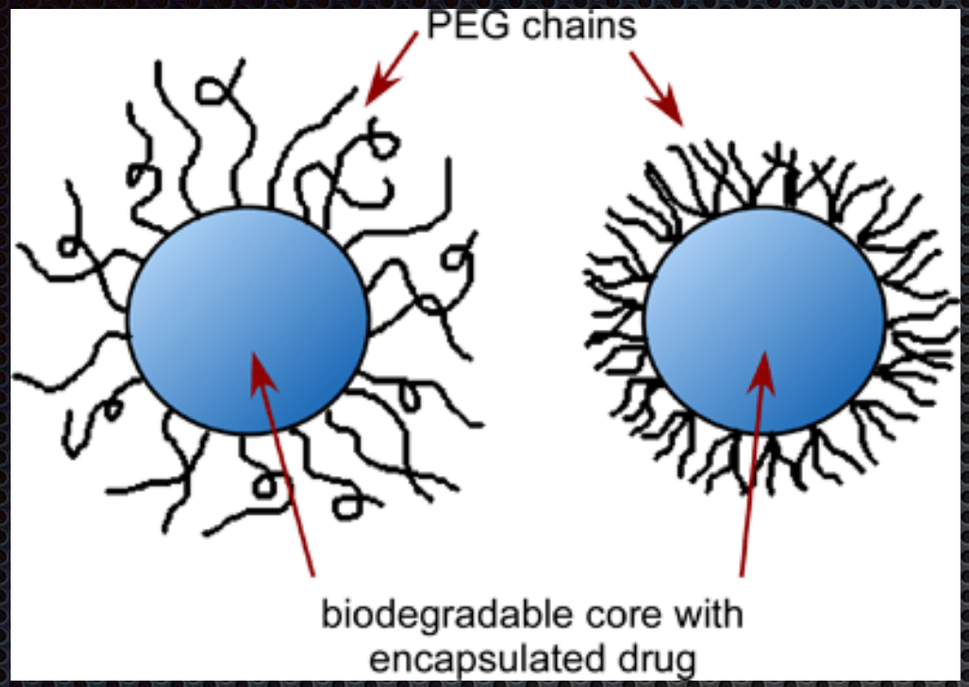


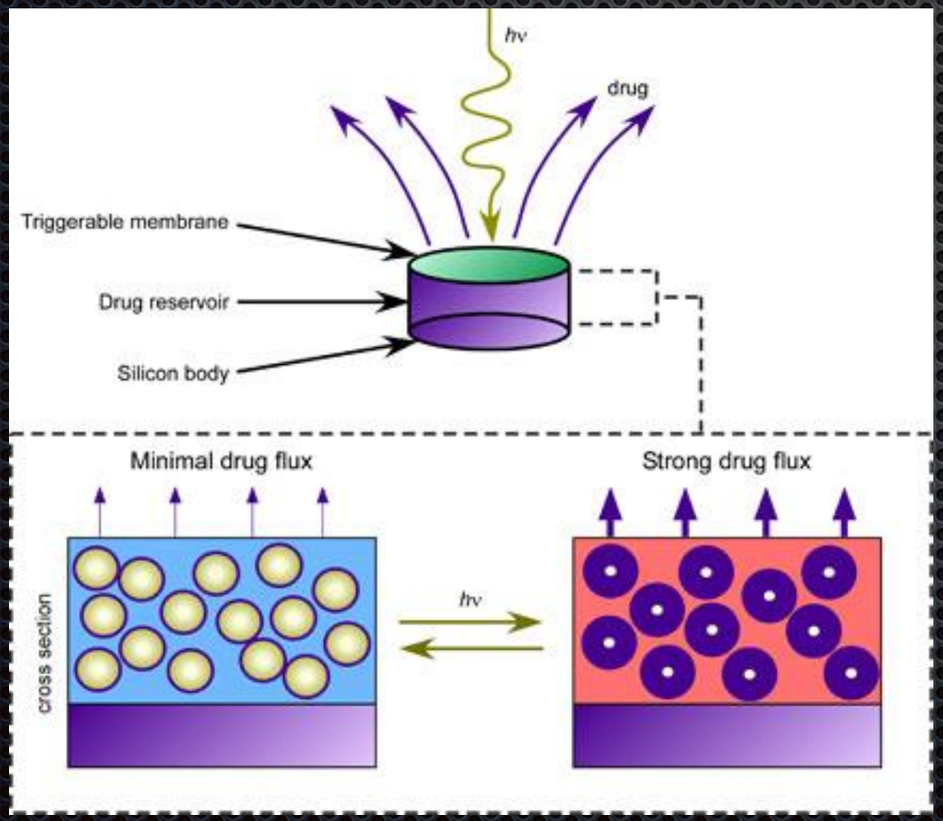
Different areas of the body have different pHs, which affects bioavailability/solubility:

- Stomach = pH 1.5 – 3.5
- Duodenum = pH 6
- Small intestine = pH 6 increasing to 7.4
- Large intestine = pH 5.7
- Rectum = pH 6.7
- Blood = pH 7.35 – 7.45

# Polymers

**Polymers are useful to encapsulate high molecular-weight drug molecules**



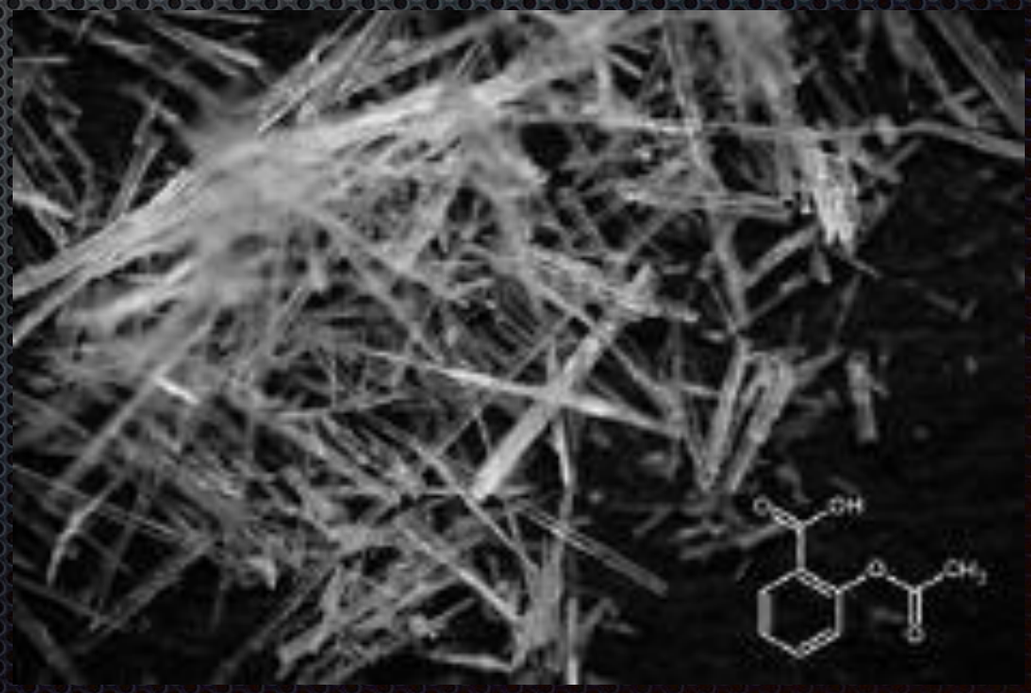




- Depending on the polymer, the diffusion rate through the shell can be controlled
- Attached polymer chains can act as specific lock-and-key receptors
- With a lock-and-key receptor, the drug release location can be controlled
- One problem: The possibility of rapid drug release if certain regions degrade faster than others—causing a toxic pharmaceutical overdose

# Cocrystallization

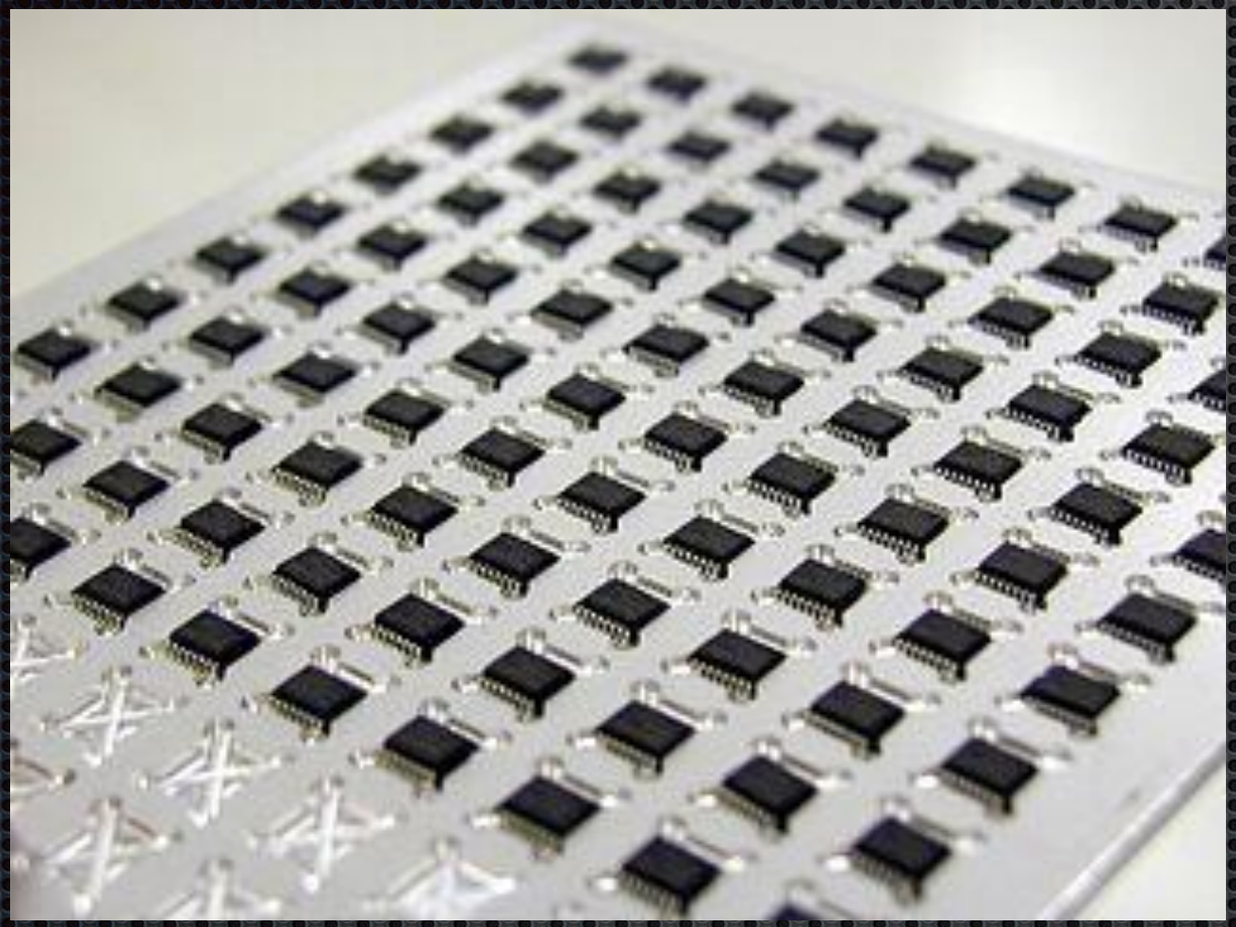
- Most drugs are actually crystals
- However, the properties of certain drugs cause them to not be bioavailable
- To alter drug properties while maintaining efficacy, cocrystals are made

A cocrystal is a crystal composed of two or more components (ions, atoms or molecules) in a specific stoichiometric ratio



# New Devices

**Computer chips provide inspiration for new pharmaceutical technologies**



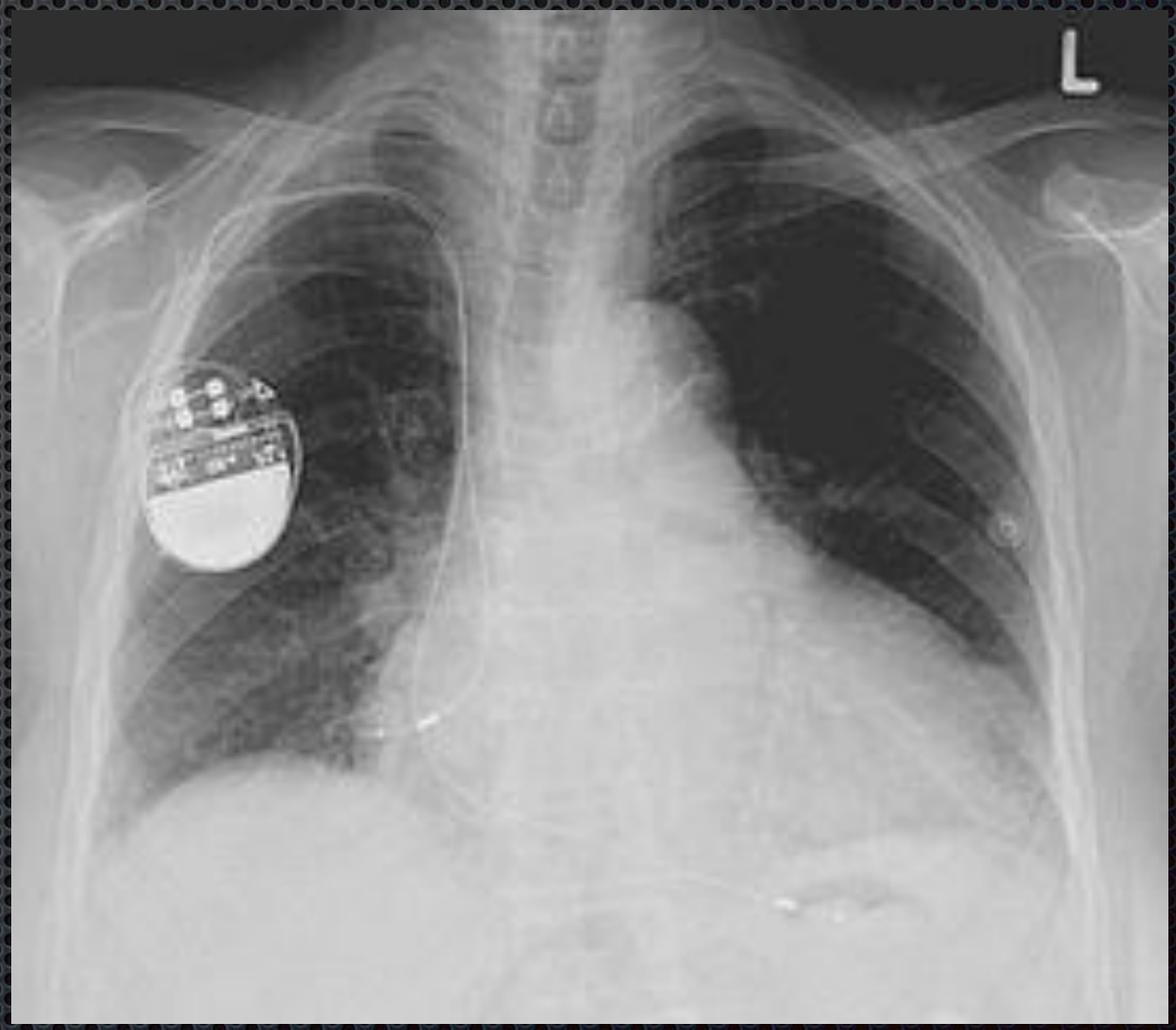
- Biocompatible chip devices are made with wells filled with certain drugs
- The wells are covered with a biodegradable metal covering that is removed when and electrical charge is applied
- Drugs can be released from each well individually at specific, desired times

*Example*: birth control

# Problems with Devices

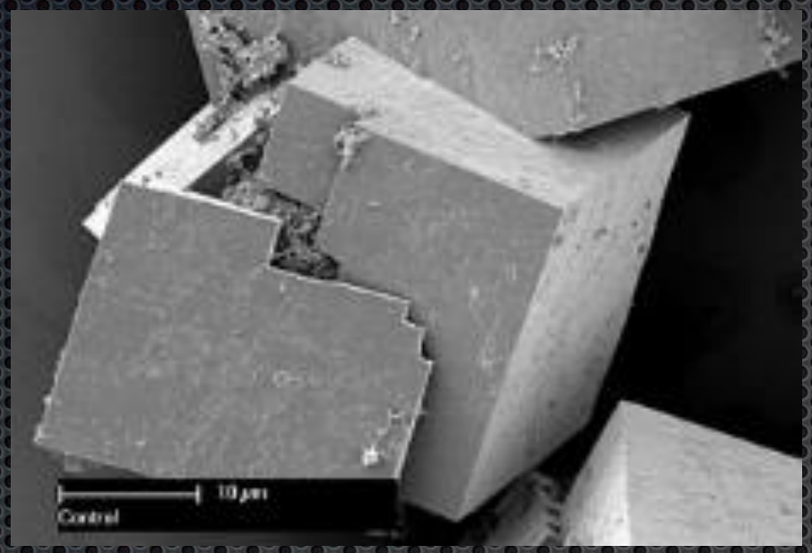
**Body considers devices to be foreign objects**

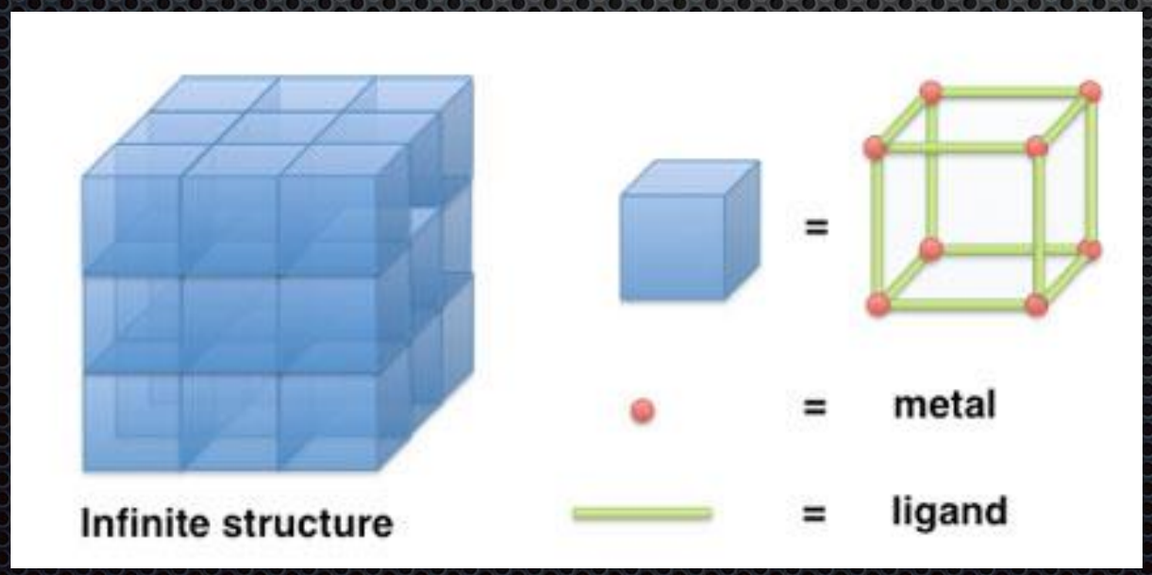
- Medical devices have blood surface interactions, which can cause infections, blood clotting and antibiotic resistance—leading to device failure
- To negate these interactions, artificial surfaces are developed
- One method is a drug eluting surface



# Metal Organic Frameworks (MOF)

Drug eluting surface: a drug is released over time by the device surface
Drugs can be made catalytically (produce inside the body by chemical reaction) by the device surface




- MOF – compounds consisting of metal ions coordinated to organic molecules creating one-, two- or three-dimensional porous structures
- Nitric oxide – helps neurotransmission for chronic wound treatments
- MOFs can last 2 to 12 weeks to provide sustained nitric oxide release