Crystallization in the Body
rock salt

diamond

snowflake
What is a crystal?

A crystal is a solid material whose atoms, molecules or ions are arranged in an ordered pattern extending in all directions.

salt \rightarrow (sodium chloride)
Crystal Surface & Growth Process

Each side of a crystal is called a **face**.

During crystal growth, steps are layers or sheets of molecules stacked on top of each other.

Crystal shapes are determined by the speed of step growth on each face of the crystal.
Crystal Formation Process

Crystal has three growth phases:

- clustering
- nucleation
- growth

What is the driving force?

* supersaturation *
Rock Candy

- Sugar dissolved in water
- Higher temperatures – more sugar dissolves
- Supersaturation occurs when left at room temperature, due to differences in solubility
- The higher the supersaturation, the faster the growth
- Seed crystals cause growth to start immediately and skip past the nucleation phase
Inhibiting Crystallization

Impurity incorporation

Solution of impurity ions or drug
Crystal Shape Changes

When inhibitors bind to specific faces, they affect the overall crystal shapes.
Kidney Stone Formation

Kidneys filter the blood, remove waste, maintain electrolyte levels.

Waste products form crystals that are usually very small and pass through the urinary system with no effects.

- Crystals that grow large can block the ureter (kidney stones or renal stones).
- Supersaturation caused by:
  - dehydration
  - diet

kidney stone ➔
ureter ➔

kidney
Types of Kidney Stones

Four main types:
- calcium oxalate
- struvite
- uric acid
- cystine
Drug Development Considerations

- 1 in 11 people have kidney stones in their lifetimes
- 80% of all cases are men
- Kidney stones usually reoccur
- Surgery and shock therapy are the usual removal methods, for which $2 billion is spent each year — for a condition that could be prevented
- The body makes natural crystal inhibitors: citrate
- Diuretics: reduce calcium excretion in urine

Researchers are creating new drugs to block crystallization intending to more effectively prevent kidney stones
Drug Design Considerations

**Efficacy**: Full inhibition of crystal growth

**Potency**: A small amount causes large amount of inhibition

**Toxicity**: Can this drug be put into the body without radical side effects?

**Administration**: How is the drug going to be delivered into the body? Oral, IV, rectally, aerosol or topical?

**Cost**: Is this drug feasible to produce?