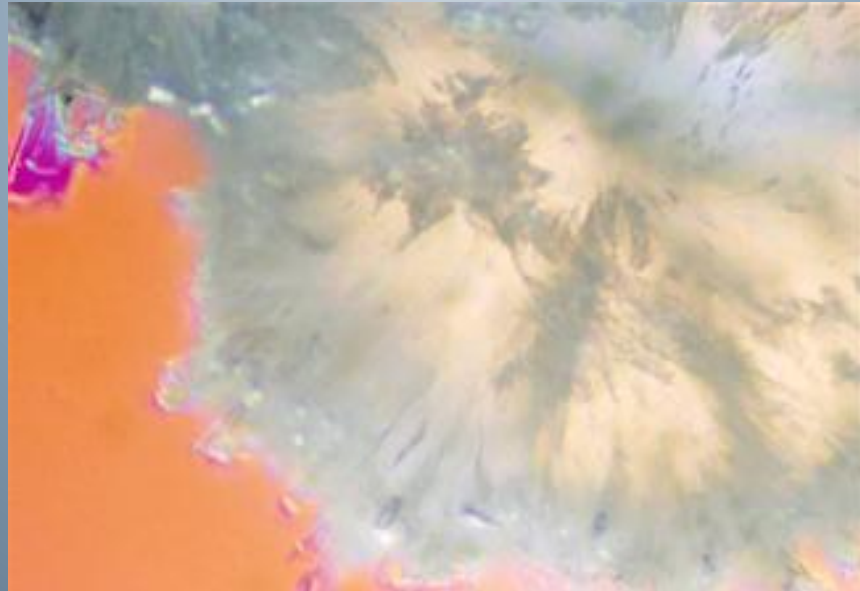


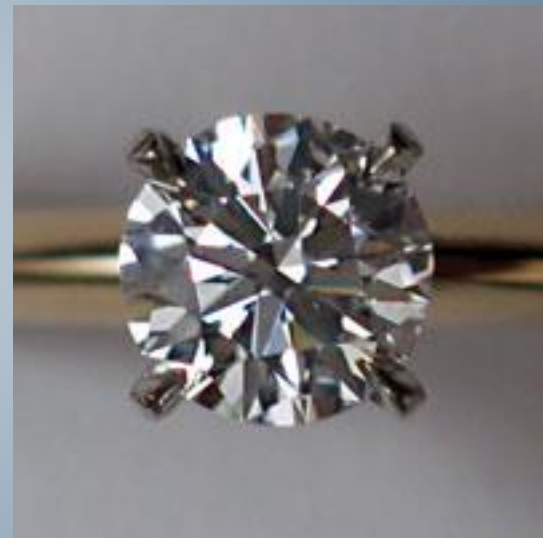
Crystallization in the Body



rock salt

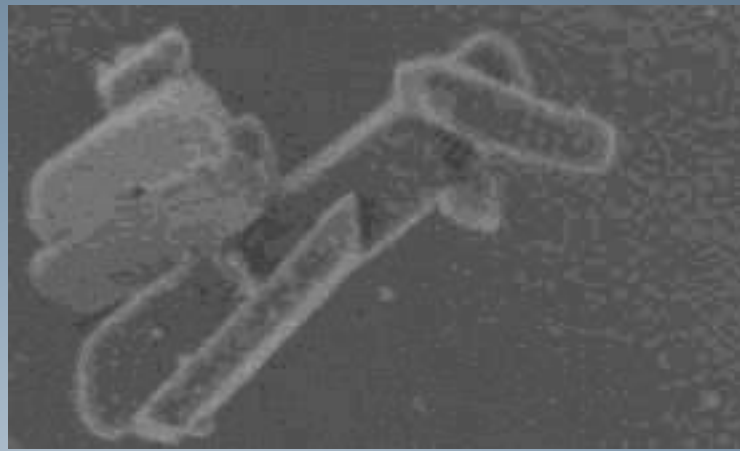


diamond

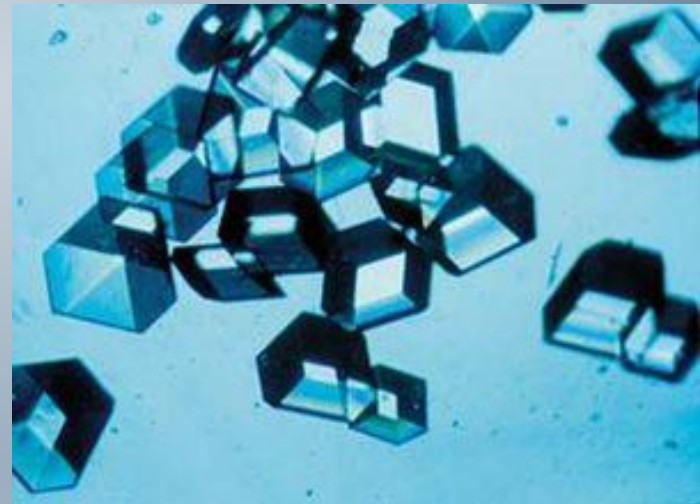


snowflake

aspirin



hemozoin found in malaria



insulin

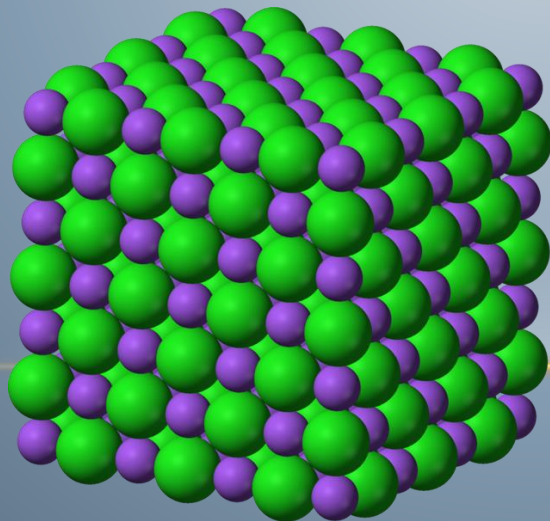


cataracts

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 →
(sodium chloride)

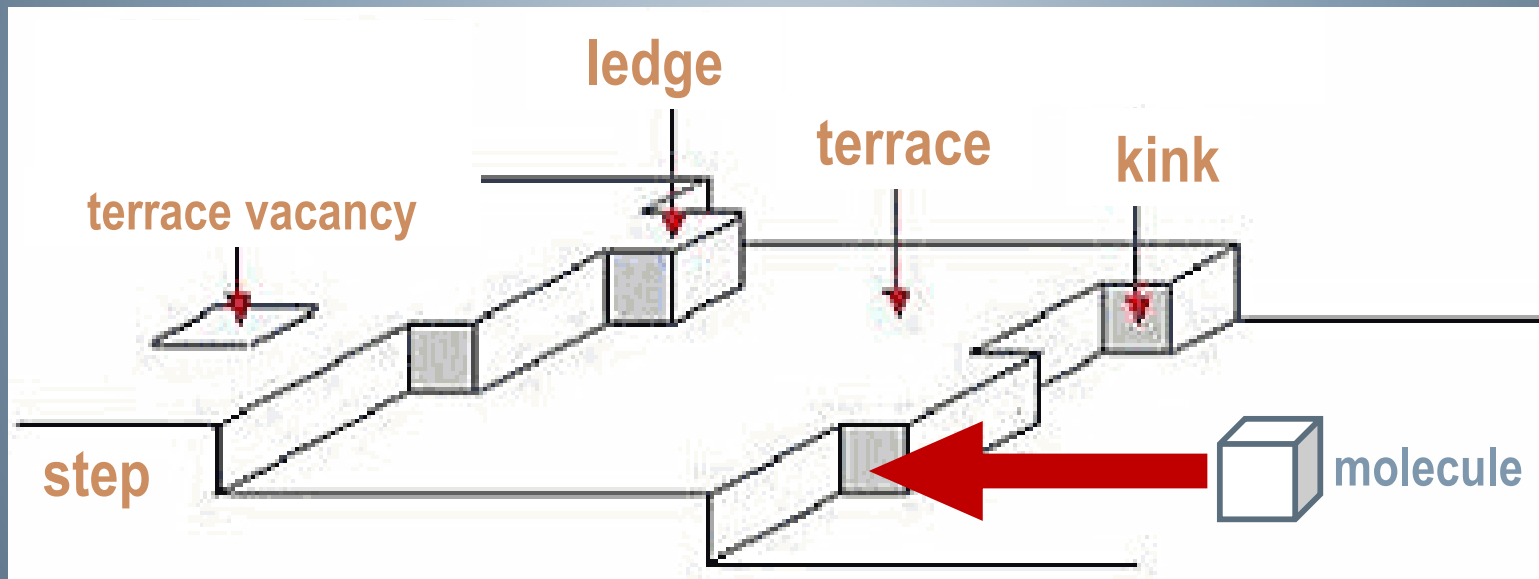


1. triclinic (none)	$\alpha, \beta, \gamma \neq 90^\circ$ 			
2. monoclinic (1 diad)	simple	base-centered		
	$\alpha \neq 90^\circ$ $\beta, \gamma = 90^\circ$ 	$\alpha \neq 90^\circ$ $\beta, \gamma = 90^\circ$ 		
3. orthorhombic (3 perpendicular diads)	simple	base-centered	body-centered	face-centered
	$a \neq b \neq c$ 	$a \neq b \neq c$ 	$a \neq b \neq c$ 	$a \neq b \neq c$
	4. rhombohedral (1 triad)			
	$\alpha = \beta = \gamma \neq 90^\circ$ 			
5. tetragonal (1 tetrad)	simple	body-centered		
	$a \neq c$ 	$a \neq c$ 		
6. hexagonal (1 hexad)				
7. cubic (4 triads)	simple (SC)	body-centered (bcc)	face-centered (fcc)	

Crystal Surface & Growth Process

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

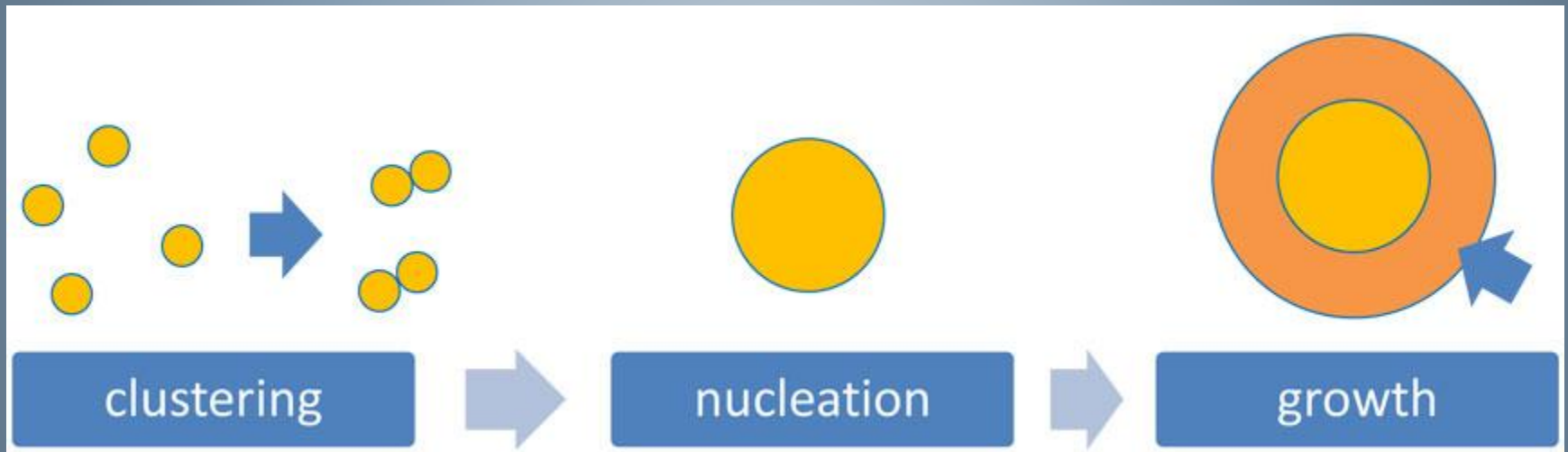
During crystal growth, steps are layers or sheets of molecules stacked on top of each other.



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

Crystal Formation Process

Crystal has three growth phases:



What is the driving force?

*** supersaturation ***

Rock Candy

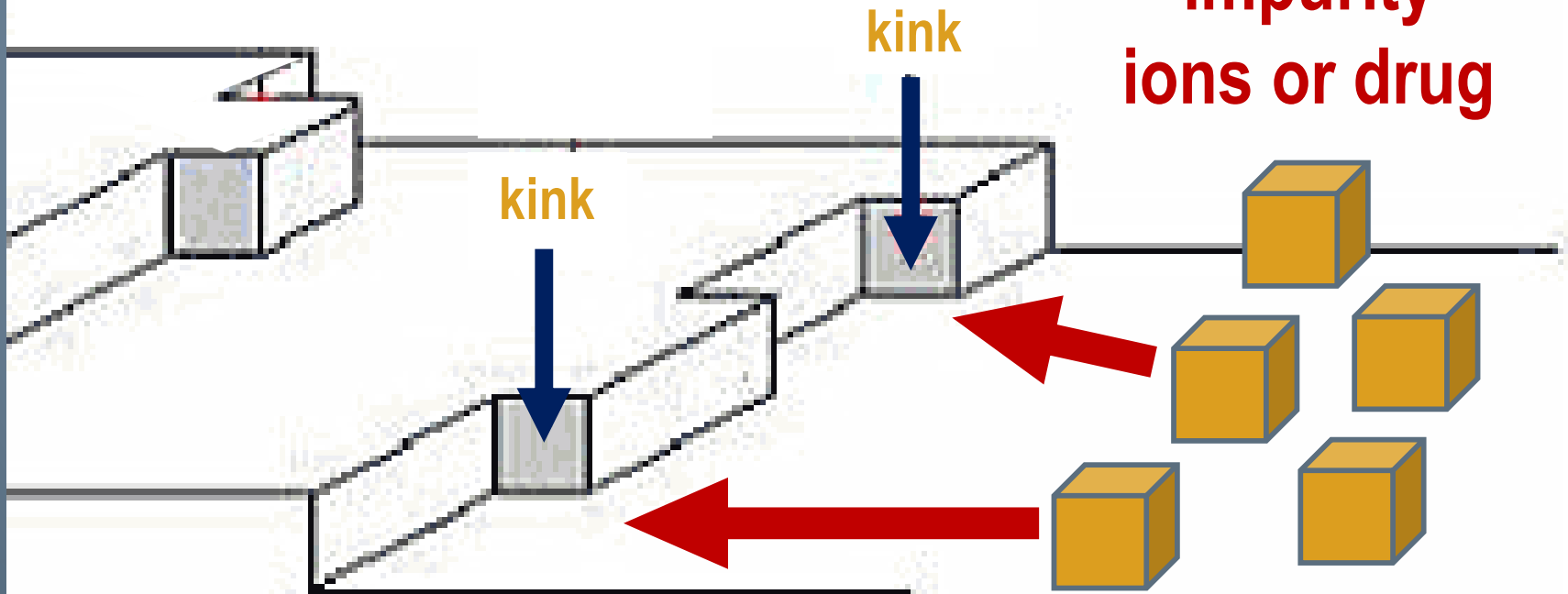


- Sugar dissolved in water
- Higher temperatures – more sugar dissolves
- Supersaturation occurs when left at room temperature, due to differences in solubility
- The higher the **supersaturation**, the faster the growth
- Seed crystals cause growth to start immediately and skip past the nucleation phase

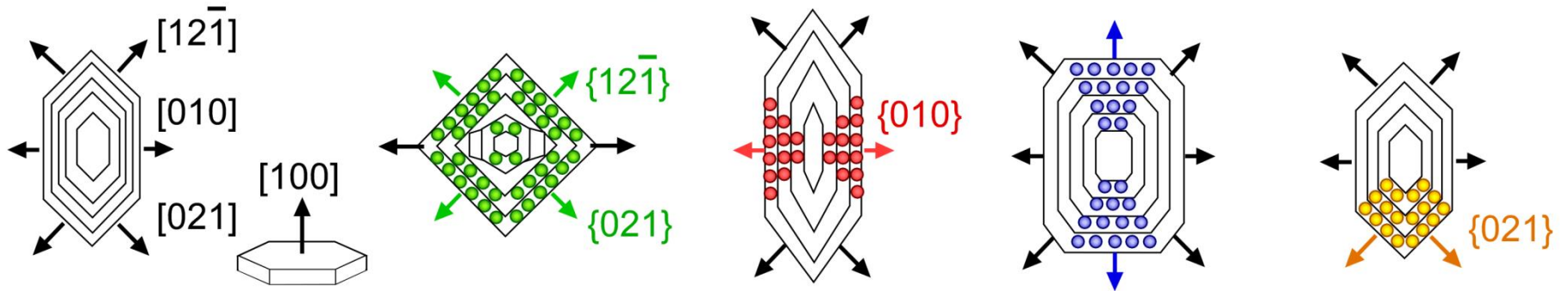
Inhibiting Crystallization

Impurity incorporation

**solution of
impurity
ions or drug**

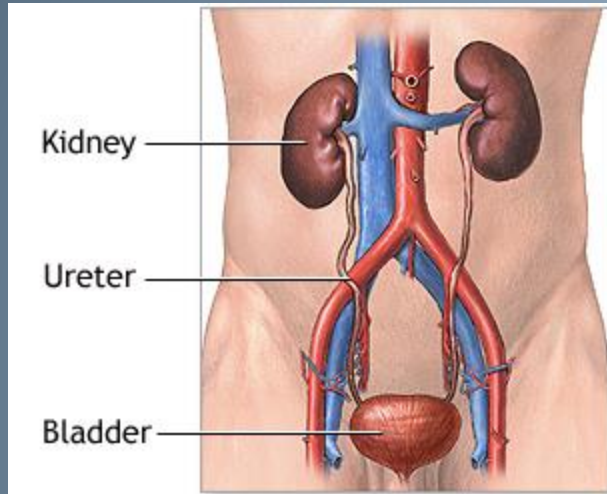


Crystal Shape Changes



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

Kidney Stone Formation



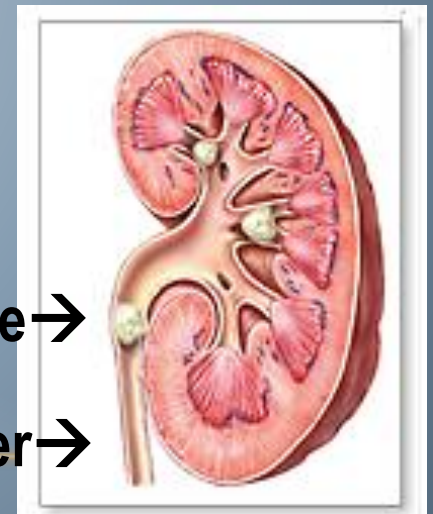
Kidneys filter the blood, remove waste, maintain electrolyte levels

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

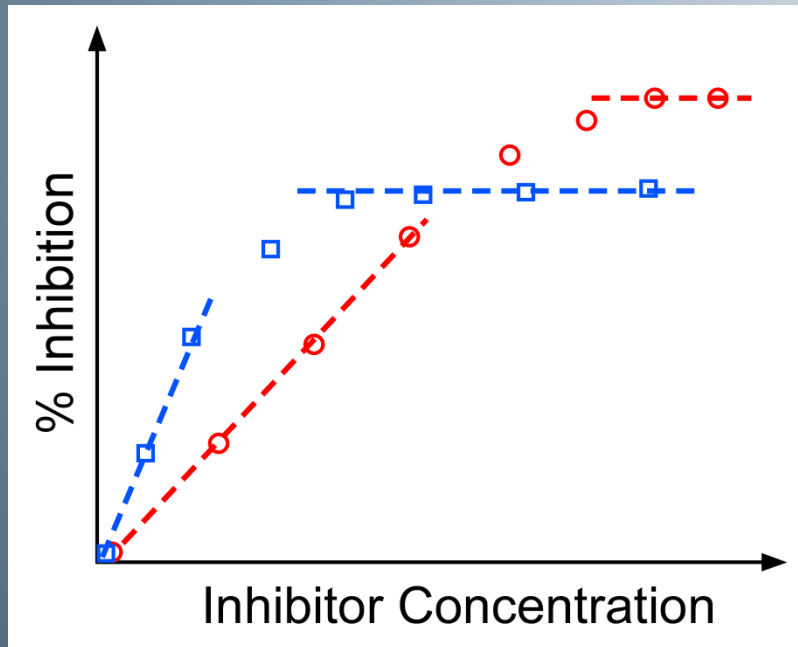
Researchers are creating new **drugs to block crystallization** intending to more effectively prevent kidney stones

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?