

# Cell Signaling Pathways

## Receptor Types

- GPCR: G-protein coupled
- RTK: receptor tyrosine kinase
- Ion channel receptors
- Nuclear receptors

## Second Messengers

- cAMP: activates PKA
- $\text{Ca}^{2+}$ : multiple targets
- $\text{IP}_3$  and DAG
- Amplify signal

## Kinase Cascades

- MAPK pathway
- Sequential phosphorylation
- Signal amplification
- Specificity and crosstalk

## Feedback Regulation

- Negative feedback: stability
- Positive feedback: switches
- Desensitization mechanisms
- Temporal dynamics