

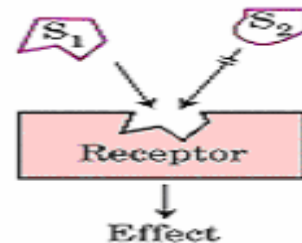
## Biosignaling

### Some Signals to Which Cells Respond

Antigens  
Cell surface glycoproteins/oligosaccharides  
Developmental signals  
Extracellular matrix components  
Growth factors  
Hormones  
Light  
Mechanical touch  
Neurotransmitters  
Odorants  
Pheromones  
Tastants

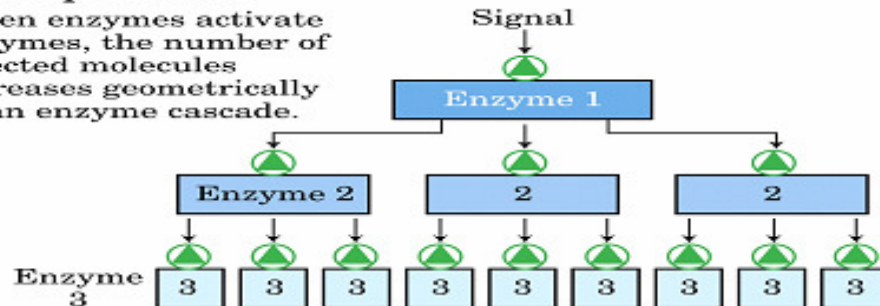
#### (a) Specificity

Signal molecule fits binding site on its complementary receptor; other signals do not fit.



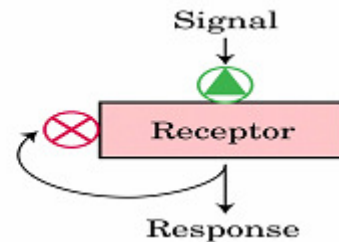
#### (b) Amplification

When enzymes activate enzymes, the number of affected molecules increases geometrically in an enzyme cascade.



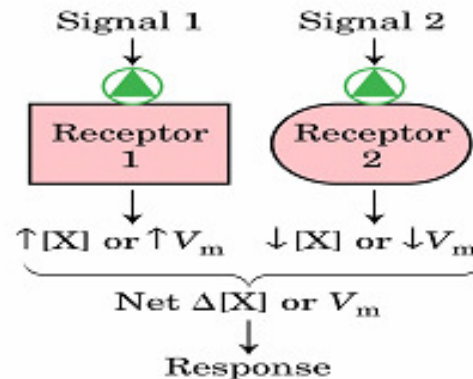
#### (c) Desensitization/Adaptation

Receptor activation triggers a feedback circuit that shuts off the receptor or removes it from the cell surface.



#### (d) Integration

When two signals have opposite effects on a metabolic characteristic such as the concentration of a second messenger X, or the membrane potential  $V_m$ , the regulatory outcome results from the integrated input from both receptors.



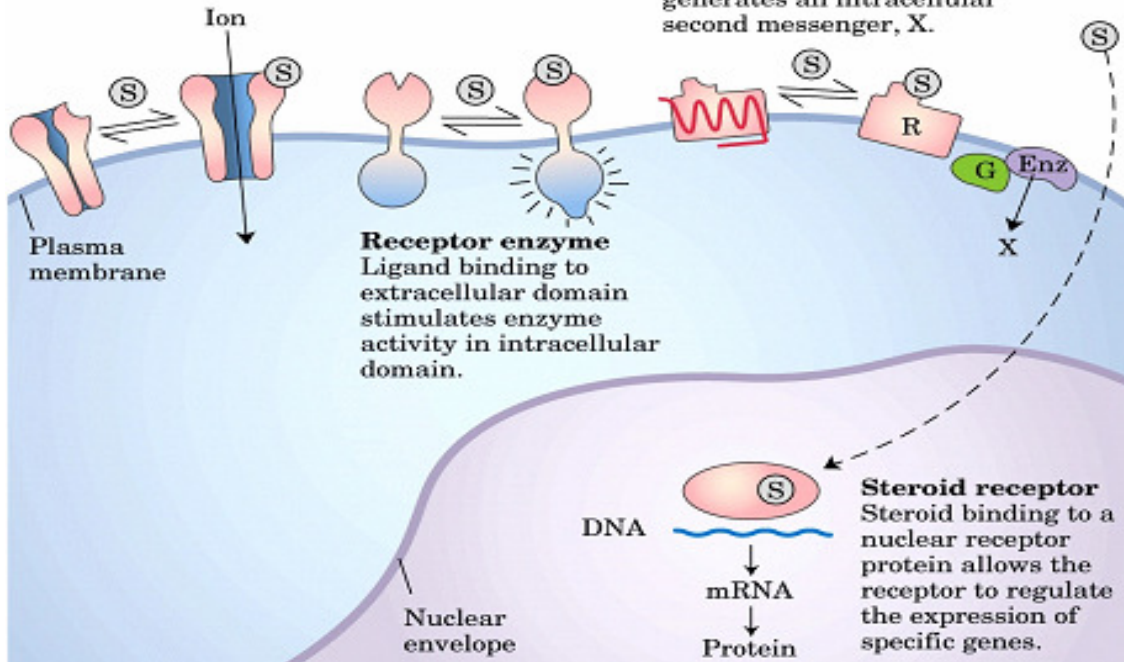
## Four general types of signal transducers

### Gated ion channel

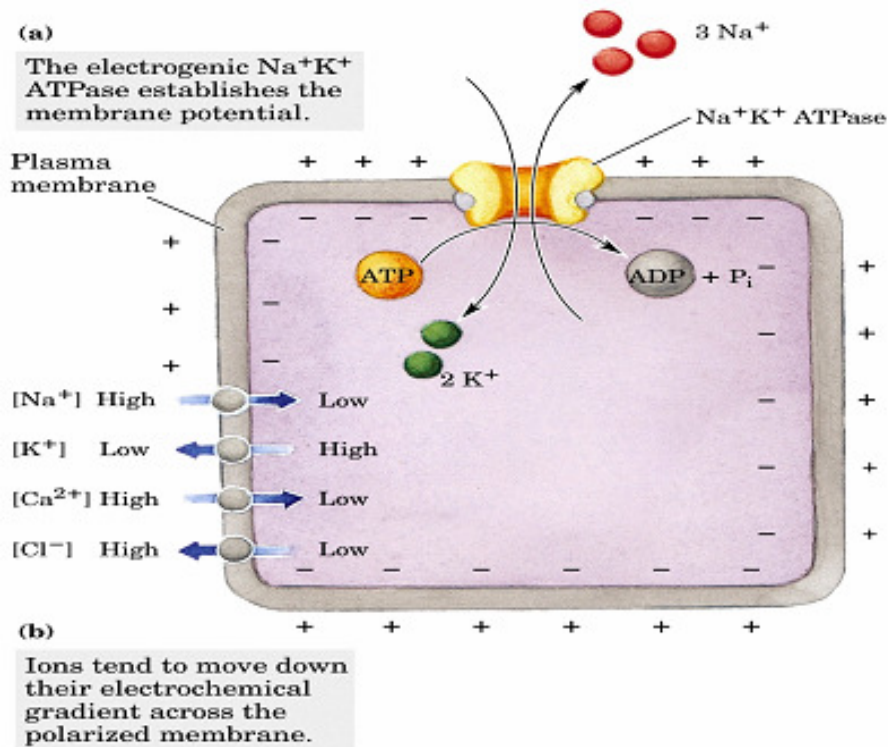
Opens or closes in response to concentration of signal ligand (S) or membrane potential.

### Serpentine receptor

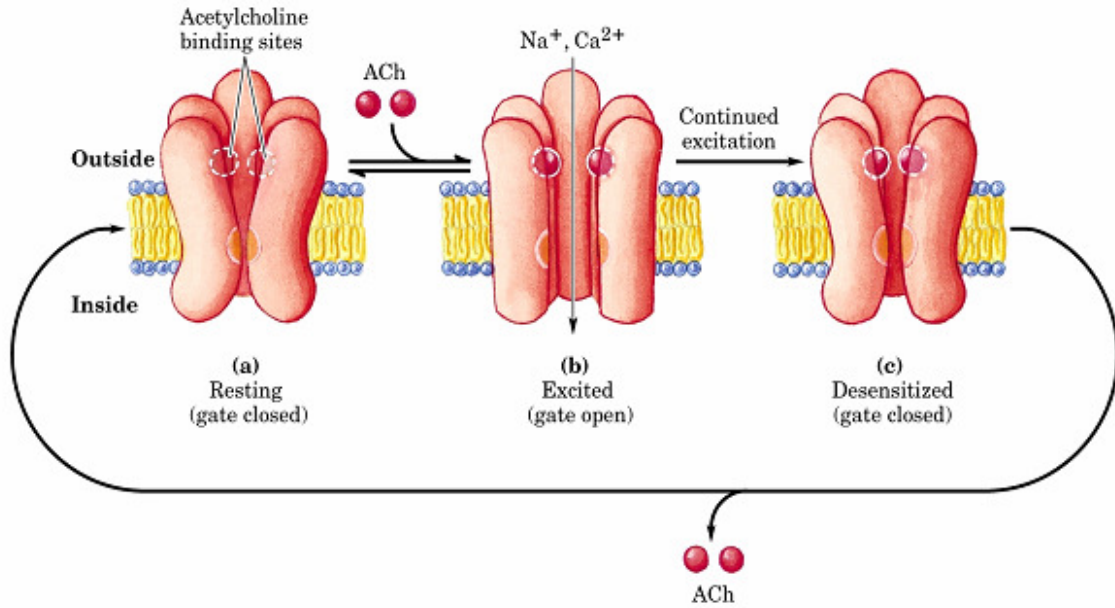
External ligand binding to receptor (R) activates an intracellular GTP-binding protein (G), which regulates an enzyme (Enz) that generates an intracellular second messenger, X.



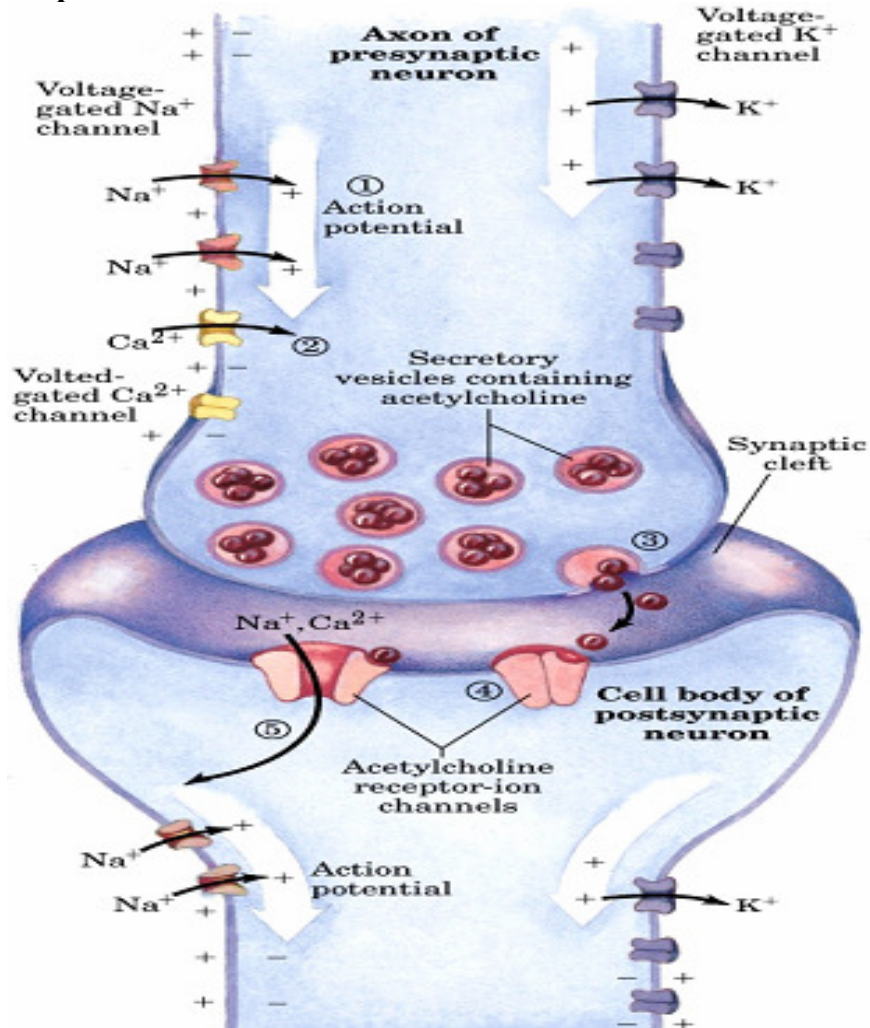
## Gated Ion Channels



## Ligand-gated Ion Channels

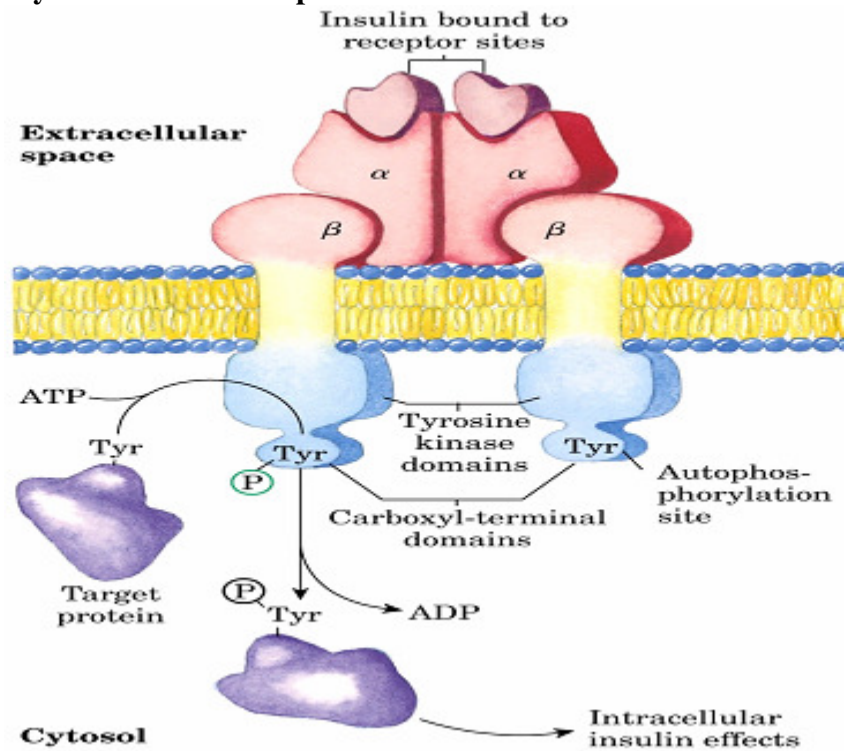


## Neural action potential

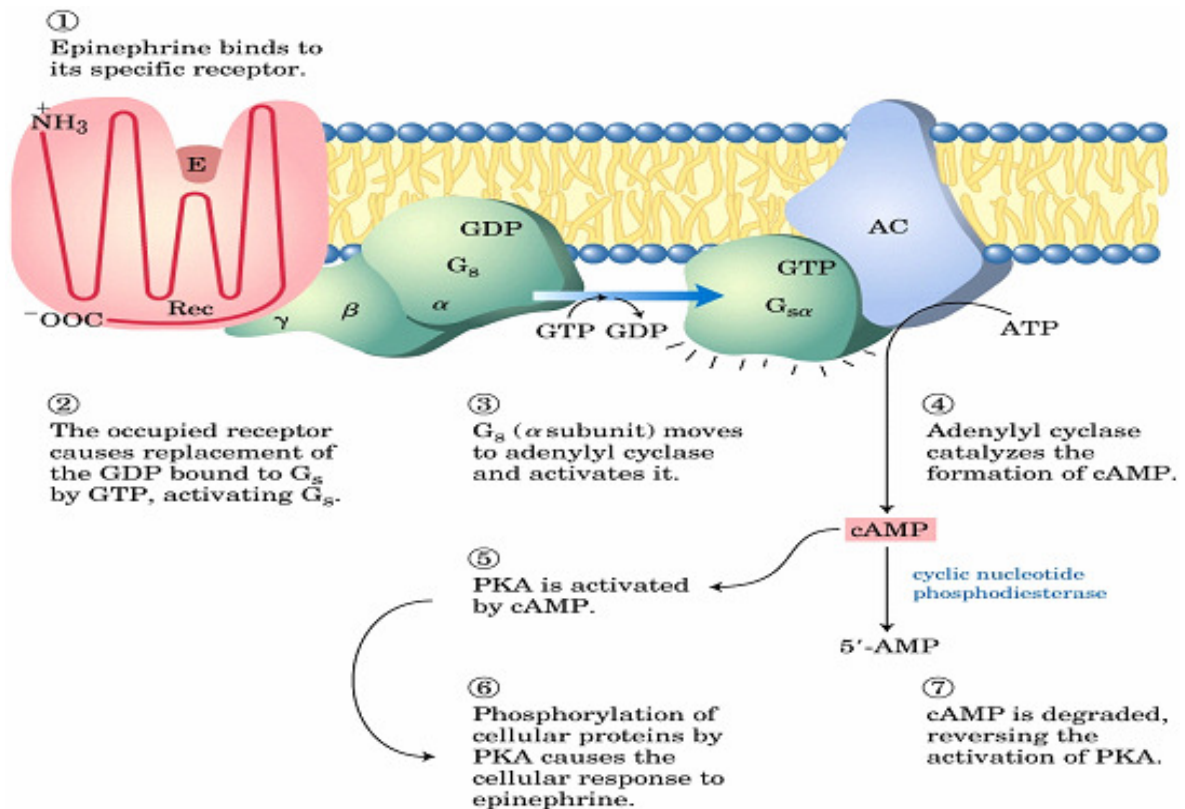


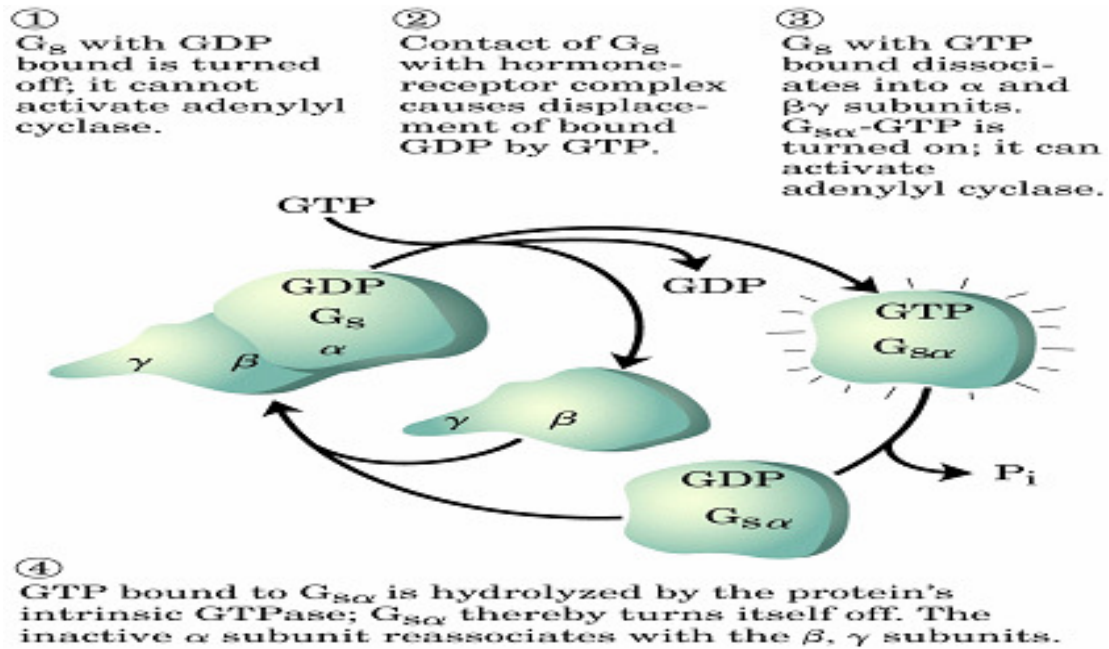


## Receptor Enzymes – Insulin receptor

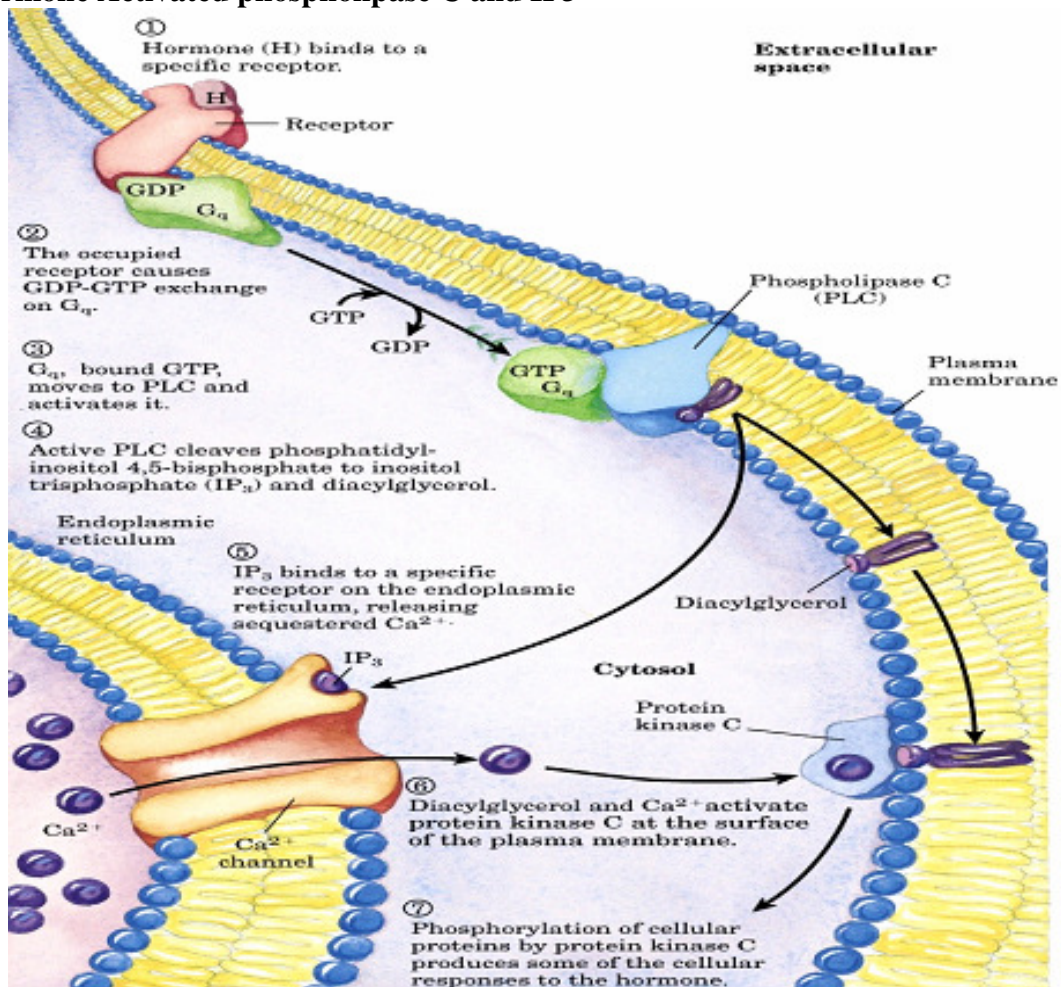


## Serpetine receptors – G Protein-Coupled receptors

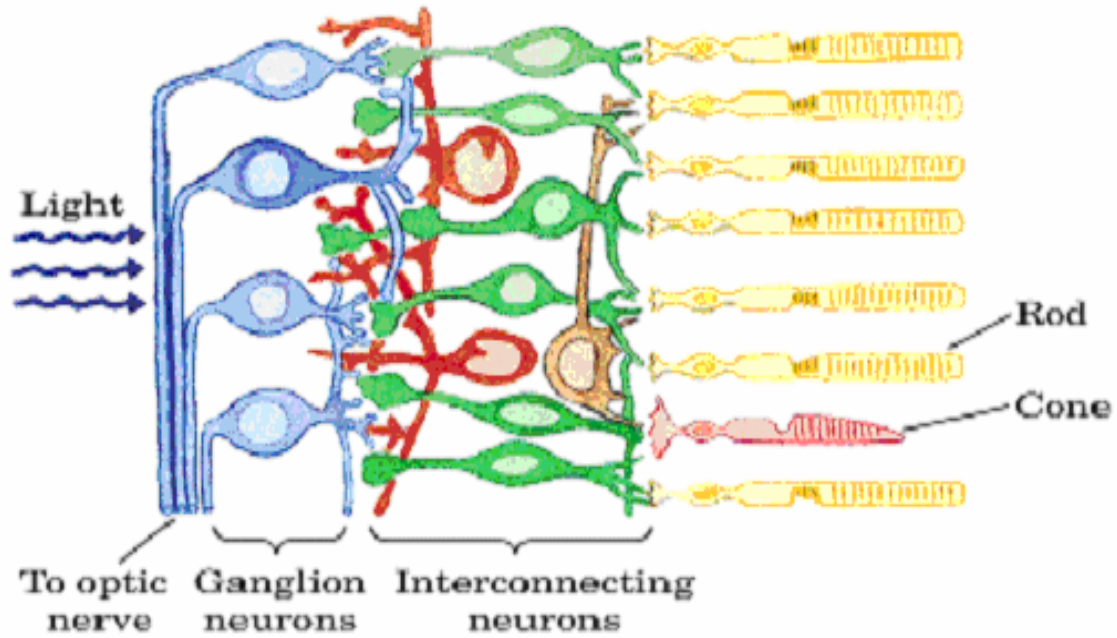




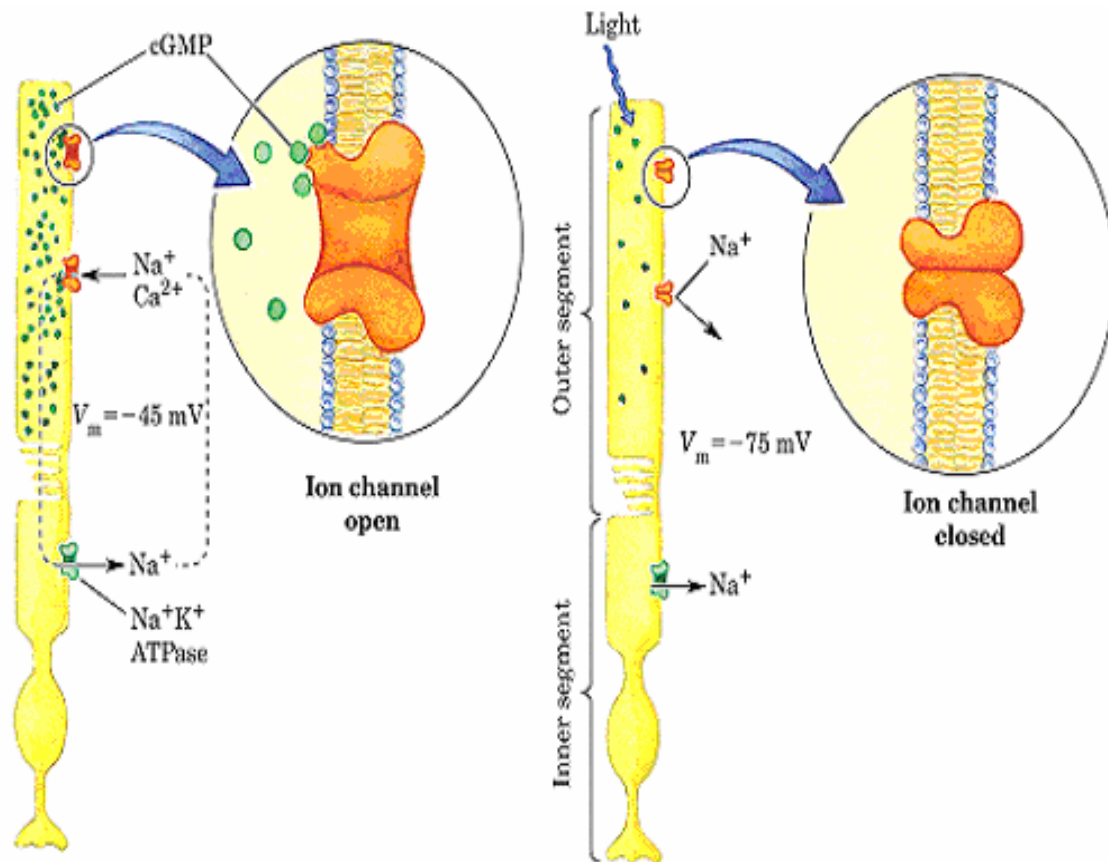
### Hormone Activated phospholipase C and IP3



## Light reception in the vertebrate eye



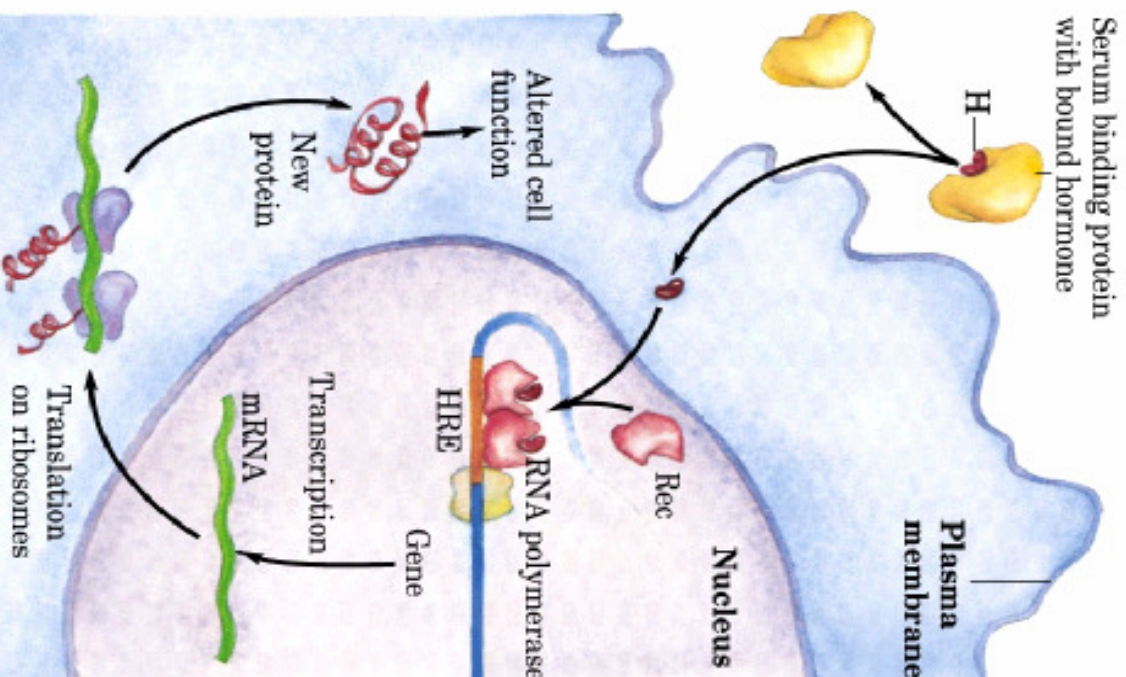
## Light-induced hyperpolarization of rod cells





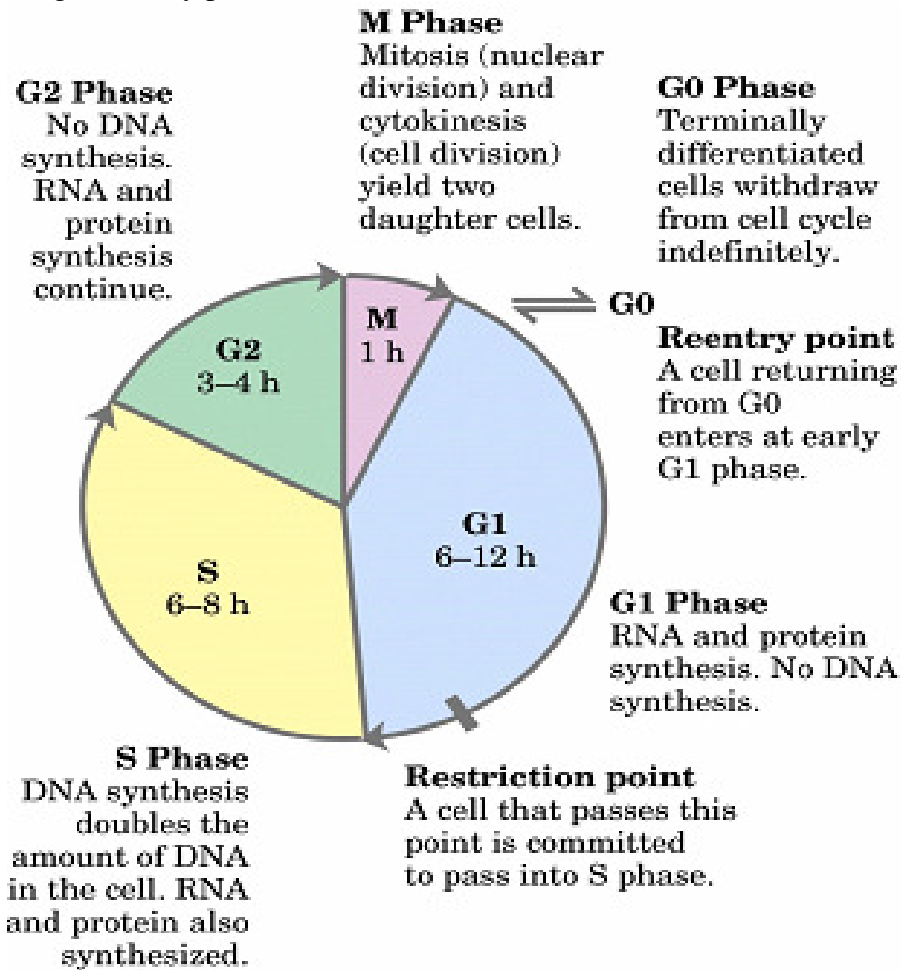
## Regulation of transcription by steroid hormones

- ① Hormone (H), carried to the target tissue on serum binding proteins, diffuses across the plasma membrane and binds to its specific receptor protein (Rec) in the nucleus.
- ④ Altered levels of the hormone-regulated gene product produce the cellular response to the hormone.



- ② Hormone binding changes the conformation of Rec; it forms homo- or heterodimers with other hormone-receptor complexes and binds to specific regulatory regions called hormone response elements (HREs) in the DNA adjacent to specific genes.
- ③ Binding regulates transcription of the adjacent gene(s), increasing or decreasing the rate of mRNA formation.

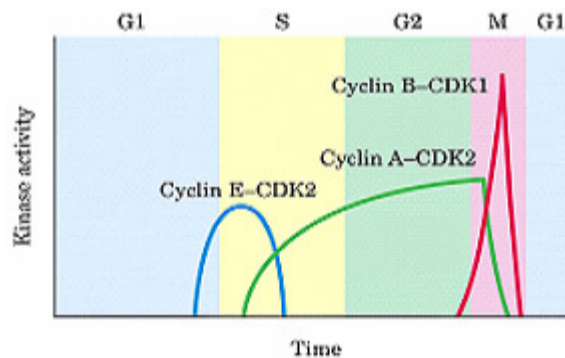
## Cell cycle regulation by protein kinases



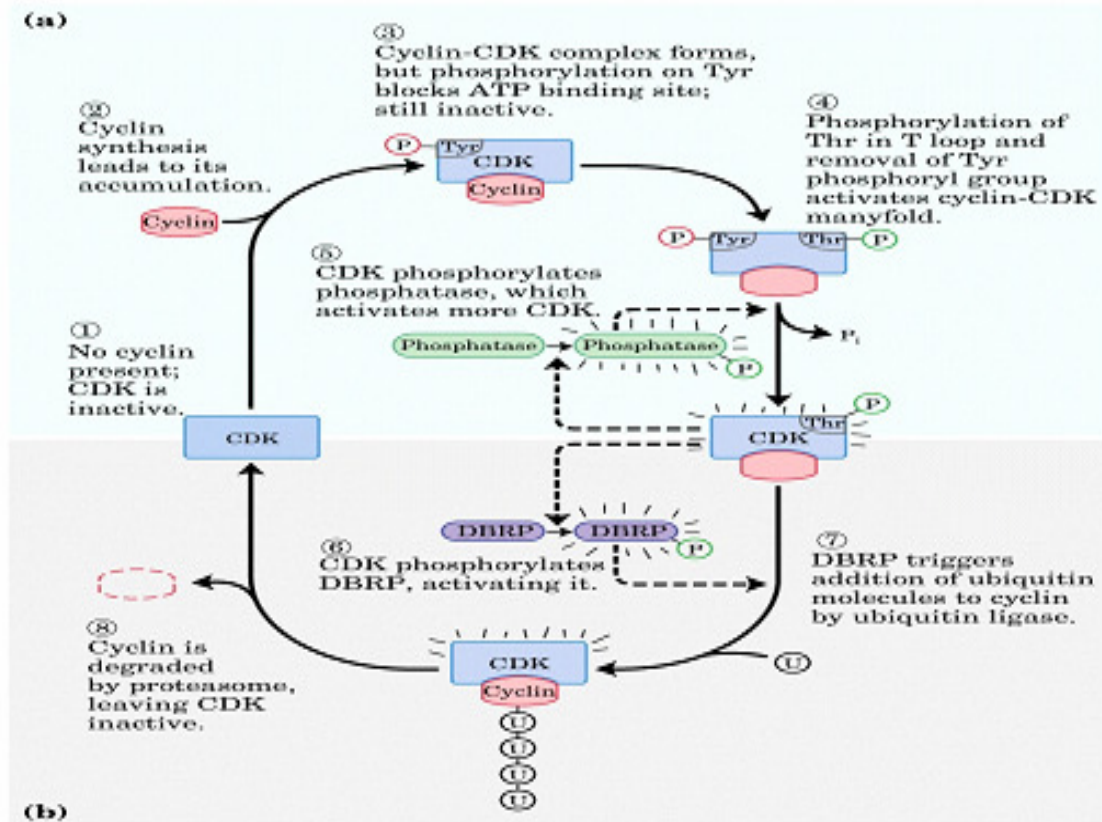
## Cell cycle control

**DBRP** –destruction box recognizing protein

**CDK** – cyclin-dependent protein kinase







### Regulation of passage from G1 to S by phosphorylation of pRb

