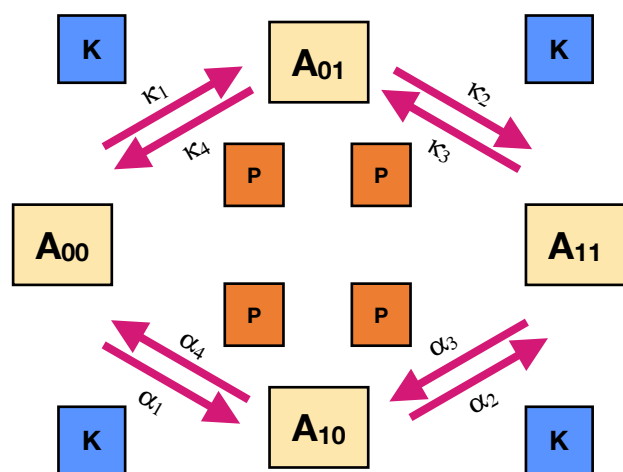
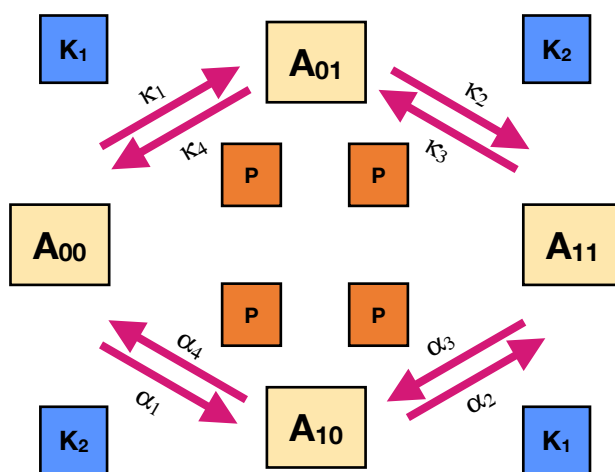


## (A) RANDOM DISTRIBUTIVE DSP

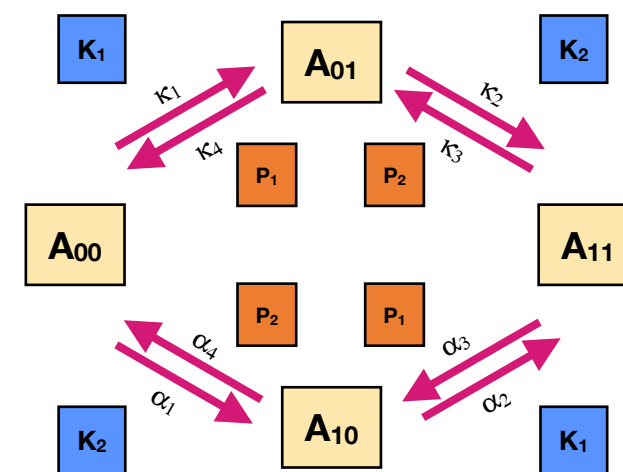
**System 1**  
Common Kinase Common Phosphatase



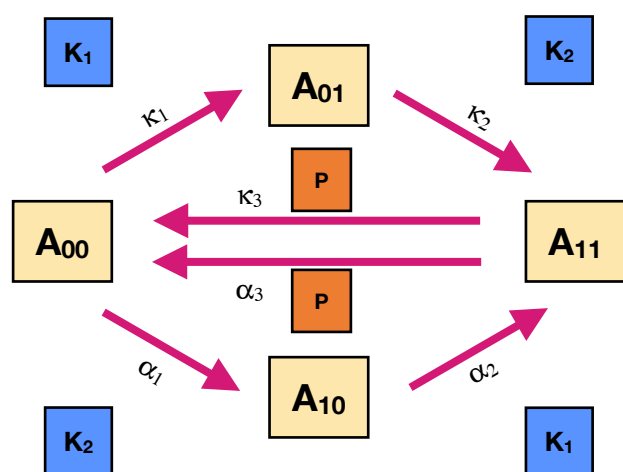
**System 2**  
Separate Kinase Common Phosphatase



**System 3**  
Separate Kinase Separate Phosphatase



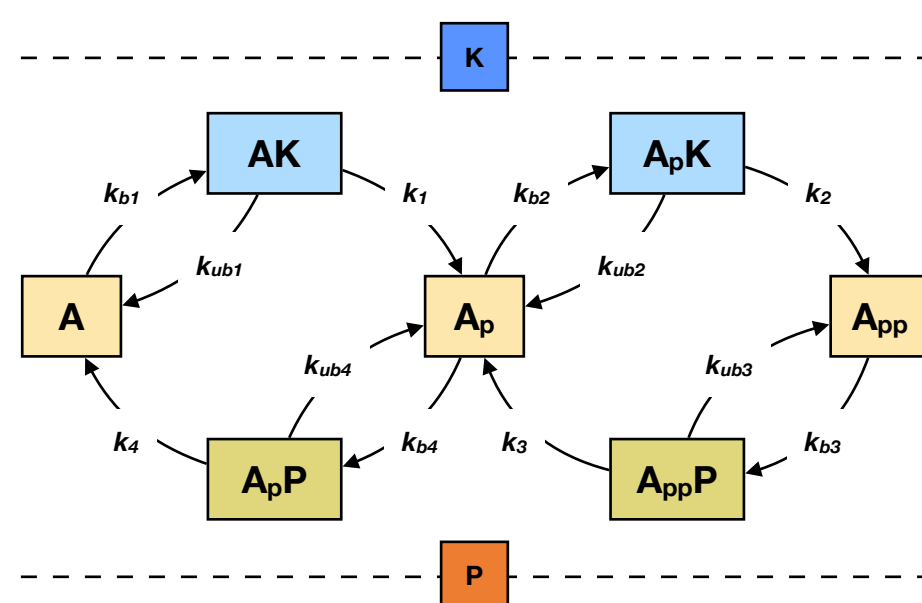
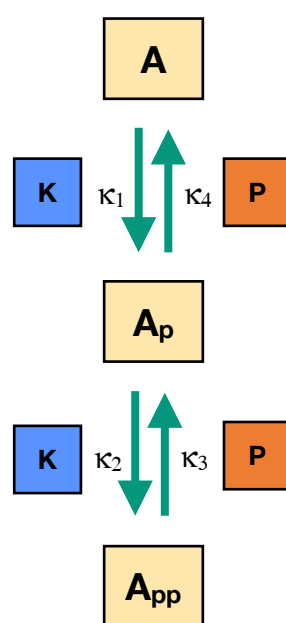
## (B) MIXED RANDOM DSP



**Mixed Random 2**

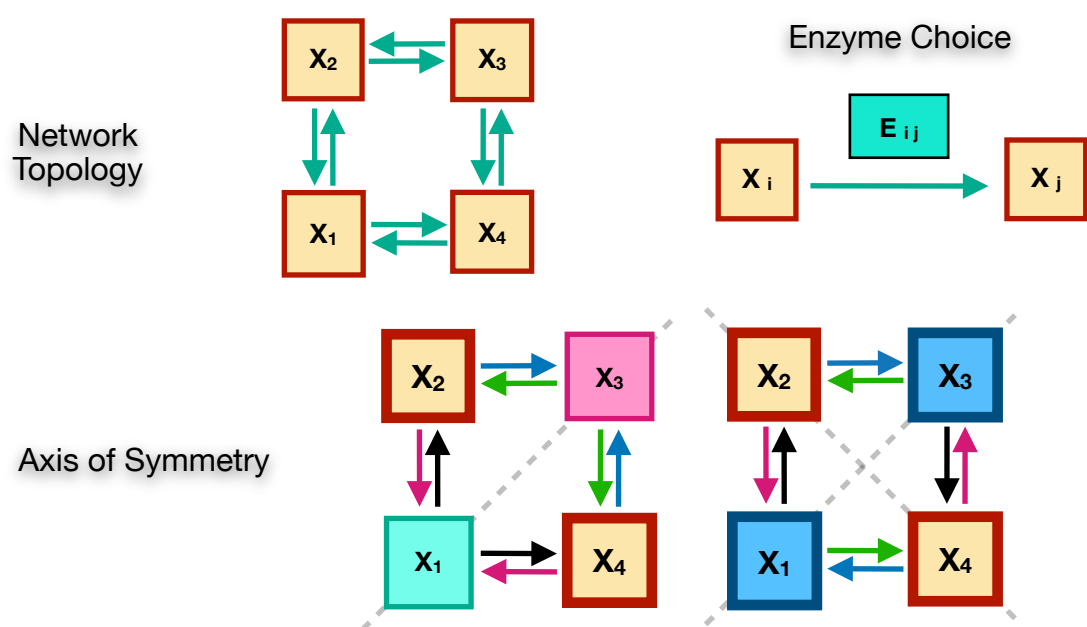
Separate Kinase Common Phosphatase  
Distributive Phosphorylation Processive Dephosphorylation

## (C) ORDERED DISTRIBUTIVE DSP



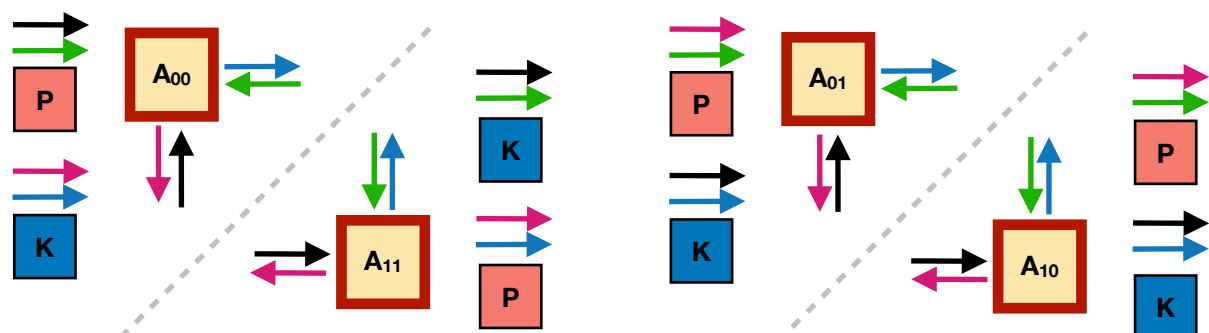
## (D) SYMMETRY : FROM ENZYMIC NETWORKS TO MULTISITE MODIFICATION

### Symmetry in Enzymatic networks

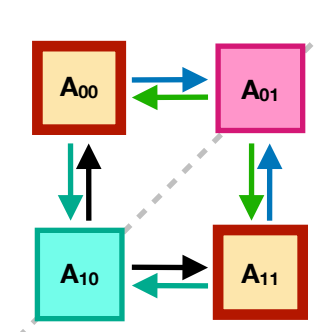


### Multisite modification

Substrate Identity and Enzyme-Substrate Affinity



### CASE 1



Symmetric Pair

$A_{00} \& A_{11}$

Kinetic Constraints

$$\begin{aligned} \kappa_1 &= \kappa_3 & \alpha_1 &= \alpha_3 \\ \kappa_2 &= \kappa_4 & \alpha_2 &= \alpha_4 \end{aligned}$$

Enzyme Constraints

Com. Kinase  
Com. Phosphatase

$$K_{\text{Total}} = P_{\text{Total}}$$

Com. Kinase  
Sep. Phosphatase

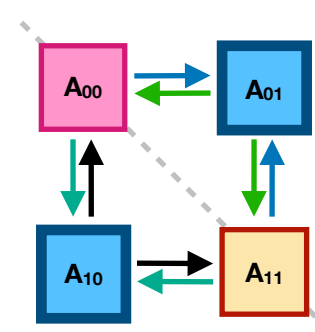
Not Possible

Sep. Kinase  
Sep. Phosphatase

$$K_{1,\text{Total}} = P_{2,\text{Total}}$$

$$P_{1,\text{Total}} = K_{2,\text{Total}}$$

### CASE 2



Symmetric Pair

$A_{01} \& A_{10}$

Kinetic Constraints

$$\begin{aligned} \kappa_1 &= \alpha_1 & \kappa_2 &= \alpha_2 \\ \kappa_3 &= \alpha_3 & \kappa_4 &= \alpha_4 \end{aligned}$$

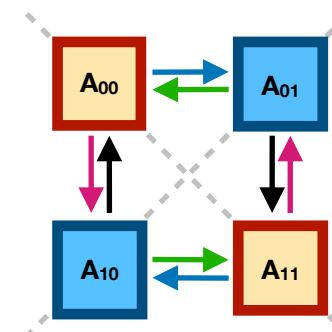
Enzyme Constraints

None

$$P_{1,\text{Total}} = P_{2,\text{Total}}$$

$$P_{1,\text{Total}} = P_{2,\text{Total}}$$

### CASE 3



Symmetric Pair

$A_{00} \& A_{11}$  and  $A_{01} \& A_{10}$

Kinetic Constraints

$$\begin{aligned} \kappa_1 &= \alpha_3 & \alpha_1 &= \kappa_3 \\ \kappa_2 &= \alpha_4 & \alpha_2 &= \kappa_4 \end{aligned}$$

Enzyme Constraints

$$K_{\text{Total}} = P_{\text{Total}}$$

Not Possible

$$K_{1,\text{Total}} = P_{1,\text{Total}}$$

$$P_{2,\text{Total}} = K_{2,\text{Total}}$$