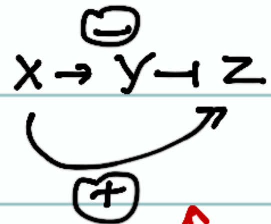
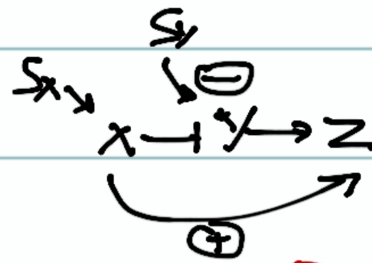


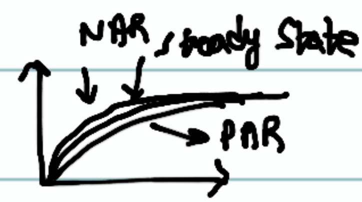


(A) More prefer than this (B)

In general, we prefer A as in B, if X inhibits and Y goes down, then S_y has no purpose.

Whereas in (A), that's not case S_x, S_y are needed

⊕X → Positive Autoregulation



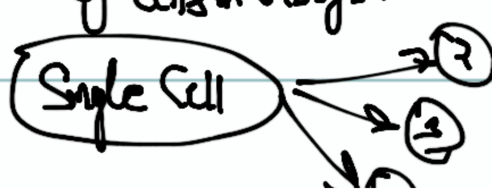
Transcriptional Network.

Delay is useful in sensory network by reaching to external environment

Transcriptional

Sensory

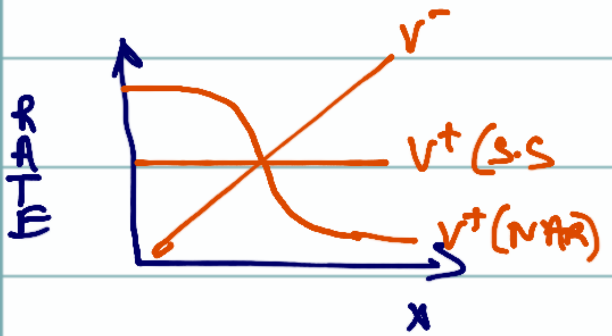
Developmental Network
eg. Cells in embryos.



Takes lots of Time

These developmental are dependent on celltype, specific gene expression

It also helps in integrating multiple inputs that are stable



$$\frac{dx}{dt} = k_s - k_d x \quad [S.S]$$

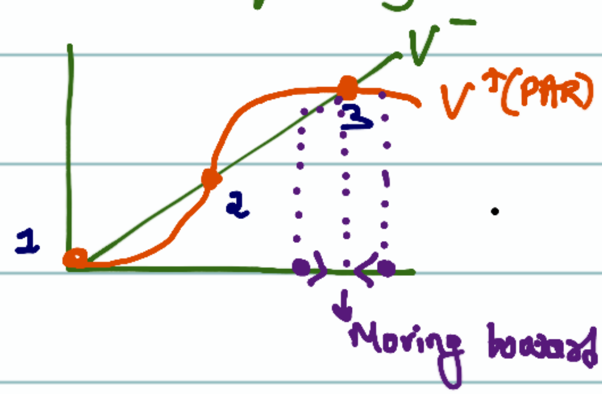
$$\frac{dx}{dt} = k_s\left[\frac{K^n}{K^n+x^n}\right] - k_d \cdot x \quad [NAR]$$

$$\frac{dx}{dt} = k_s\left[\frac{x^n}{x^n+K^n}\right] - k_d x \quad [PAR]$$

Try to find for PAR:

$$\frac{dx}{dt} = k_s\left[\frac{x^n}{x^n+K^n}\right] - k_d x$$

→ To Solve equation, we ~~need~~ even find out by integration.



Intersection gives steady state values i.e. when $V^+ = V^-$

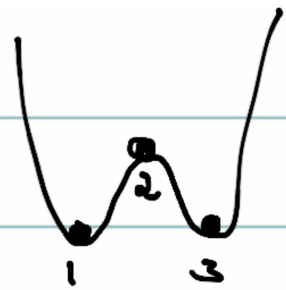
As per this there are 3 steady states

To find which is stable:

If $x - \Delta x$, $x + \Delta x$ move towards again then its steady

That way, 1,3 are stable → Its a sink

2 is unstable → It a source

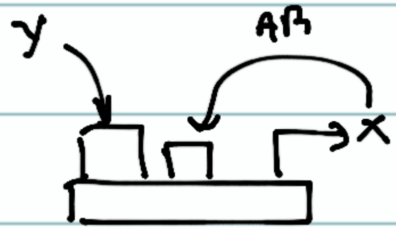


Bistable - as it has two steady state.

If it has two steady state

X AND Y

X OR Y



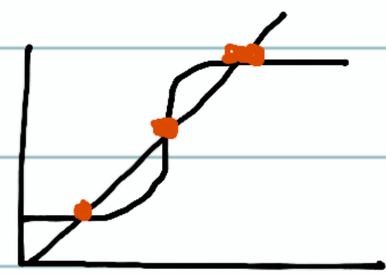
$$\frac{dx}{dt} = k_s\left[\frac{x^n}{x^n+k^n}\right] - k_d X$$

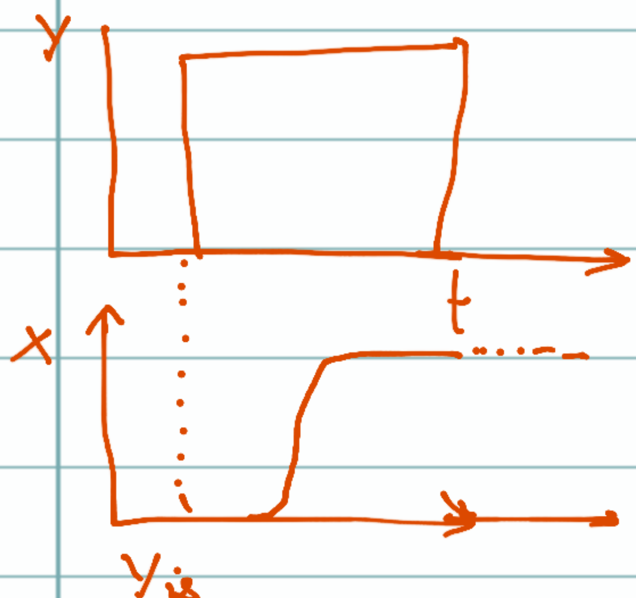
At $x(t=0) = X_0$

If $\frac{dx}{dt} = k_s + k_s\left[\frac{x^n}{x^n+k^n}\right] - k_d X$

↓

Won't start from origin

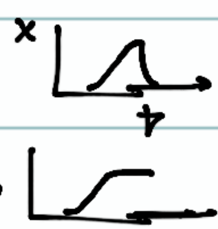




When Y is dropped, X

AND → Expected to go down

OR – Stays in the same place and acts like $\boxed{\text{memory}}$



Pysical example

→ Elevators

→ Starting Bike

→ Switches [Typically called Toggle Switches]

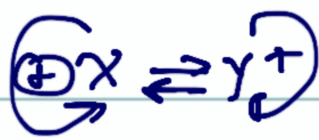
↓ Can become independent of input

↳ Used in explaining Bistability

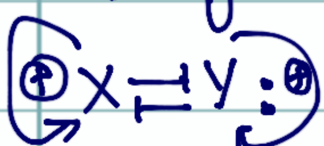
→ Buzzer [Switch calling]

→ Dependent on input

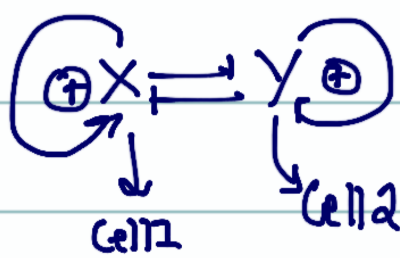
→



Self Sustaining



Mutually exclusive as only X, Y one of them stay.



When X is activated, it means to it stays is the same value

There can be input which is → activating X, inhibiting Y
→ activating Y, inhibiting X

→ Ideal characteristic is to maintain self-maintaining when once input is given

Biological Switches

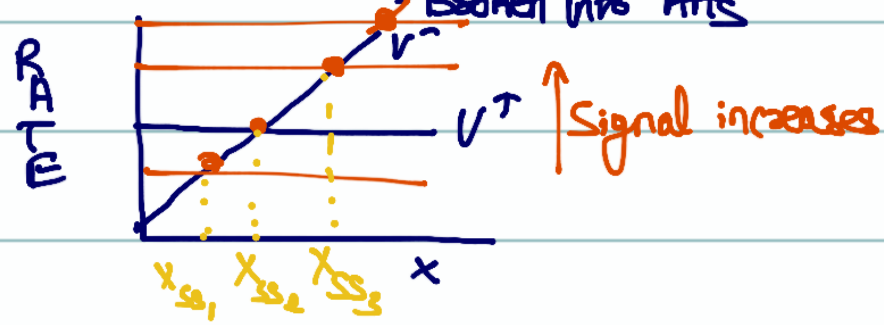
Signal [can be any]

$\xrightarrow{k_s} X \xrightarrow{k_d} ::$

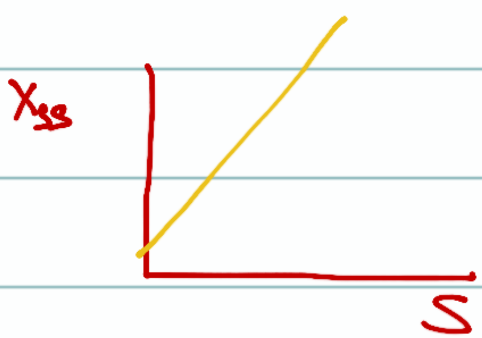
Synthesis

Transcriptional Network

Broken into AAs



If signal varies then the steady states can be shifted according to change in signal.



Protein Modifications:

$$S \rightarrow \quad X \underset{k_i}{\overset{k_a}{\rightleftarrows}} X^*$$

(inactive) (active)

Fast

Assume one of them is active

k_a = Activation

k_i = Inactivation

Examples: * Phosphorylation

$$\frac{dx^*}{dt} = k_a x - k_i x^*$$

2 states: Modified, Unmodified

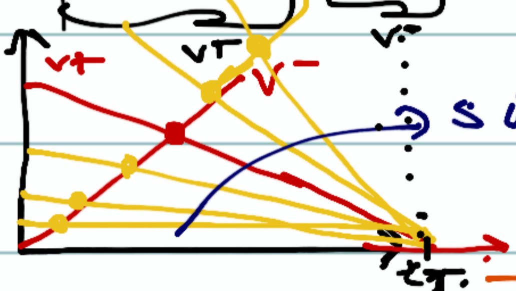
$x_{Total} = x + x^*$ [Mass balance

$$\frac{dx^*}{dt} = k_a(x_T - x^*) - k_i x^*$$

After a long time, obtains constant steady state

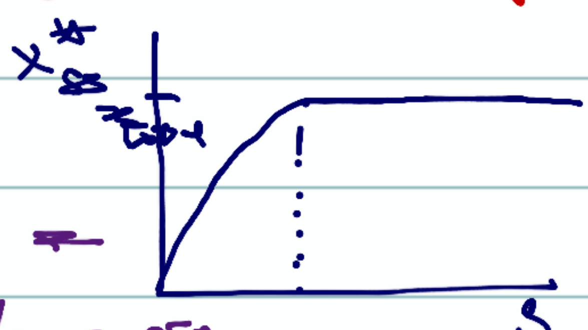
Assume protein is already available and plays role in transfer like a baton in a race which is why x_T = Constant

RATE PLOTS



If signal is imposed promoting X^* then

SIGNAL RESPONSE CURVES / DOSE RESPONSE



Hyperbolic Dependencies

$$X \underset{E_2\,(v^-)}{\overset{E_1\,(v^+)}{\rightleftharpoons}} X^*$$

(X, X^* are prot

E_1, E_2 are enzymes which bind

$$X + E_1 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} [X:E_1] \xrightarrow{k_2} X^* + E.$$

$$V^+ = V_{max}\left[\frac{X}{K_M + X}\right]$$ → Based on enzyme characteristics

Michaelis Menten Kinetics ←

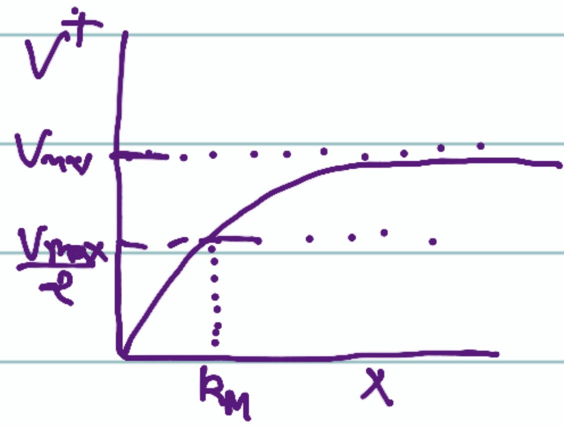
Review

Borden

1:27

$$V_{max} = k_2 \cdot E_{1T}$$

$$K_M = \frac{k_{-1} + k_2}{k_1}$$



Hyperbolic

To find K_M,

If $V = V_{max}/2$, $K_M = X$ = Unit of concentration

→ Affinity/Binding Constant

If $k_2 = 0$ we get dissociation constant

Signals control the enzyme

Small change can also help to bind

Good Substrate ←

Lower Constant (K_M) → High Affinity Substrate

Higher Constant (K_M) → Low " " → More concentration

Bad Substrate