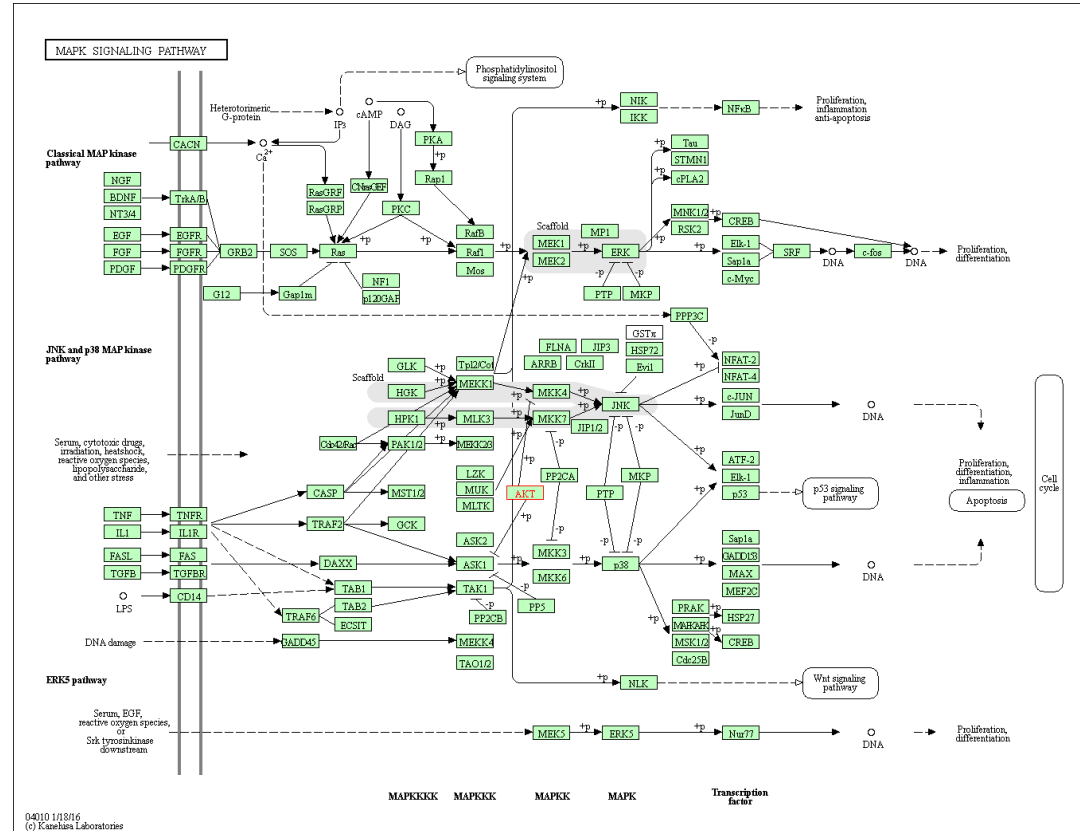


Modeling Molecular Processes in Cell

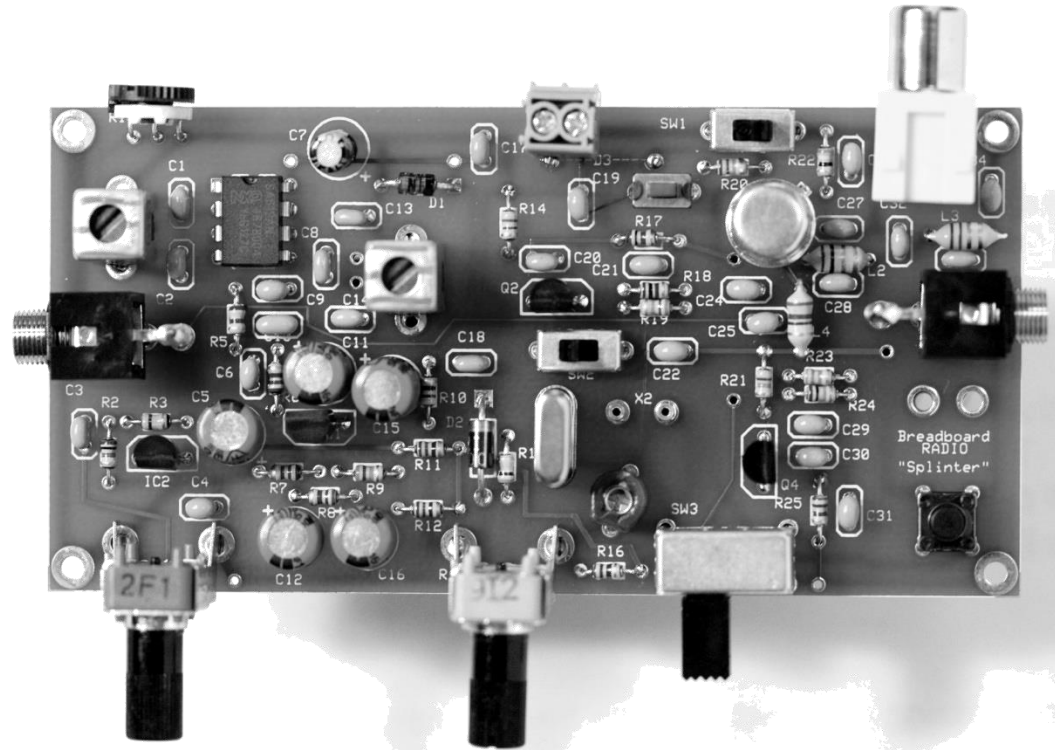
Biological molecular networks

1. Involves large number of molecules
2. Involves various types of processes
3. Difficult to collect information on dynamics of all the molecules by experiments
4. Difficult to estimate kinetic parameters and other quantitative information of all the molecules and processes



Building blocks for large network

A large complicated electronic circuit can be broken down into small parts having independent functions



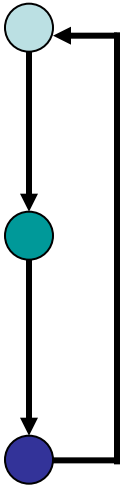
Network Motifs

A large network can be broken down in sub-networks or **motifs** involving a few molecular processes.

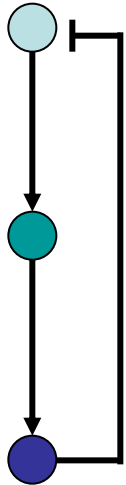
Such sub-networks occurs repeatedly and connect with each others to create a large network.

Each such sub-network has certain characteristic dynamical properties and functions

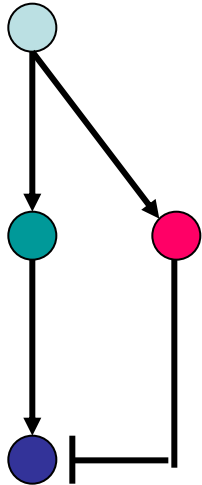
Common Network Motifs



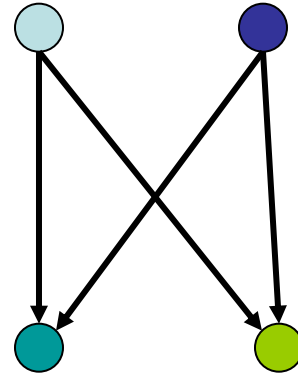
Positive Feedback



Negative Feedback



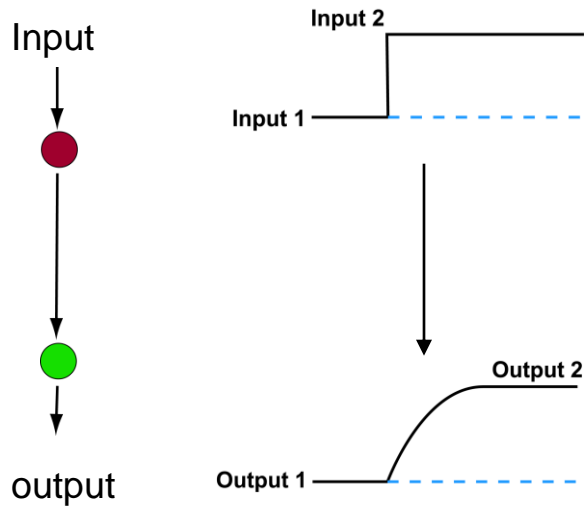
Incoherent feed-forward



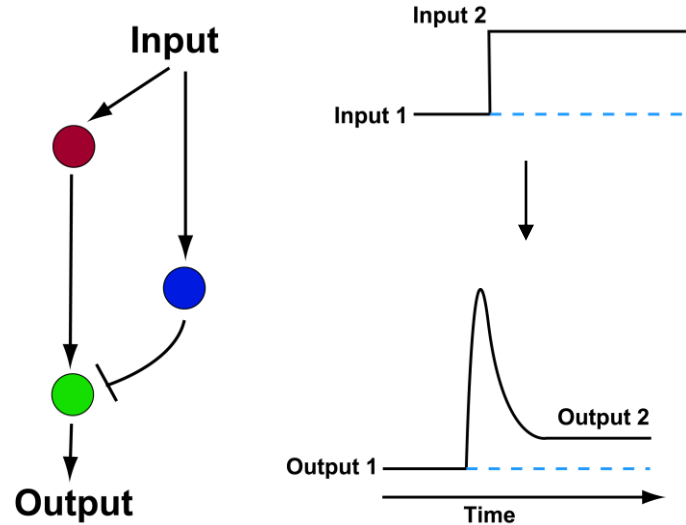
Bi-fan

Network motif: Specific dynamics

Linear path



Incoherent feed-forward



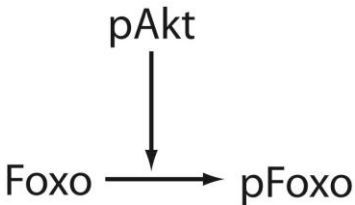
Elementary process

A large molecular network or a network motif can be broken down into multiple elementary processes.

For example:

Ligand-receptor interaction: $\text{EGF} + \text{EGFR} \rightleftharpoons \text{EGF-EGFR}$

Enzymatic reaction:



```
graph LR; pAkt -- inhibits --> F1[Foxo -> pFoxo];
```

The diagram shows a horizontal arrow pointing from 'Foxo' to 'pFoxo'. A vertical arrow points down from 'pAkt' to the horizontal arrow, indicating inhibition of the reaction.

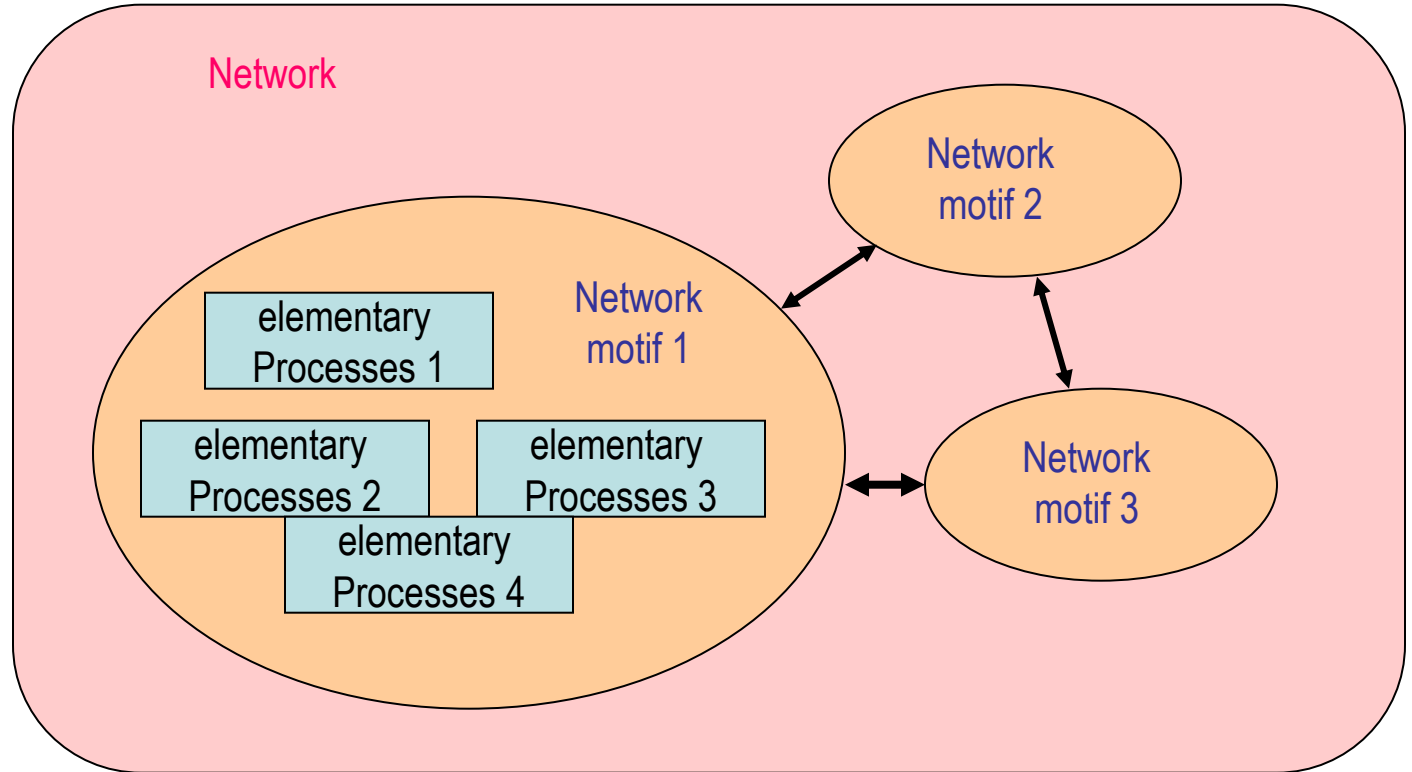
Transcription:



```
graph TD; Foxo -- binds to --> DNA[DNA]; DNA --> p15[p15];
```

The diagram shows a horizontal line representing a DNA sequence. A vertical arrow points down from 'Foxo' to the DNA line. From the DNA line, a horizontal arrow points right to a box labeled 'p15'. From the 'p15' box, an arrow points up and to the right, labeled 'P15'.

Hierarchical structure of molecular networks



Key points:

1. A large molecular network controlling a cellular process involves large number of molecules and processes.
2. It is often difficult to study such large network as it is.
3. Recurring small sub-networks with specific dynamics and functions are called network motifs
4. A large network can be broken down into number of network motifs.
5. A network motif is made up of a few elementary processes.