Genetic network modeling and identification

Junior Barrera

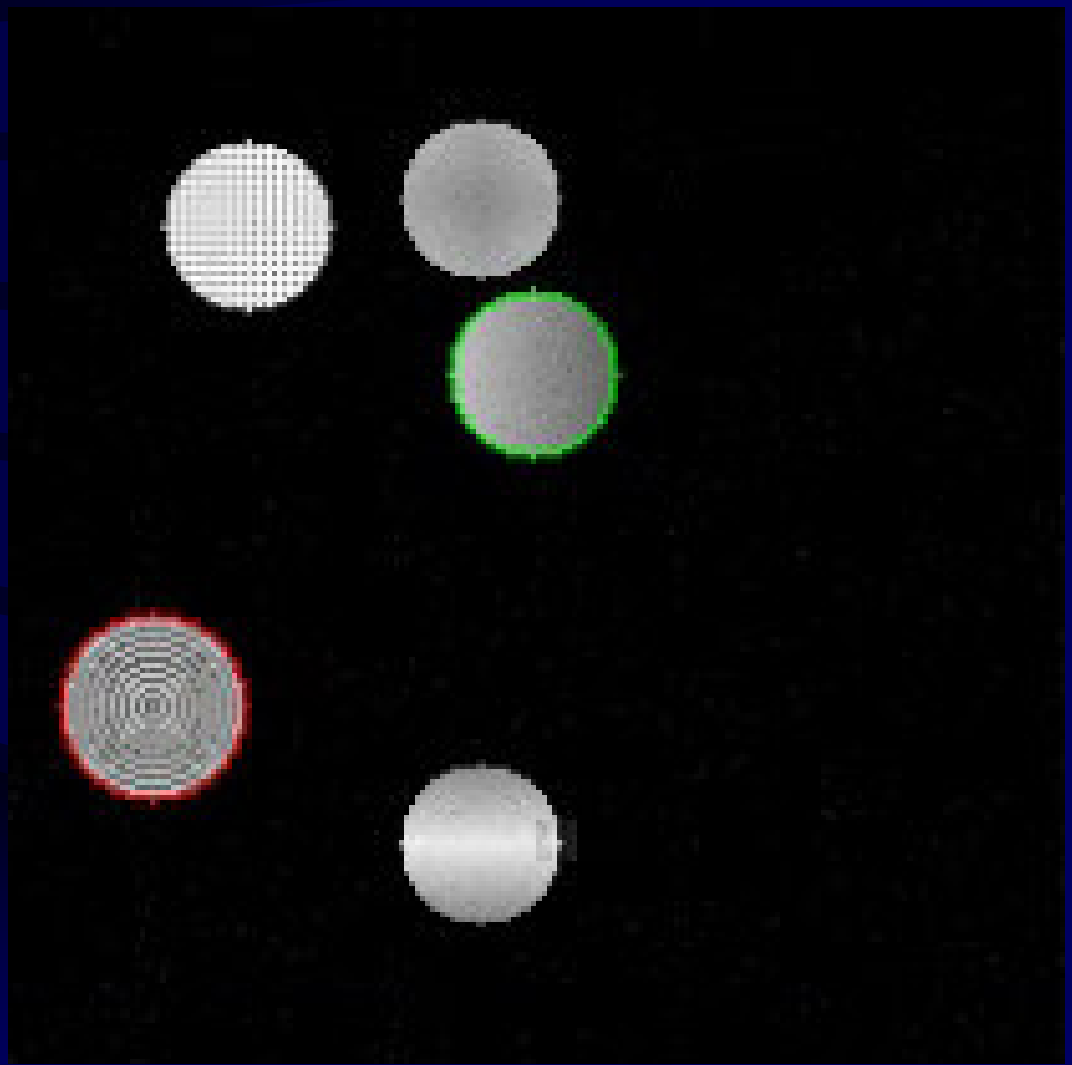
BIOINFO-USP

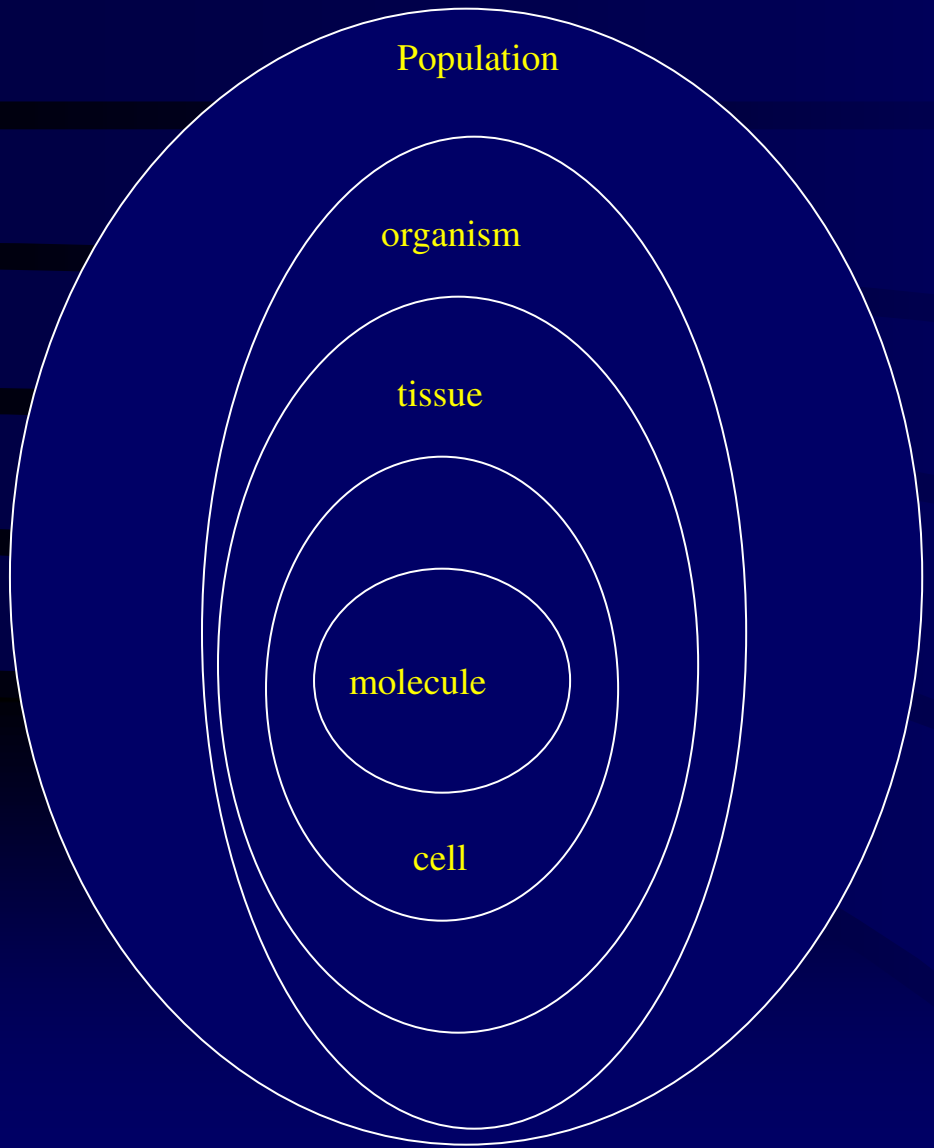
Layout

- Introduction
- Dynamical systems
- System identification
- Knowledge discovery in biology

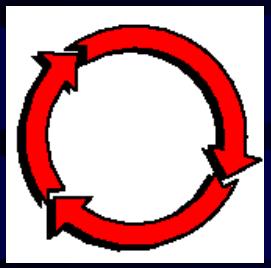
Introduction

Dynamical System



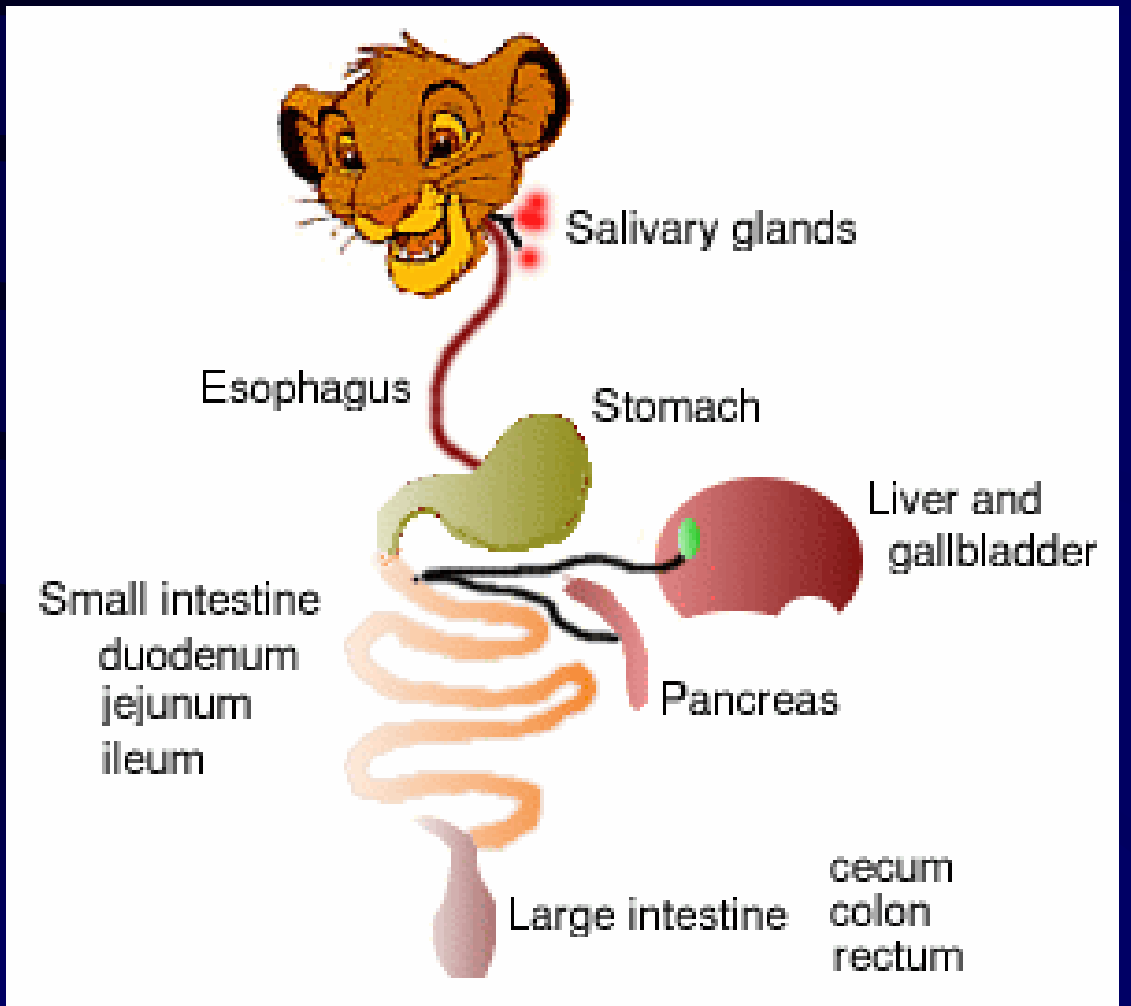


Biological Phenomena are multi-scale, dynamical and, in many cases, measurable



Ecological System

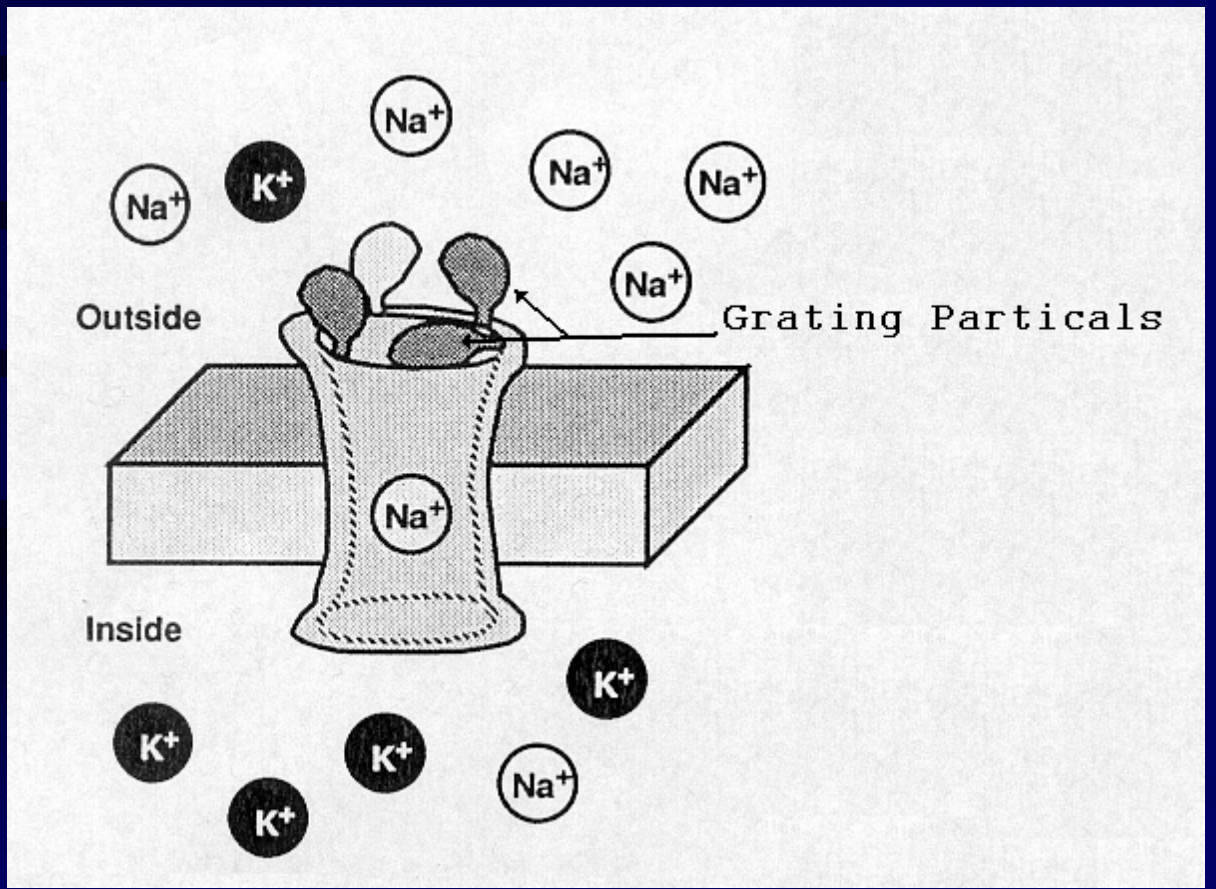
Digestive System

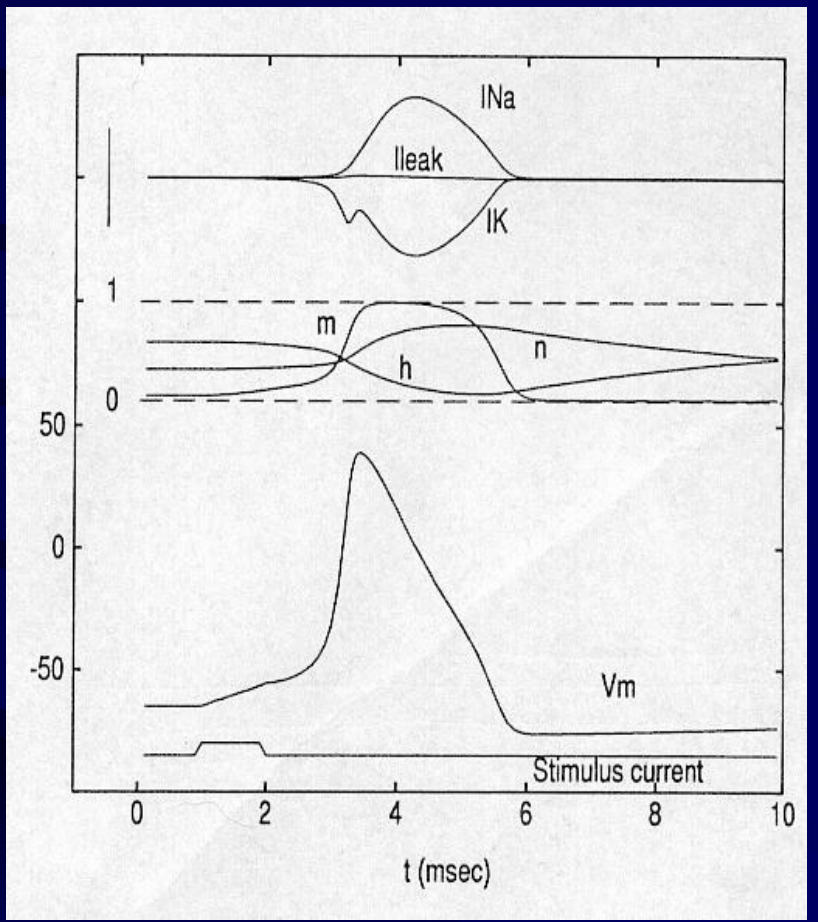


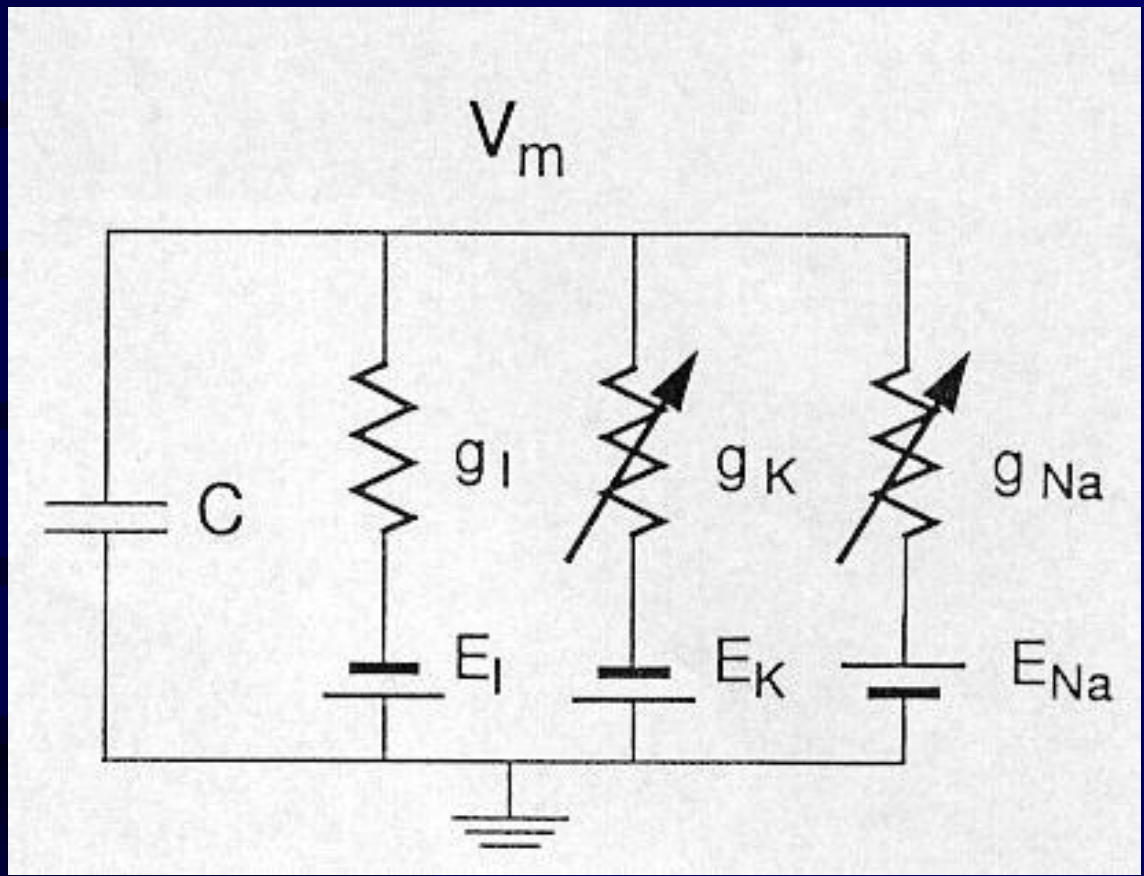
Neuron

The key unit of living beings for electric signal processing

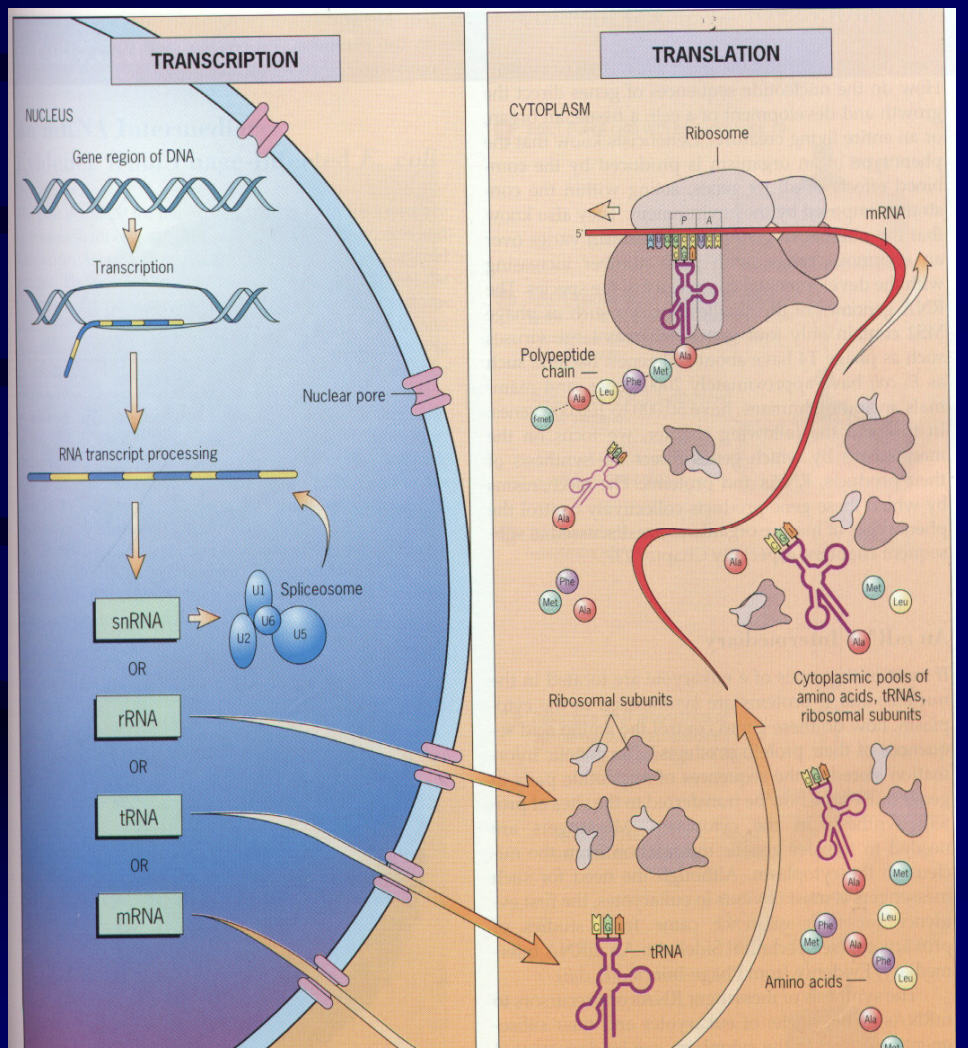
Nobel Prize in Medicine 1963: Hodgkin - Huxley




INa
Ileak
IK
1
m
h
n
0
50
0
-50
Vm
Stimulus current
0
2
4
6
8
10
t (msec)


V_m
C
g_l
g_K
g_{Na}
E_l
E_K
E_{Na}

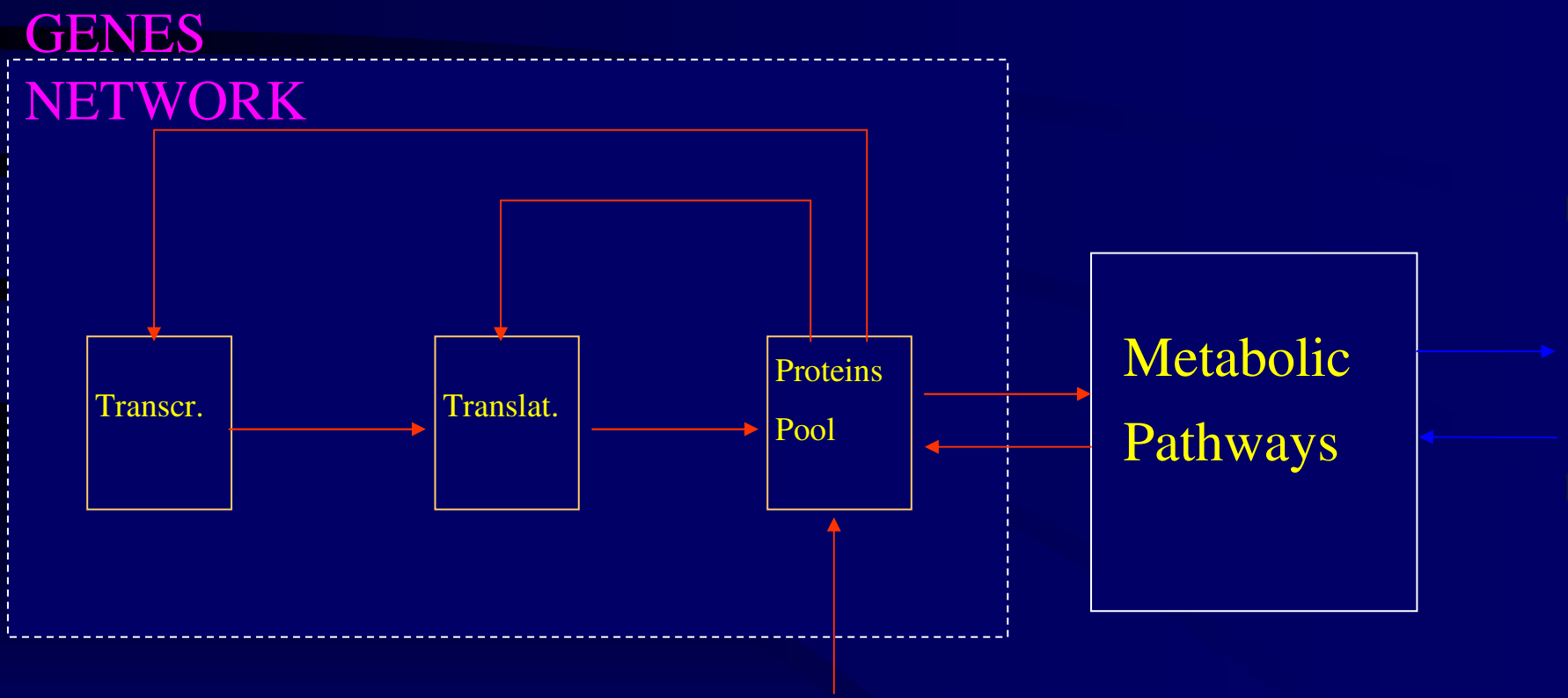
Molecular Biology



Cell

peptide

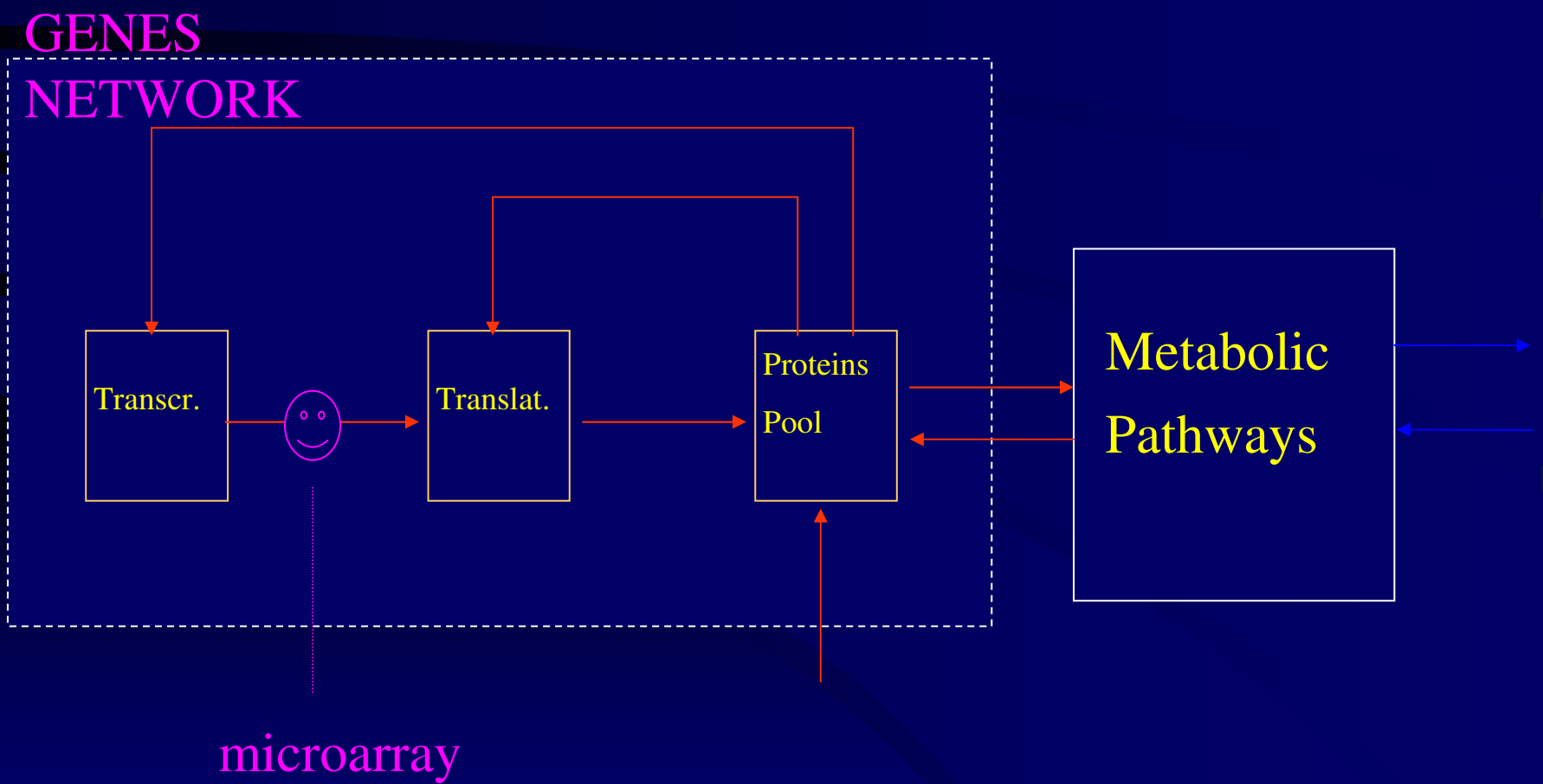
non peptide



Cell

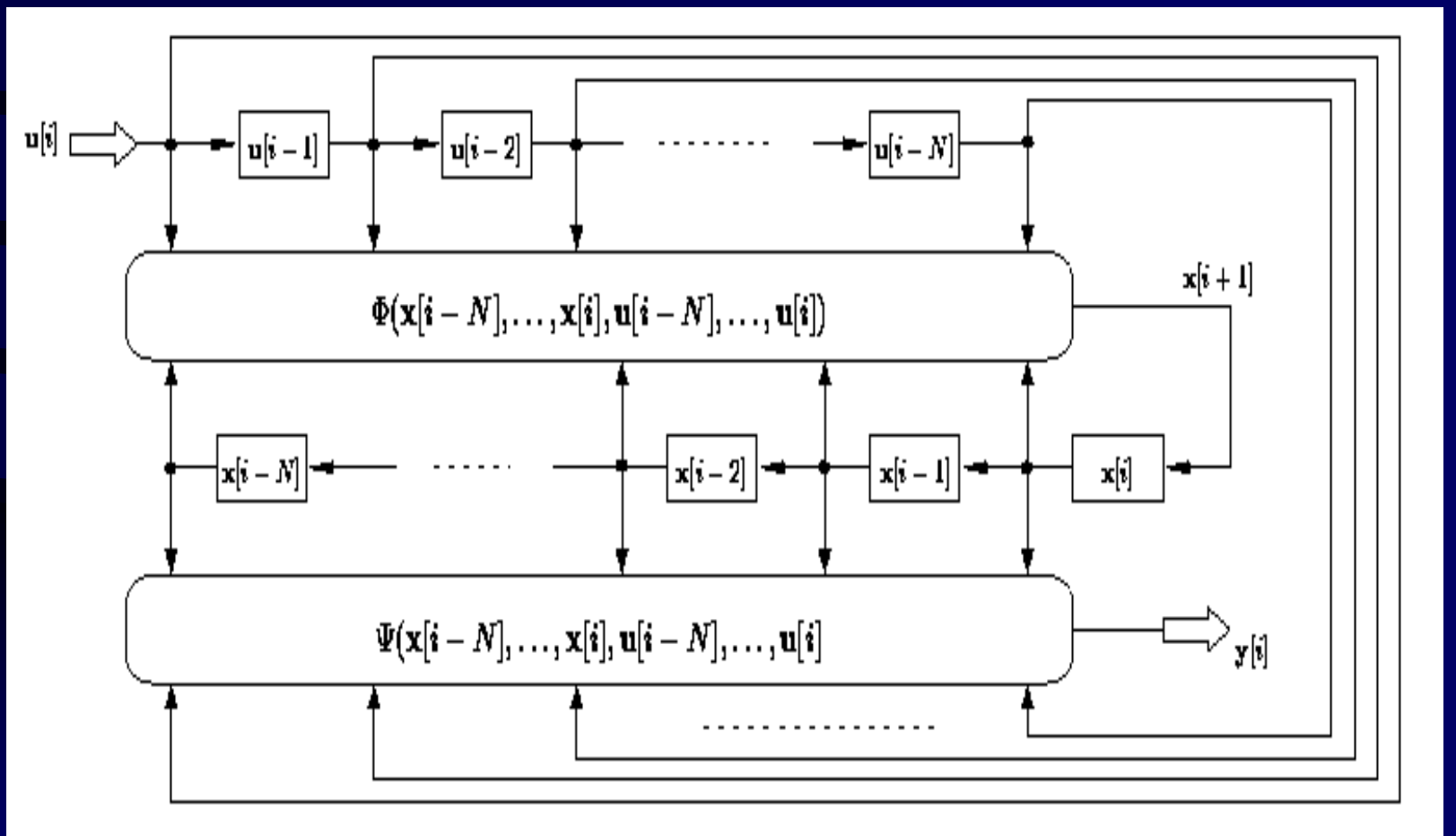
peptide

non peptide

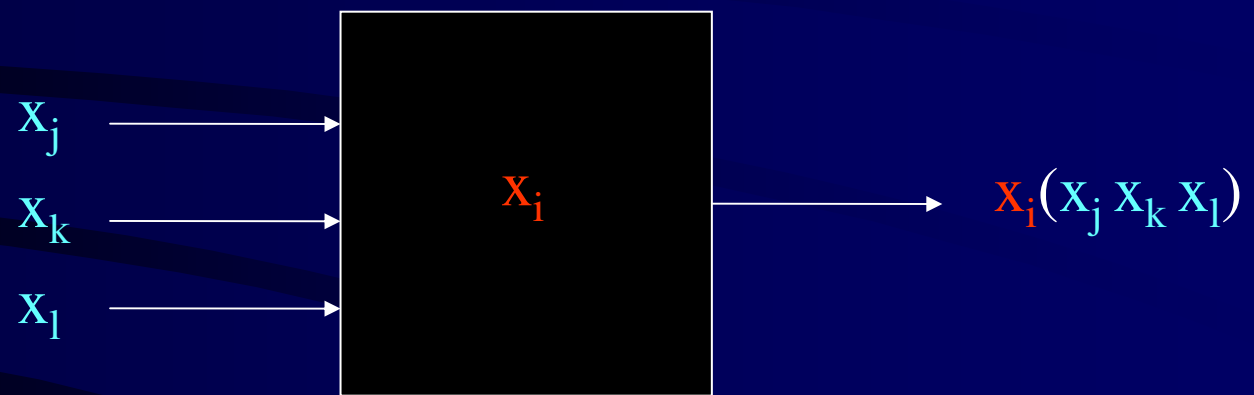


Dynamical System

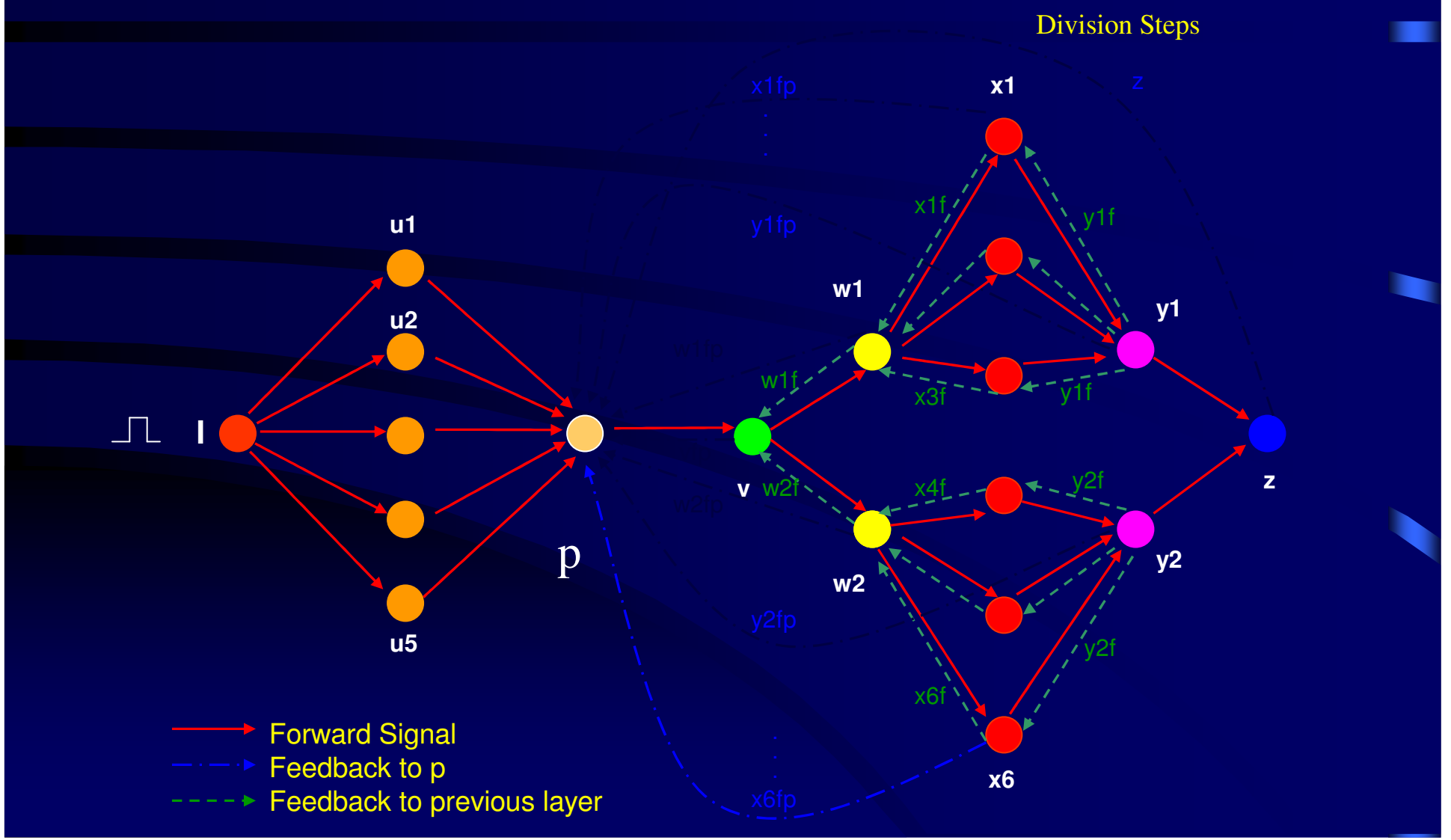
Graphical Interpretation

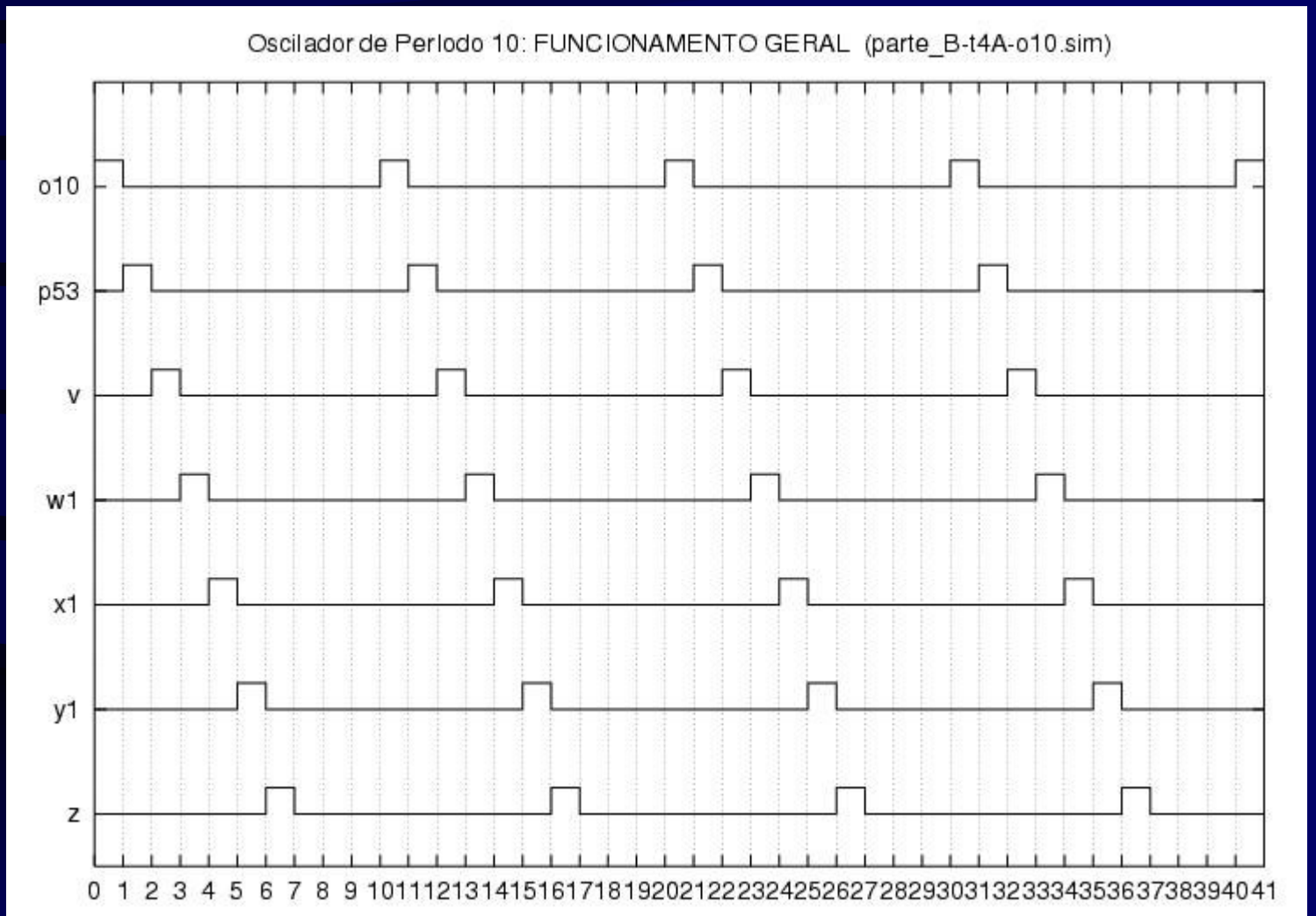


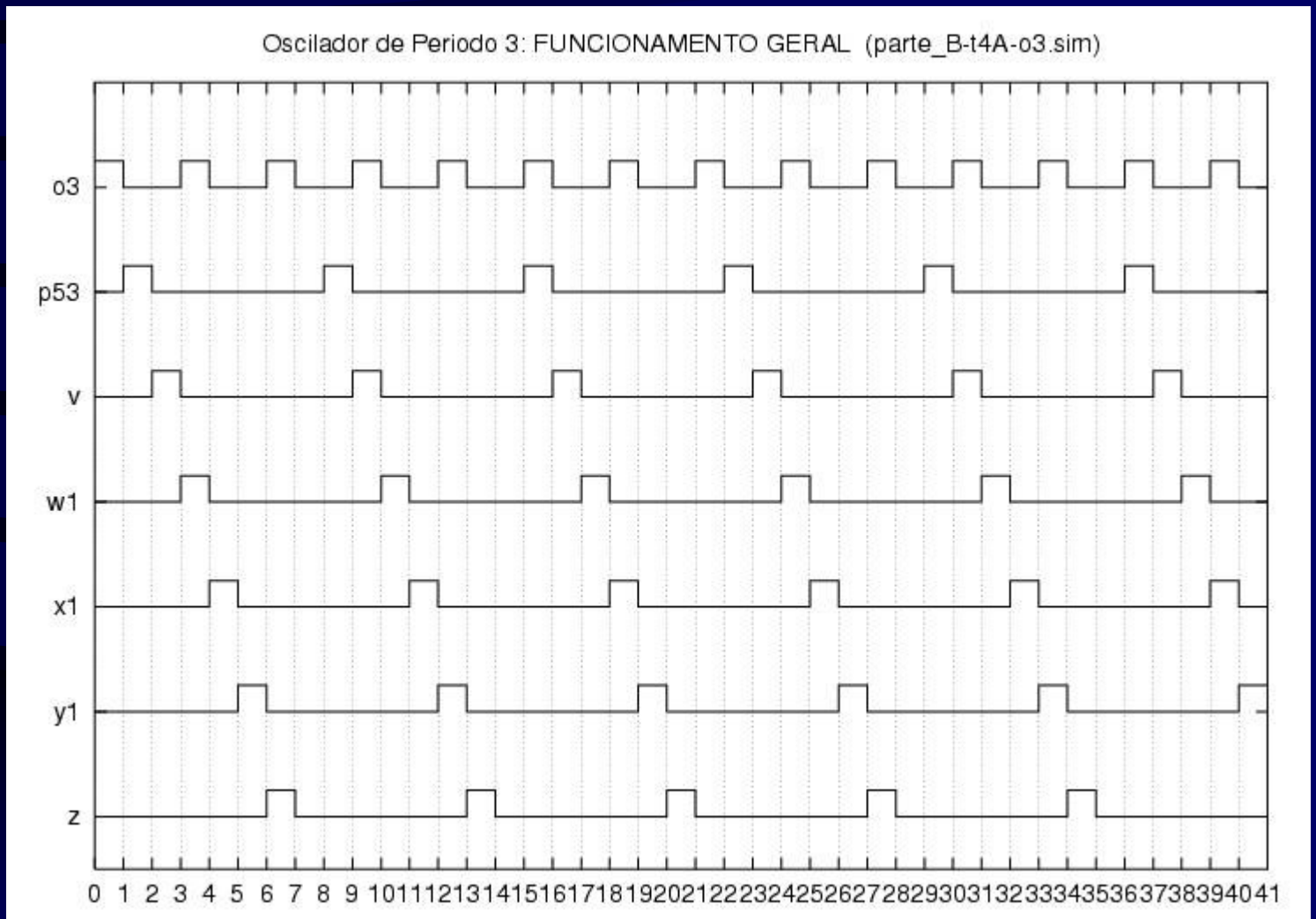
Deterministic System



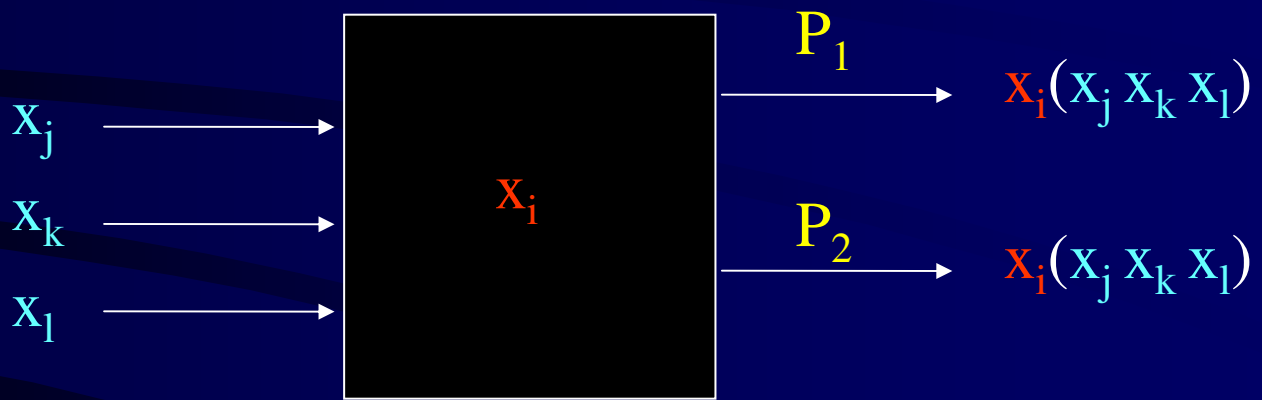
Cell Cycle Modeling




Oscilador de Perlodo 10: FUNCIONAMENTO GERAL (parte_B-t4A-o10.sim)
o10
p53
v
w1
x1
y1
z
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41


Oscilador de Periodo 3: FUNCIONAMENTO GERAL (parte_B-t4A-o3.sim)
o3
p53
v
w1
x1
y1
z
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41

Stochastic System



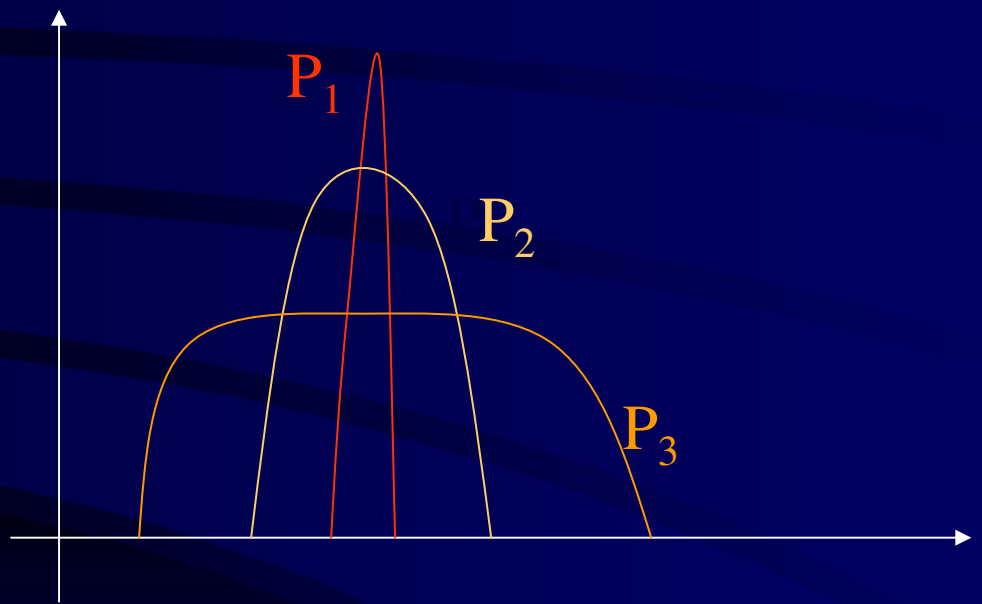
$P_1 + P_2 = 1$

Almost deterministic system: $P_1 >> P_2$

System Identification

Entropy

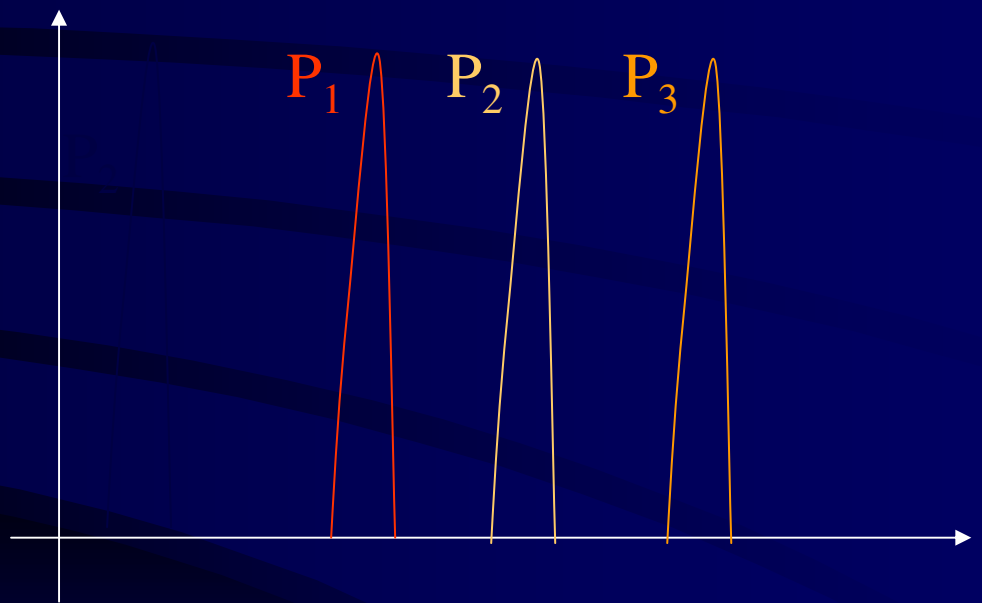
$$H(P) = -\sum p_i \log p_i$$



$H(P_1) < H(P_2) < H(P_3)$

Entropy

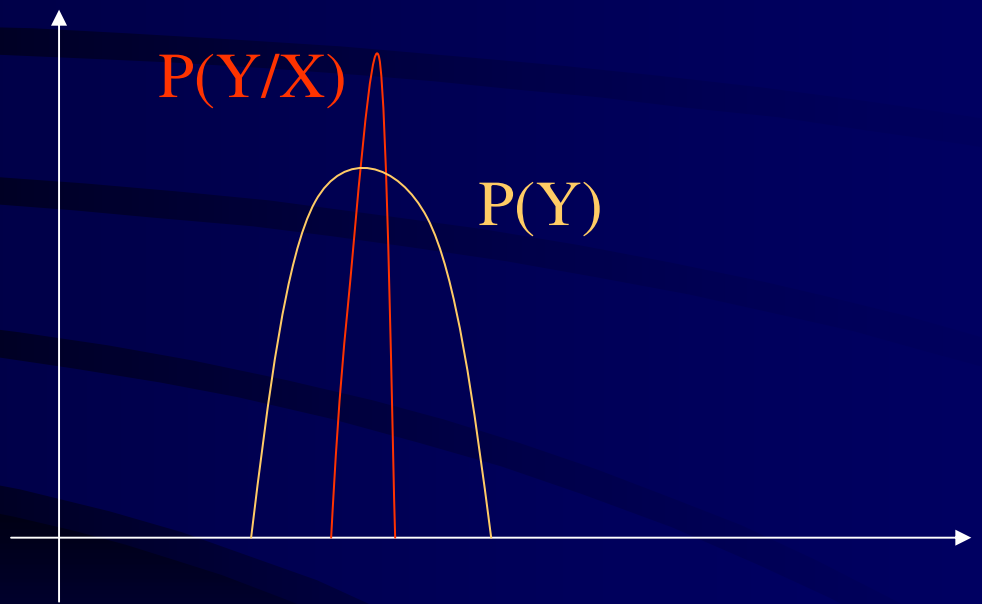
$$H(P) = -\sum p_i \log p_i$$



$H(P_1) = H(P_2) = H(P_3)$

Mutual information

$$I(X,Y) = H(Y) - H(Y/X)$$



H(Y/X) < H(Y)

Mean conditional entropy

$$E[H(Y/X)] = -\sum P(X) \sum P(Y/X).\log(P(Y/X)).$$

Mean mutual information

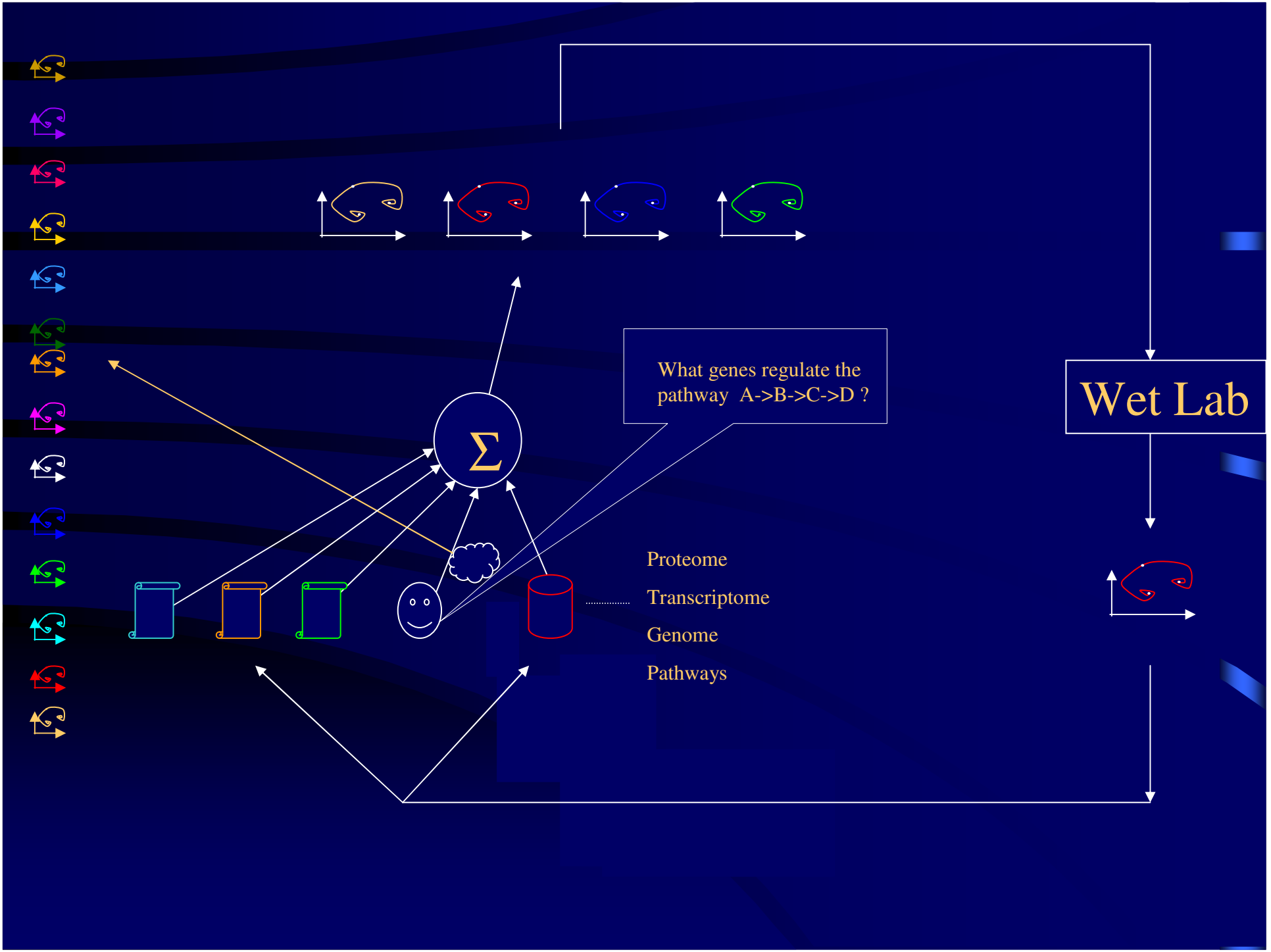
$$E[I(X,Y)] = H(Y) - E[H[Y/X]]$$

Mean mutual information estimation

$$\hat{E}[H(Y/X)] = -\sum \hat{P}(X) \sum \hat{P}(Y/X) \log(\hat{P}(Y/X)).$$

$$\hat{E}[I(X,Y)] = \hat{H}(Y) - \hat{E}[H(Y/X)]$$

Knowledge discovery in Biology


What genes regulate the pathway A->B->C->D ?
Wet Lab
Σ
Proteome
Transcriptome
Genome
Pathways

The life cycle of the malaria parasite