Challenges of Bio-Nanotechnology

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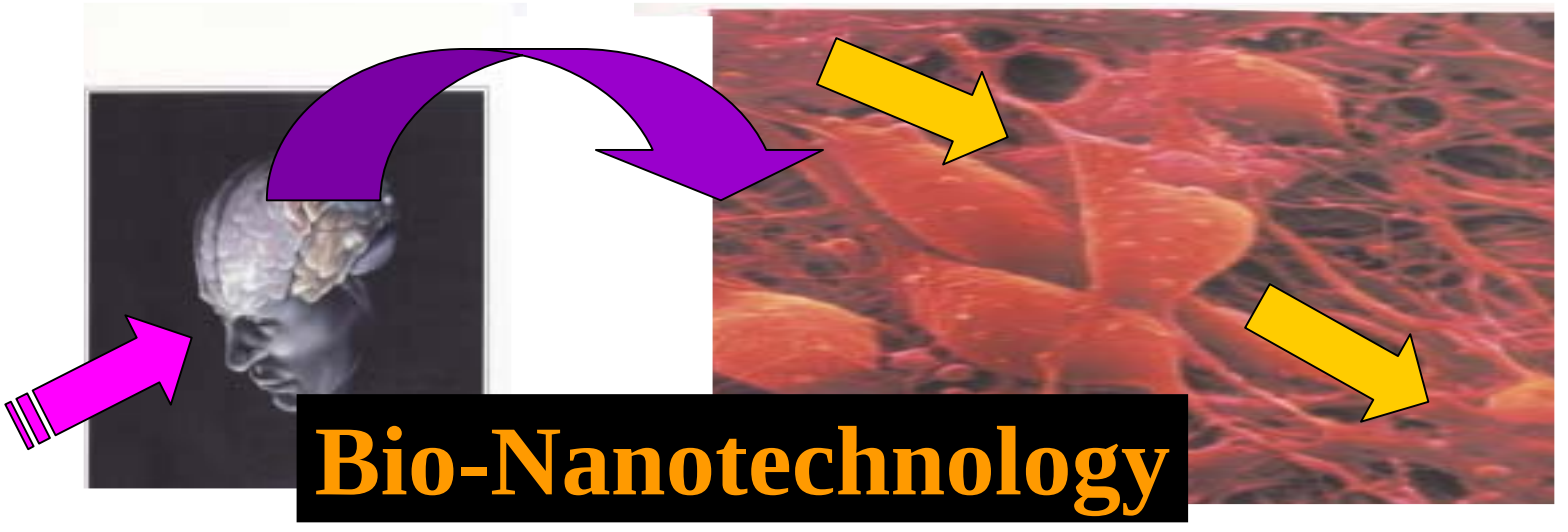
Explore the Biological Information World



Bio-Nanotechnology

Stimulation

Biological Information World

Inter-cellular Information Networks

Brain, Sensory, Nerve, Immune, and Excretary Systems

Intra-cellular Information Networks

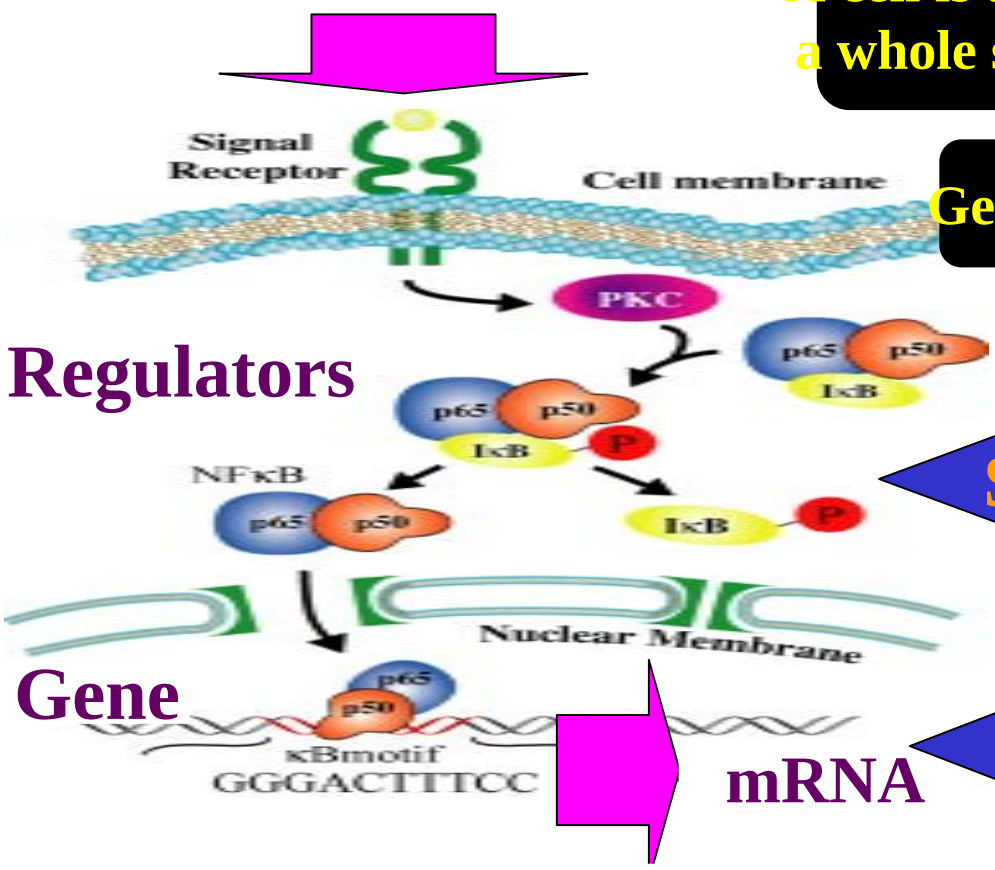
Signal Transducing Networks, Genome Networks

Nanotechnology Unveils How Biological Information Is Processed

Input Signal

A cell is a minimum unit of life, containing a whole set of information networks.

Gene Information is stored in DNA.



Regulators

Signal Transduction

How ?

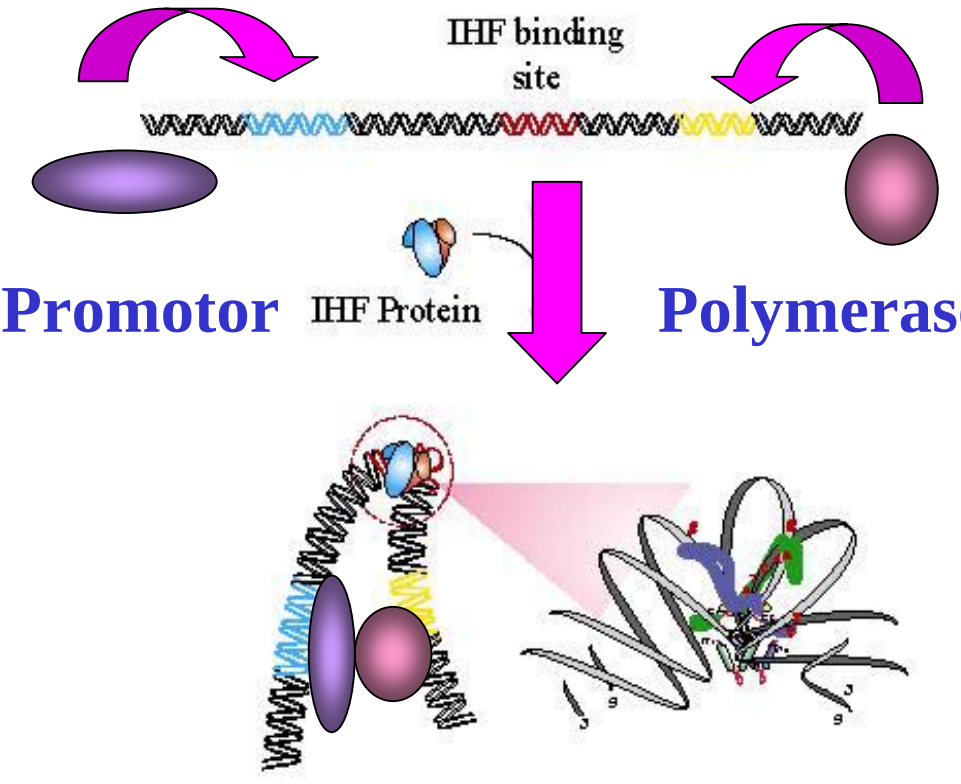
Gene Expression

mRNA

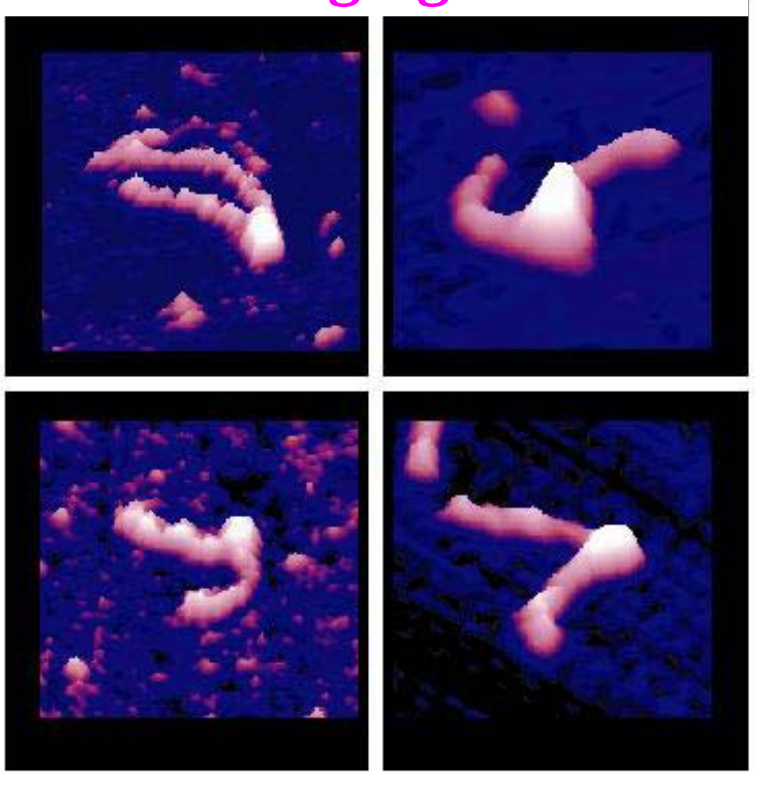
Transcription

When ? How ?

DNA Nano-structure Change Proven inTranscription by Single Mol. AFM Imaging

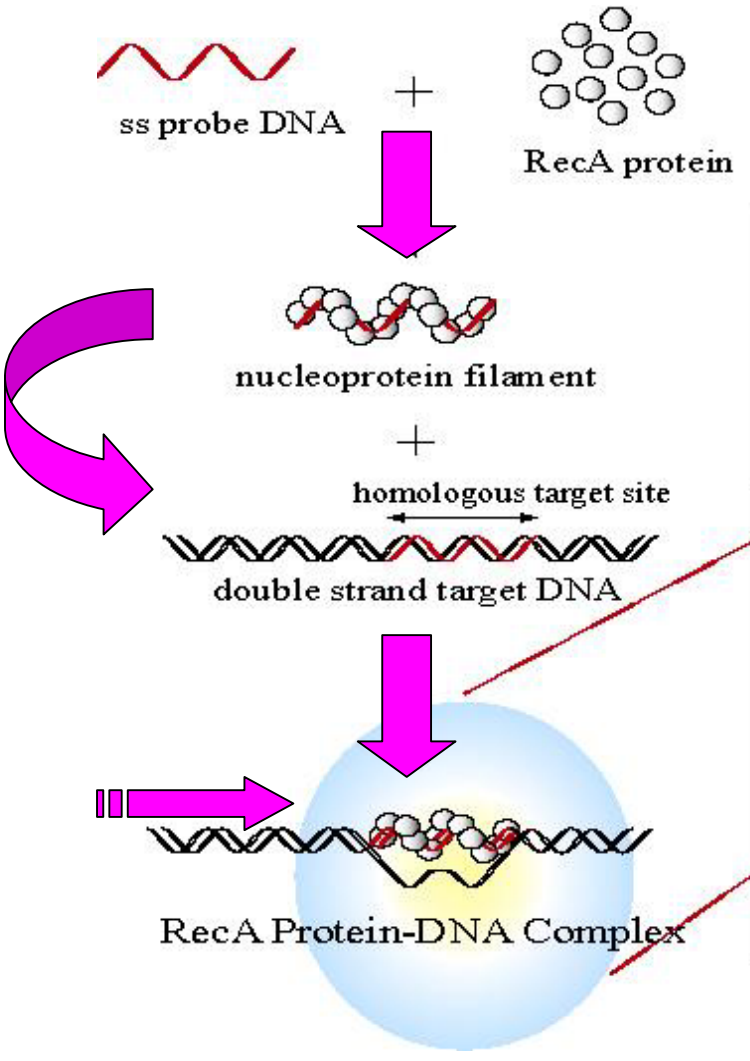


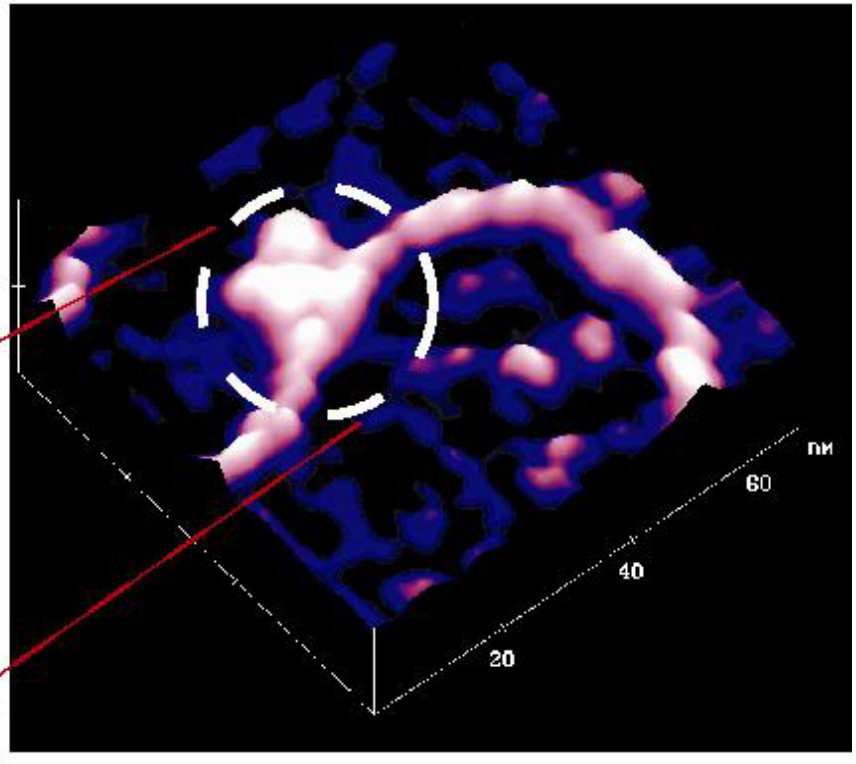
AFM Imaging of DNA



Biochem. Biophys. Res. Commun., 291, 361-366 (2002)

RecA Protein Slides along a DNA Chain





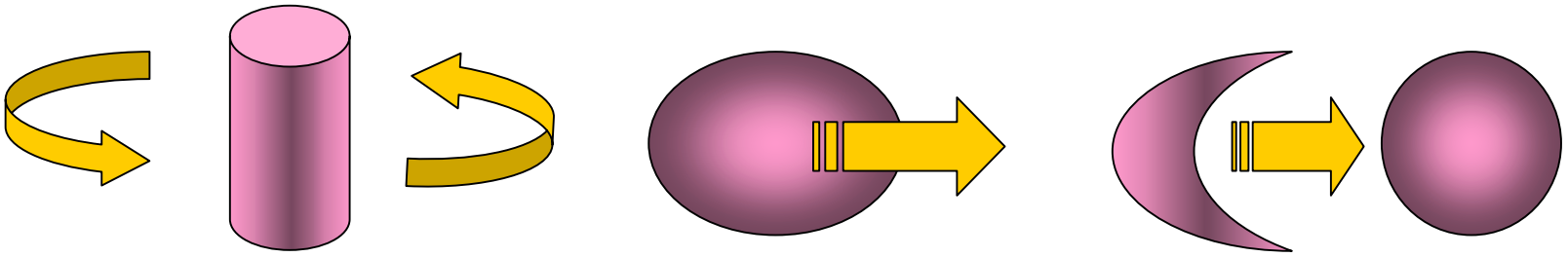
Anal. Chem., 72 (6), 1288-1293 (2000)

Biological Information Processed by Nano-structure Changes of Molecules

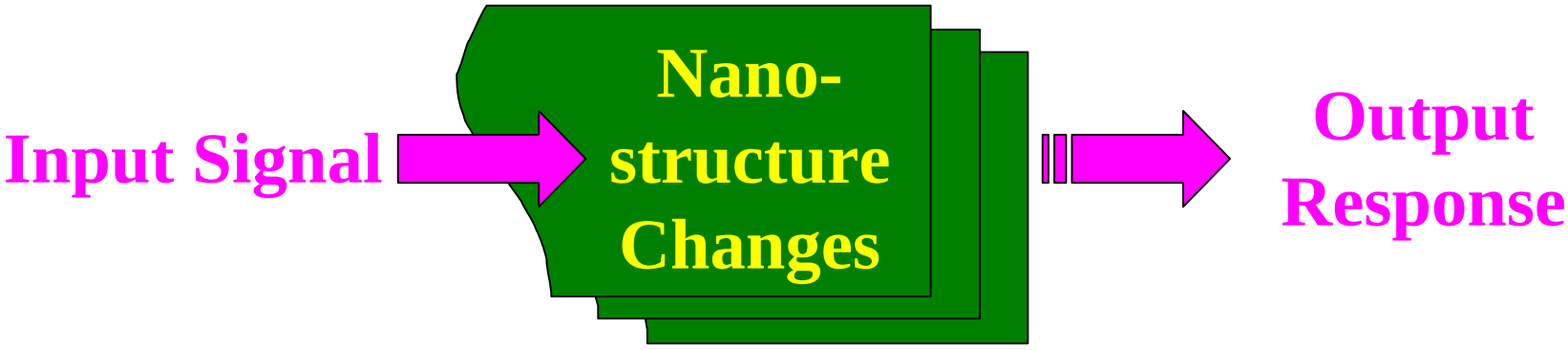
Molecular Rotation

Translation

Conformation Change

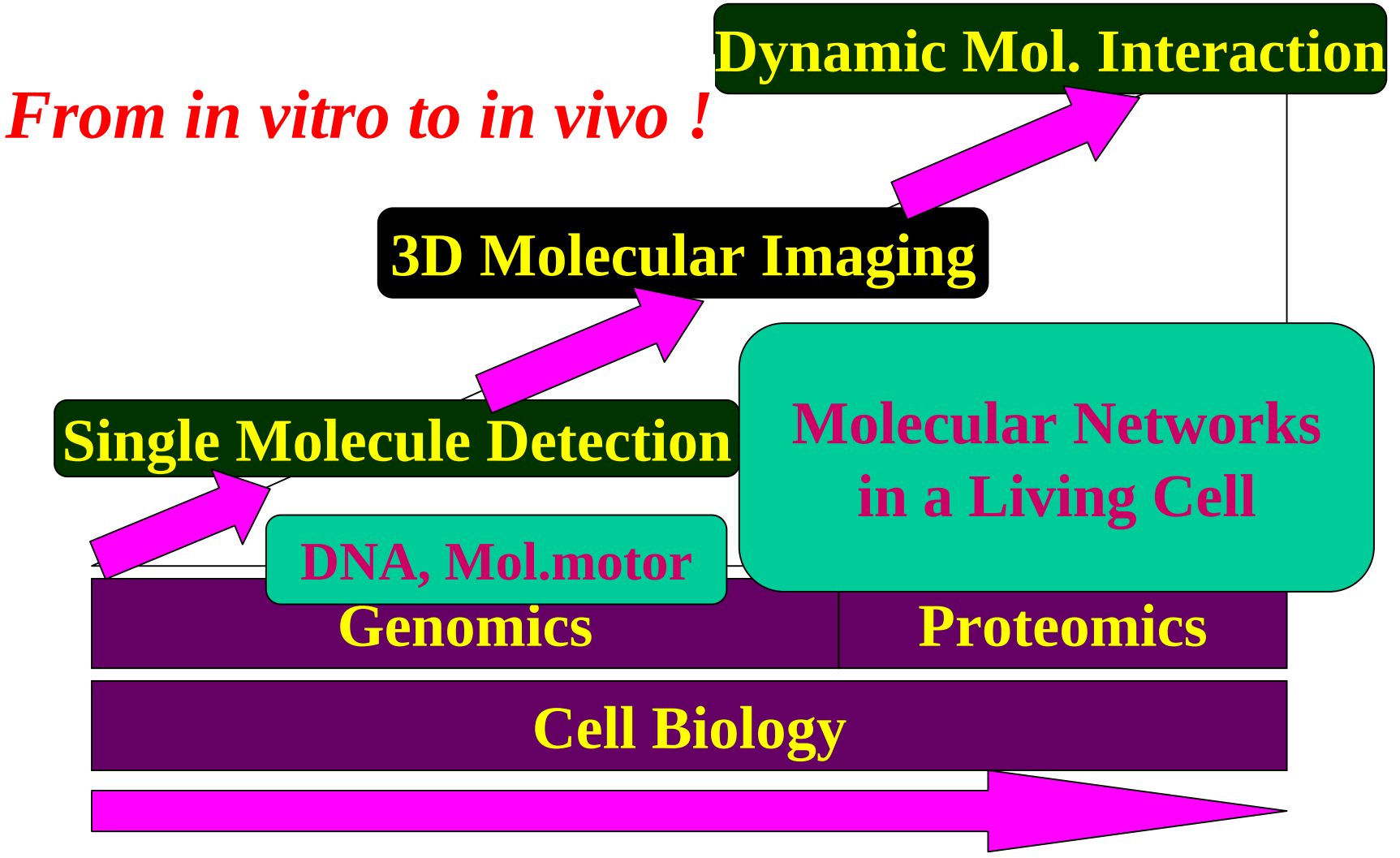


Molecular Computing !

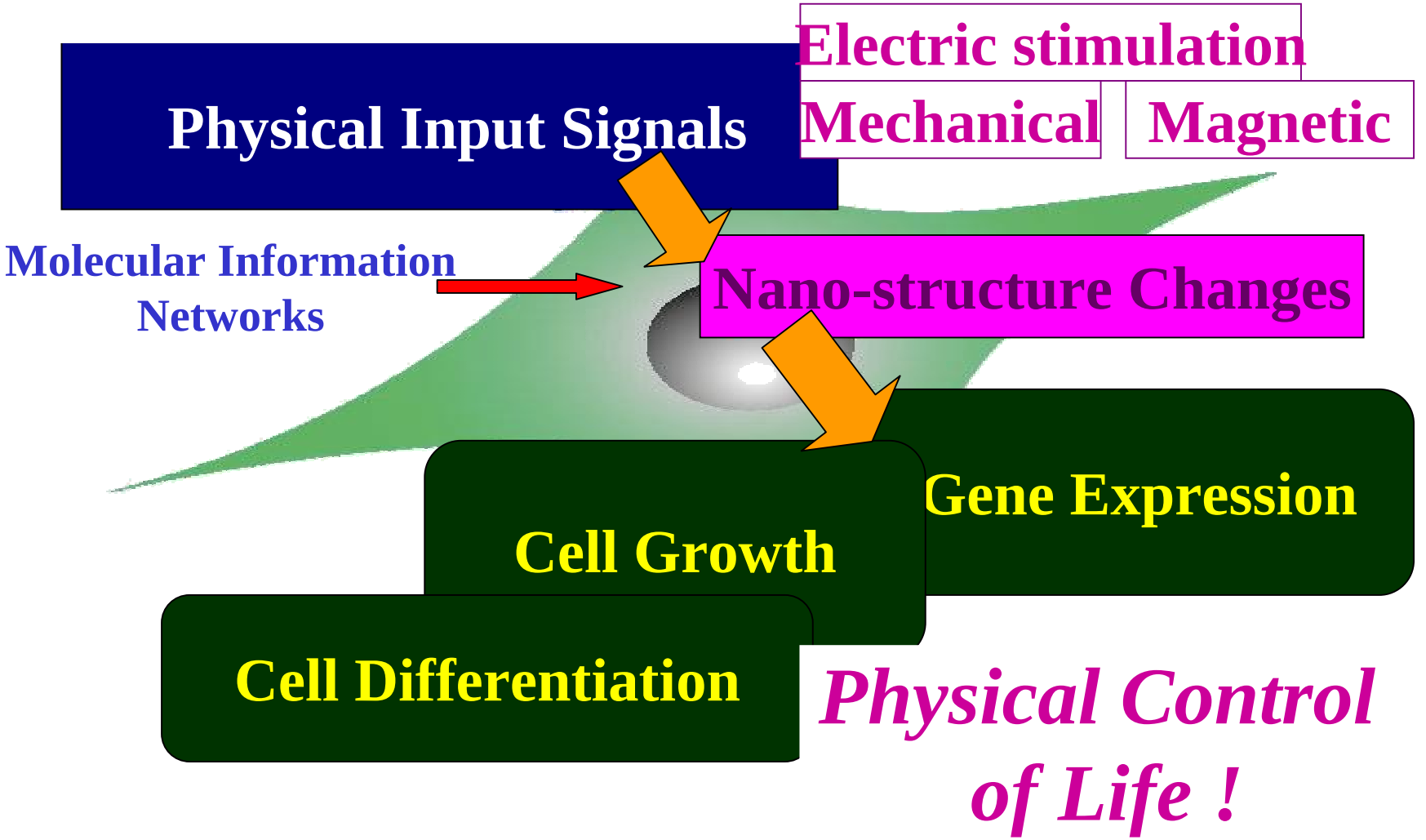


Different from Electronic Computing

Where to go ?
Bio-Nanotechnology Measurements

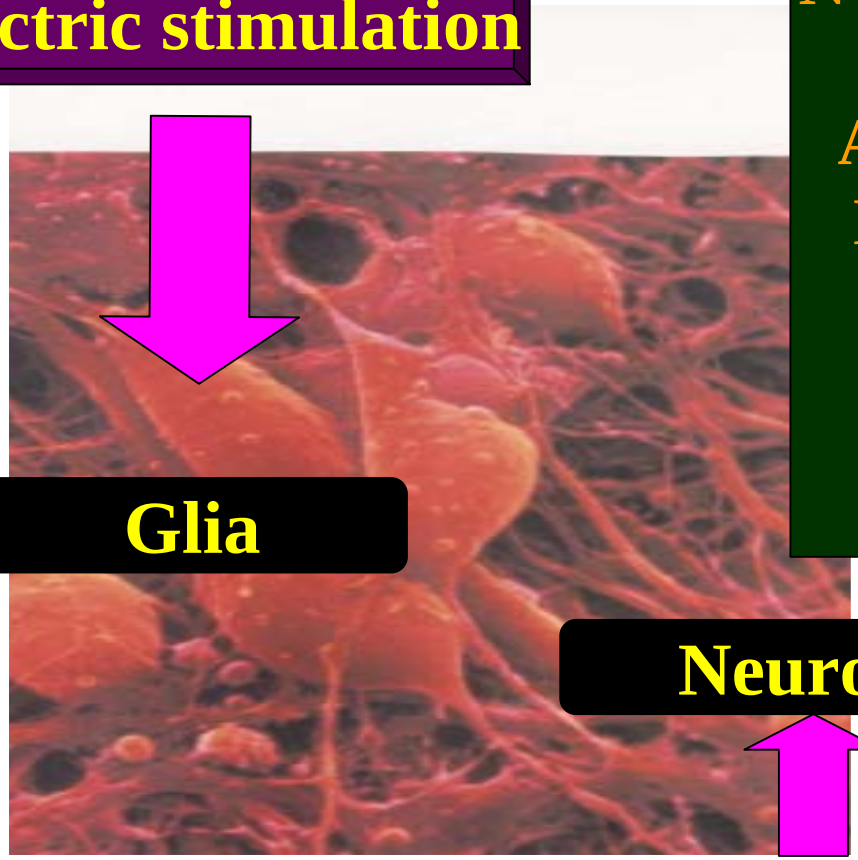


Challenging Physical Control of the Biological Information Processing



Discovery of Electrically Controlled Gene Expression in a Living Cell

Electric stimulation



NGF gene at resting stage

Activation of NGF gene Expression by Electric Stimulation

Excretion of NGF

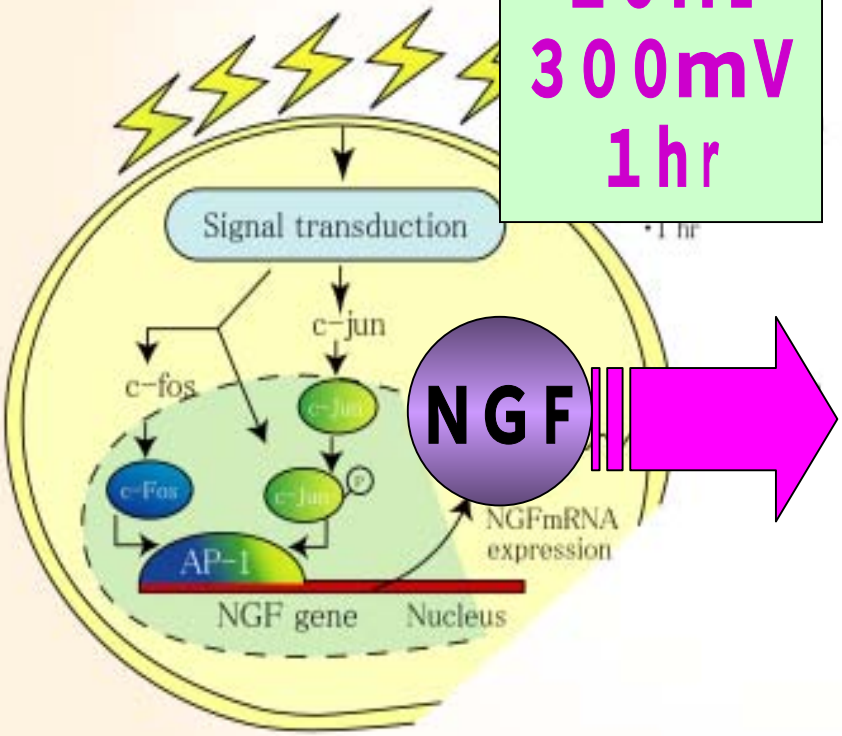
Glia

Neuron

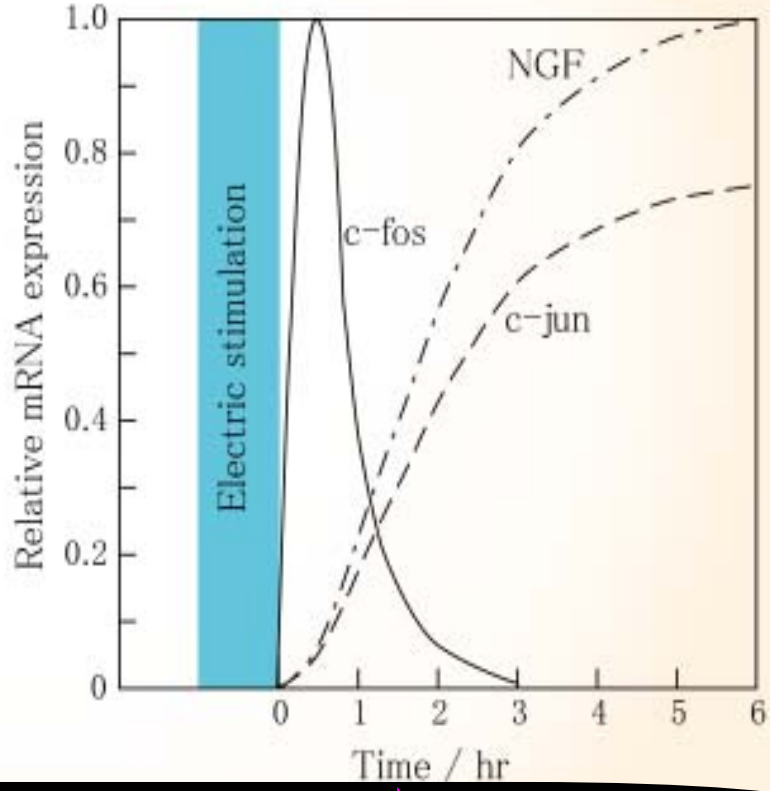
Excreted Nerve Growth Factor (NGF)

NGF Gene is Electrically Activated

10Hz
300mV
1hr

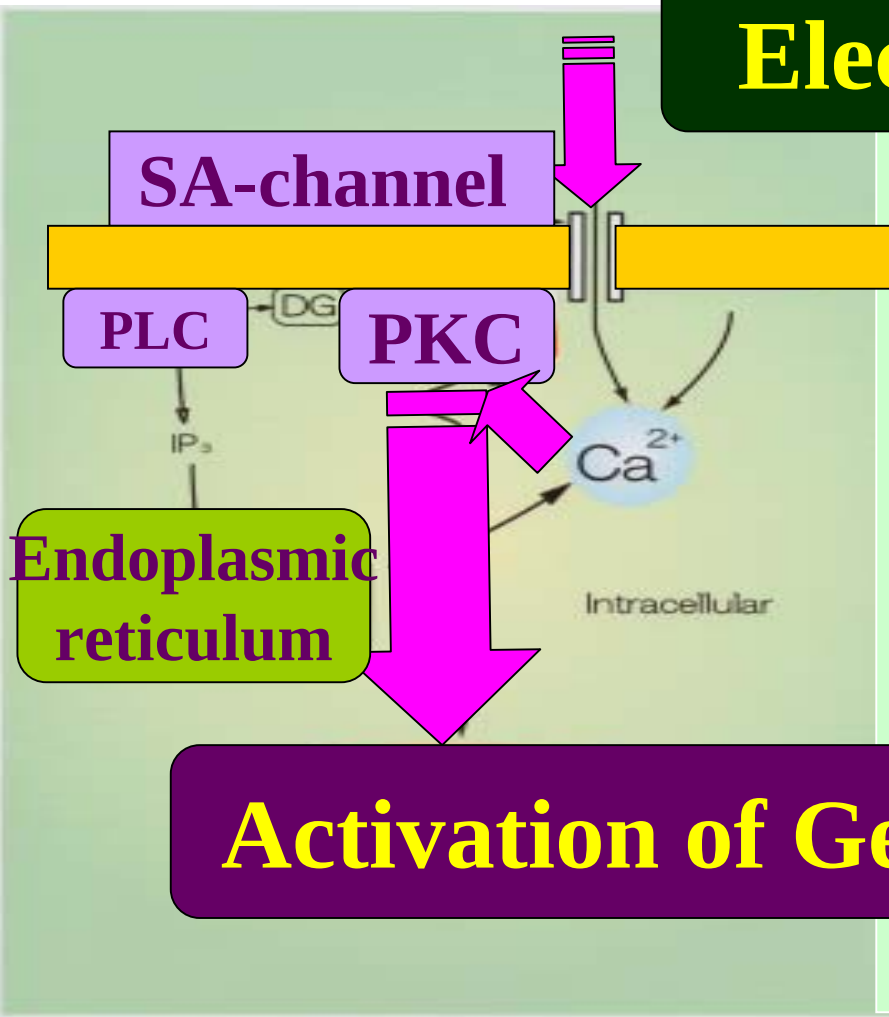


Nature Biotech., 15, 164 (1997)



NGFGene → NGFmRNA → NGF

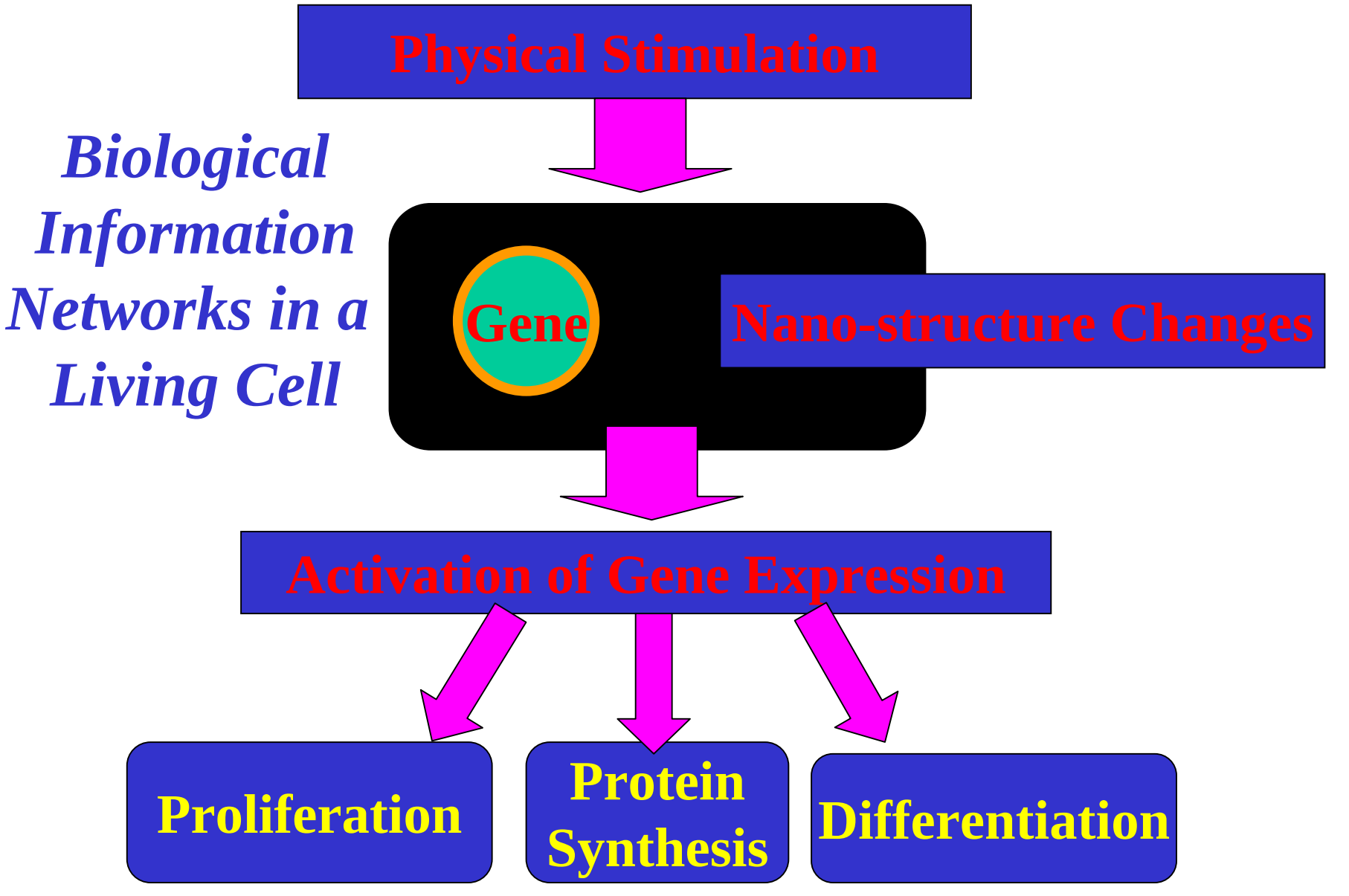
Postulated Cellular Response Mechanism



Electric stimulation

Activation of hsp promotor

Activation of Gene Expression


Physical Stimulation
Biological Information Networks in a Living Cell
Gene
Nano-structure Changes
Activation of Gene Expression
Proliferation
Protein Synthesis
Differentiation