

# Emerging trends in Synthetic Biology

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**CENTRE FOR SYSTEMS  
AND SYNTHETIC BIOLOGY**

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Biological Systems are  
**noisy** and **unpredictable**

To design well behaved systems we need  
**standards** and **rules** of composition

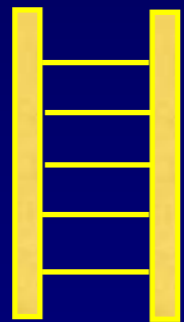
Engineering Standards do not exist in biology

Organisms did not evolve  
to solve human problems

top down



cell



ground up

traditional approach

decompose the system  
one-part-at-a-time

KEY IDEA: CONTROL

compose the system  
one-part-at-a-time

engineering approach

# Synthetic Biology

Rational design, Construction,  
Control leading to useful applications

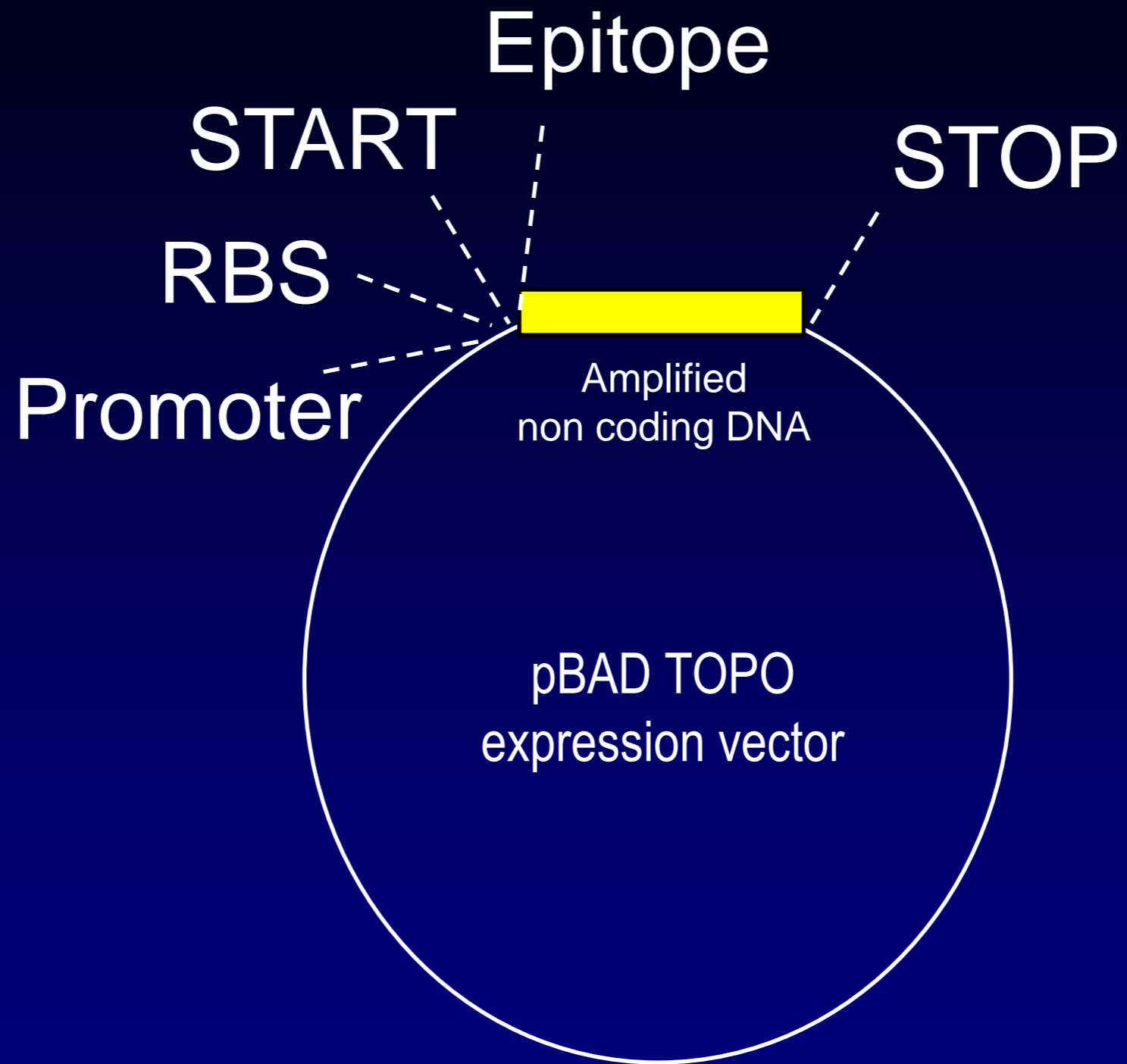
We are reasonably good in making ...

**junk** out of genes

point mutations  
knock downs  
knock outs

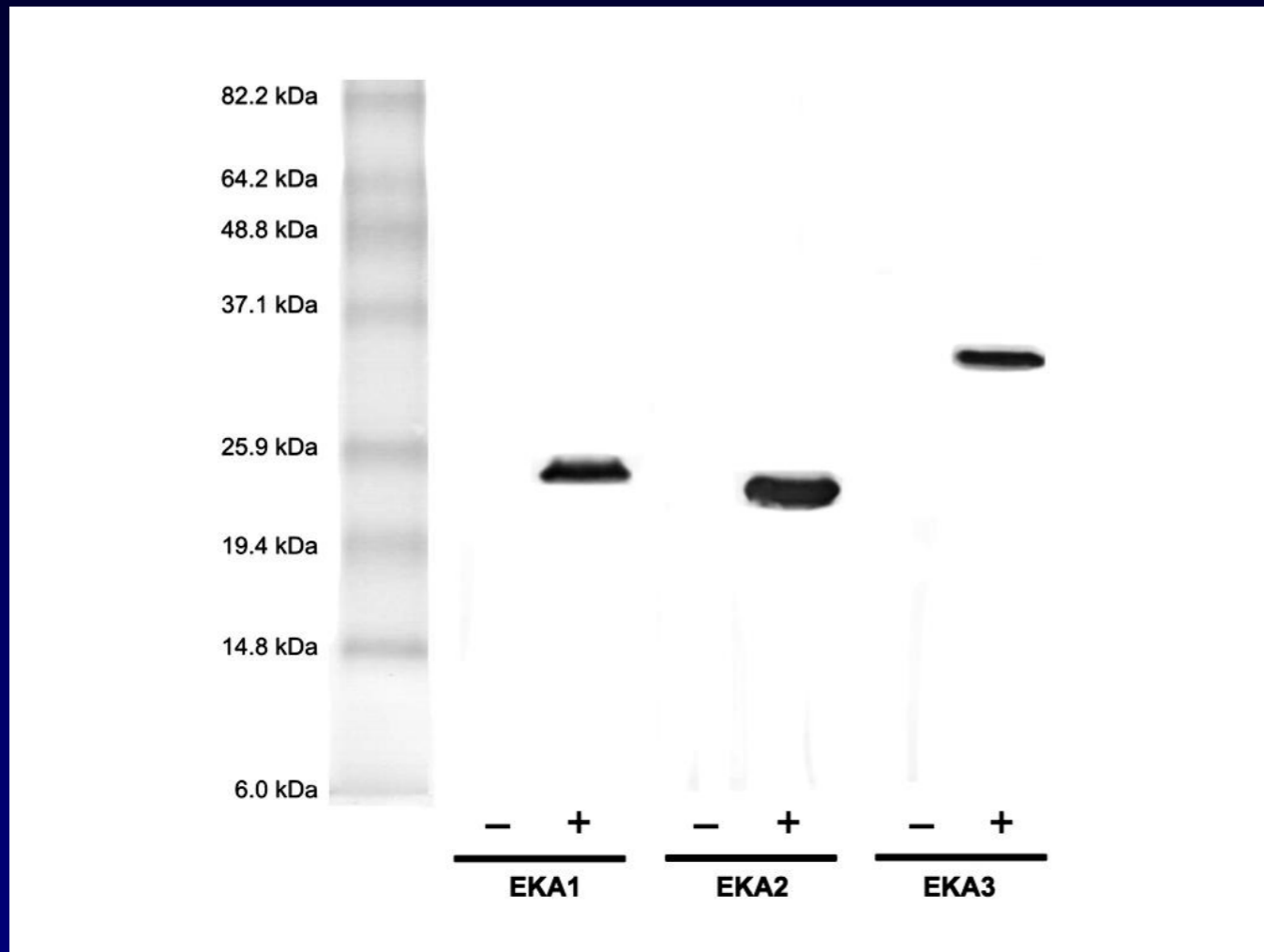
Q: Can we 'reclaim' the junk DNA ?

E.coli intergenic regions  
with no evidence  
of transcription

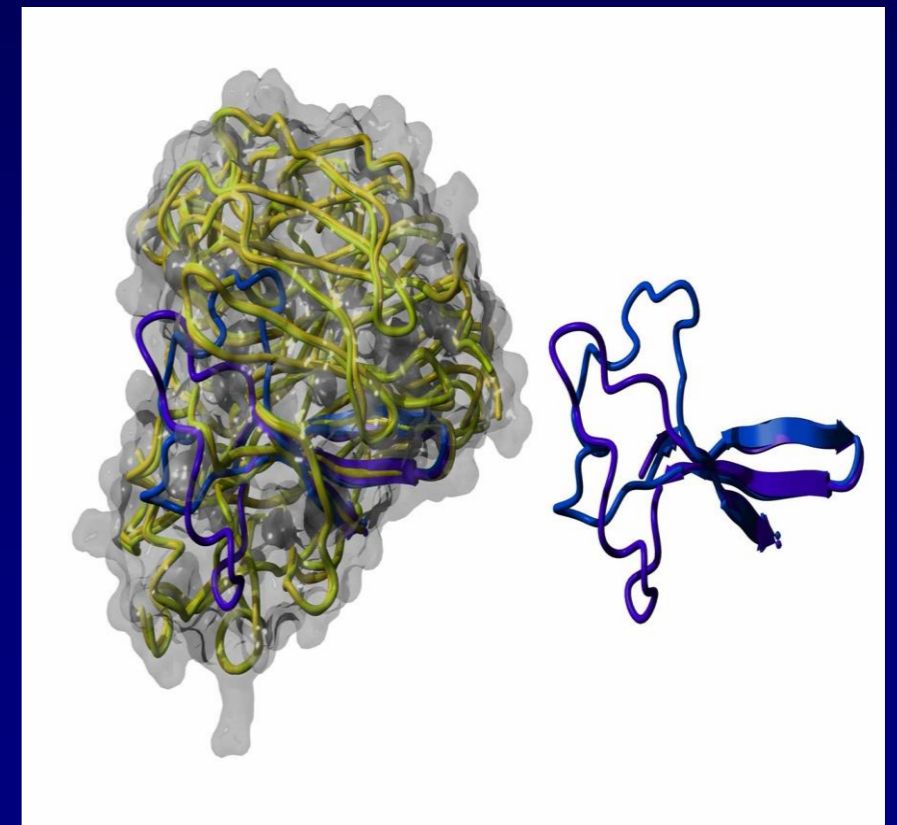
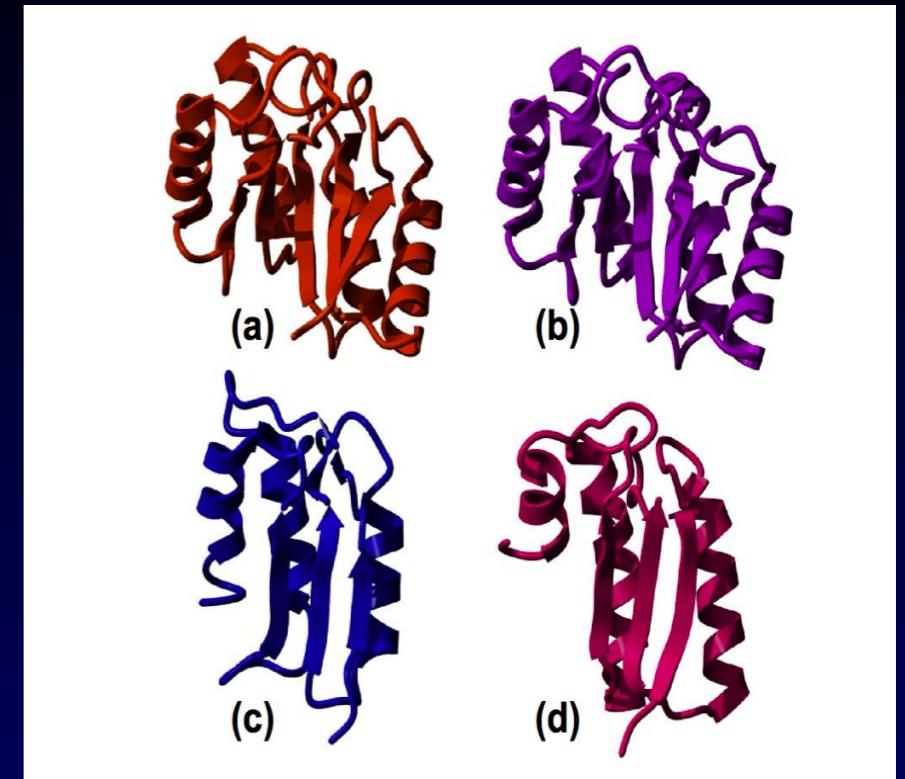


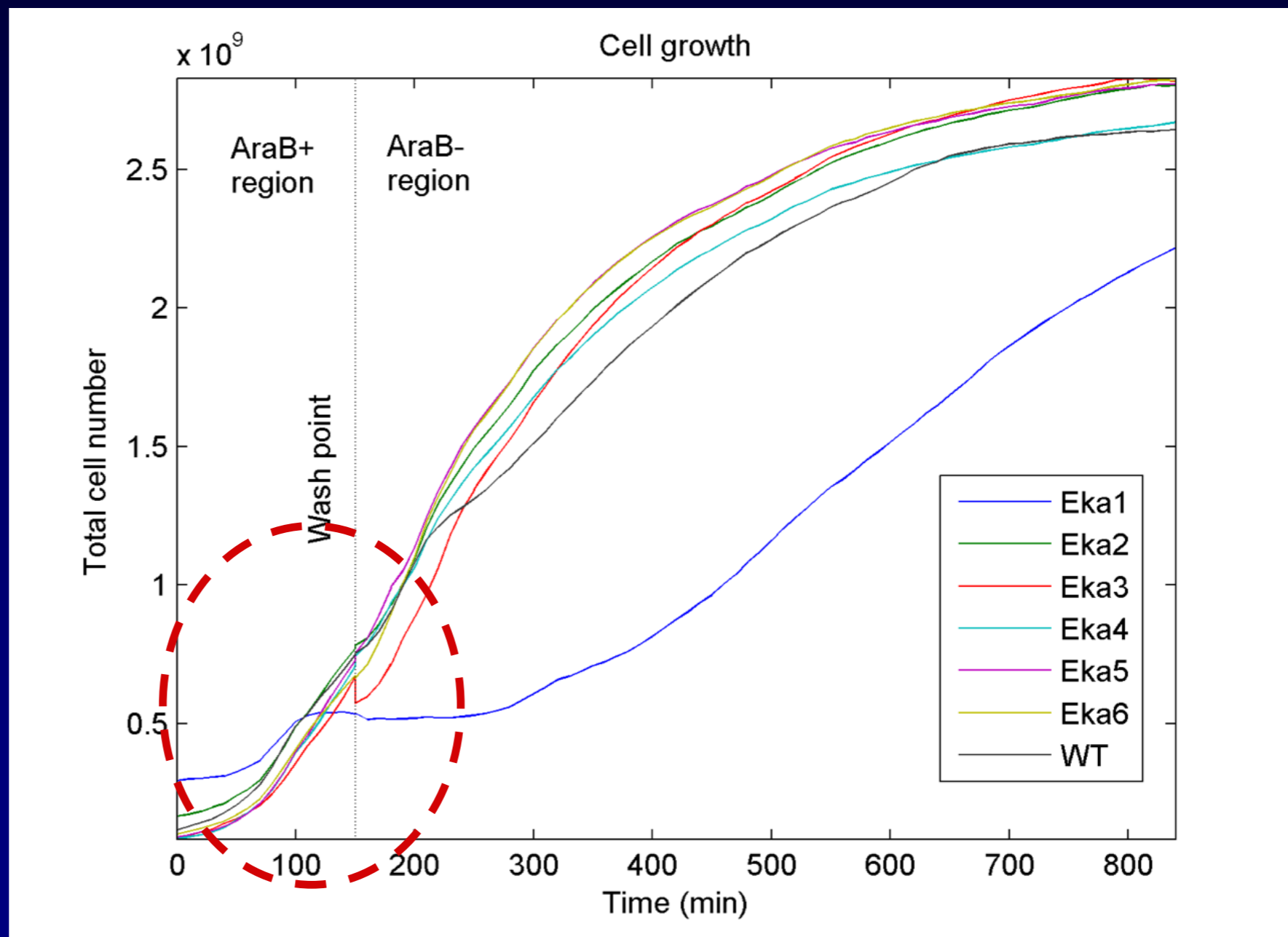
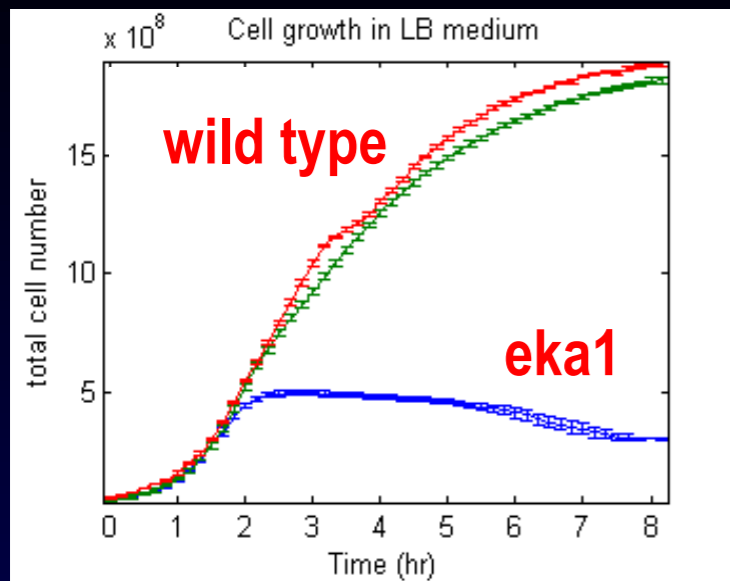


made six protein coding genes  
from non-coding DNA



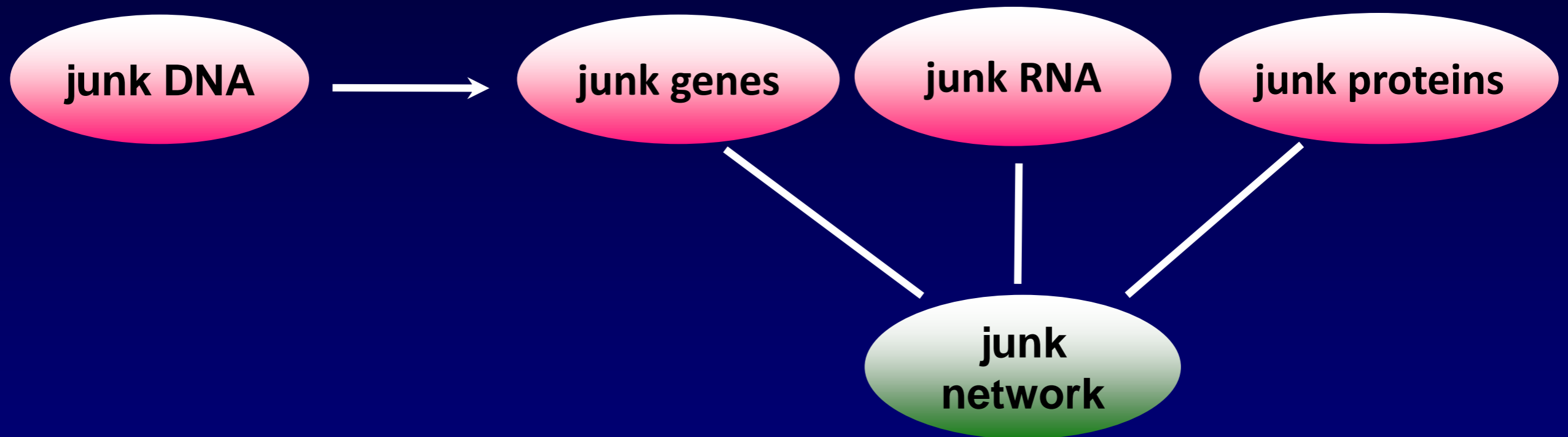
**Western Blot**  
(using His tag)





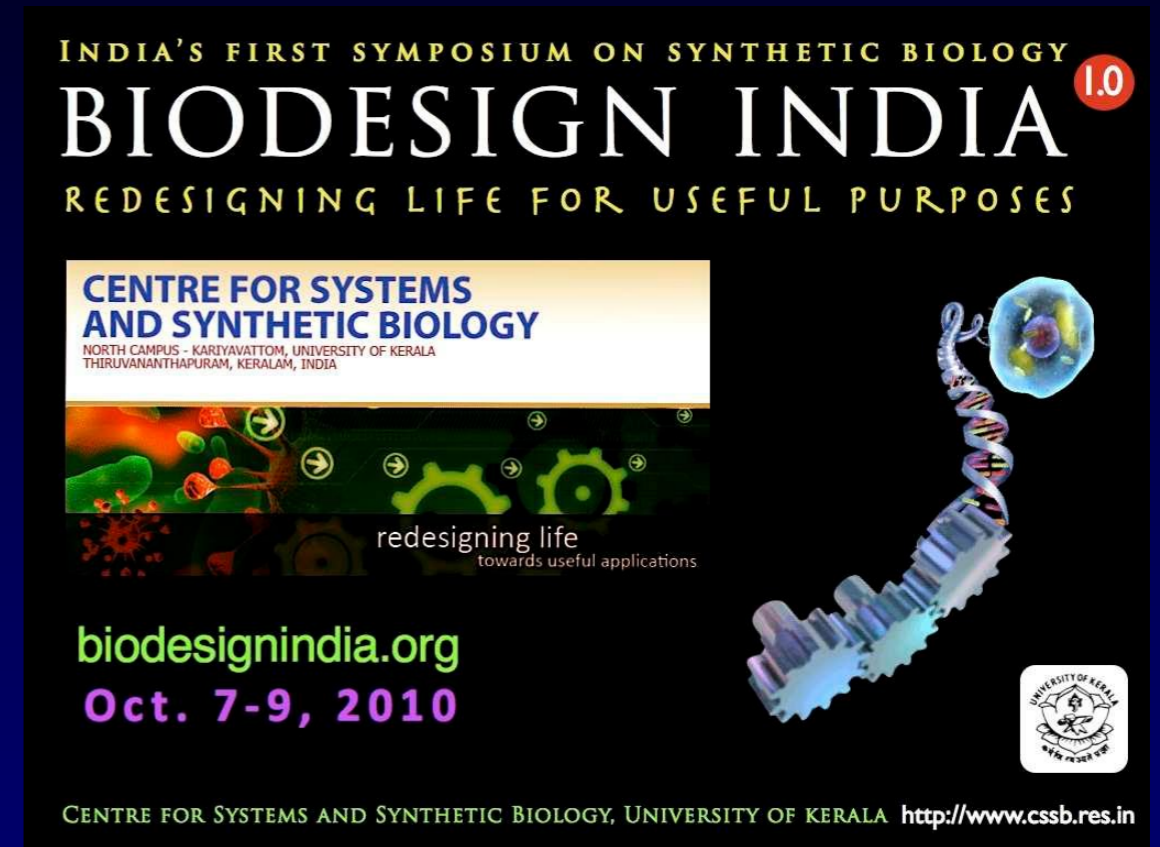
# Junkomics

a new way of  
doing biology...



# Scenario in India

1. Promoter design
2. Oscillators
3. Cell specific targeting
4. DNA self assembly
5. Biofuel (Jatropha)
6. Isoprenoid biosynthesis
7. Ethical, safety & legal guidelines



outcome: Wiki based management of synthetic biology research in India

Biodesign India 2.0  
IIT Madras (Dec.2011)

BioDesign India 3.0  
IIT Delhi (Dec. 2012)

# Global scenario

# TECHNOLOGY

Trends 2000 - 10

long DNA synthesis

whole genome cloning

bioCAD platform

Predictions 2010 – 20

Faster, cheaper DNA  
synthesis technologies

whole genome cloning

Automated Design of  
Pathways

# BIOLOGY

## Trends 2000 - 10

switches  
cascades  
bio bricks  
oscillators  
spatial patterns  
non-natural parts  
pulse generators  
time delayed circuits  
artificial chromosome  
bacterial synthetic cell  
whole genome transplantation

## Predictions 2010 – 20

synthetic chromosomes  
alternative genetic codes  
registry of non-BioBricks  
RNA structural engineering  
kinetic model of promoters  
contextual Bio Rule Library  
predictive genome engineering  
custom designed genetic circuits  
application oriented synthetic cells

# GENERAL

## Trends 2000 - 10

Few Centers of Excellence

iGEM, Genocon

Biology through rDNA

Low Speed, High Cost

## Predictions 2010 – 20

Masters and PhD programs in Synthetic Biology worldwide

Many non BB initiatives in Europe and Asia

Biology through synthesis

High Speed, Low Cost



# FRUSTRATIONS

Trends 2000 - 10

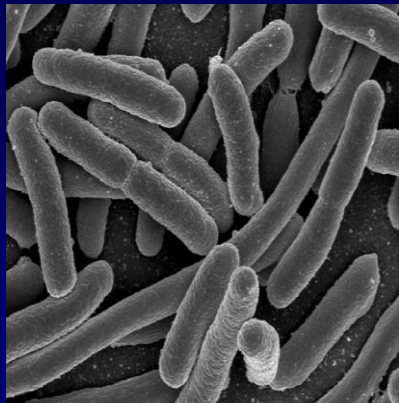
Lack of absolute  
control

Predictions 2010 – 20

Lack of absolute  
control

# THE KEY BWC CONCERN

In future are we going to see some people firing microbes as bullets ?



.. bullets that think !

BIG CHALLENGES, UNCLEAR ROADMAP, FEAR OF THE UNKNOWN

Biological and Toxin  
Weapons Convention  
Beijing, Oct.30-Nov3, 2010

**Thank you !**

**Sun does not  
wait for an  
auspicious  
moment to rise**

