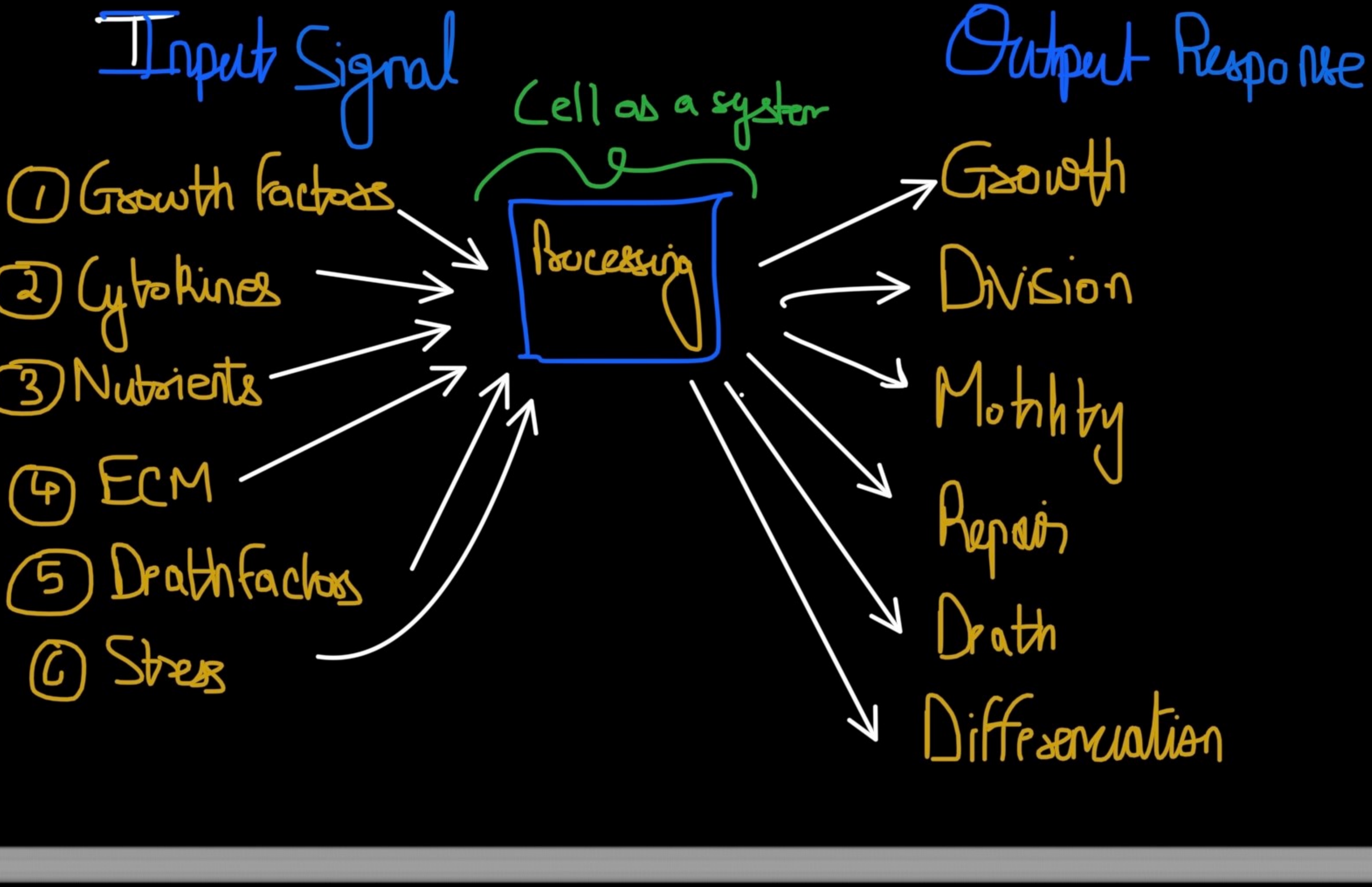
1

09/10/20
Systems Thinking



4 forms of signals

1. Contact Dependent
2. Paracrine
3. Synaptic
4. Endocrine

Subsystems in cell

1. Sensing
2. Signaling : Carries info from surface to inner parts
3. Regulation
4. Metabolism : Glucose production can under different forms..

Systems:

Bacterial Cell:

- Plasma membrane → Flagellum to search, sense, move
- Cell Wall
- Ribosomes
- DNA

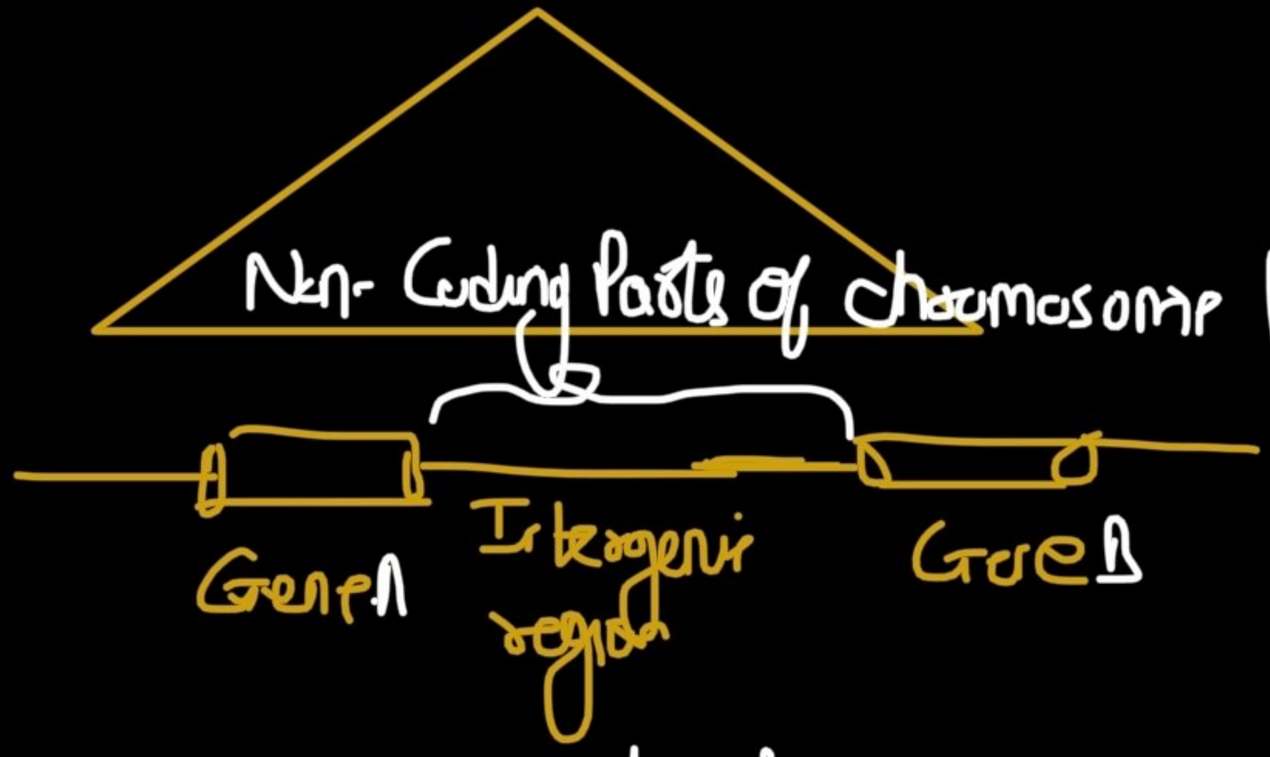
Animal Cell

No cell wall for animal cell

Overall of Genome

} 4 Chromosomes combined together is called genome

} 1 chromosome



[Doesn't have any info] can be used for non-coding RNA

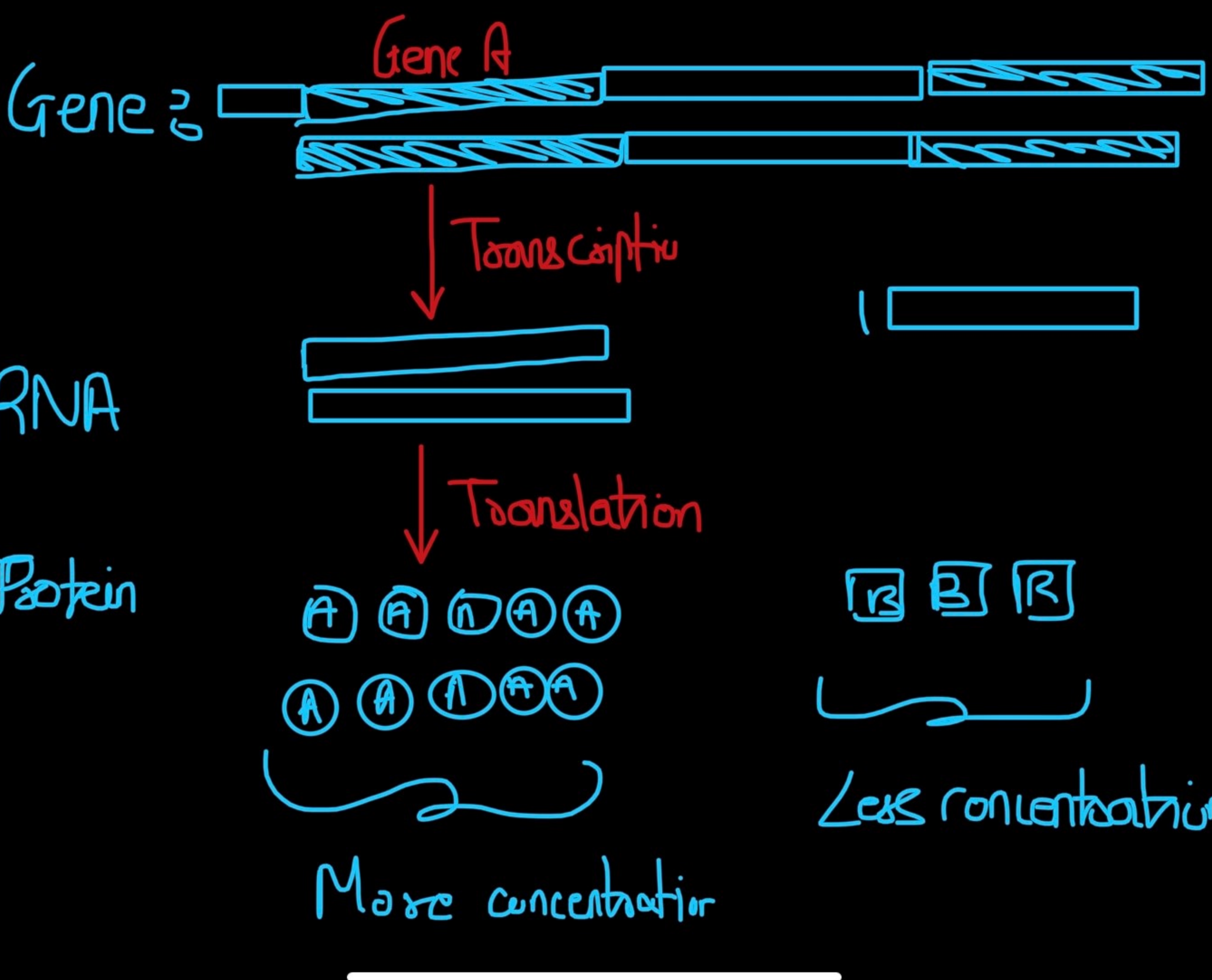
→ Nucleus stores DNA in form of chromosomes

→ GeneA, GeneB are called coding parts due to their ability to make proteins

→ Simple organisms are tightly packed.... but they have regulatory potential

4 How Cells Read GNOME

Conversion from gene to protein:



Translation, transcription rates can be different for different genes

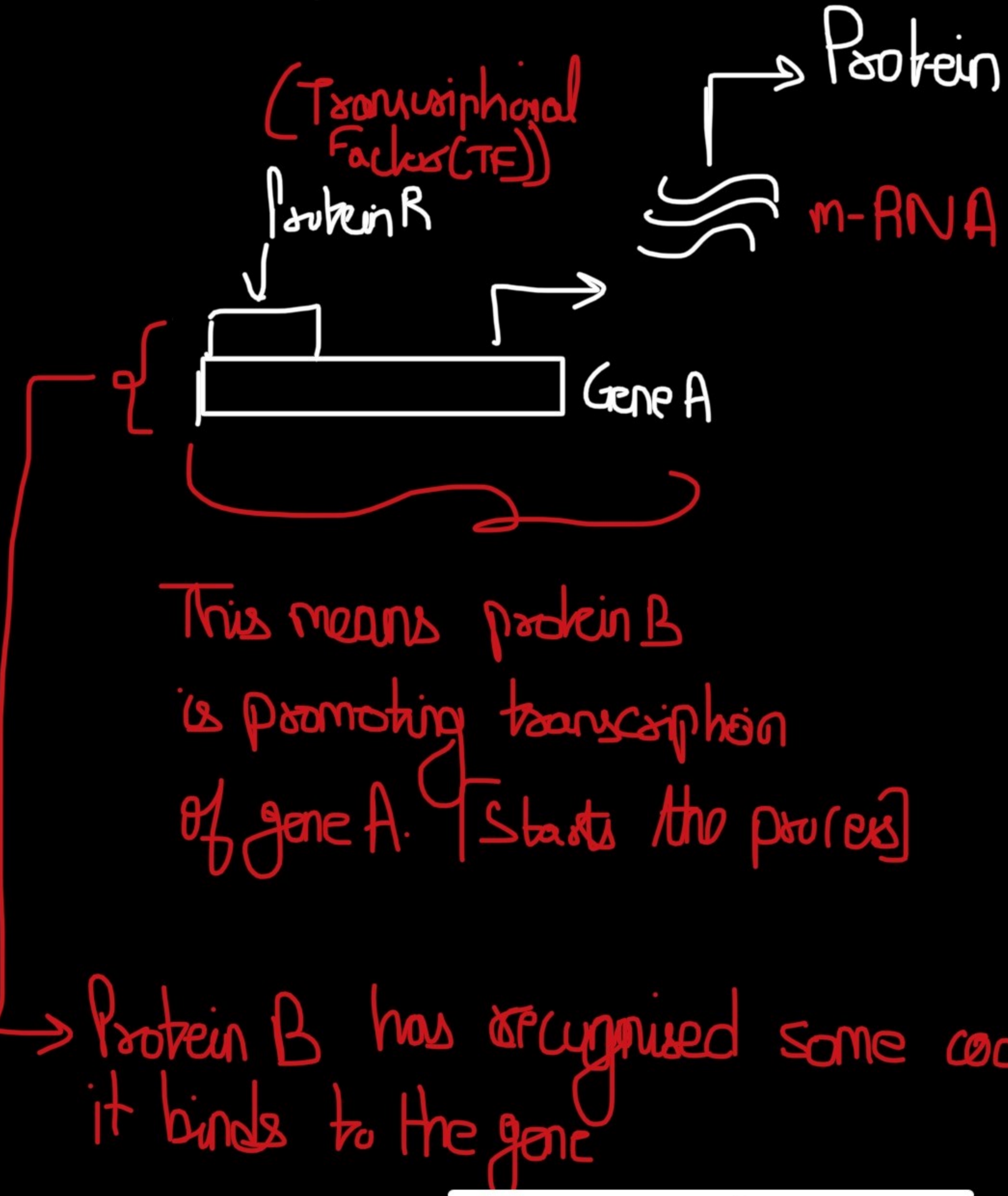
DNA [A, T, G, C]

↓

mRNA [Messenger RNA] [A, U, G, C]

↓

Protein [20 amino acids]



This means protein B is promoting transcription of gene A. [Starts the process]

↳ Protein B has recognised some code after which it binds to the gene

This code comprises of A, T, G, C

7

Region of binding is called promotor

Protein:

_____ (20 chained Amino Acids)

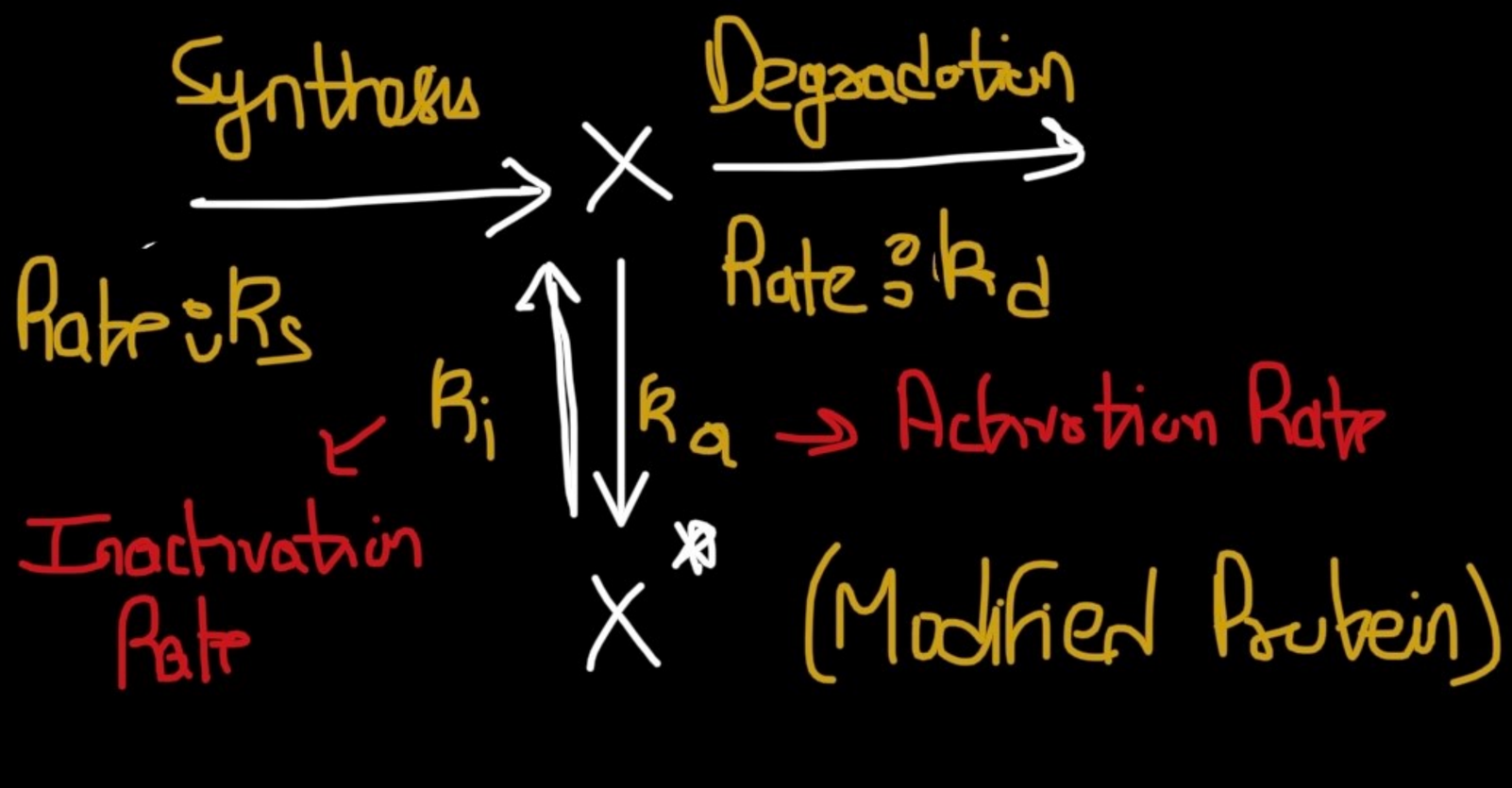
For functionality,

Protein takes a 3-D structure

(Folded so that protein is functional)

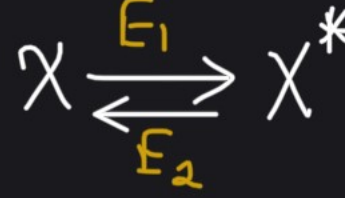
Protein is modified

[Give functionality]



R_s should be proportional to binding

↳ Lumped parameter



To synthesise proteins, we need other proteins called enzymes

→ All proteins are not enzymes

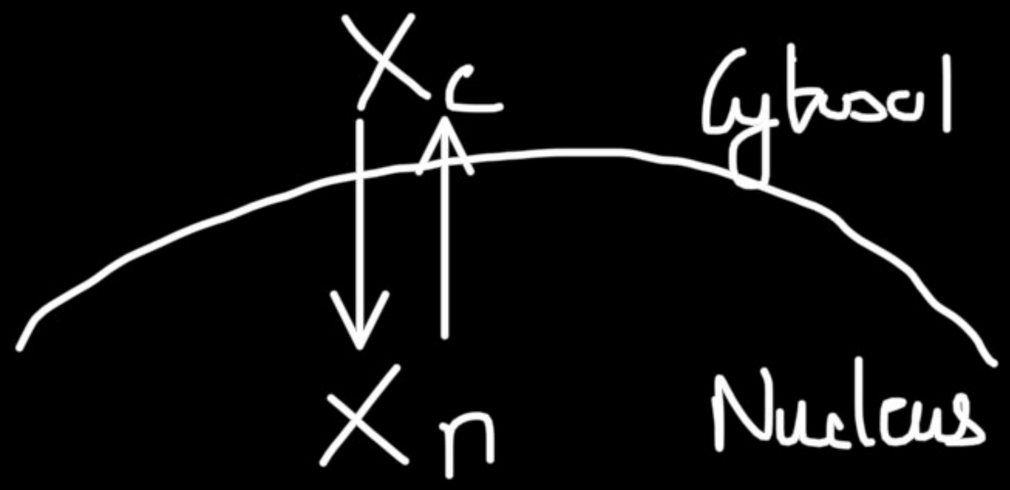
→ All enzymes are proteins

Metabolism { Glucose (substrate) $\xrightarrow{E_1, E_2 \ldots E_n}$ Pyruvate → Lactate

Enzyme is like a substrate

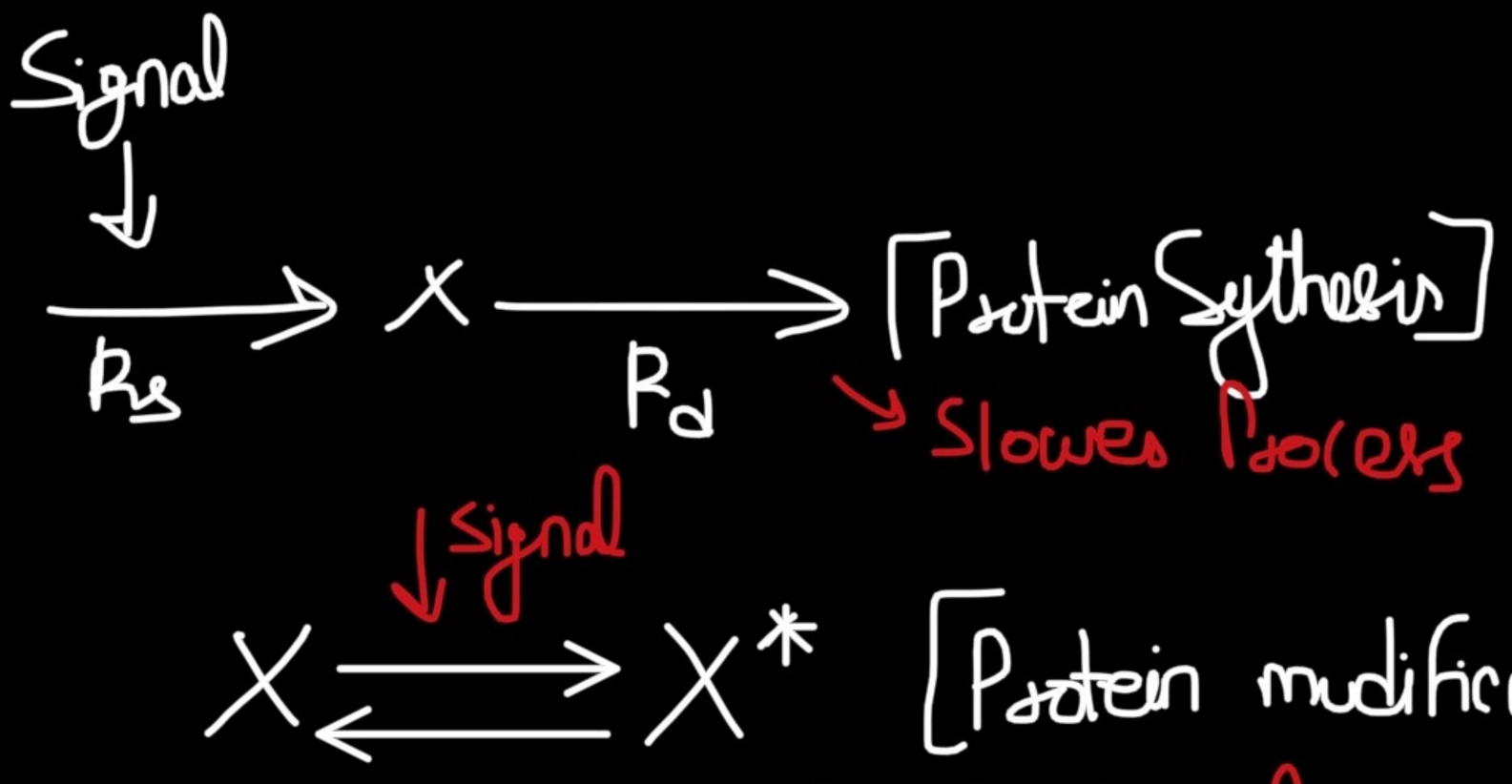
$$E + S \rightleftharpoons ES \longrightarrow E + P$$

Enzyme Substrate



[Protein Translation]

10



Possible D.E

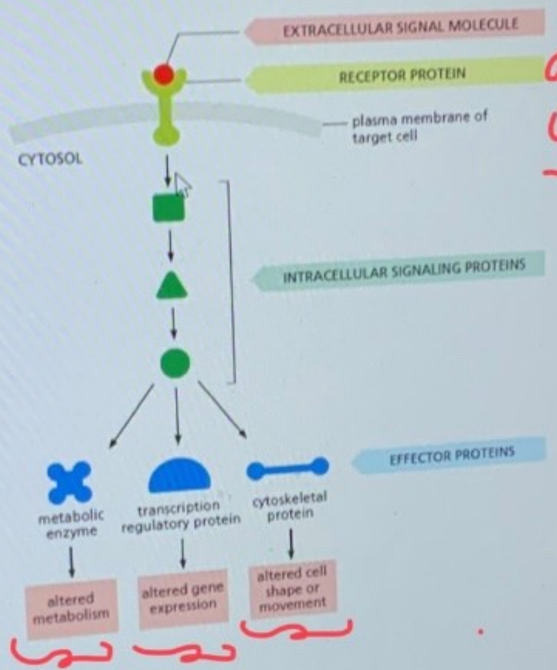
$$\frac{dx}{dt} = R_s - R_d X$$

How to copy a DNA to a DNA?
gene A to gene A

Yes, through replication which is done during cell division

PowerPoint Slide Show - Class_Systems_Thinking - PowerPoint

A simple intracellular signaling pathway activated by an extracellular signal molecule



Sensing
↓
Transmission
↓
Effect

Cup shaped receptor used for sensing

Relay of info

Functions as per signal

Modify proteins accordingly

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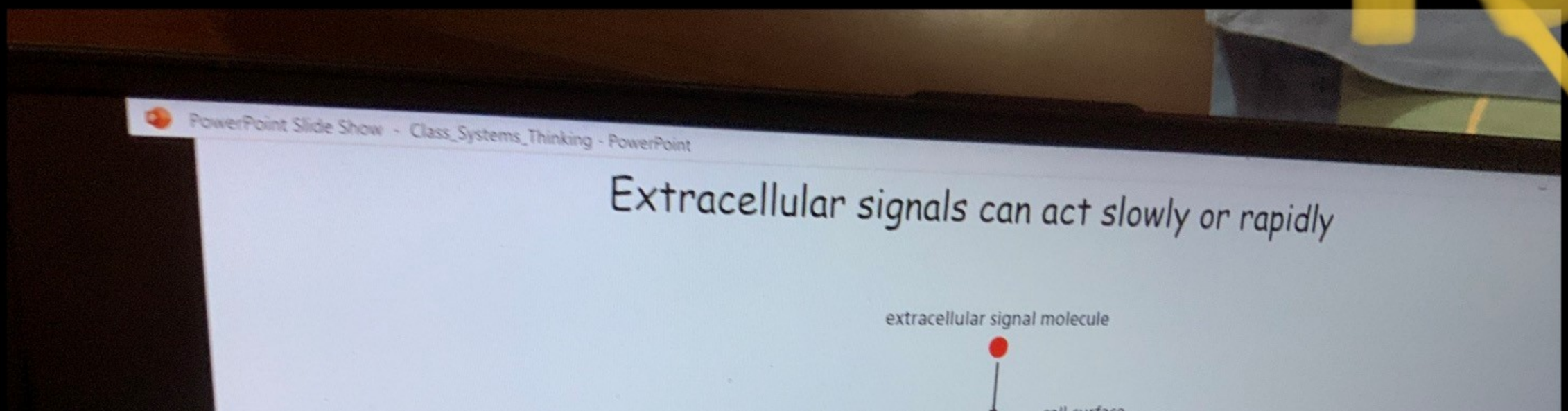
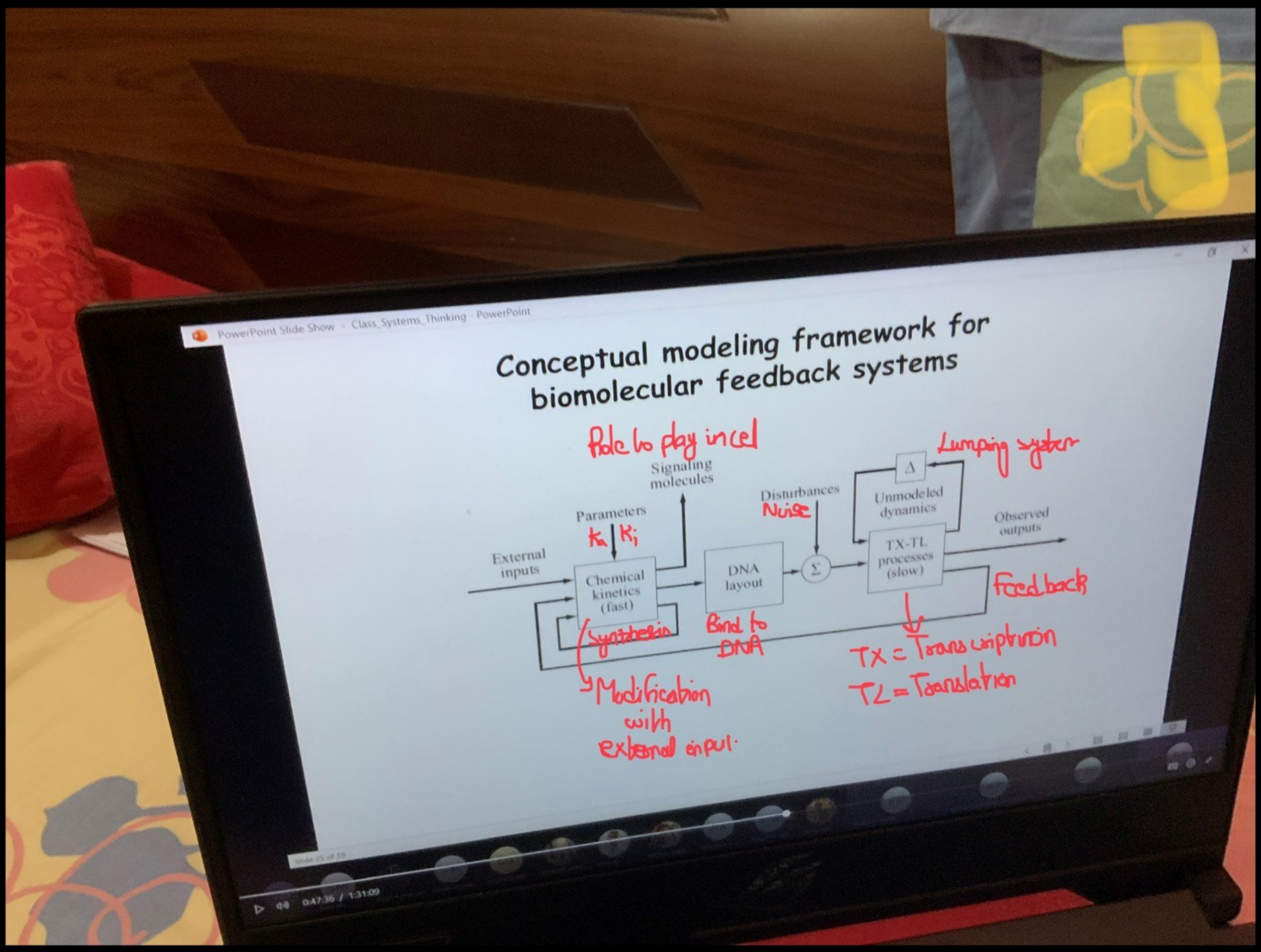
144Hz 3ms


PowerPoint Slide Show - Class_Systems_Thinking - PowerPoint
Extracellular signals can act slowly or rapidly
extracellular signal molecule
intracellular signaling pathway
cell-surface receptor protein
nucleus
Faster responses like punching
FAST (< sec to mins)
ALTERED PROTEIN FUNCTION
DNA
RNA
SLOW (mins to hrs)
ALTERED PROTEIN SYNTHESIS
plasma membrane
ALTERED CYTOPLASMIC MACHINERY
ALTERED CELL BEHAVIOR
Both fast, slow are important
Slide 23 of 59
+32
SM
SS
PP
SG
VG
AA
PM
PP
KY
VP
S2


PowerPoint Slide Show - Class_Systems_Thinking - PowerPoint
Conceptual modeling framework for biomolecular feedback systems
Role to play in cell
Lumping system
Signaling molecules
Disturbances
Noise
Unmodeled dynamics
Parameters
Observed outputs
External inputs
Chemical kinetics (fast)
DNA layout
TX-TL processes (slow)
feedback
synthesis
Bind to DNA
TX = Transcription
TL = Translation
Modification with external input
0:47:36 / 1:31:09