DAY 4
APPLICATIONS AND ETHICS OF SYNTHETIC BIOLOGY

So, till now, we have learned about the principles of Synthetic Biology, and now we are going to look at the real-world applications of Synthetic Biology, how they are actualized, and the ethical concerns associated with them.

TOPICS COVERED:
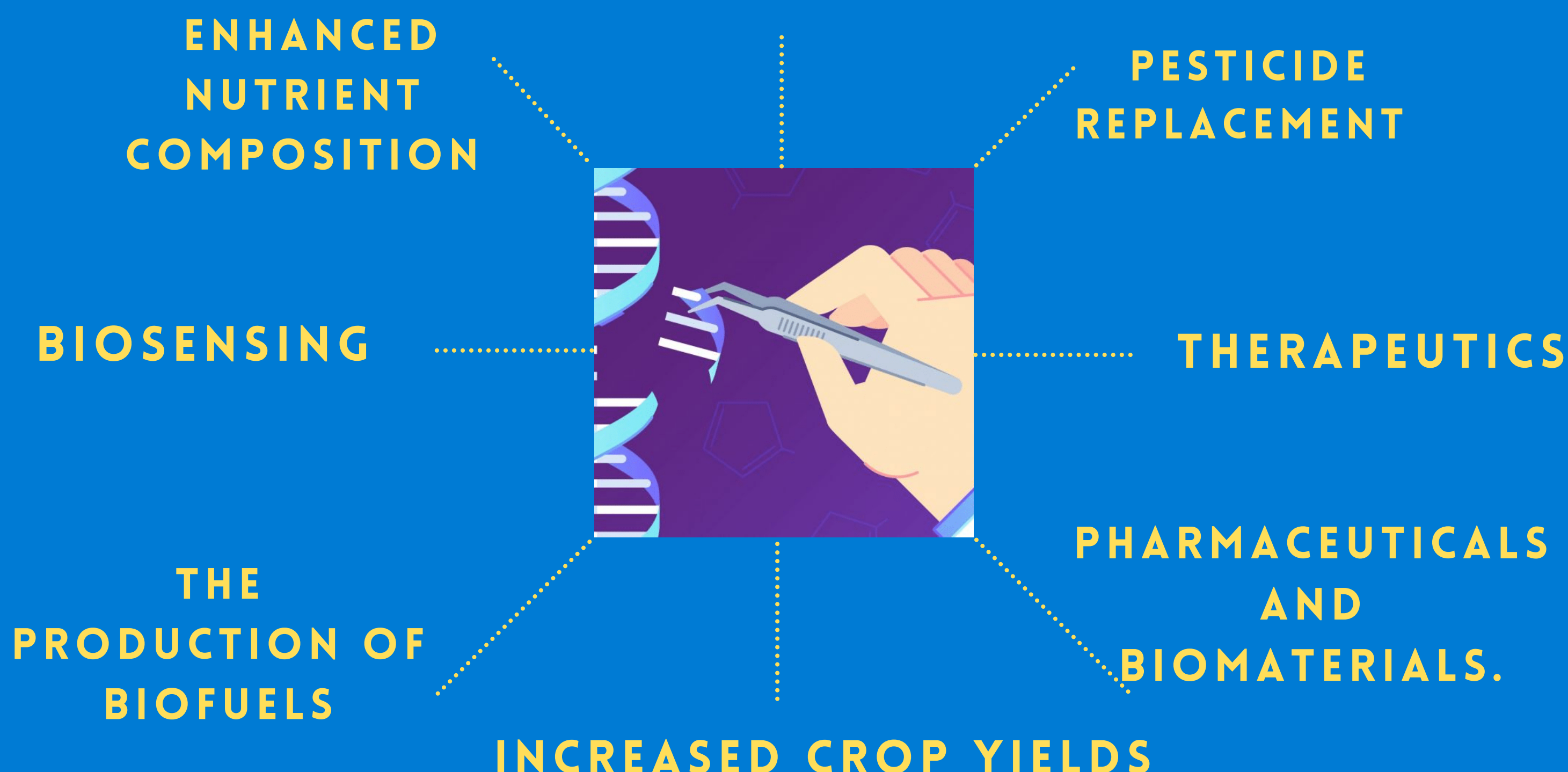
Applications of Synthetic biology
Ethics in Synthetic biology
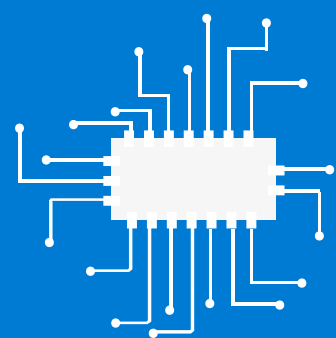iGEM
A taste of interdisciplinary

APPLICATIONS OF SYNTHETIC BIOLOGY

FOOD AND DRUG PRODUCTION

ENHANCED NUTRIENT COMPOSITION

PESTICIDE REPLACEMENT

BIOSENSING

THERAPEUTICS

THE PRODUCTION OF BIOFUELS

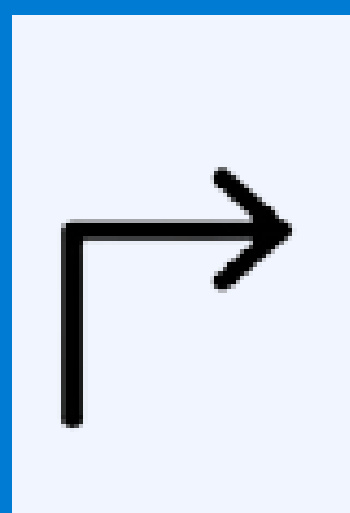PHARMACEUTICALS AND BIOMATERIALS.

INCREASED CROP YIELDS

DAY 4
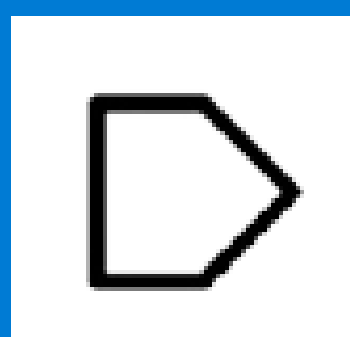## APPLICATIONS AND ETHICS OF SYNTHETIC BIOLOGY

GENETIC CIRCUITS

The simplest of the genetic circuit comprises a promoter, a ribosome binding site, a coding region, and a terminator.

- A **promoter** is a sequence of DNA needed to **turn a gene on or off**.
- The process of **transcription is initiated** at the promoter.
- We can choose the promoter to be **always on** or **metal sensitive** or **stress-sensitive** upon our wish in accordance with the need of the genetic circuit.
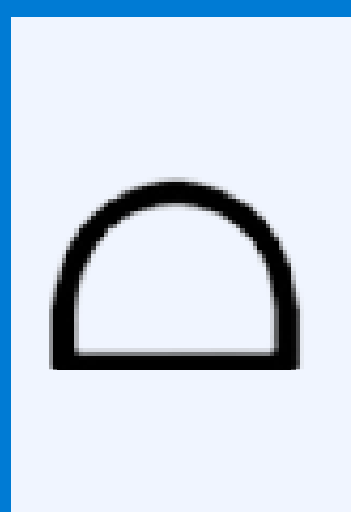
- **A ribosome binding site, or ribosomal binding site (RBS),** is a sequence of nucleotides upstream of the start codon of an mRNA transcript.
- It is responsible for the **recruitment of a ribosome** during the initiation of translation.

- The coding region essentially is the **gene encoding the protein** to be expressed.
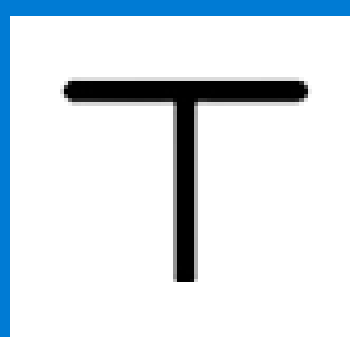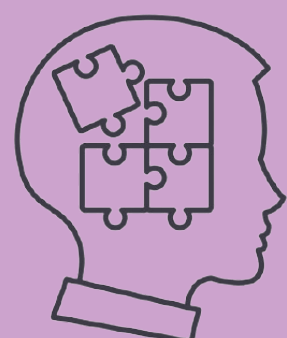
- The terminator **stops the translation** process.

GENE **G**ALA

ETHICS

Synthetic biology holds out the possibility of significant benefits to humanity. However, it also raises some significant concerns.

(1) concerns about 'playing God'

(2) concerns about undermining the distinction between living things and machines

(3) concerns about the intentional misuse of knowledge from synthetic biology

LAB SAFETY

Don't touch the animals

Wear safety goggles

Wear lab coat

Wear gloves when necessary

Don't eat at your workstation
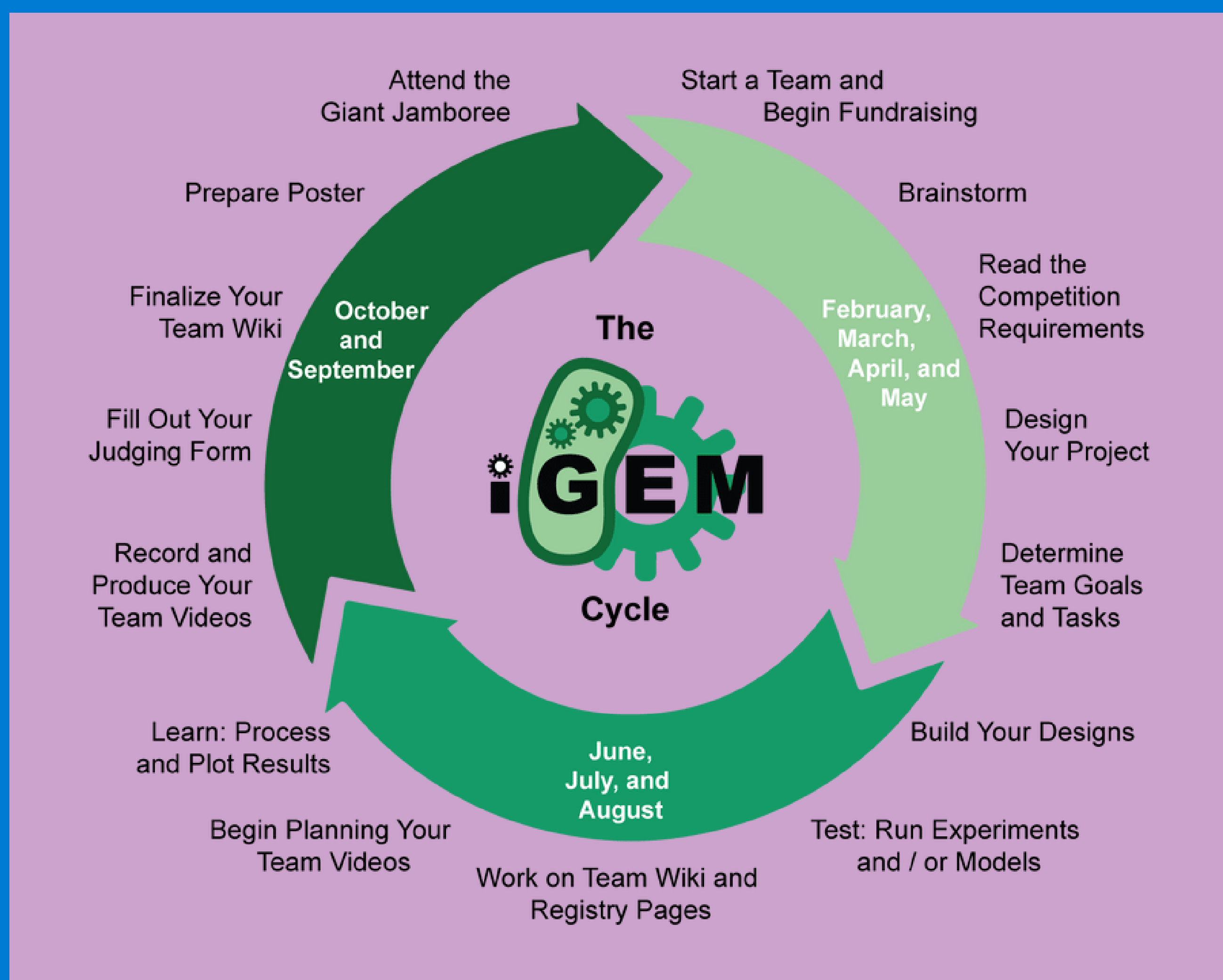
Clean up your workspace

GENE GALA

iGEM

iGEM, or the International Genetically Engineered Machine Competition, is where Teams worldwide investigate and generate synthetic biology solutions to significant problems and present these solutions at a conference, known as the Giant Jamboree, every fall in Boston, Massachusetts.
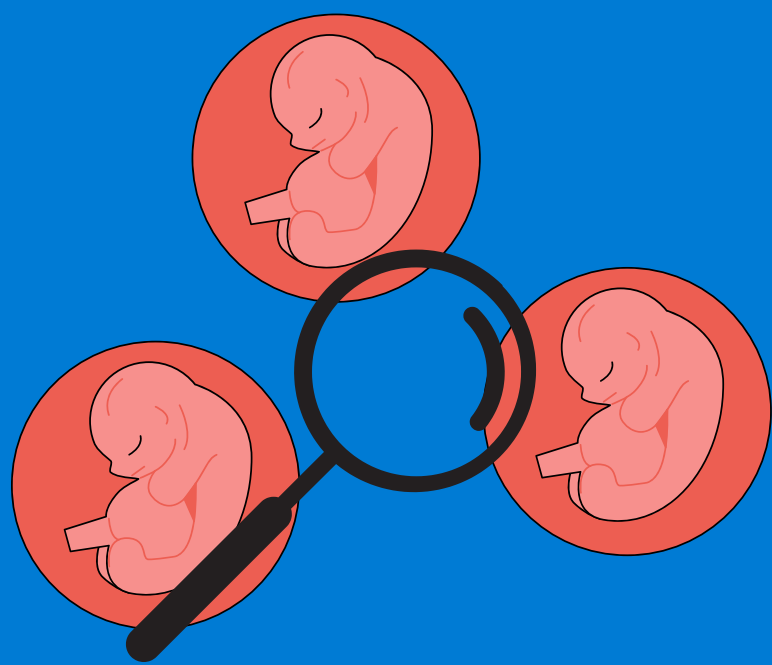
WHAT IS IT REALLY ABOUT?

The iGEM Cycle

Attend the Giant Jamboree
Start a Team and Begin Fundraising
Prepare Poster
Brainstorm
Finalize Your Team Wiki
October and September
Read the Competition Requirements
February, March, April, and May
Fill Out Your Judging Form
Design Your Project
Record and Produce Your Team Videos
Determine Team Goals and Tasks
Learn: Process and Plot Results
June, July, and August
Build Your Designs
Begin Planning Your Team Videos
Work on Team Wiki and Registry Pages
Test: Run Experiments and / or Models

HTTPS://IGEM.ORG/MAIN_PAGE
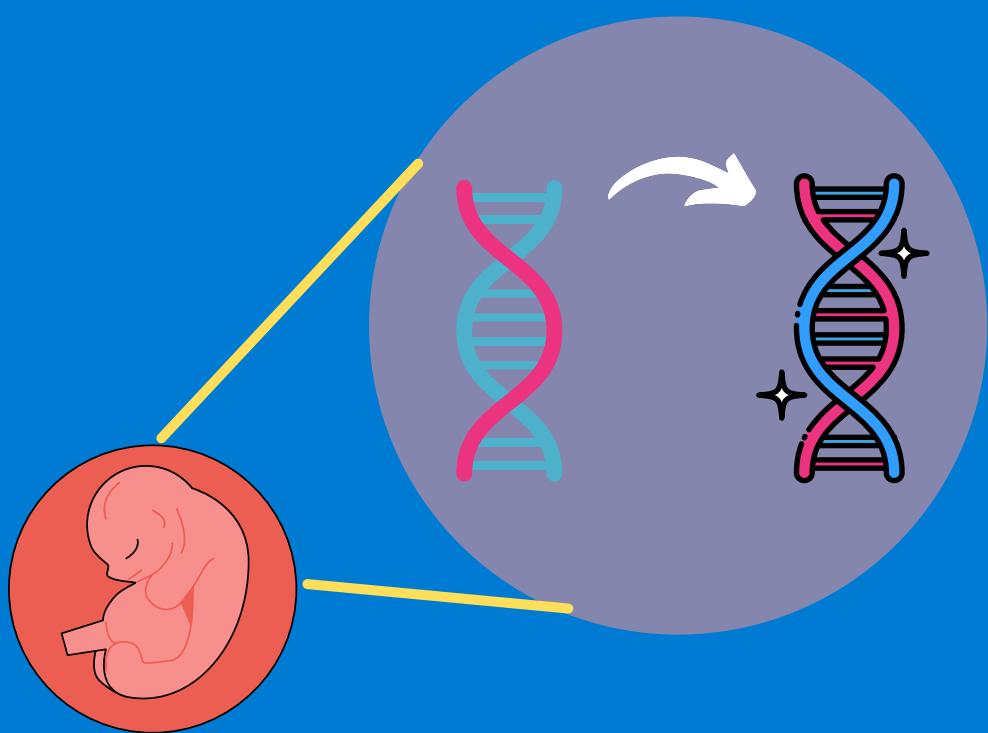
GENE
GALA

DESIGNER BABIES

A designer baby is a baby whose genetic makeup has been selected or altered, often to include a particular gene or to remove genes associated with a disease.

Analyzing a wide range of human embryos to identify genes associated with particular diseases and characteristics, and selecting embryos that have the desired genetic makeup

1.PREIMPLANTATION GENETIC DIAGNOSIS.

Alter the genomic composition of a person by deleting inserting or mutating genes

2. GENE EDITING

But this techniques are highly unethical both in terms of rights as well as the health complications.
In India there exist many strict laws and ministry arms like the Department of Biotechnology to prevent such actions.

GENE GALA

TASTE OF INTERDISCIPLINARY

Synthetic biology is solely not concerned with biology only

THINK AND REFLECT

WHY IS IT REALLY NECESSARY TO HAVE AN INTERDISCIPLINARY APPROACH? (THINK ABOUT MAKING A CASTLE OUT OF CARDS)

MATHEMATICAL MODELING.

- Quantification of the product
- Understanding the interaction (in silico)
- Calculating the kinetic parameters
- Standardization of detection techniques

are some of those key aspects that can not be done without mathematical modeling.

Mathematical model is logical representation and quantification of biological processes requires help from other disciplines like chemistry, physics, math and computer science.
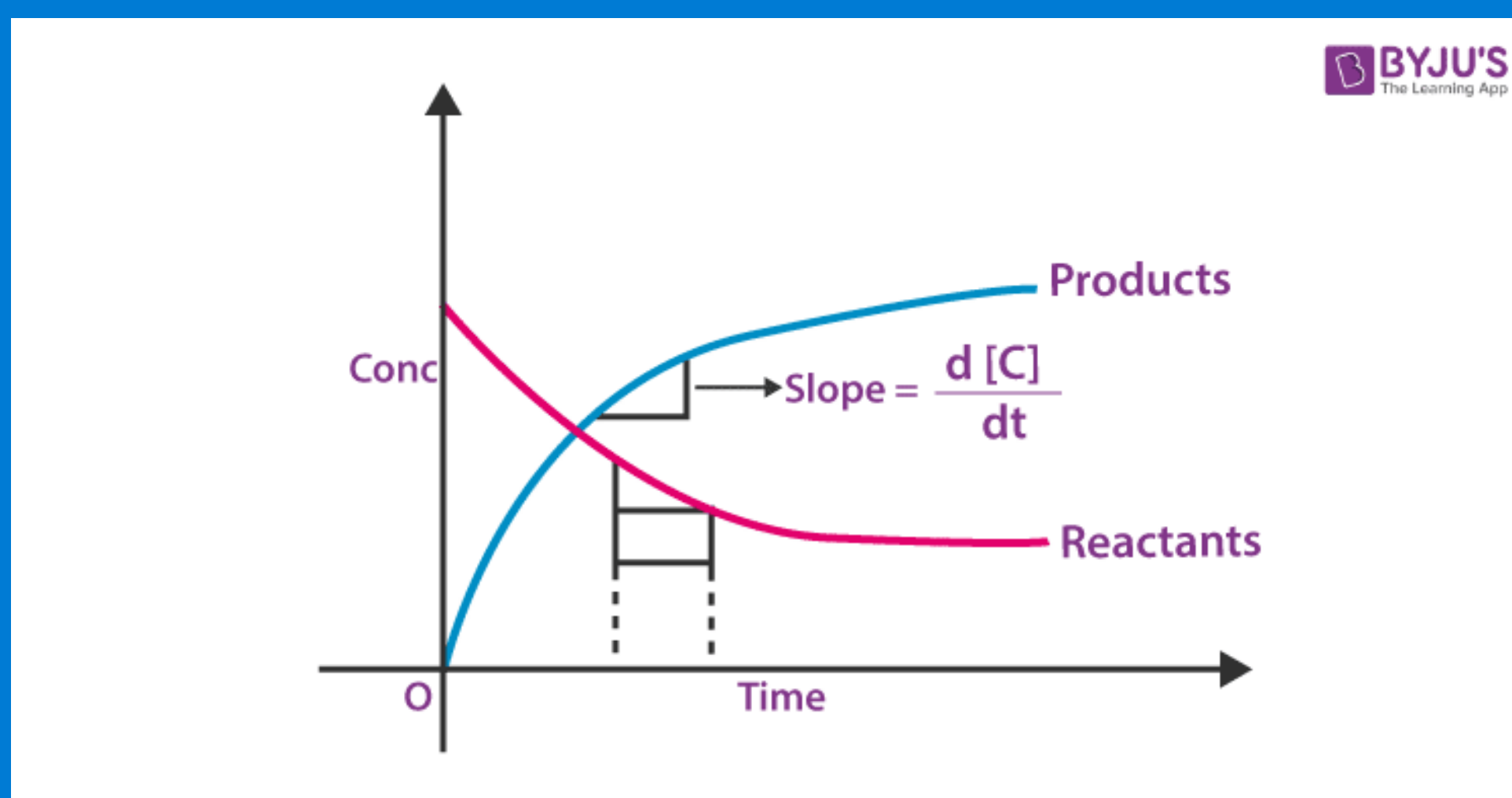
TASTE OF INTERDISCIPLINARY

CHEMICAL KINETICS:

Whenever a reaction takes place, the concentration of reactants reduced and that of product increases.

A + B -> C
RATE OF APPEARANCE OF C = Δ[C]/ΔT
RATE OF DISAPPEARANCE OF A = Δ[A]/ΔT
RATE OF DISAPPEARANCE OF B = Δ[B]/ΔT
RATE OF REACTION = (-1/A)*Δ[A]/ΔT = (-1/B)*Δ[B]/ΔT = (1/C)*Δ[C]/ΔT

$$r_{inst} = \lim_{\Delta t \to 0} \frac{\Delta [C]}{\Delta t} = \frac{d[C]}{dt}$$

APPLICATIONS AND ETHICS OF SYNTHETIC BIOLOGY

TASTE OF INTERDISCIPLINARY

Now let's dive into the applications:

Growth of microorganisms

Let N = Number of cells

Reaction for cell division: N -> 2N

$dN/dt = r*N$

Reaction for death of a cell: N -> 0N

$dN/dt = - kd*N$

Combining together we write,

$dN/dt = r*N - kd*N$

GENE **G**ALA

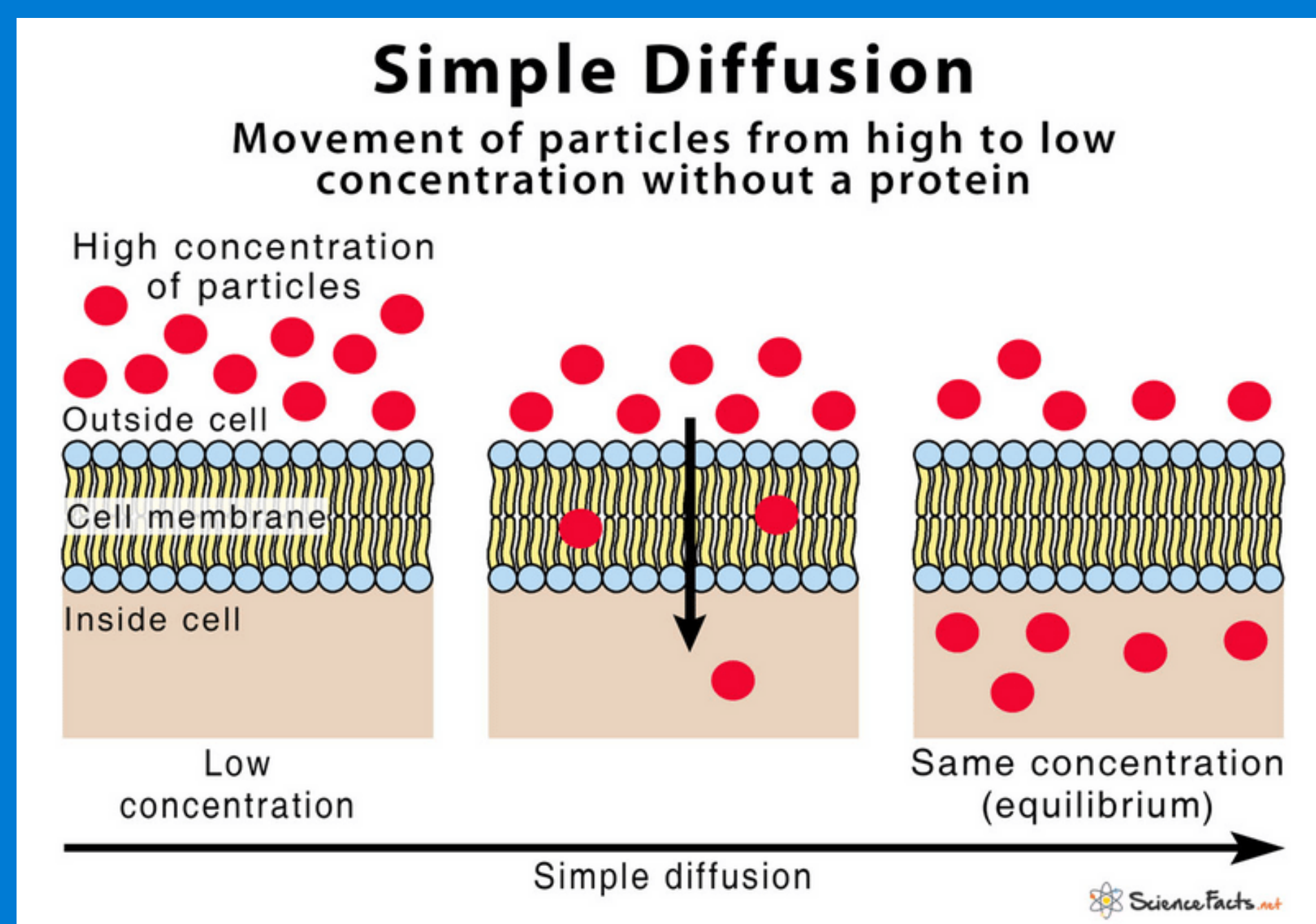### THINK AND REFLECT

$DN/DT = - KD*N$

WHY IS THERE A NEGATIVE SIGN HERE?

DIFFUSION OF PROTEINS THROUGH THE CELL MEMBRANE:

Simple Diffusion
Movement of particles from high to low concentration without a protein

High concentration of particles

Outside cell

Cell membrane

Inside cell

Low concentration

Same concentration (equilibrium)

Simple diffusion

ScienceFacts.net

The rate of diffusion is dependent on
(1) **temperature**
(2) **size of the particles**
(3) **the size of the concentration gradient.**

- **The diffusion coefficient** is taken into account the effect of temperature and particle on the rate of diffusion.

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DIFFUSION OF PROTEINS THROUGH THE CELL MEMBRANE

Now let's dive into the applications:

Determining the concentration of protein

Diffusion coefficient along with concentration of the molecule can be used to form an equation. This can be used to determine the concentration of protein that has reached the other side and allow us to calculate how much protein should be produced for a fixed amount to come out or vice versa.

USE OF SOFTWARES

THINK AND REFLECT

a) Use of python, Matlab for solving the equations and getting graphs.

Can you think of some more applications of Python and Matlab
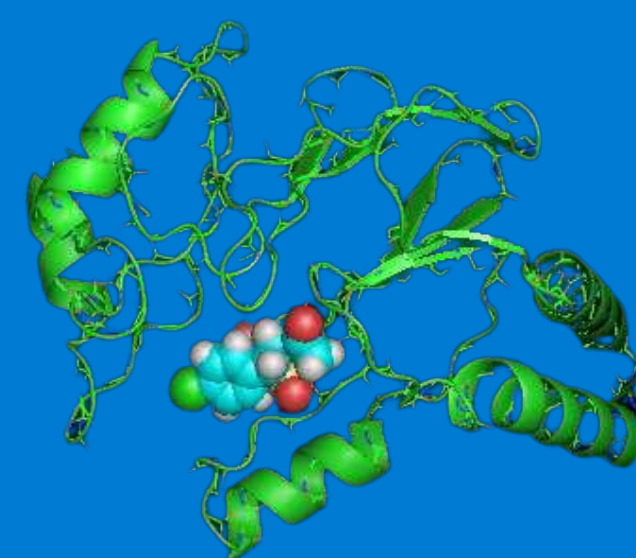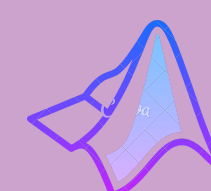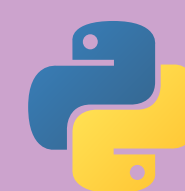
b) Protein modeling

With the advancement of computing and computer graphics, today several 3D structures of proteins are present in databases or data banks. These structures are then superimposed and studied to check the interaction with other proteins or small molecules which act as ligands.

Now let's dive into the applications:

A very common example of using protein structures is in drug designing

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APPLICATIONS AND ETHICS OF SYNTHETIC BIOLOGY

FIND OUT!

Have researchers ever been able to synthesize the entire genome of an organism? If yes, what were the repercussions?

HINT : do boond zindagi ki!

REFERENCES

LAB SAFETY – HTTPS://WWW.YOUTUBE.COM/WATCH?V=BRDAPYGVDQQ

DESIGNER BABIES – HTTPS://WWW.YOUTUBE.COM/WATCH?V=K1A2LARFMIA

DIFFERENTIAL EQUATIONS – HTTPS://WWW.YOUTUBE.COM/WATCH?V=QPM1BDJXADK