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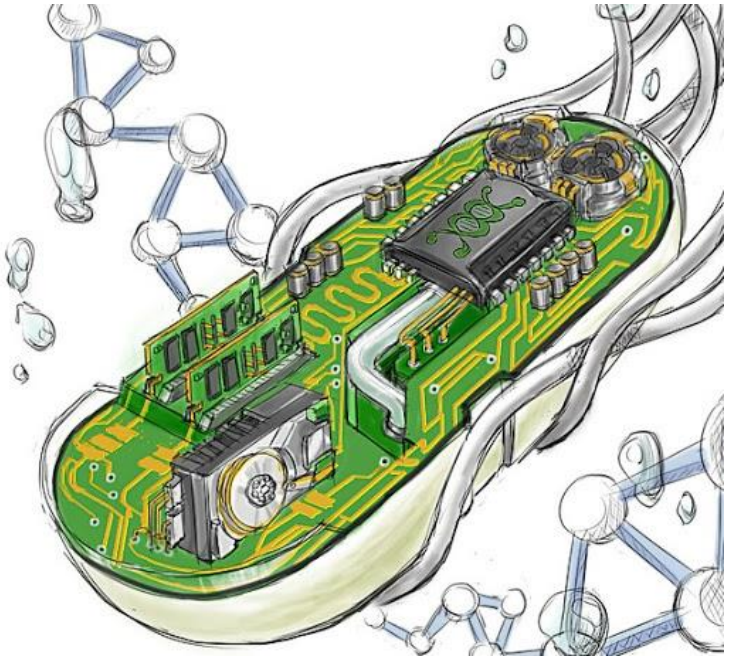
GADJAH MADA

Webinar BEM Biologi 11-03-2021
Brainstorming BIOS

Pengantar *Computer Aided Cell Factory Design*



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Natural Products Genome Mining

The Novo Nordisk Foundation Center for Biosustainability

DTU Danmarks Tekniske Universitet

Luaran

- Peserta dapat menjelaskan *Genome-Scale Metabolic Models (GSM)*
- Peserta dapat mencari GSM di database online
- Peserta mengenal Constraint Based Analysis dengan menggunakan COBRApy*
- Peserta dapat memberikan contoh desain *Cell Factory* dengan melakukan manipulasi GSM

Outline

- Perkenalan
- Kompetisi Bioengineering
- Cell Factory & Novo Nordisk
- Systems Biology & Flux Balance Analysis
- *Hands-on Session*

The Novo Nordisk Foundation
Center for Biosustainability

novo nordisk fonden

Copenhagen Bioscience PhD Programme

Åbo Akademi University

The University of Edinburgh

lpdp

sagasitas

DTU Danmarks Tekniske Universitet

KSK BIOGAMA

TUT WURI HANDAYANI

BEASISWA UNGGULAN

Bioteknologi

Systems & Synthetic Biology

(Meta) Genome Mining

Cell Factory Engineering

iGEM

جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

UNIVERSITAS GADJAH MADA

https://cphbiosciencephd.org/

The 2021 call for applications close on January 12, 2021!

Copenhagen Bioscience PhD Programme

Novo Nordisk Foundation Center for Biosustainability

Novo Nordisk Foundation Center for Protein Research

DanStem

Novo Nordisk Foundation Center for Stem Cell Biology

Novo Nordisk Foundation Center for Basic Metabolic Research

University of Copenhagen

DTU Danmarks Tekniske Universitet

novo nordisk fonden

Kompetisi Bioengineering

Kompetisi Bioengineering

- Menyelesaikan masalah dengan merekayasa sistem hayati
  - **Problem solving**
  - **Engineering**
  - **Biological systems**

"Find a problem which is dear and near to your heart"

https://2021.igem.org/

http://biomod.net/

https://synbio.id/bios/

Kompetisi Bioengineering

https://igem.org/

http://biomod.net/

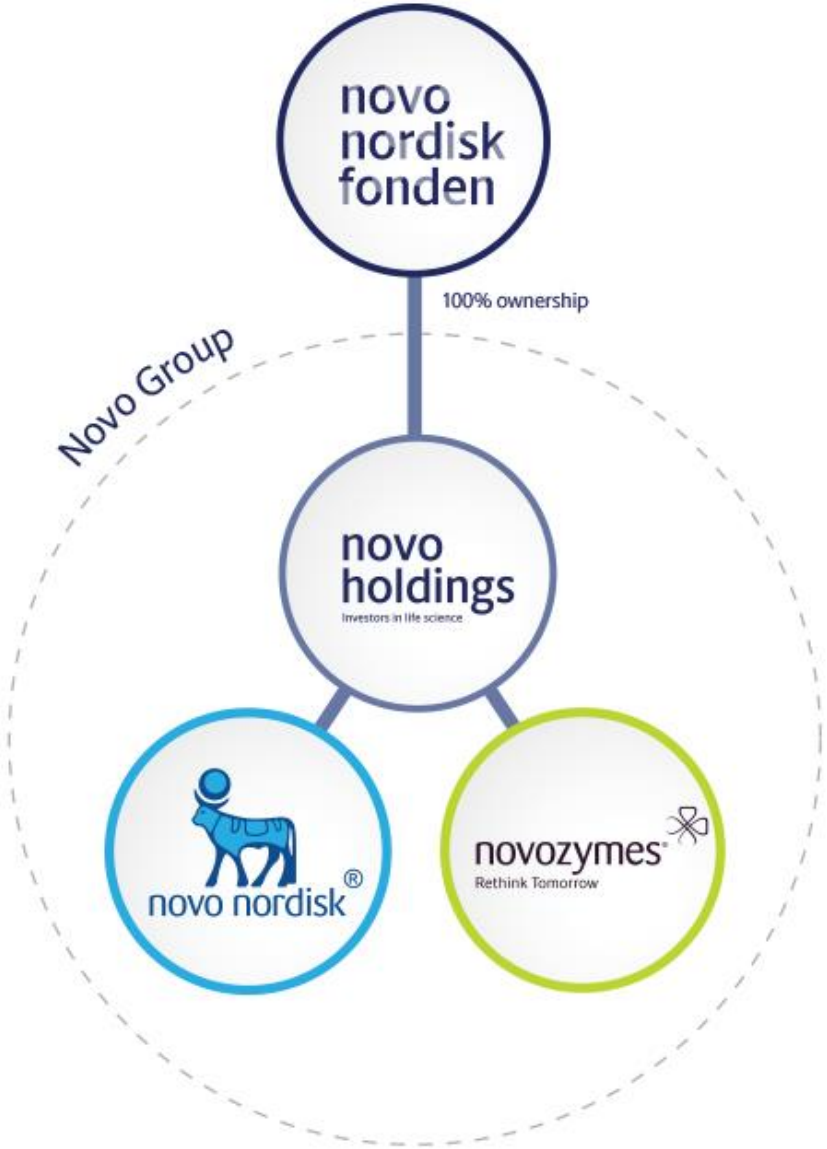
https://synbio.id/bios/

- To Do:
  - Look at past projects, find inspiration **NOT plagiarize**!
  - Ask these questions:
    - What is the problem they are solving? Do they have the same problem as us?
    - How do they solve the problem? What kind of approach / technology they use?
    - **What can we do better?**

Cell Factories & Novo Nordisk

Novo Nordisk Foundation

- dates back to 1922
- Nobel laureate August Krogh
- Produce insulin in the Nordic countries
- 4,893 Million DKK Awarded grants for research & education in 2019



NNF Research Centers

Copenhagen Bioscience Cluster

THE CLUSTER

The Cluster

Four major research centers, two infrastructures and a number of supporting initiatives form the backbone of the Copenhagen Bioscience Cluster. Located in Greater Copenhagen, the Cluster is surrounded by a rich life science environment including other Novo Nordisk Foundation initiatives that provide multiple opportunities for interaction and collaboration.

Novo Nordisk Foundation Center for Protein Research

Proteins are deeply involved in diseases processes. Understanding disease at a protein level is therefore imperative in order to develop future generations of diagnostics and treatment.

Novo Nordisk Foundation Center for Basic Metabolic Research

The Center explores the molecular mechanisms and gene-environment interactions that underlie causes of diabetes and obesity with the ultimate aim of contributing to the development of new ways of treating and preventing diabetes and obesity.

The Novo Nordisk Foundation Center for Stem Cell Biology, DanStem

The Section unites leading scientists within stem cell biology to understand how stem cells contribute to the formation and maintenance of organs and tissues and how their aberrant behaviour explains such diseases as cancer.

Novo Nordisk Foundation Center For Biosustainability

The Center develops novel and innovative technologies for cell-based production of a broad range of chemicals and pharmaceuticals as a contribution to promoting the transformation from an oil-based chemical industry to a more sustainable bio-based industry.

Copenhagen Bioscience Cluster

NNF CfB 2.0 (2021 – 2025)

The Novo Nordisk Foundation
Center for Biosustainability

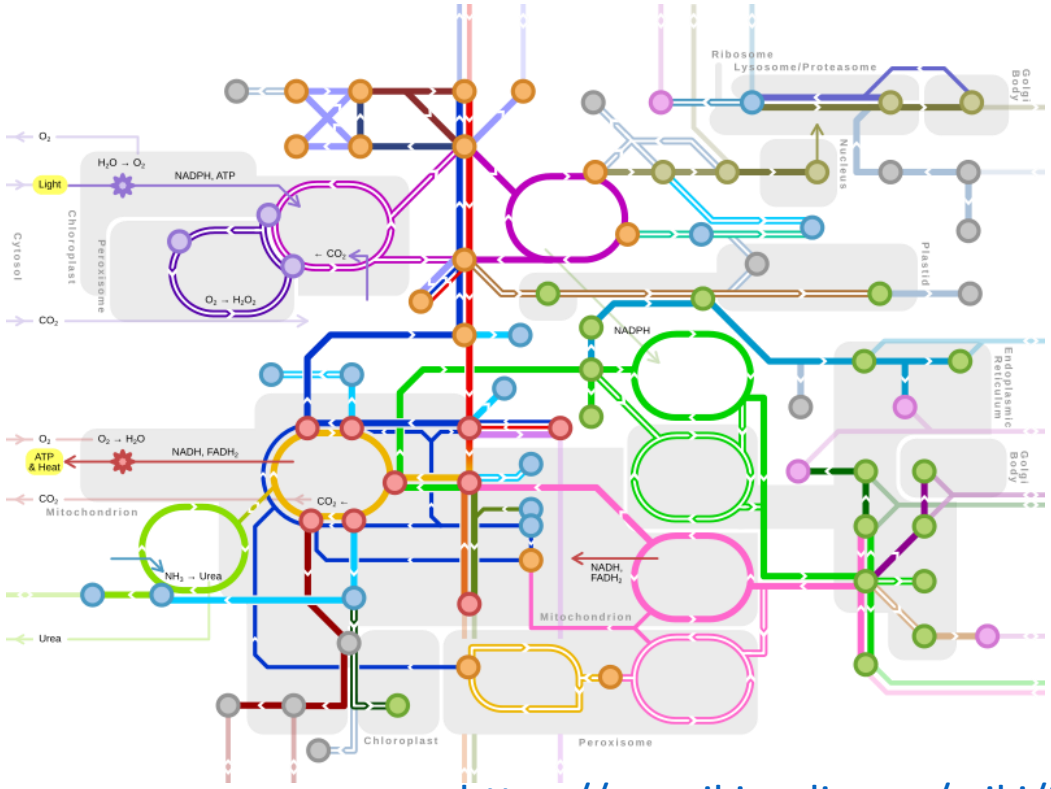
- Develop new knowledge and technologies to a **sustainable bio-based industry**.
- Chemicals and other products are produced using microbial production hosts **– cell factories.**
- **Design** the next generation of cell factories using:
  - High-quality **big data** generation and analysis
  - **Synthetic biology**
  - **Machine learning** and **AI**
  - **Metabolic modelling** and **engineering**
- We do this with "**the end in mind**"
  - Commercial and industrial approach in order to take products to market faster for the benefit of consumers.

https://www.biosustain.dtu.dk/about

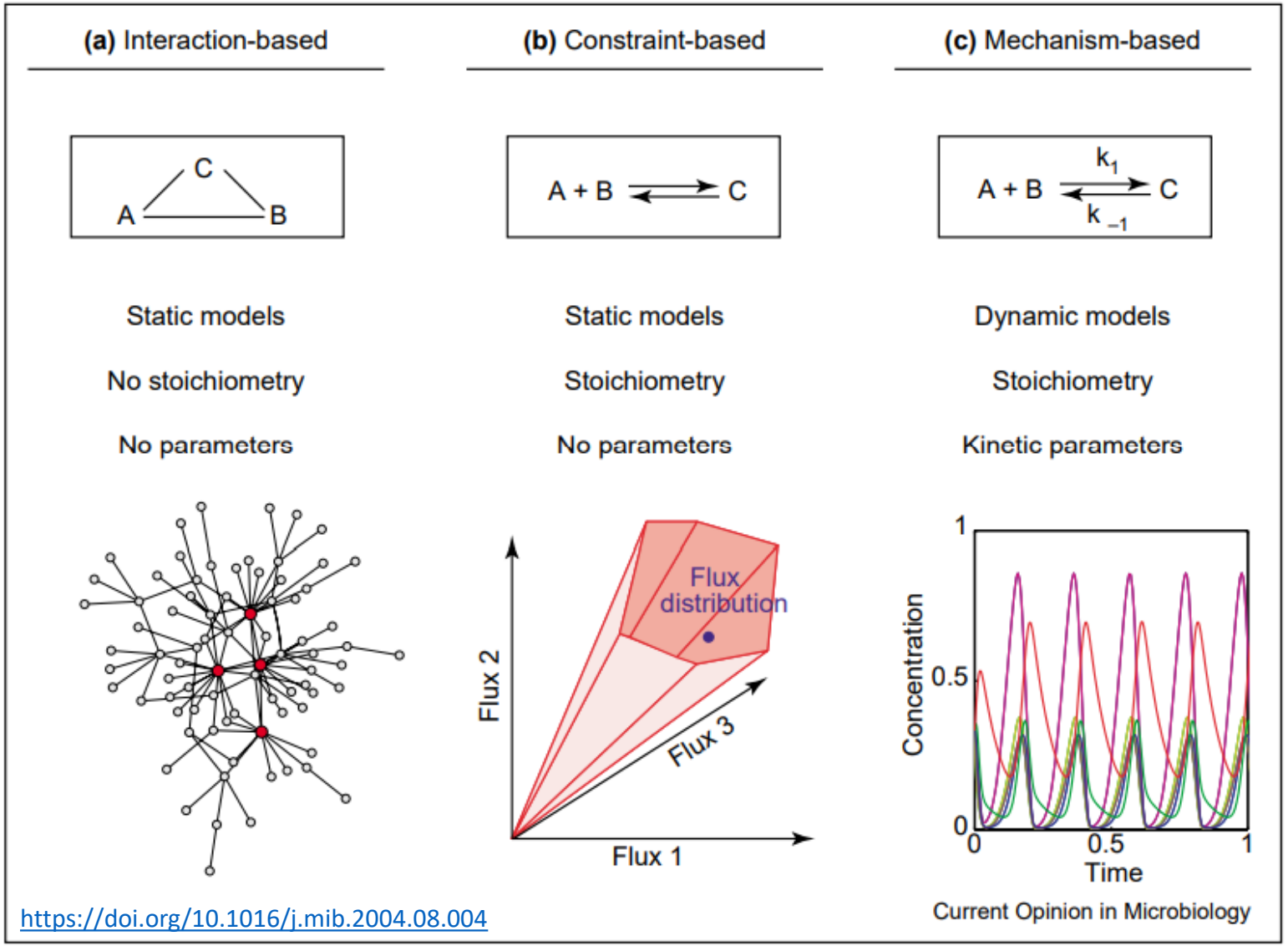
Systems Biology & FBA

Systems Biology

- Studying the relationship and **interactions** between various **parts** of biological objects to create understandable **model** of **the whole system**
- Biological Components:
  - Gene
  - Metabolites
  - Reactions
  - Proteins
  - Etc.

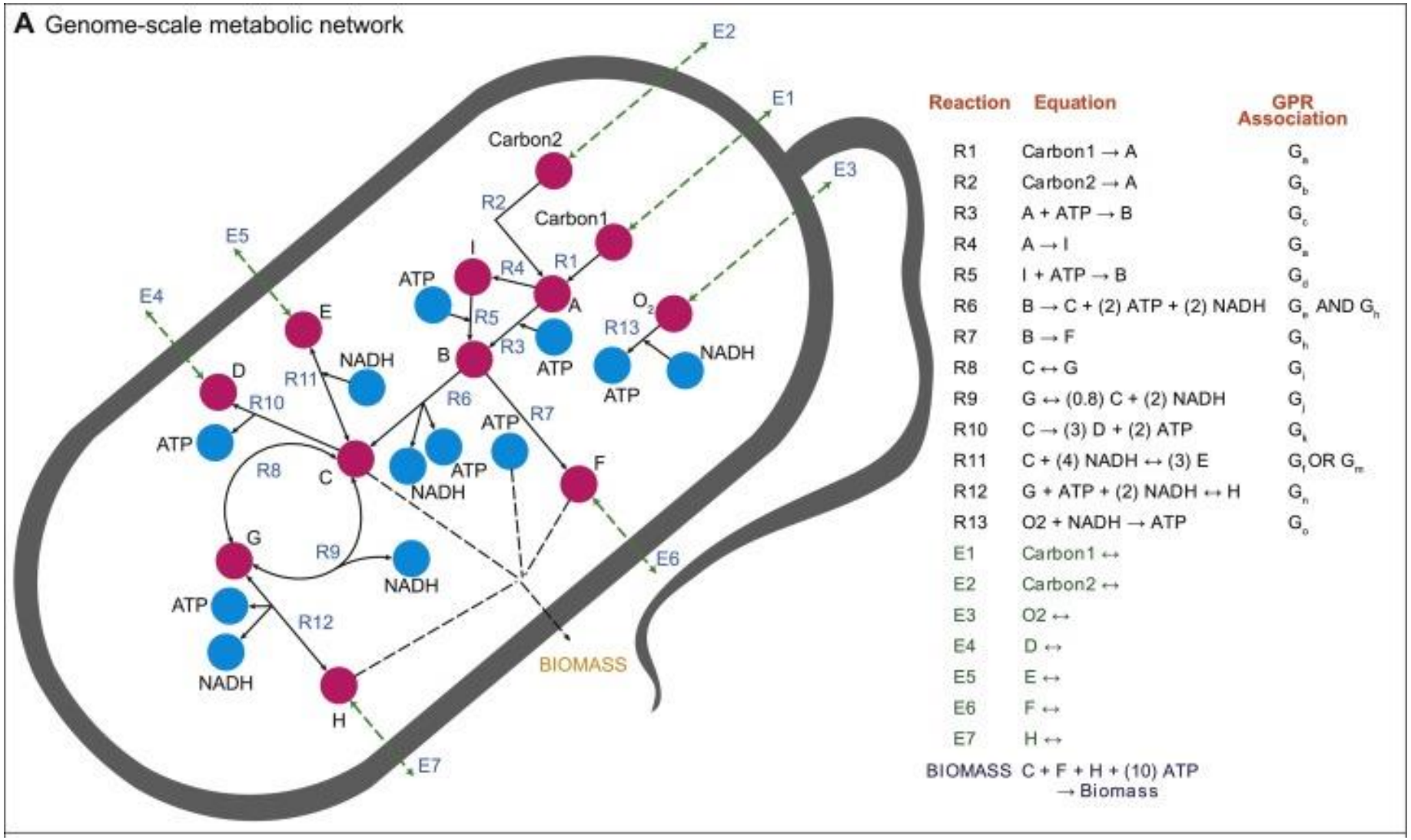


https://en.wikipedia.org/wiki/Metabolic_network



- Mathematical models of cellular networks can start from network representations based on:
  - interactions alone
  - constraints, including network topology, stoichiometries and reaction reversibilites → **Flux Analysis**
  - (detailed) reaction mechanisms → **Kinetic Models**

Genome-Scale Metabolic Models



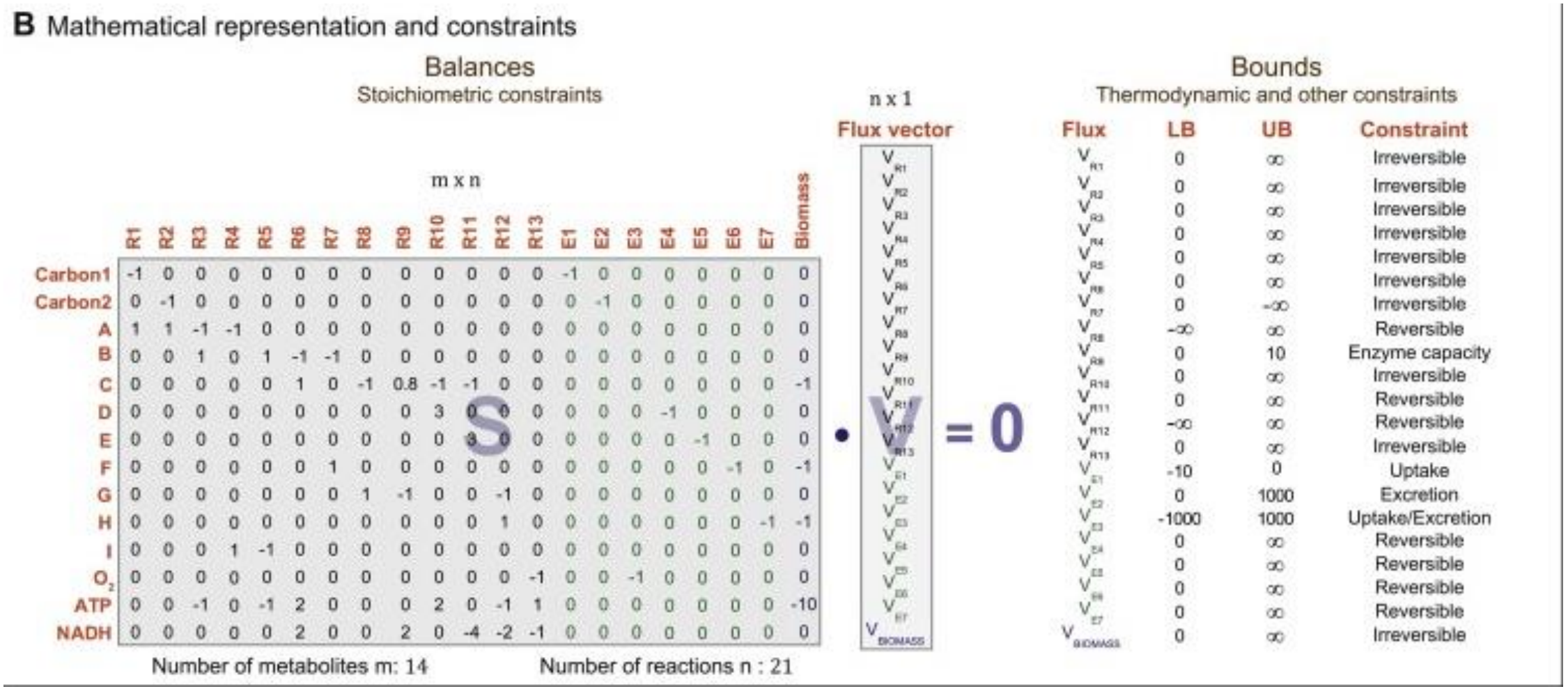
Reaction	Equation	GPR Association
R1	Carbon1 → A	G_a
R2	Carbon2 → A	G_b
R3	A + ATP → B	G_c
R4	A → I	G_e
R5	I + ATP → B	G_d
R6	B → C + (2) ATP + (2) NADH	G_e AND G_h
R7	B → F	G_h
R8	C ↔ G	G_i
R9	G ↔ (0.8) C + (2) NADH	G_j
R10	C → (3) D + (2) ATP	G_k
R11	C + (4) NADH ↔ (3) E	G_l OR G_m
R12	G + ATP + (2) NADH ↔ H	G_n
R13	O2 + NADH → ATP	G_o
E1	Carbon1 ↔	
E2	Carbon2 ↔	
E3	O2 ↔	
E4	D ↔	
E5	E ↔	
E6	F ↔	
E7	H ↔	
BIOMASS	C + F + H + (10) ATP → Biomass	

List of :

- metabolic reactions
- transport reactions
- biomass reaction

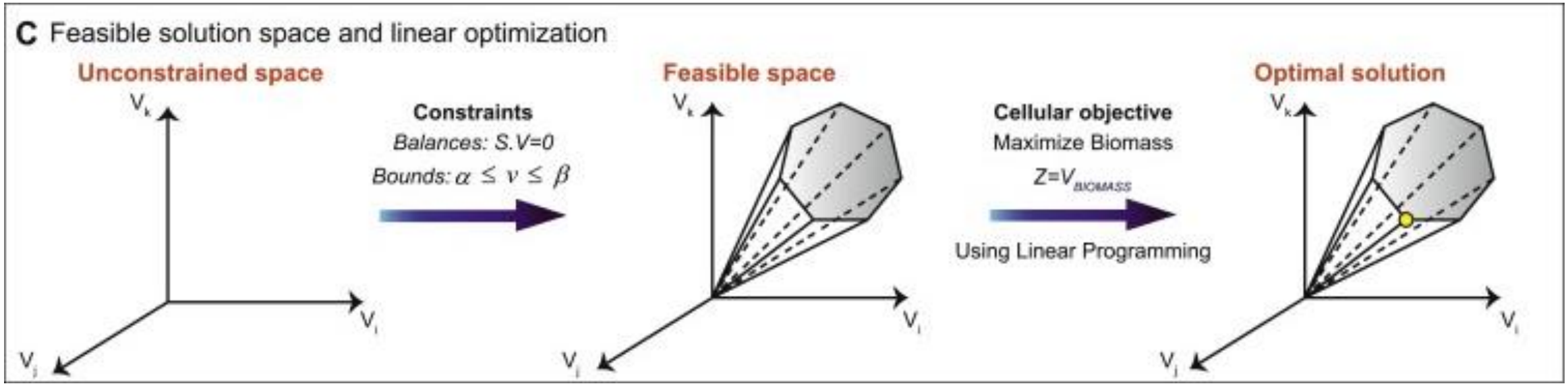
https://doi.org/10.1016/j.biosystems.2016.06.001

Stoichiometric Matrix



https://doi.org/10.1016/j.biosystems.2016.06.001

Solution Space



Flux-Balance Analysis framework:

- Prepare a genome-scale metabolic network
- Set stoichiometric matrix and bounds
- Uses linear programming (or other approaches) to maximize objective within the allowable space

https://doi.org/10.1016/j.biosystems.2016.06.001

Hands On Session

Link to the jupyter notebook will be updated