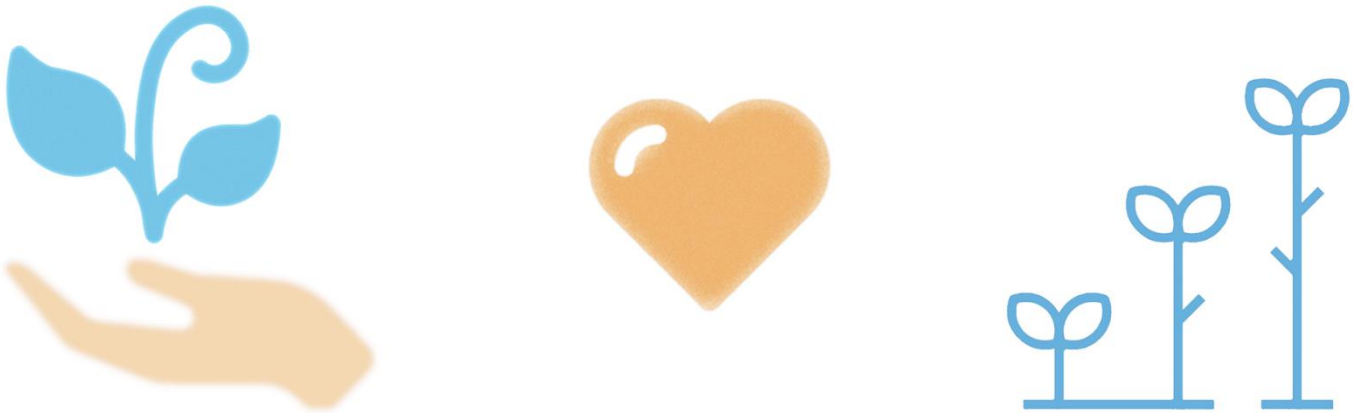
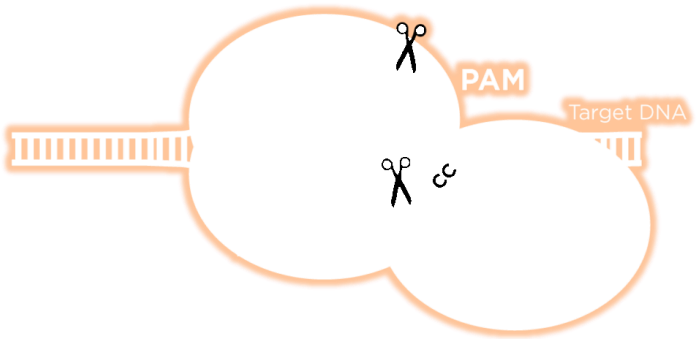
International Conference

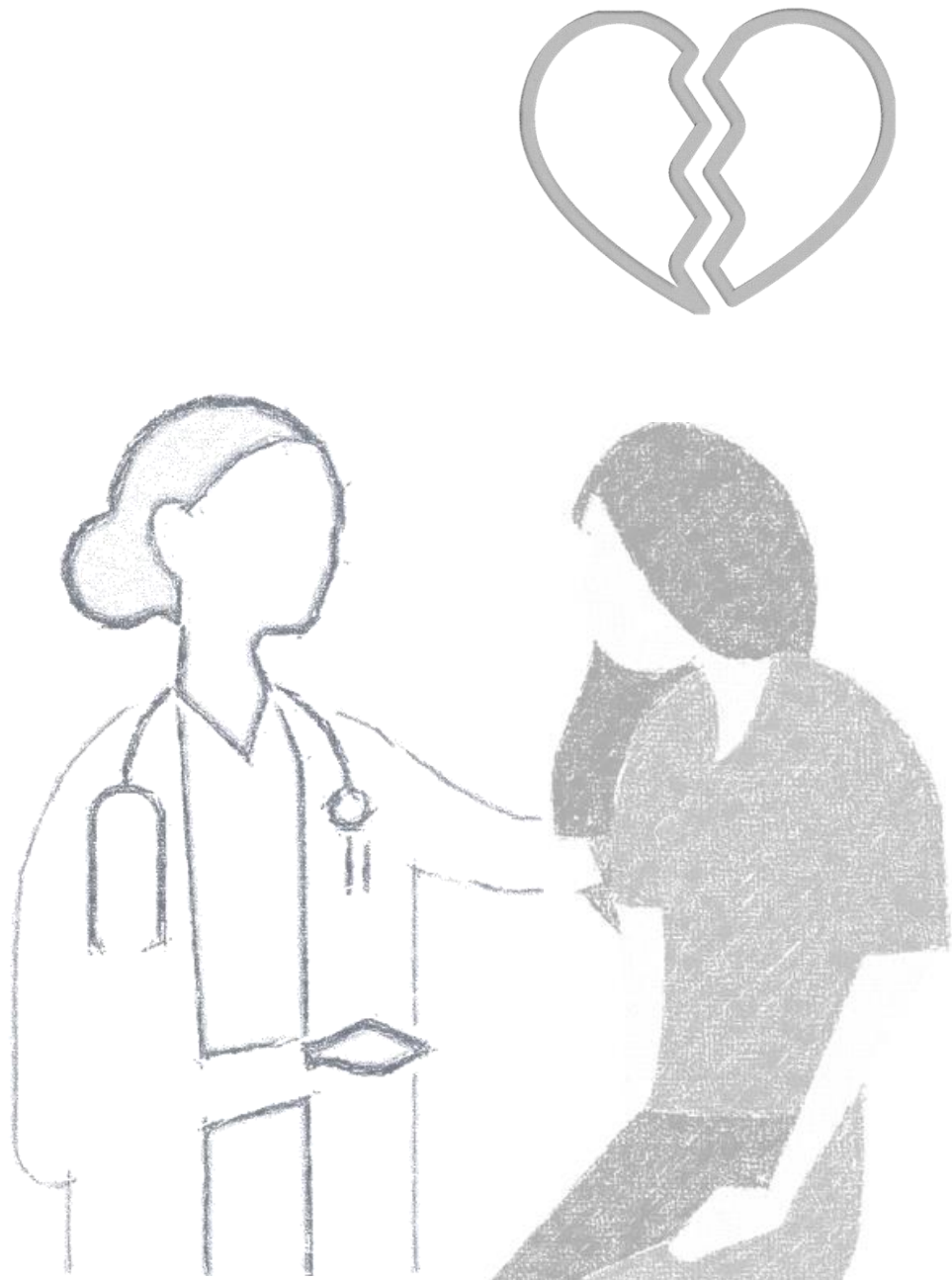
On the tools to fight the antibiotic resistance pandemic

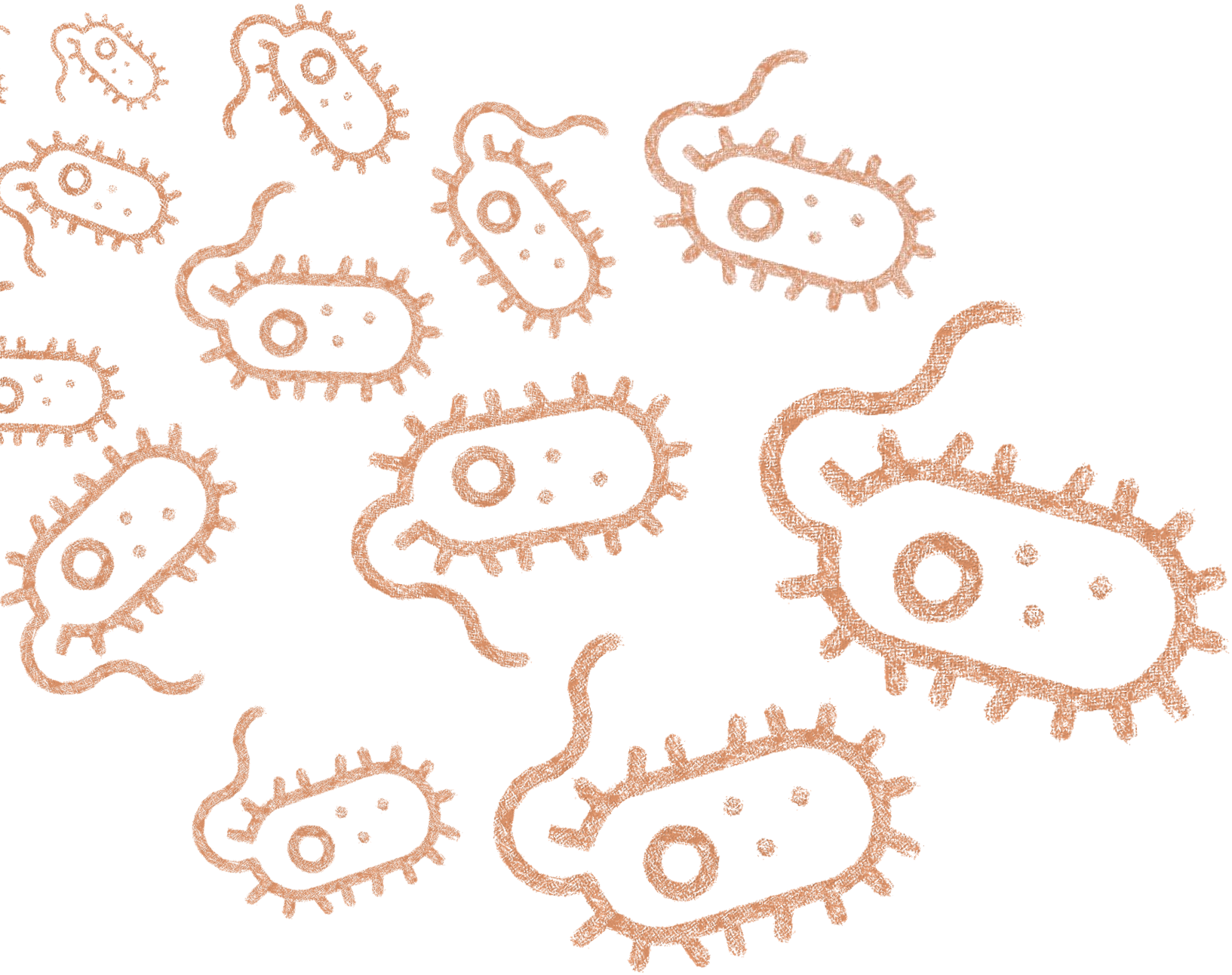


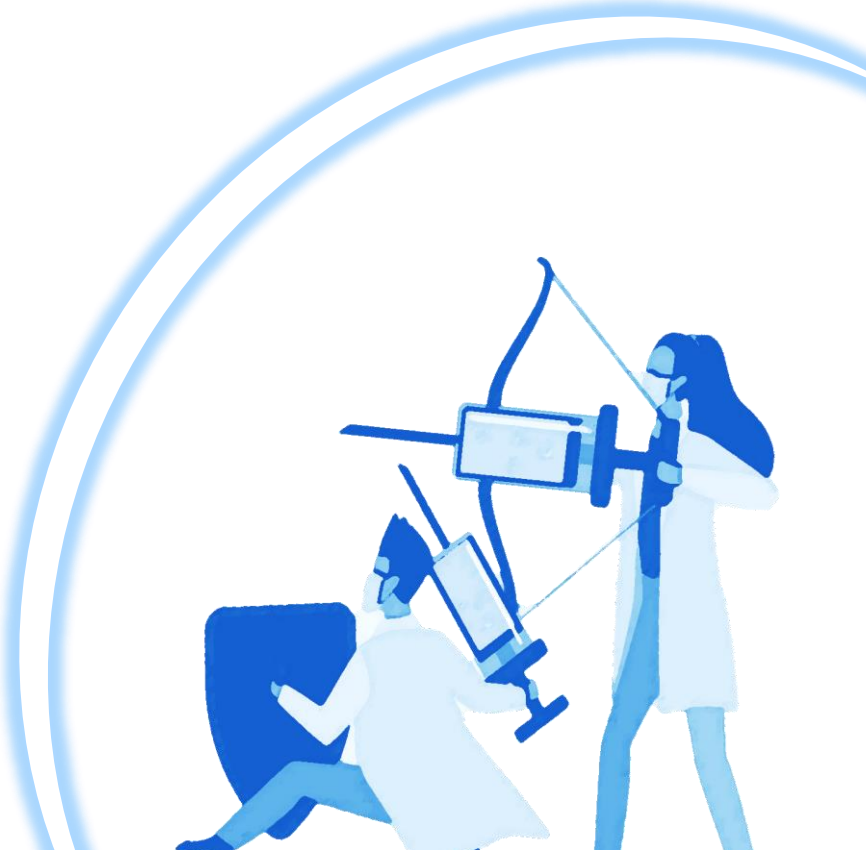
Barcelona Biomedical Research Park

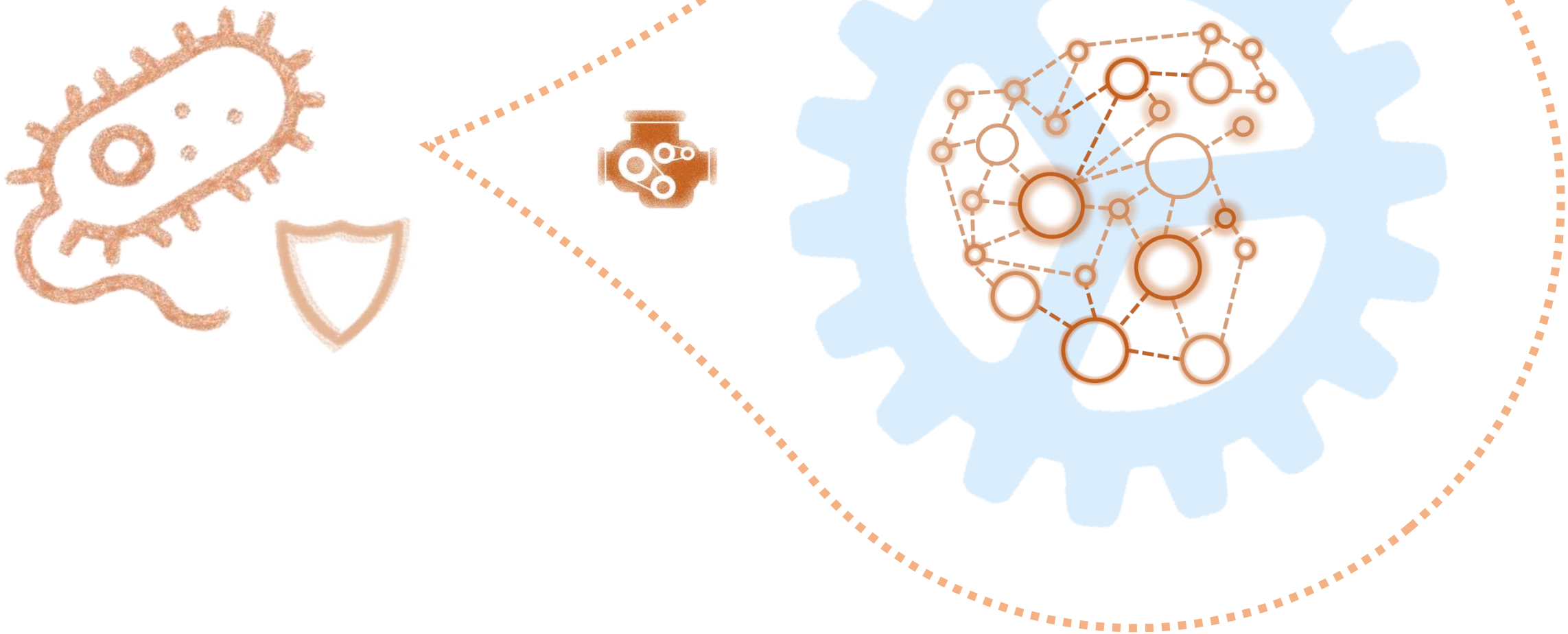
ARIA iGEM Team
Joel Romero Hernández


PAM
Target DNA
cc

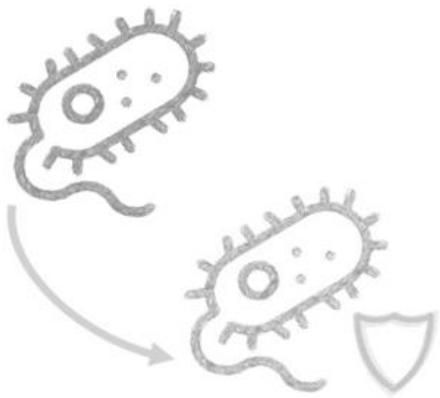








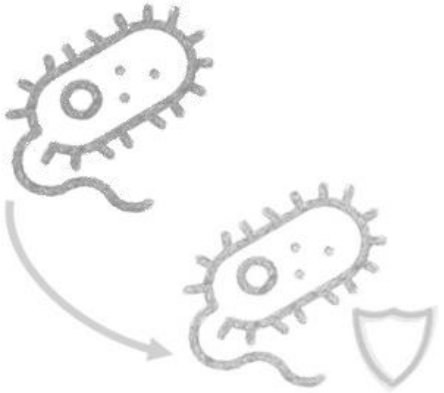
Multi-resistant Infection



Cancer

Cardiovascular Disease

Multi-resistant Infection



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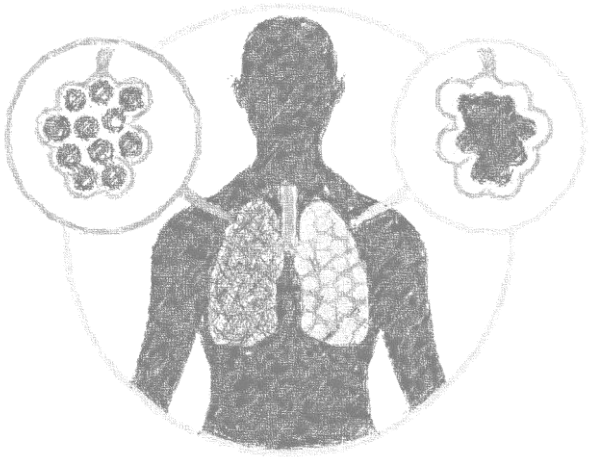
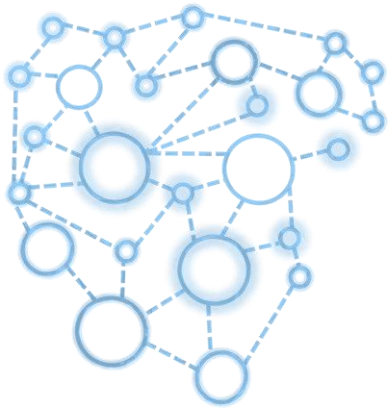
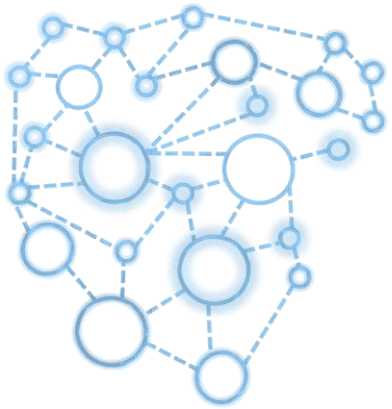


Multifactorial Phenomena

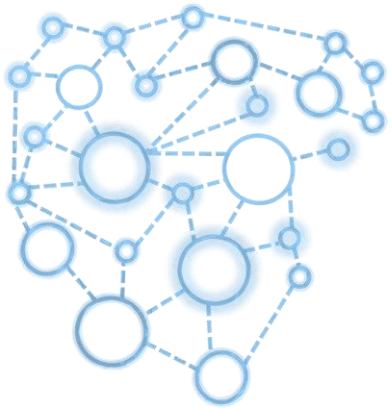


Multifactorial Phenomena



Multiscale Implications

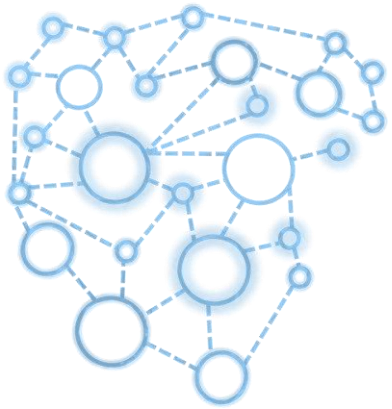
Multifactorial Phenomena



Multiscale Implications

Unpredictable Effects

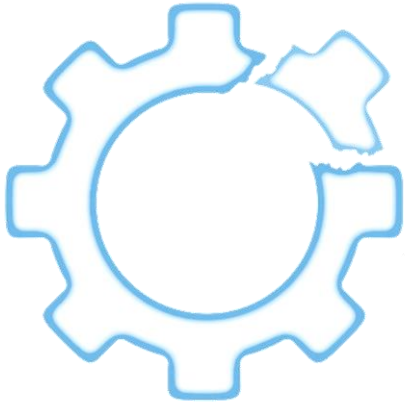
Multifactorial Phenomena



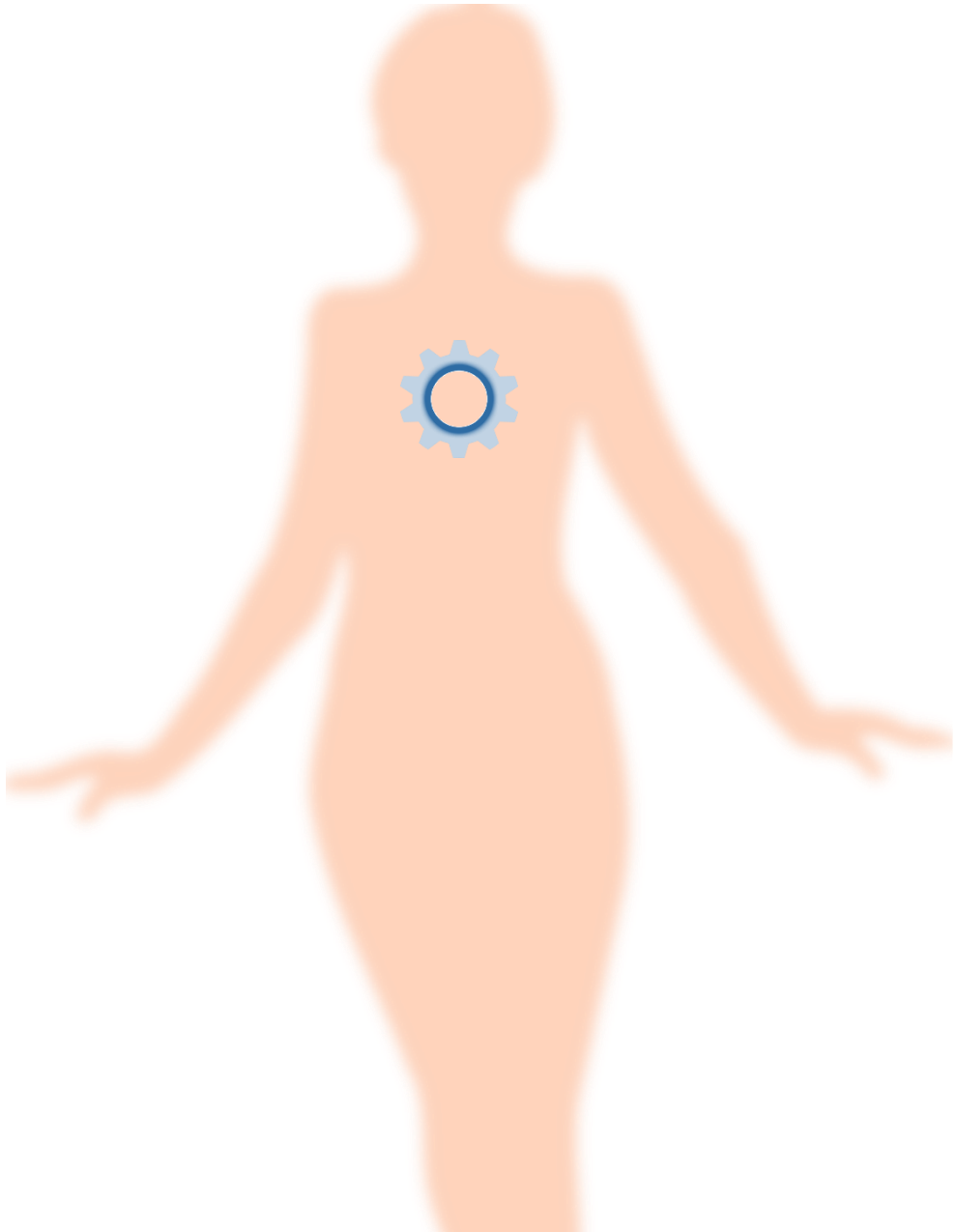
Multiscale Implications

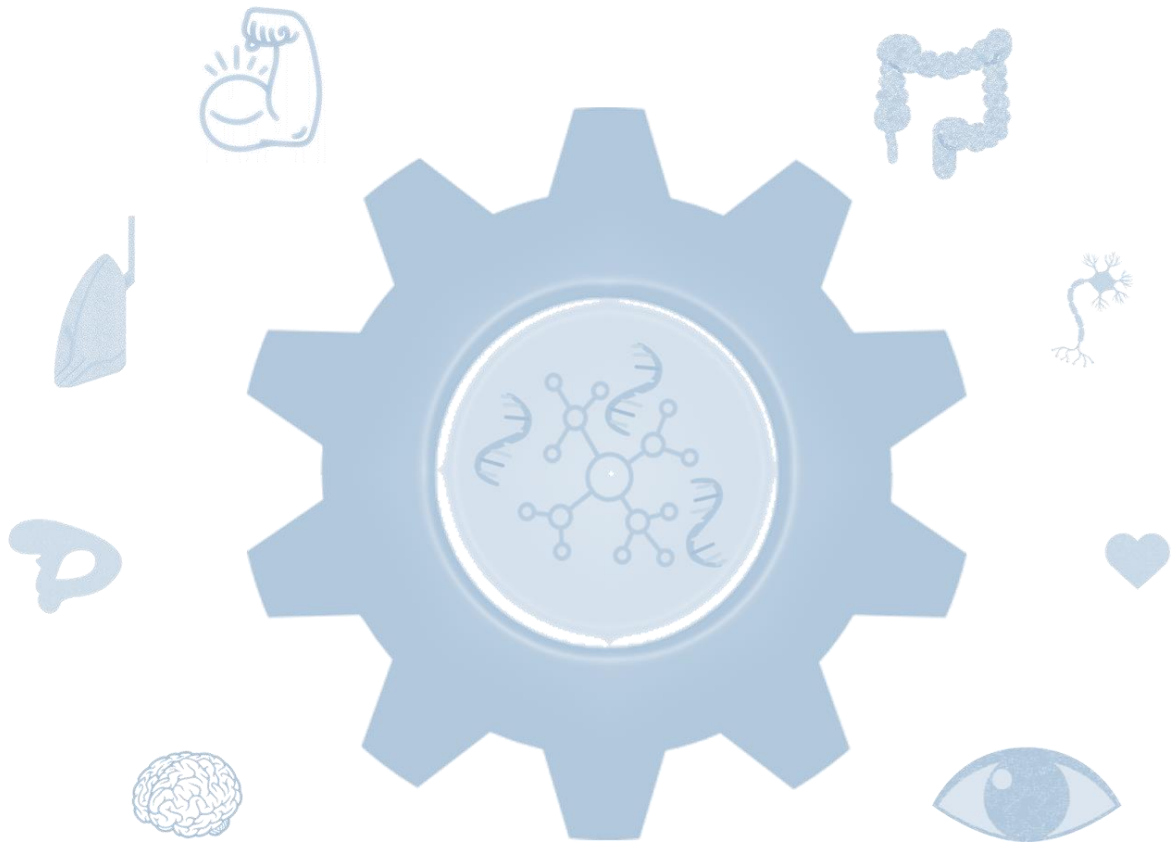
Unpredictable Effects

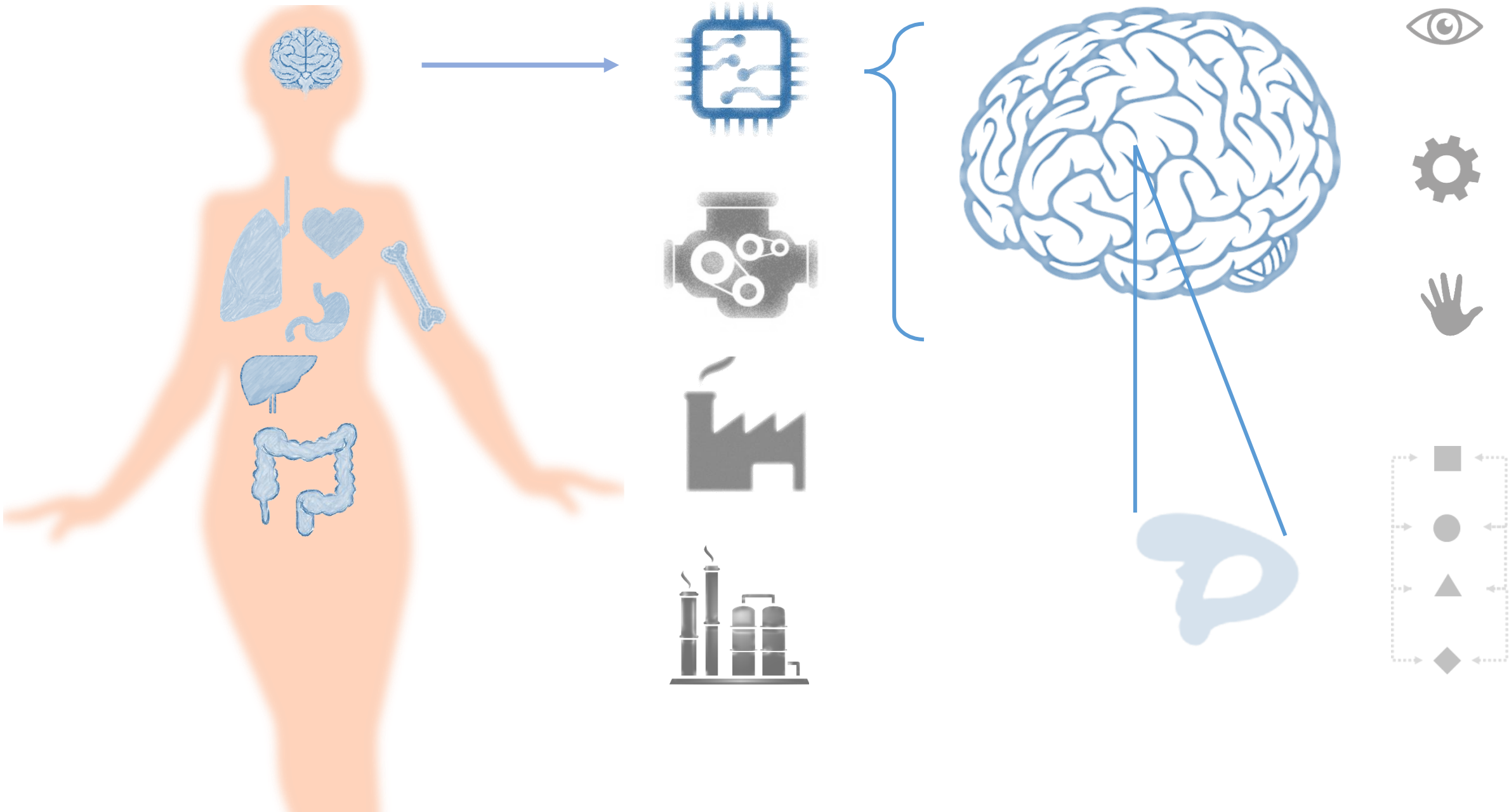
Physiological Failure

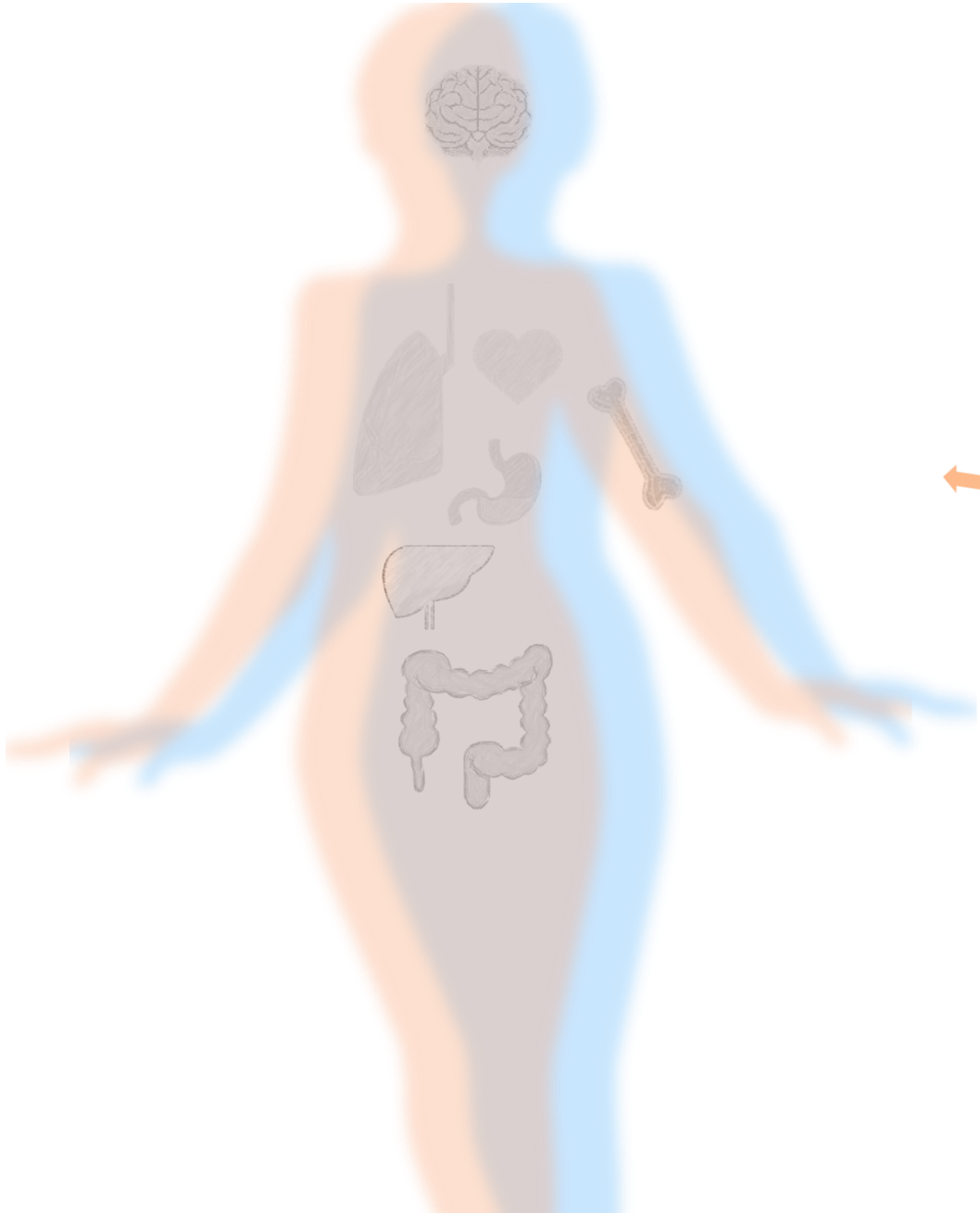


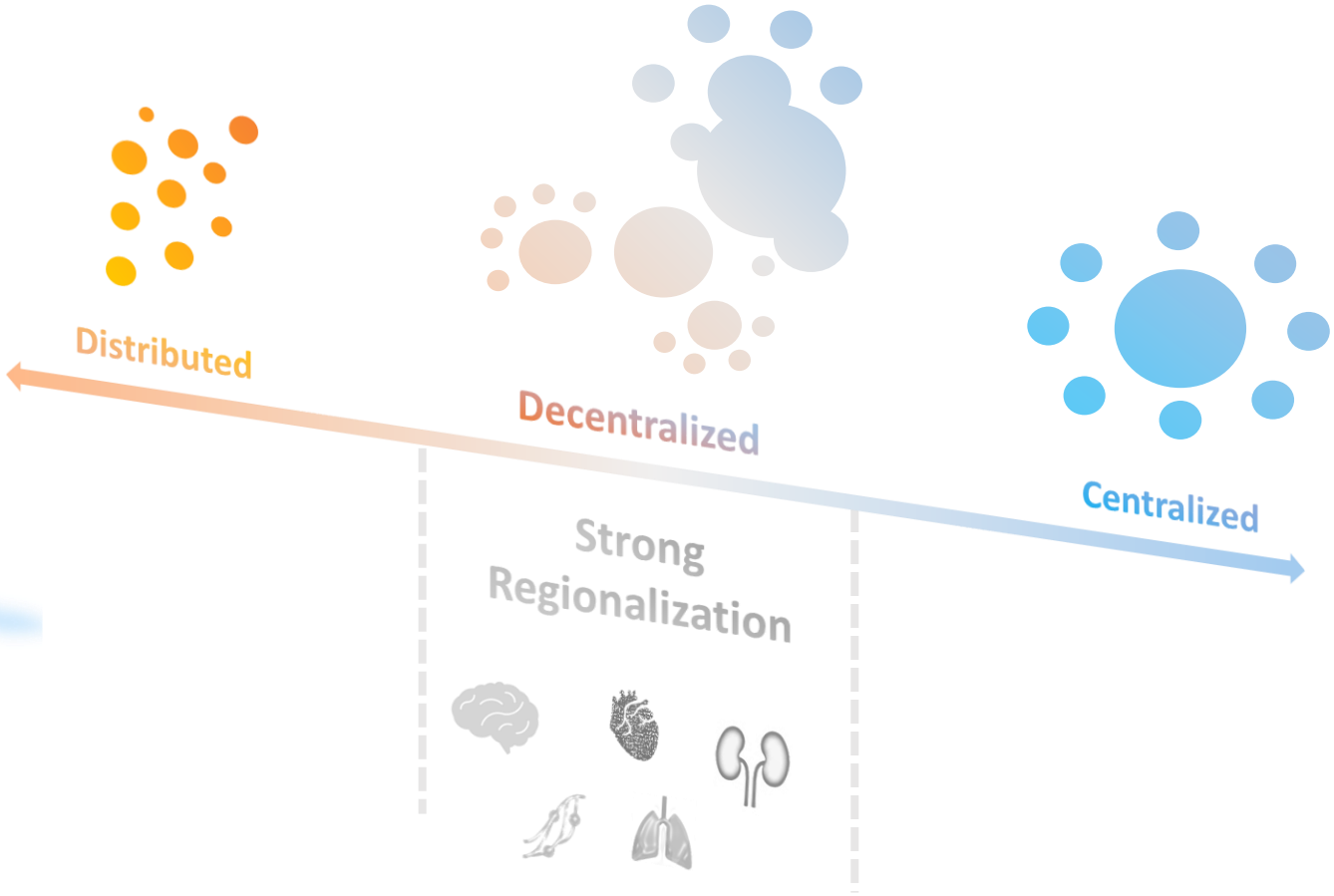
Complex Disease



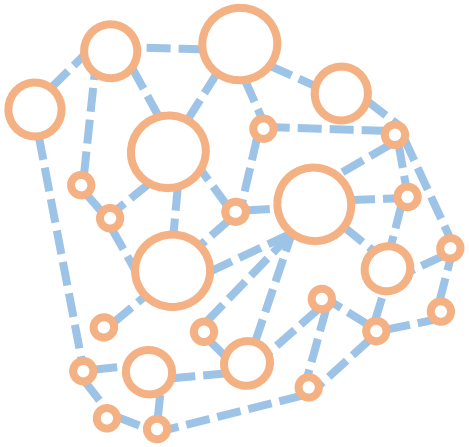


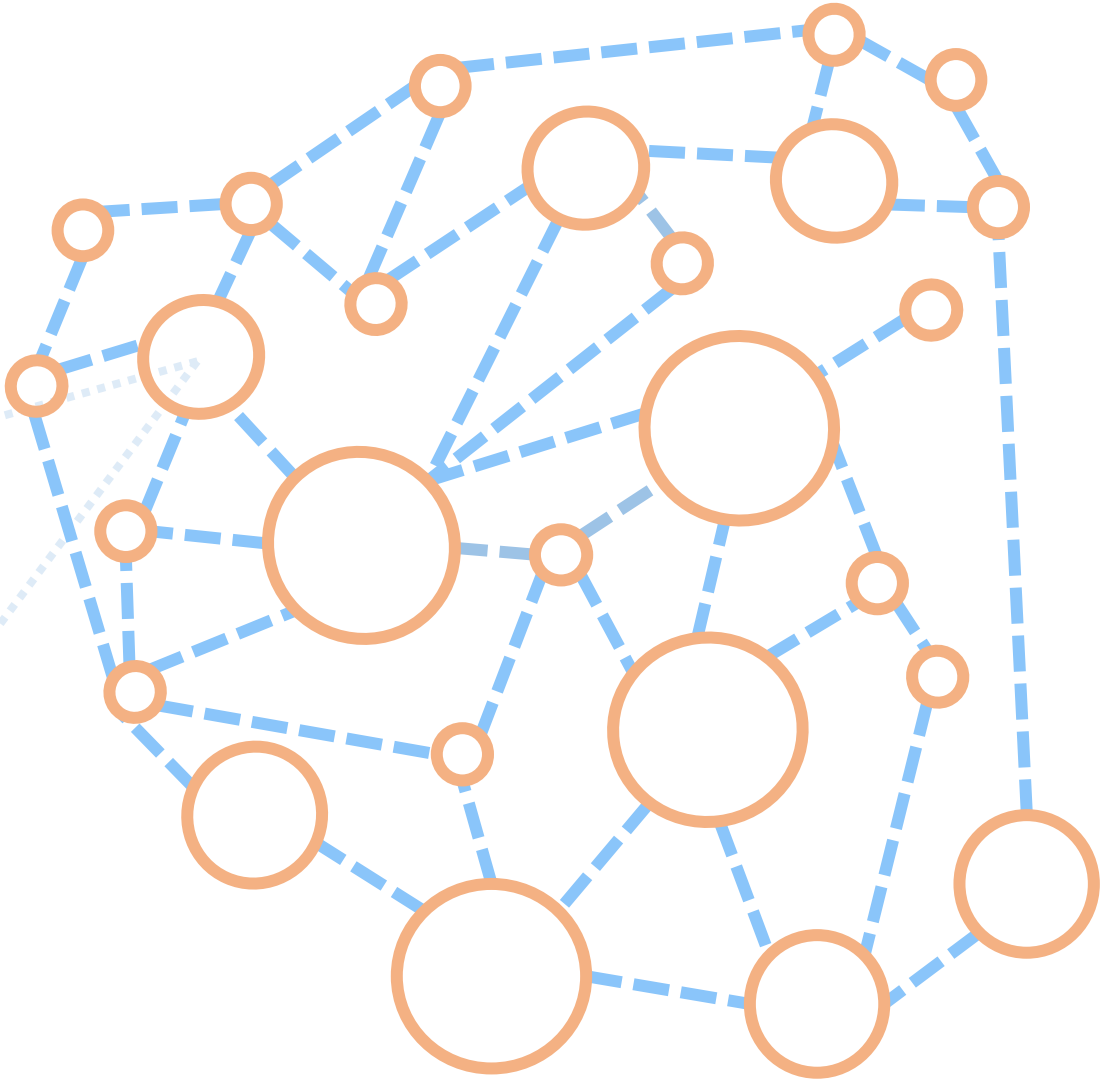




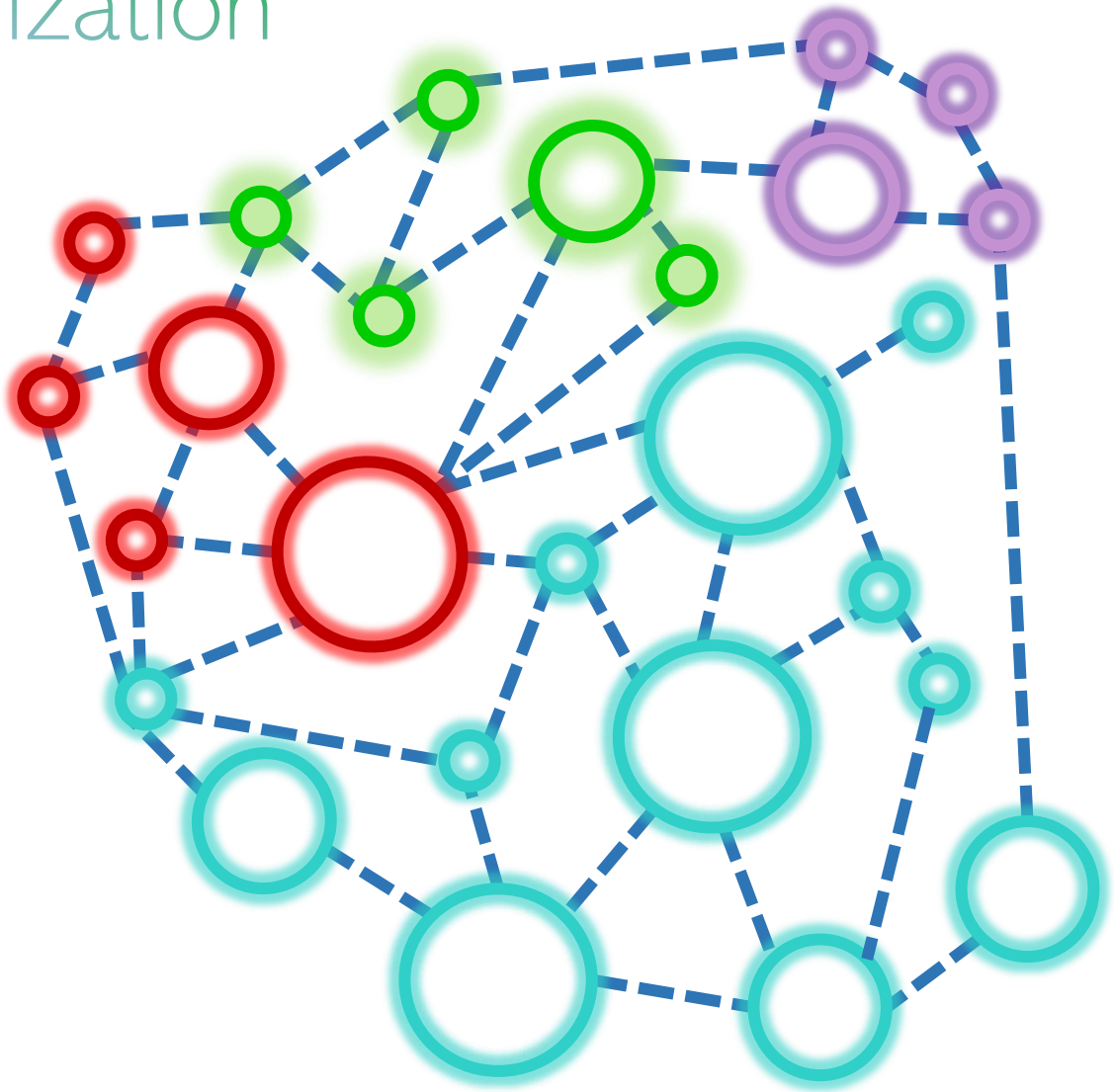

Distributed
Decentralized
Centralized
Strong
Regionalization

Self-organization

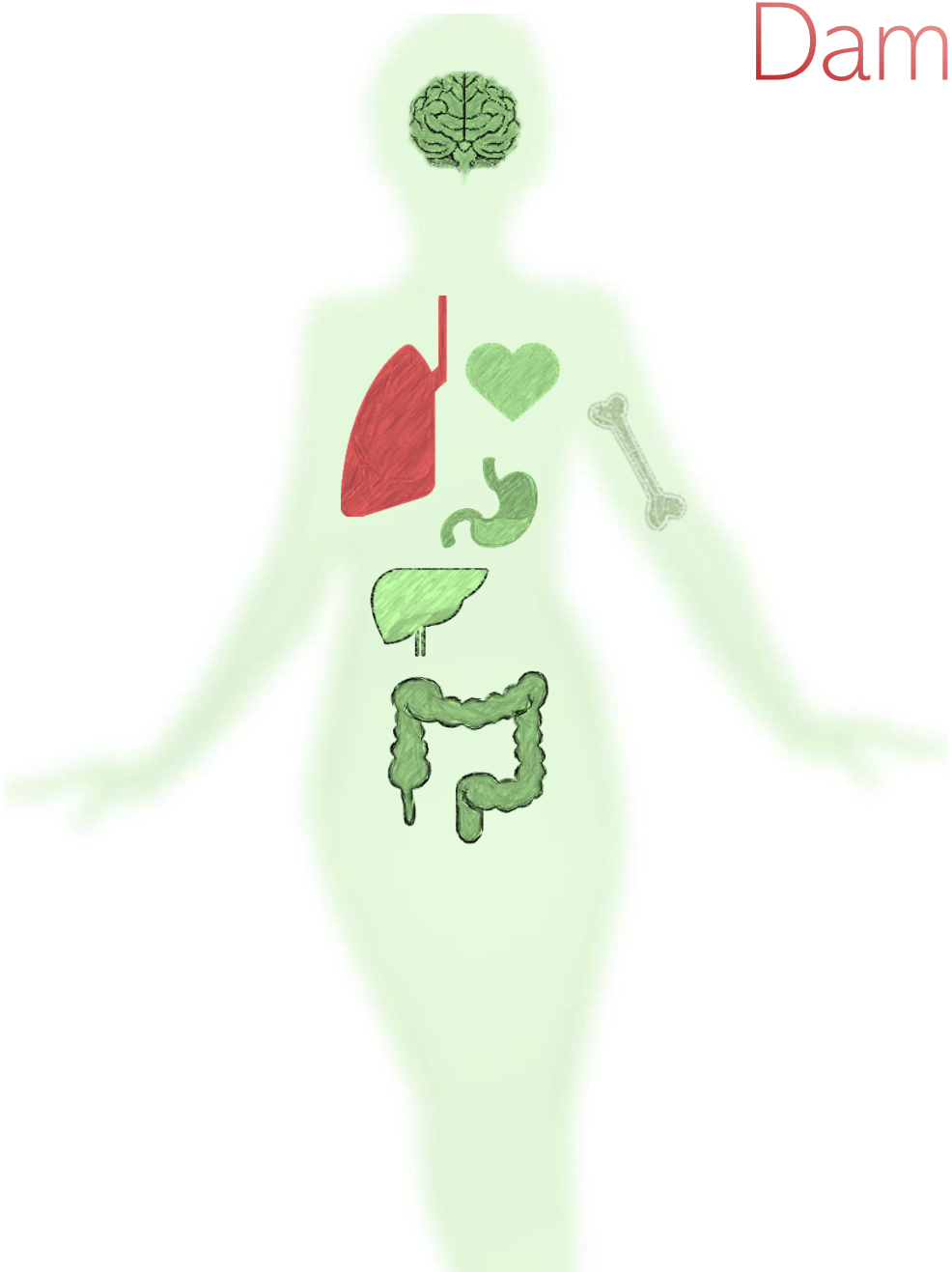


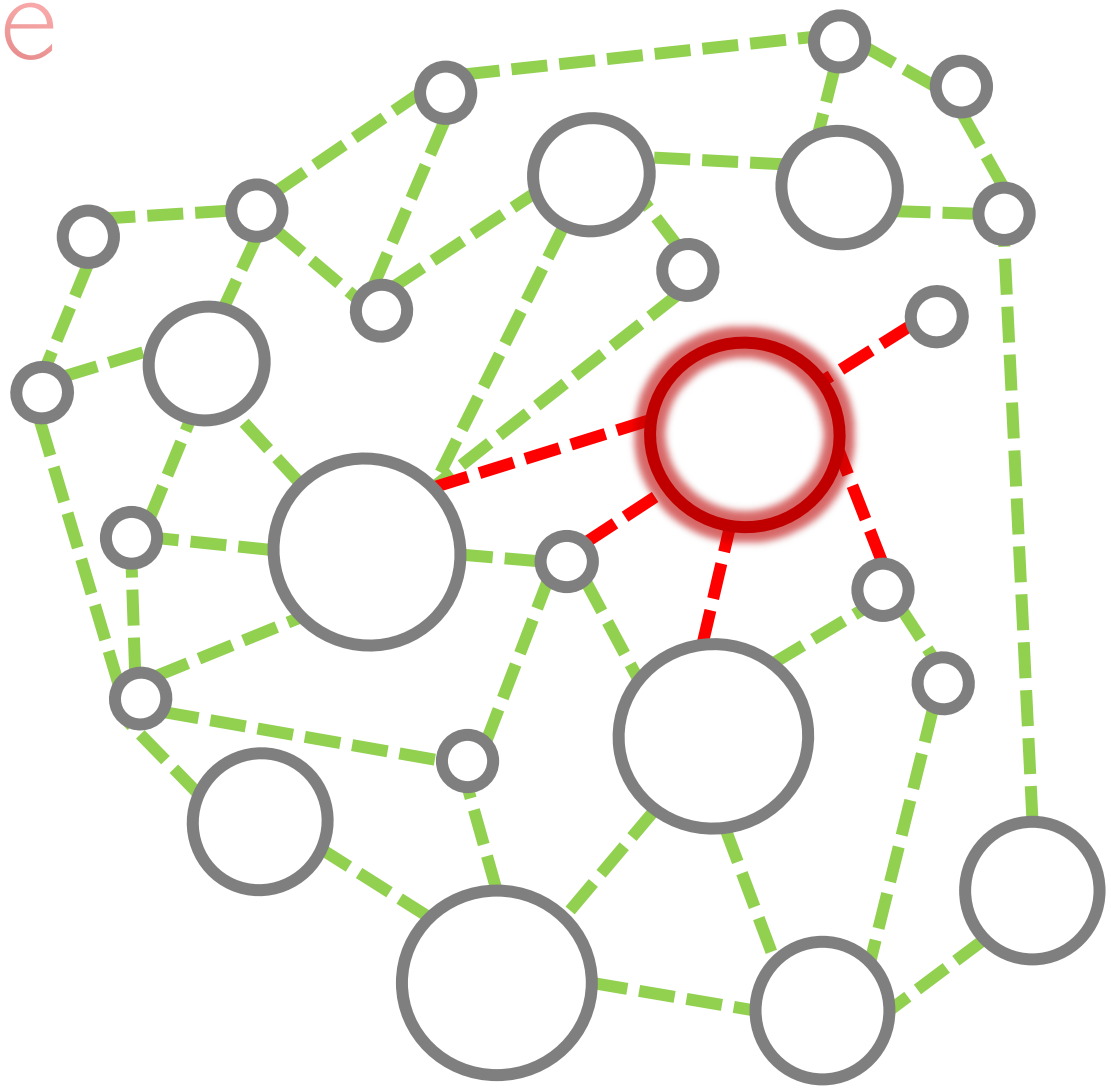


Specialization

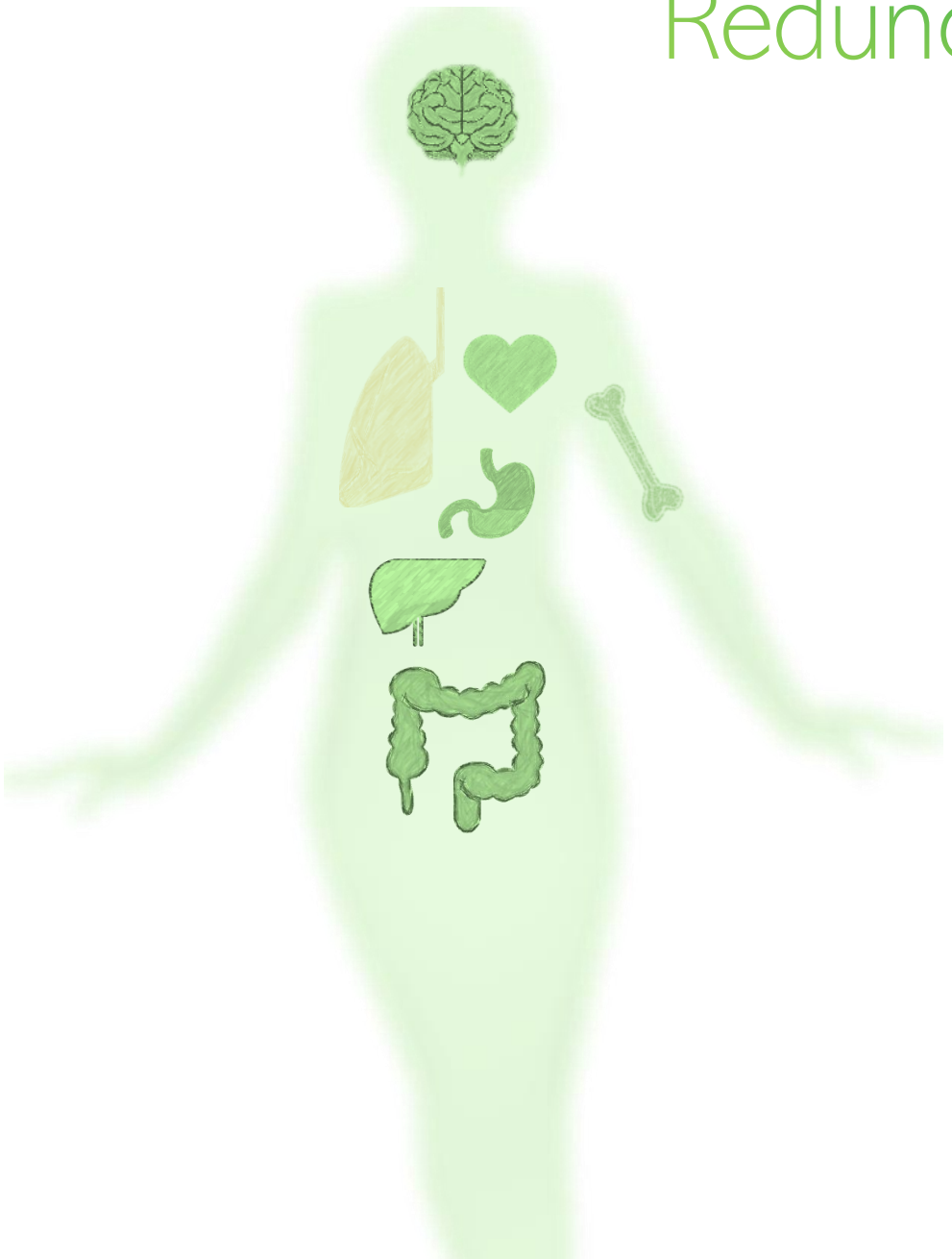


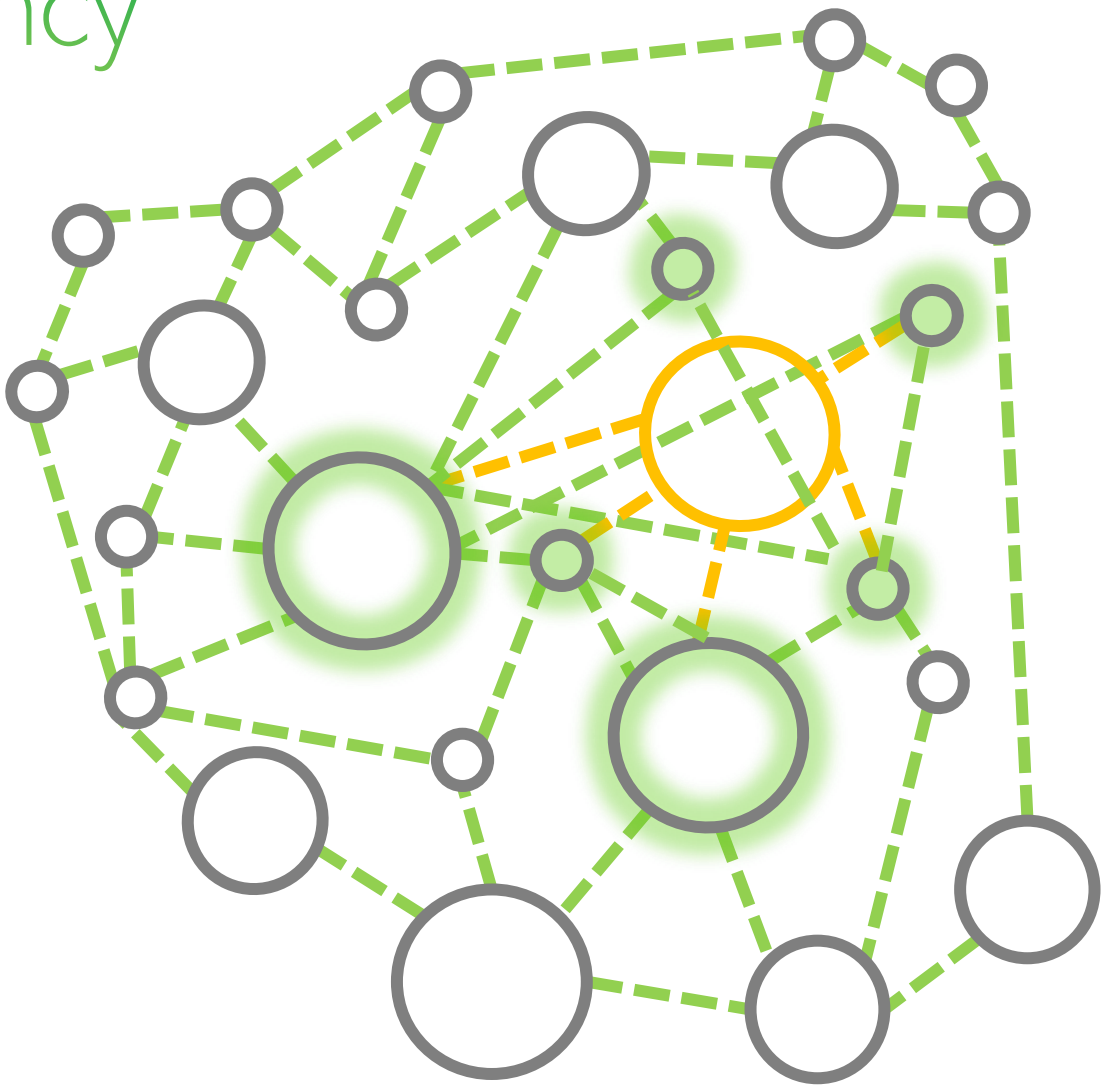
Damage





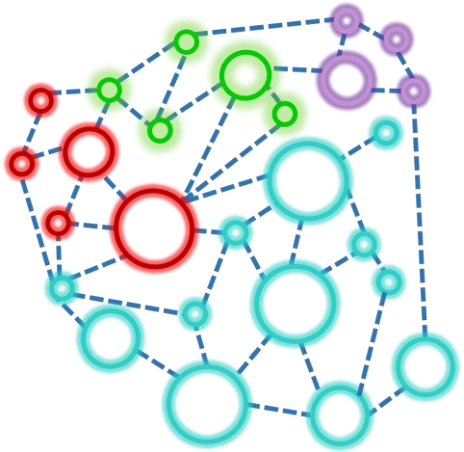
Redundancy

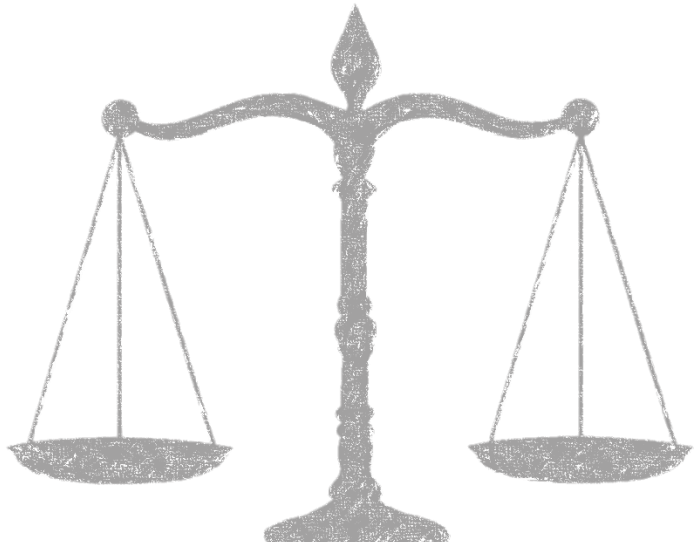




Self-organization

Specialization

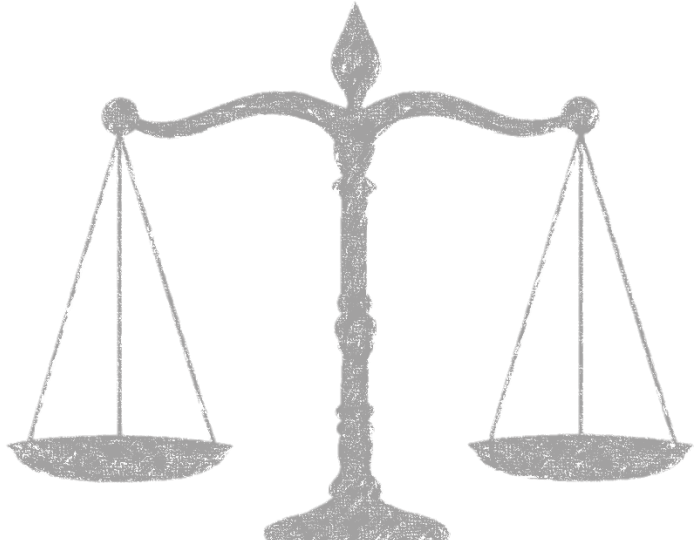




Redundancy

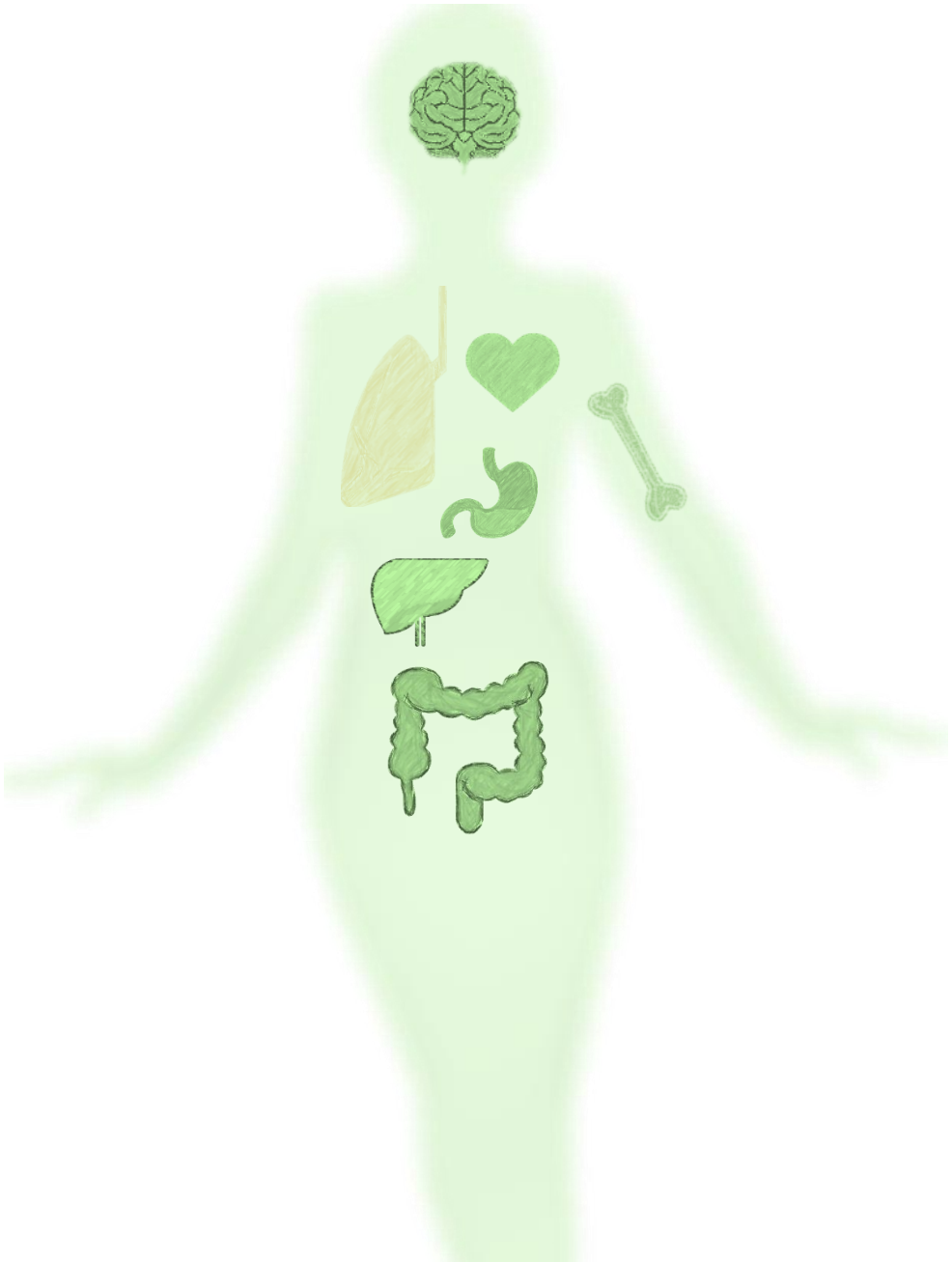
Structure and function

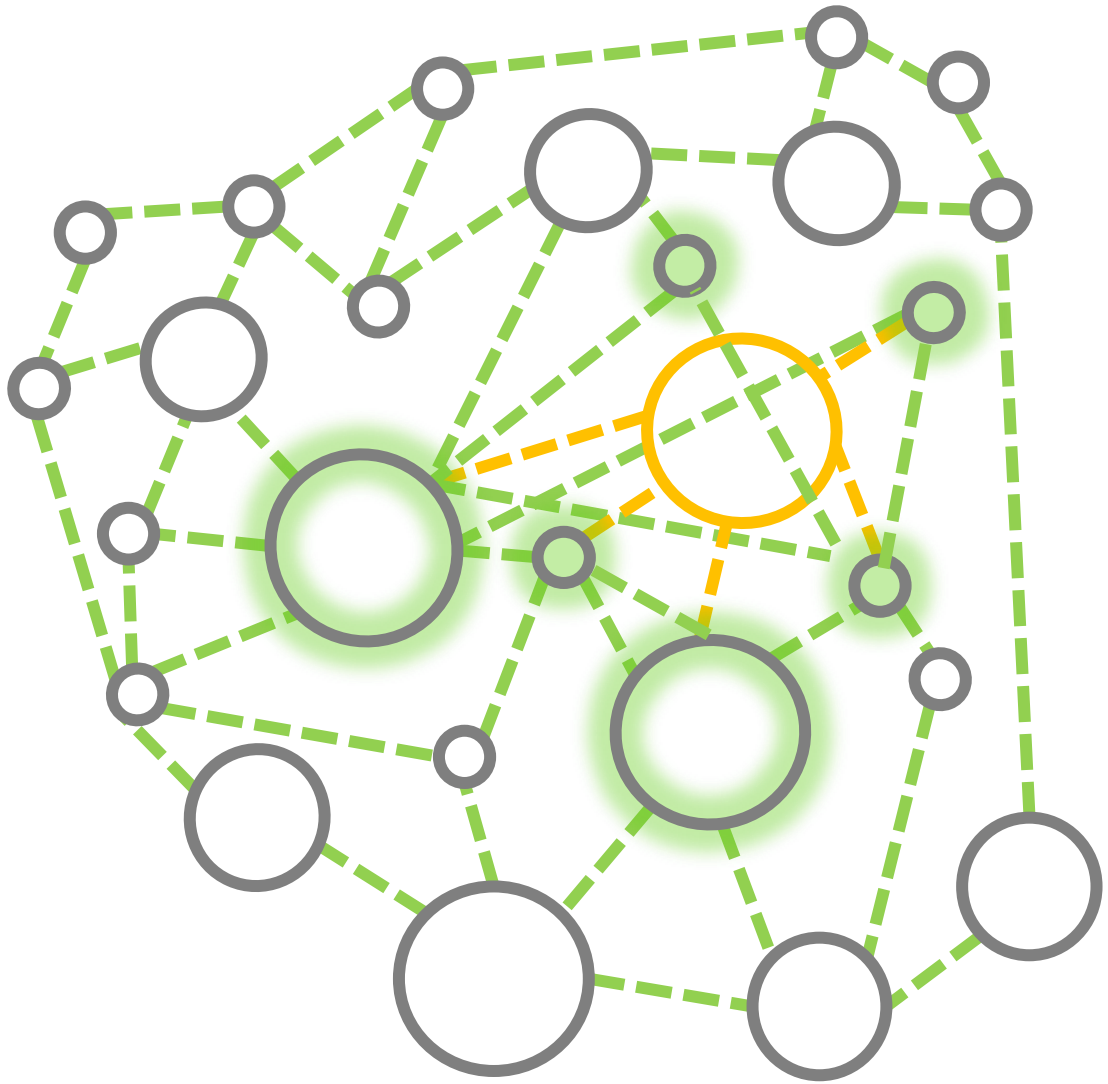
Power

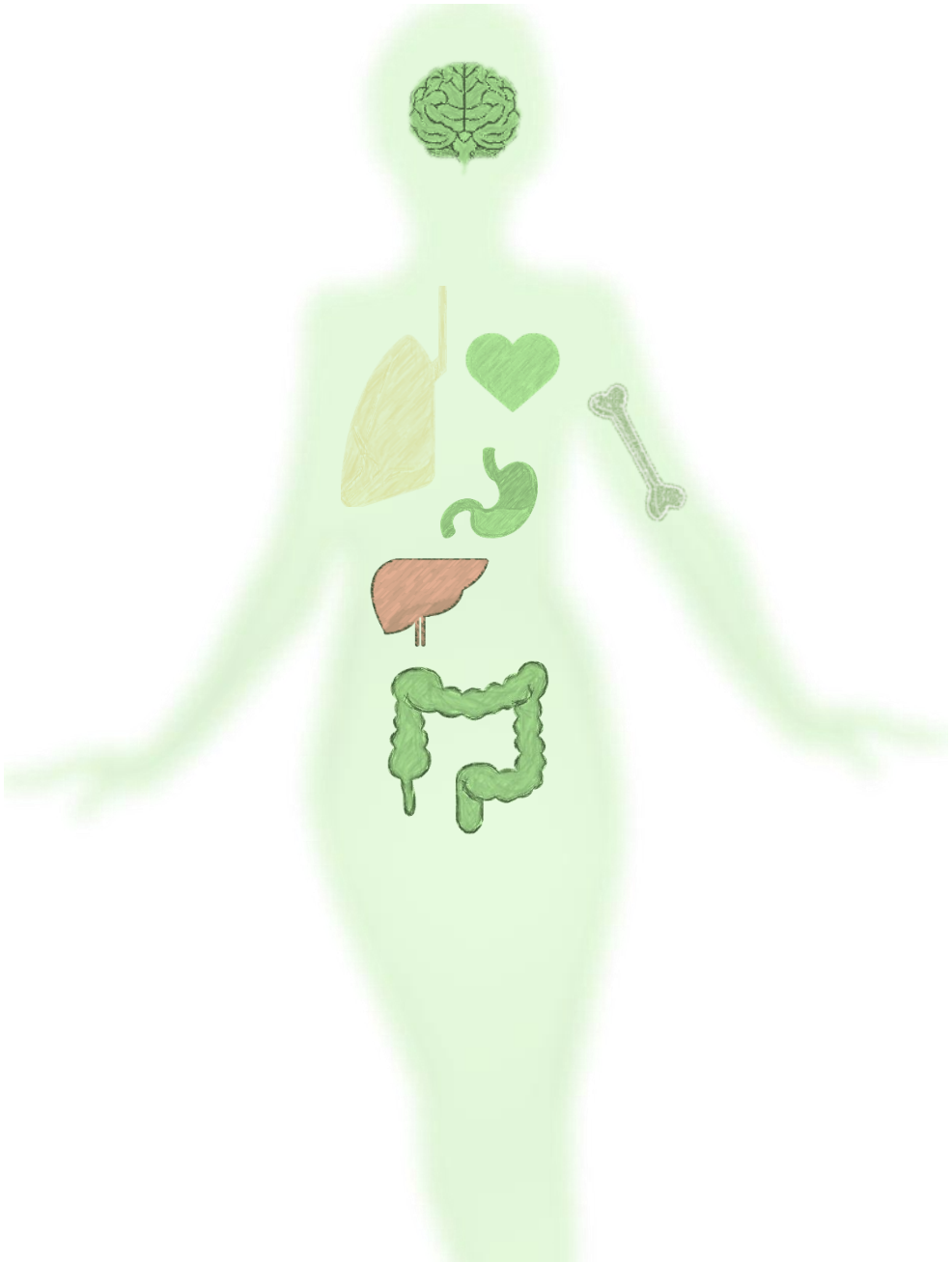


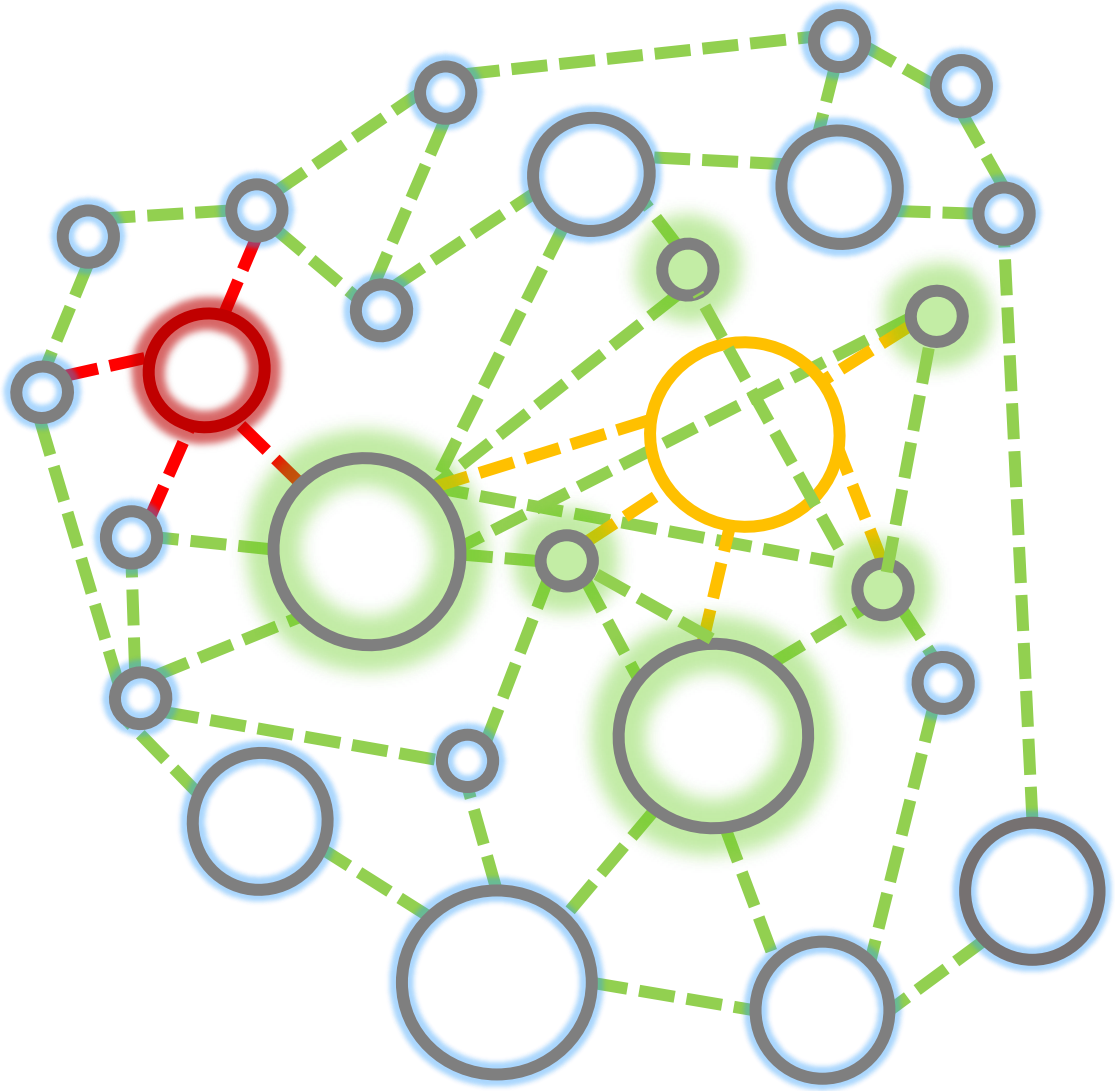
Resilience

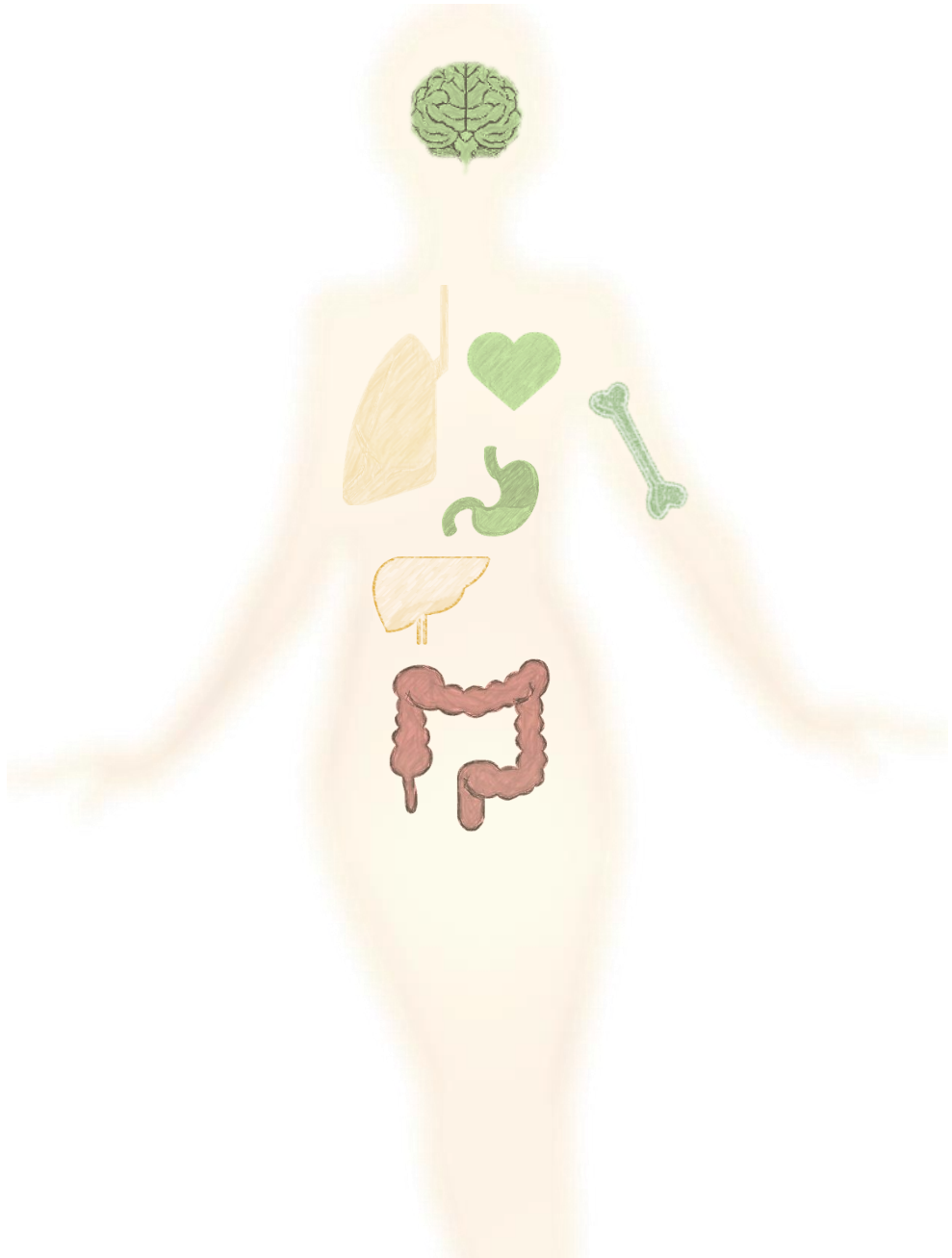
Complex Disease

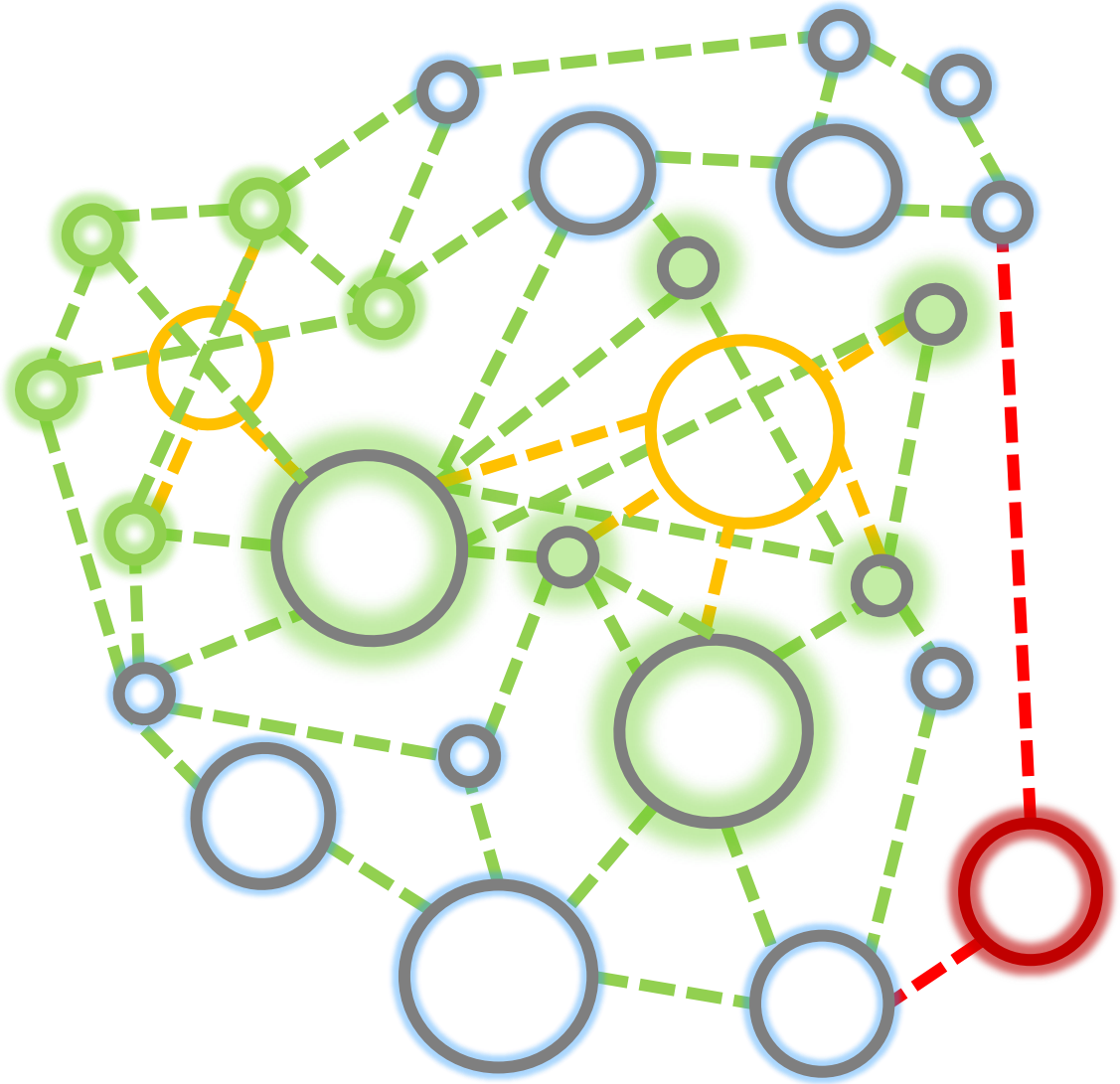


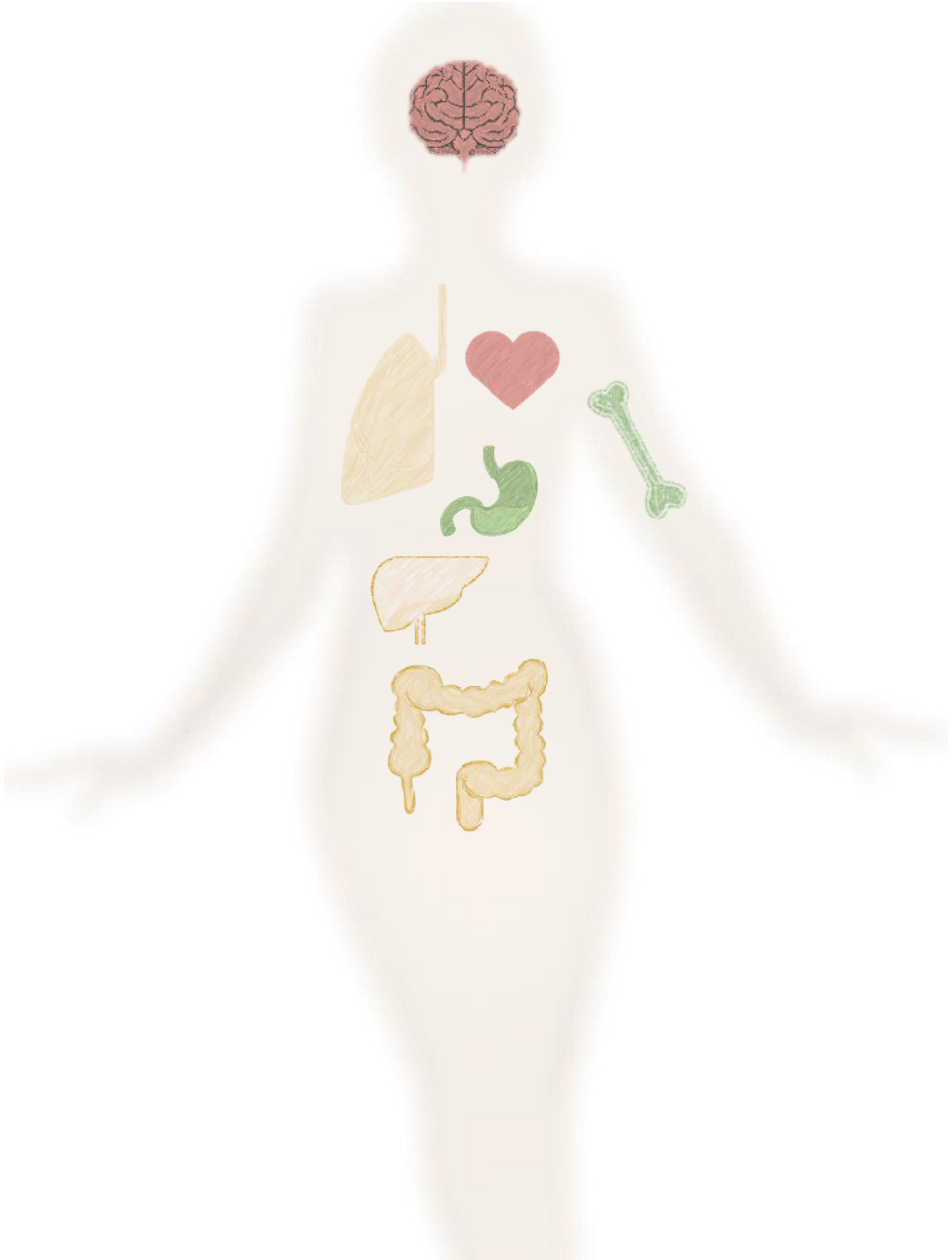


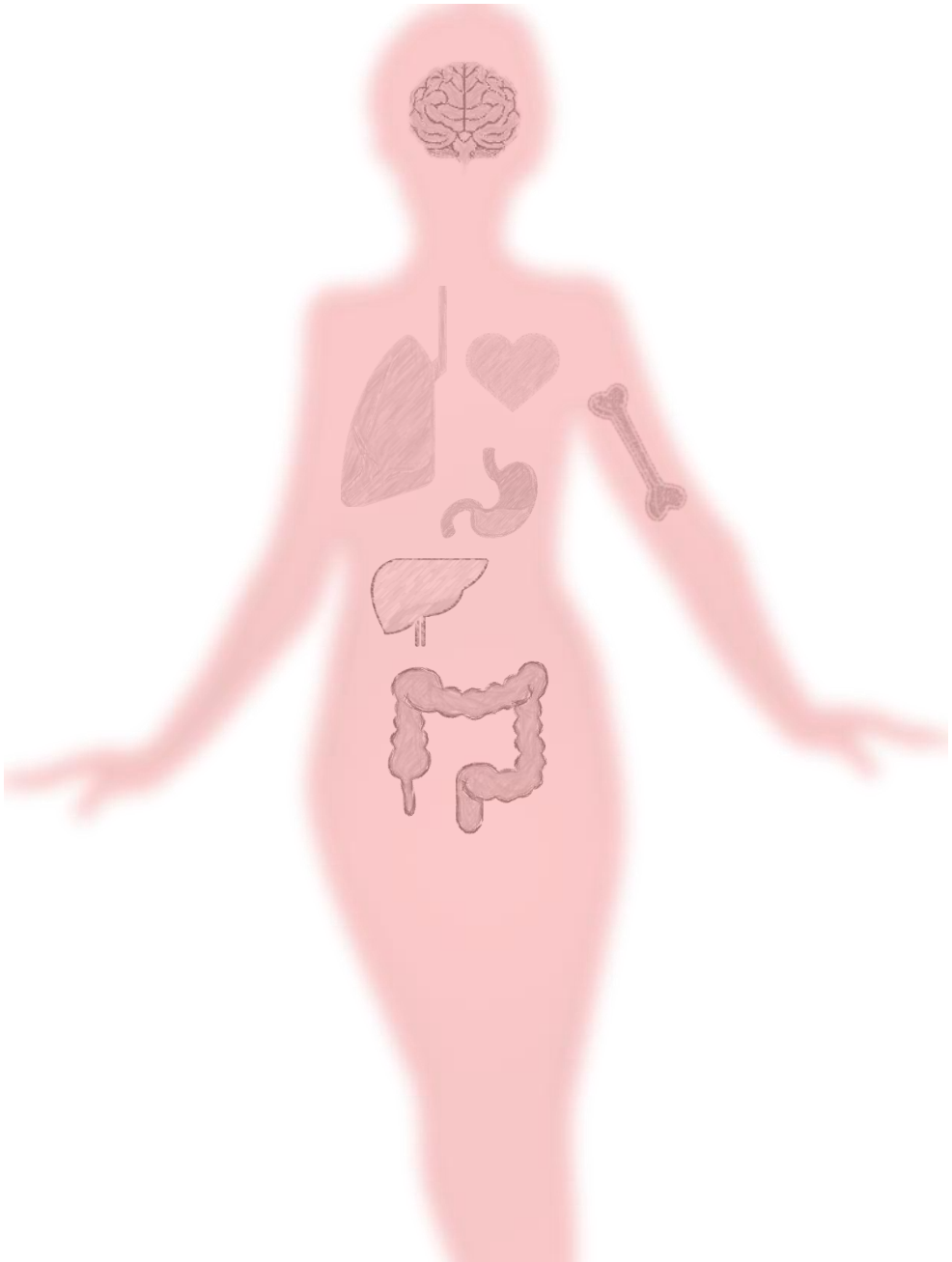


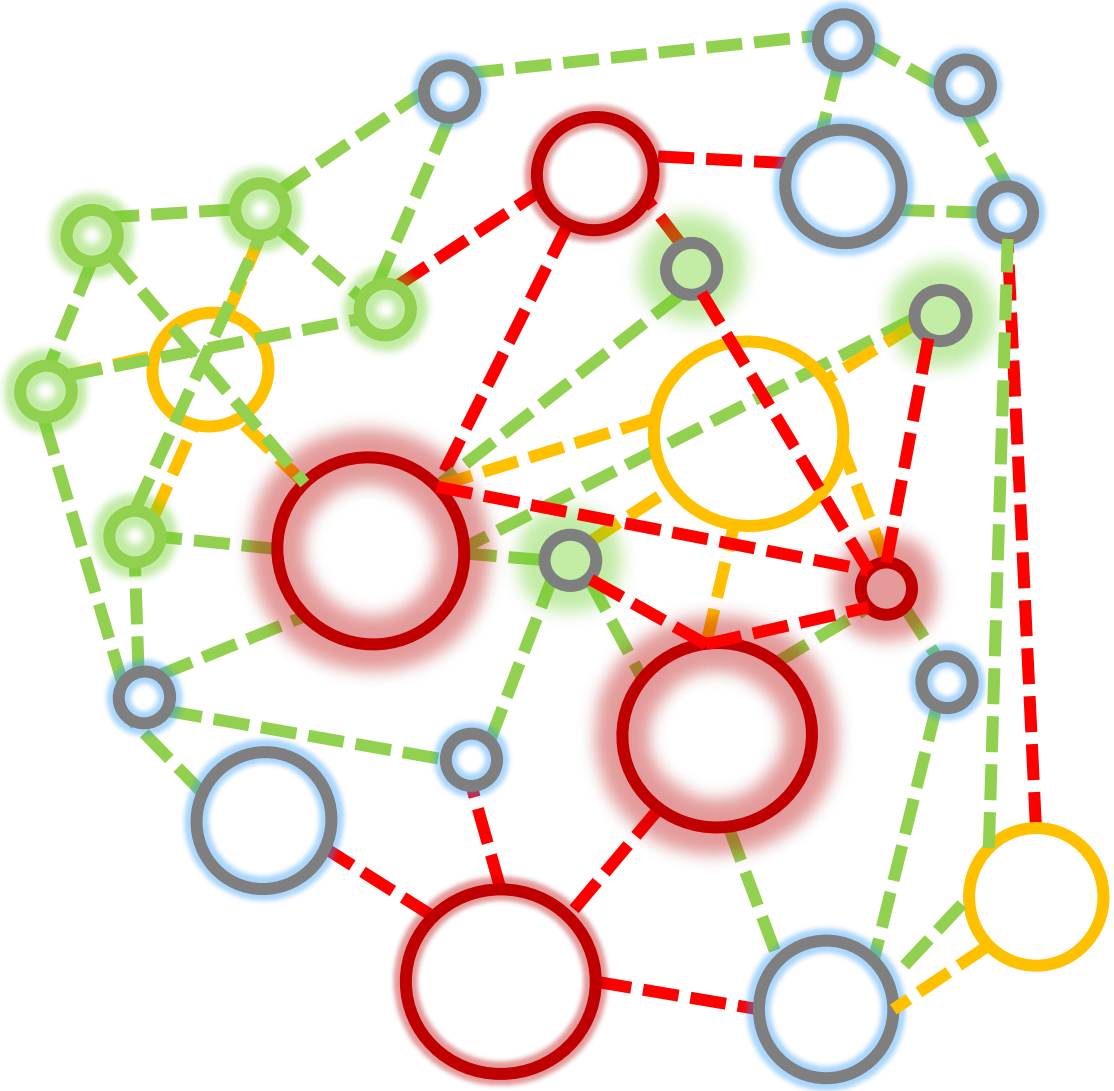


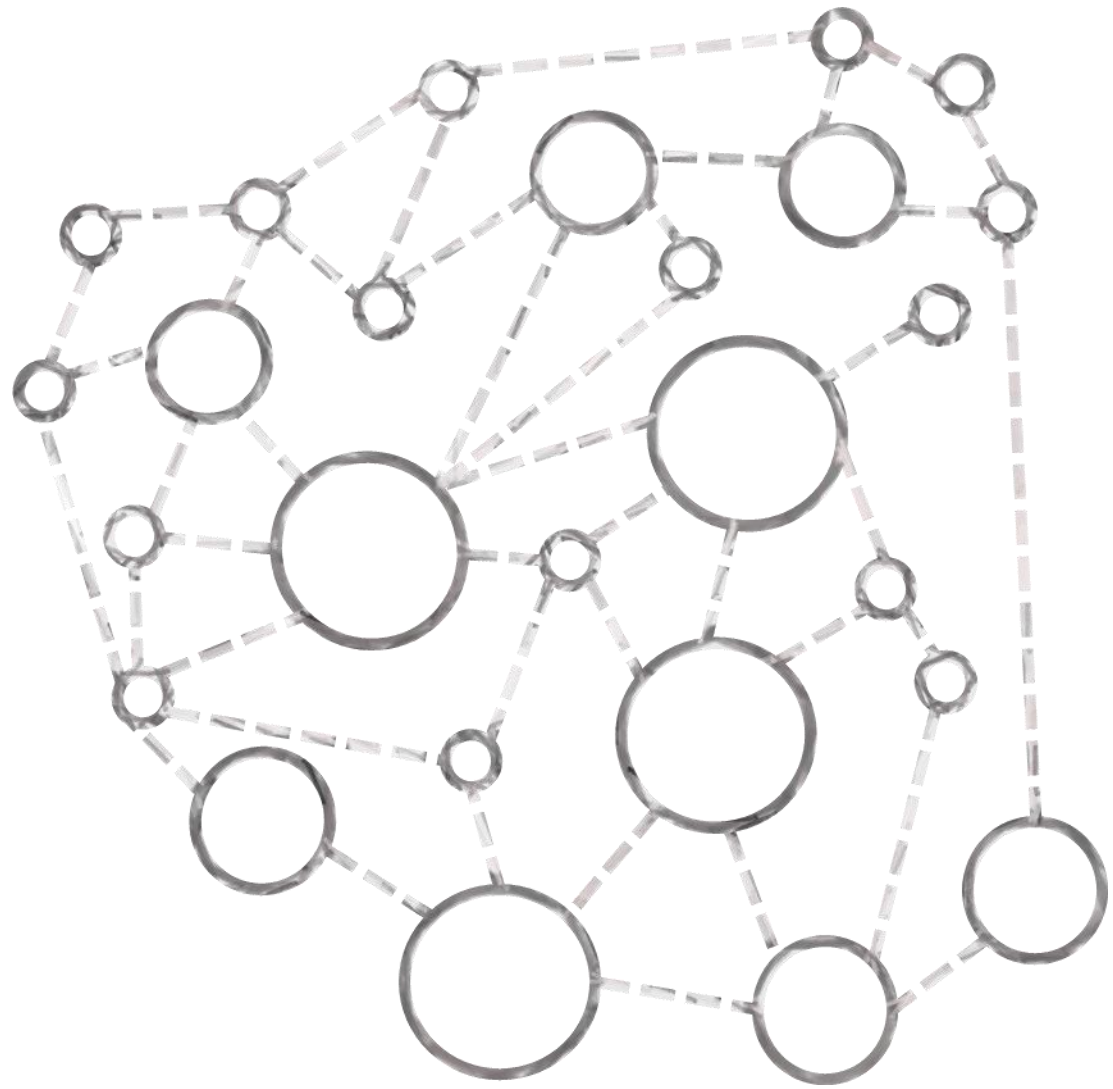












Speed, understanding and accuracy are the key to save lives

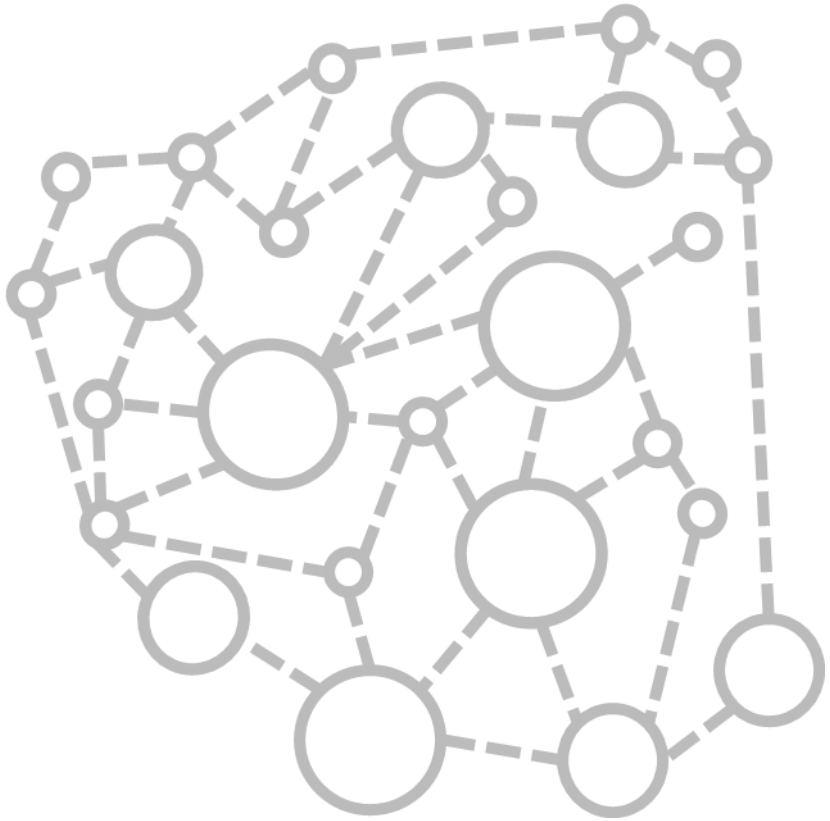
XXI

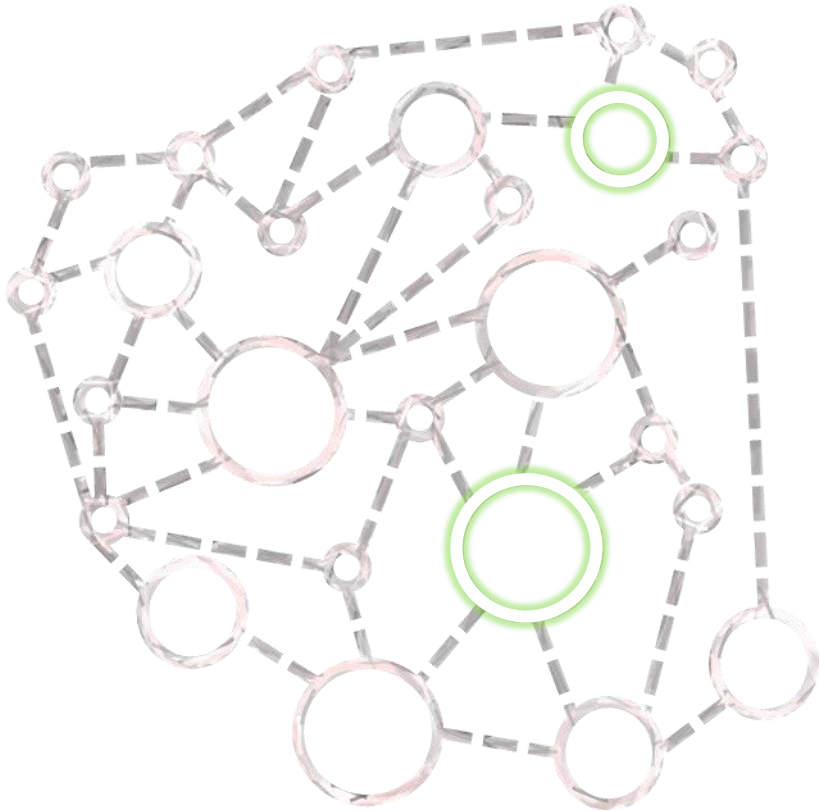
AI

Bioengineering

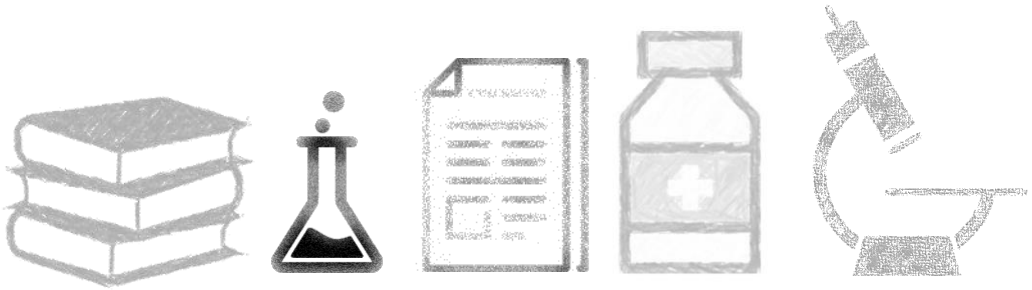
Internet

A biological system can be understood as a complex node network united by intricate connections at multiple scales

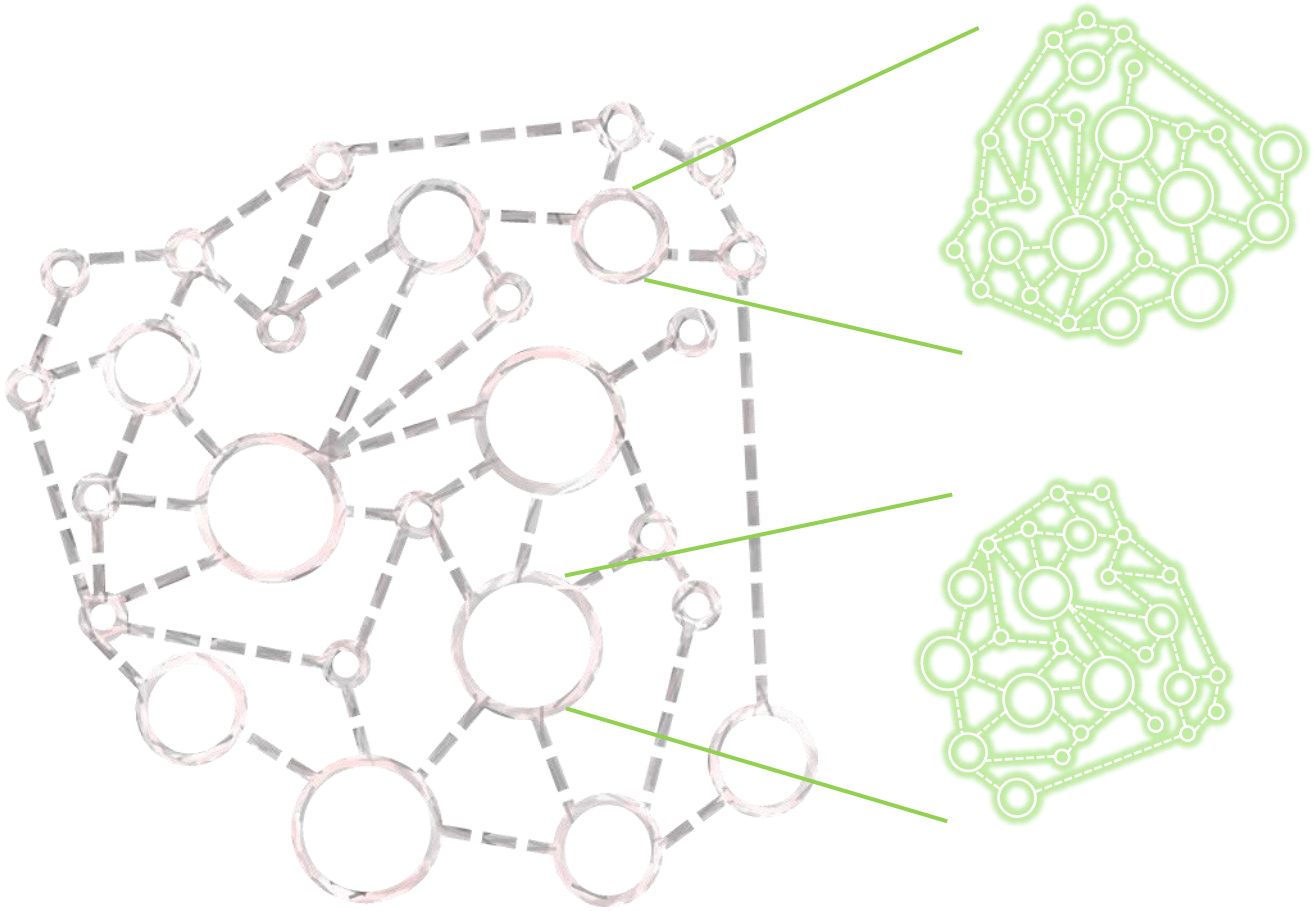




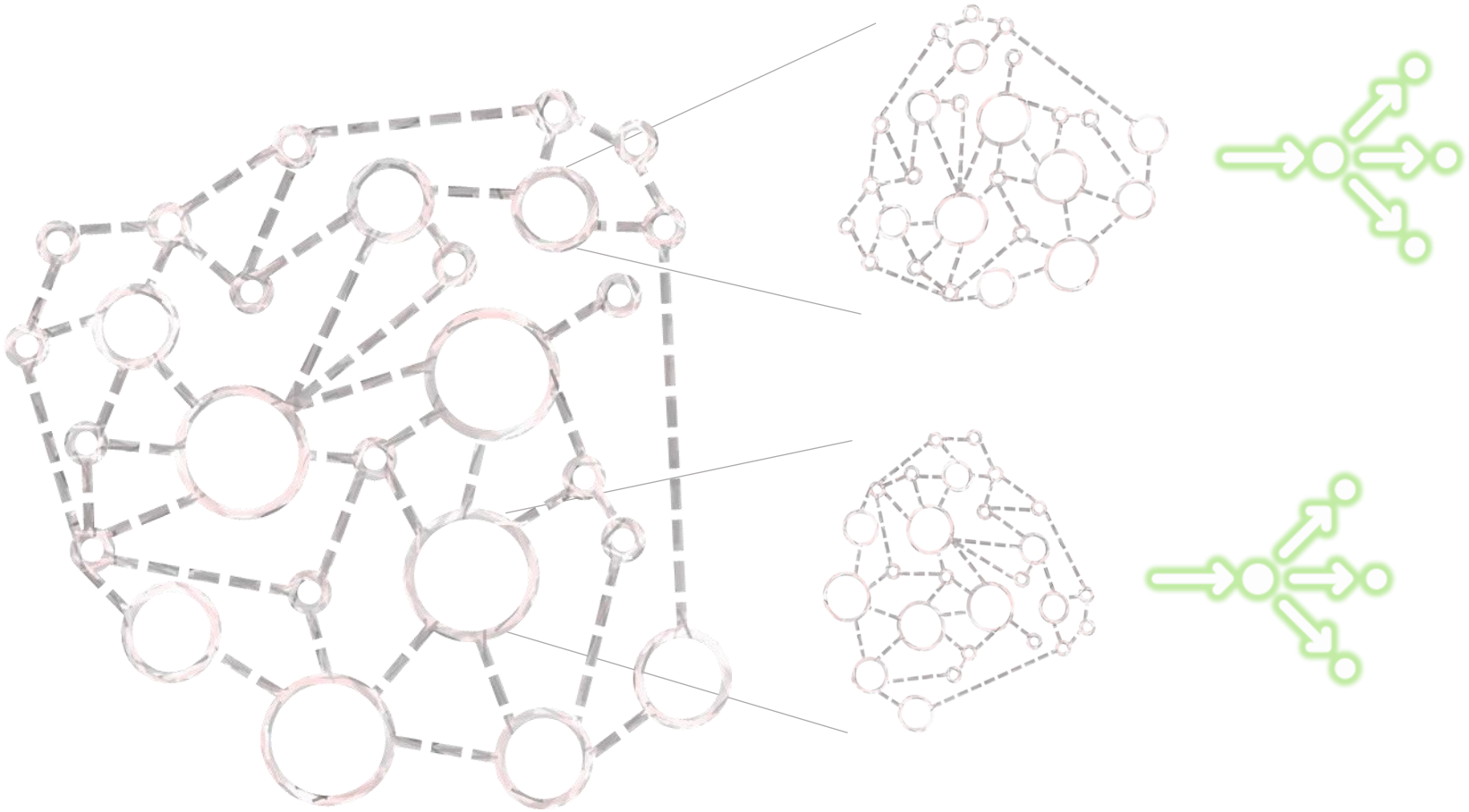
There is a wide
fundamental knowledge



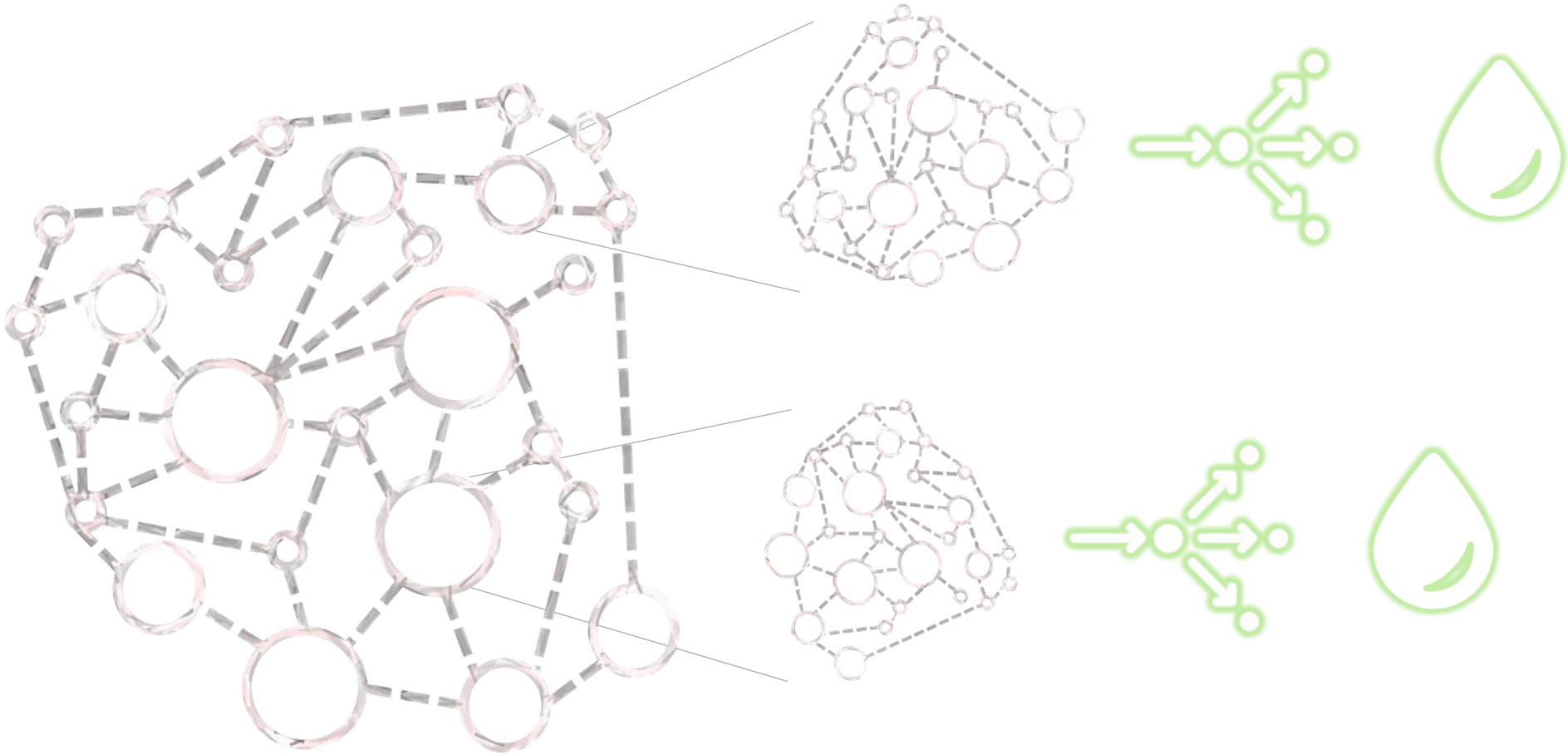
Specific relations between the external manifestations of the system and its internal state



Specific relations between the external manifestations of the system and its internal state



Specific relations between the external manifestations of the system and its internal state



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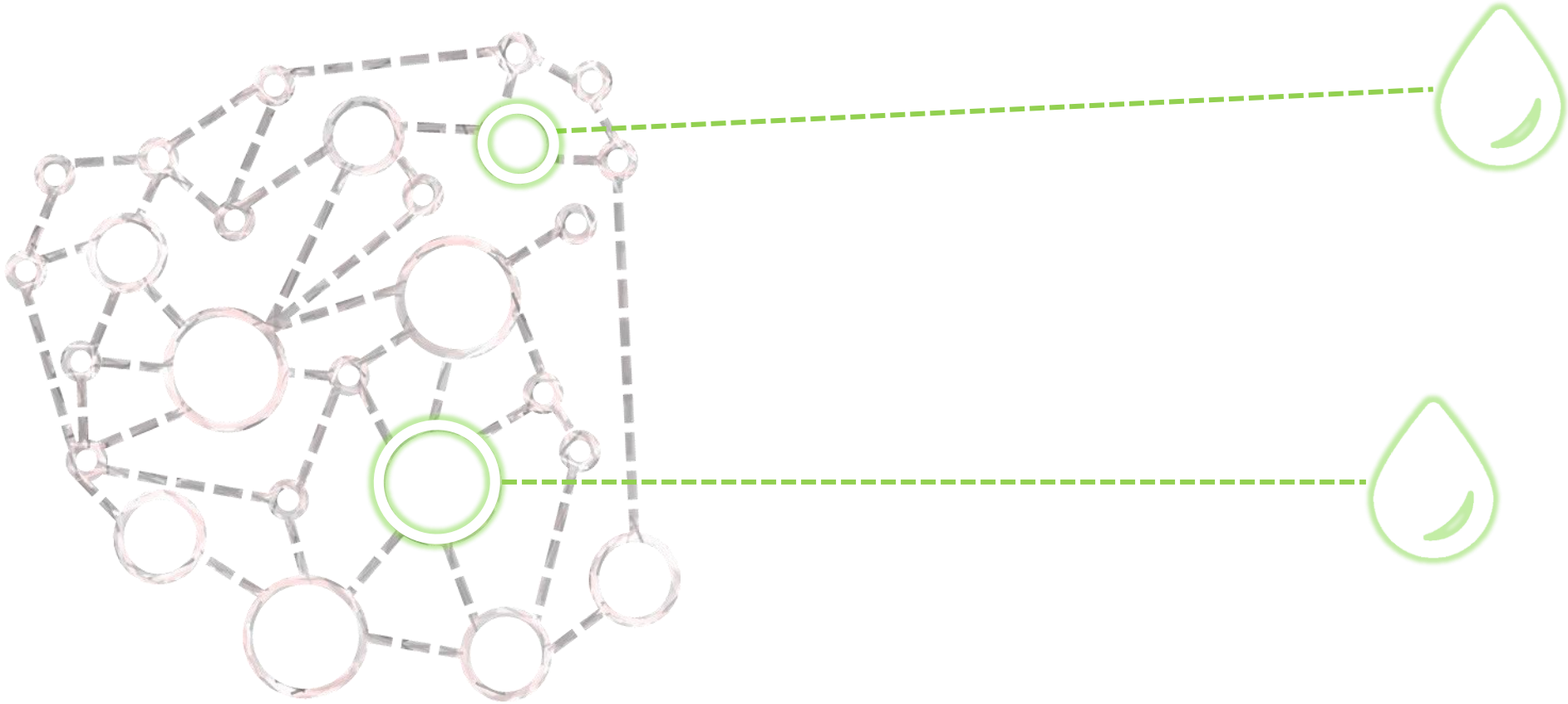
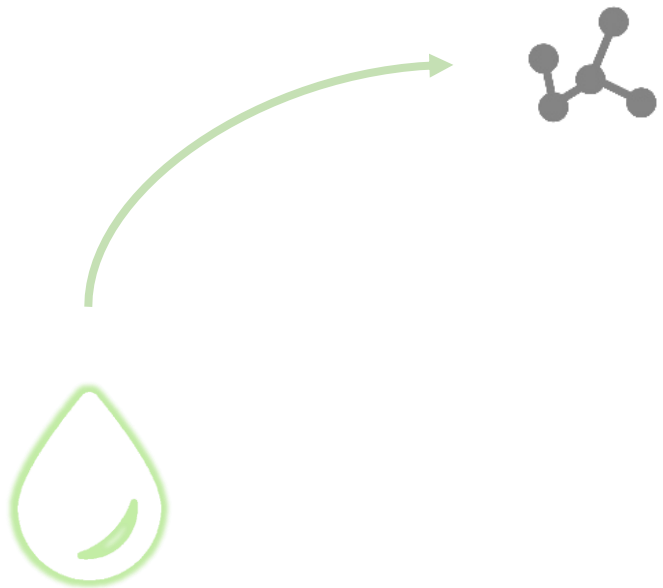
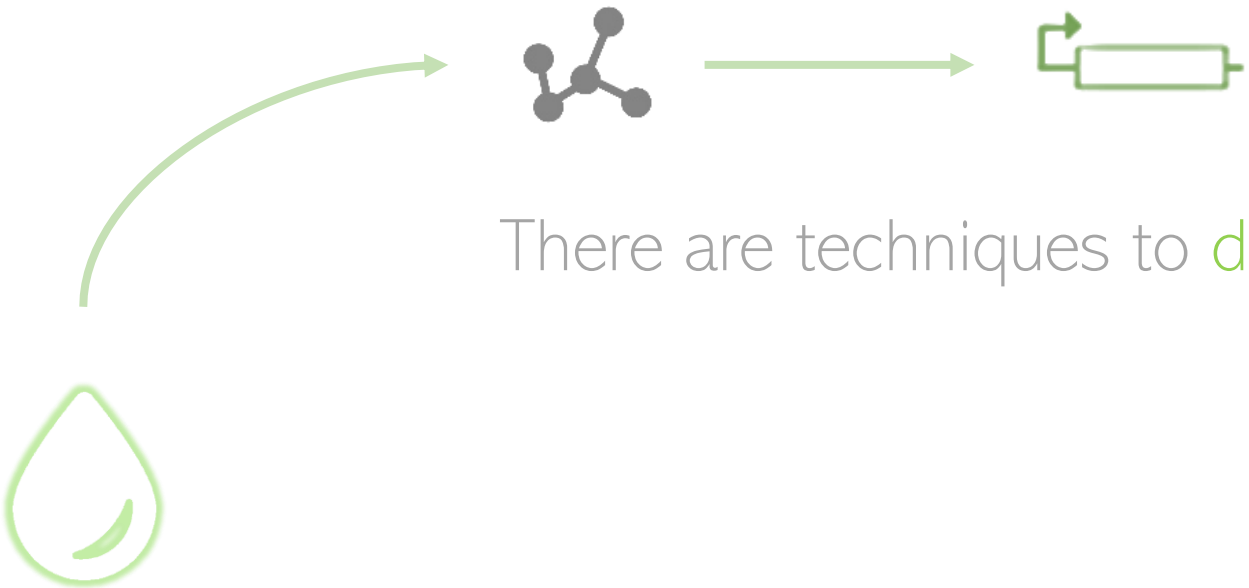
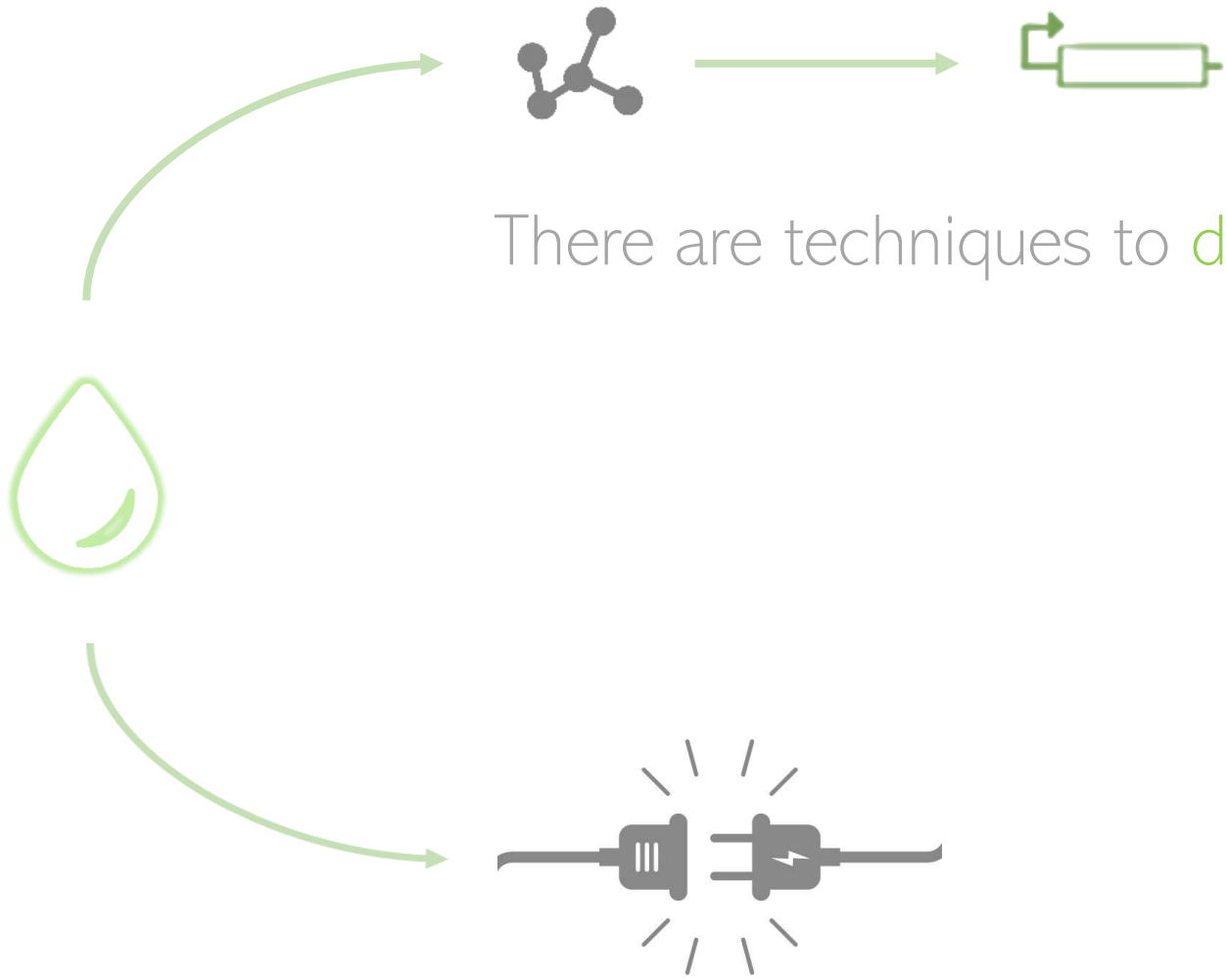






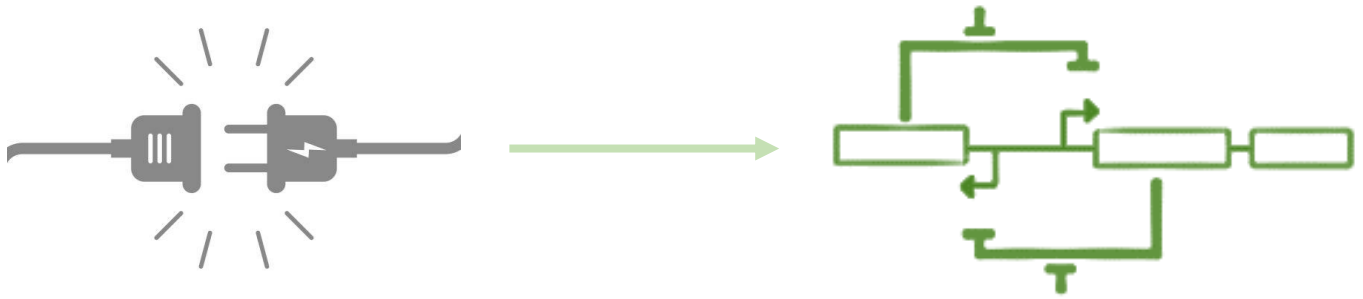
There are techniques to detect nodes

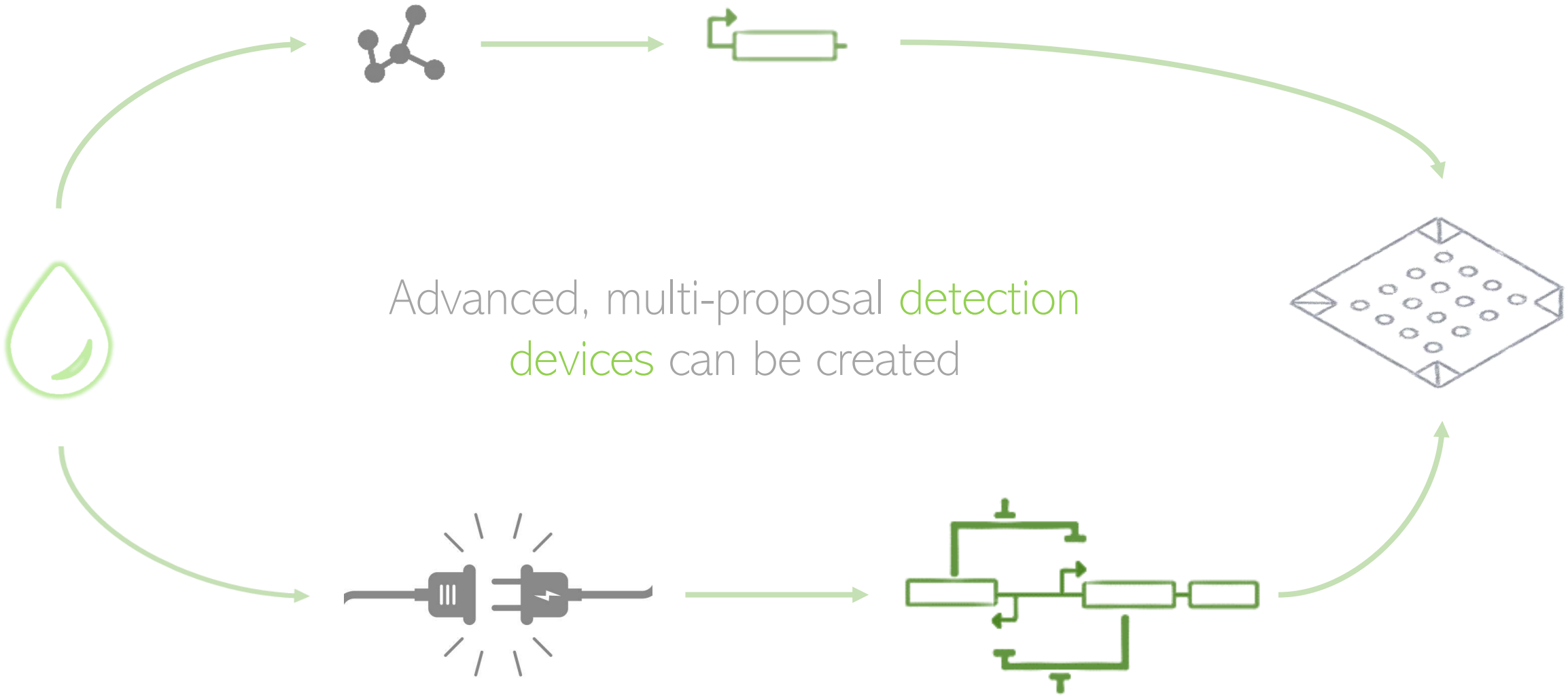


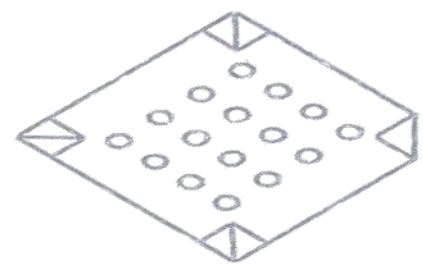
There are techniques to detect nodes

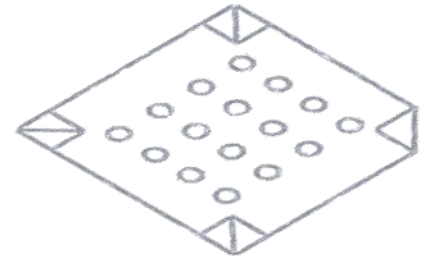
There are techniques to detect nodes

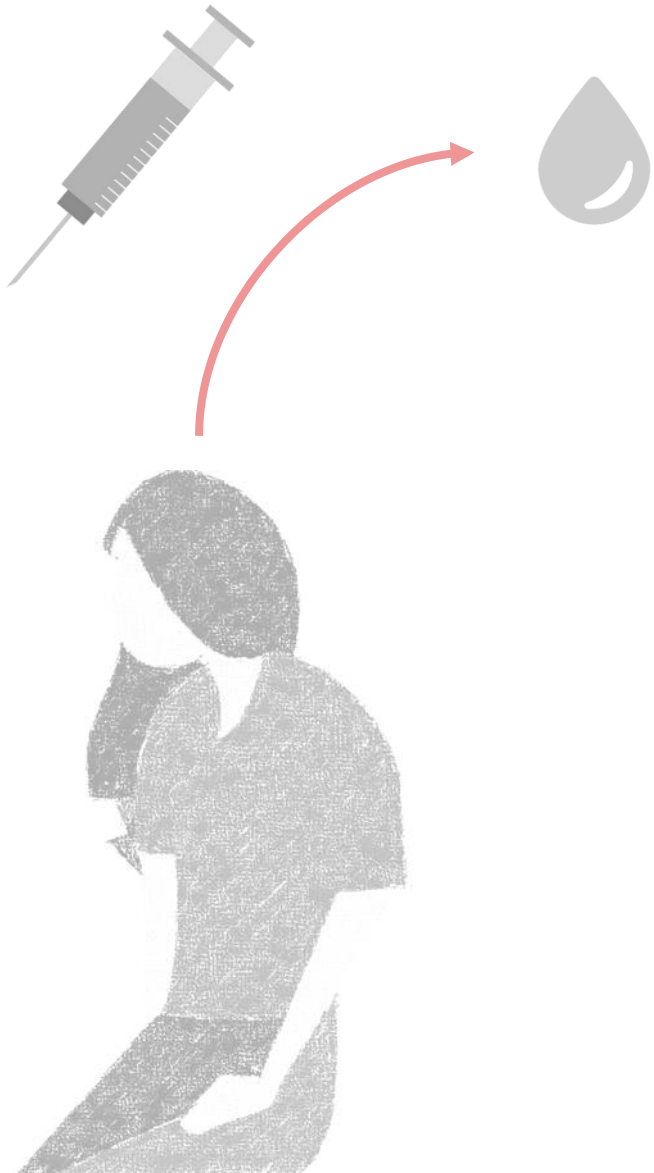
There are techniques to detect their interactions

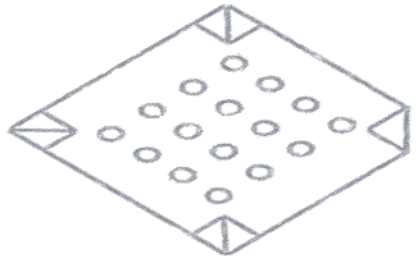


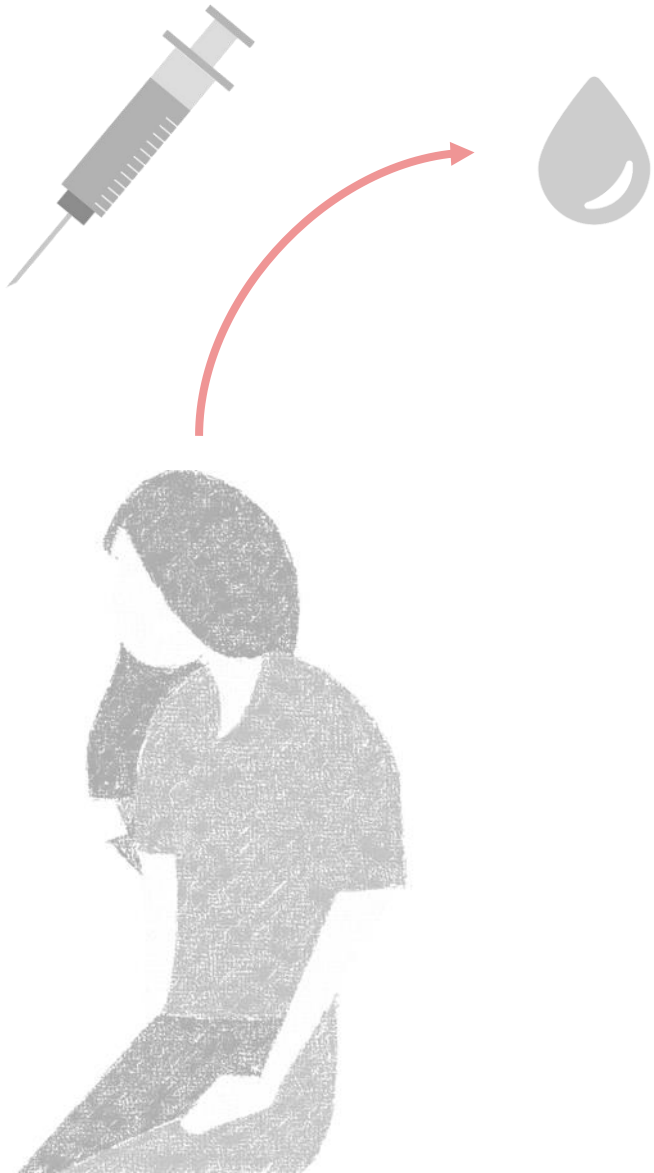

Advanced, multi-proposal detection
devices can be created

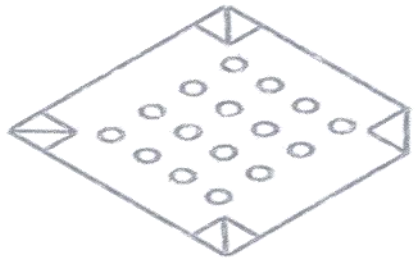


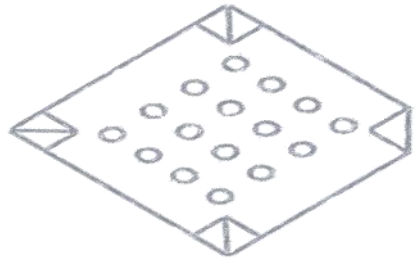


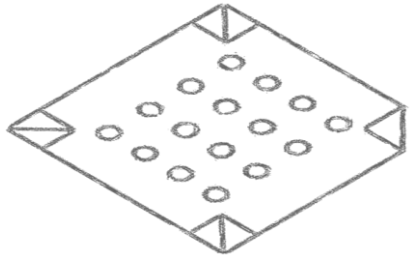


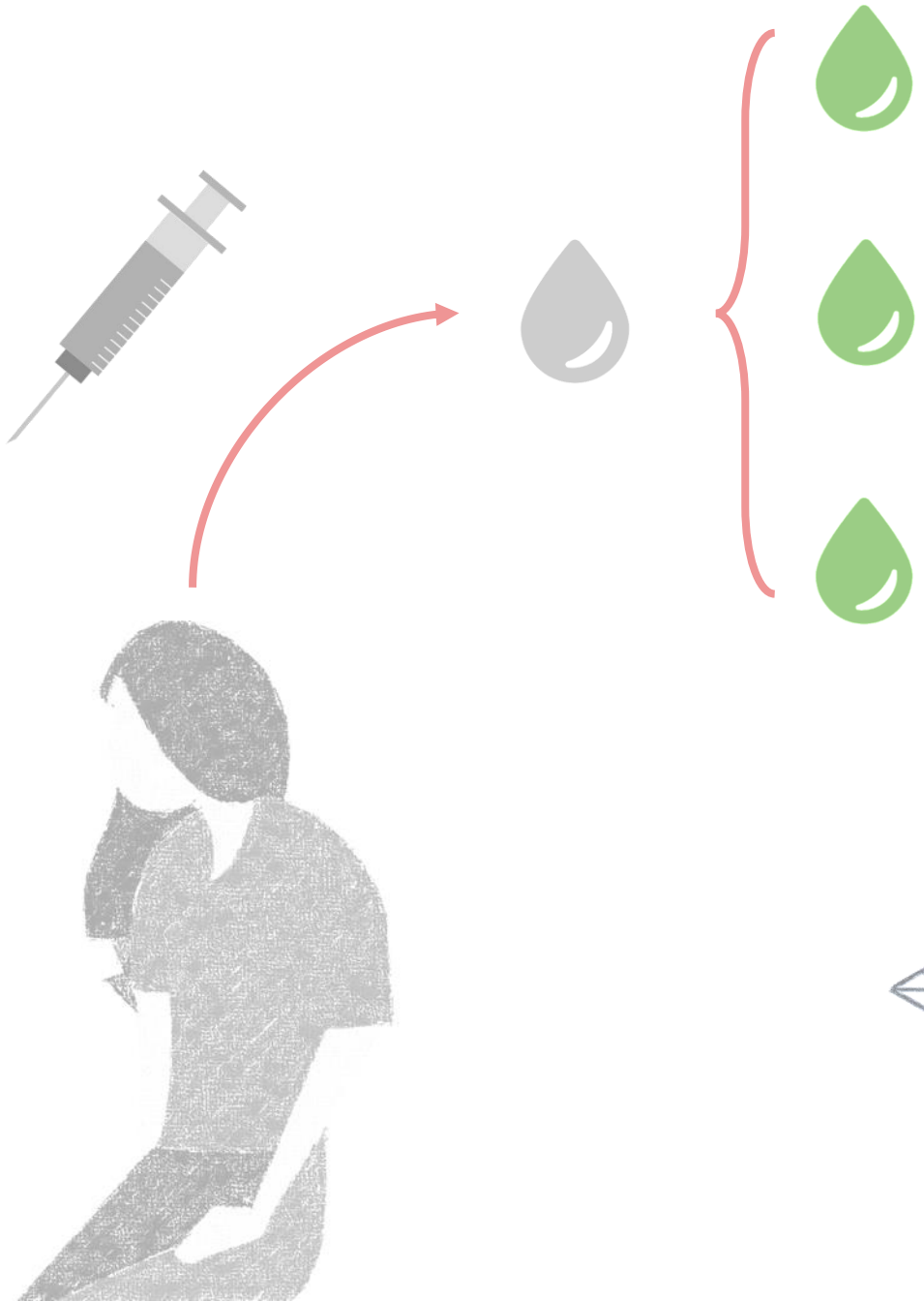




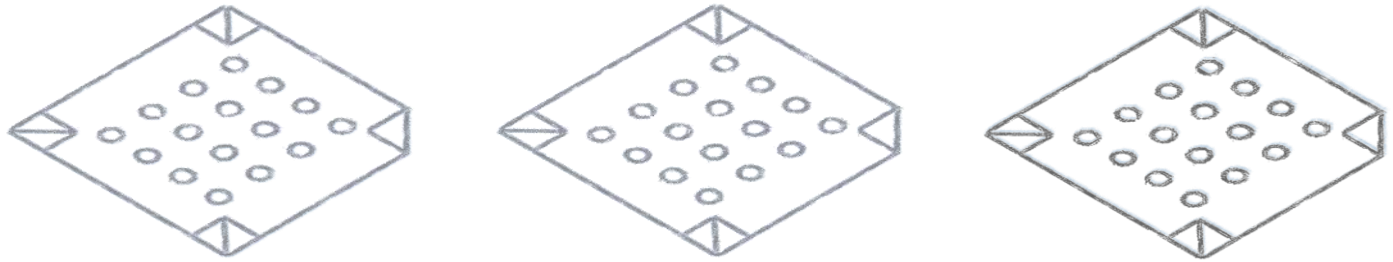


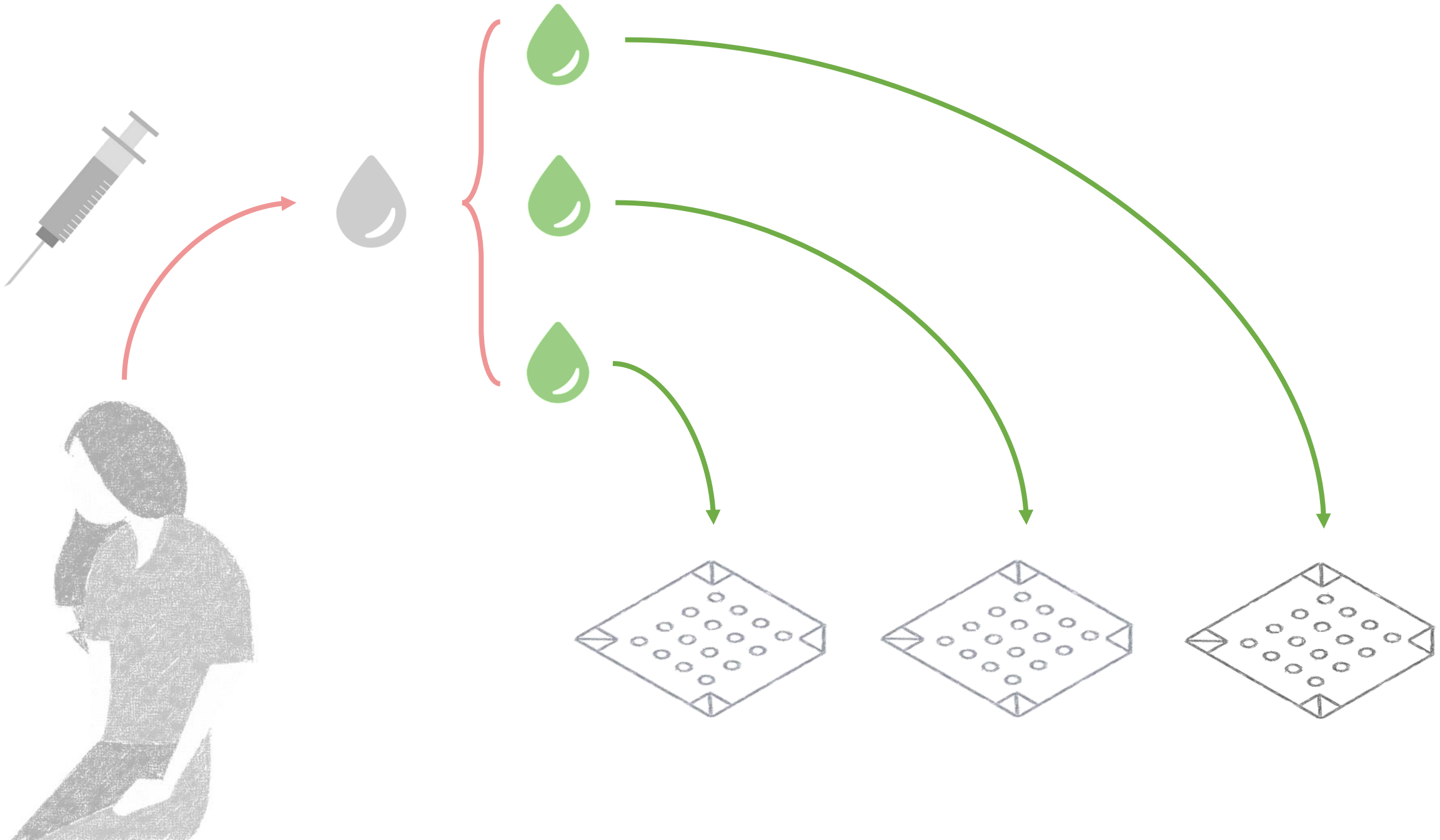


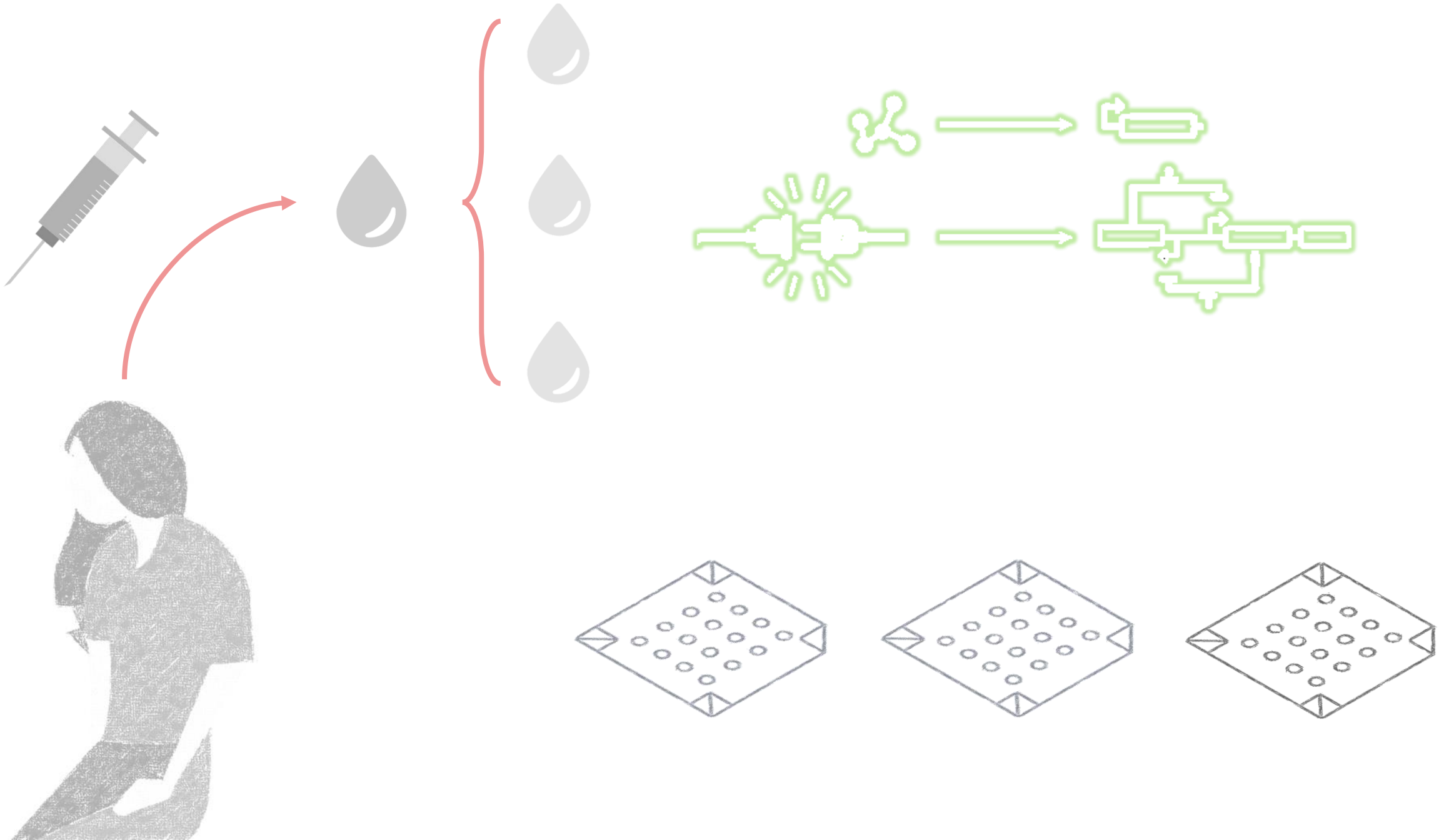




Liquid biopsies are becoming more efficient and powerful, and less invasive







The spread of smart and connected devices creates an infinite range of possibilities

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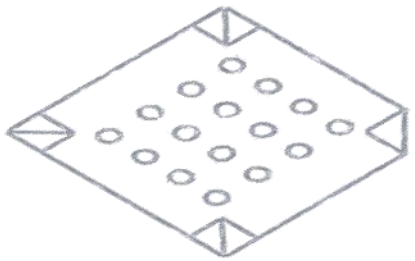
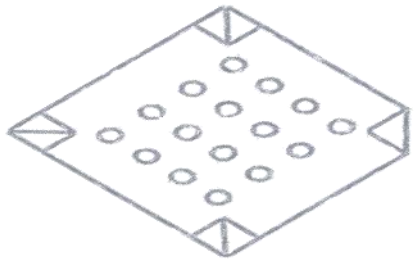
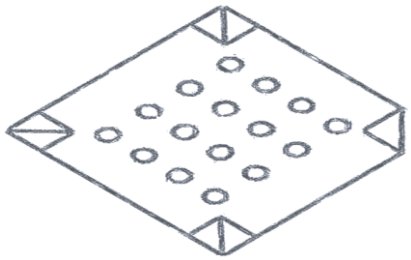
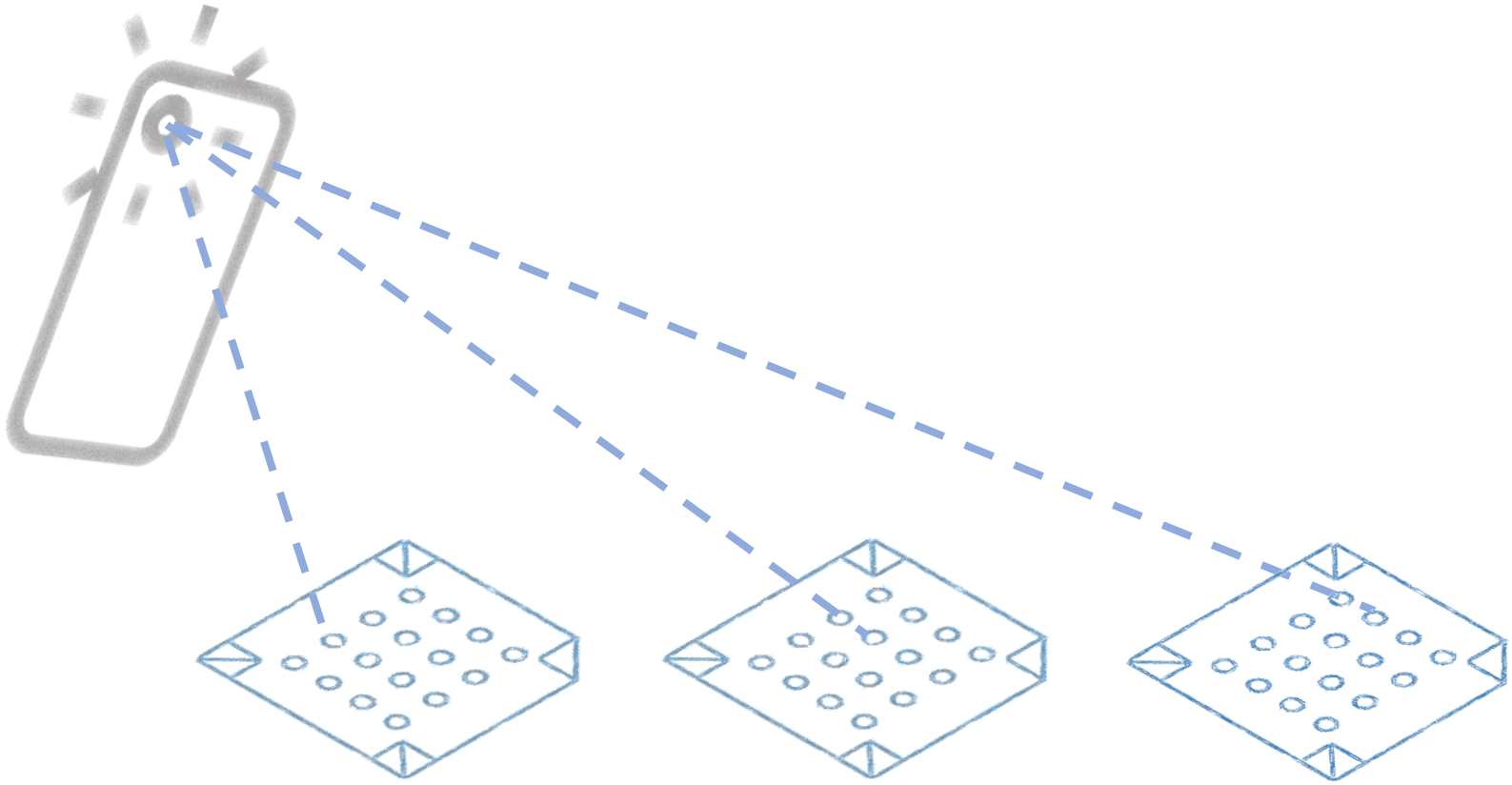


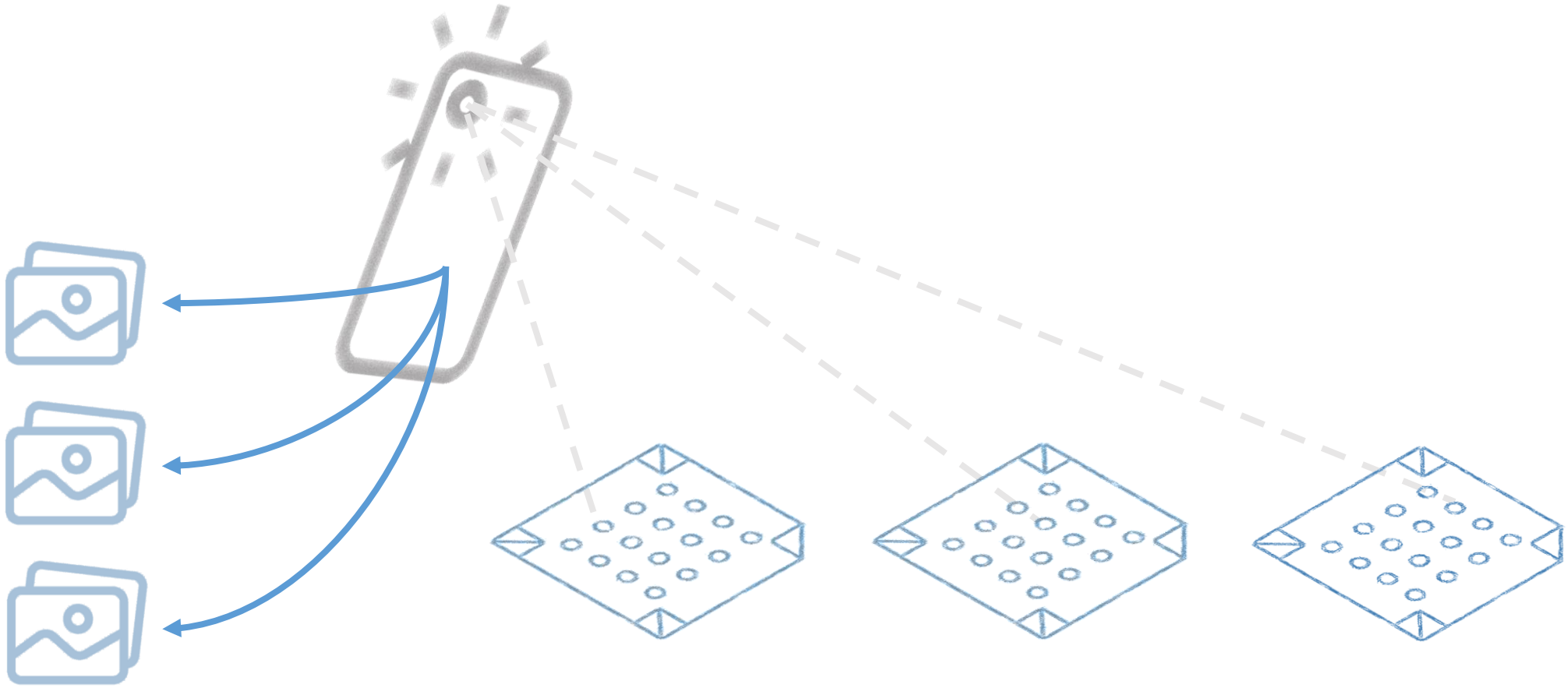


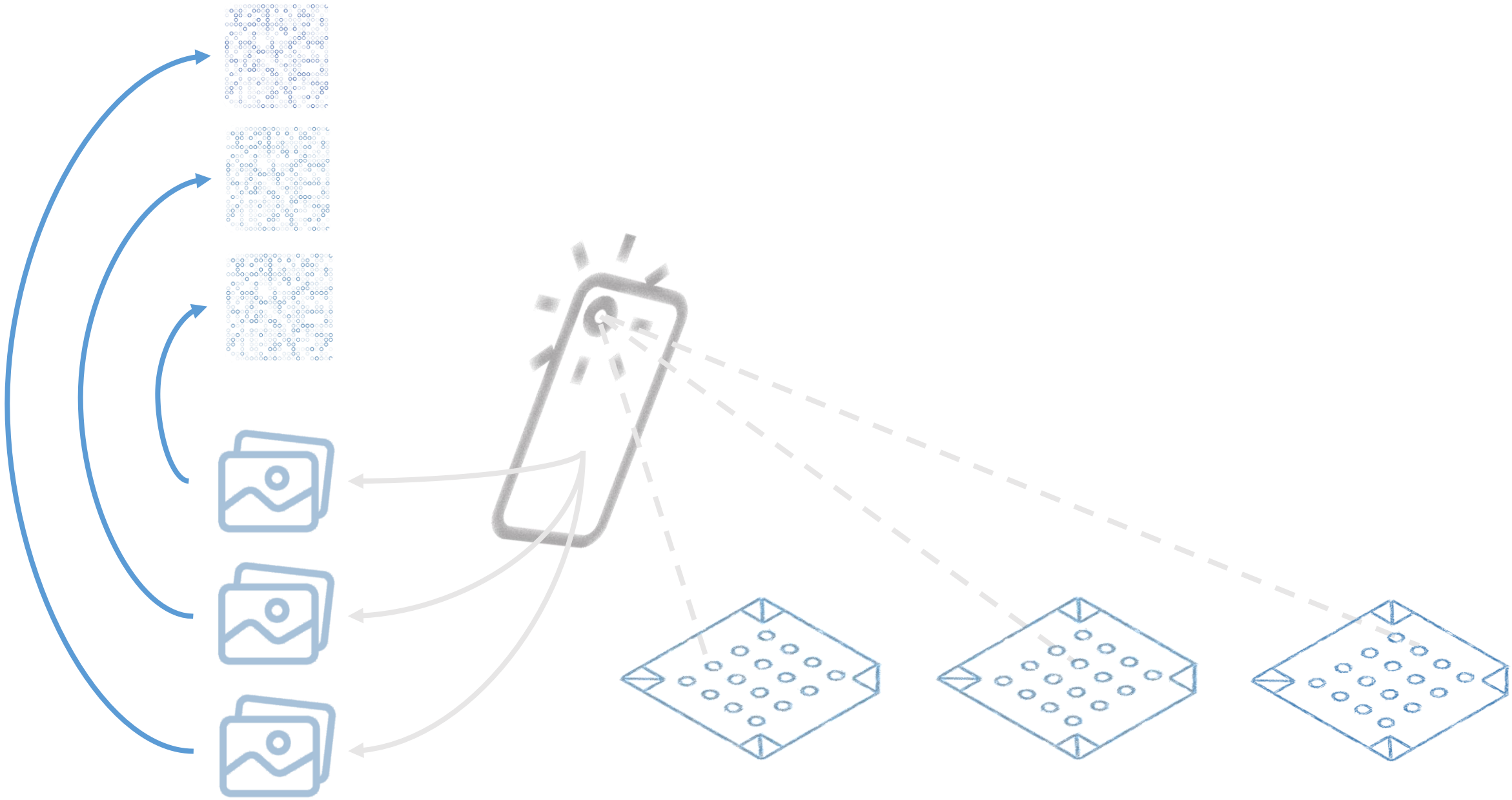


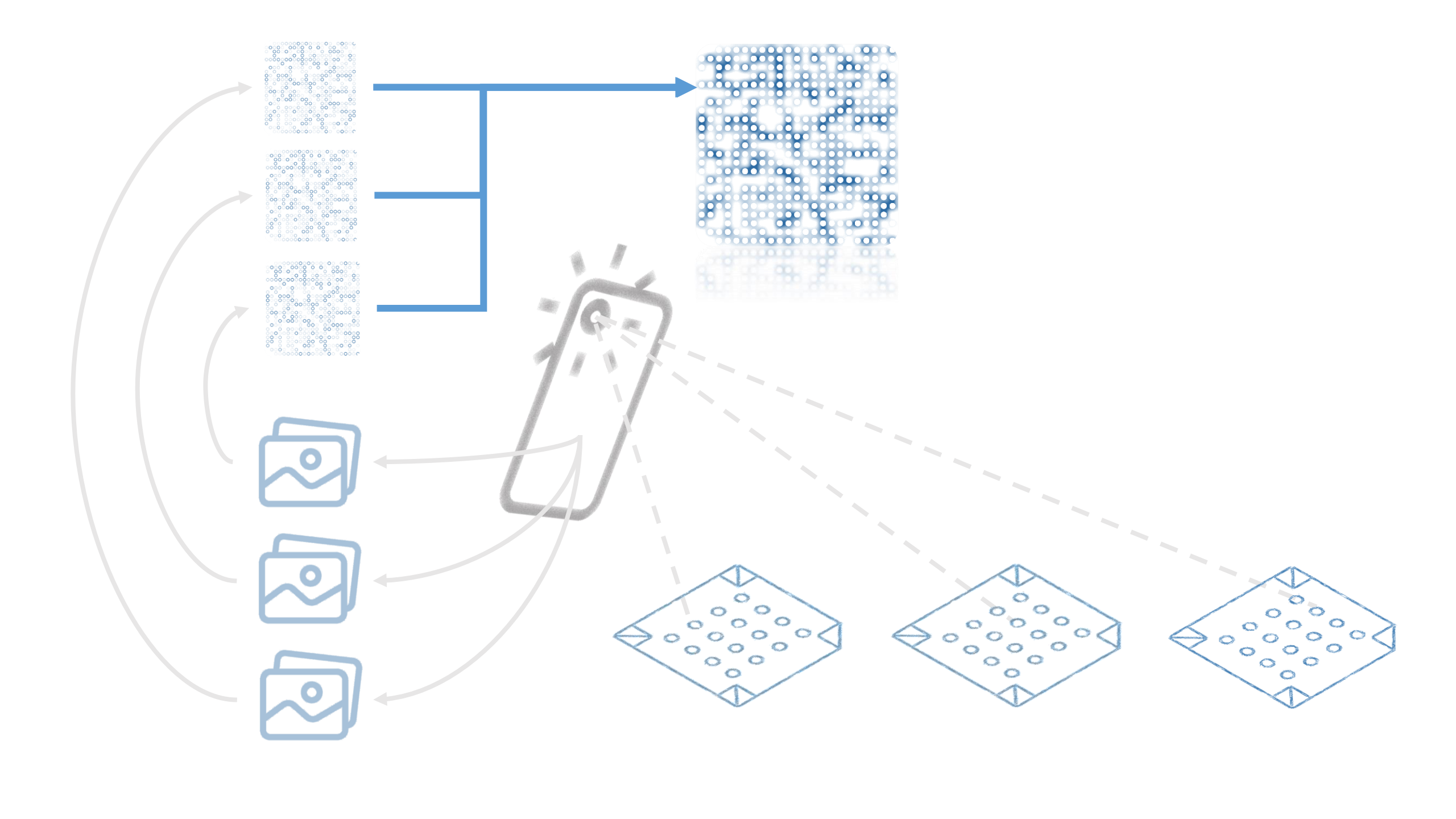
The spread of smart and connected devices creates an infinite range of possibilities

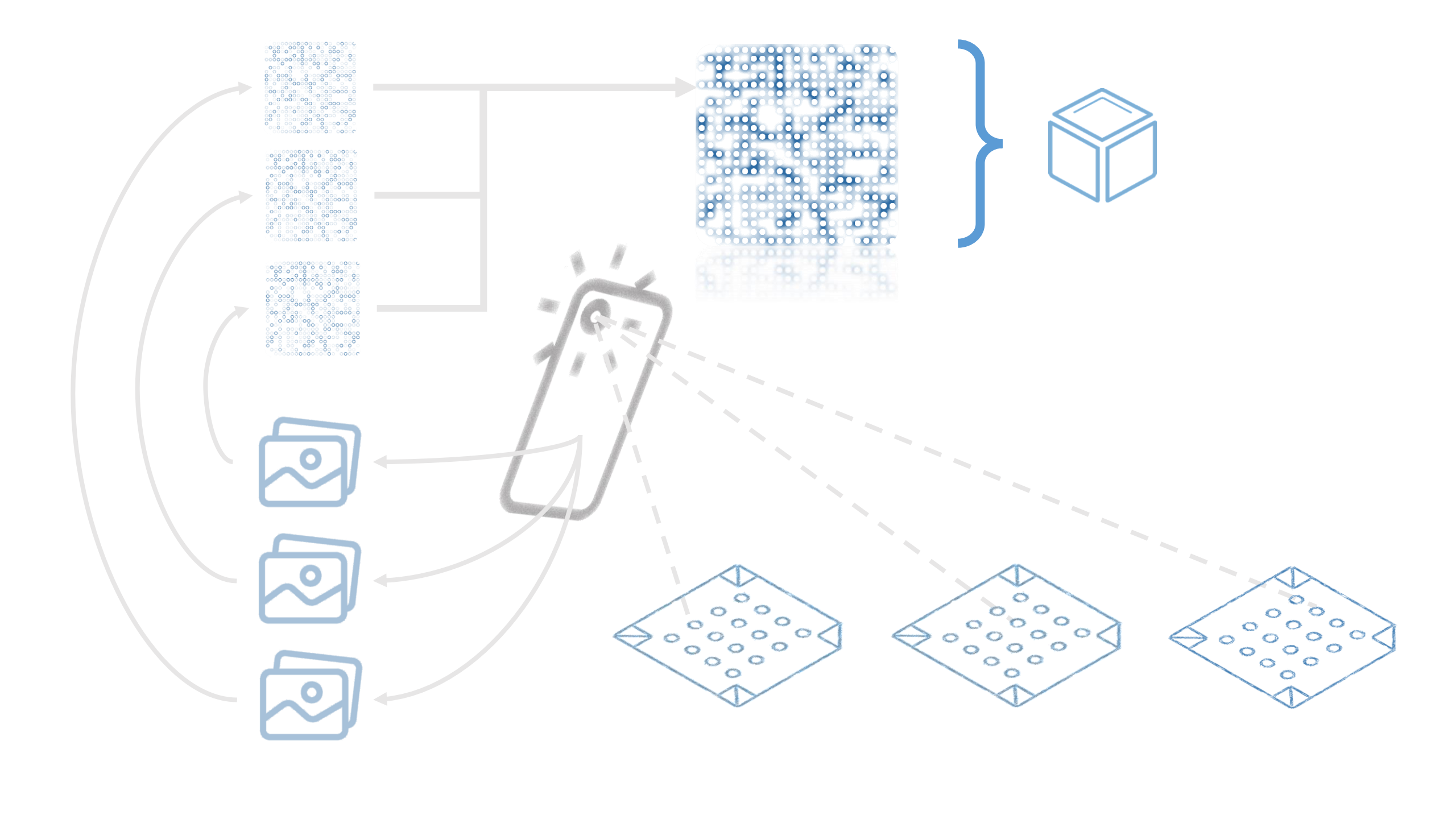


The spread of smart and connected devices creates an infinite range of possibilities



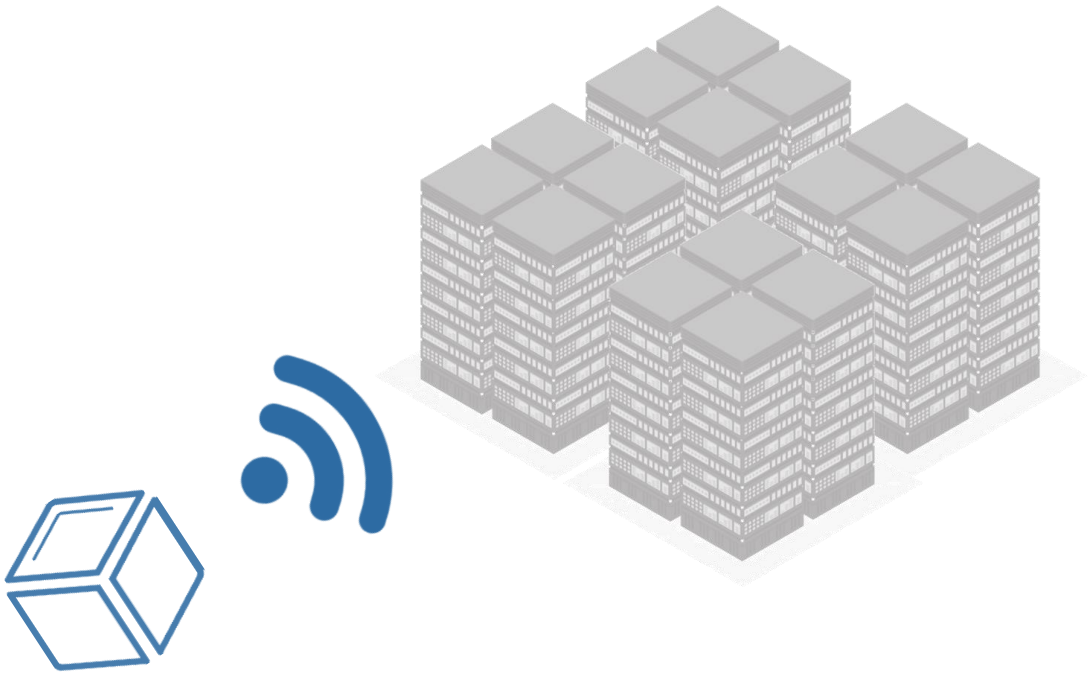




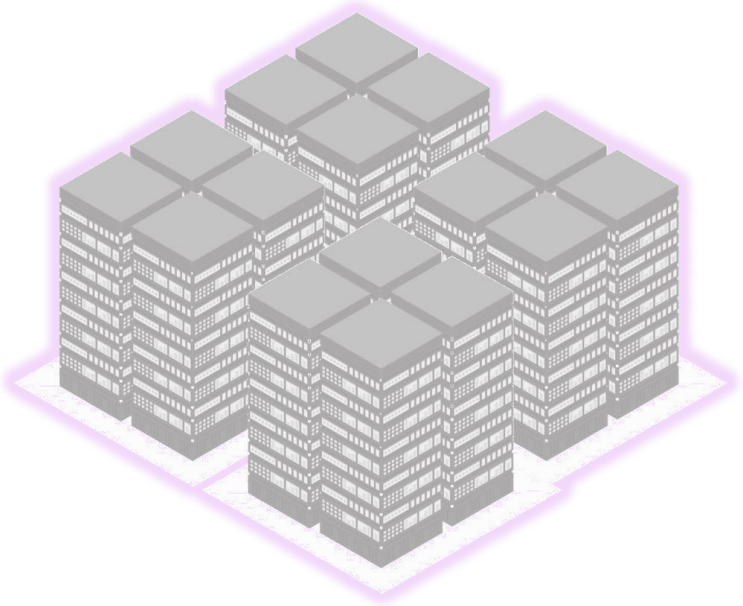


It is possible to integrate, analyze and send information from almost any place or situation, and increasingly fast

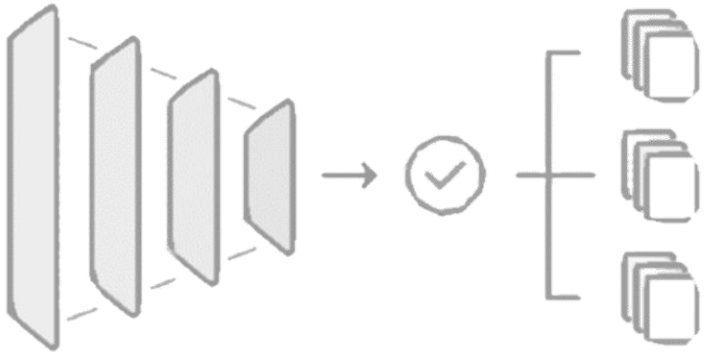
Internet allows massive sets of interconnected devices to act as powerful computing architectures



The great advances in hardware and software have supported a huge development in the field of Artificial Intelligence

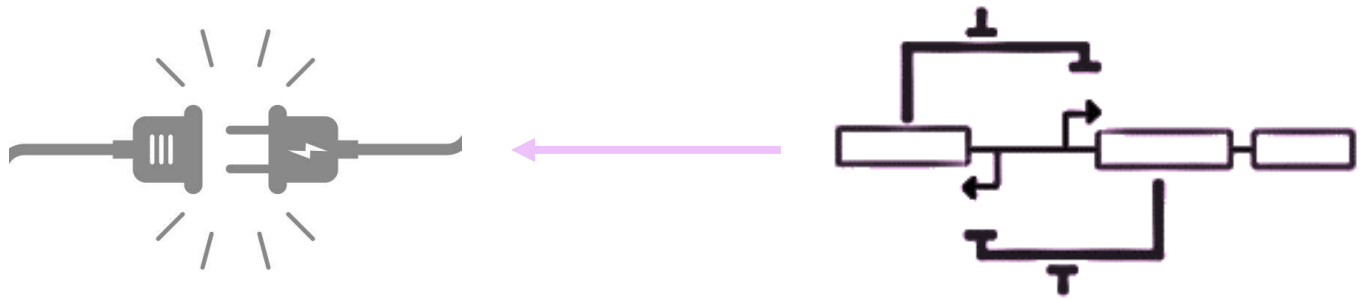


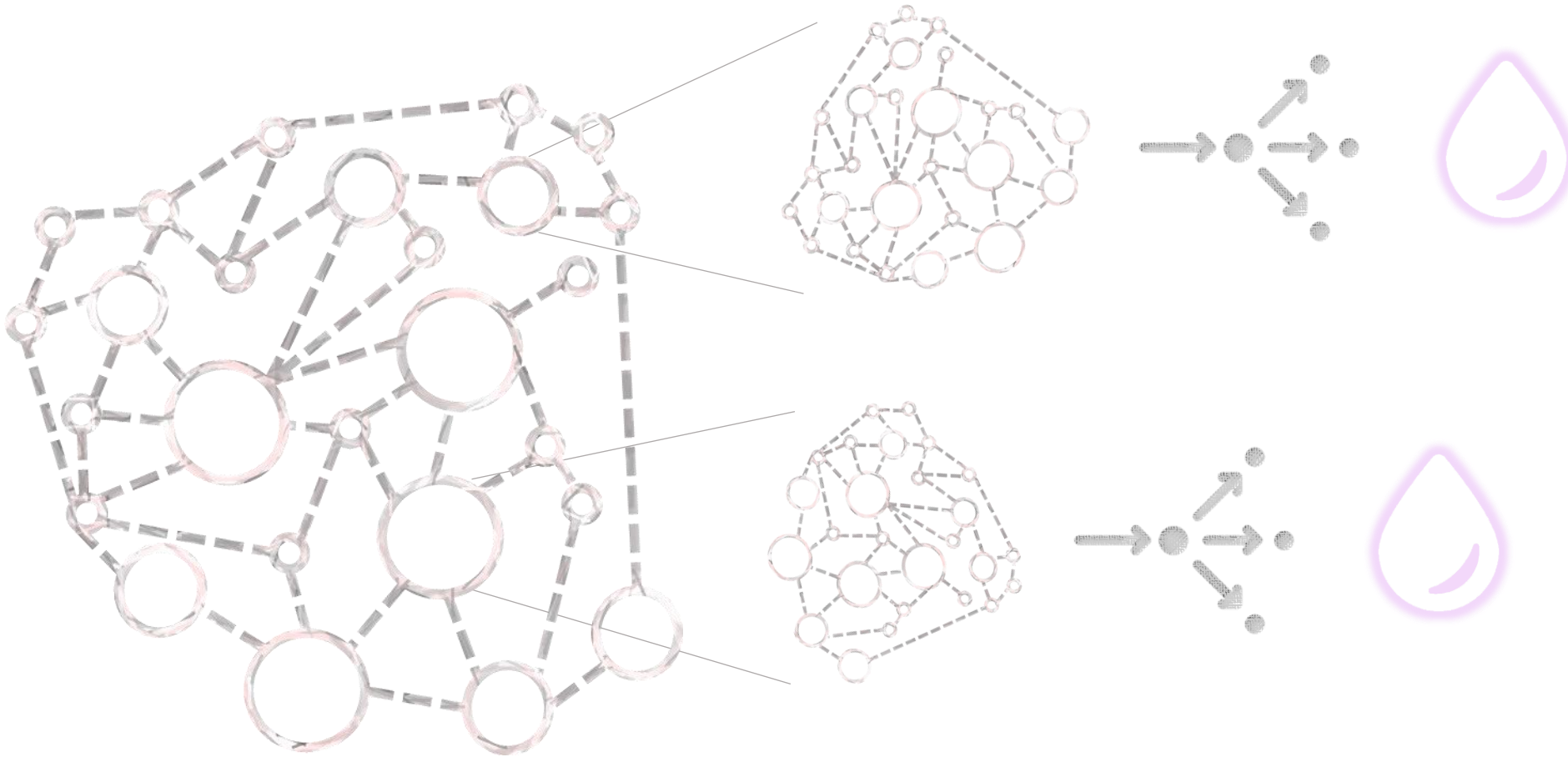
Deep Neural Network systems have demonstrated their amazing potential

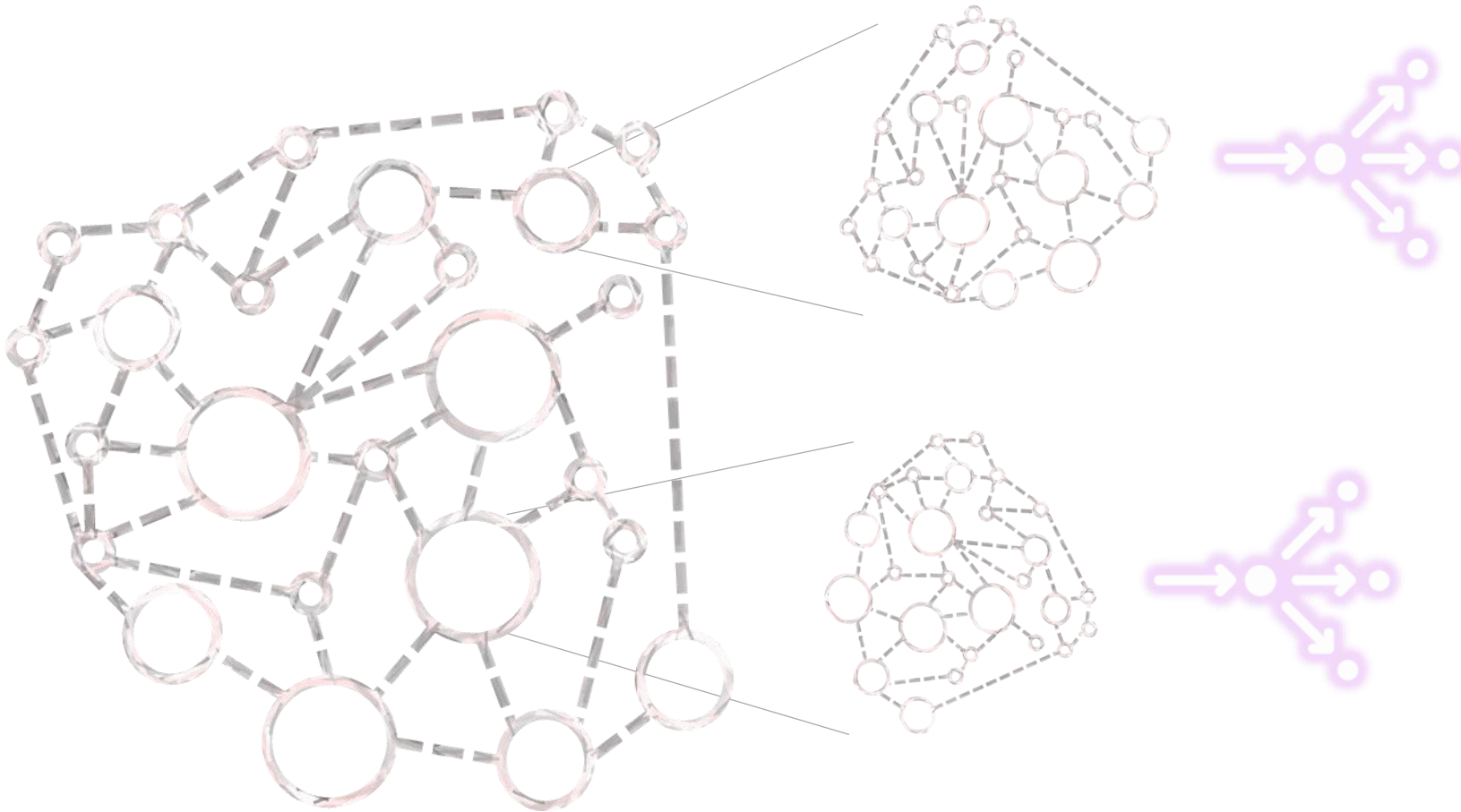


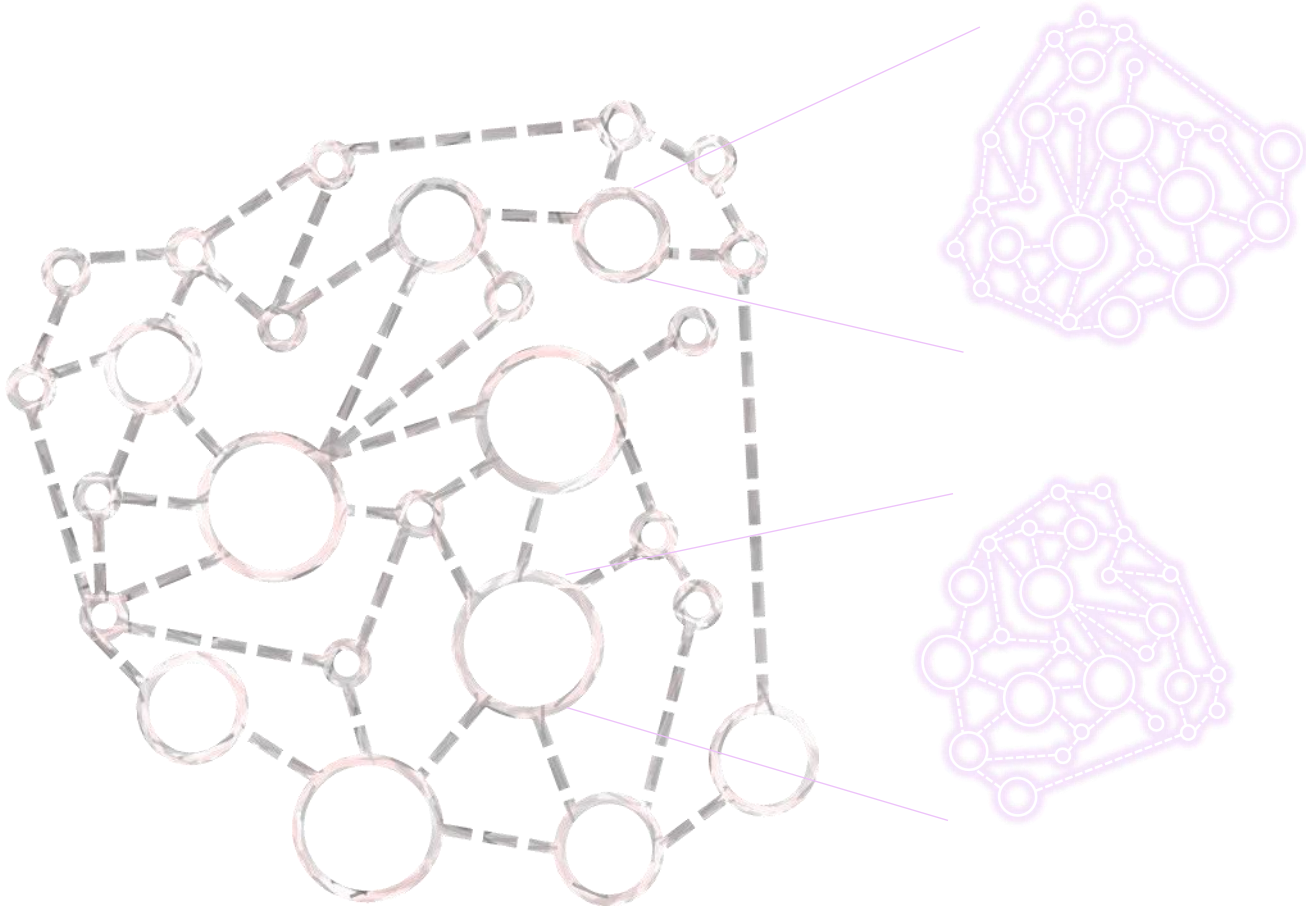
With enough training, they can recognize subtle patterns to solve difficult tasks

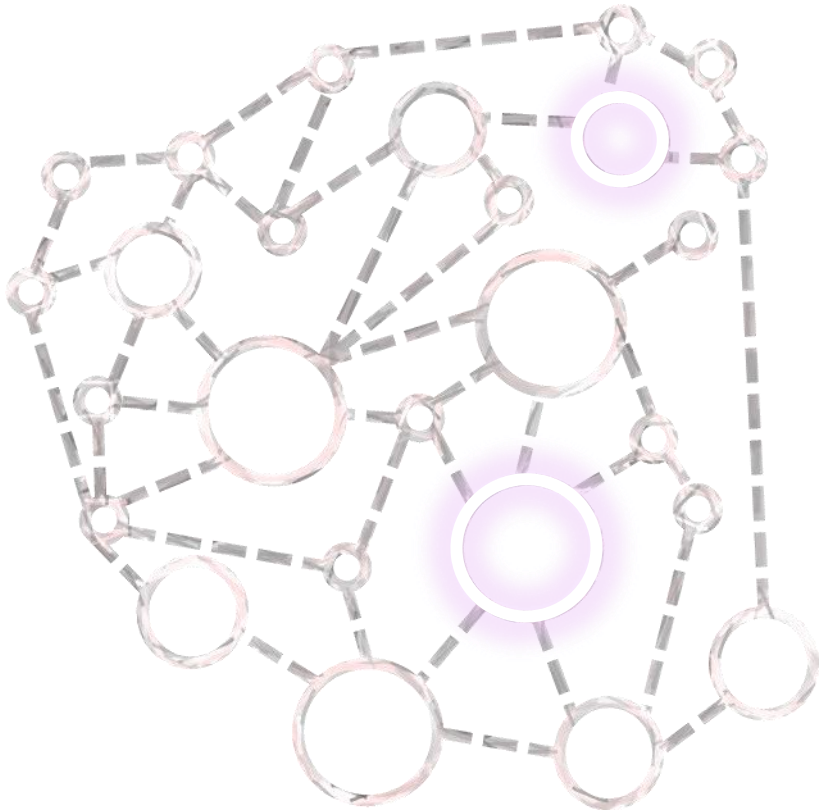
They can infer the system state
from the detections and previous knowledge

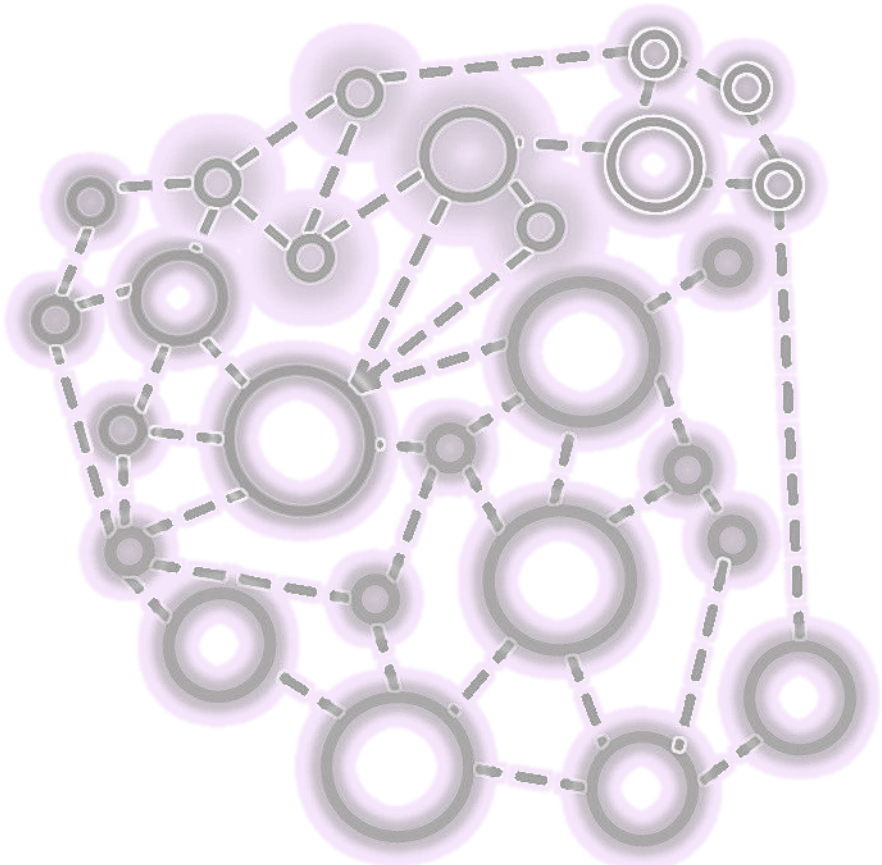




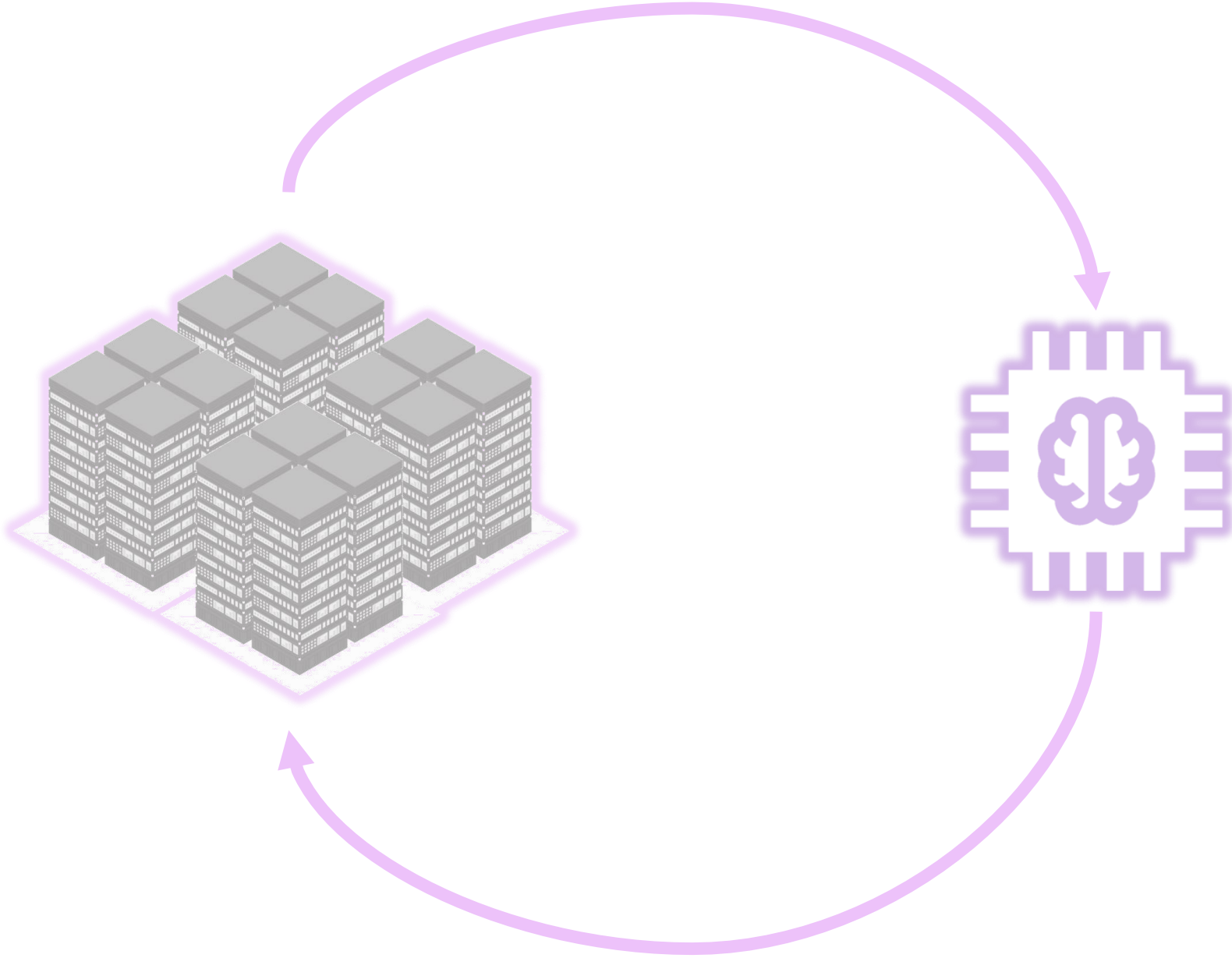


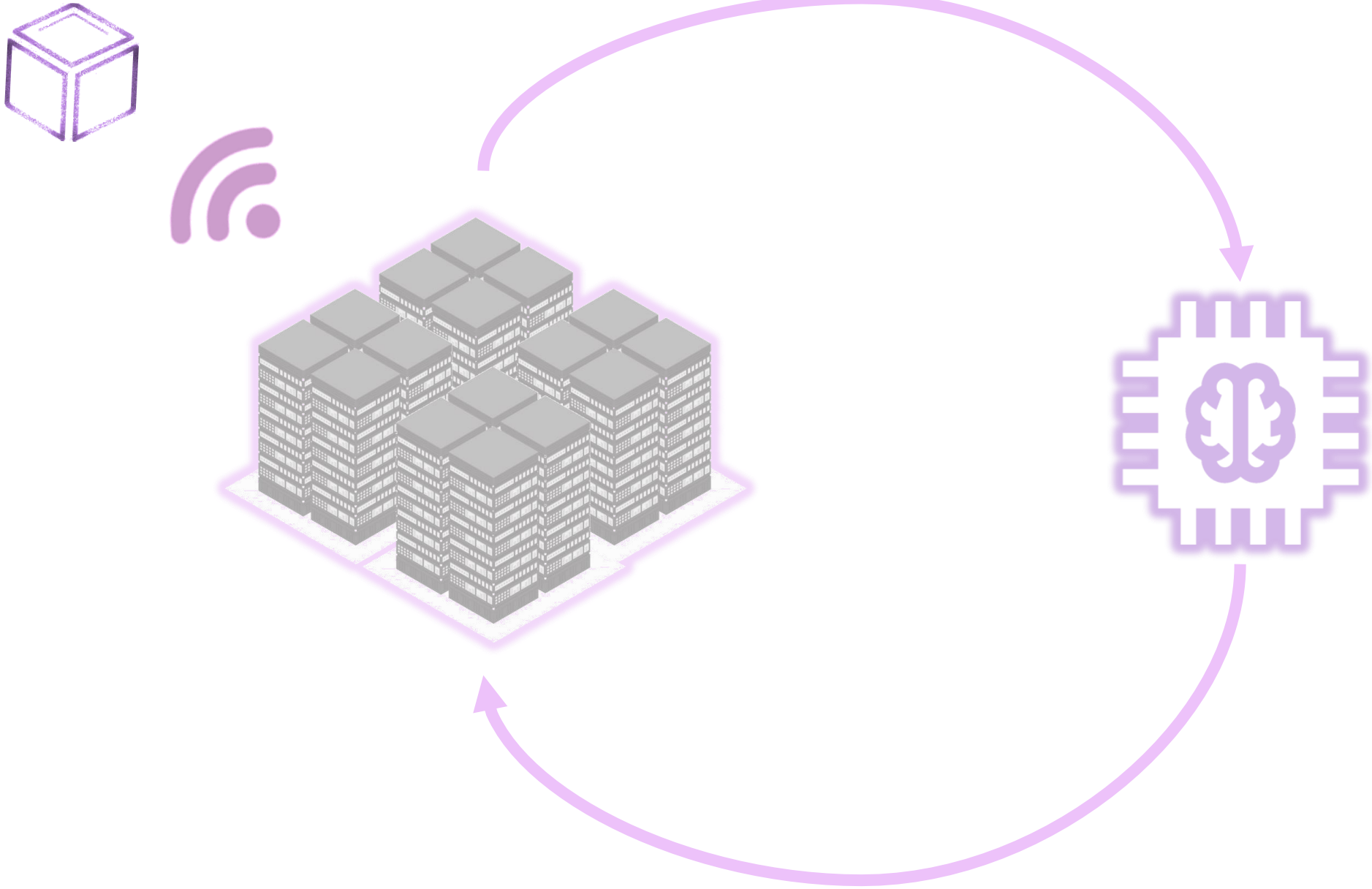






Recognizing nuances
that were invisible before



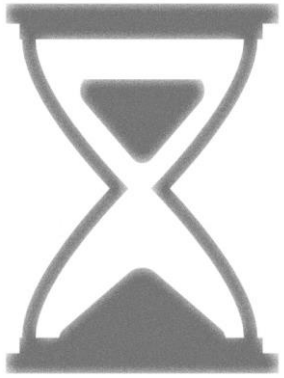


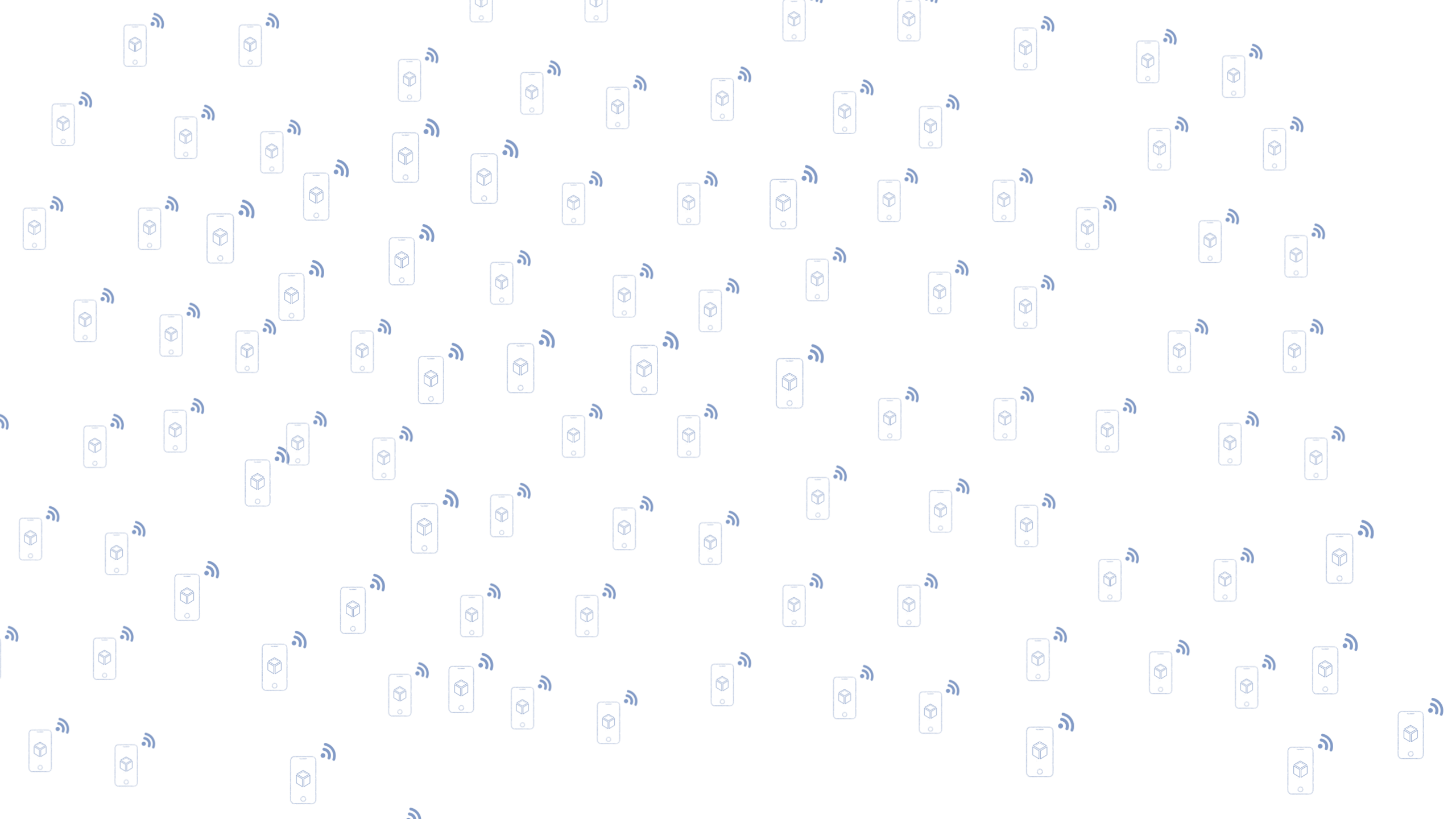
Thanks to the Internet

Systems can serve wherever it is needed

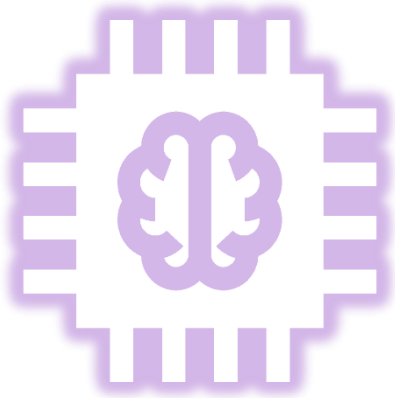
Providing the key information
to clinicians

To fight complex diseases
more efficiently

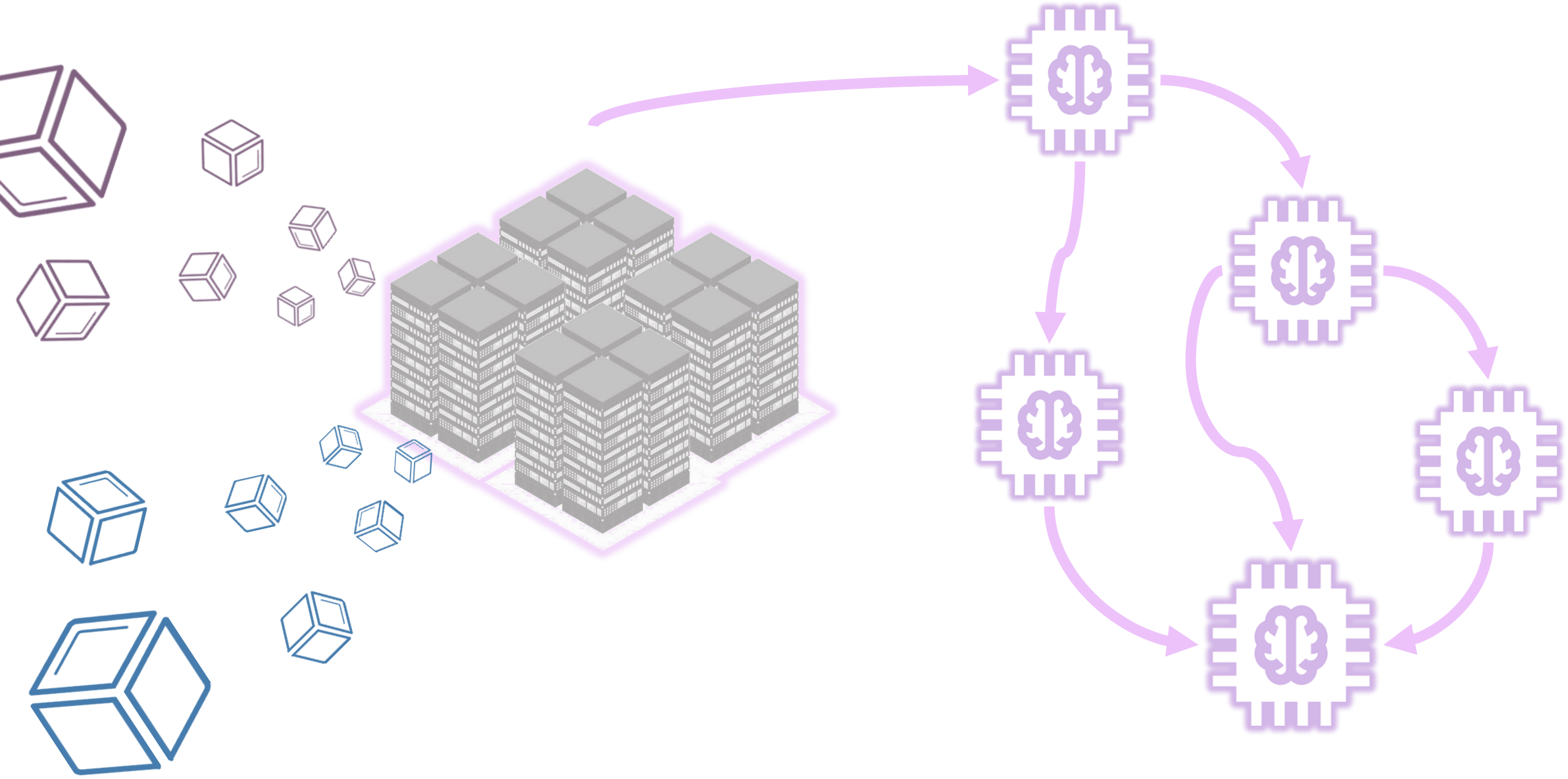




Non-supervised Learning systems are the perfect expansion tool



They can define new interesting patterns using raw data, which could then be used to train more neural networks

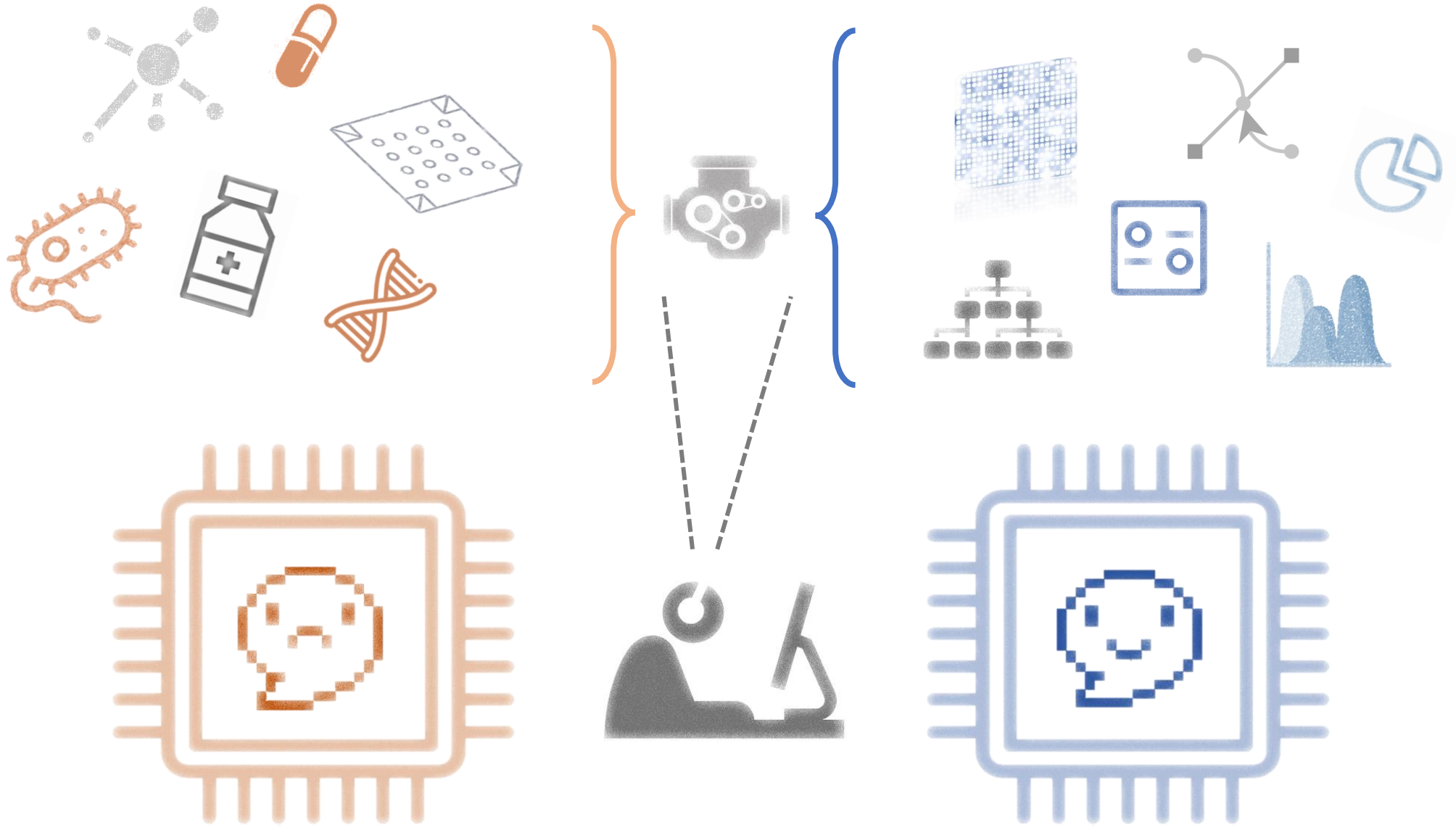


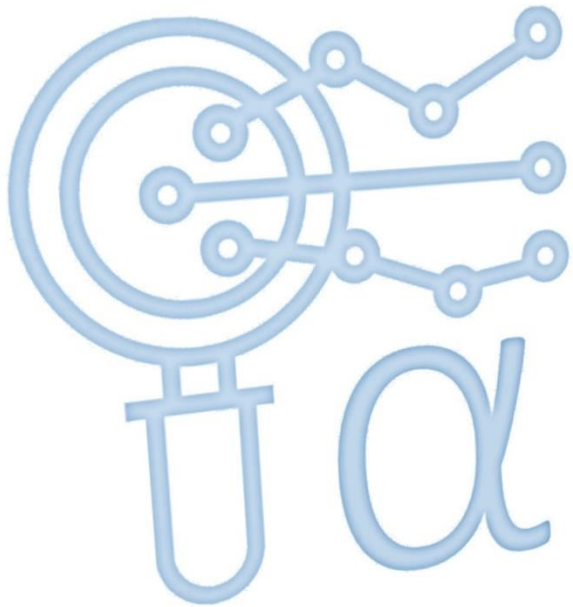
The goal is an architecture that becomes more efficient and powerful with time

ARIA

ARIA

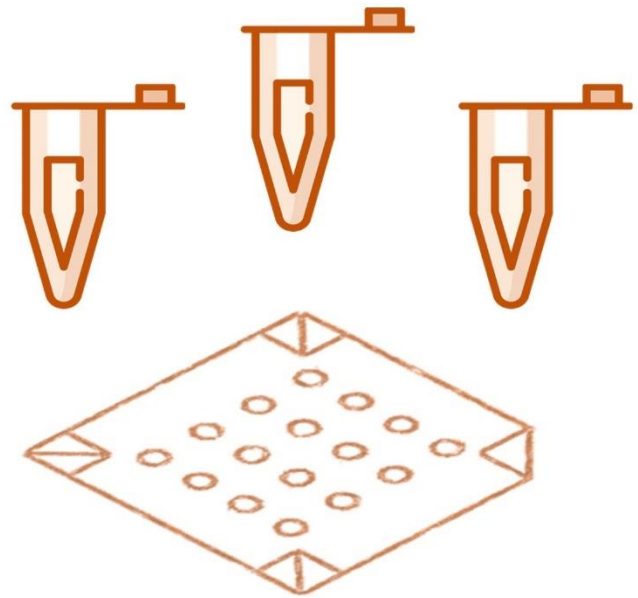
00101
0010110
011101





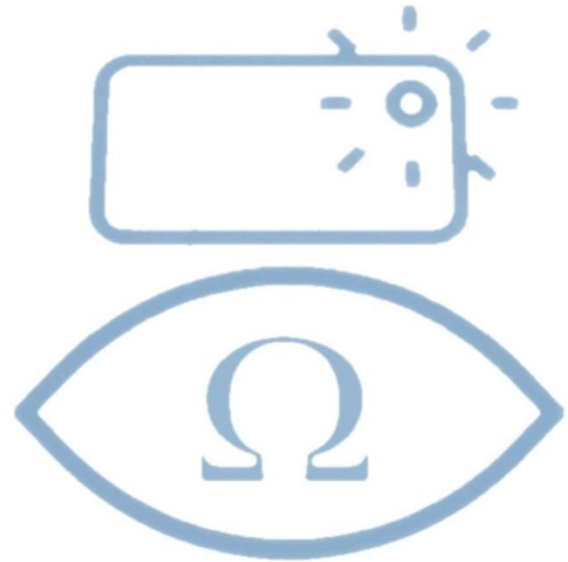
Alpha

Research AI



Alexandria

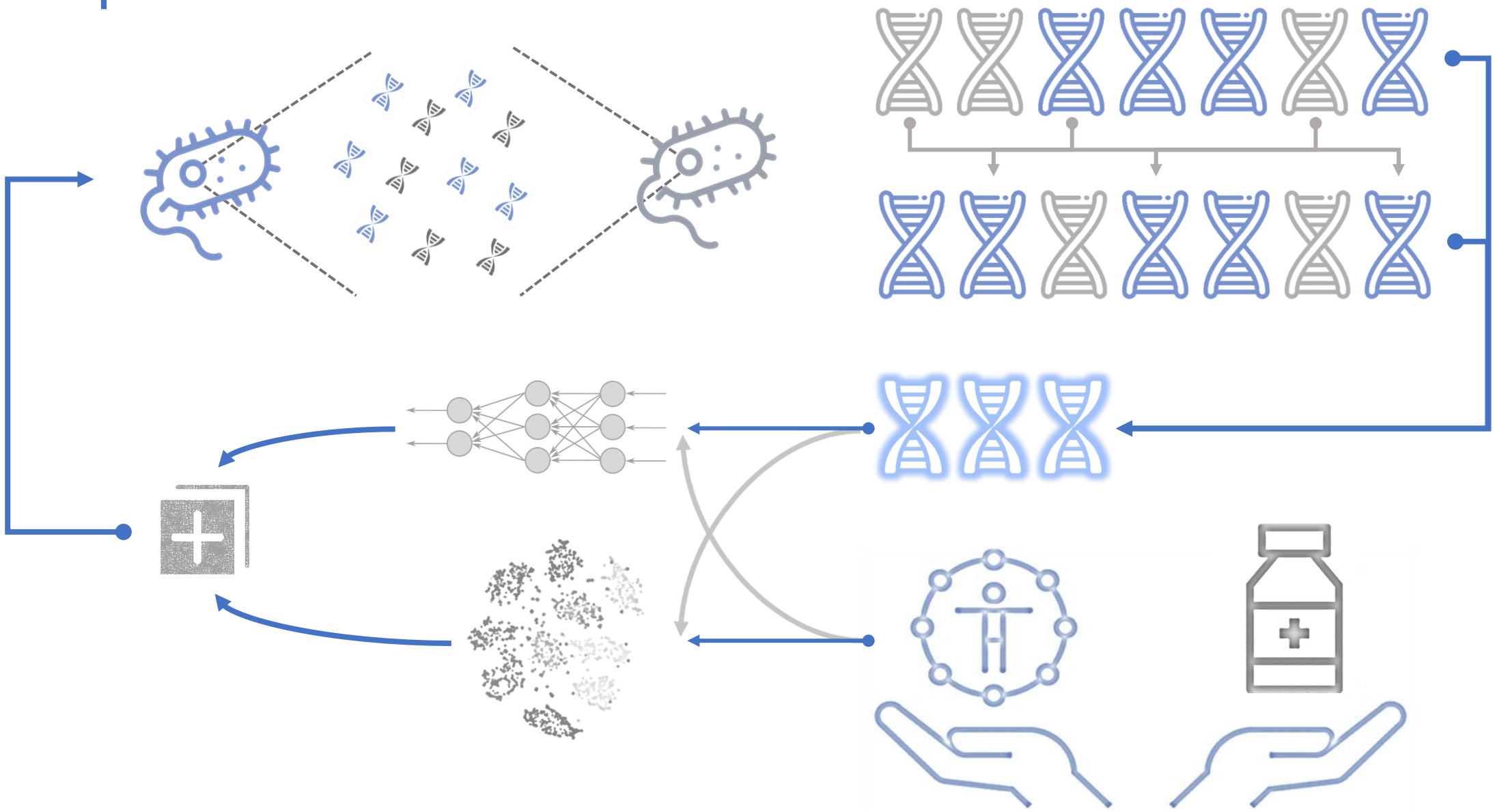
Biosensor Library



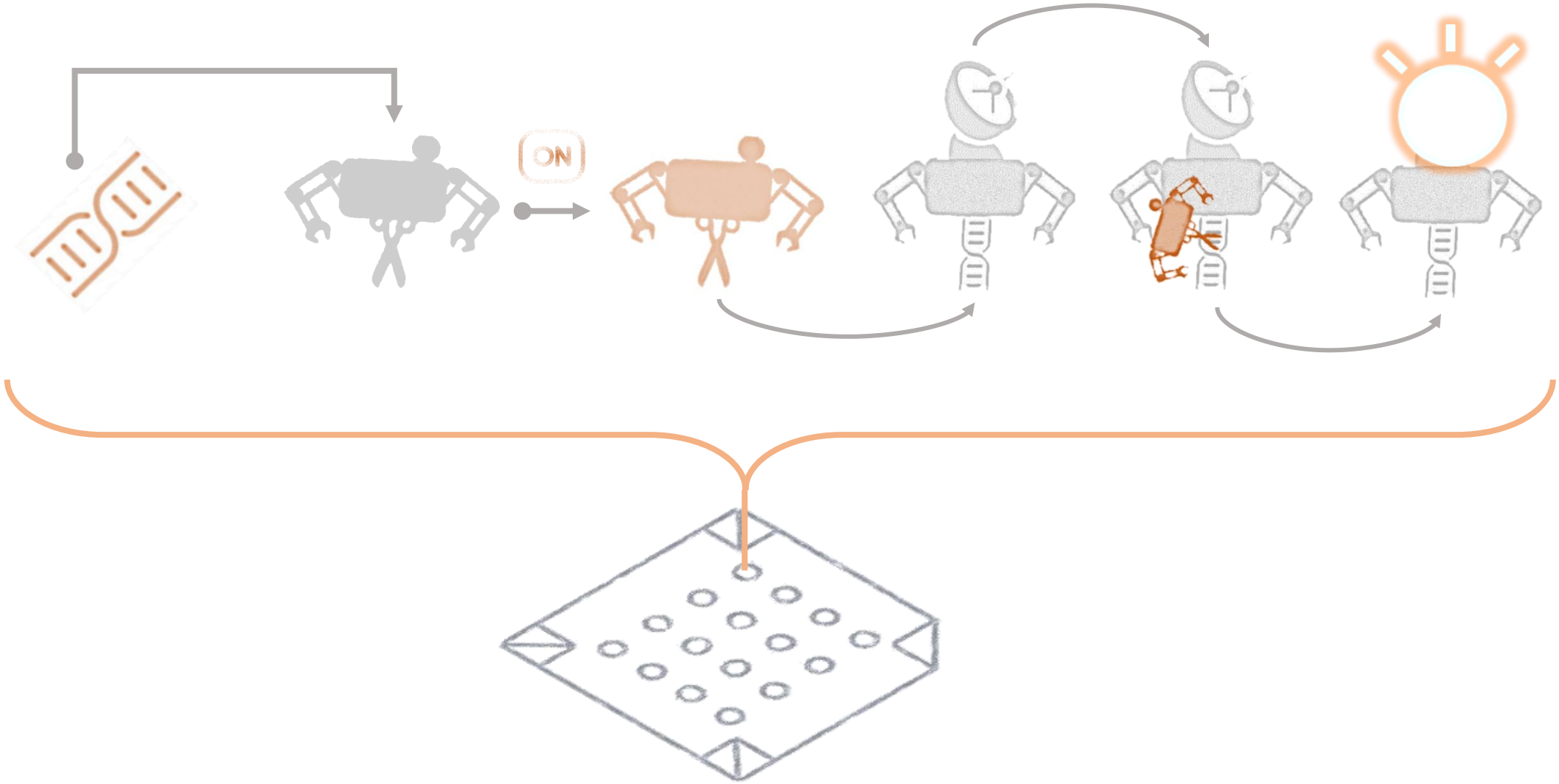
Omega

Inference AI

Alpha



Alexandria



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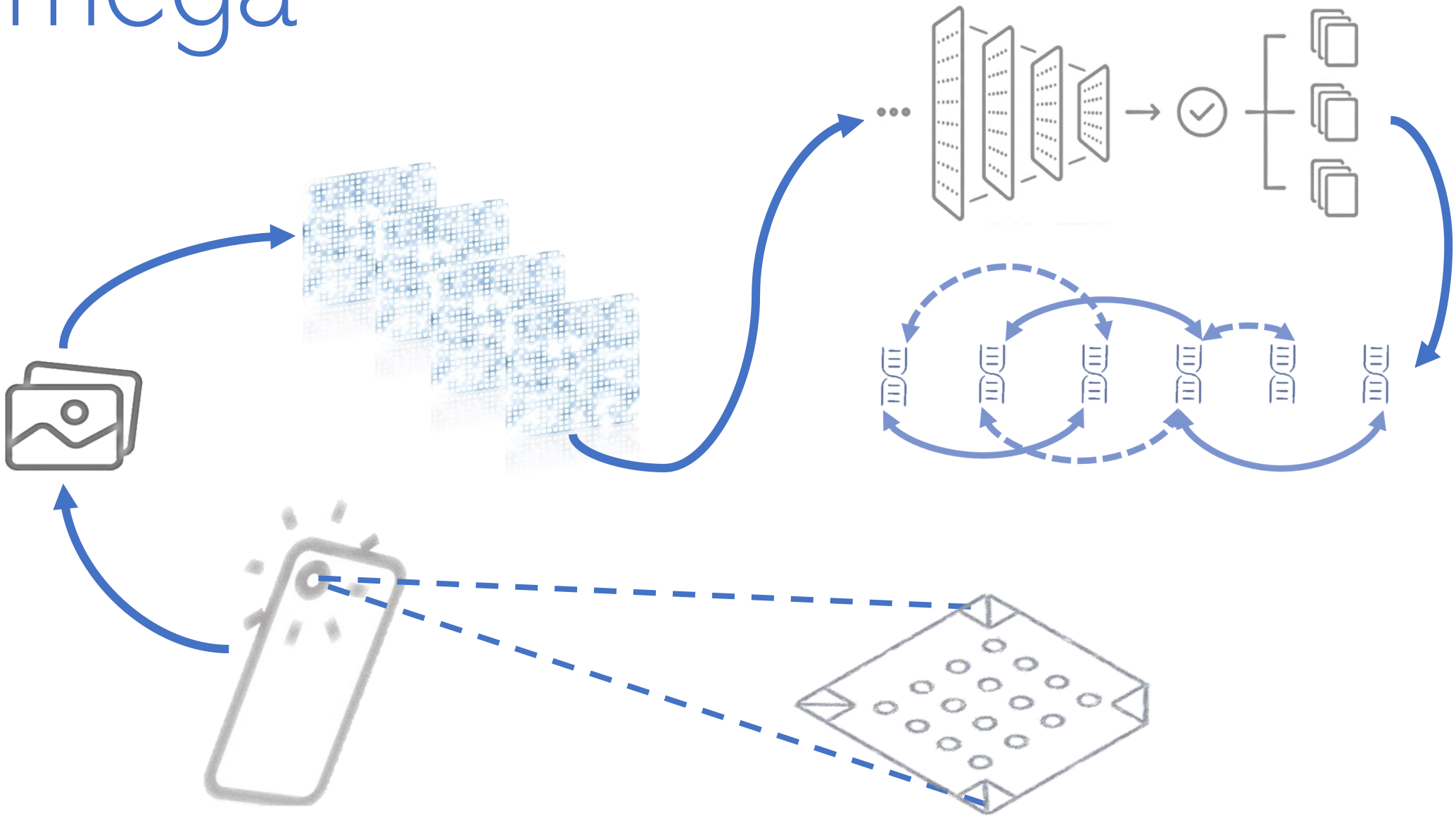
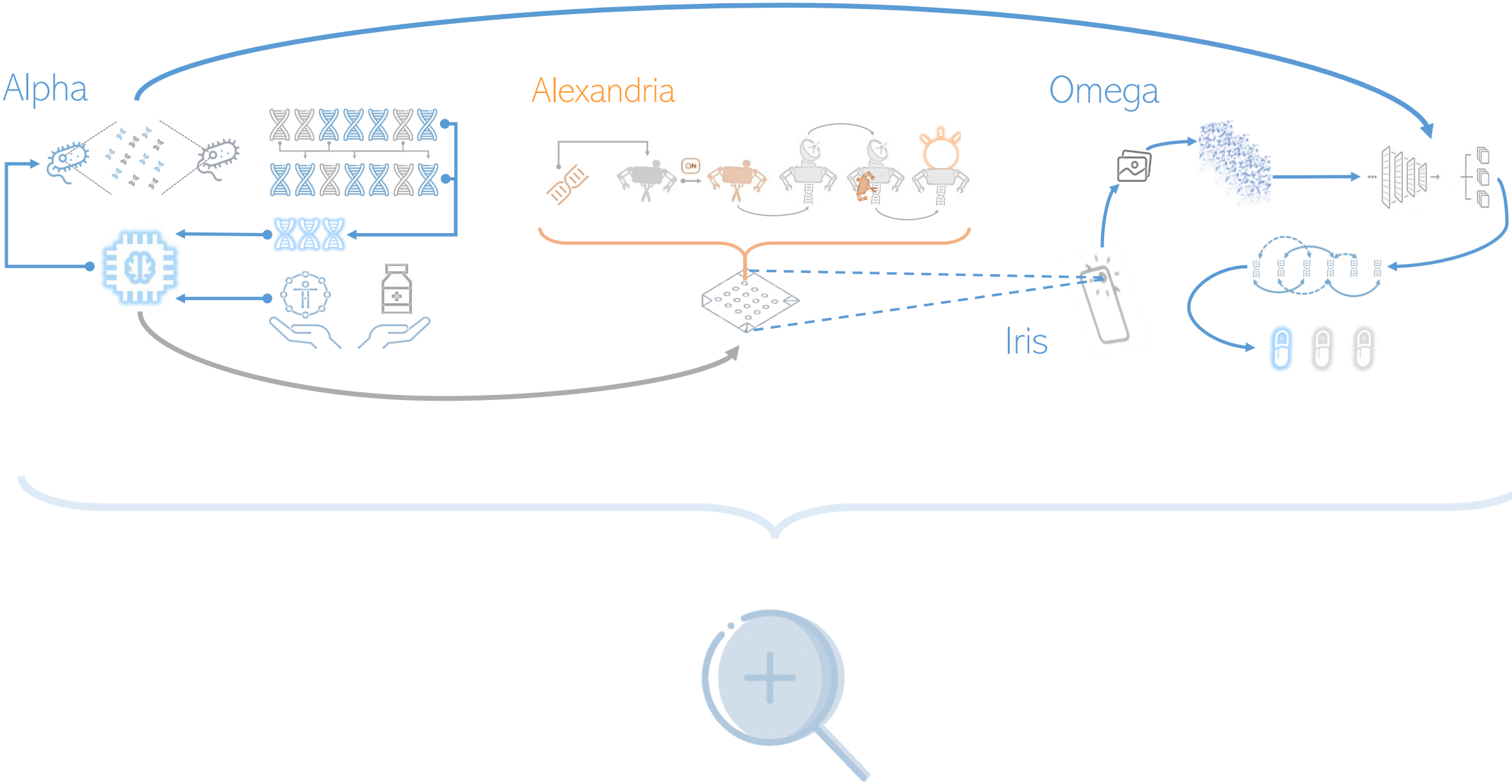



Alpha
Alexandria
Omega
Iris

Thank you

Bacteria: robots of 21st century

Antibiotic
Resistance
Inference
Array

Universitat Pompeu Fabra Barcelona

Barcelona Biomedical Research Park

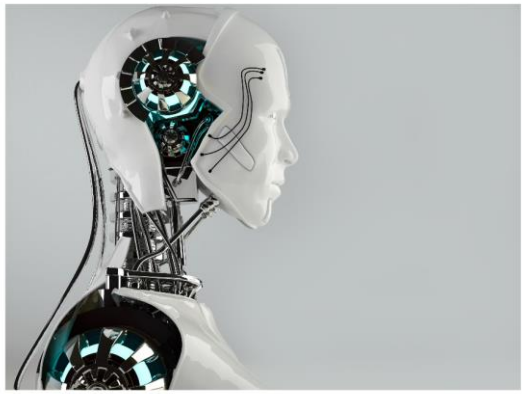
arquicalcul

TASALIA SOCIEDAD DE TASACIÓN

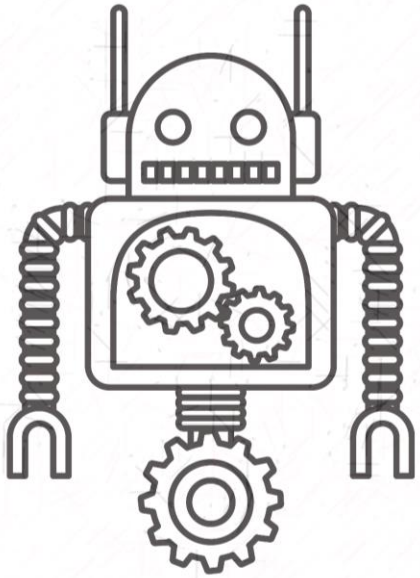
Auba FP

ARIA iGEM Team

Robots



Robots vs. bacteria



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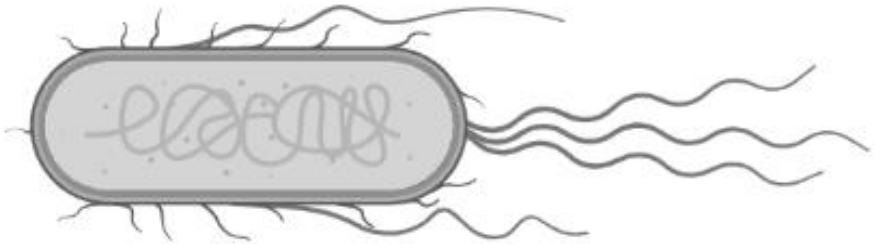
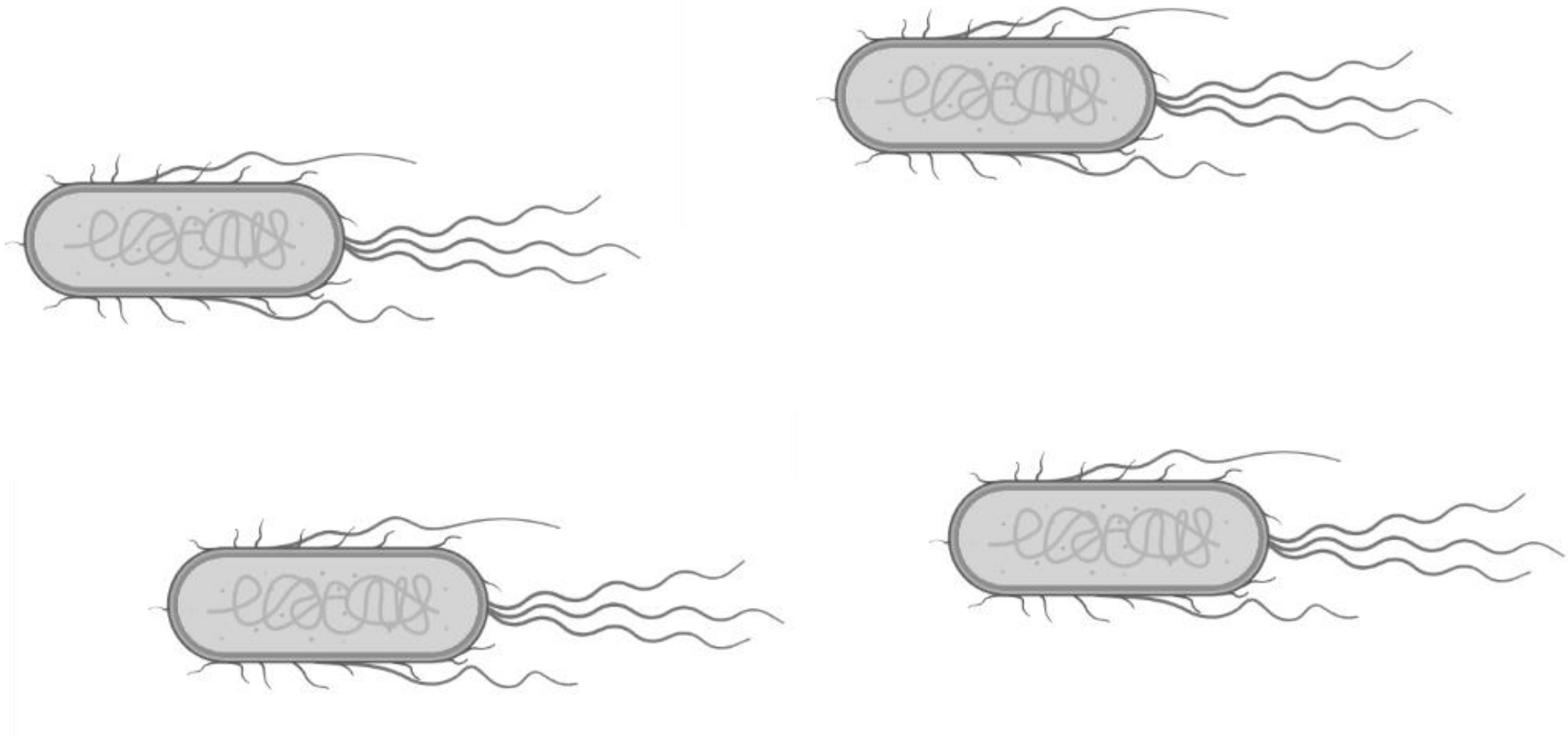
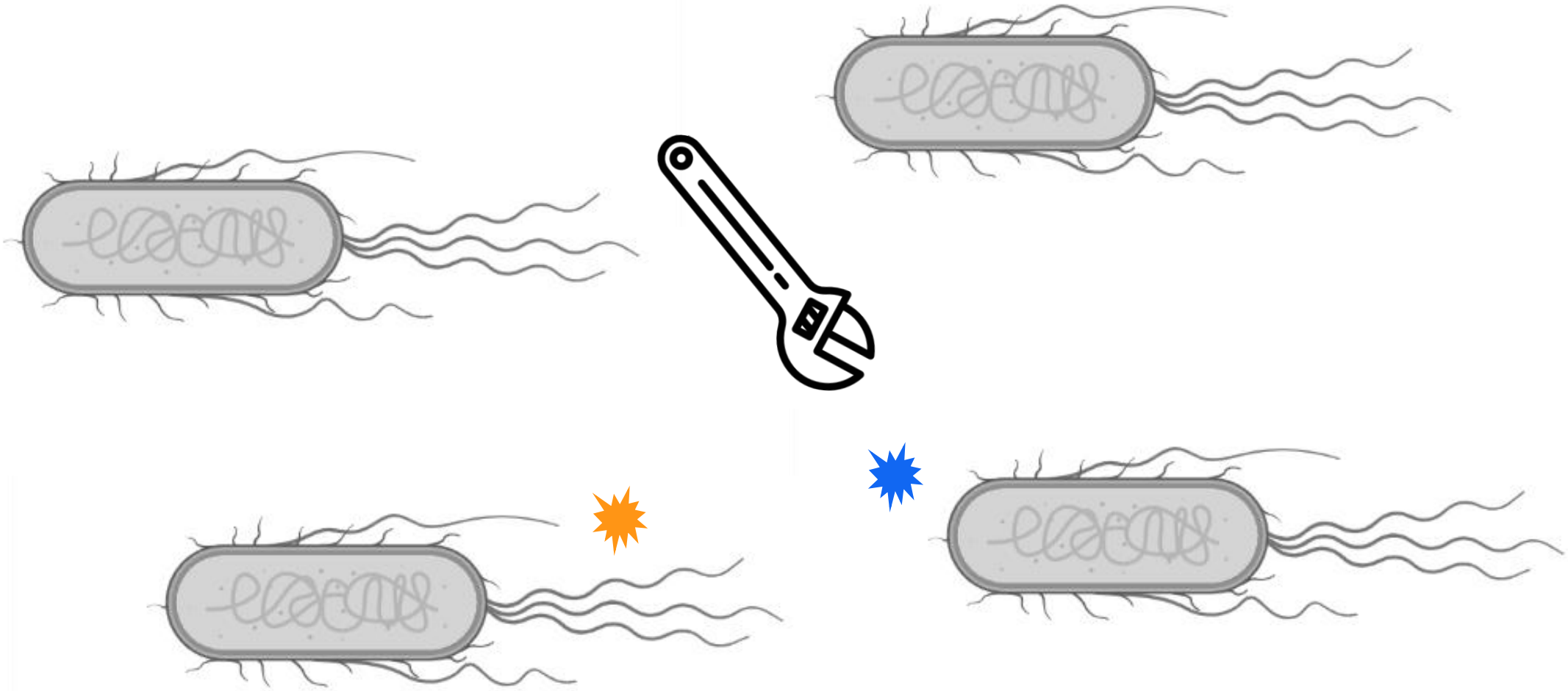


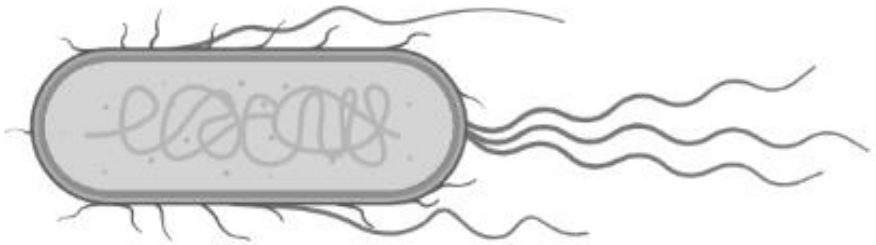
Robots vs. bacteria

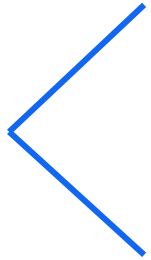


Robots vs. bacteria



Genetic engineering





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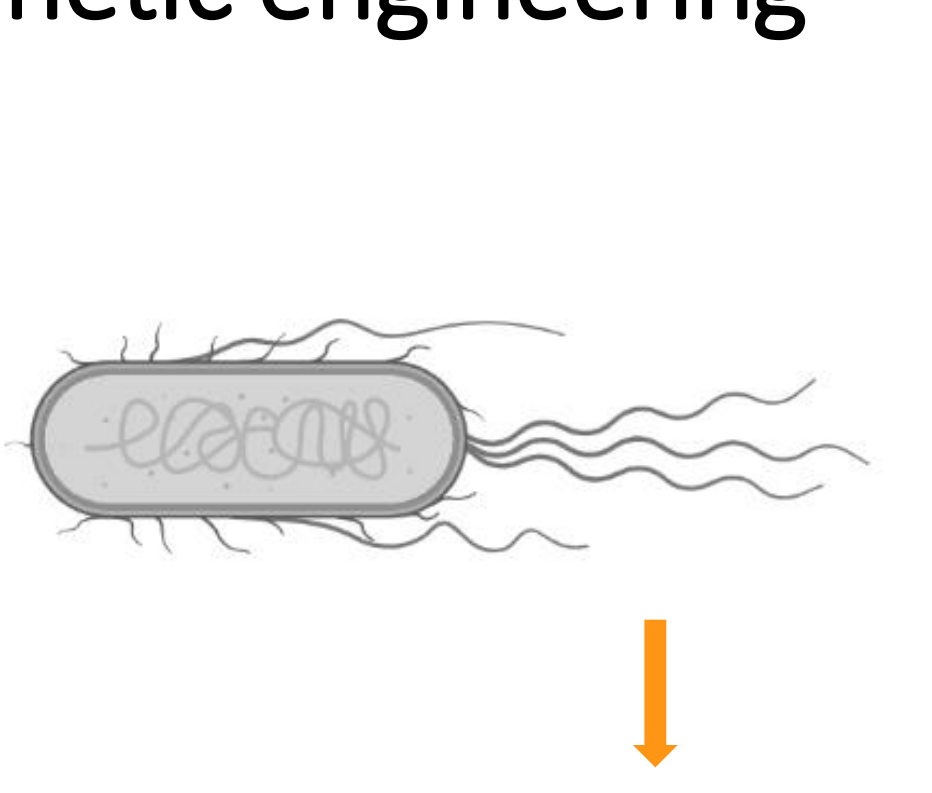
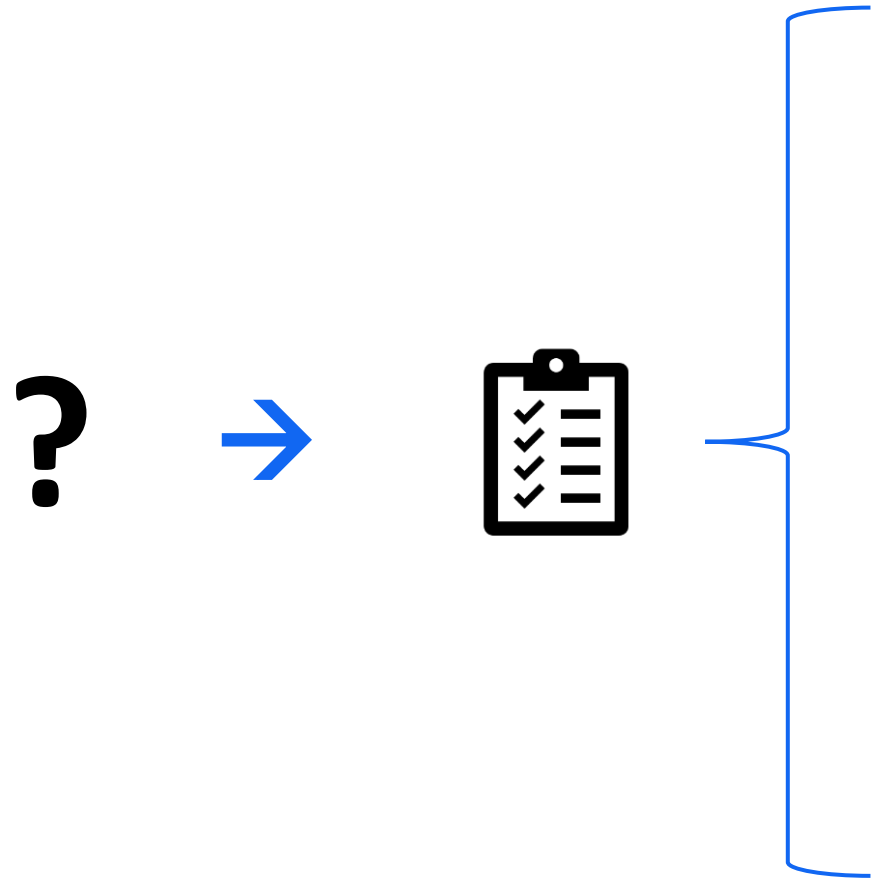


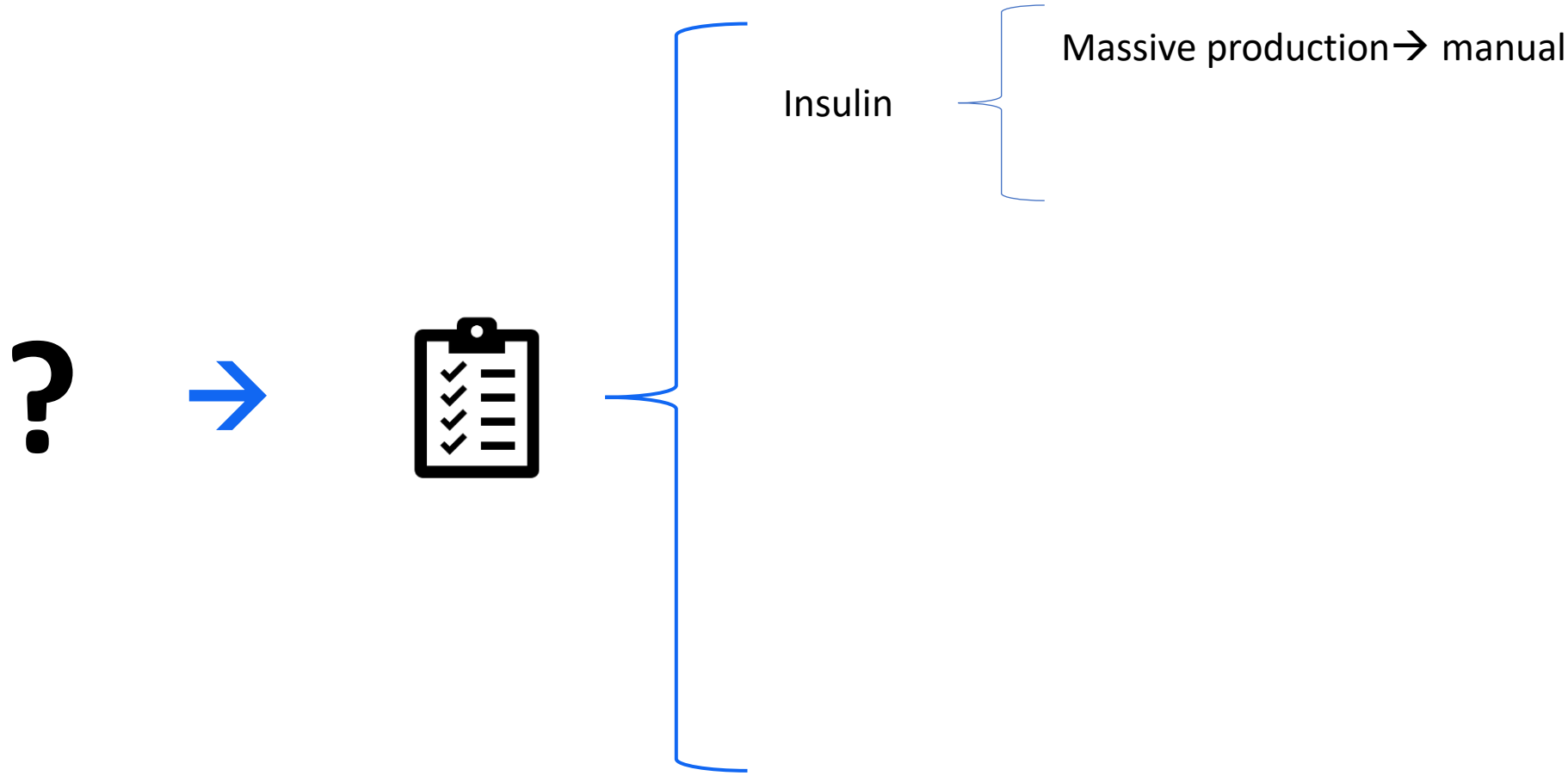
Programming bacteria

? →

Programming bacteria



Programming bacteria



Programming bacteria

?

- Insulin
  - Massive production→ manual
  - Sensing glucose – producing insulin

Programming bacteria

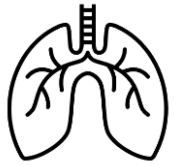
?

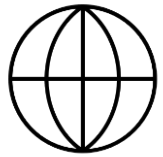
Insulin

Massive production→ manual

Sensing glucose – producing insulin

Other sectors





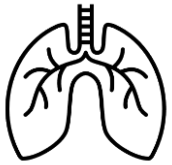
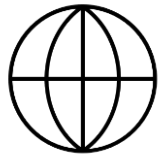
Programming bacteria

?

Insulin

- Massive production→ manual
- Sensing glucose – producing insulin

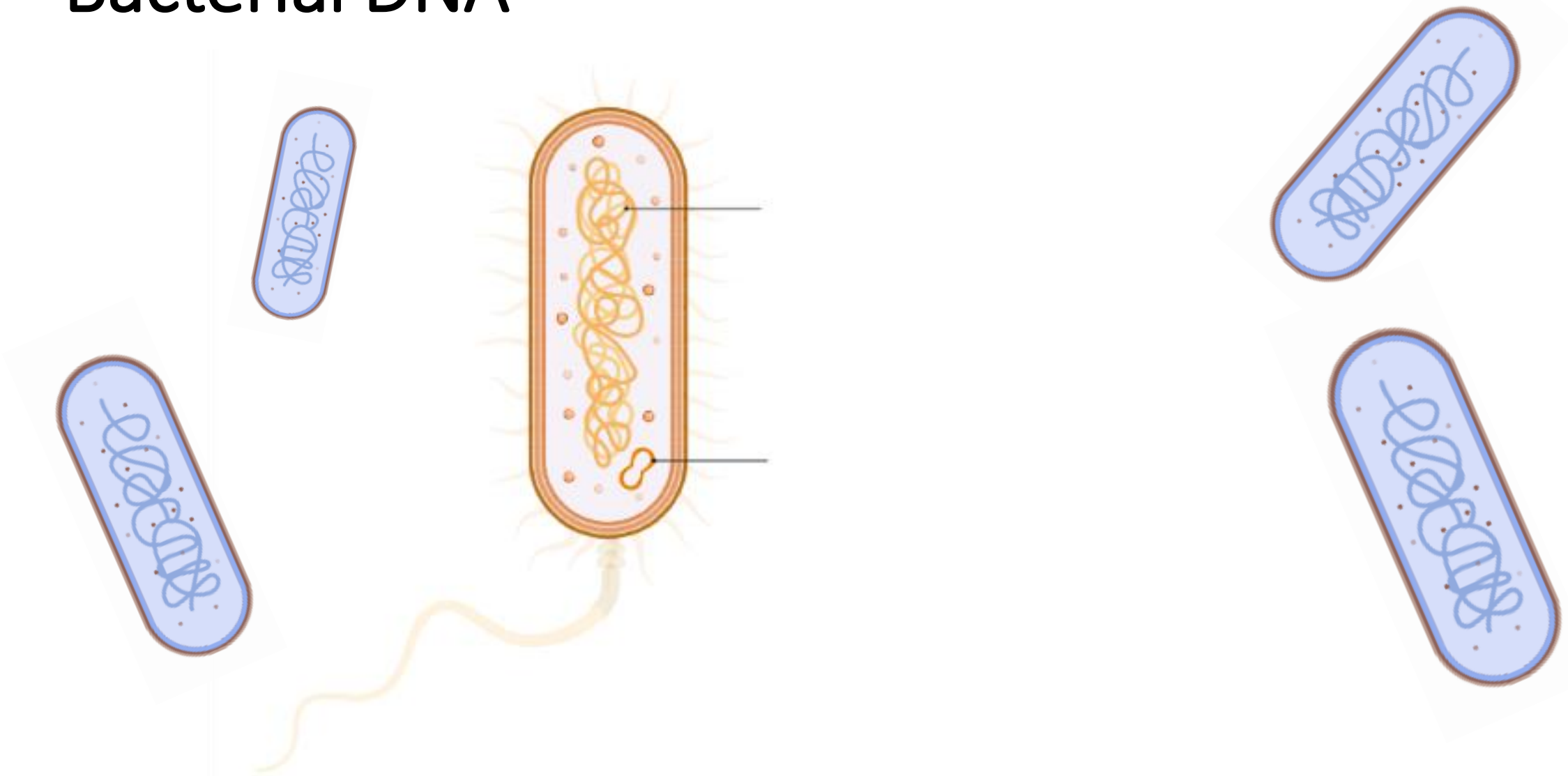
Other sectors

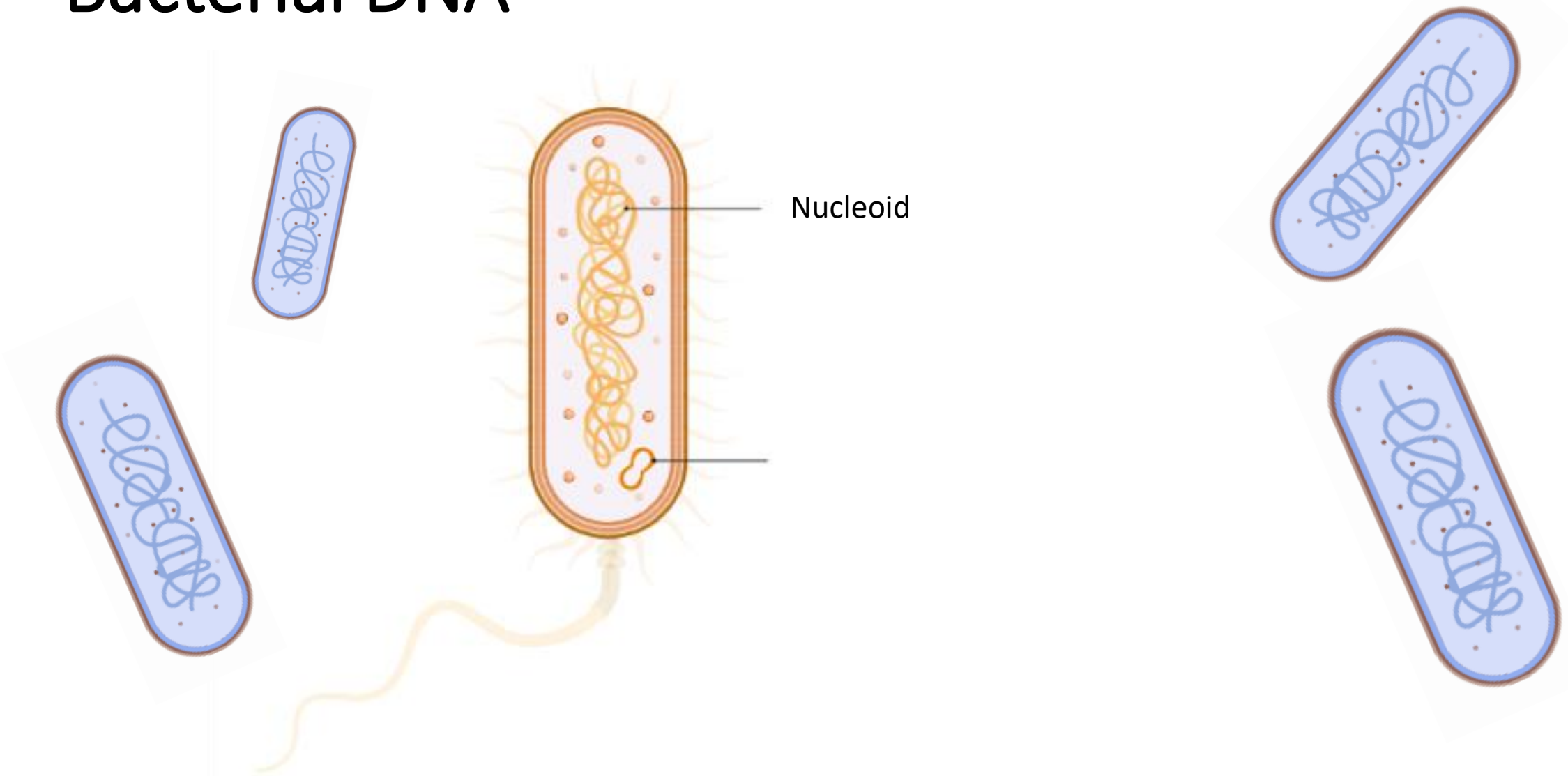
ARIA

Antibiotic
Resistance
Inference
Array

Bacterial DNA



Bacterial DNA



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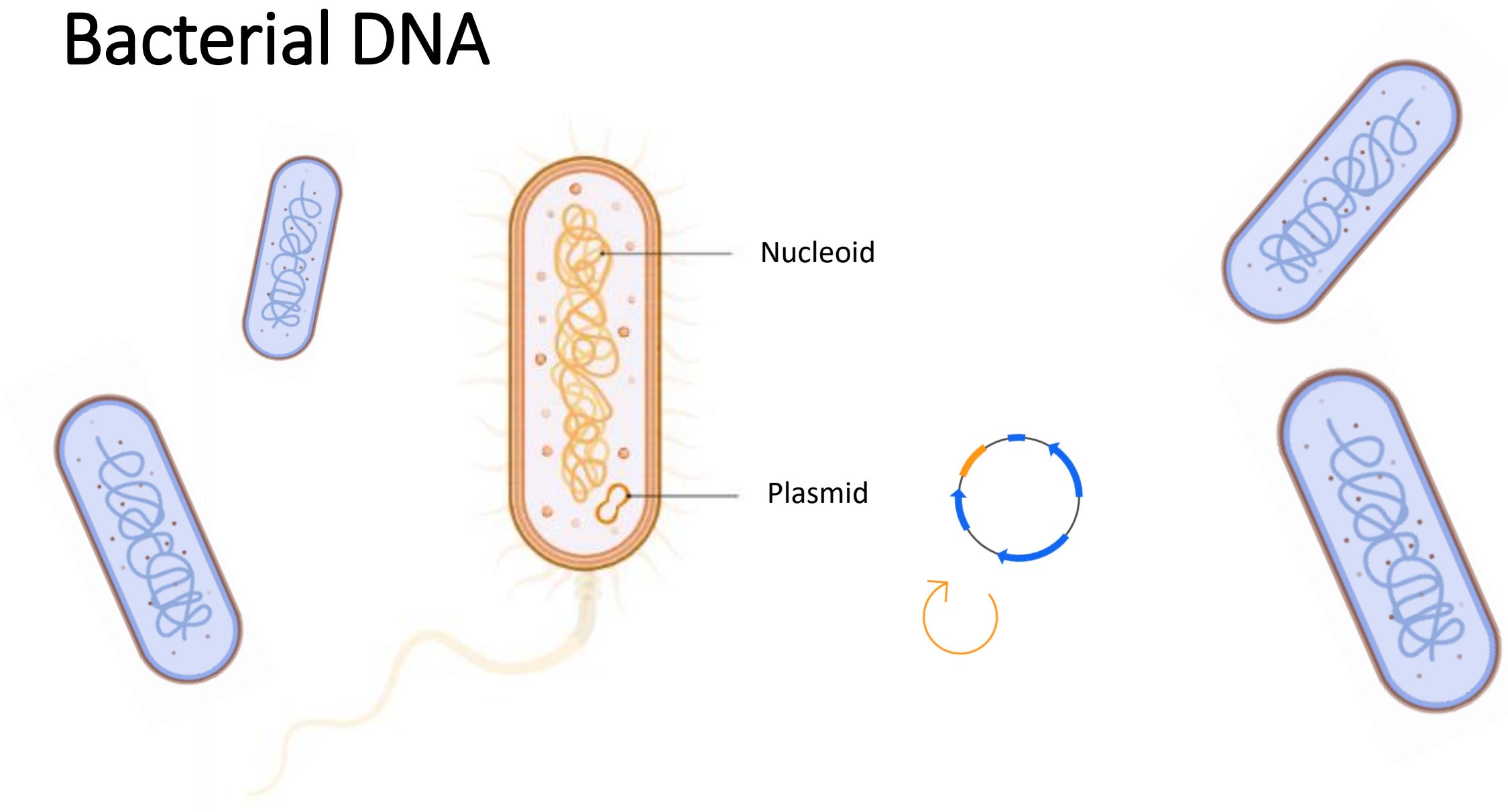
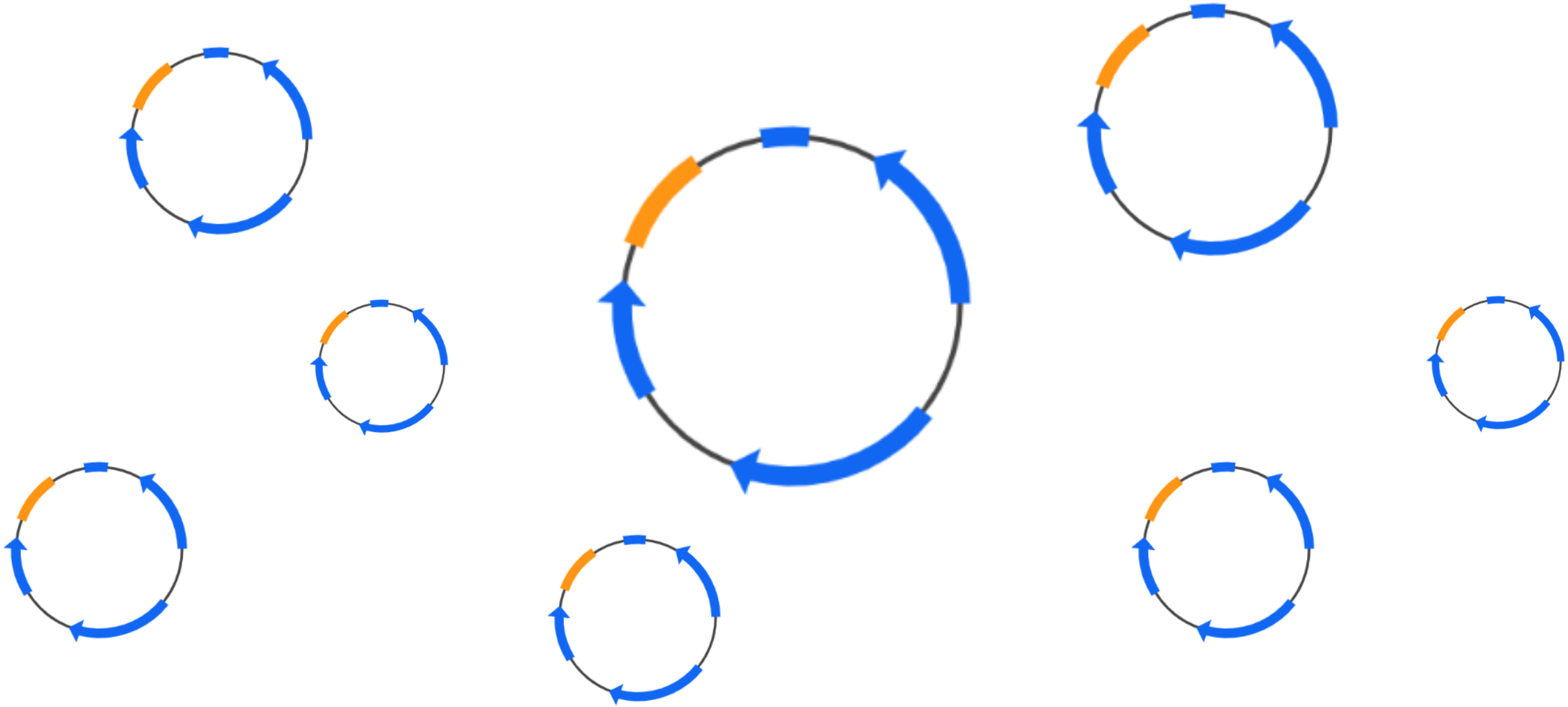


Plasmid structure



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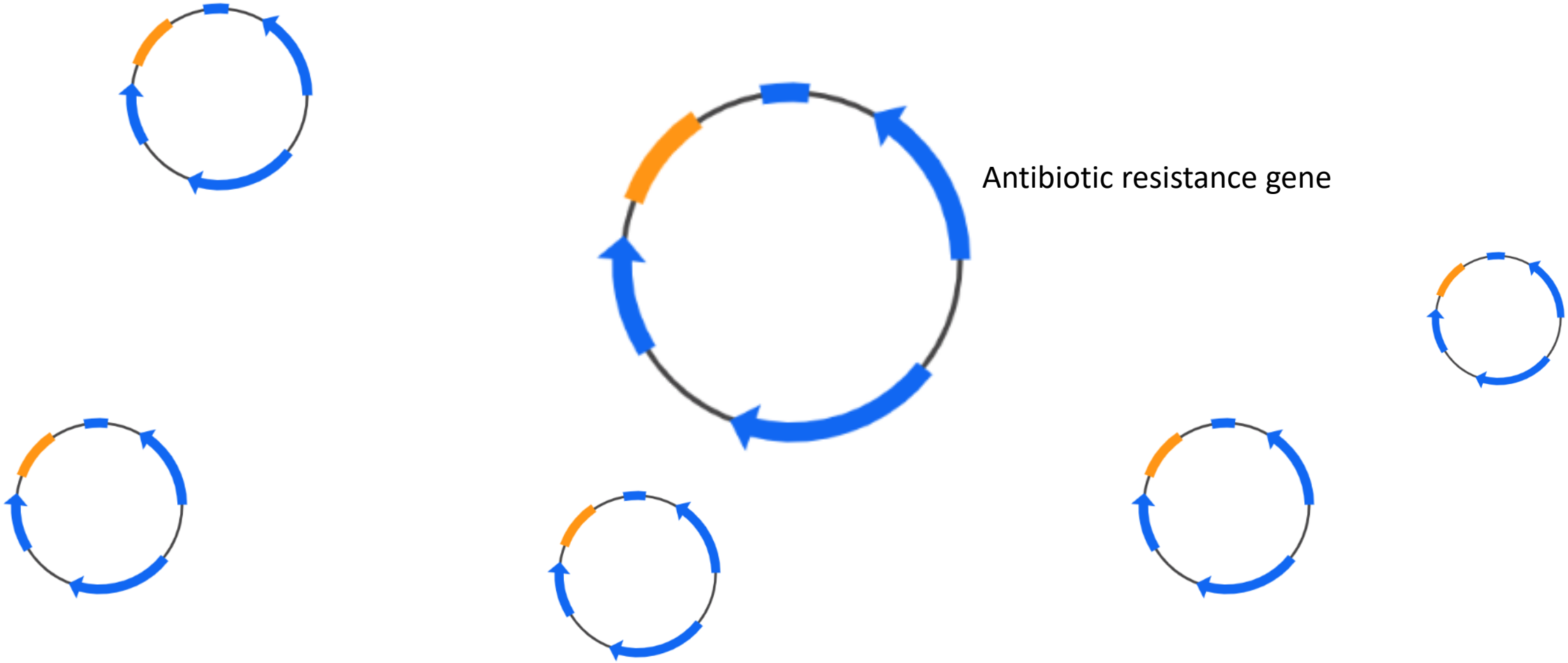
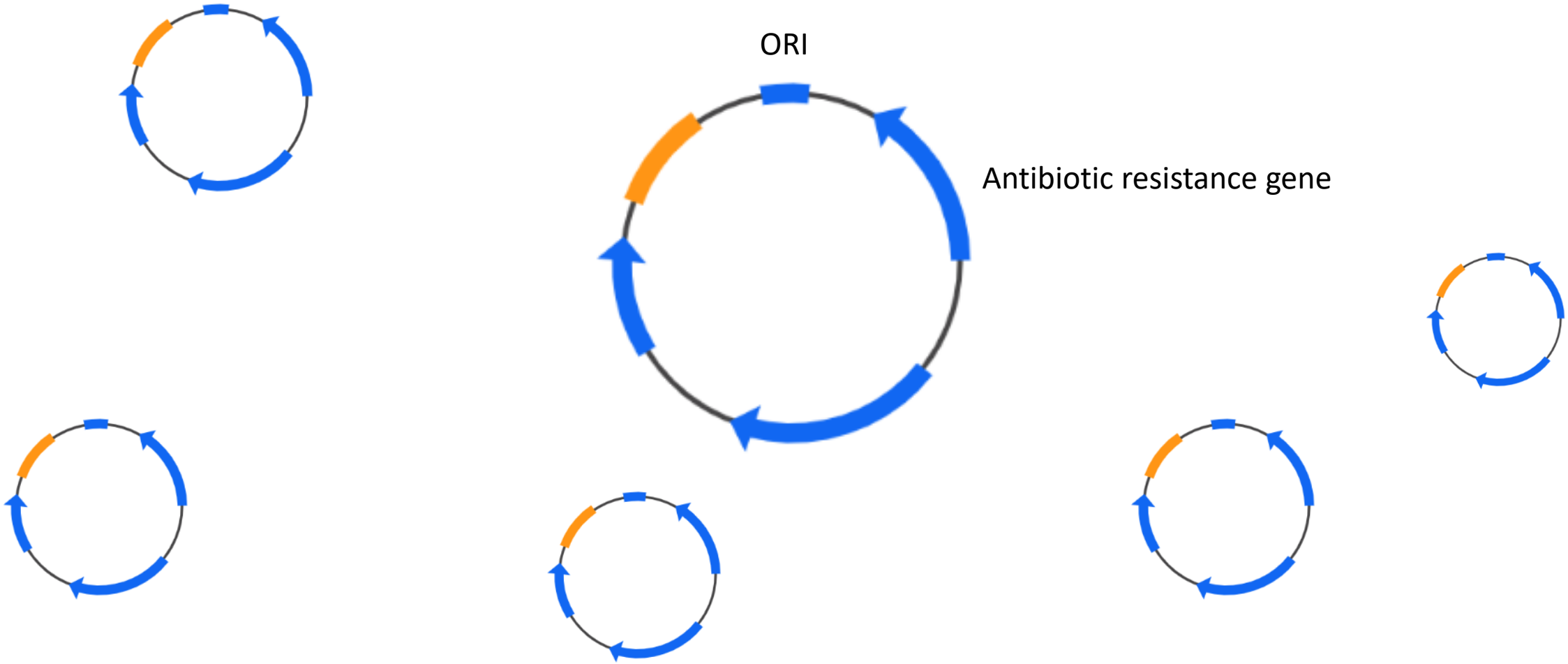
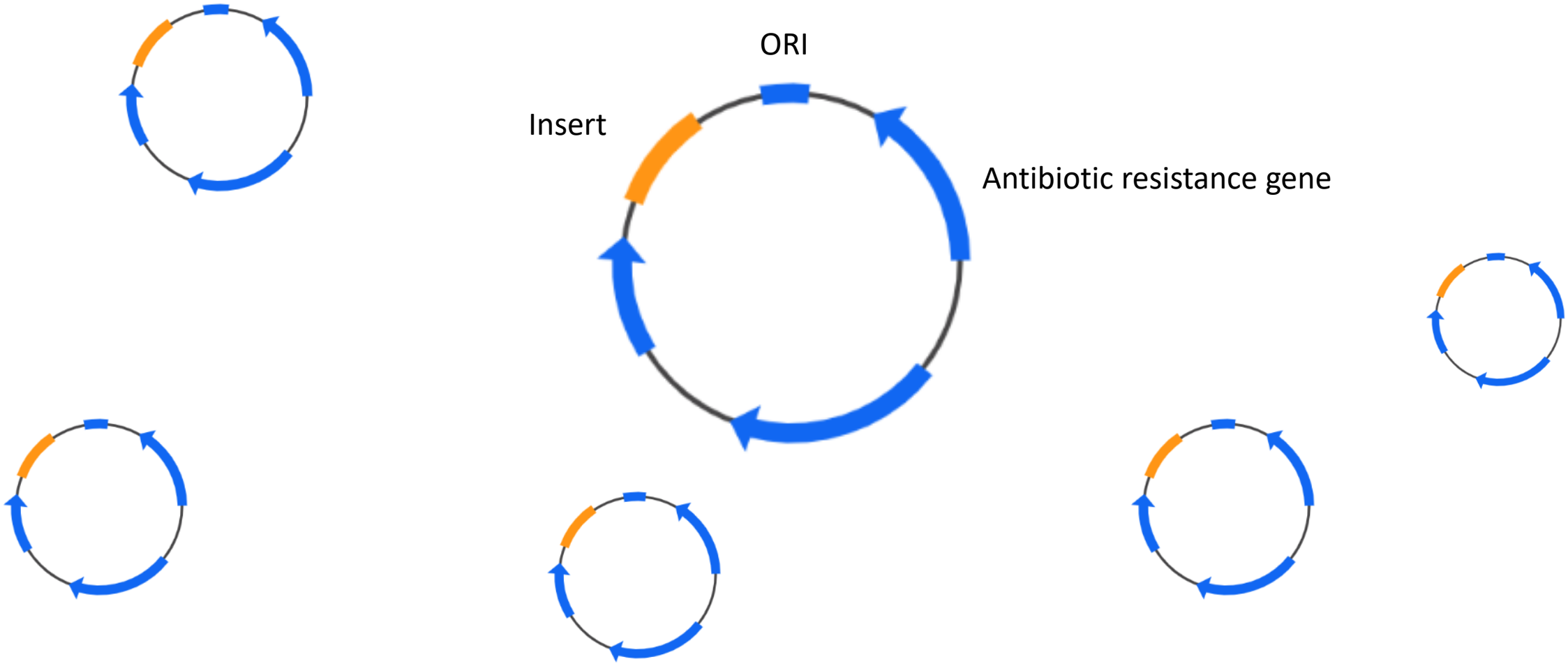


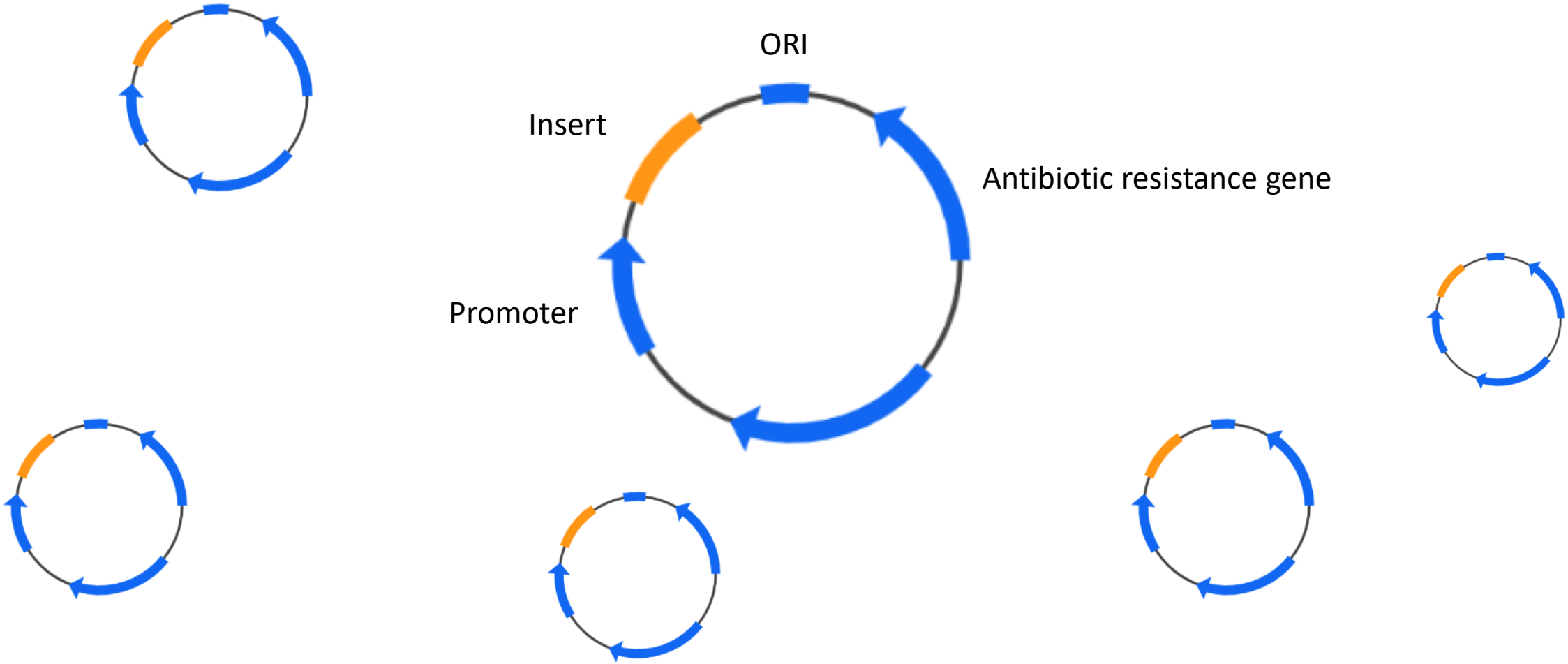
Plasmid structure



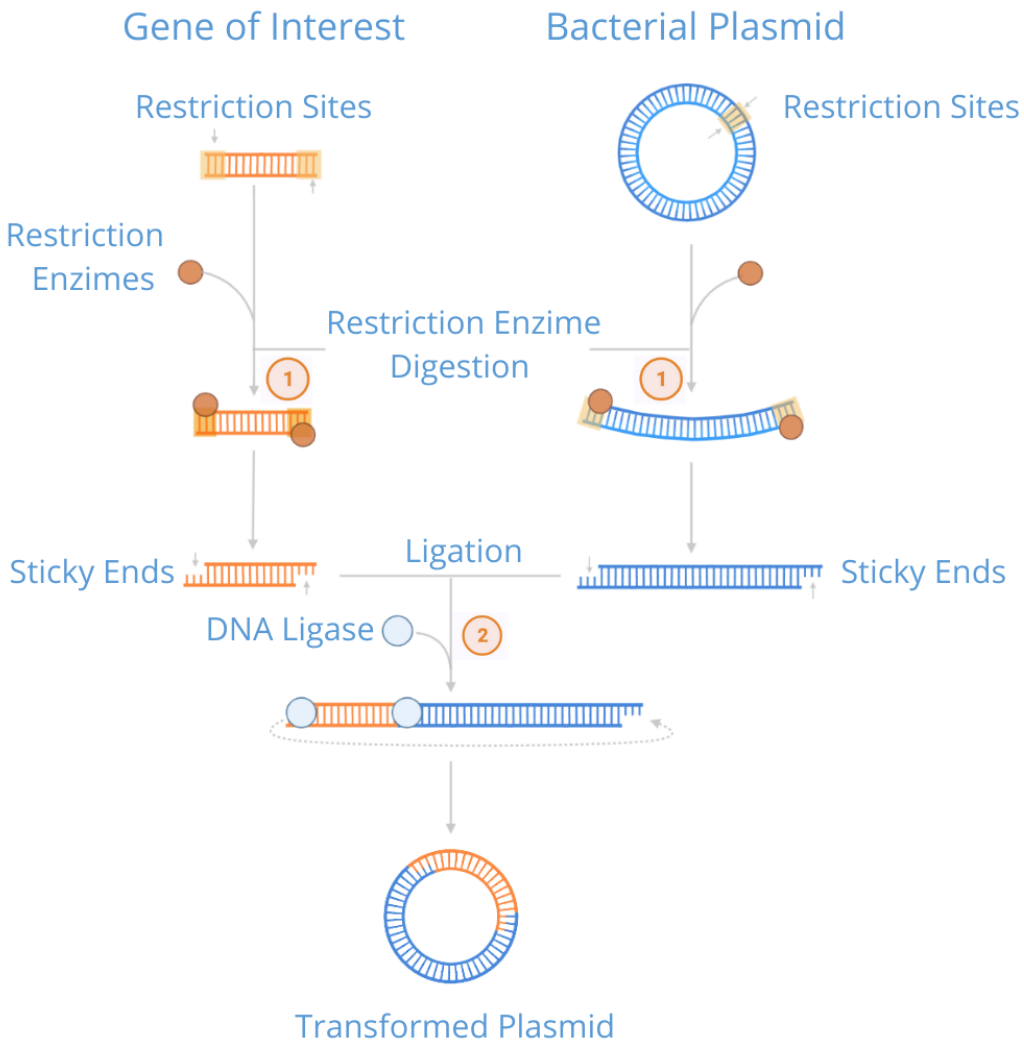
Plasmid structure



Plasmid structure



How can we modify plasmids?



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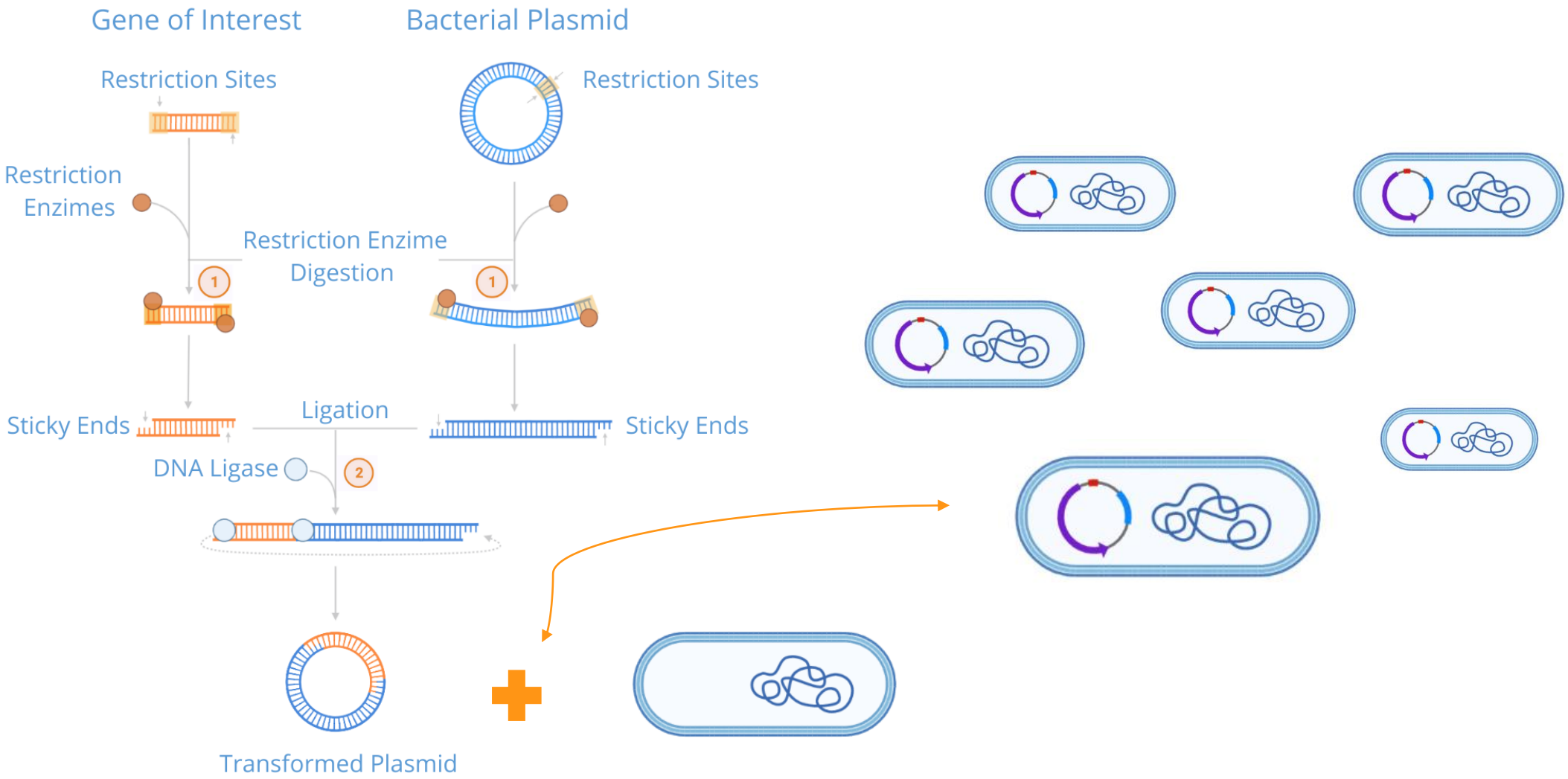
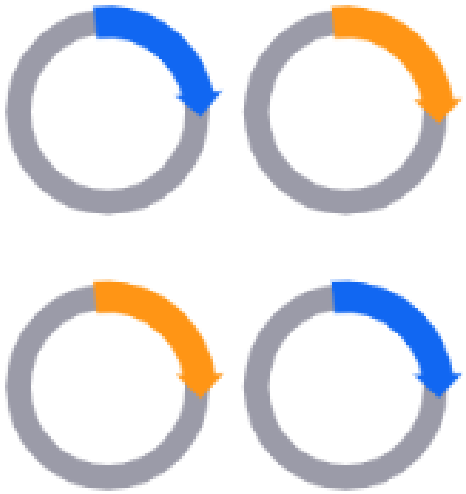
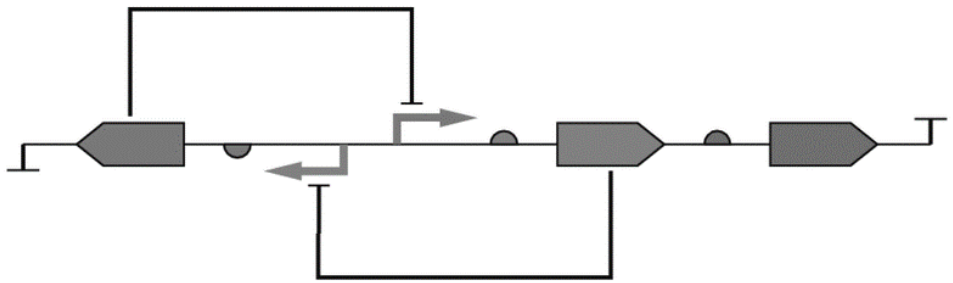
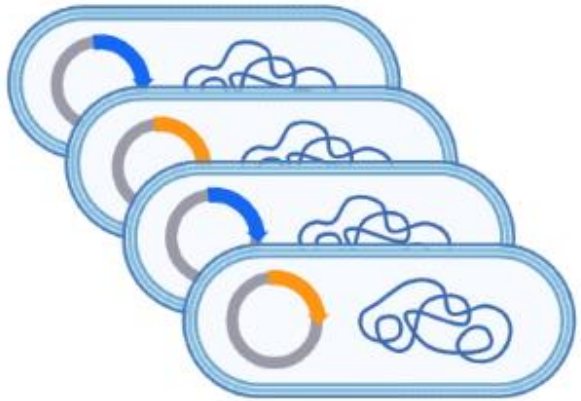
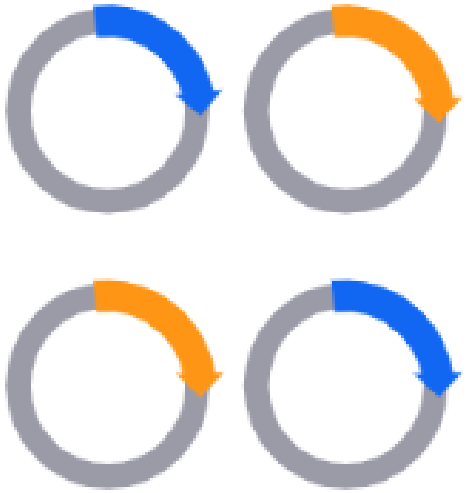
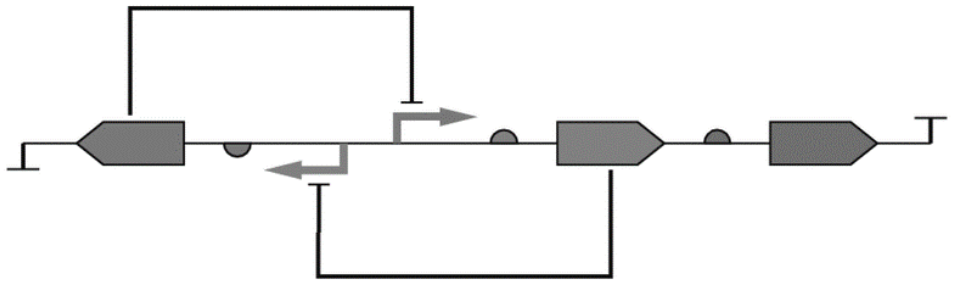


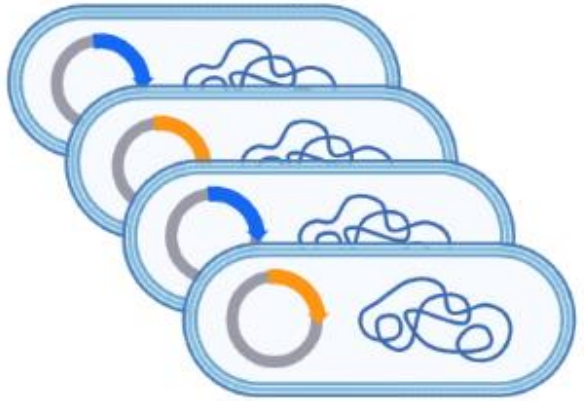






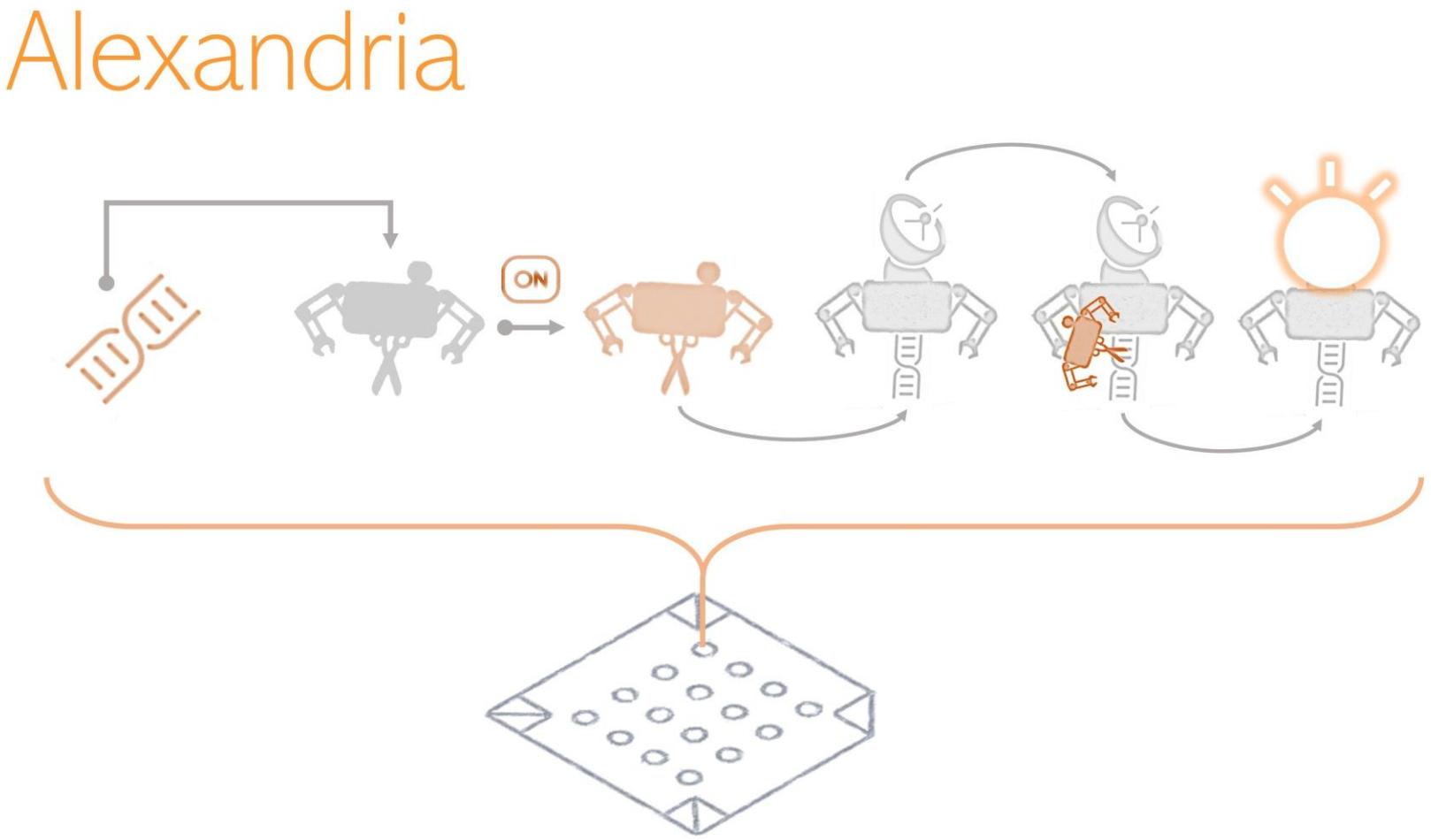






Synthetic biology

ARIA: Antibiotic Resistance Inference Array



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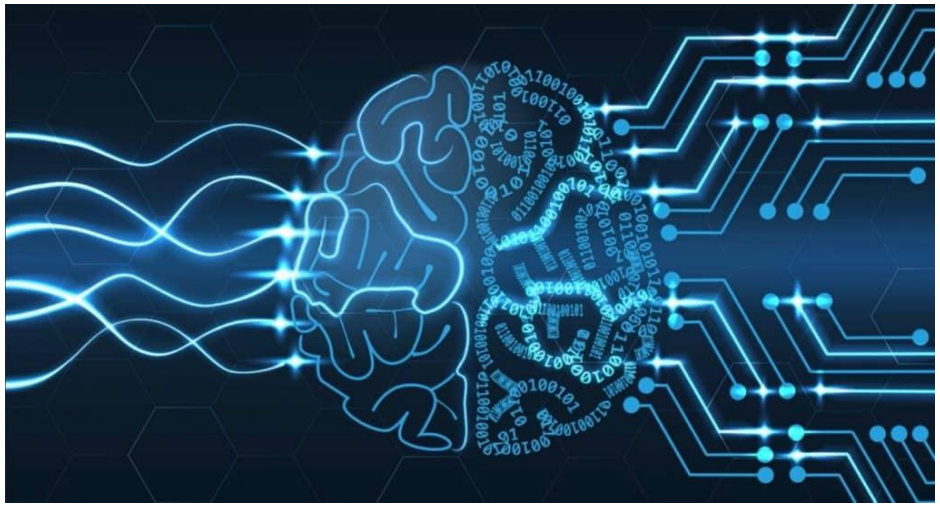
Artificial Neural Networks

upf.

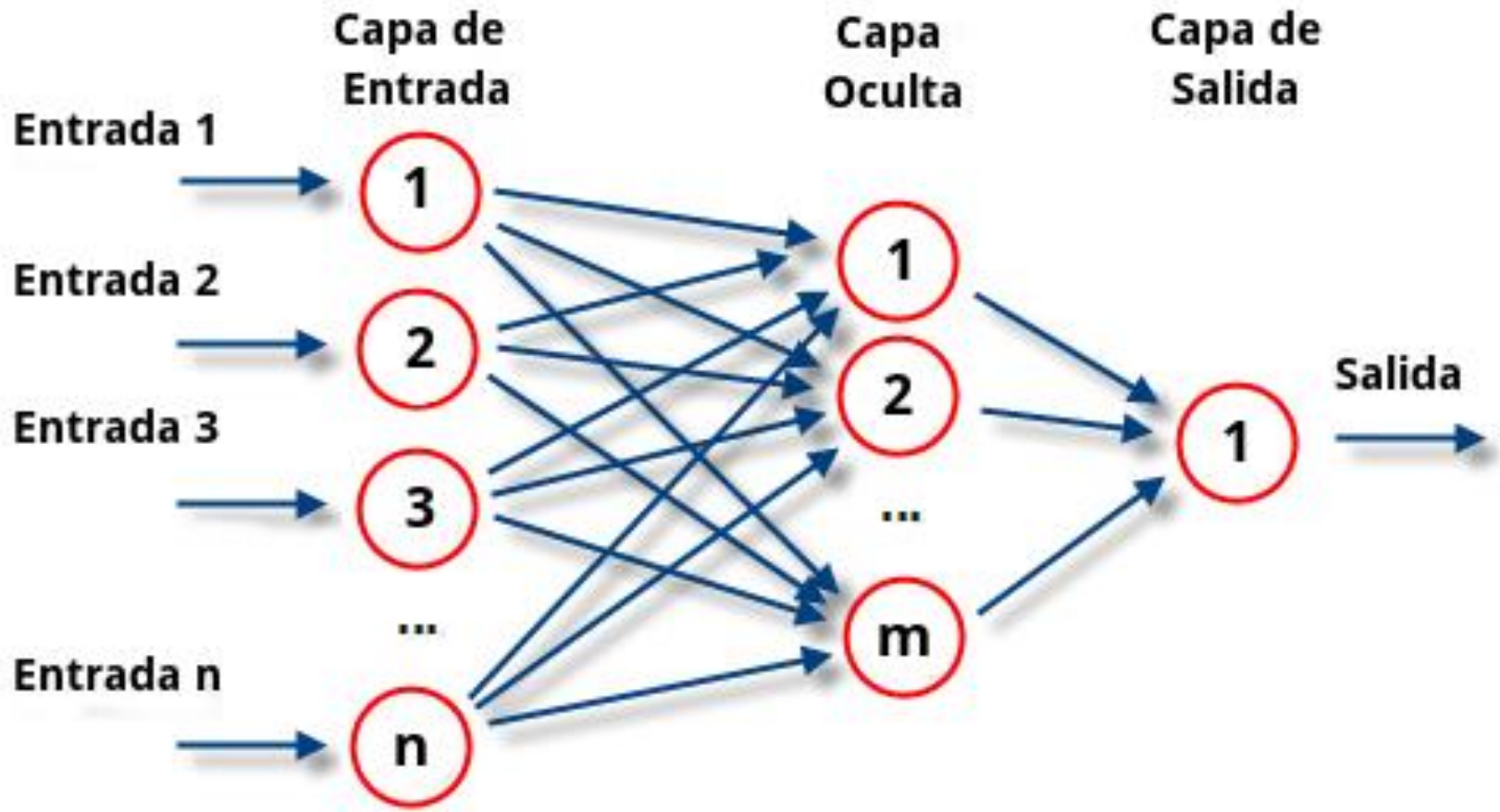
iGEM

What are they?

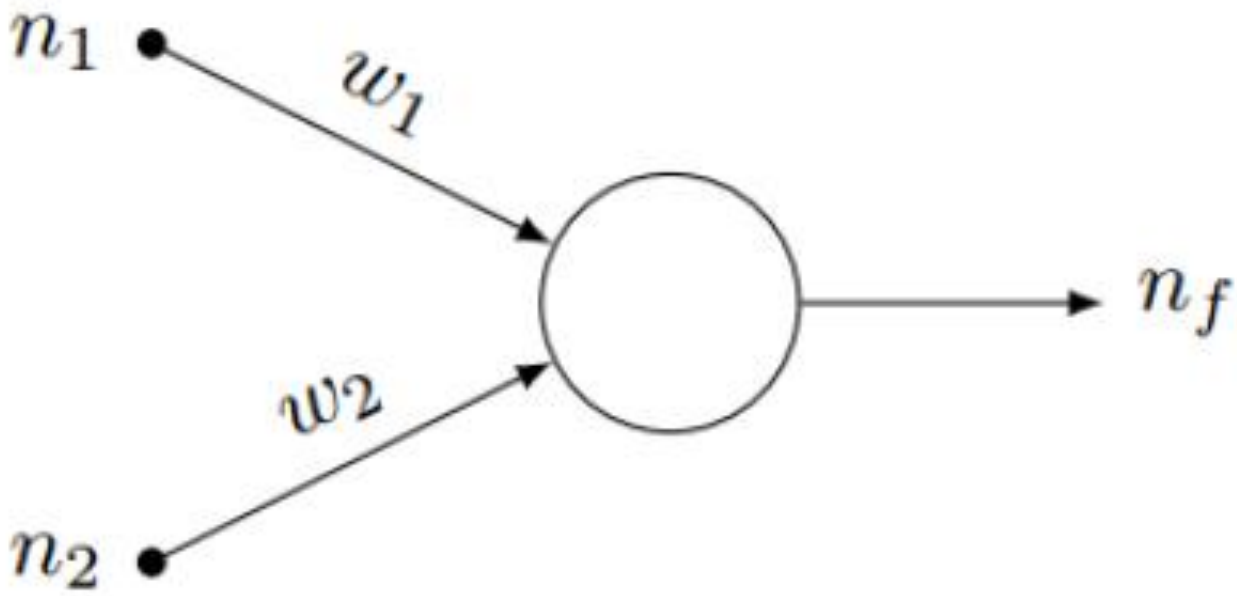
Machine learning is a branch of artificial intelligence that allows machines to learn, with respect to a particular task, without being explicitly programmed to do so.



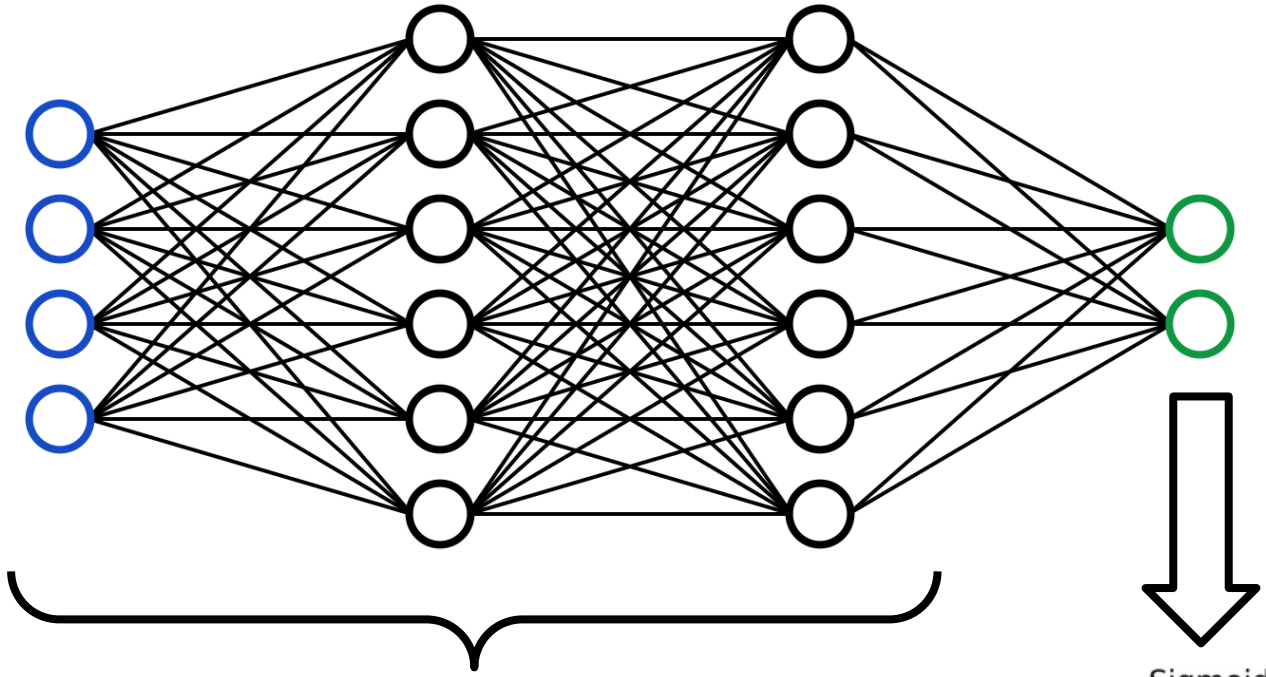
Basic Structure



Perceptron

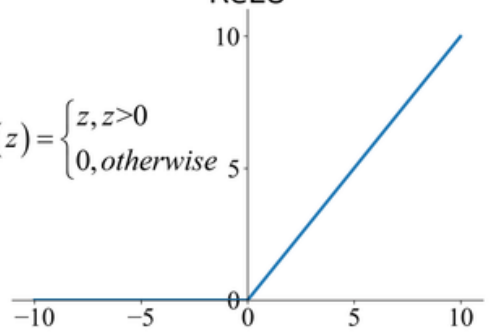


Layers and activation functions



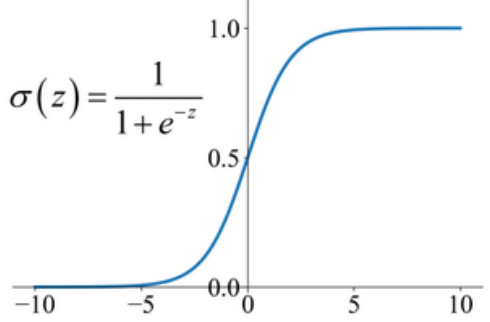
ReLU

$$\mathrm{ReLU}(z)=\begin{cases} z, z>0 \\ 0, otherwise \end{cases}$$

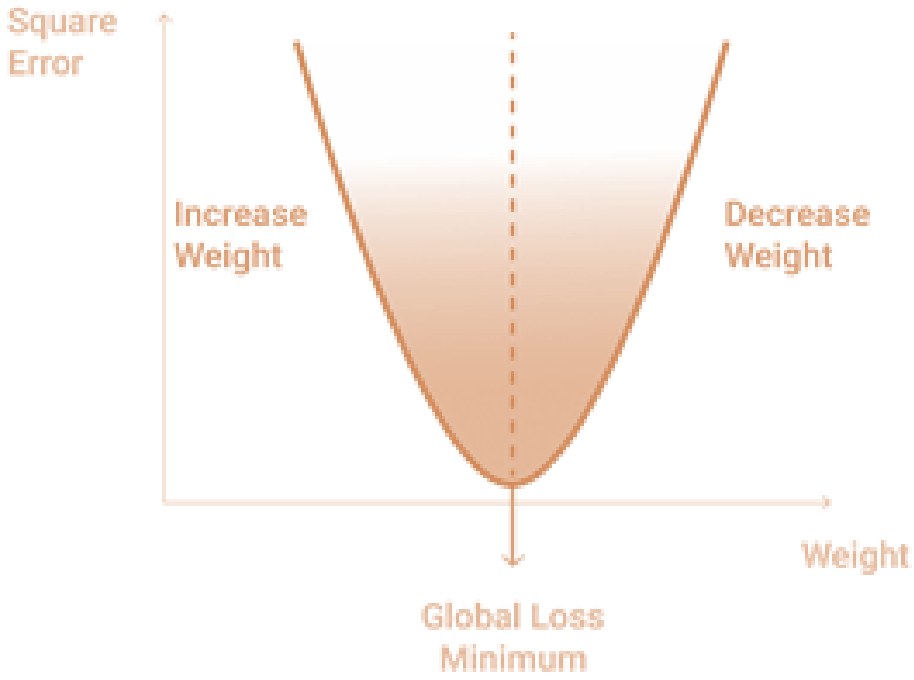


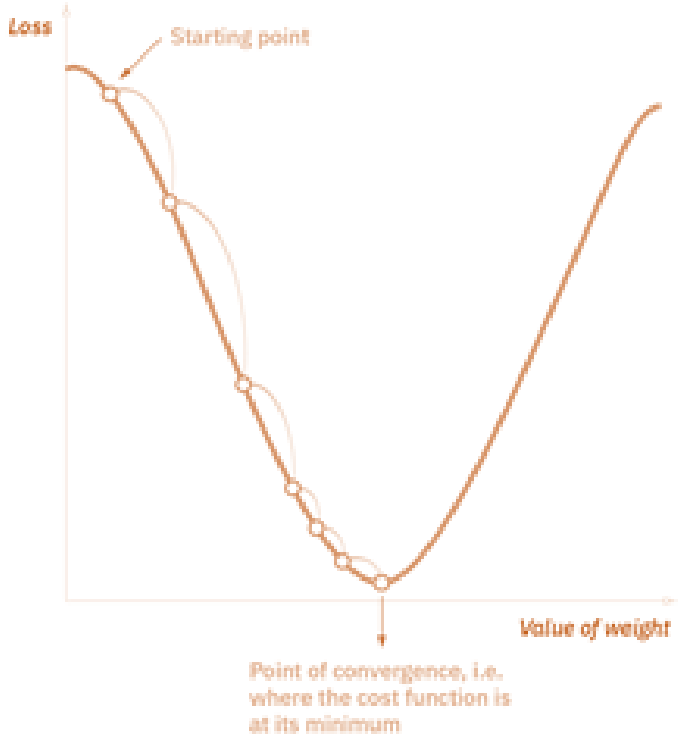
Sigmoid

$$\sigma(z)=\frac{1}{1+e^{-z}}$$

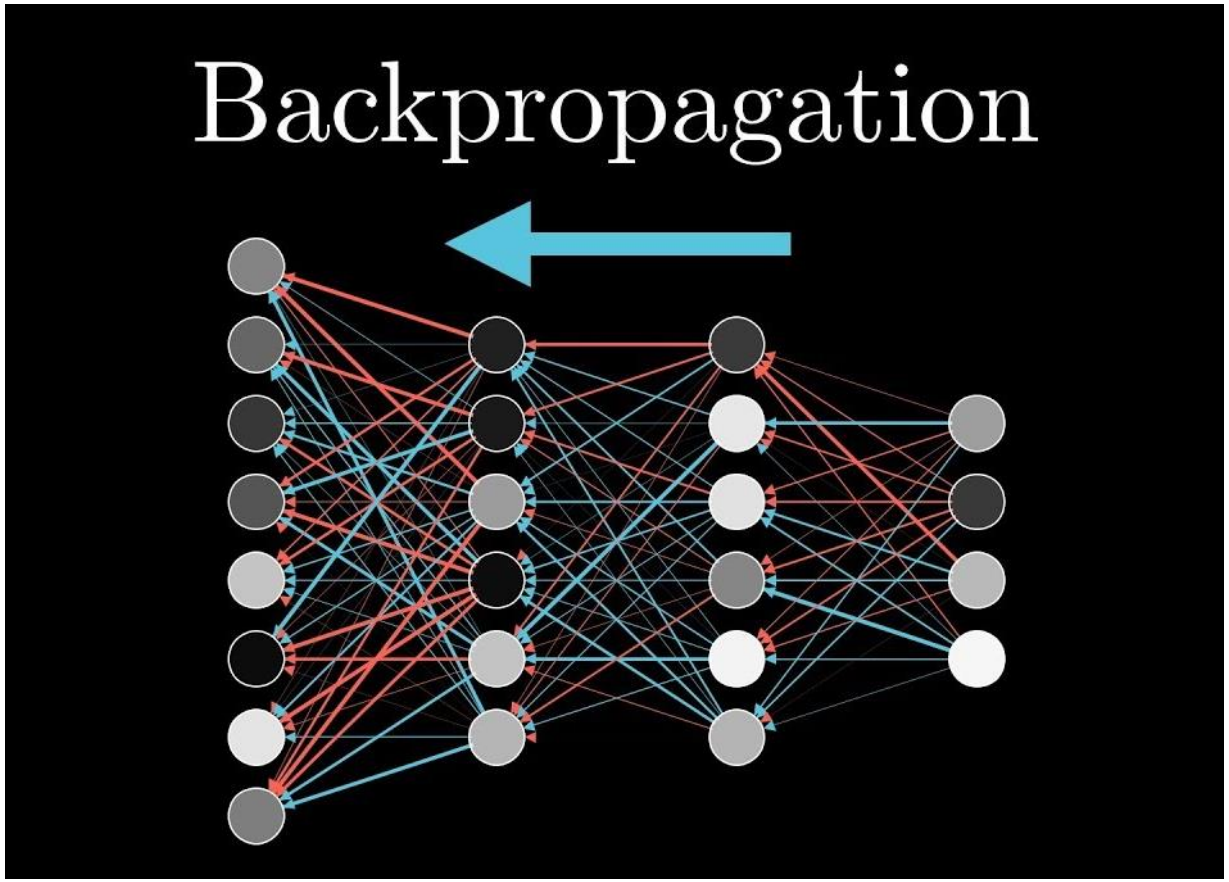


Gradient Descent

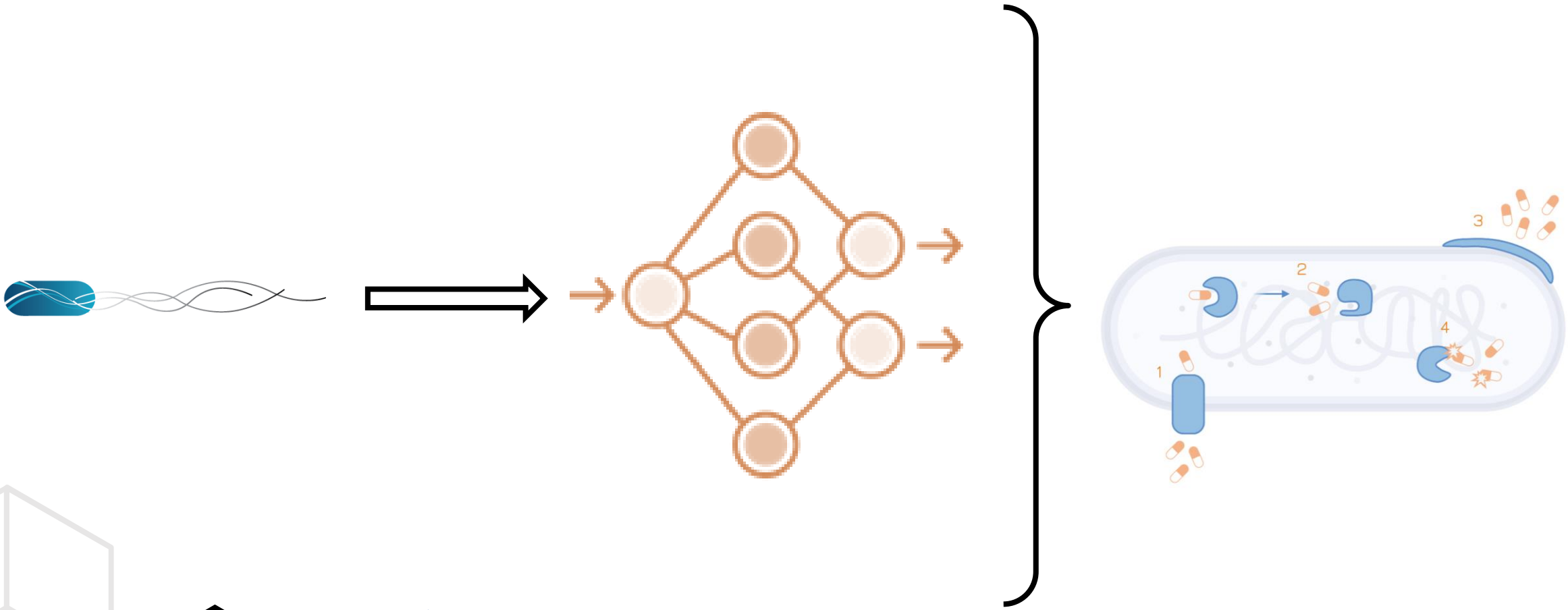




Backpropagation



ARIA’s function



CRISPR-Cas12a biosensor library: Alexandria

Antibiotic
Resistance
Inference
Array

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prbb Barcelona Biomedical Research Park

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iGEM

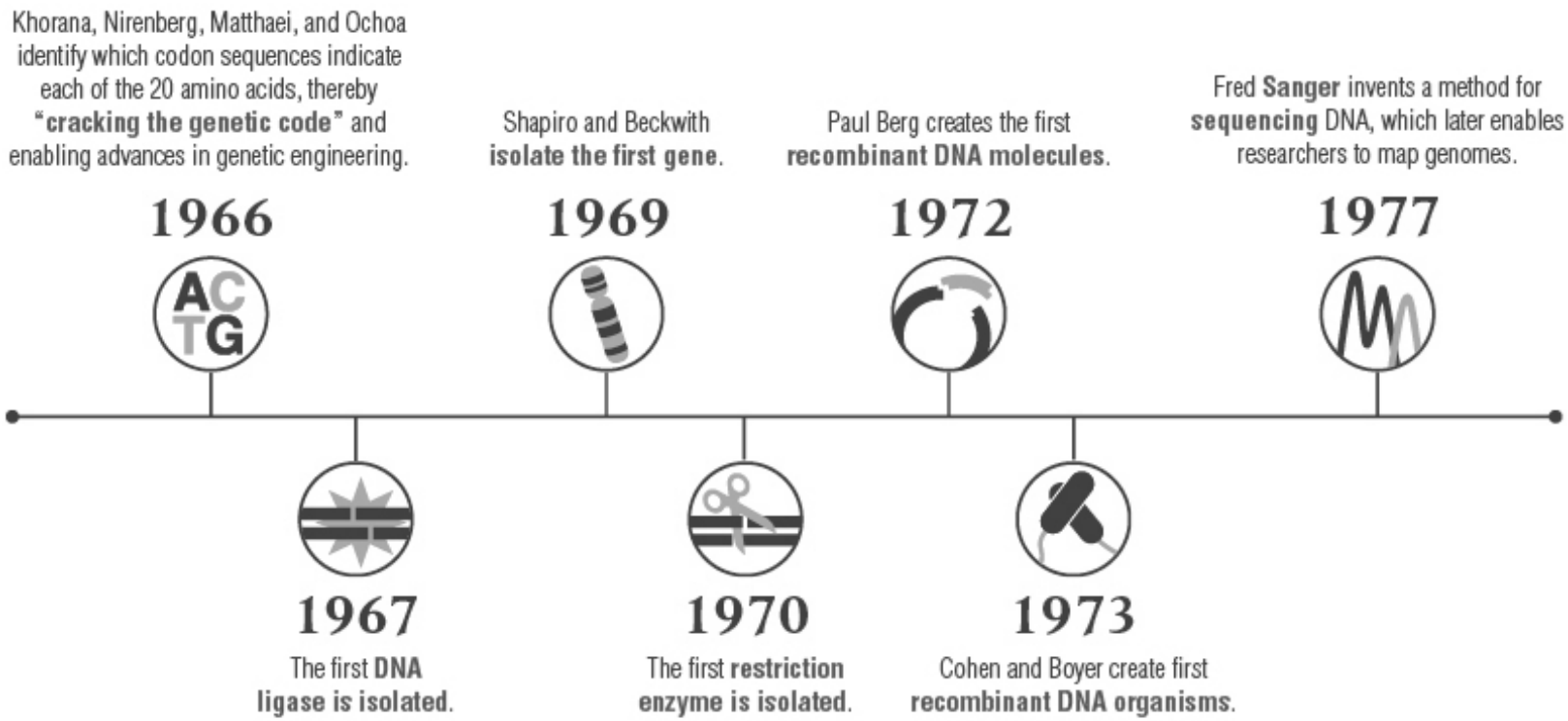
CRISPR-Cas ?

CRISPR-Cas ?

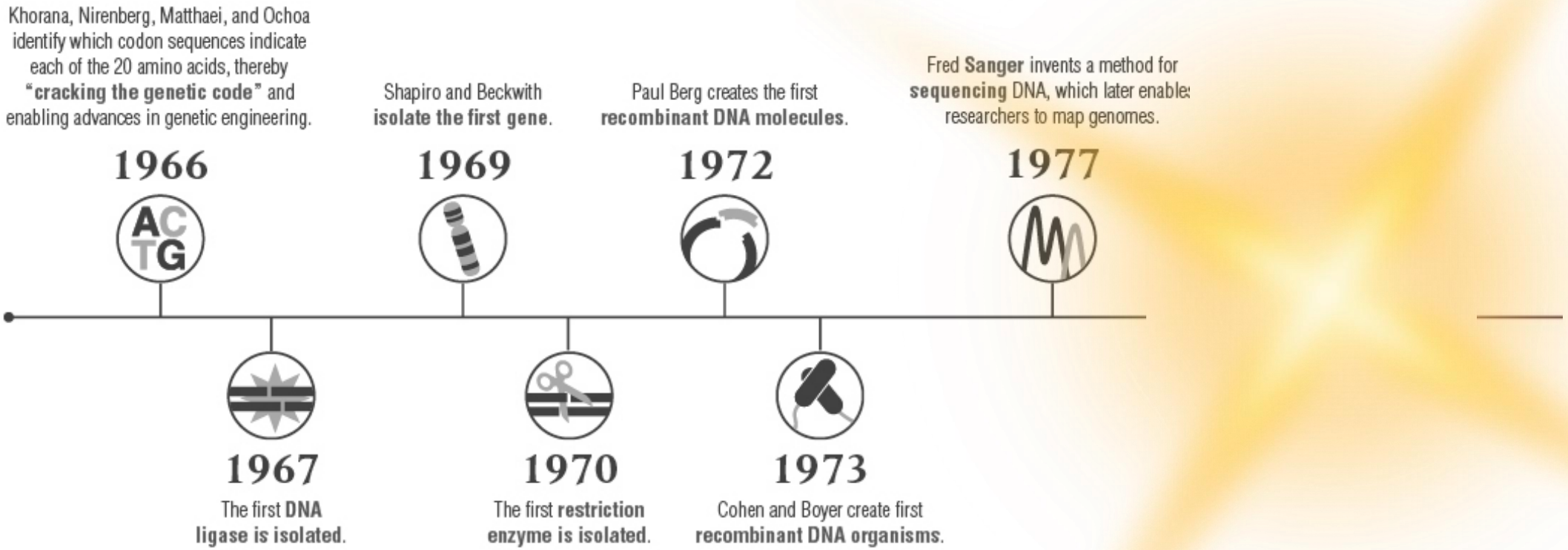
CRISPR-Cas ?

CRISPR-Cas ?

CRISPR-Cas


Khorana, Nirenberg, Matthaei, and Ochoa identify which codon sequences indicate each of the 20 amino acids, thereby "cracking the genetic code" and enabling advances in genetic engineering.
1966
ACTG
1967
The first DNA ligase is isolated.
Shapiro and Beckwith isolate the first gene.
1969
1970
The first restriction enzyme is isolated.
Paul Berg creates the first recombinant DNA molecules.
1972
1973
Cohen and Boyer create first recombinant DNA organisms.
Fred Sanger invents a method for sequencing DNA, which later enables researchers to map genomes.
1977

CRISPR-Cas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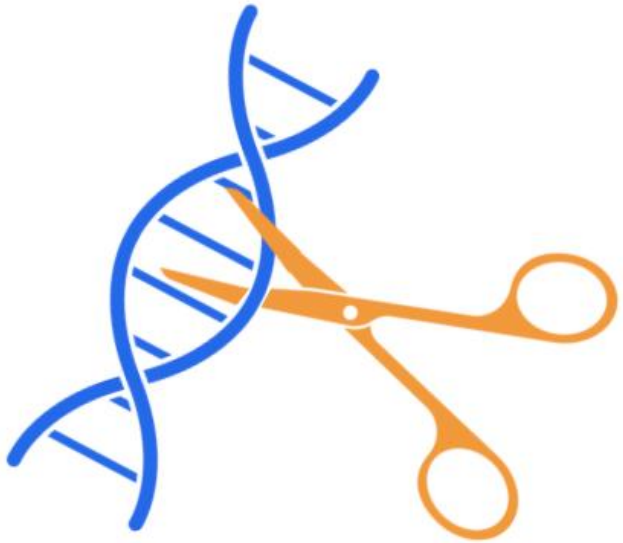
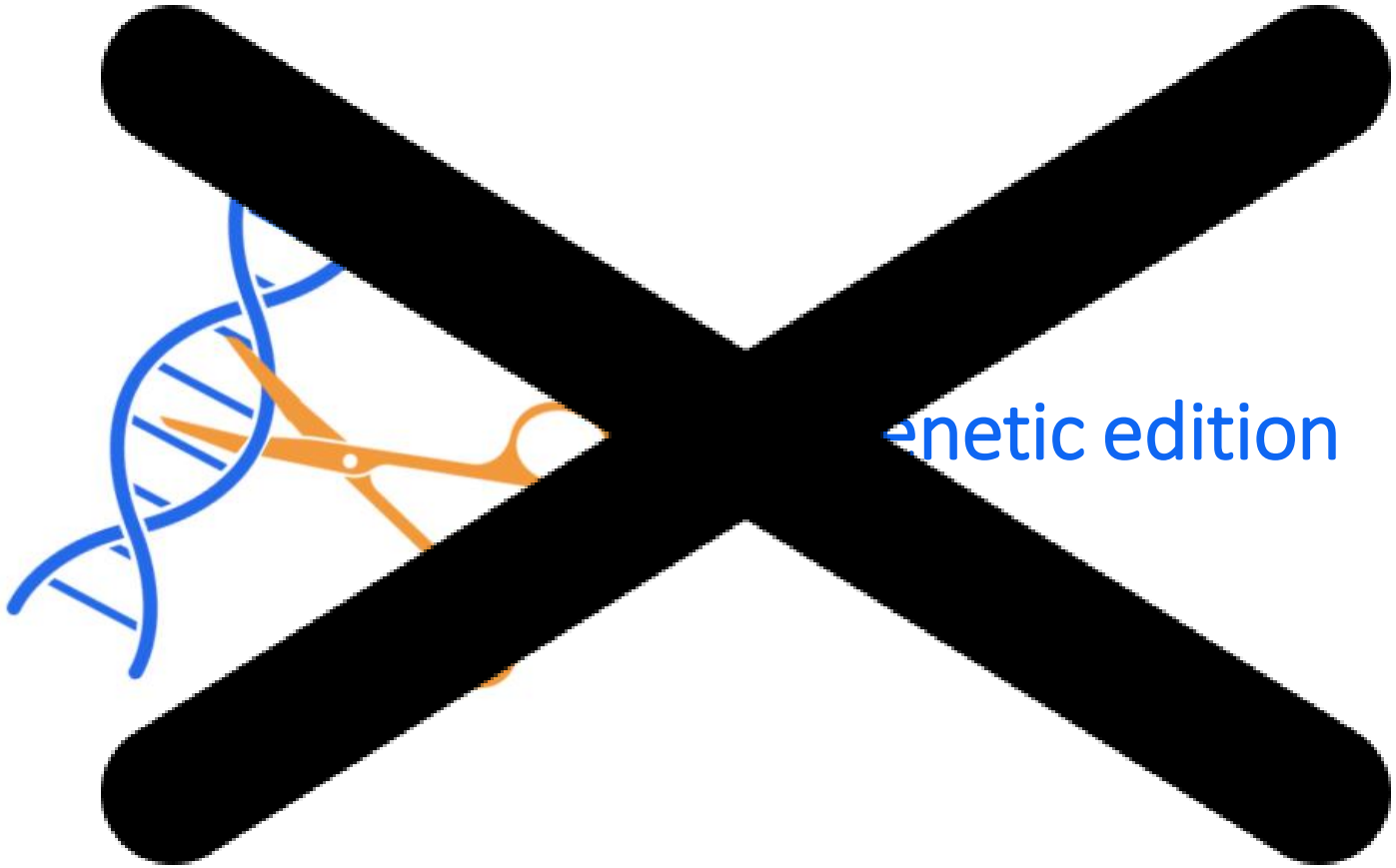
But, why?
What does this mean?

Before CRISPR-Cas…



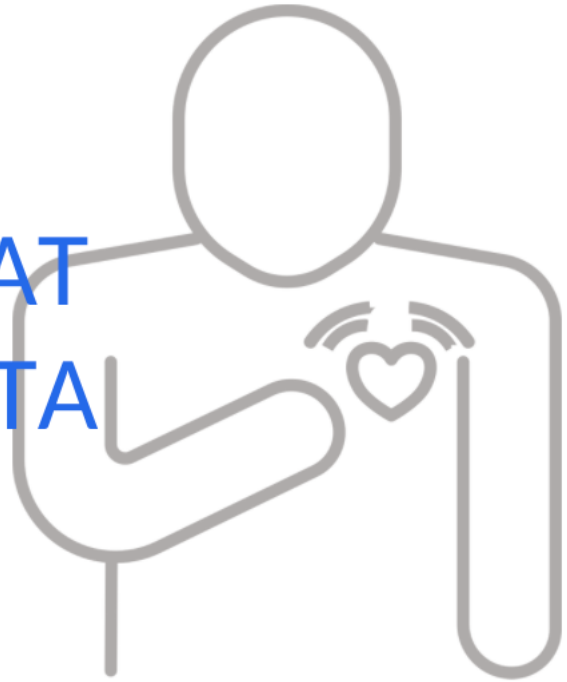
Genetic edition

Before CRISPR-Cas…



Before CRISPR-Cas…

TATTGCATGCCGAT
ATAACGTACGGCTA



Before CRISPR-Cas…

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Before CRISPR-Cas…

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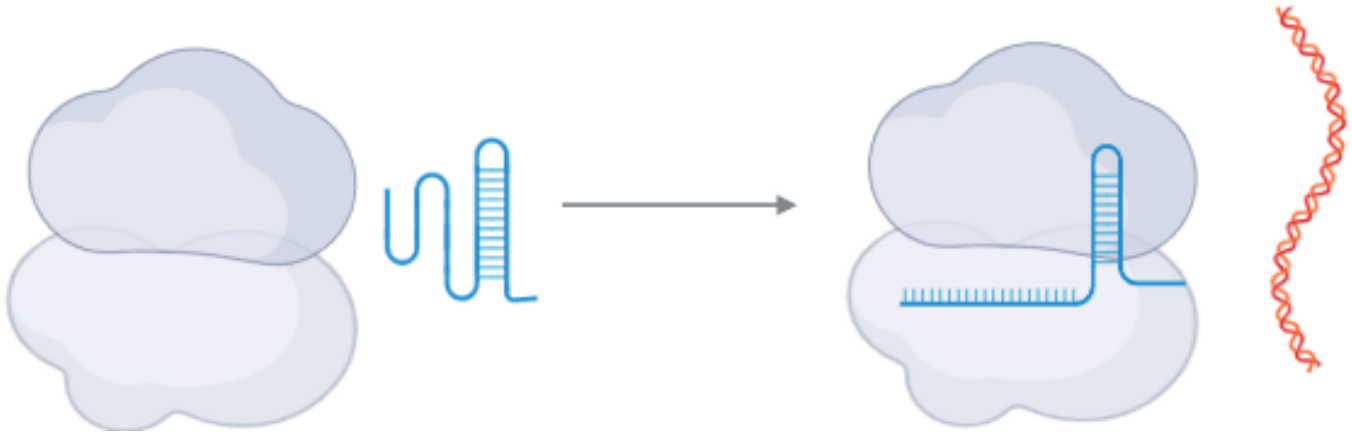
How is that possible?

CRISPR-Cas system

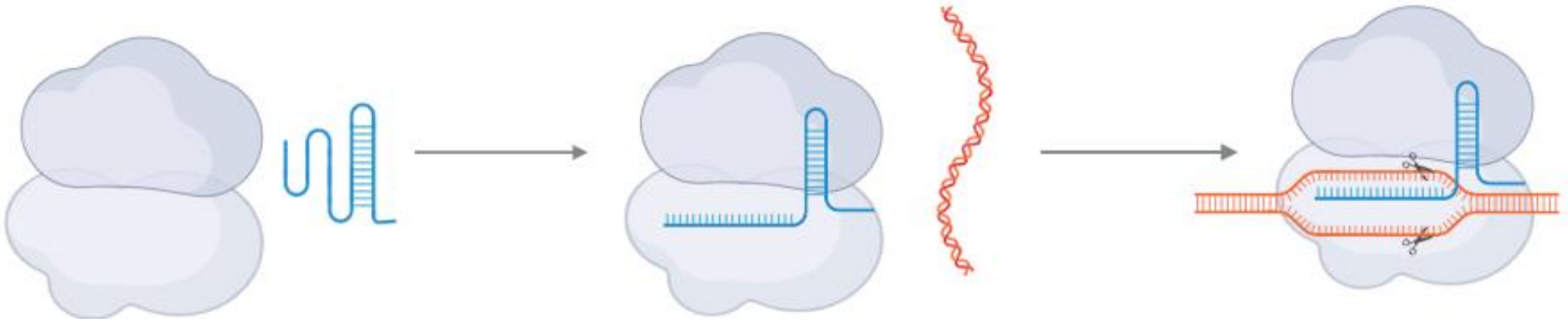
CRISPR-Cas system

CRISPR-Cas system

CRISPR-Cas system



CRISPR-Cas system



Published: 12 October 2016

CRISPR deployed to combat sickle-cell anaemia

Heidi Ledford

Nature (2016) | Cite this article

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Tomato In Japan Is First CRISPR-Edited Food In The World To ...

The first CRISPR gene-edited food has gone on sale in Japan recently, in the form of a tomato packed with an alleged increase in nutritional...

Hace 2 semanas

RNA-Guided Human Genome Engineering via Cas9

Prashant Mali,[1,5] Luhan Yang,[1,3,5] Kevin M. Esvelt,[2] John Aach,[1] Marc Guell,[1] James E. DiCarlo,[4] Julie E. Norville,[1] and George M. Church[1,2,*]

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Applications of CRISPR Technologies in Transplantation

Cem Kuscu,[1,*] Canan Kuscu,[1] Amandeep Bajwa,[1] James D. Eason,[1] Daniel Maluf,[1] and Valeria R. Mas[1]

In vivo CRISPR/Cas9 targeting of fusion oncogenes for selective elimination of cancer cells

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GENE EDITING

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Cas12a for Antibiotic Resistance diagnosis

Antibiotic
Resistance
Inference
Array

Laisa Bonin i Rallo

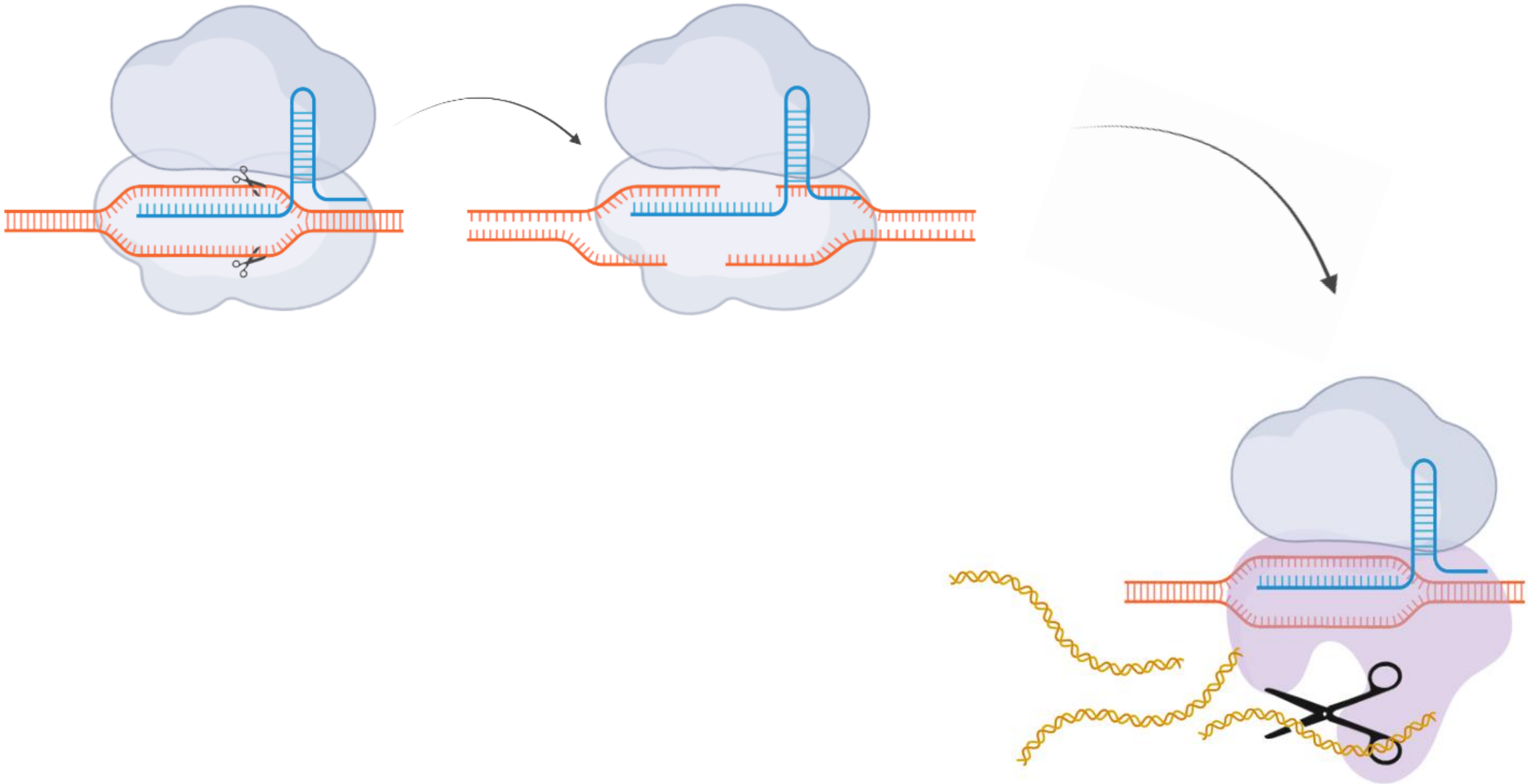
arquicalcul

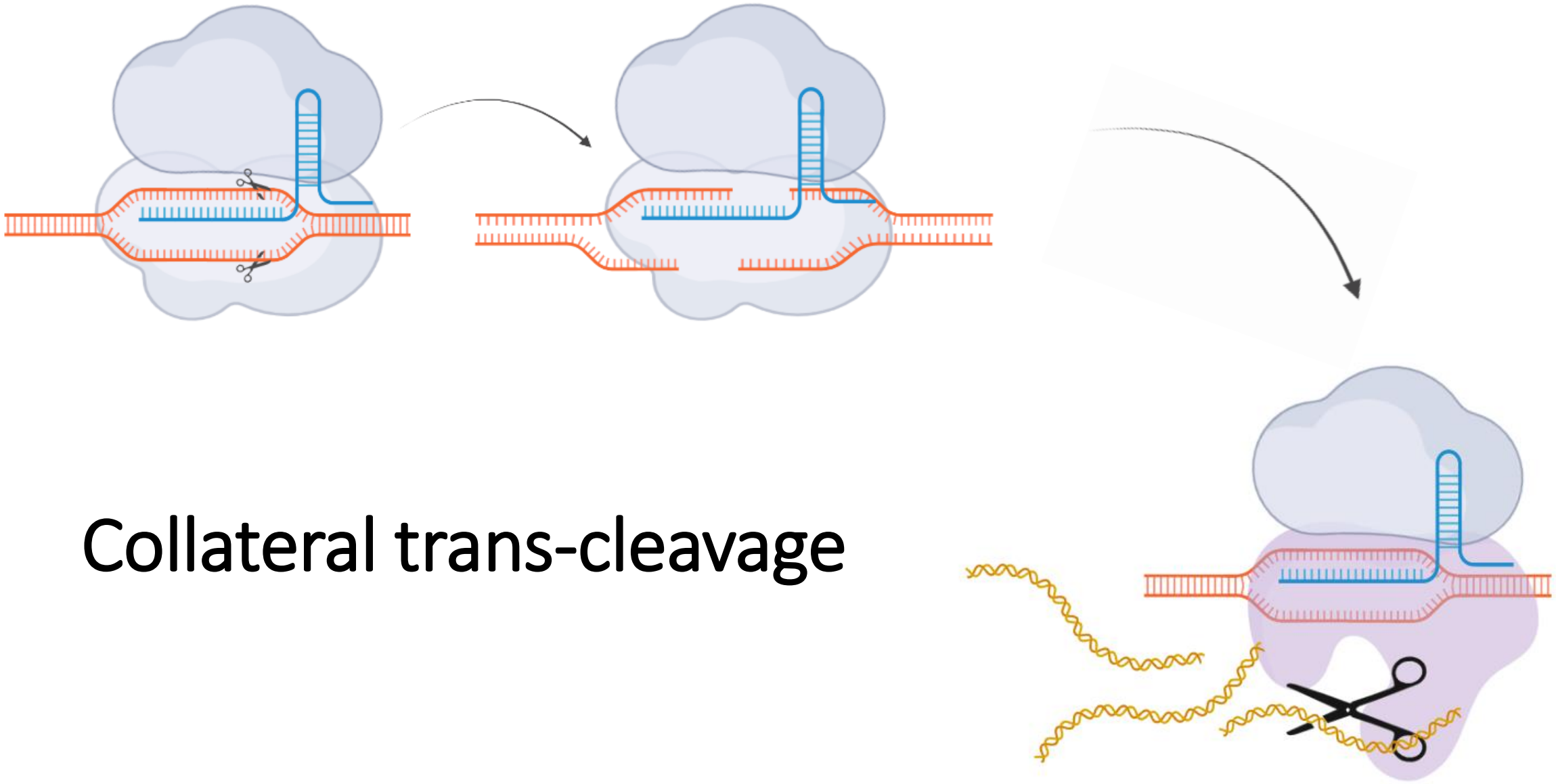
Barcelona Biomedical Research Park

Universitat Pompeu Fabra Barcelona

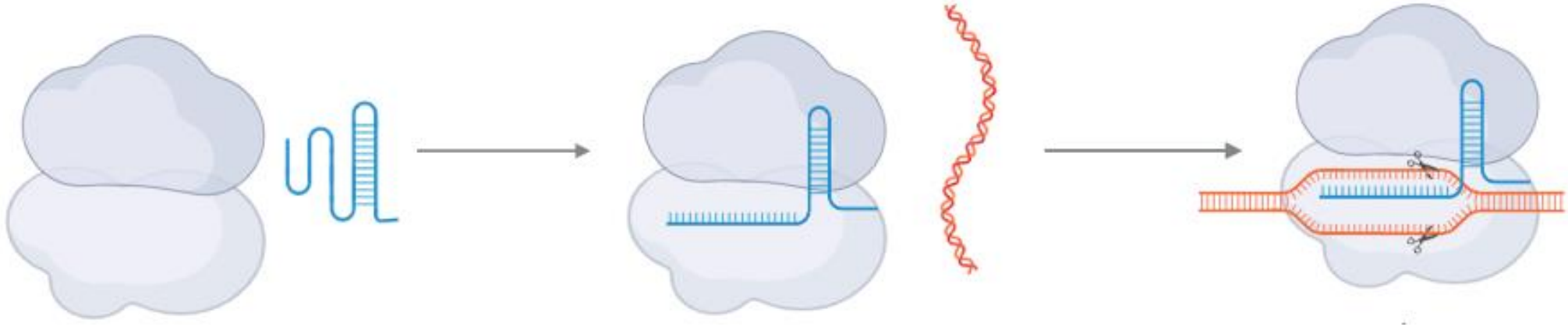
iGEM

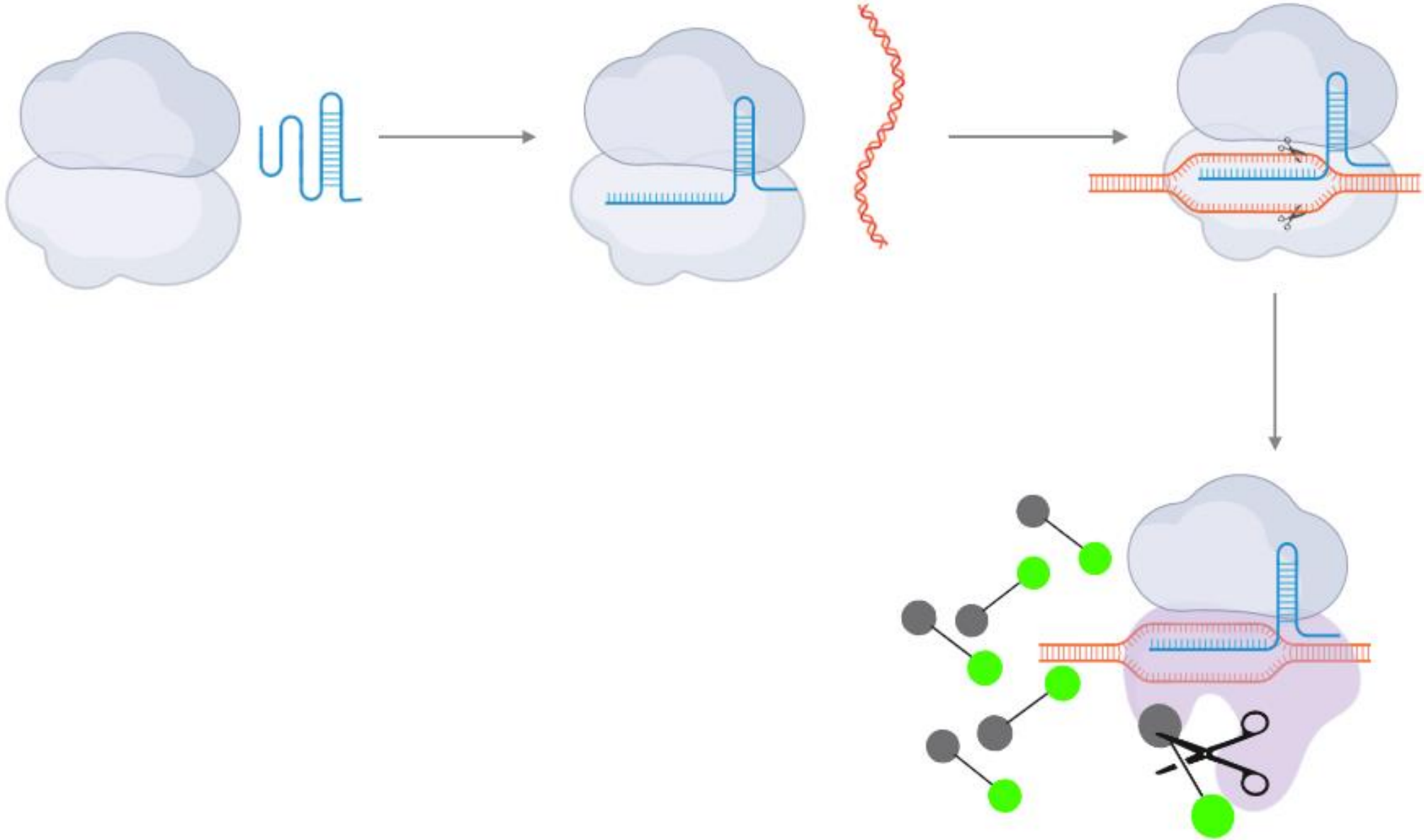
Cas12a

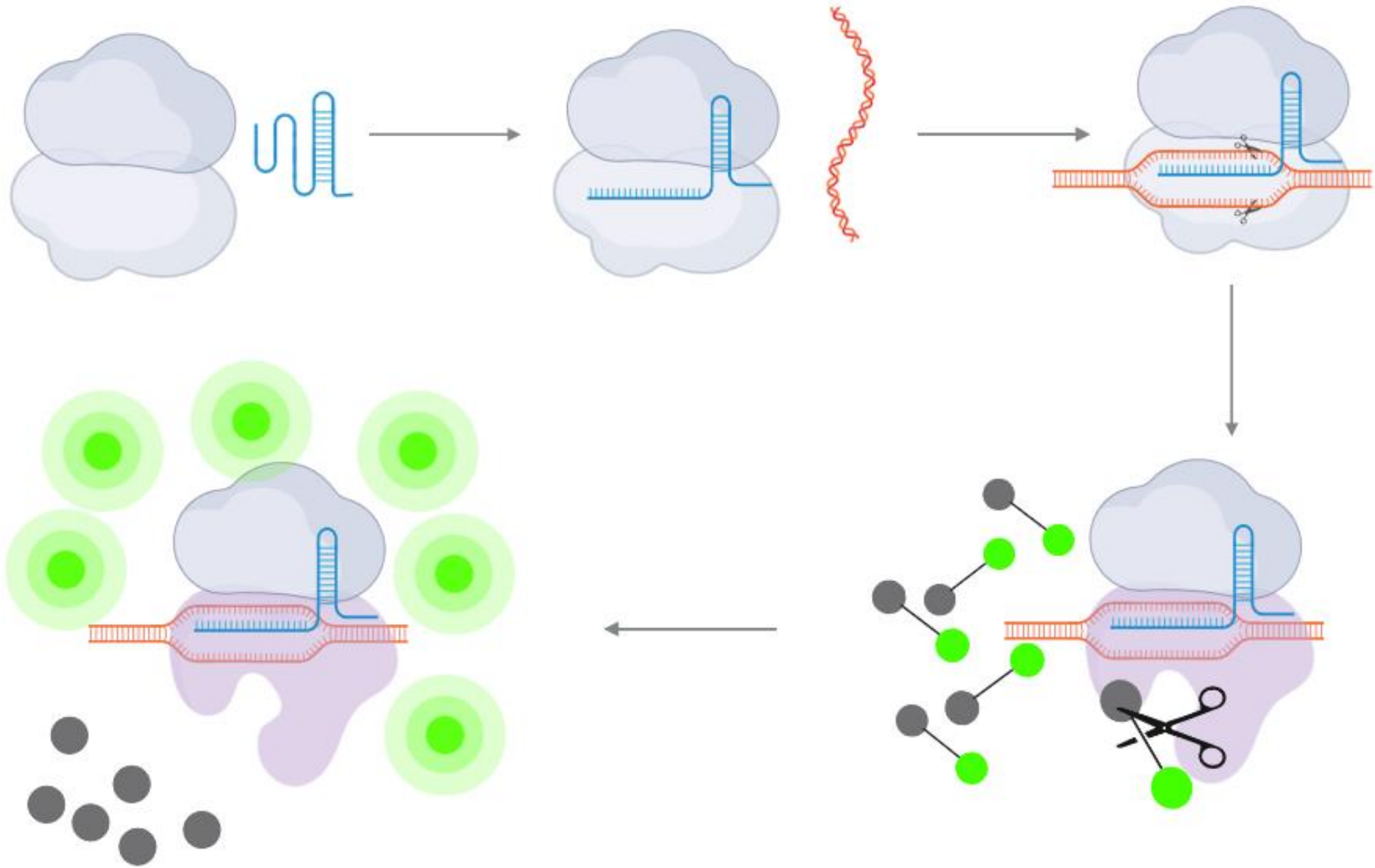




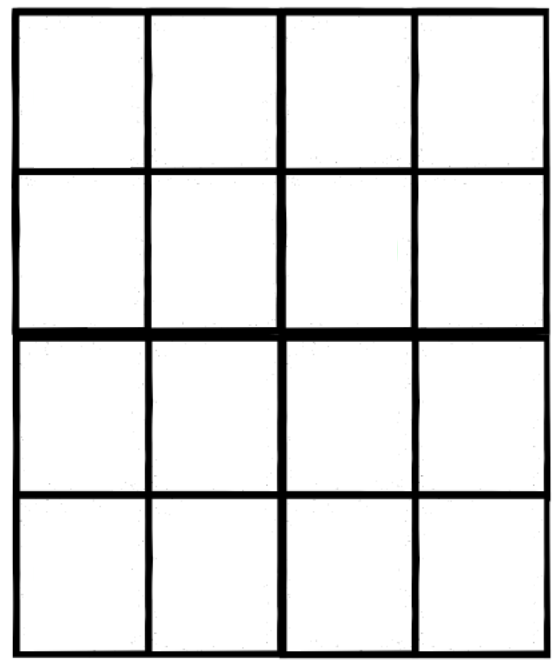
Collateral trans-cleavage

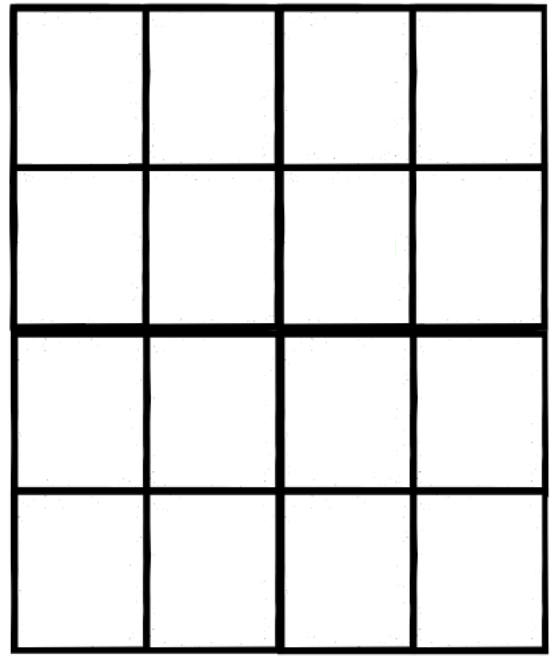


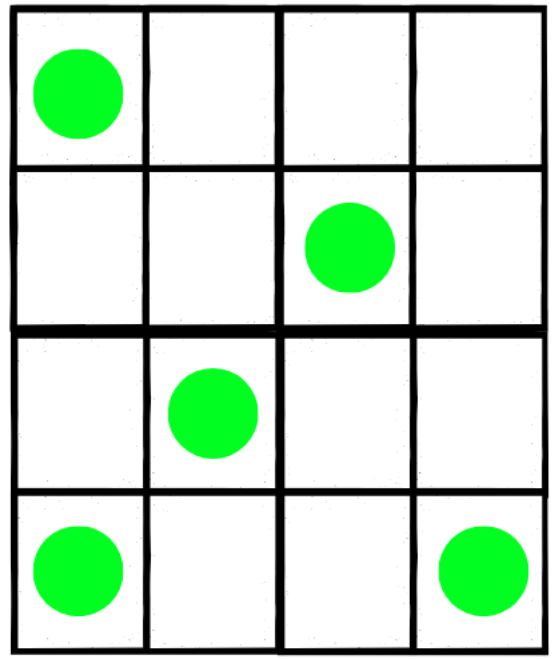


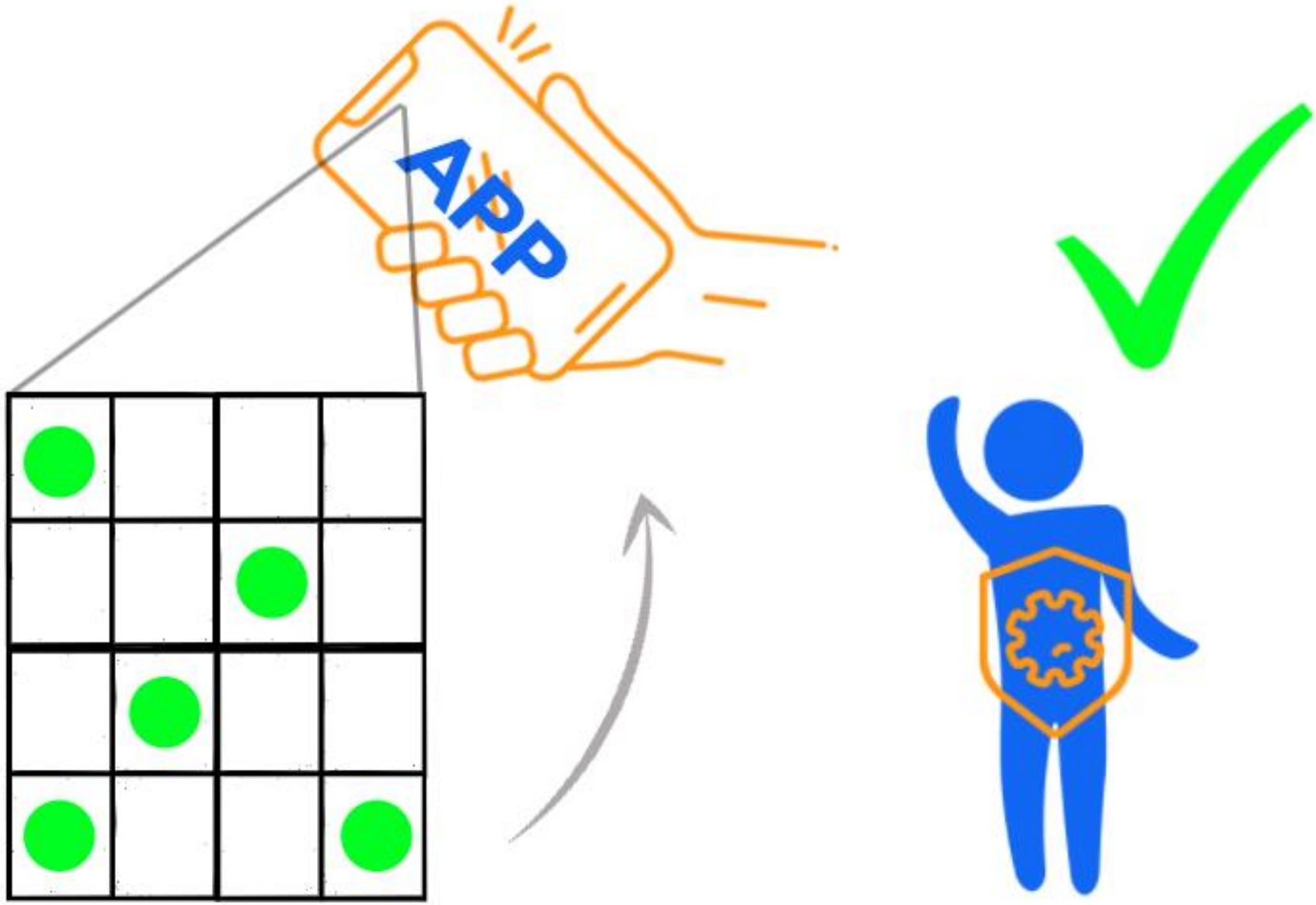


Alexandria








APP

Thanks for your attention!

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Resistance
Inference
Array

Laisa Bonin i Rallo

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