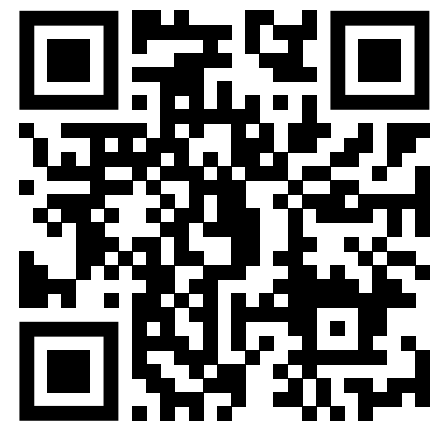


The Earth Metabolome Initiative

an introduction



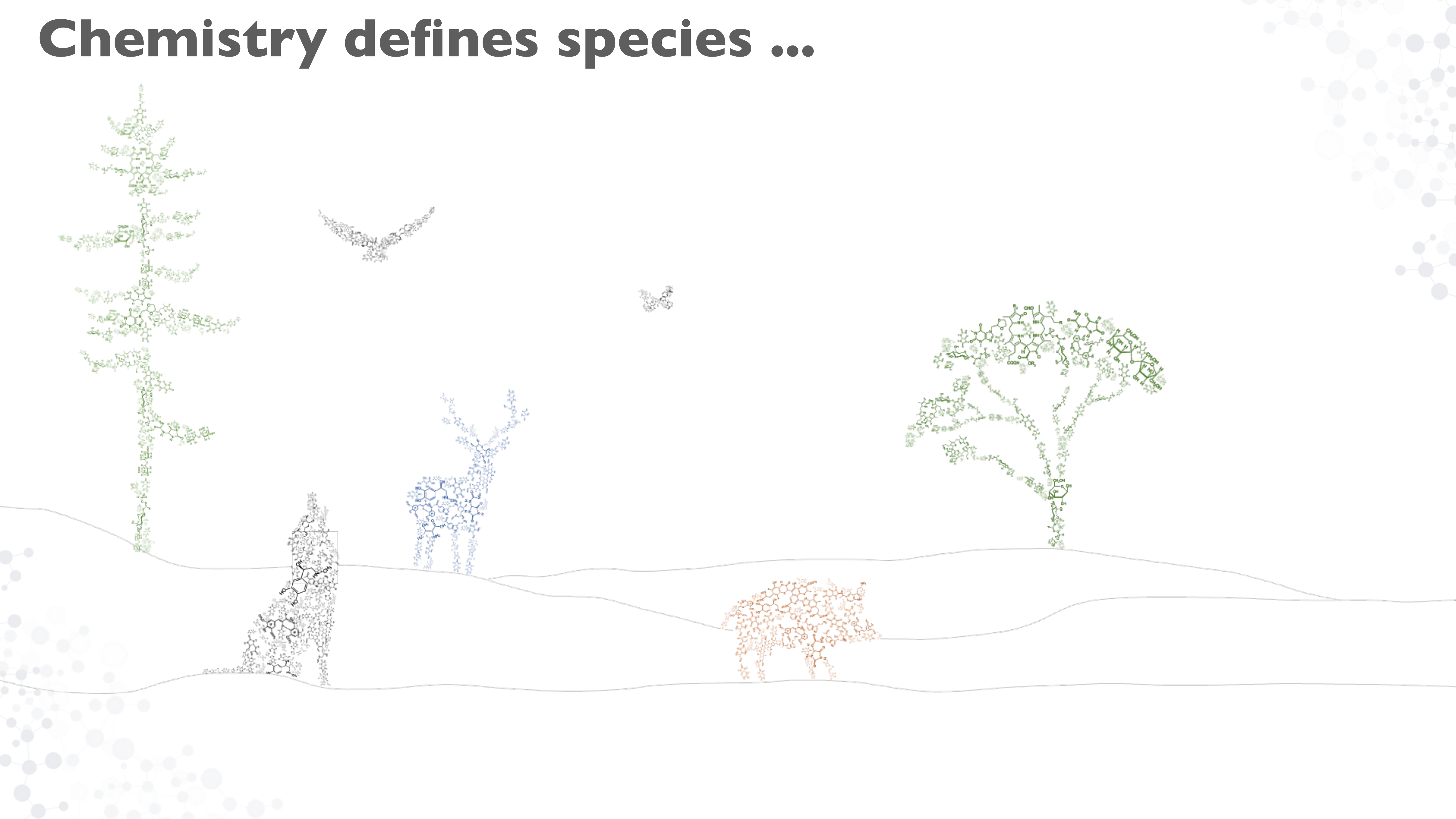
<https://doi.org/10.5281/zenodo.12173847>



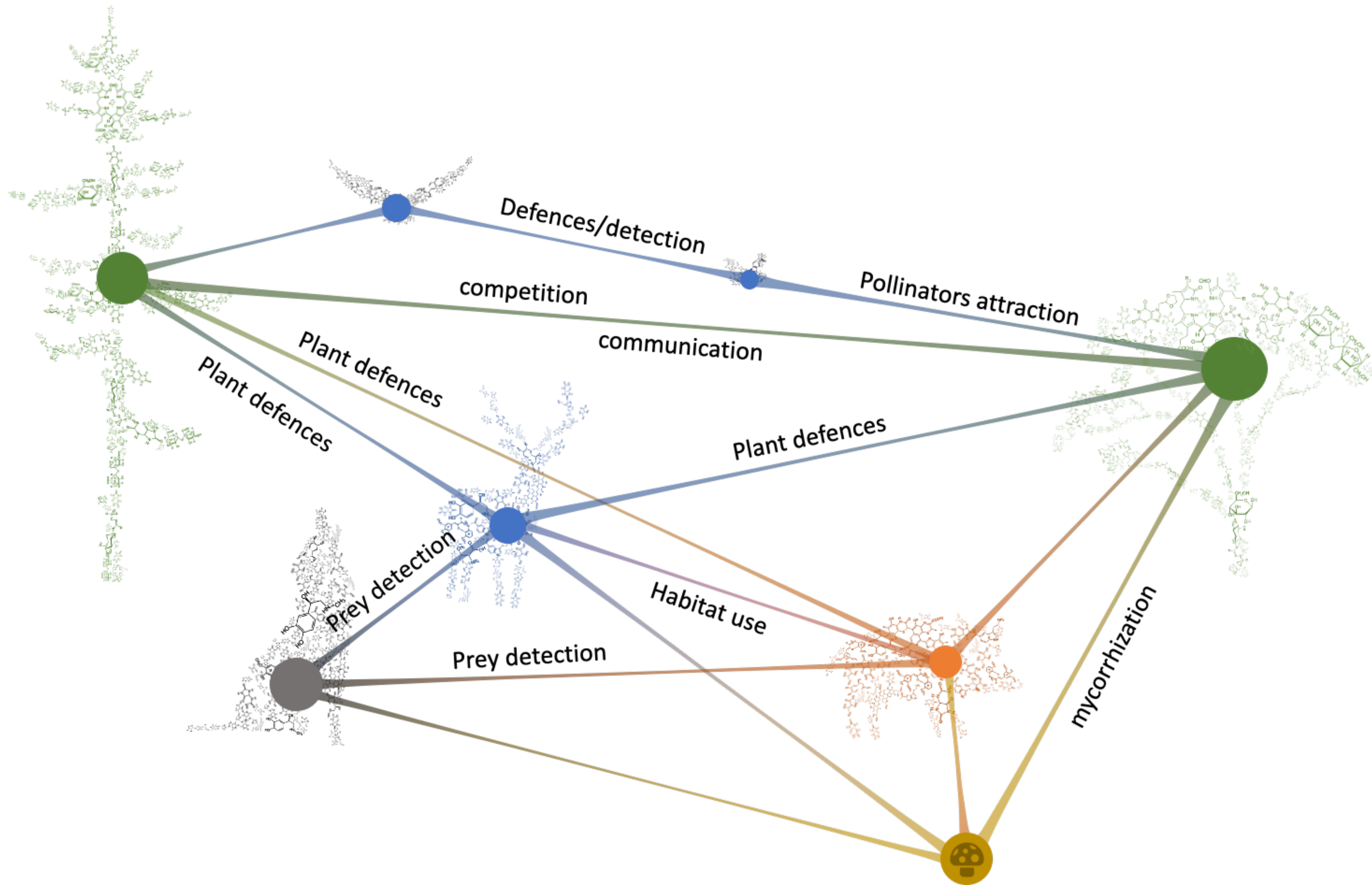




Chemistry defines species ...



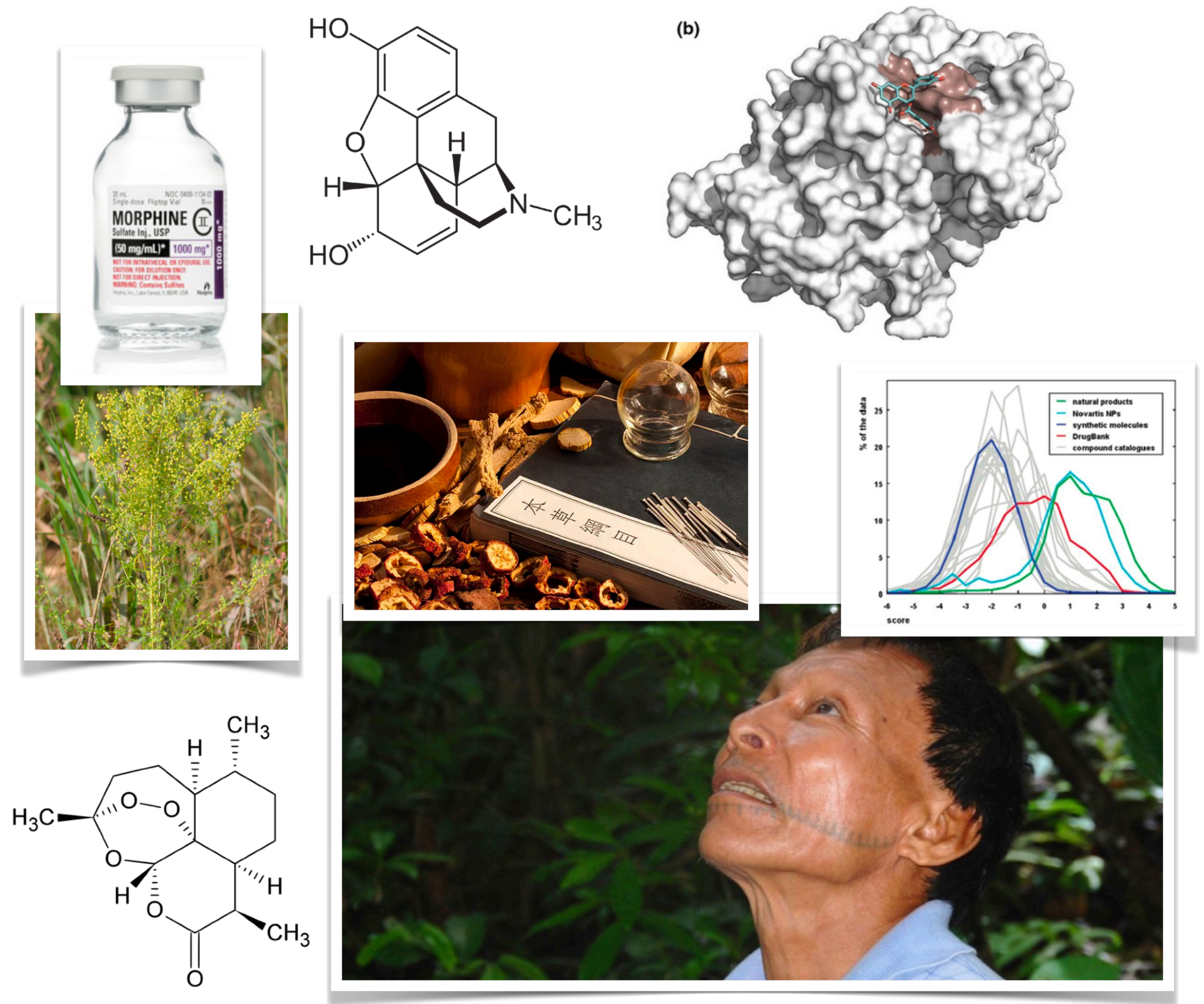
... and their interactions

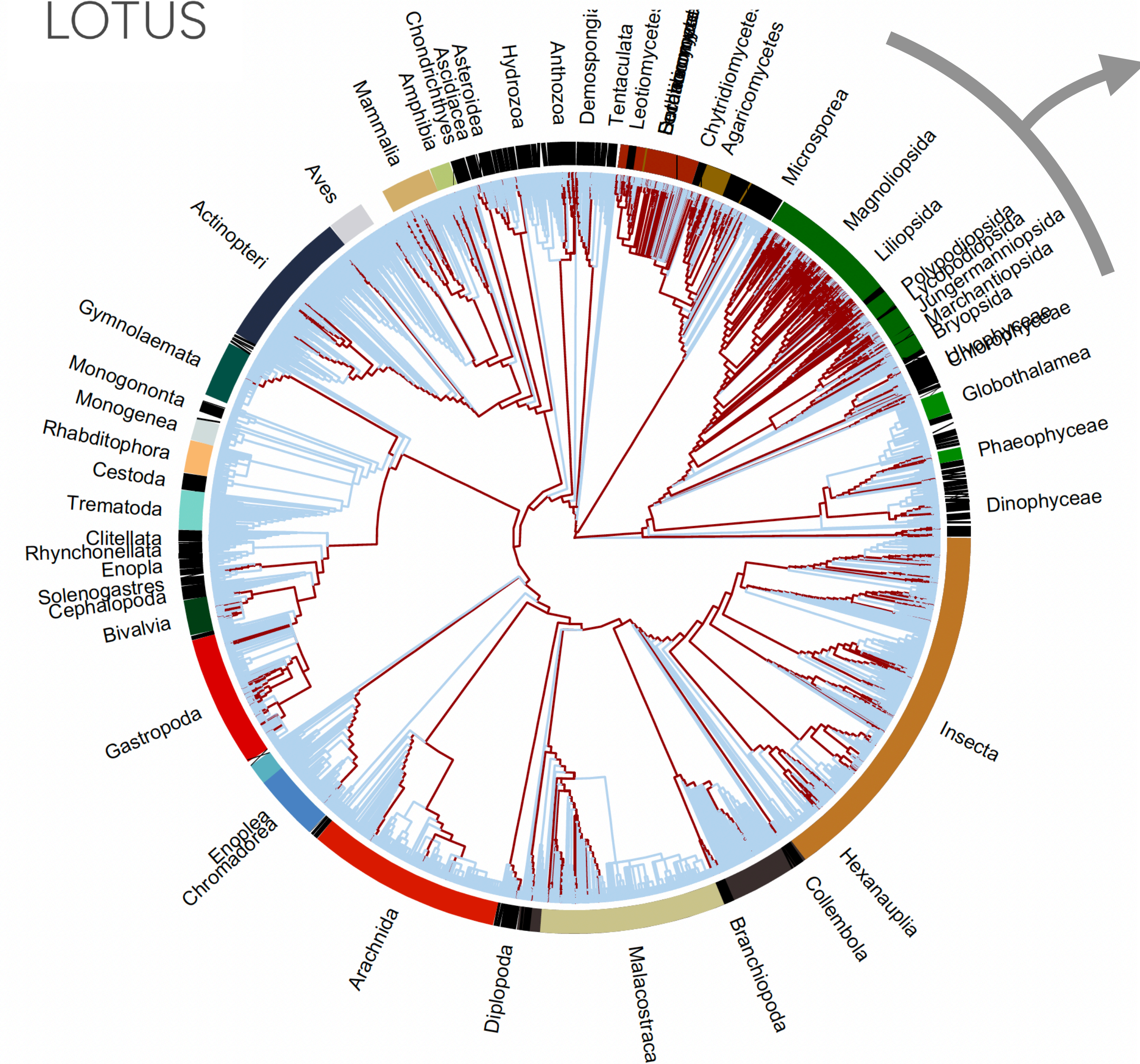


To understand Nature



To heal themselves





200 years of natural products research

~ 350'000 compounds
 ~ 30'000 species
 ~ 10 compounds for 10 % of species

➔ < 1% of plant metabolites have been characterized

➔ Physical isolation requires monthes of work

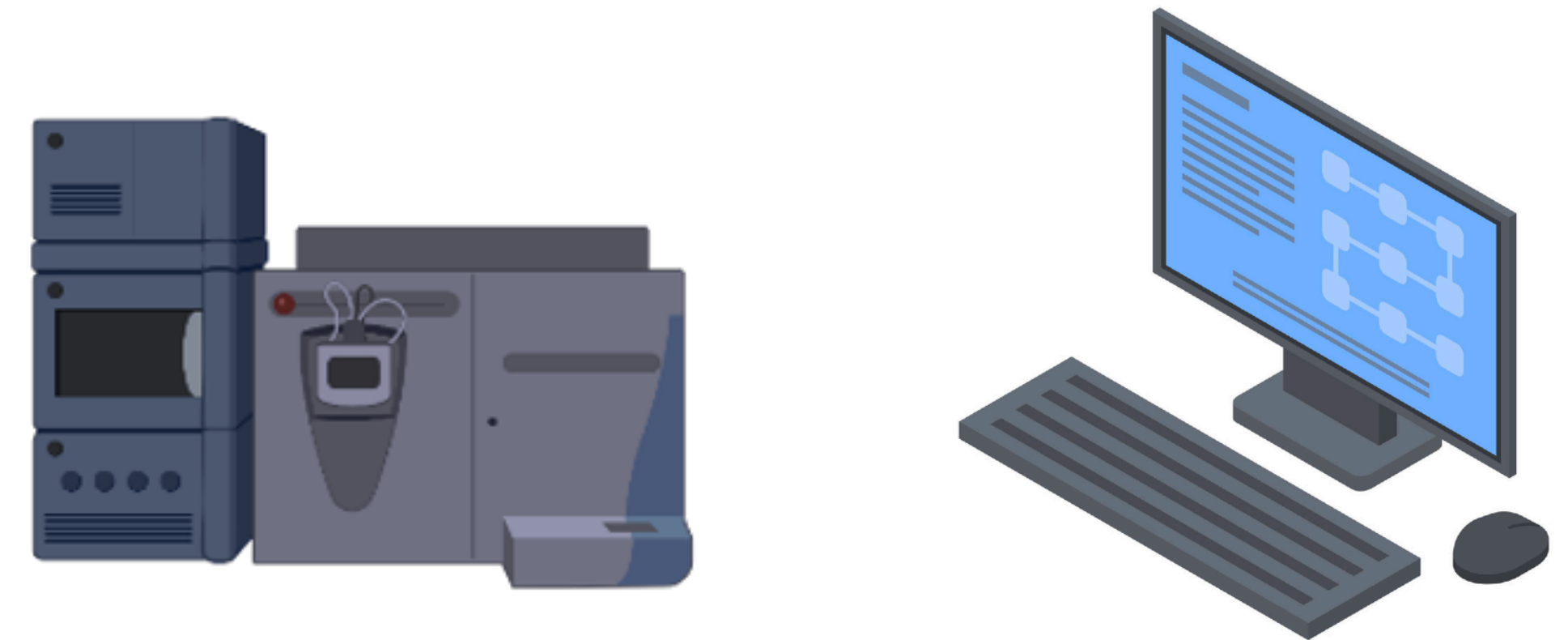
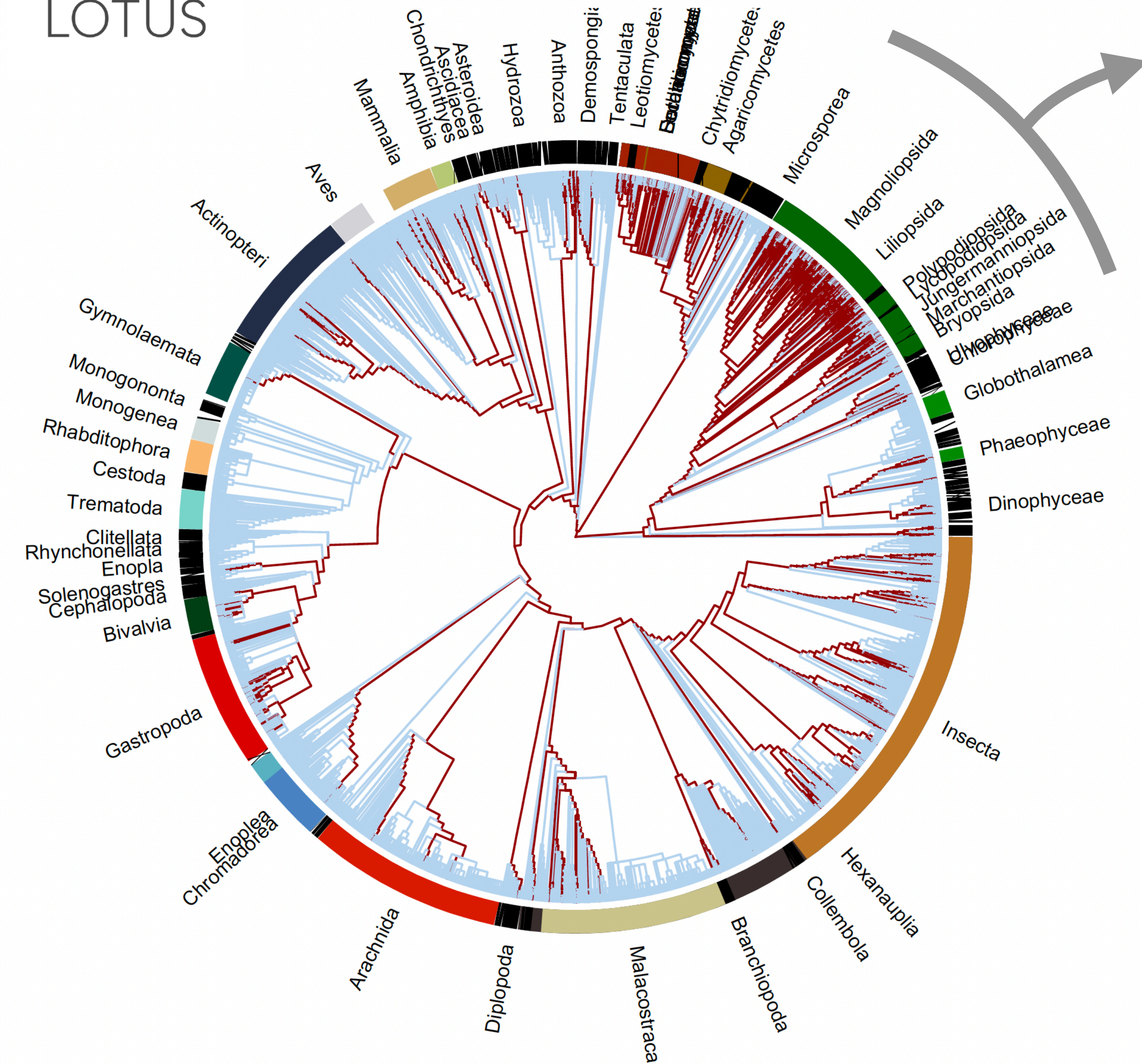
➔ Several centuries required to fully document plant metabolites

200 years of natural products research

~ 350'000 compounds

~ 30'000 species

~ 10 compounds for 10 % of species





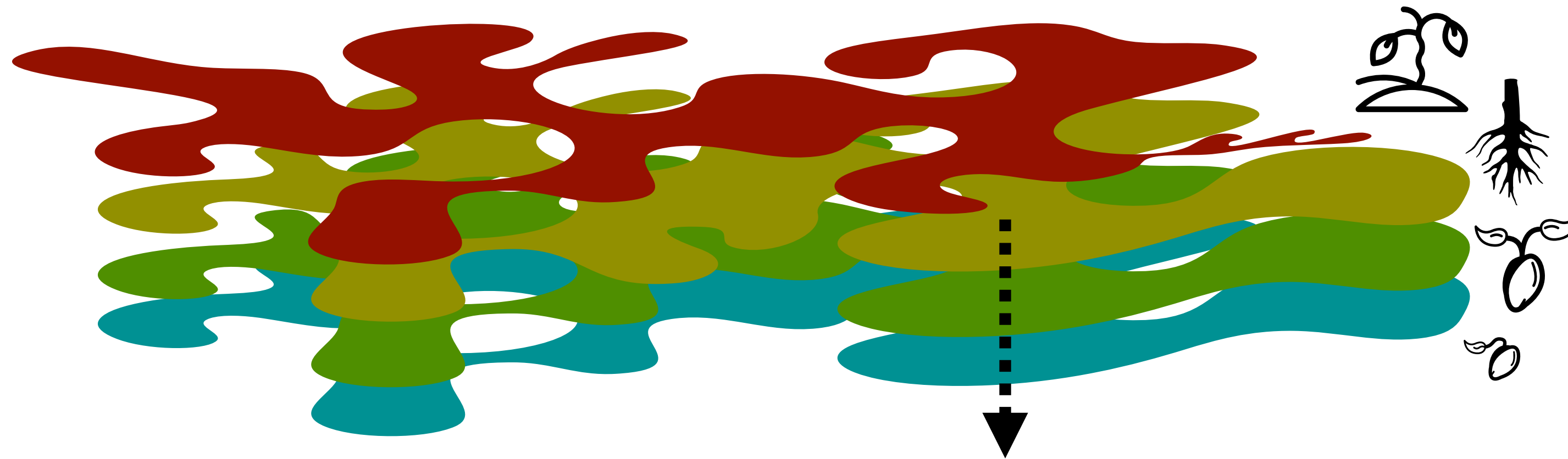
1 sample - 10 min
> 100 samples / day



1 sample
10 min
10'000 spectra
500 annotations

Stacking metabolomes for a single species

Specimen sampled in several conditions
(e.g. environmental conditions, organ, life stage)



Challenges

In large scale sequencing initiative **one** sequenced sample is enough to capture the genetic potential of the whole species.

In metabolomics, sampling at different life stages, different organs or in different environmental conditions will lead to different metabolic profiles. This is both a weakness (in terms of required experiments) and an incredible strength.

Opportunities

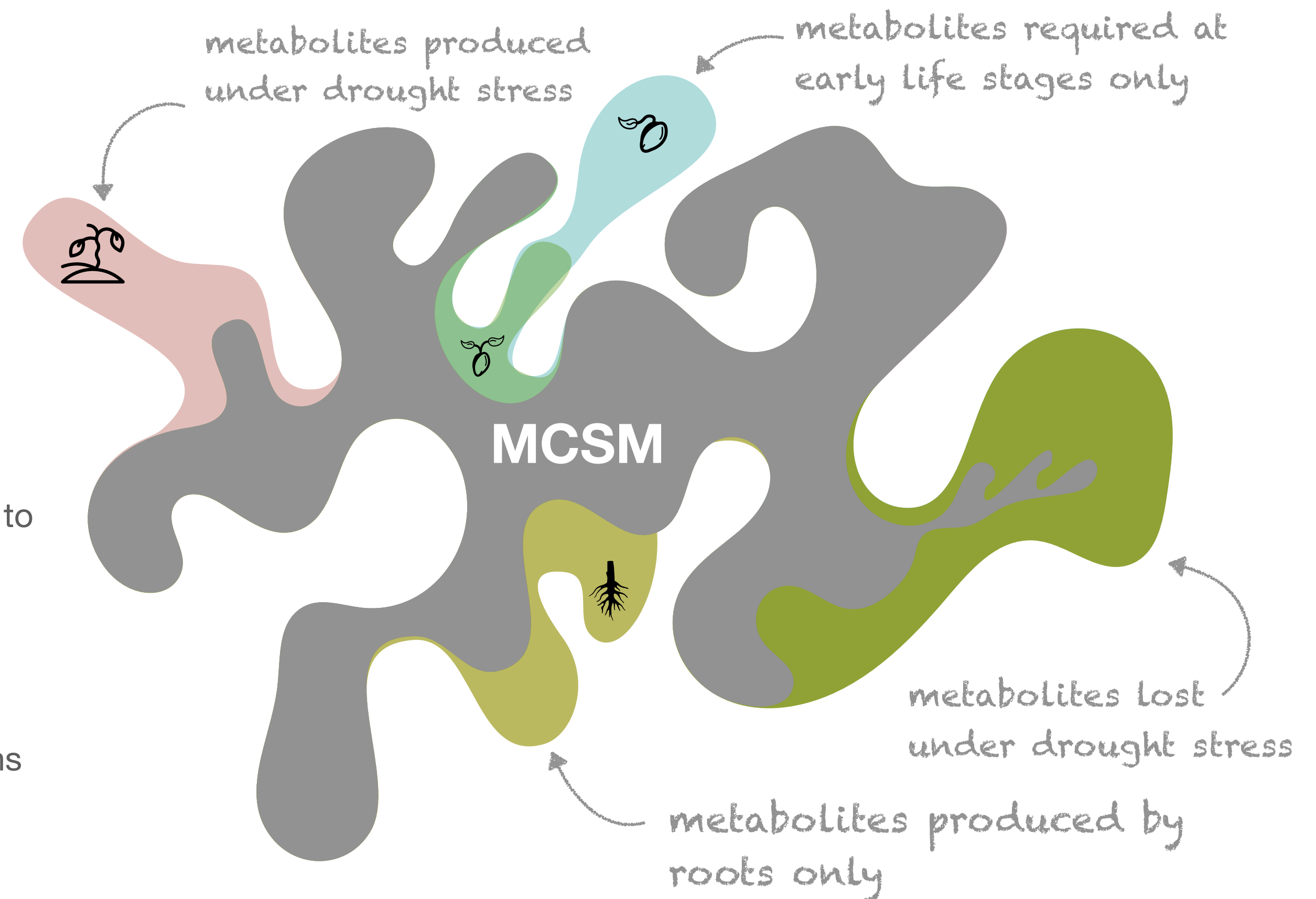
Concept of MCSM

Maximum Common Sub-Metabolome and its branches

Just like Maximum Common Substructures calculations in chemoinformatics, we propose the concept Maximum Common Sub-Metabolome. This is possible thanks to *i)* Knowledge Graph based structure *ii)* unconventional alignment approaches (e.g vectorizing spectral information at the sample level)

This MCSM will:

- capture the most stable metabolic fingerprint of a species
- inform on biosynthetic pathways invested in or shut down under several conditions
- the higher the number of layers, the more robust the MCSM
- can be applied at any taxa levels an even across the total Earth Metabolome
- can be compared across conditions



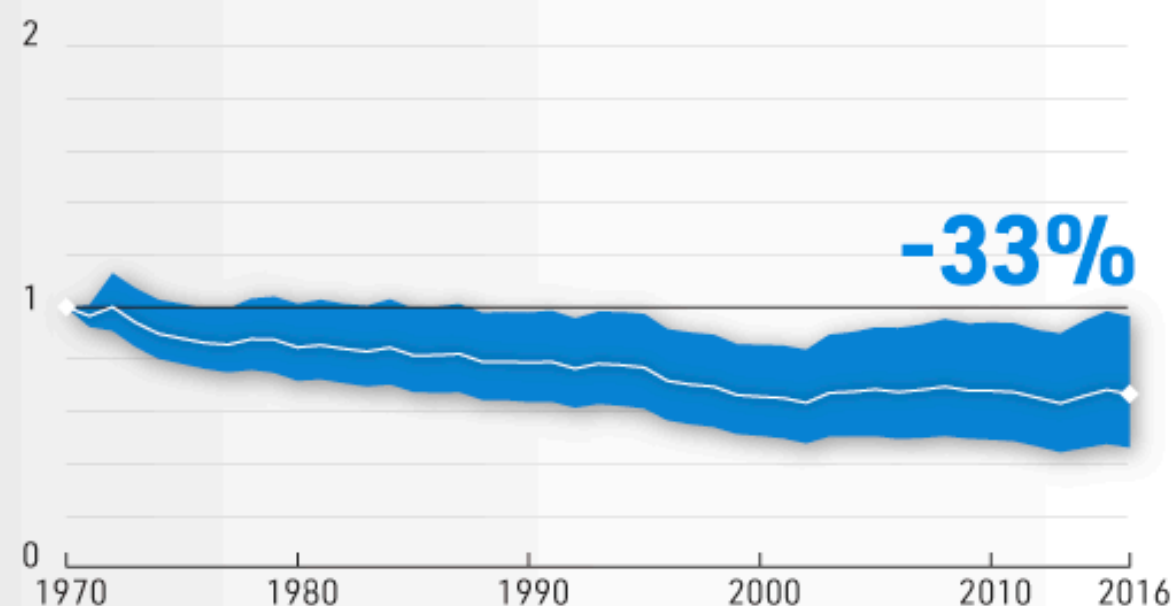
VISUALIZING THE REGIONAL DECLINE OF EARTH'S BIODIVERSITY

The **Living Planet Index (LPI)** tracks the abundance of mammals, birds, fish, reptiles, and amphibians across the globe.



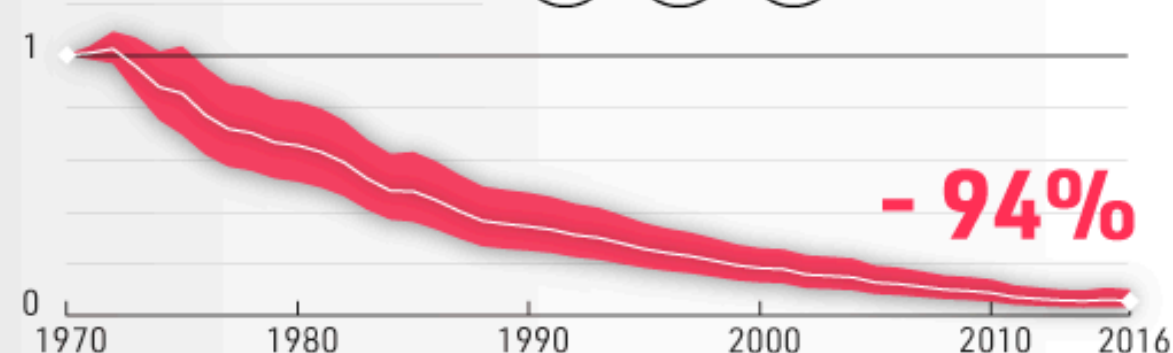
Between 1970 and 2016, vertebrate population sizes dropped by **68%** on average worldwide. However, this rate of this loss varies from region to region.

NORTH AMERICA

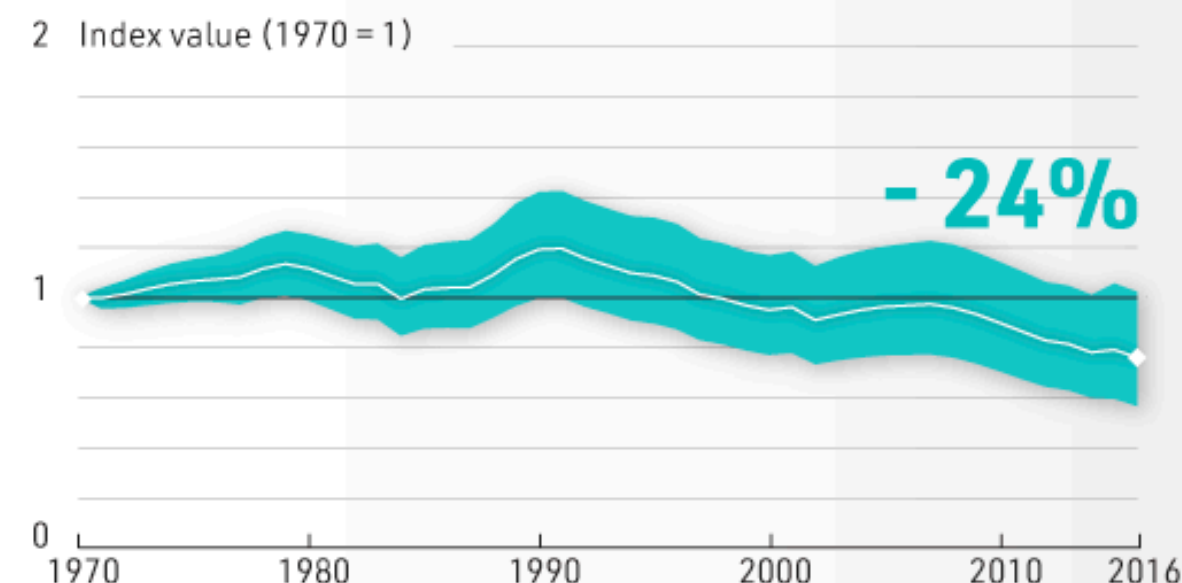


LATIN AMERICA & CARIBBEAN

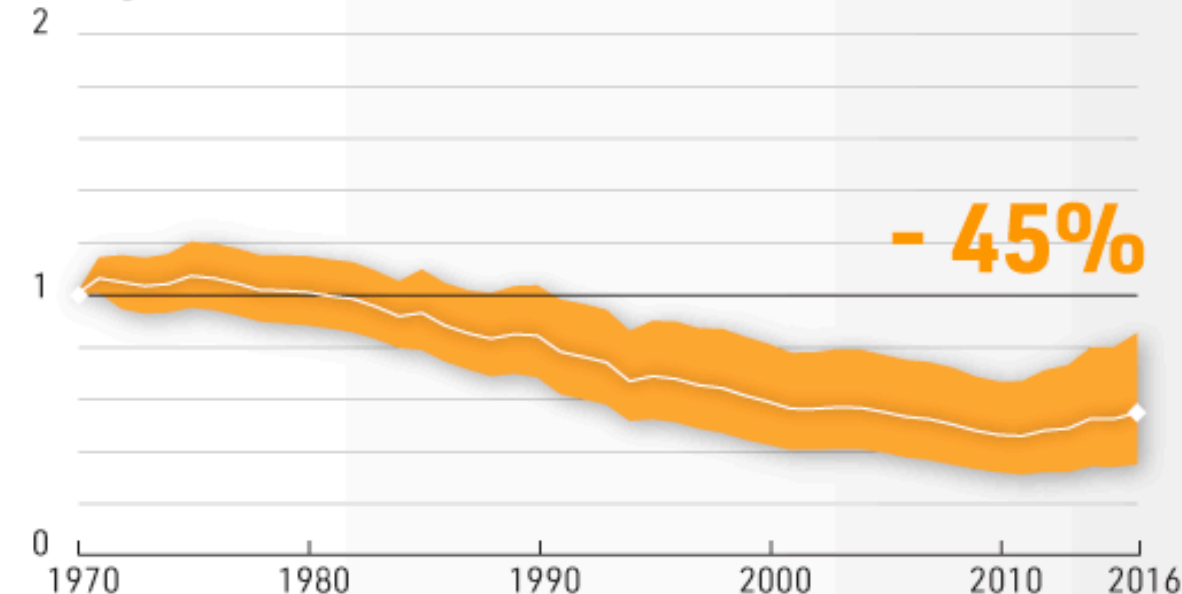
Latin America & Caribbean has seen the largest drop in biodiversity at **94%**, mainly driven by a significant decline in reptile, amphibian, and fish populations.



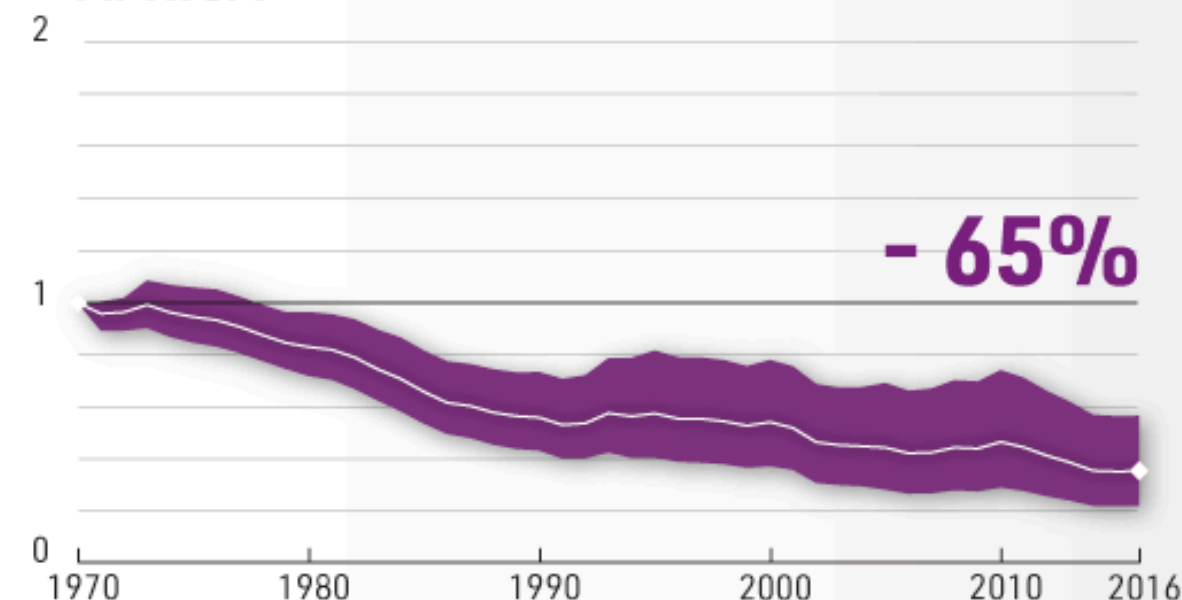
EUROPE



ASIA



AFRICA



Source: Living Planet Report 2020



Threats to biodiversity

Changes in land and sea use, including habitat loss and degradation



This refers to the modification of the environment where a species lives, by complete removal, fragmentation or reduction in quality of key habitat. Common changes in use are caused by unsustainable agriculture, logging, transportation, residential or commercial development, energy production and mining. For freshwater habitats, fragmentation of rivers and streams and abstraction of water are common threats.

Species overexploitation



There are both direct and indirect forms of overexploitation. Direct overexploitation refers to unsustainable hunting and poaching or harvesting, whether for subsistence or for trade. Indirect overexploitation occurs when non-target species are killed unintentionally, for example as bycatch in fisheries.

Invasive species and disease



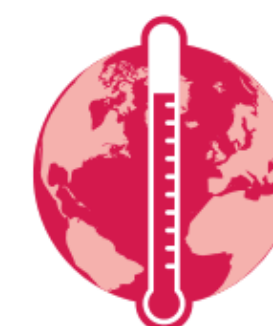
Invasive species can compete with native species for space, food and other resources, can turn out to be a predator for native species, or spread diseases that were not previously present in the environment. Humans also transport new diseases from one area of the globe to another.

Pollution



Pollution can directly affect a species by making the environment unsuitable for its survival (this is what happens, for example, in the case of an oil spill). It can also affect a species indirectly, by affecting food availability or reproductive performance, thus reducing population numbers over time.

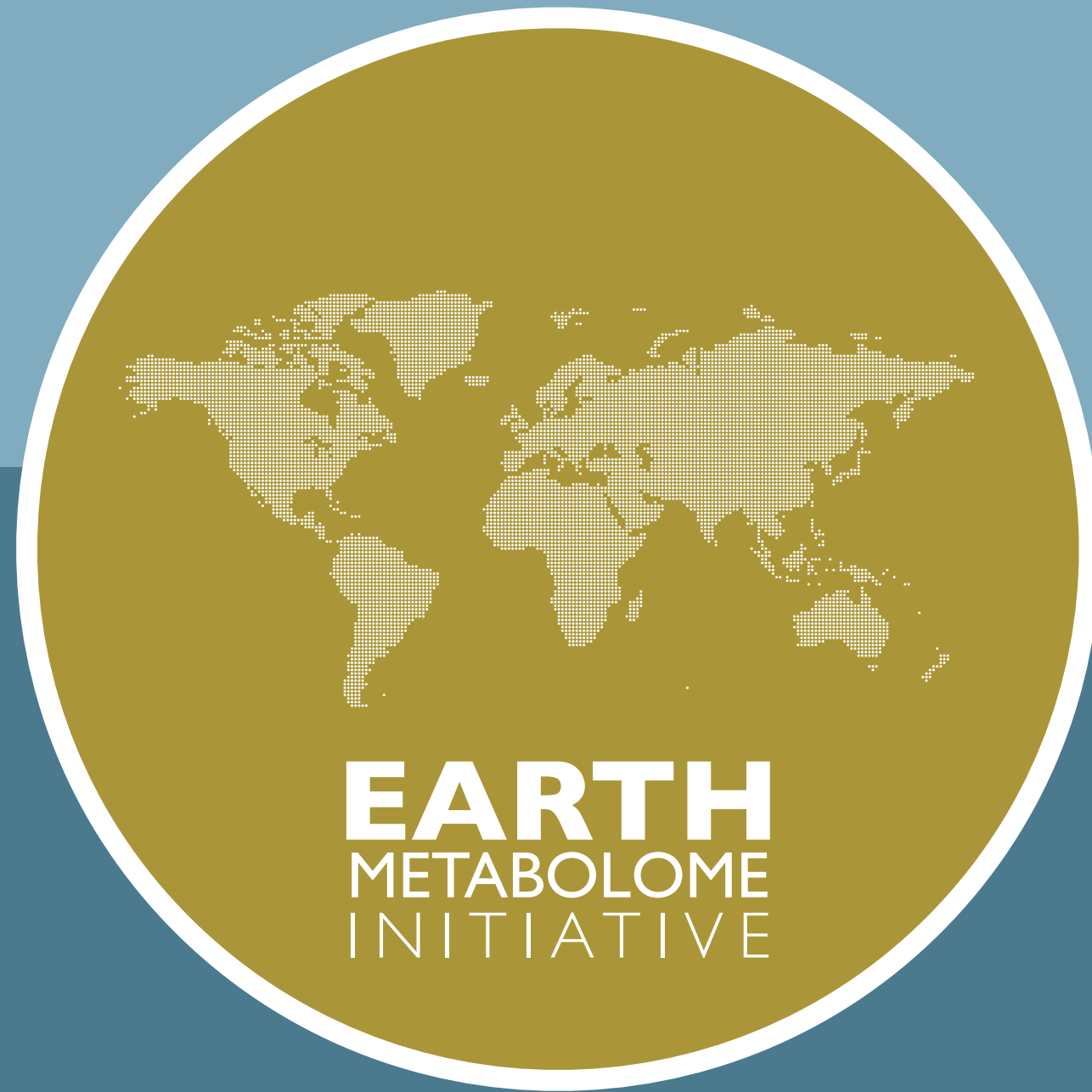
Climate change



As temperatures change, some species will need to adapt by shifting their range to track a suitable climate. The effects of climate change on species are often indirect. Changes in temperature can confound the signals that trigger seasonal events such as migration and reproduction, causing these events to happen at the wrong time (for example misaligning reproduction and the period of greater food availability in a specific habitat).



A massive undertaking ...



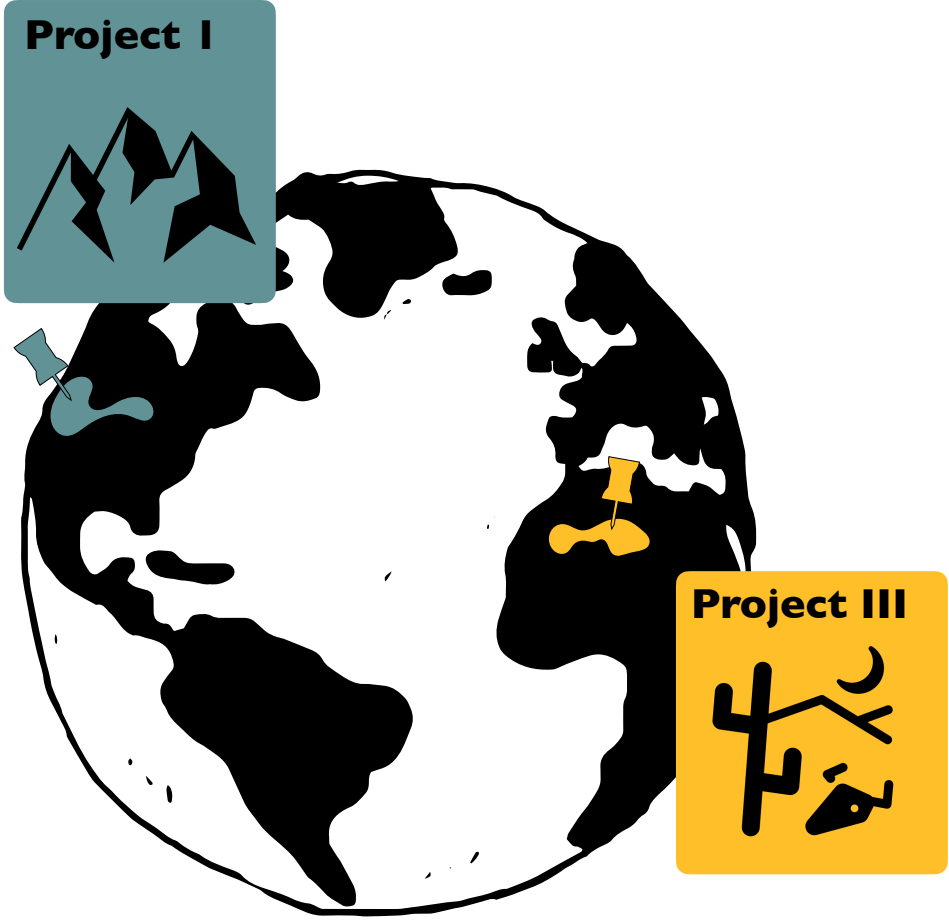
Profile the metabolic content of all currently known species on Earth.

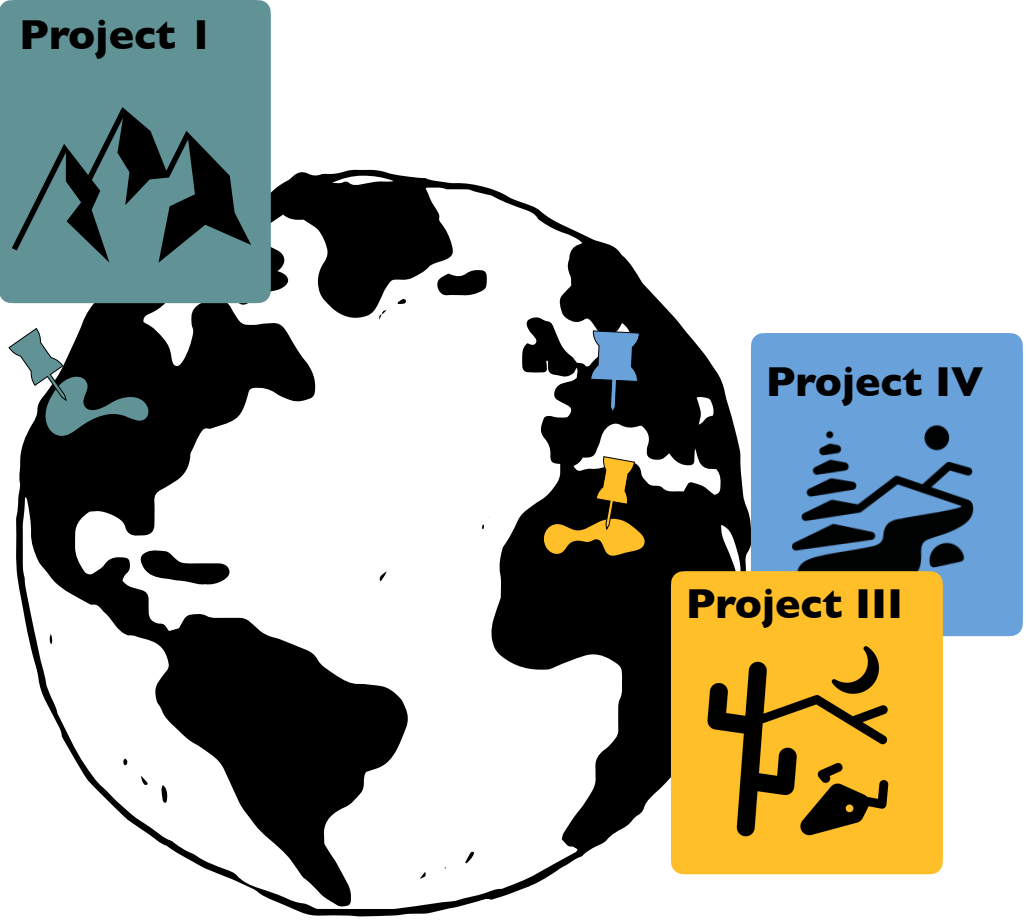
... with three objectives

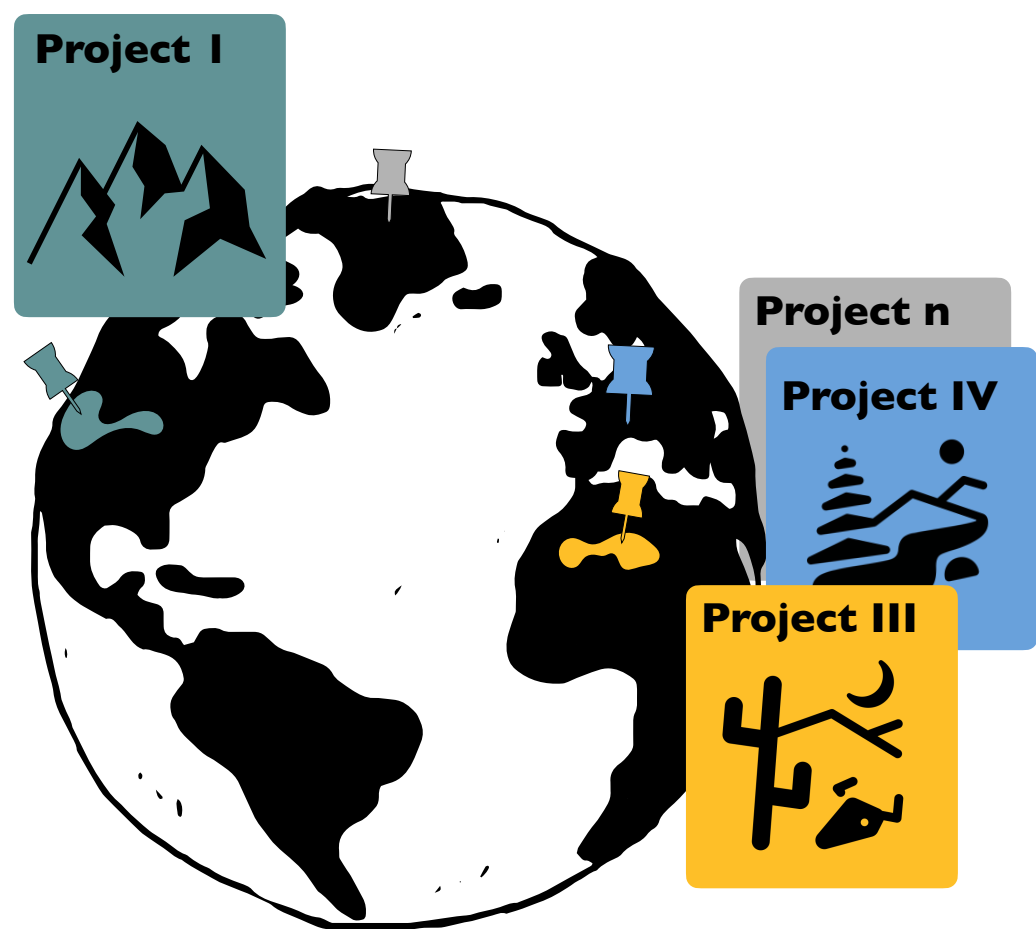
- *Explore and understand the chemical foundations of the biosphere*
- *Benefit human society*
- *Protect biodiversity*

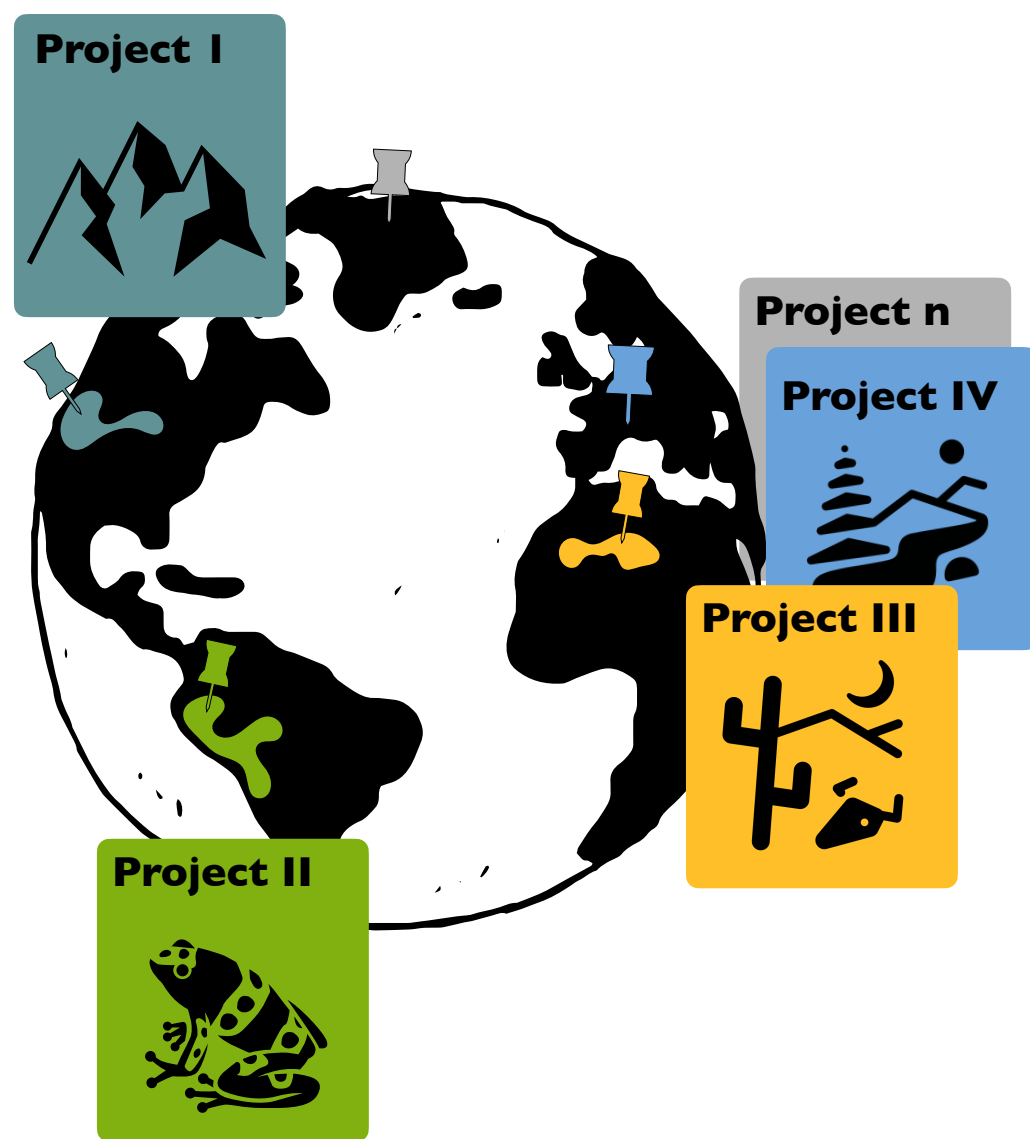


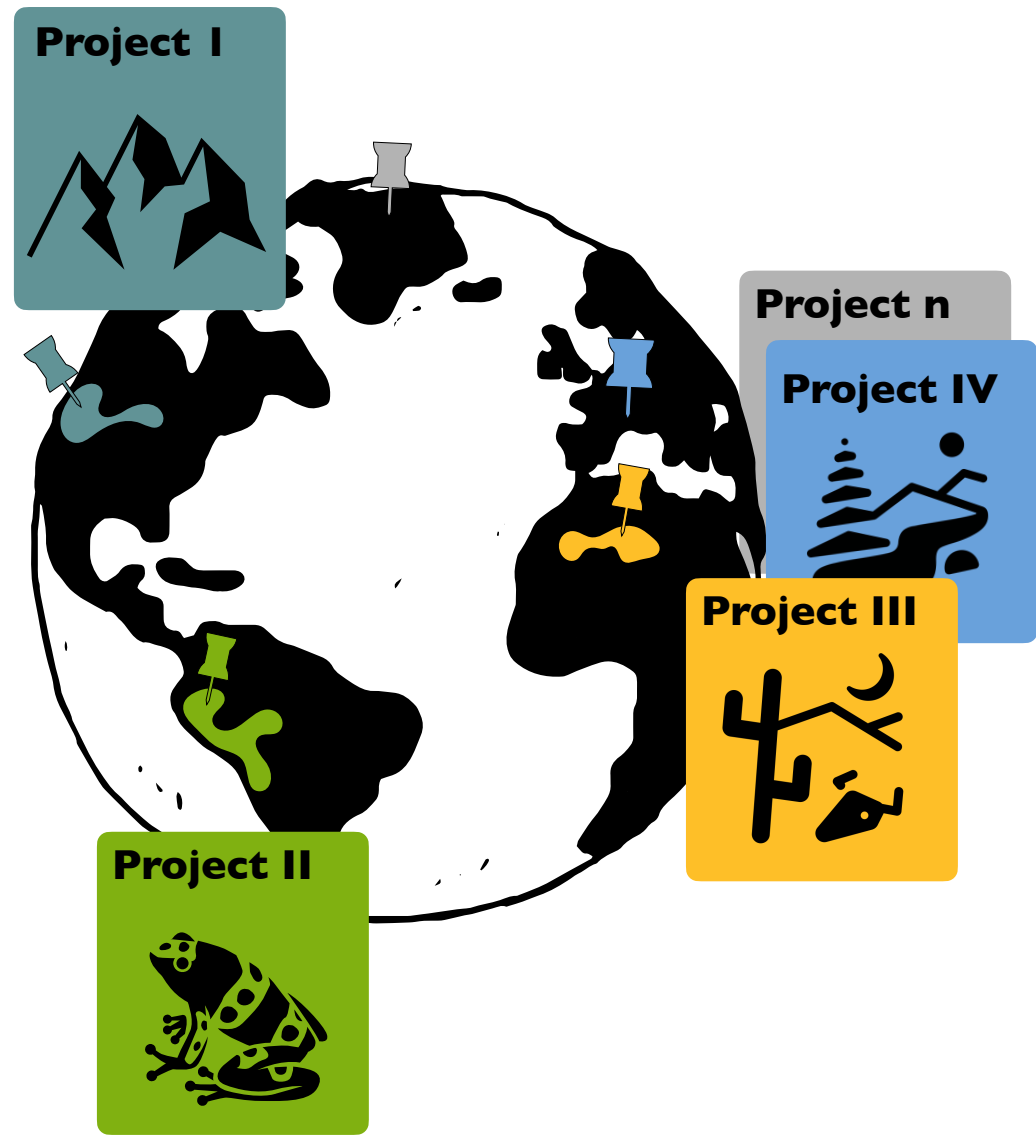




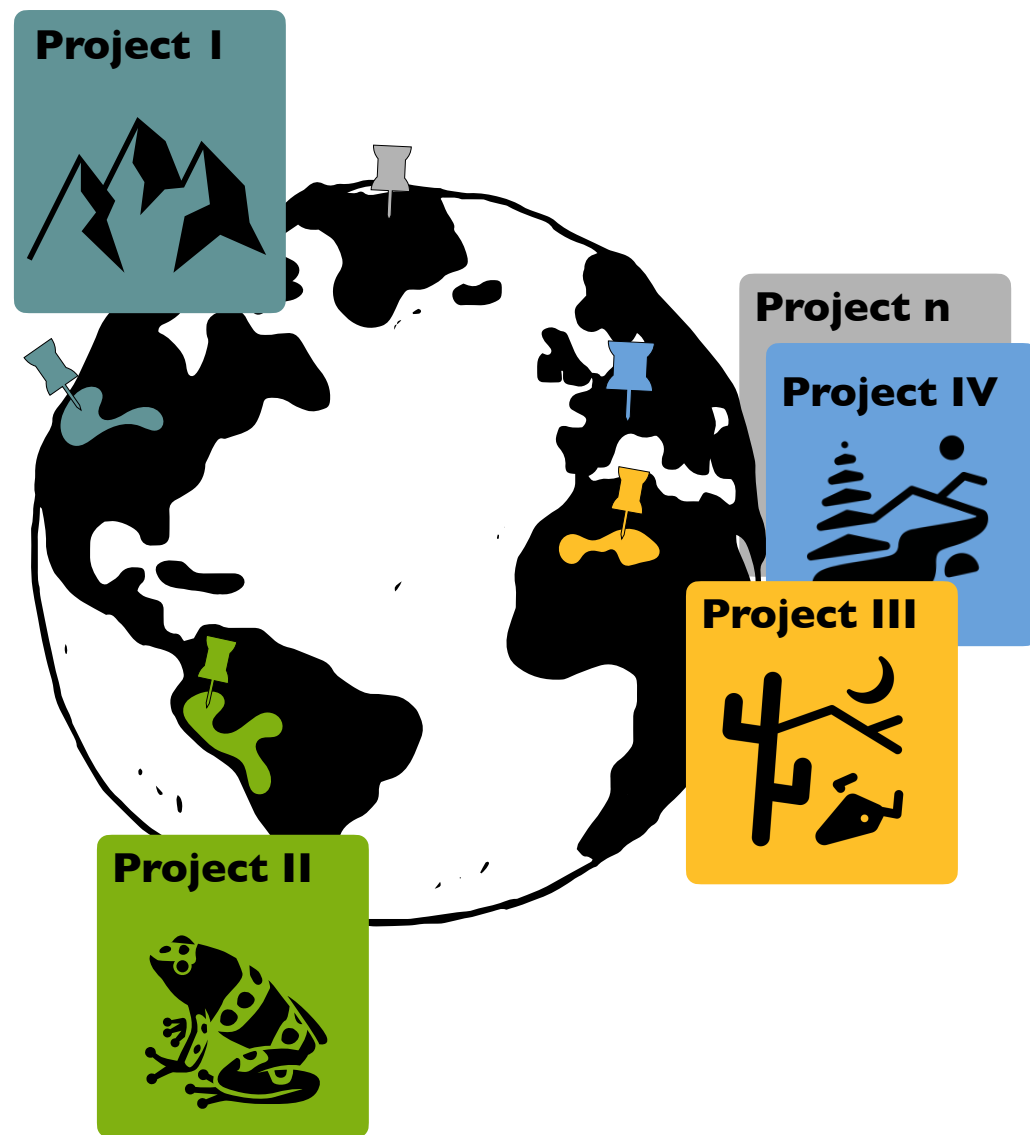




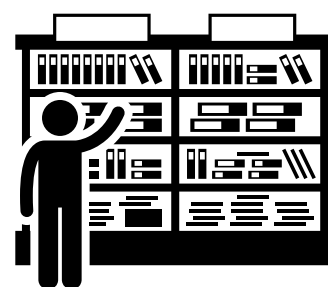




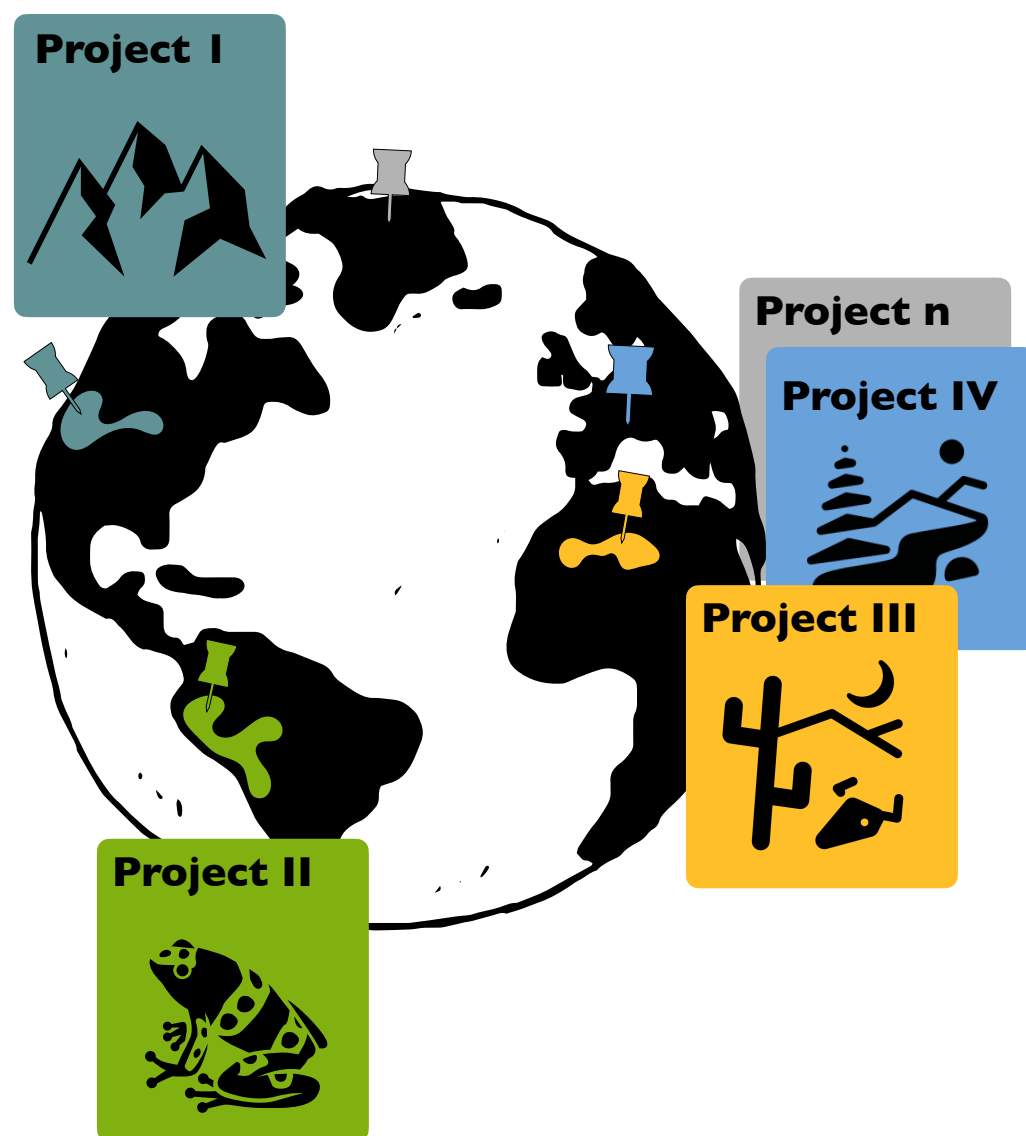
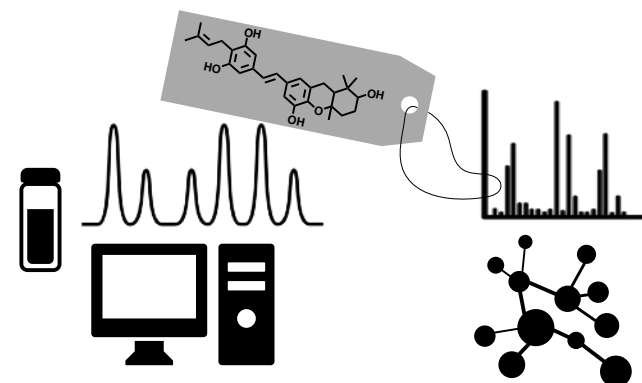
Accessing chemodiversity



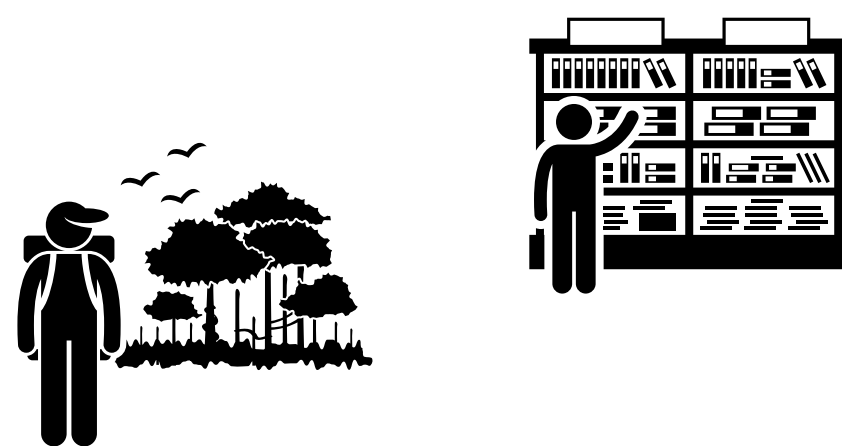
Accessing chemodiversity



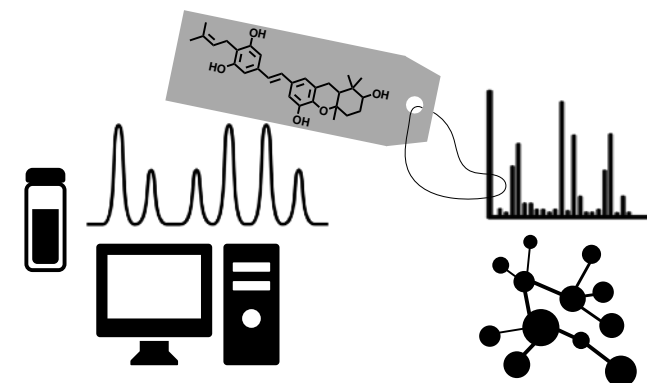
Knowledge acquisition



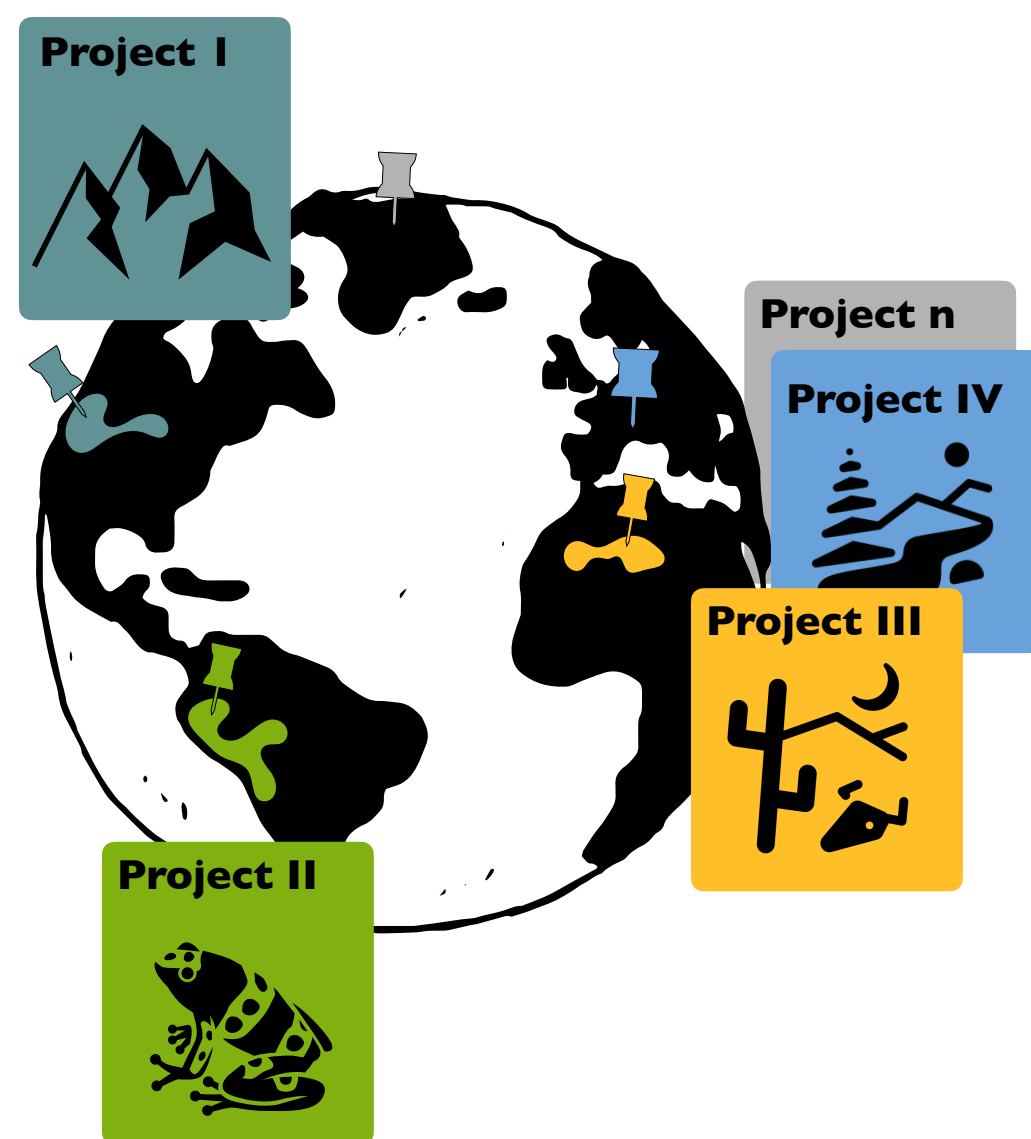
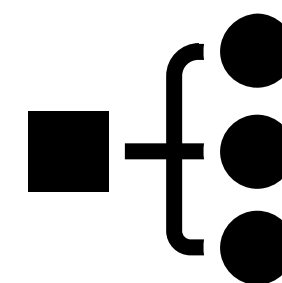
Accessing chemodiversity



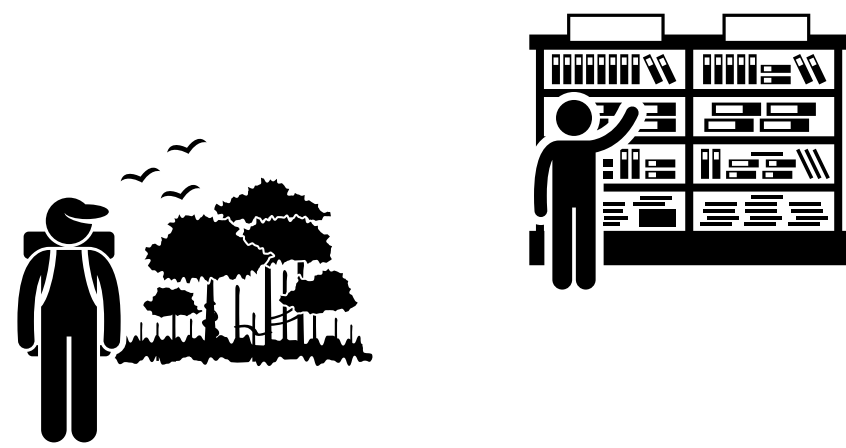
Knowledge acquisition



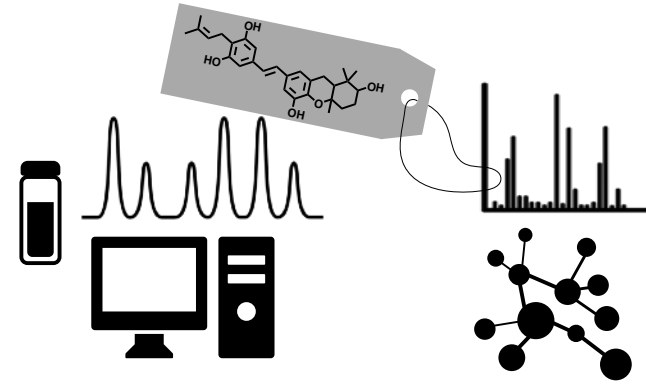
Knowledge organisation



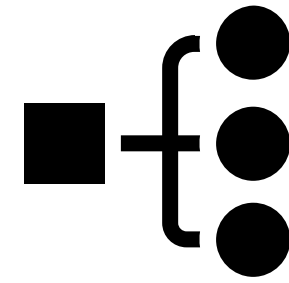
**Accessing
chemodiversity**



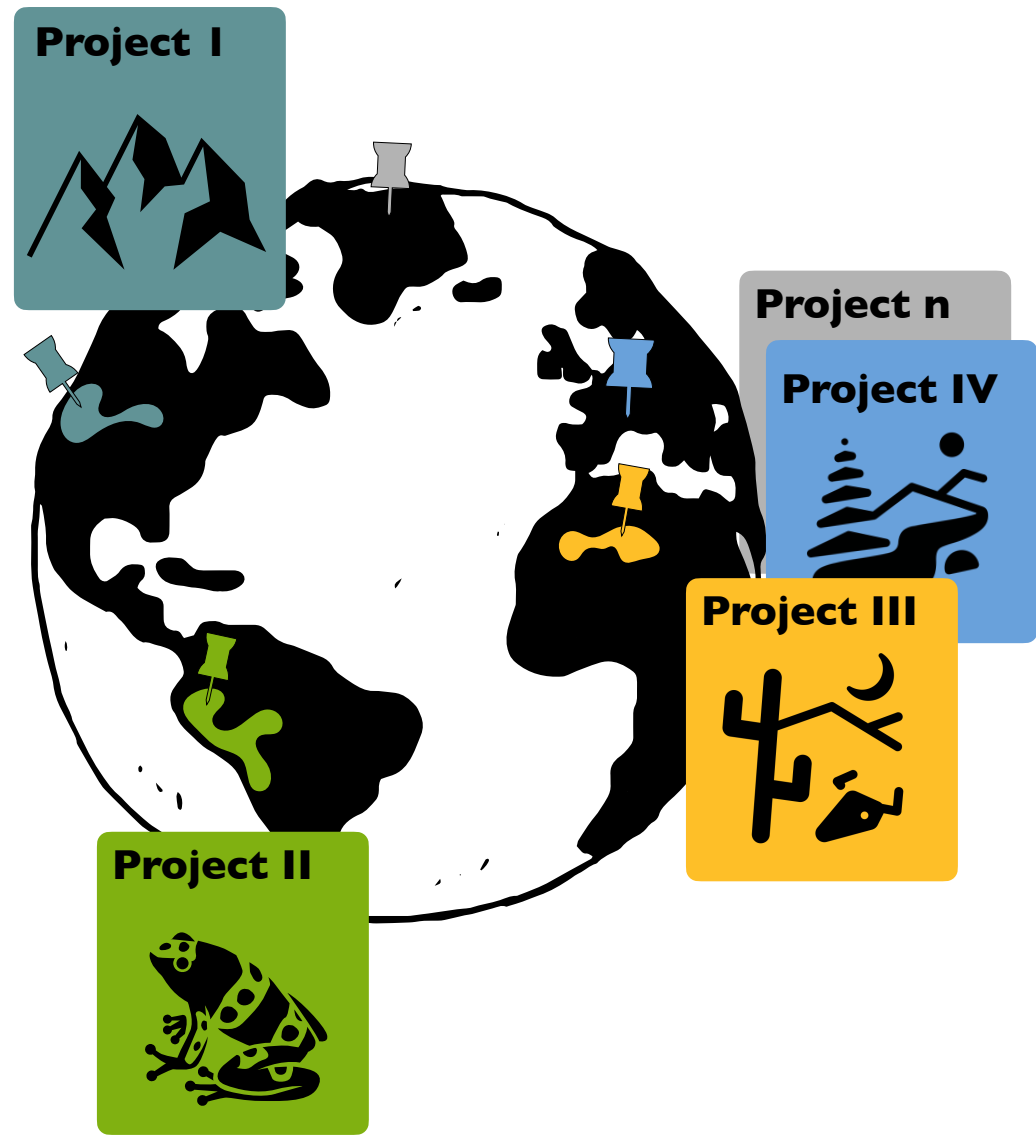
**Knowledge
acquisition**



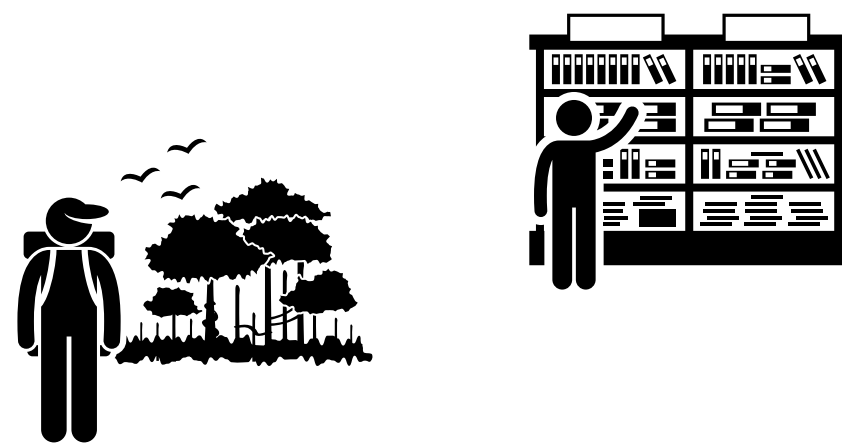
**Knowledge
organisation**



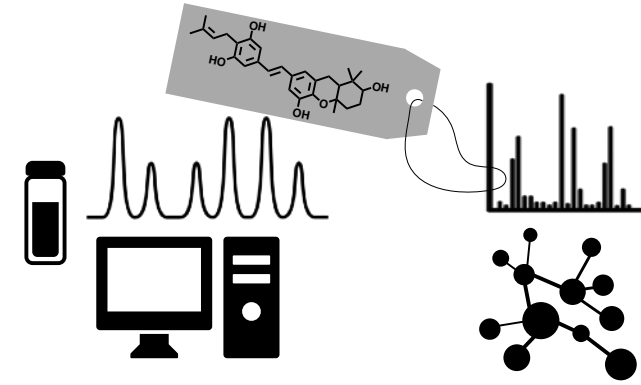
**Knowledge
dissemination**



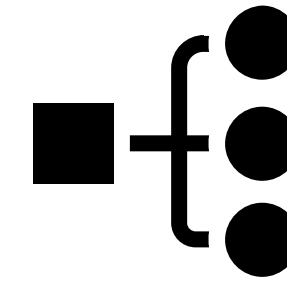
**Accessing
chemodiversity**



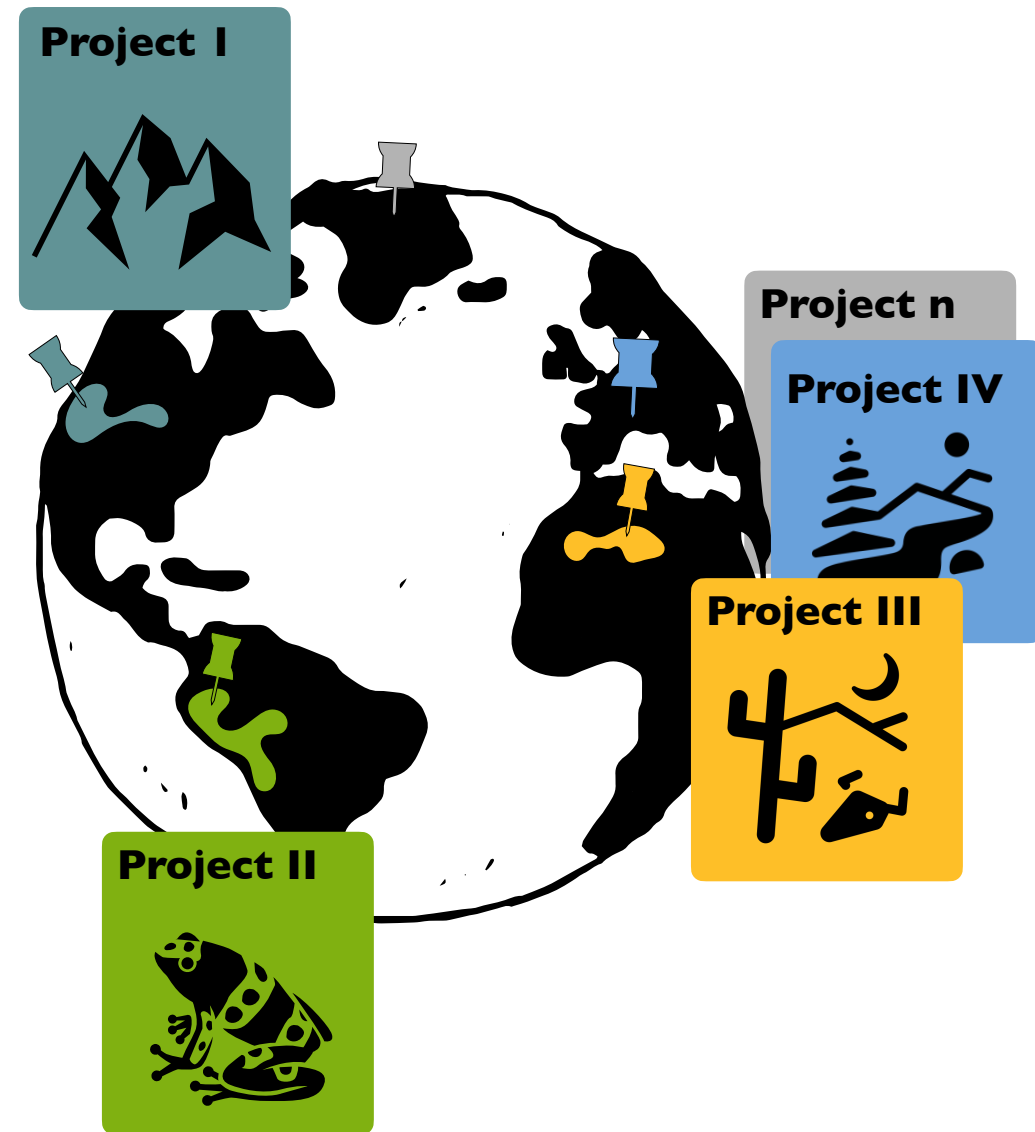
**Knowledge
acquisition**



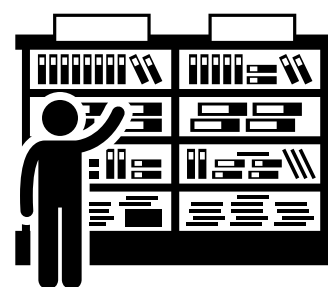
**Knowledge
organisation**



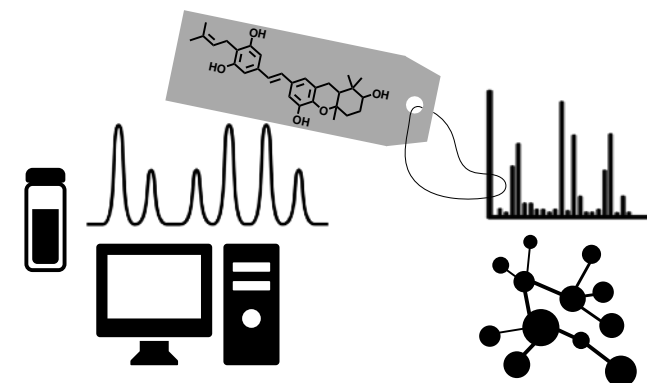
**Knowledge
dissemination**



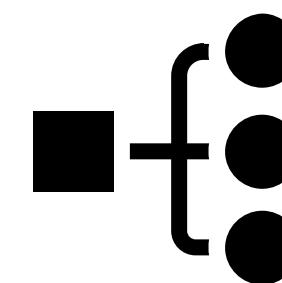
Accessing
chemodiversity



Knowledge
acquisition



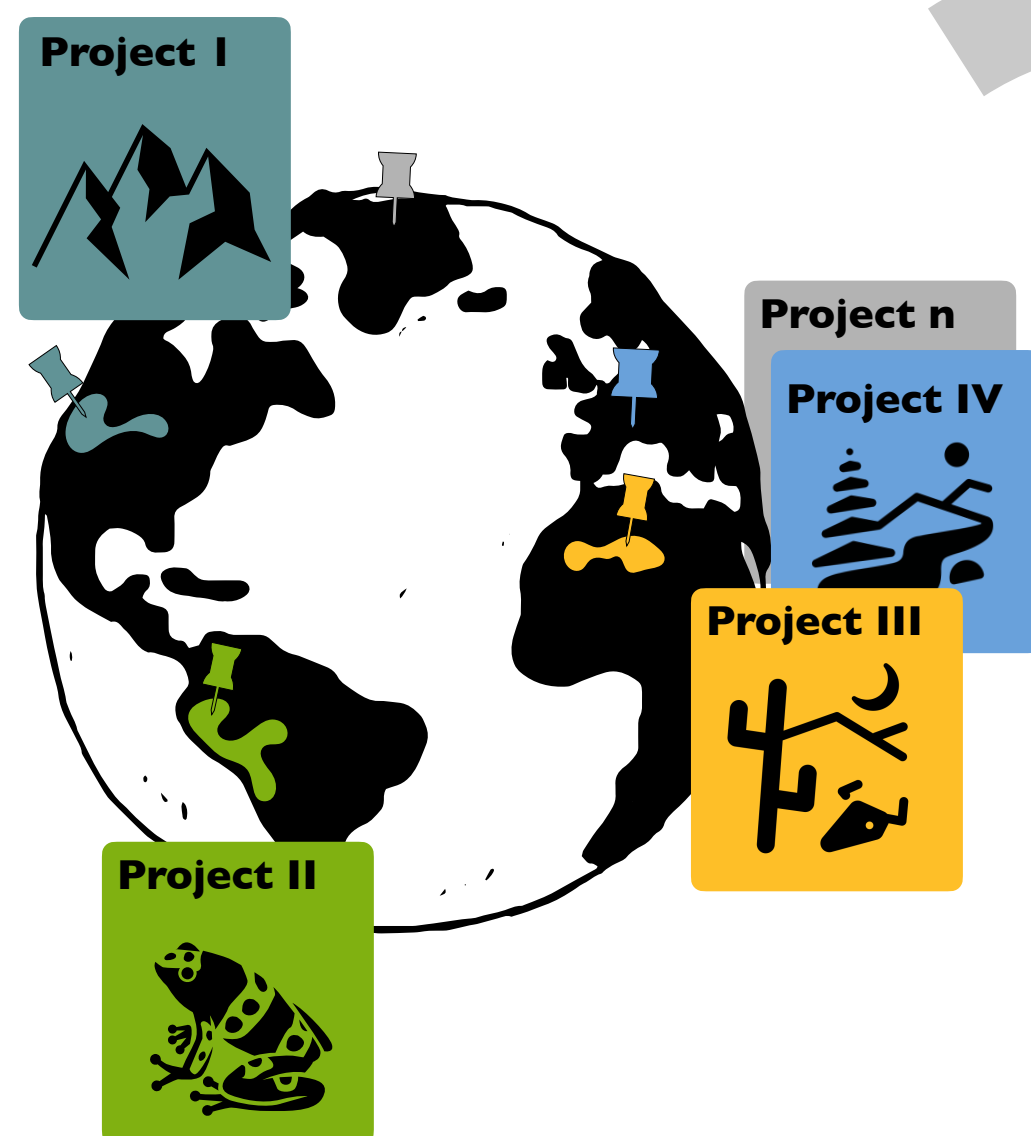
Knowledge
organisation



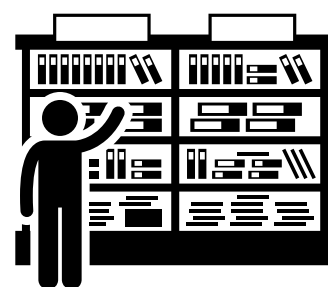
Knowledge
dissemination



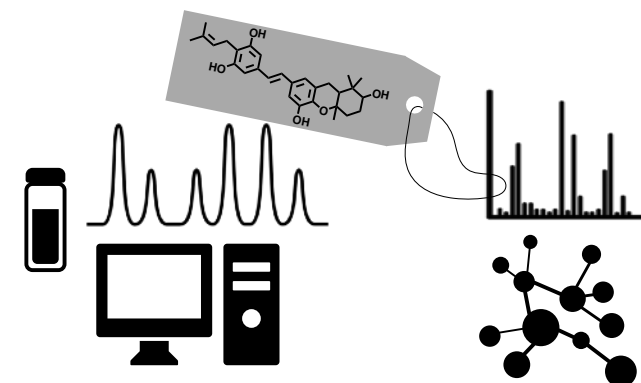
BUILDING KNOWLEDGE



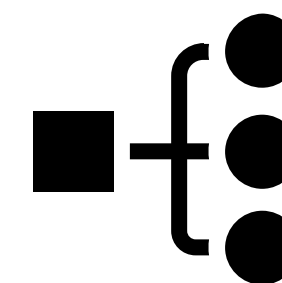
**Accessing
chemodiversity**



**Knowledge
acquisition**



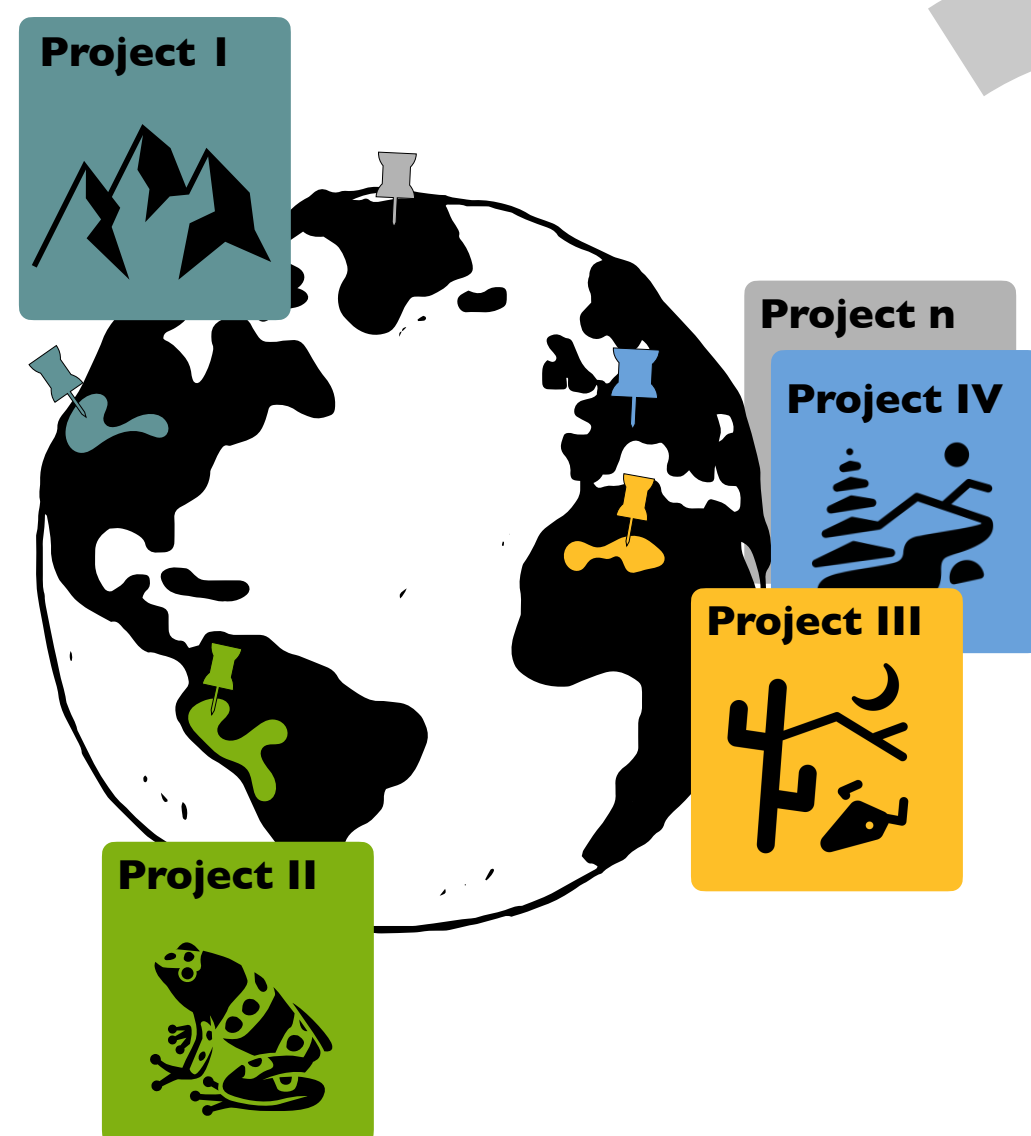
**Knowledge
organisation**



**Knowledge
dissemination**



BUILDING KNOWLEDGE



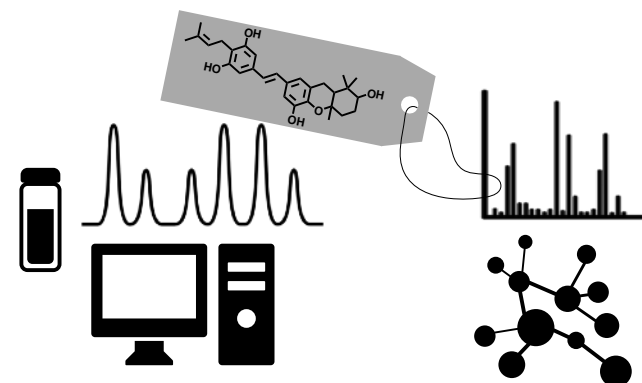
User community

Researchers, policy makers,
industry, national parks,
curators, public etc.

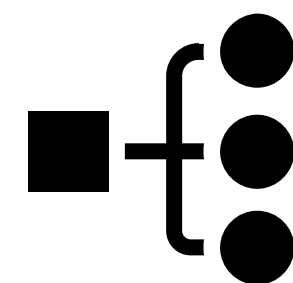
Accessing
chemodiversity



Knowledge
acquisition



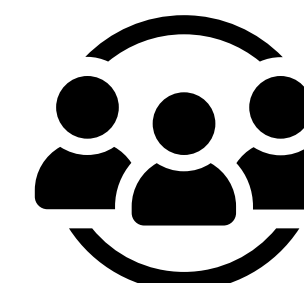
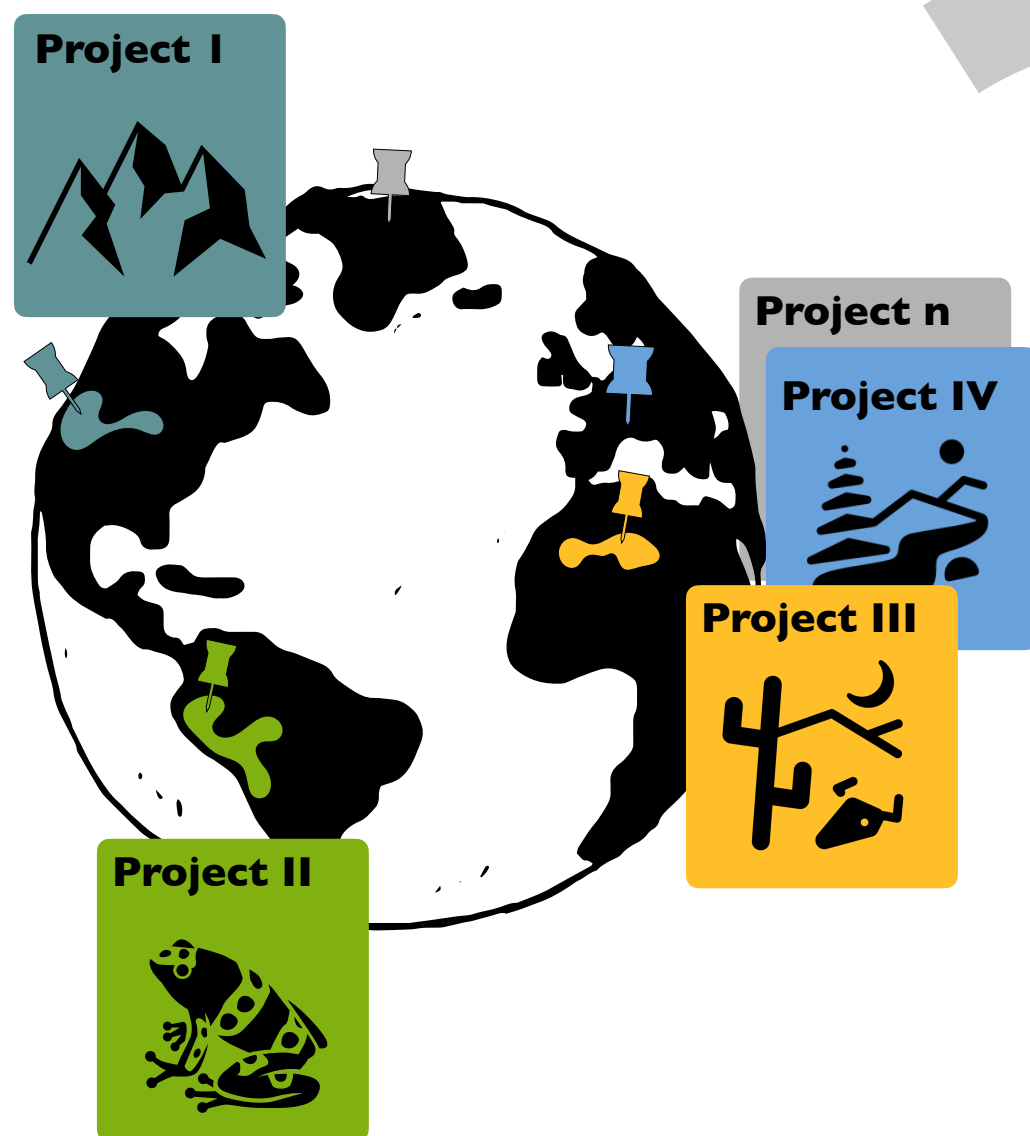
Knowledge
organisation



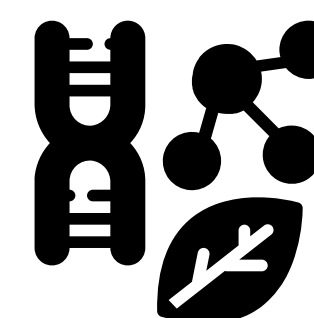
Knowledge
dissemination



BUILDING KNOWLEDGE



User community
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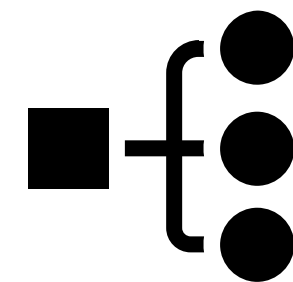
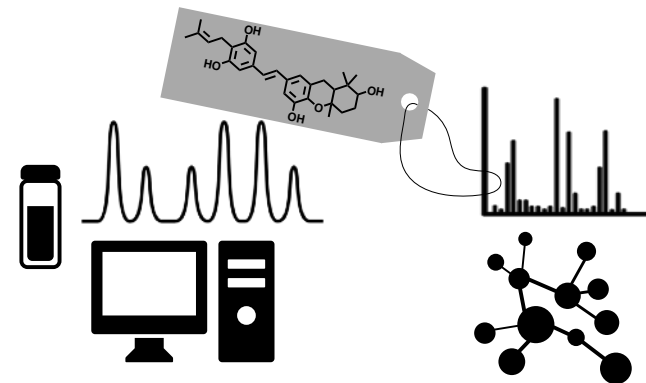
**Advance
life sciences**

Accessing
chemodiversity

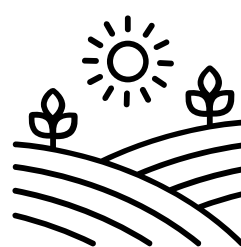
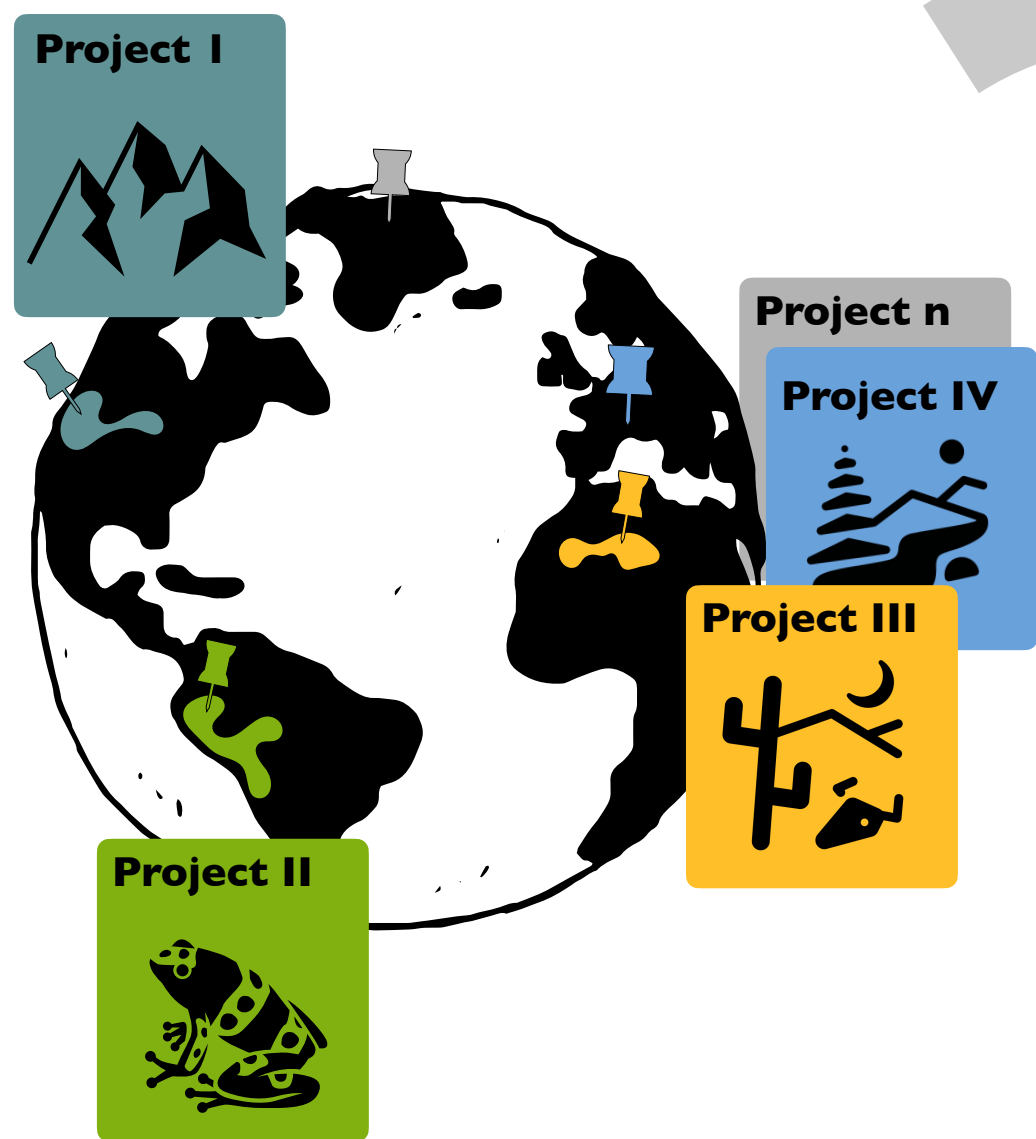
Knowledge
acquisition

Knowledge
organisation

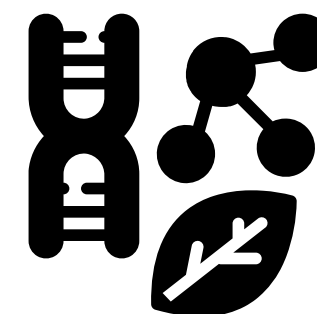
Knowledge
dissemination



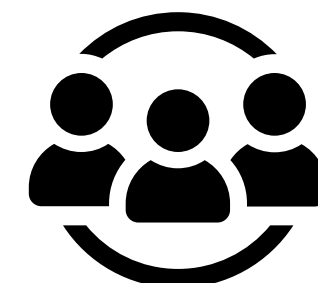
BUILDING KNOWLEDGE



Benefit
human society



Advance
life sciences



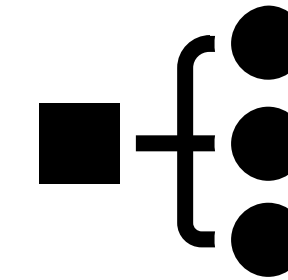
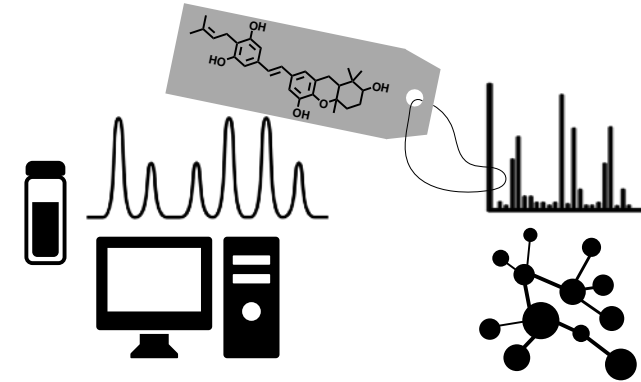
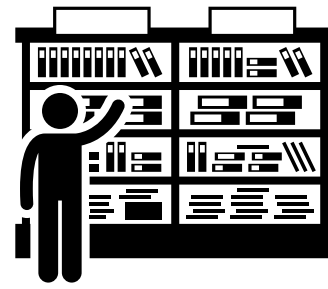
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Accessing
chemodiversity

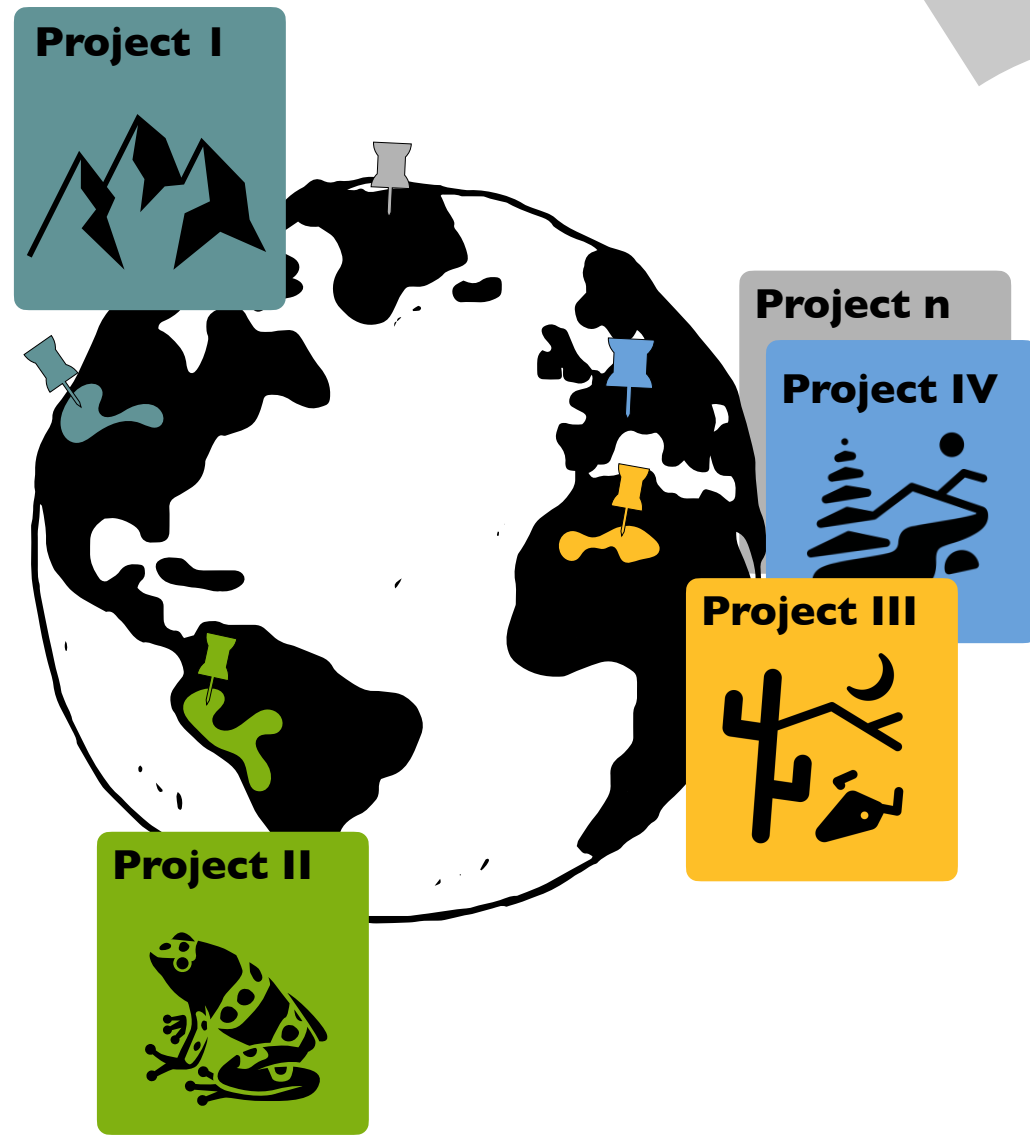
Knowledge
acquisition

Knowledge
organisation

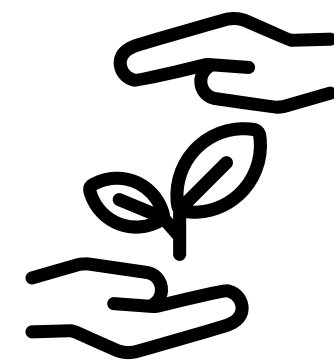
Knowledge
dissemination



BUILDING KNOWLEDGE



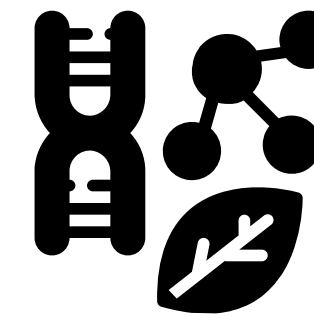
User community
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**Protect
biodiversity**



**Benefit
human society**



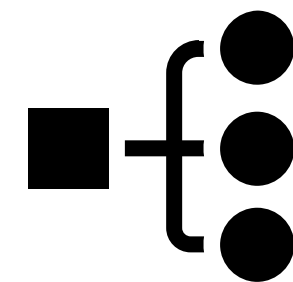
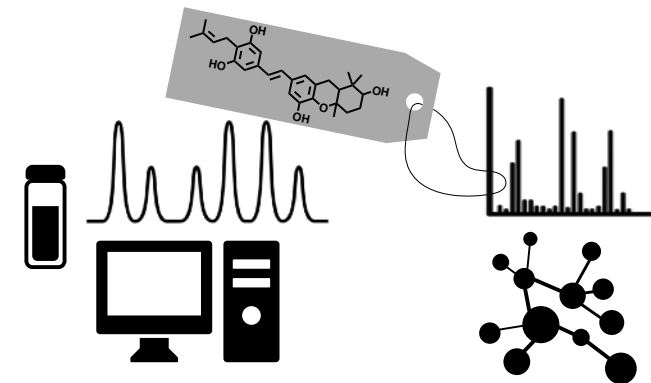
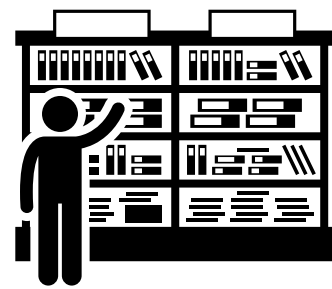
**Advance
life sciences**

Accessing
chemodiversity

Knowledge
acquisition

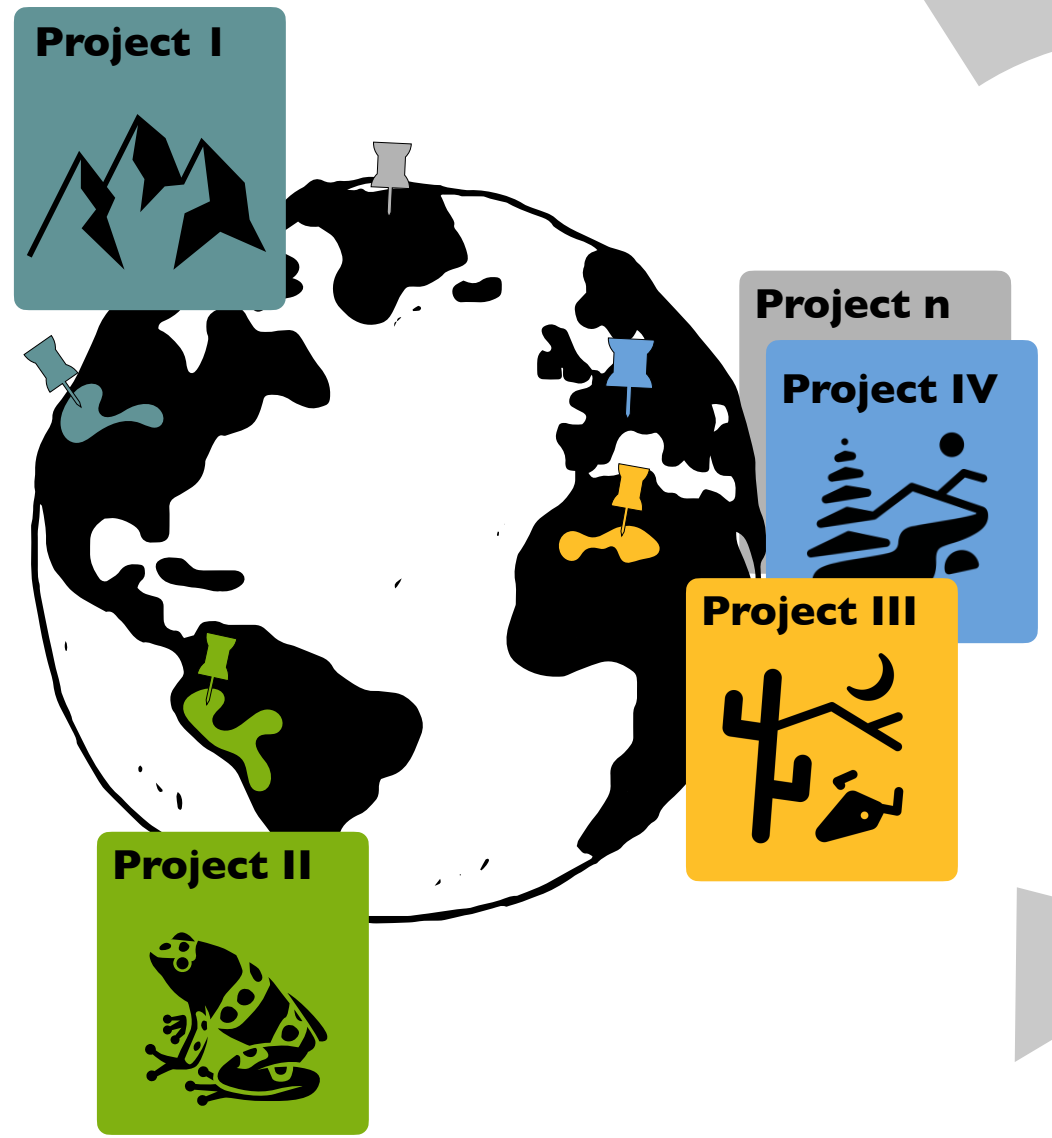
Knowledge
organisation

Knowledge
dissemination



BUILDING KNOWLEDGE

MAKING IMPACT

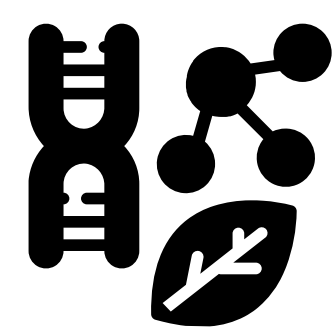
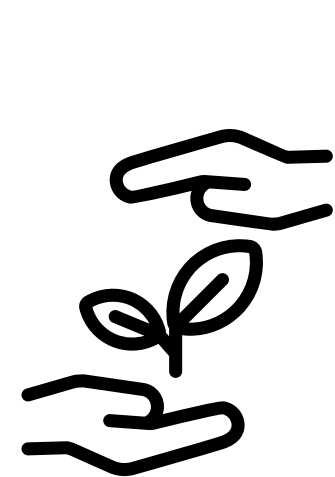


User community
Researchers, policy makers,
industry, national parks,
curators, public etc.

Protect
biodiversity

Benefit
human society

Advance
life sciences







Swiss
Digital Botanical
Gardens Initiative



Wild ecosystems



Diversity
(species)

Sampling
(easiness of)

Functions
(understanding of)

Conditions
(control of environmental)

Botanical gardens



Diversity
(species)

Sampling
(easiness of)

Functions
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Conditions
(control of environmental)

Laboratory plants



Diversity
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Wild ecosystems



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Botanical gardens




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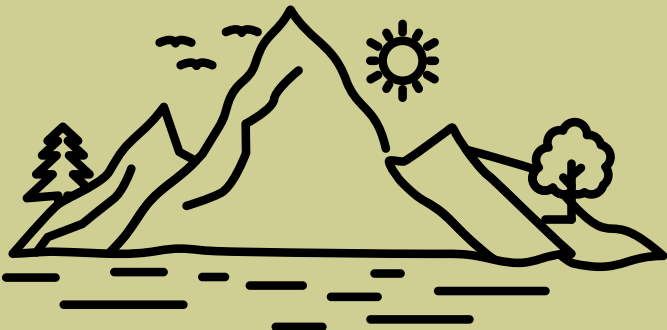
Diversity
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Diversity
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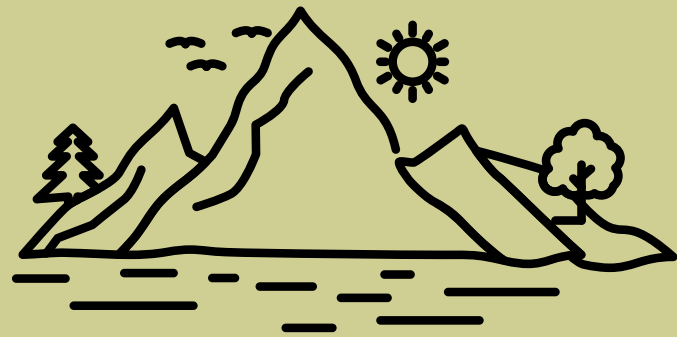
Diversity
(species)

Sampling
(easiness of)

Functions
(understanding of)

Conditions
(control of environmental)

Wild ecosystems



Diversity

(species)



Sampling

(easiness of)



Functions

(understanding of)

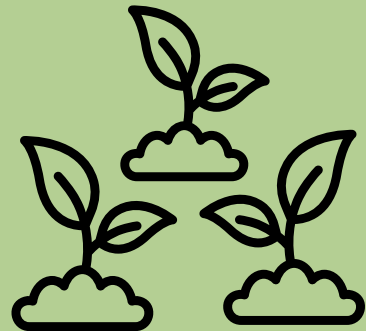


Conditions

(control of environmental)



Botanical gardens



Diversity

(species)



Sampling

(easiness of)



Functions

(understanding of)



Conditions

(control of environmental)



Laboratory plants



Diversity

(species)



Sampling

(easiness of)



Functions

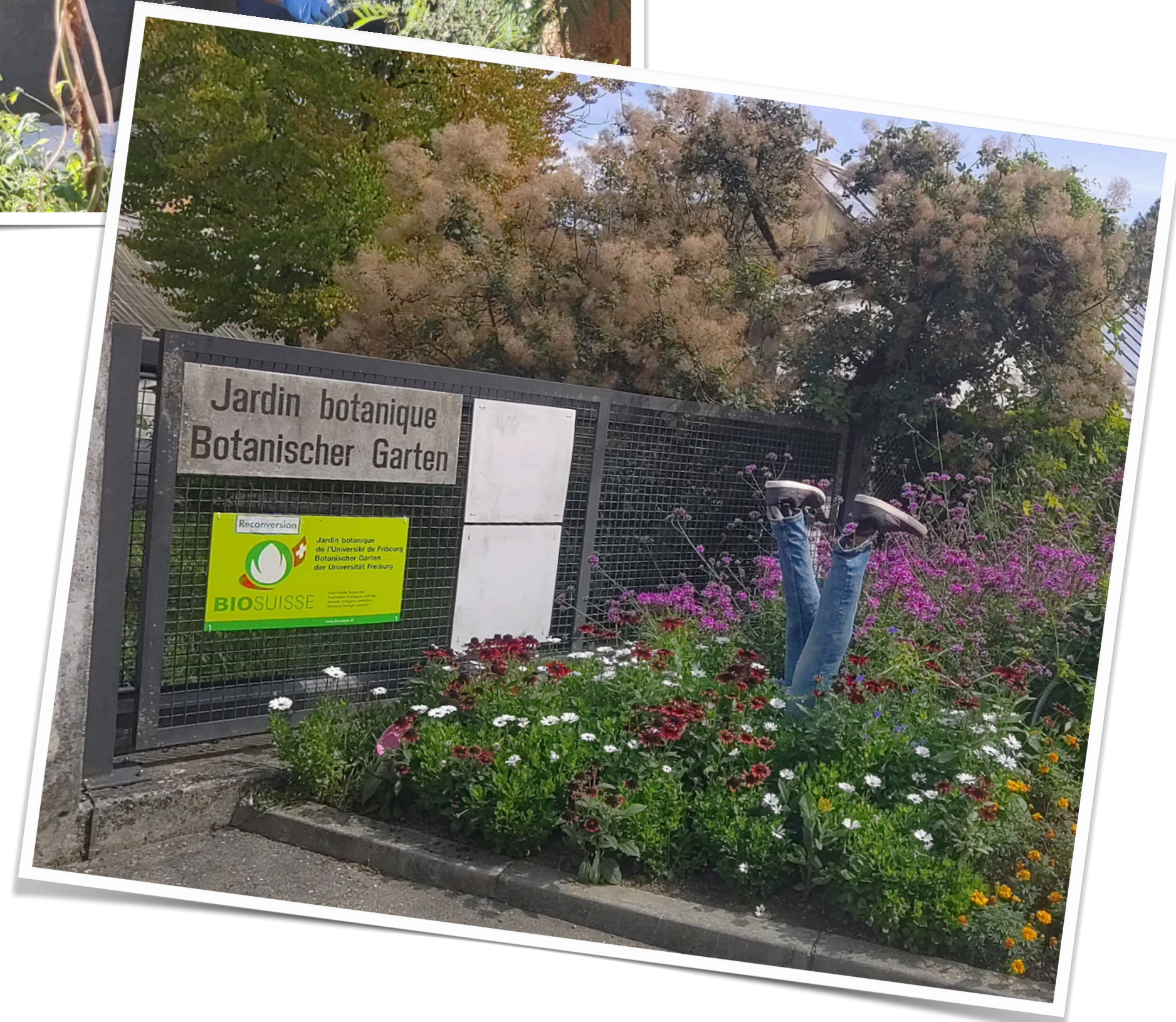
(understanding of)

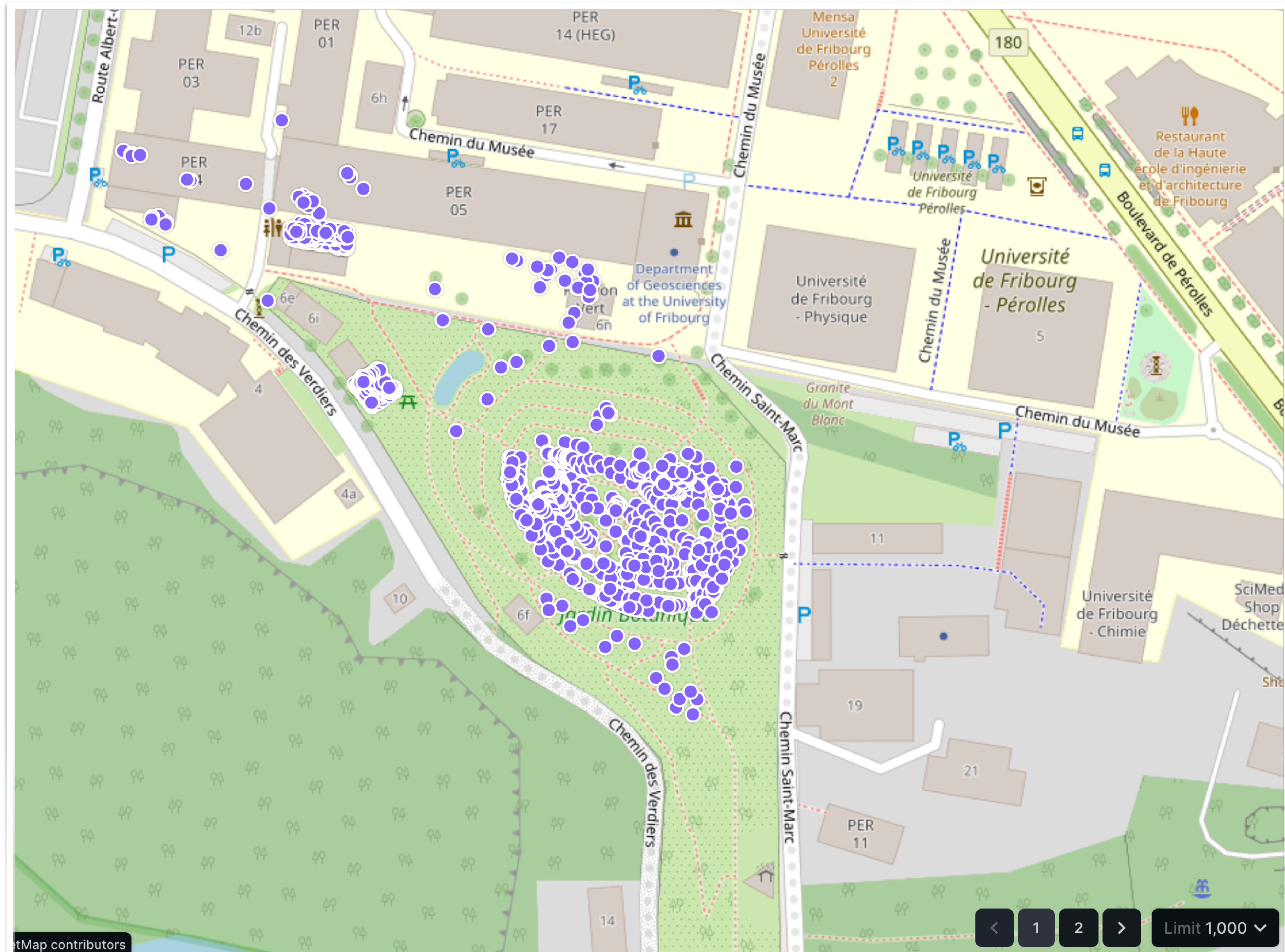


Conditions

(control of environmental)









Digital Botanical Gardens Initiative

About

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[11
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Stachys recta L.
ssp. recta
Epiaire droite
Aufrechter Ziest
S-Europe, W-Asien
Lamiaceae

[Stachys recta](#)
Perennial Yellow-Woundwort

1 2mo



Veronica austriaca L.
Véronique d'Autriche
Österreichischer Ehrenpreis
E Europe
Plantaginaceae

[Veronica austriaca](#)
Austrian Speedwell

1 2mo



Stachys officinalis L.
Epiaire officinale
Gewöhnliche Pechheide
Europe W Asia
Lamiaceae

[Genus Stachys](#)
Hedgenettles

1



Silene viscaria L.
Silène viscaire
Gewöhnliche Pechheide
Europe W Asia
Caryophyllaceae

[Genus Viscaria](#)

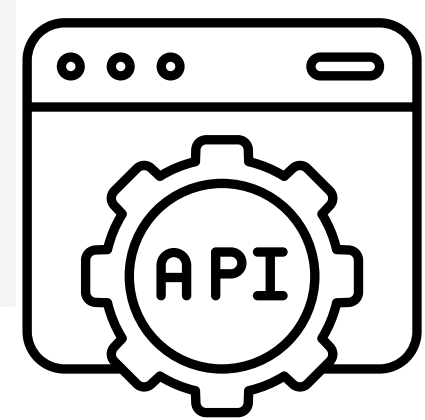
1 2mo



<https://www.inaturalist.org/projects/digital-botanical-gardens-initiative>

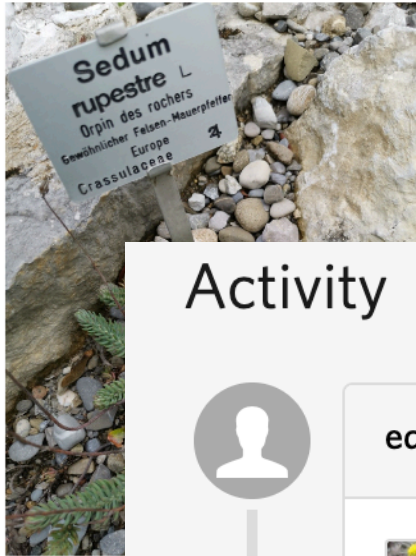
iNaturalist

183464310	289732	Species: <i>Tagetes tenuifolia</i> (Petite Marigold)	Sep 13, 2023	dbgi	Fribourg, Switzerland
183464325	242693	Variety: <i>Rudbeckia fulgida speciosa</i> (Showy Coneflower)	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464340	55976	Species: <i>Eupatorium cannabinum</i> (Hemp Agrimony)	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464357	81599	Species: <i>Silphium perfoliatum</i> (Cup Plant)	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464376	288835	Species: <i>Zinnia haageana</i>	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464401	130383	Species: <i>Helianthus pauciflorus</i> (Stiff Sunflower)	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464419	57983	Species: <i>Helianthus annuus</i> (Common Sunflower)	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464440	48651	Species: <i>Cosmos sulphureus</i> (Yellow Cosmos)	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464462	117439	Species: <i>Liatris spicata</i> (Dense Blazing Star)	Sep 15, 2023	dbgi	Fribourg, Switzerland
183464473	777243	Species: <i>Tagetes patula</i> (French Marigold)	Sep 15, 2023	dbgi	Fribourg, Switzerland




Genus *Petrosedum*

Casual




Activity



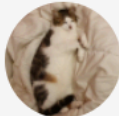
edouardbruelhart suggested an ID

Leading 4mo




Petrosedum rupestre
Reflexed Stonecrop

[Compare](#) [Agree](#)



jf920 suggested an ID*

Improving 4mo



Genus *Petrosedum*
a member of Family Crassulaceae (Stonecrop Family)

[Compare](#) [Agree](#)

cant be identified at this stage

* jf920 disagrees this is *Petrosedum rupestre* (Reflexed Stonecrop)

<https://www.inaturalist.org/observations/139418389>



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Members  22

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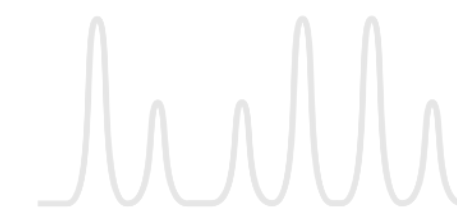
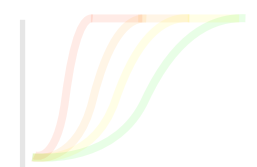
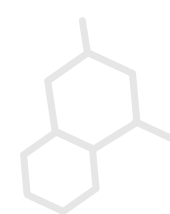
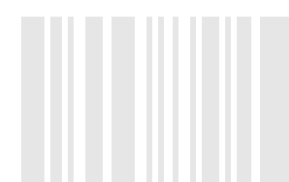
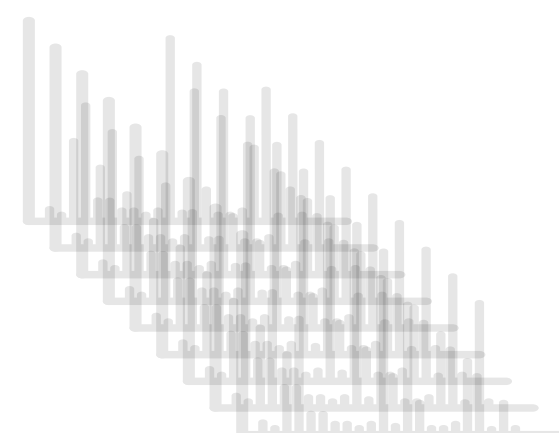
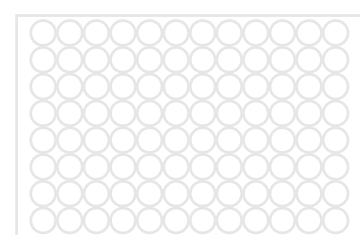
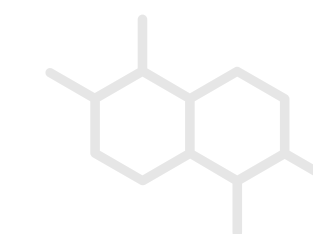
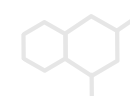
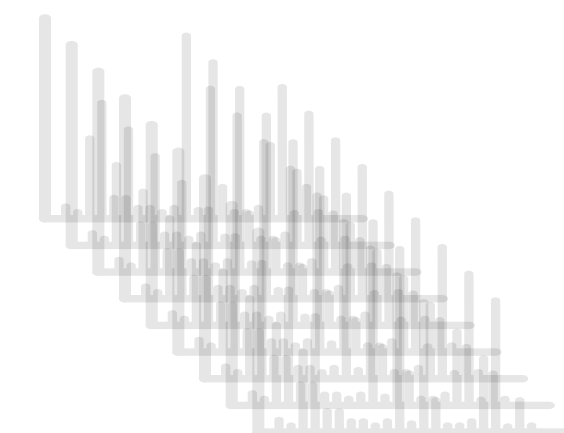
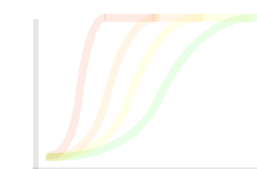
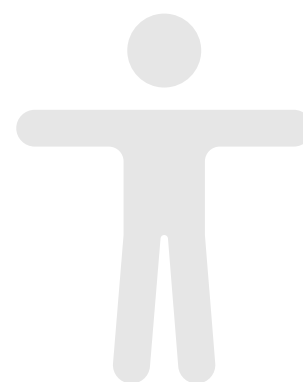
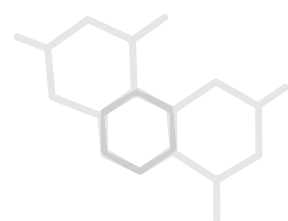
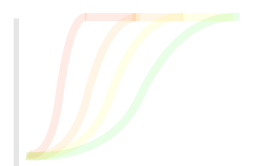
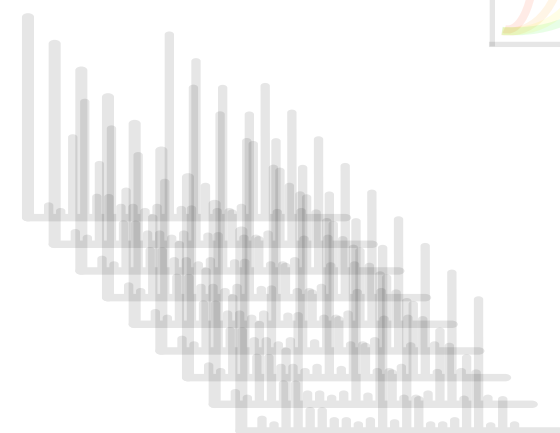
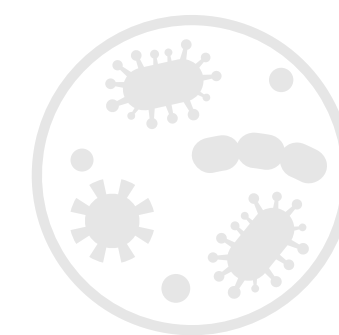
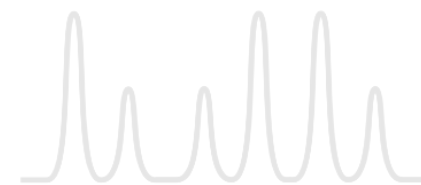
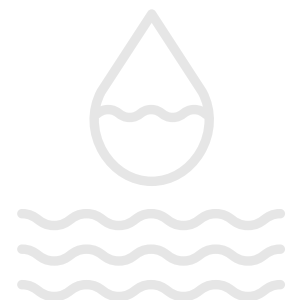
2,359
OBSERVATIONS

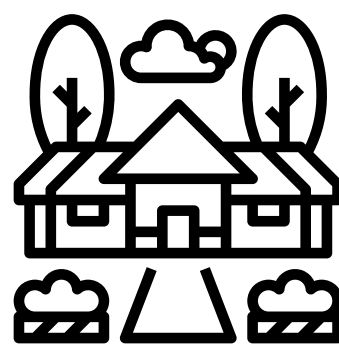
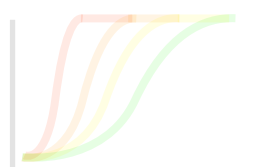
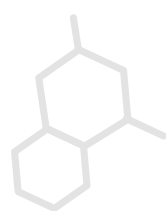
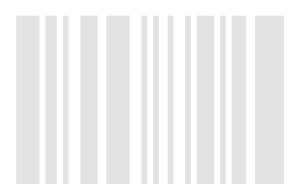
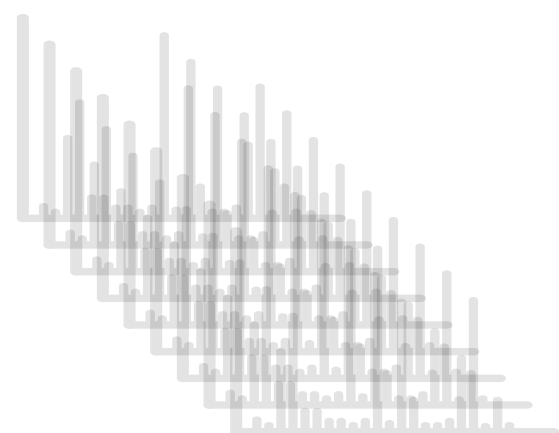
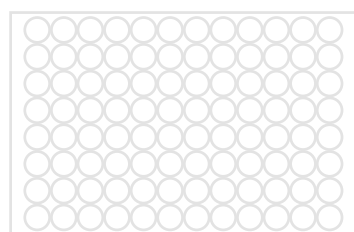
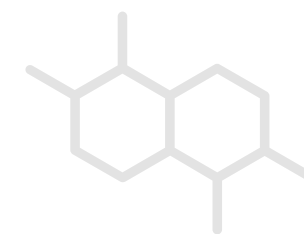
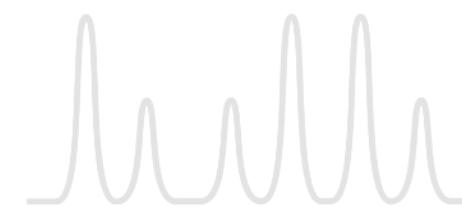
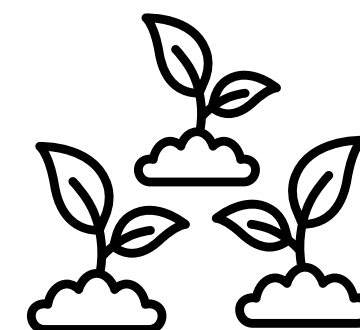
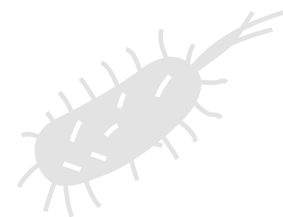
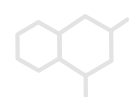
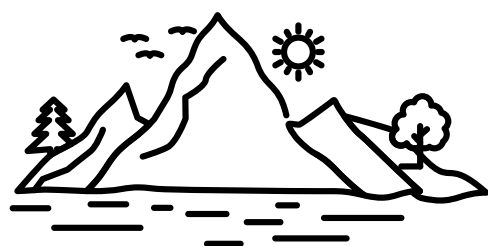
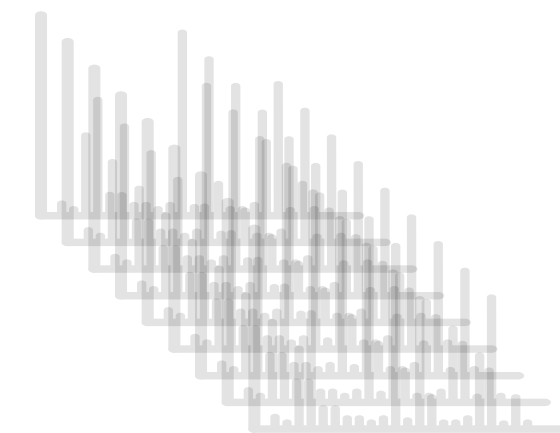
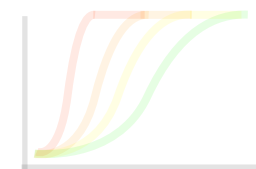
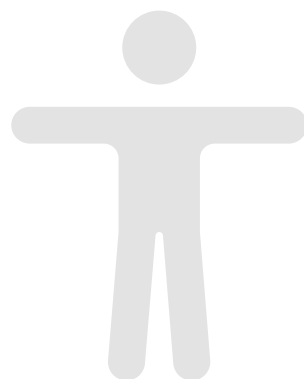
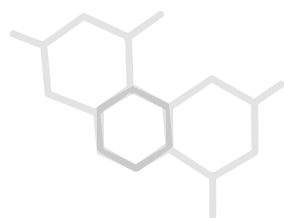
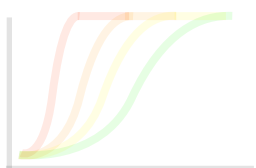
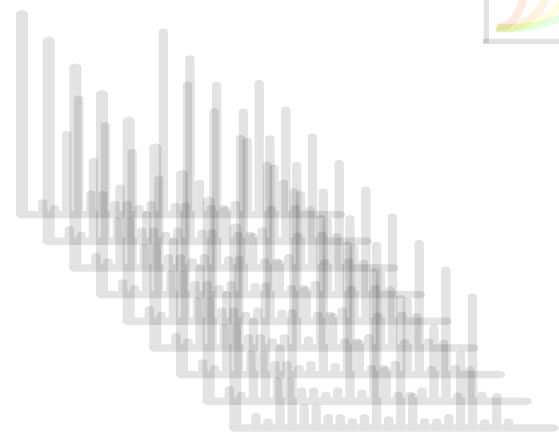
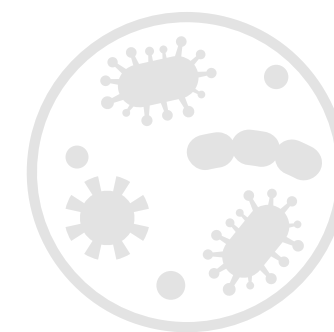
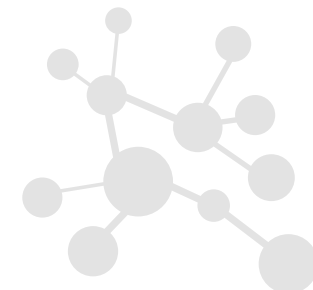
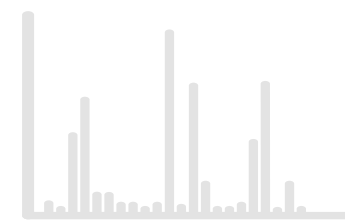
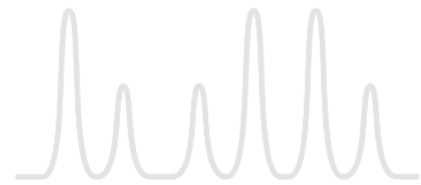
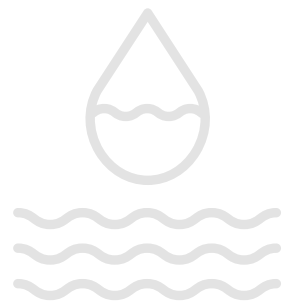
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SPECIES

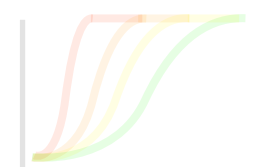
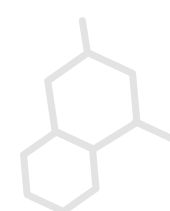
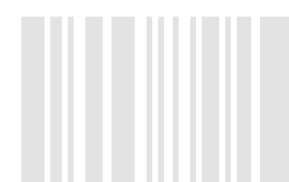
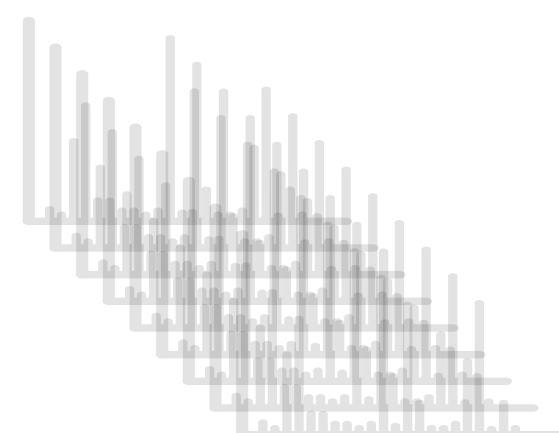
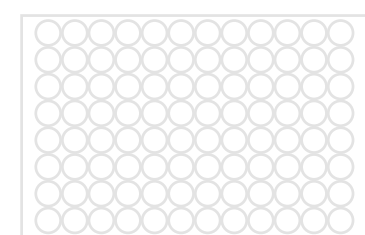
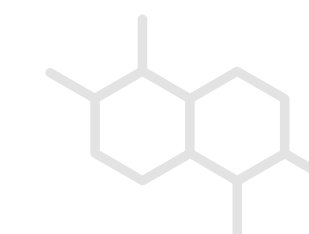
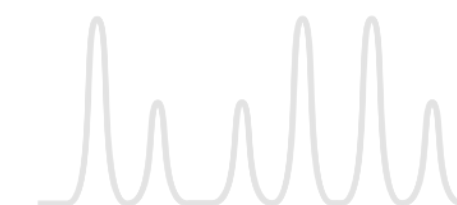
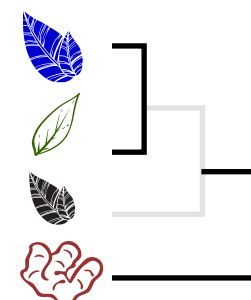
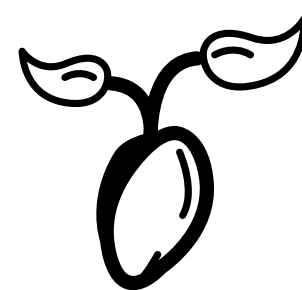
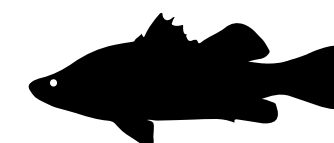
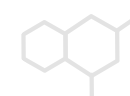
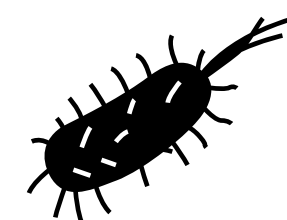
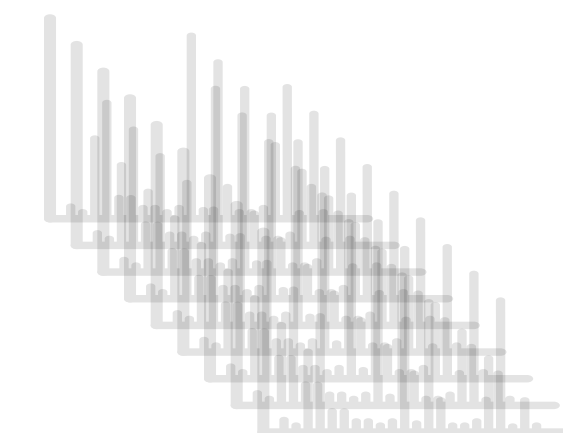
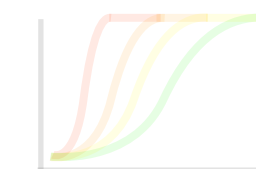
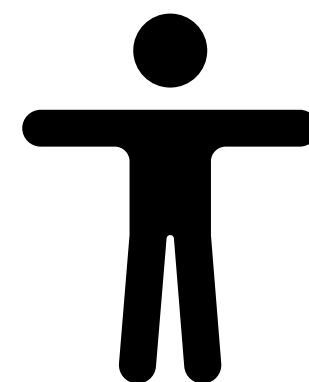
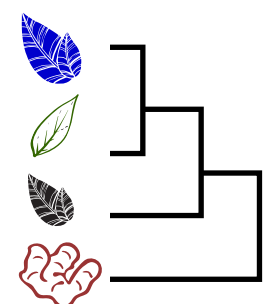
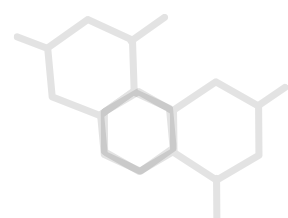
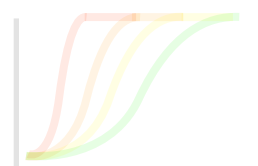
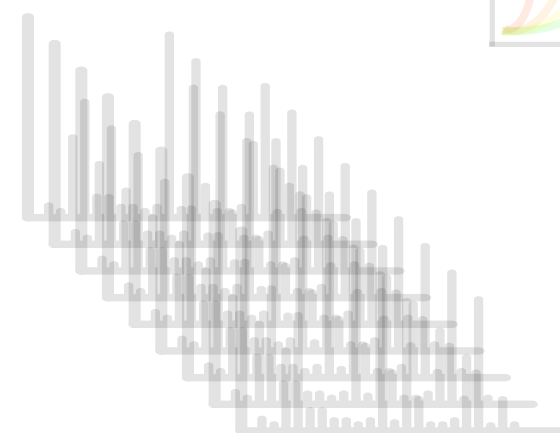
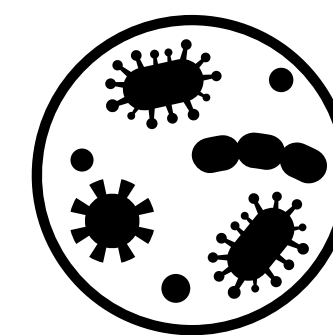
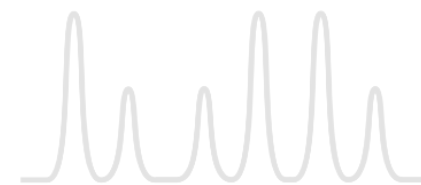
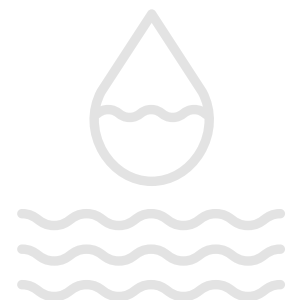
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IDENTIFIERS

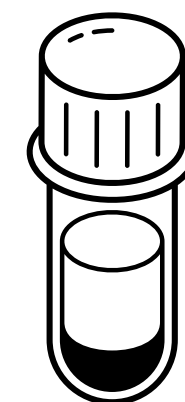
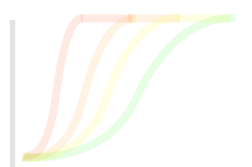
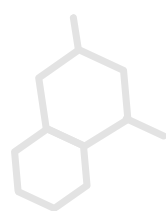
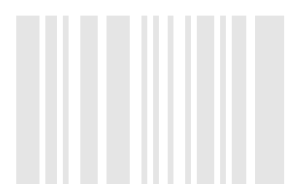
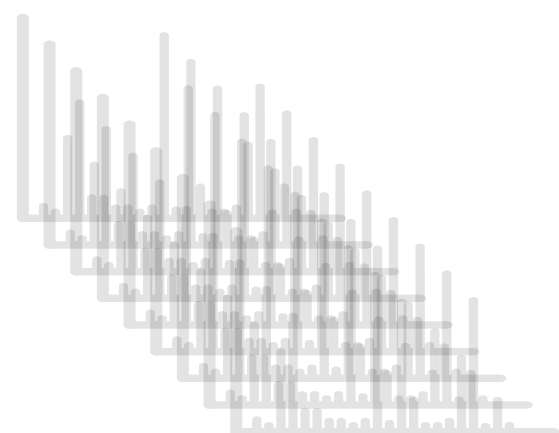
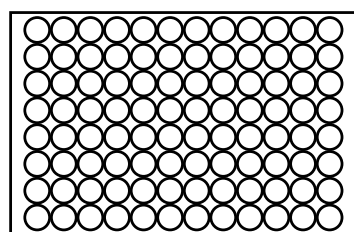
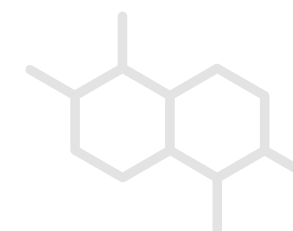
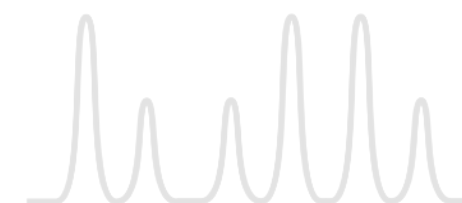
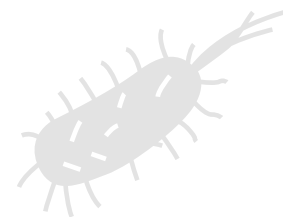
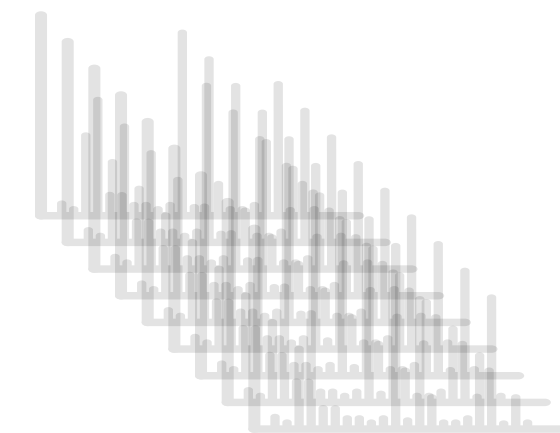
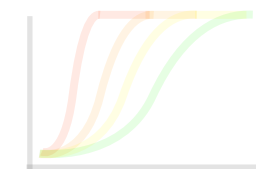
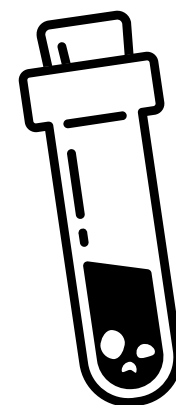
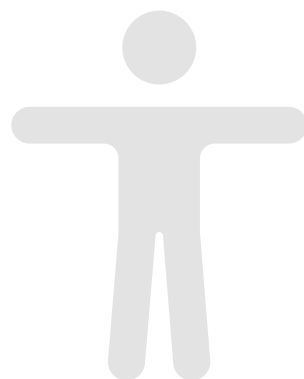
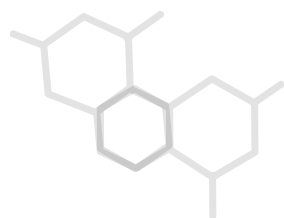
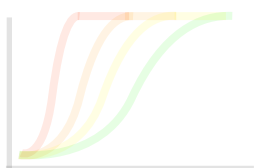
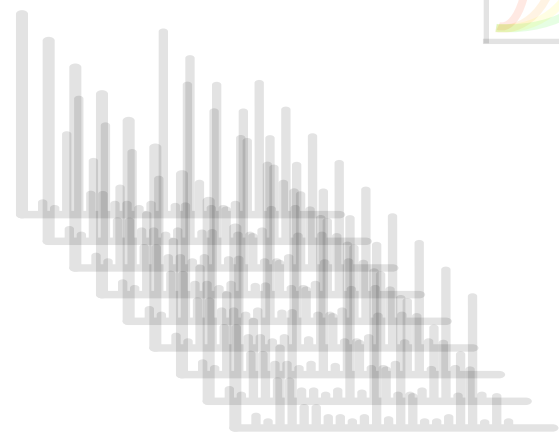
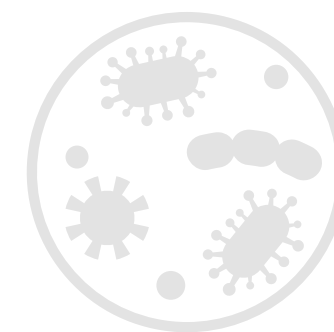
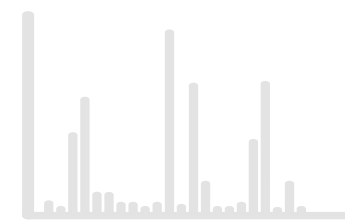
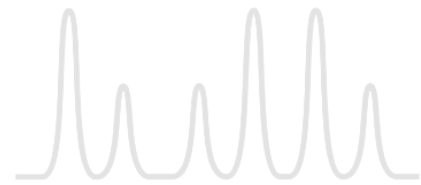
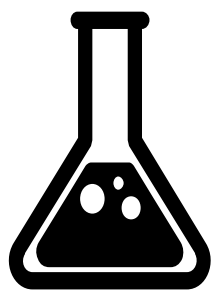
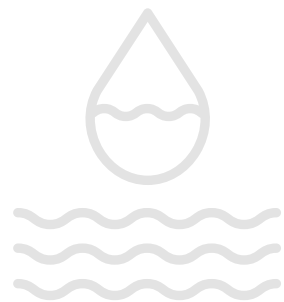
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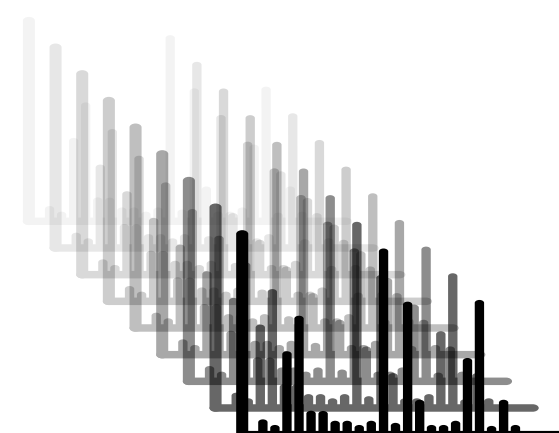
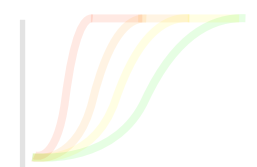
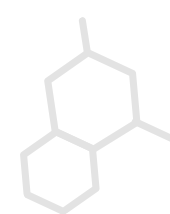
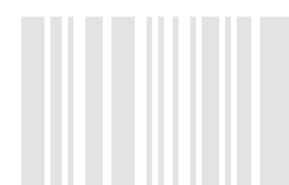
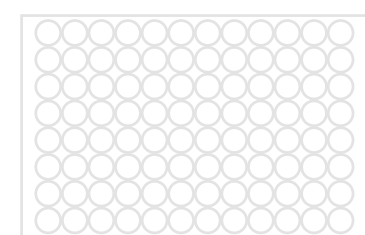
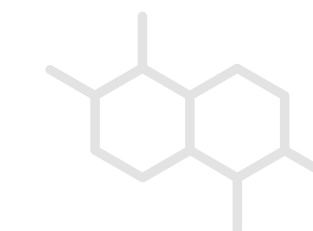
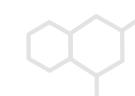
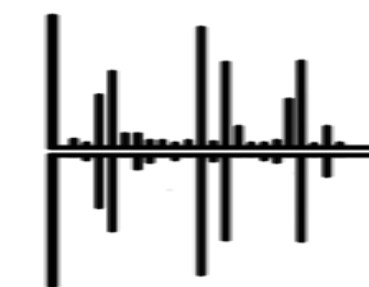
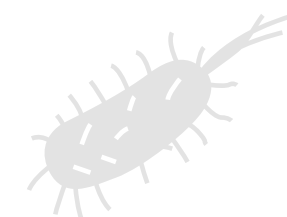
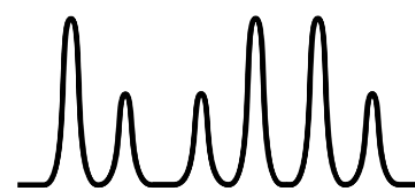
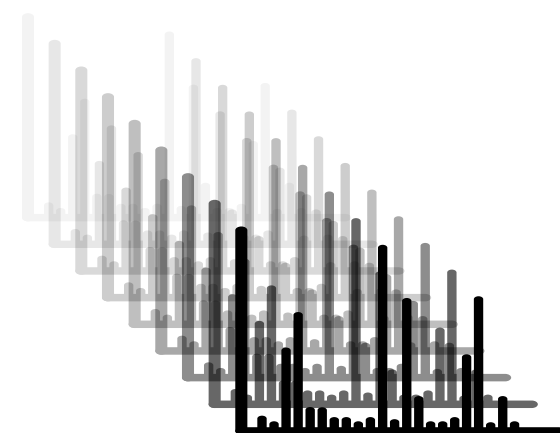
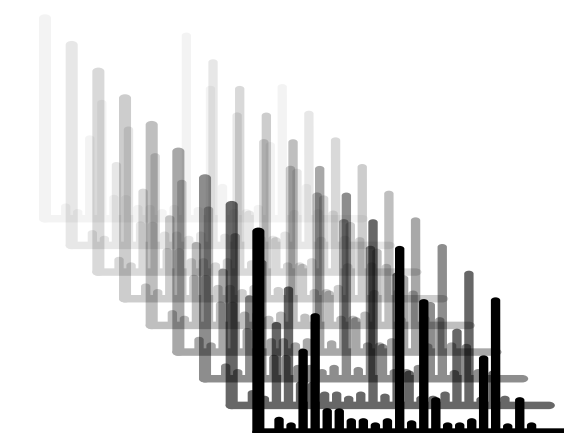
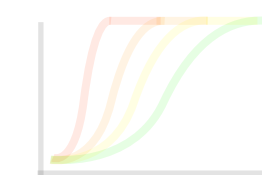
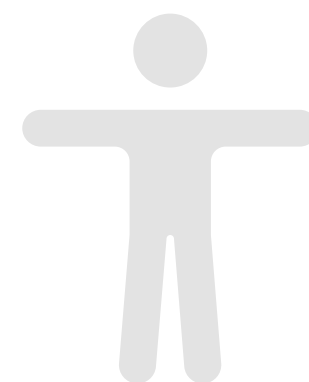
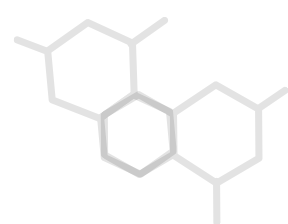
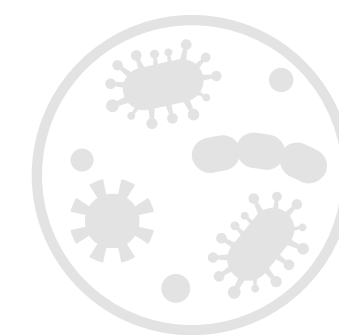
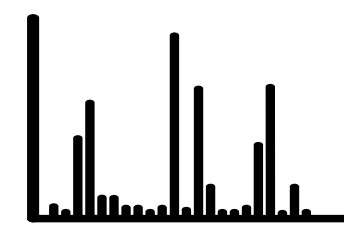
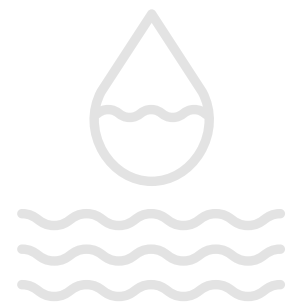
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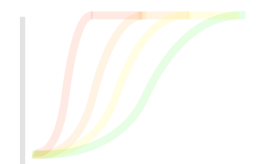
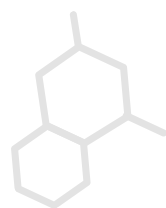
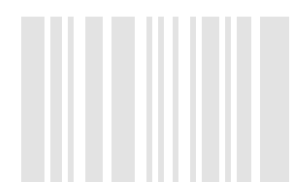
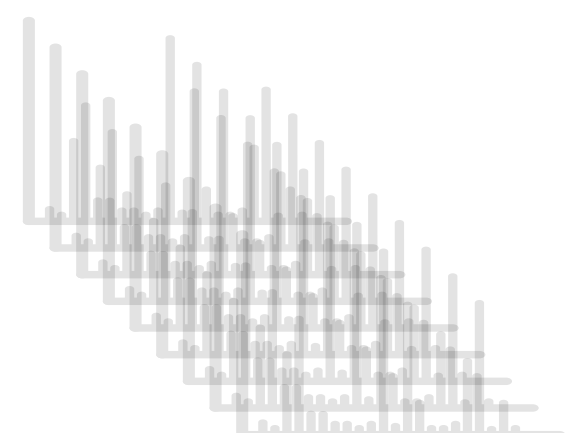
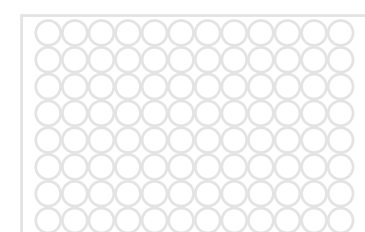
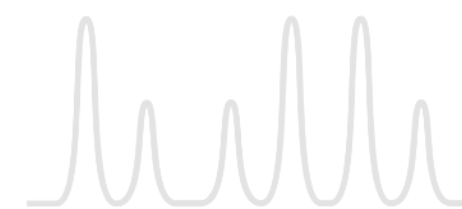
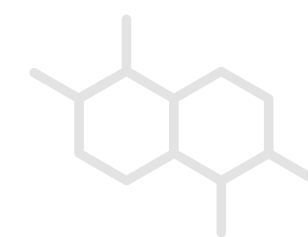
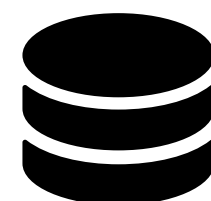
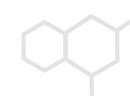
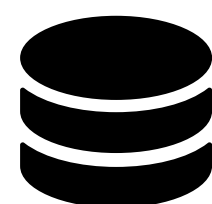
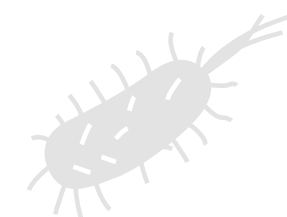
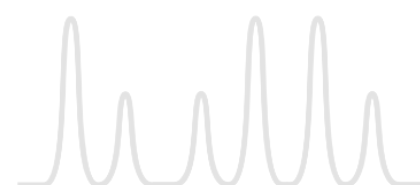
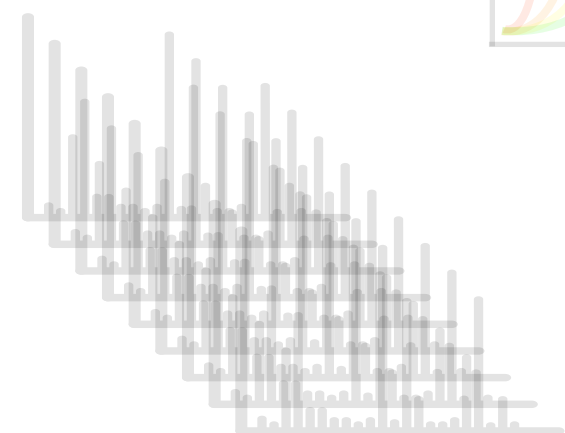
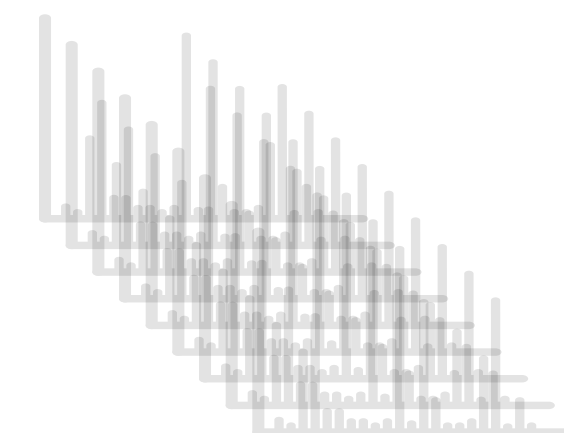
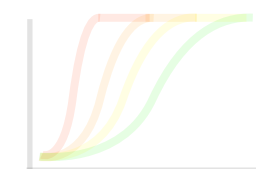
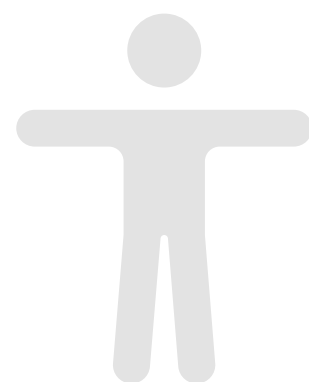
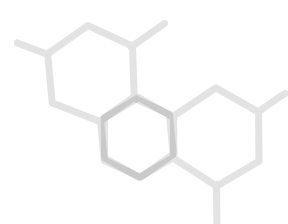
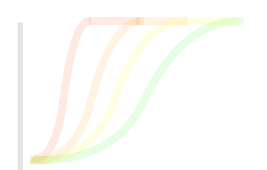
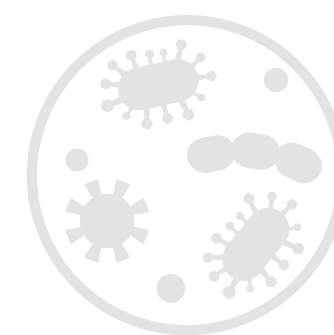
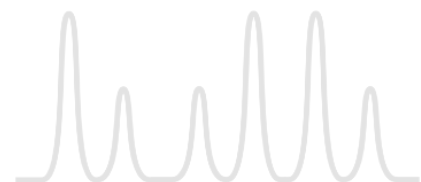
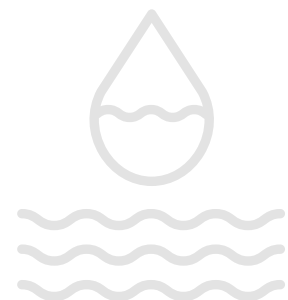


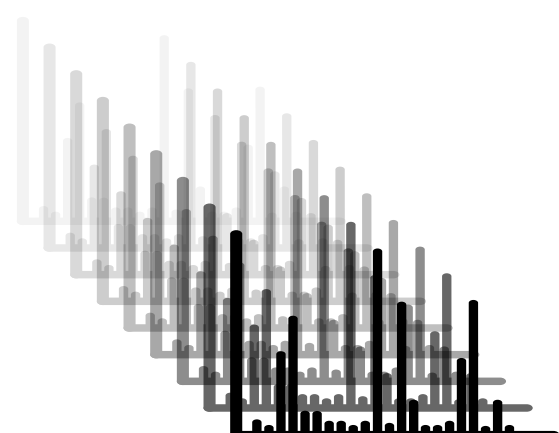
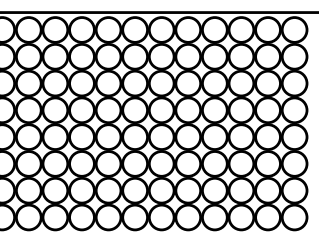
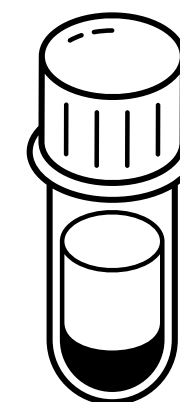
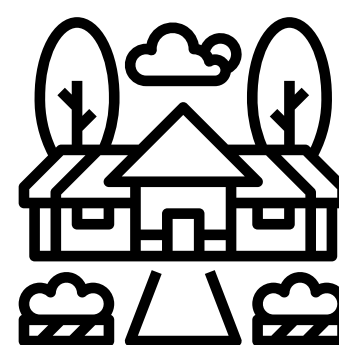
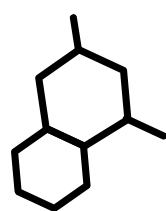
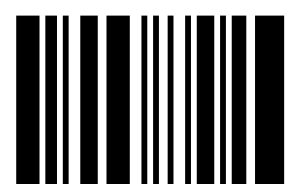
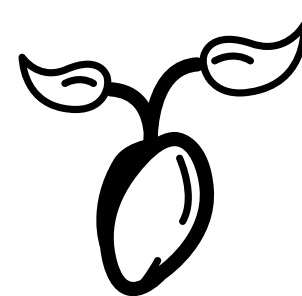
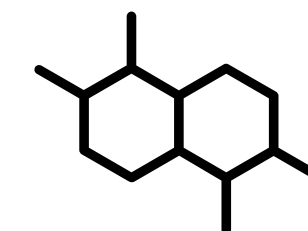
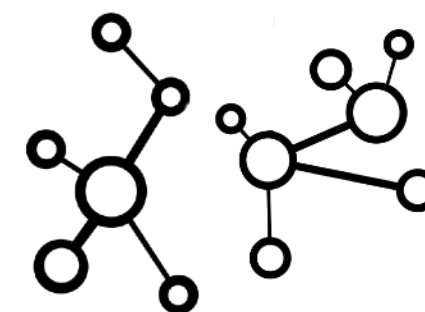
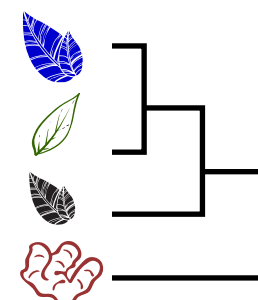
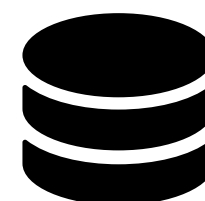
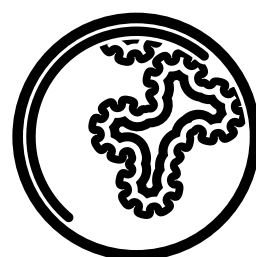
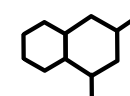
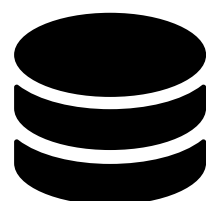
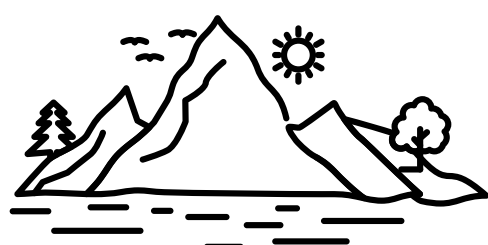
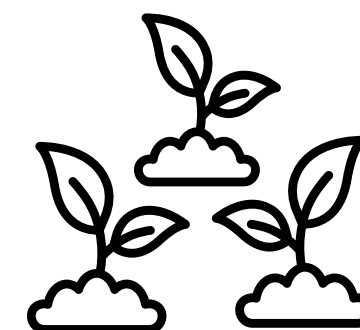
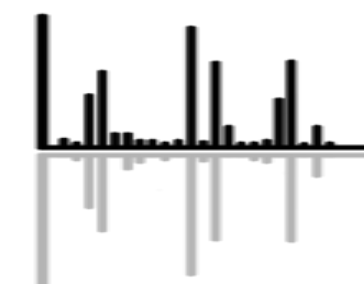
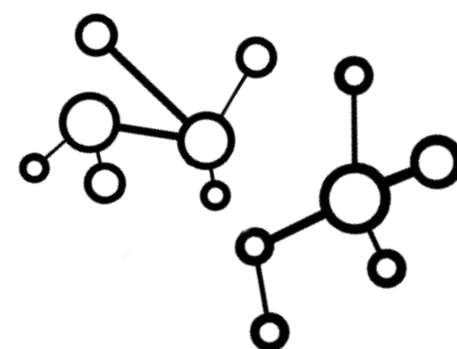
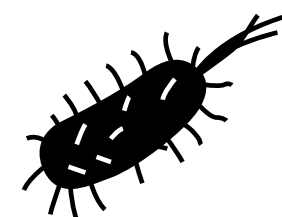
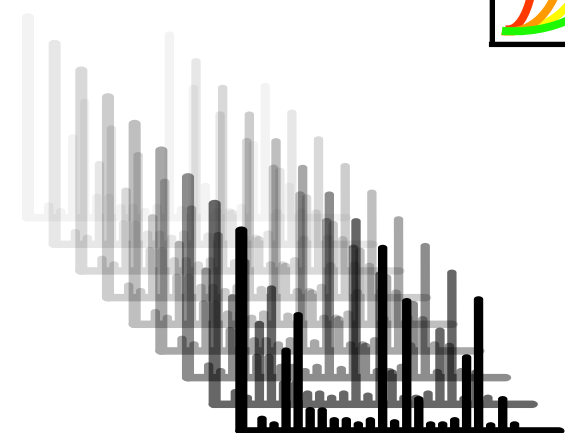
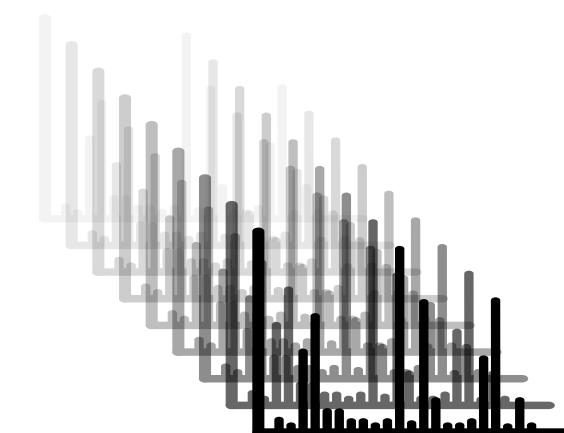
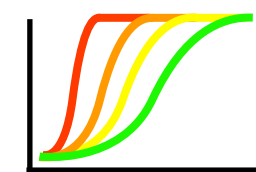
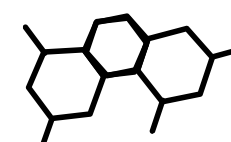
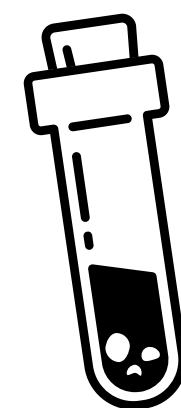
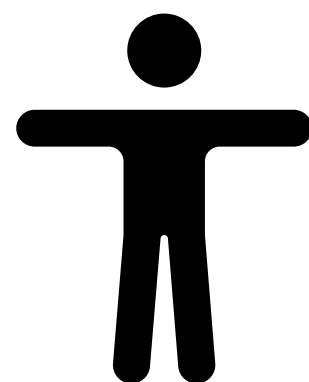
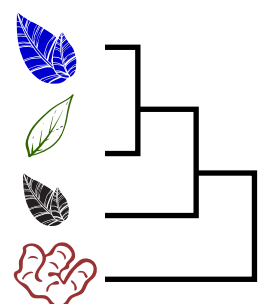
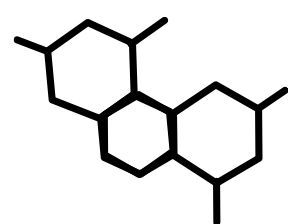
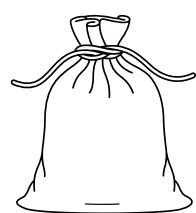
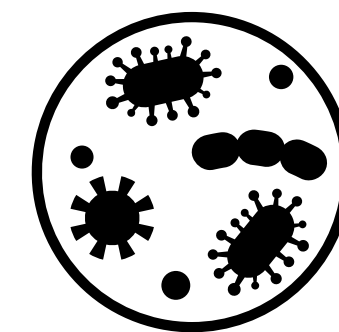
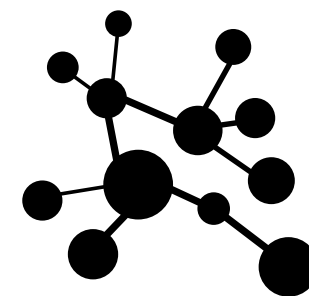
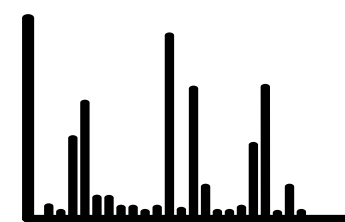
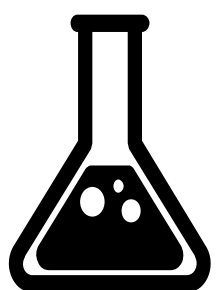
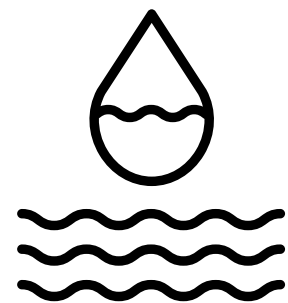




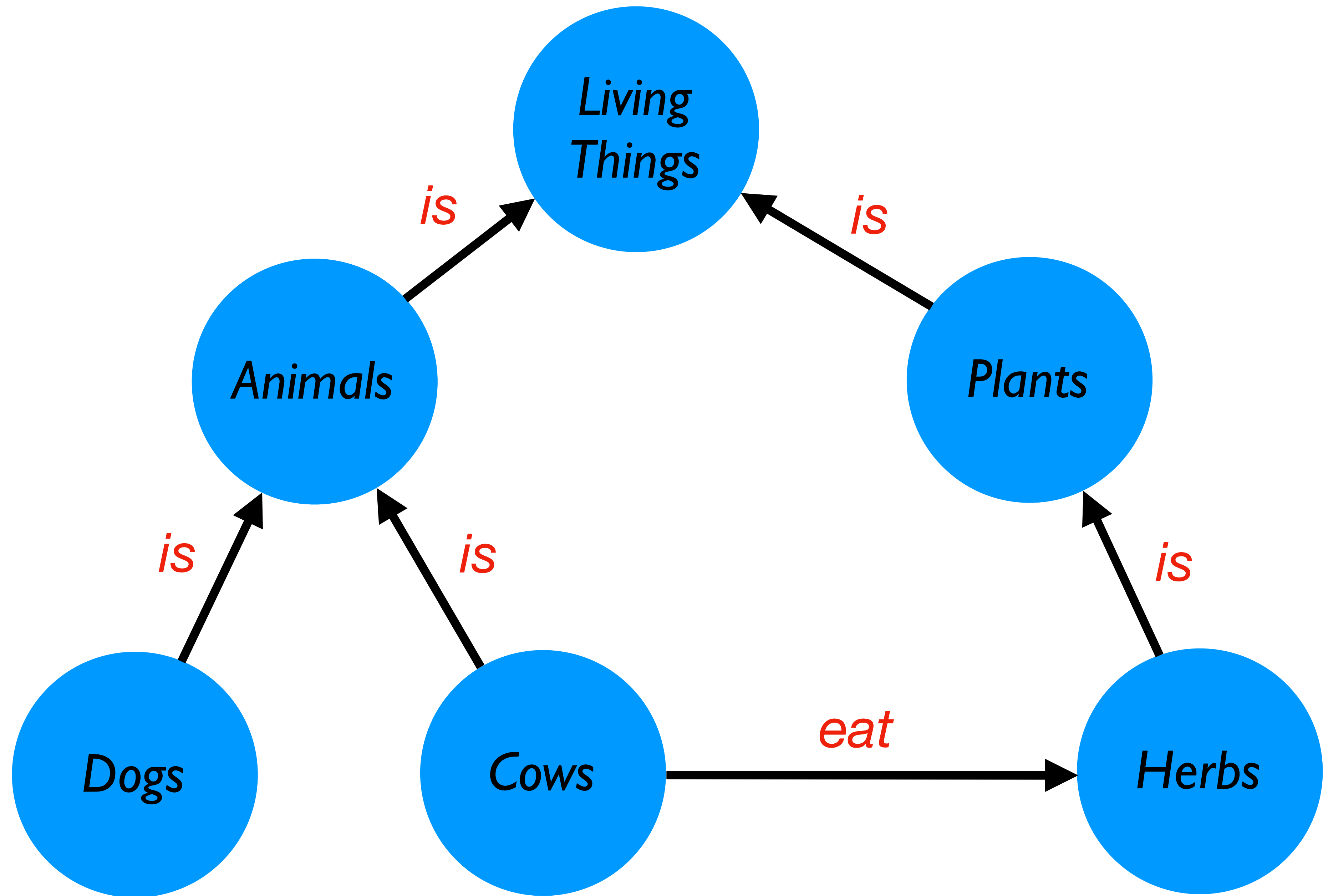


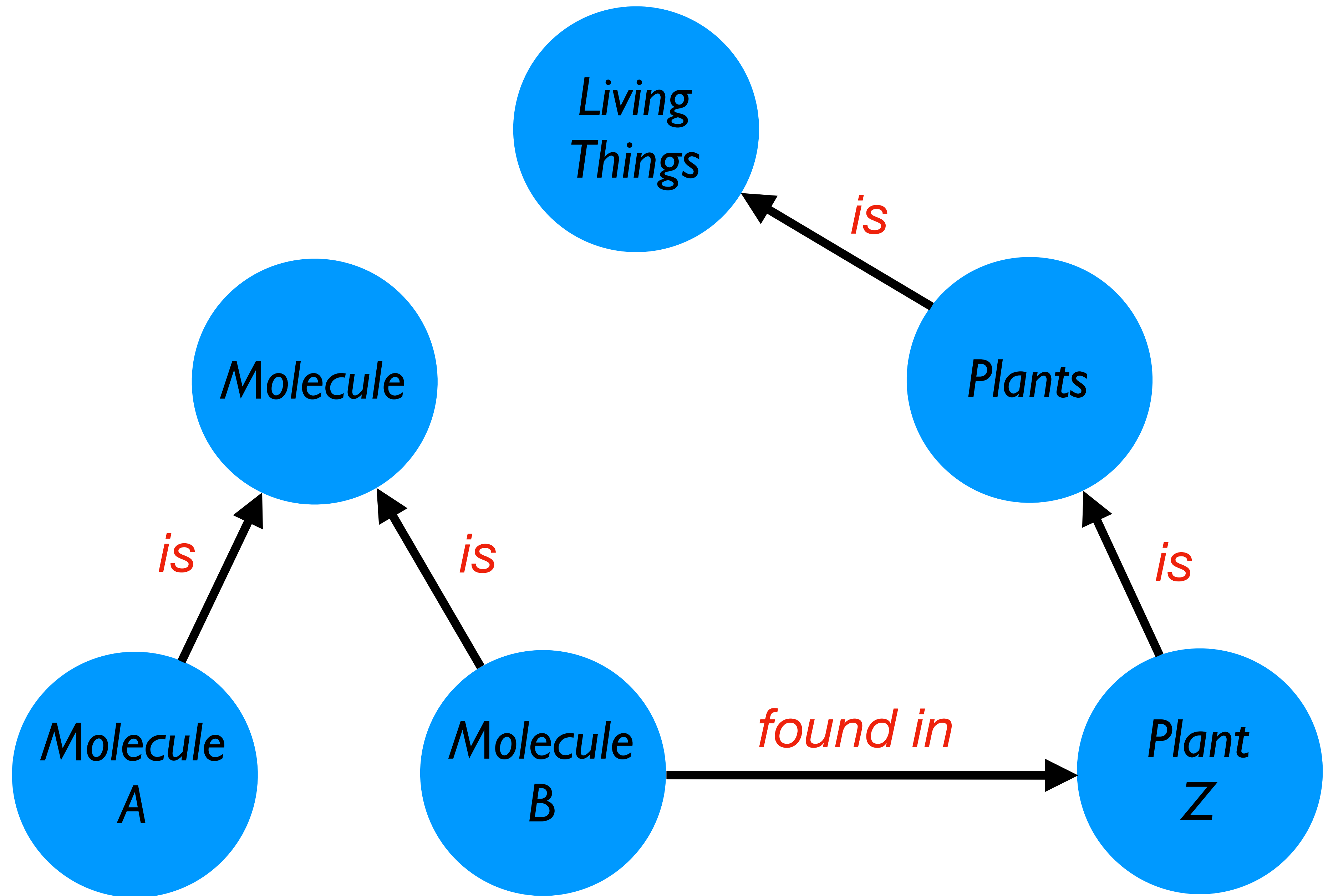


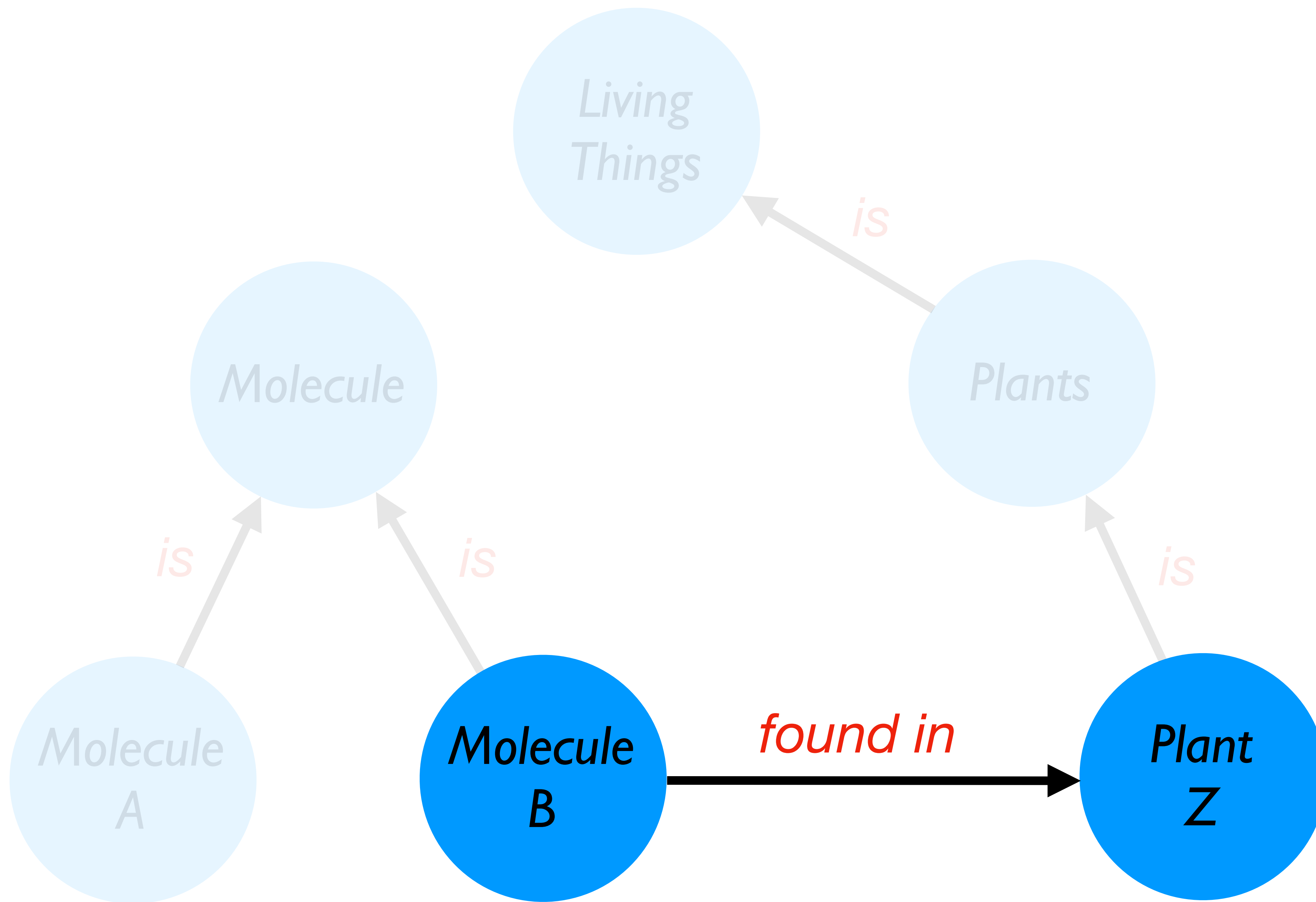


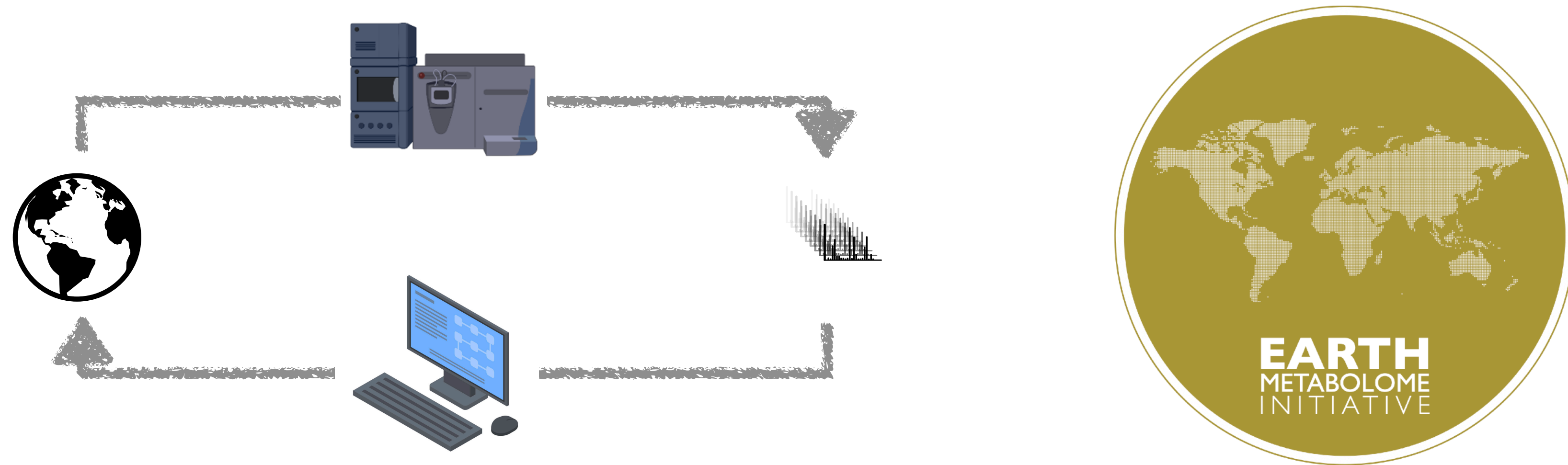


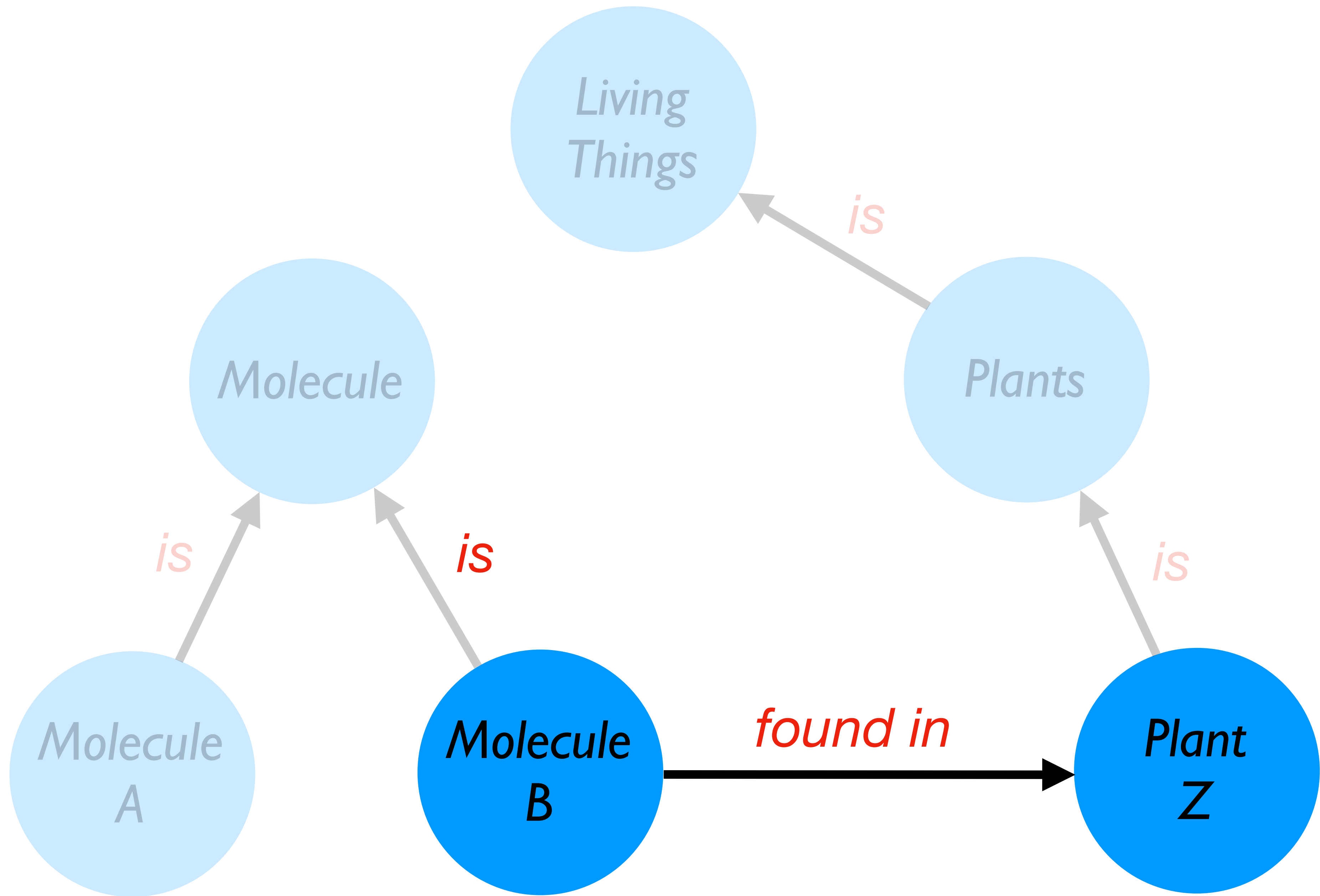


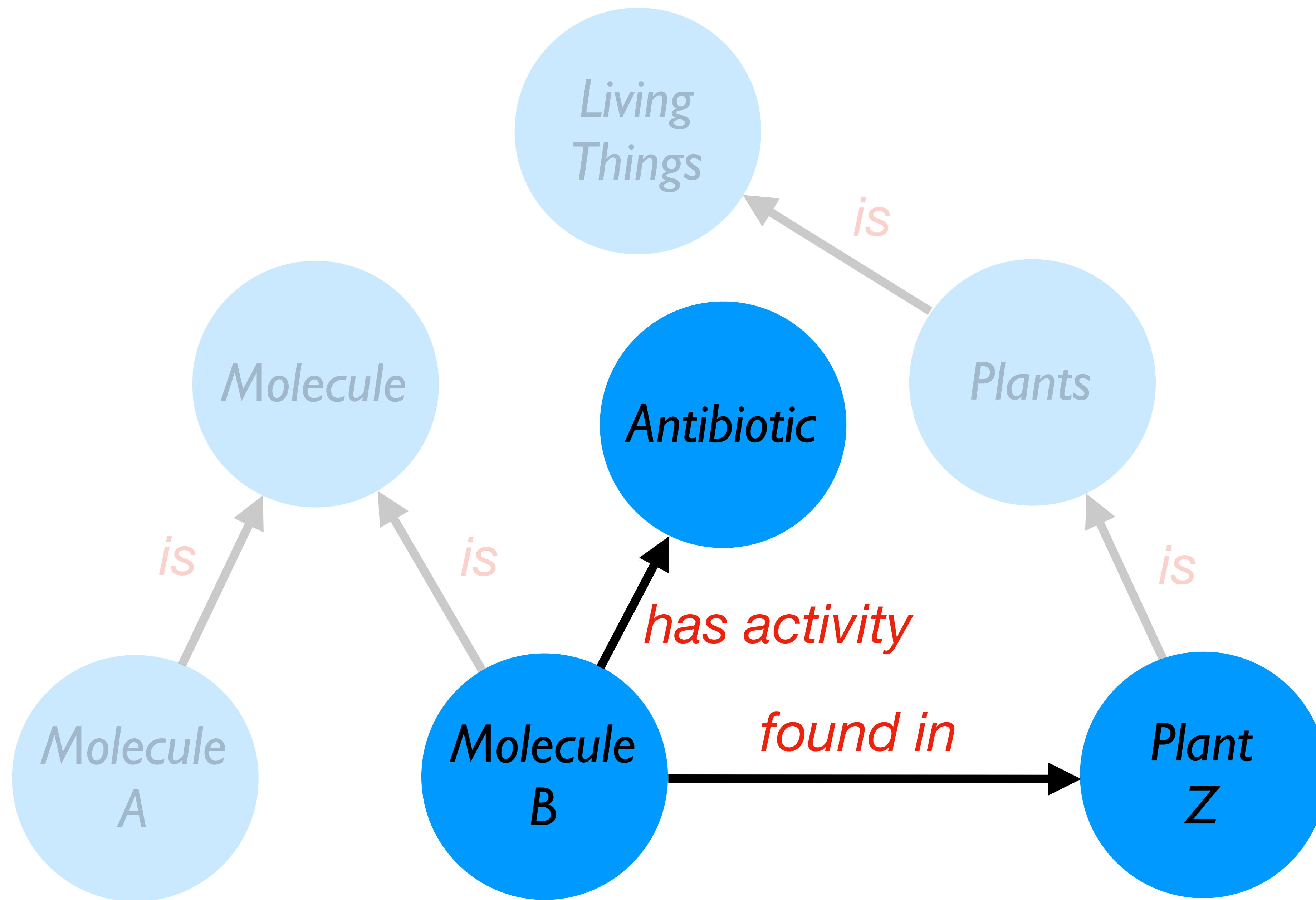


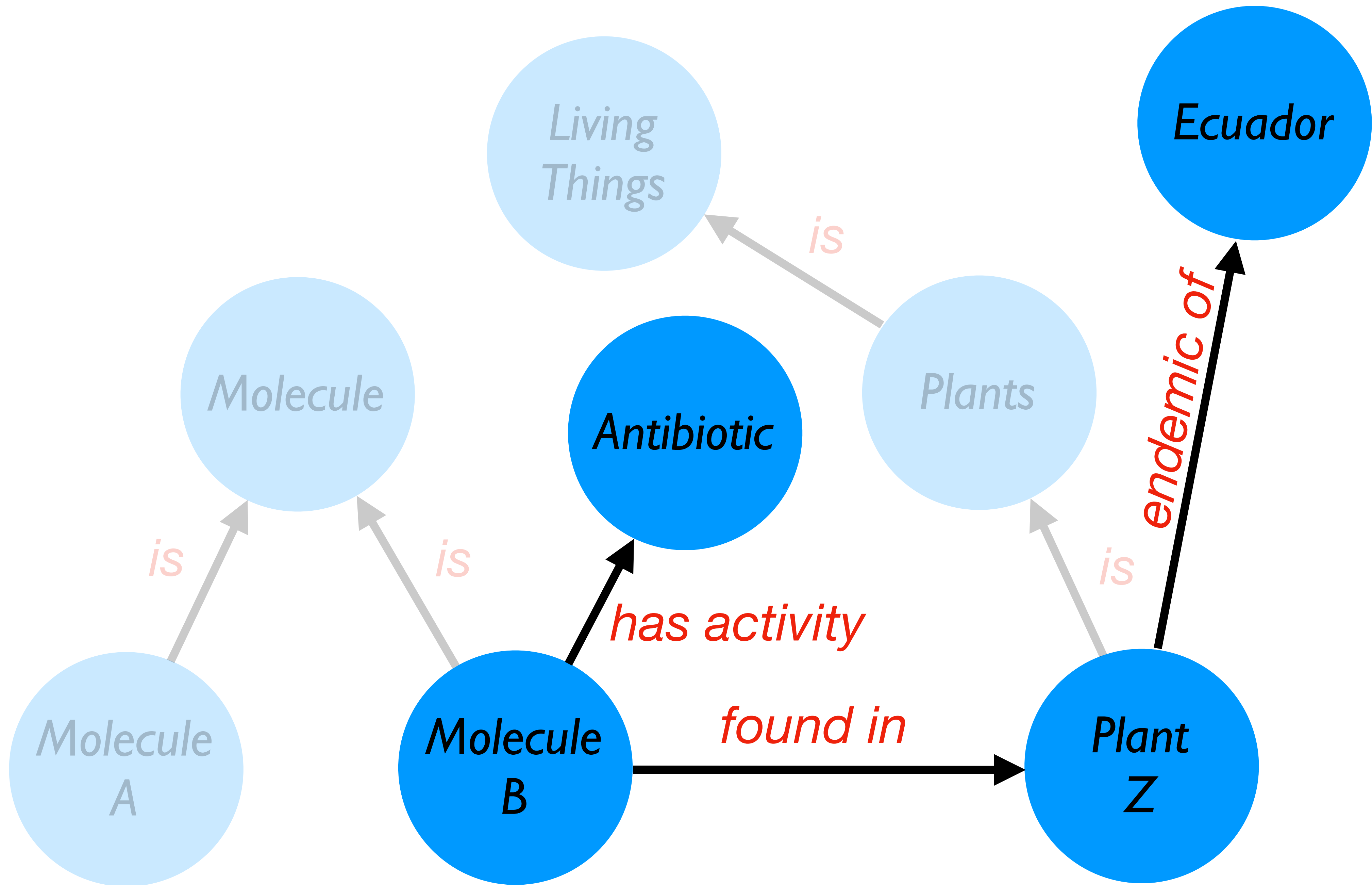


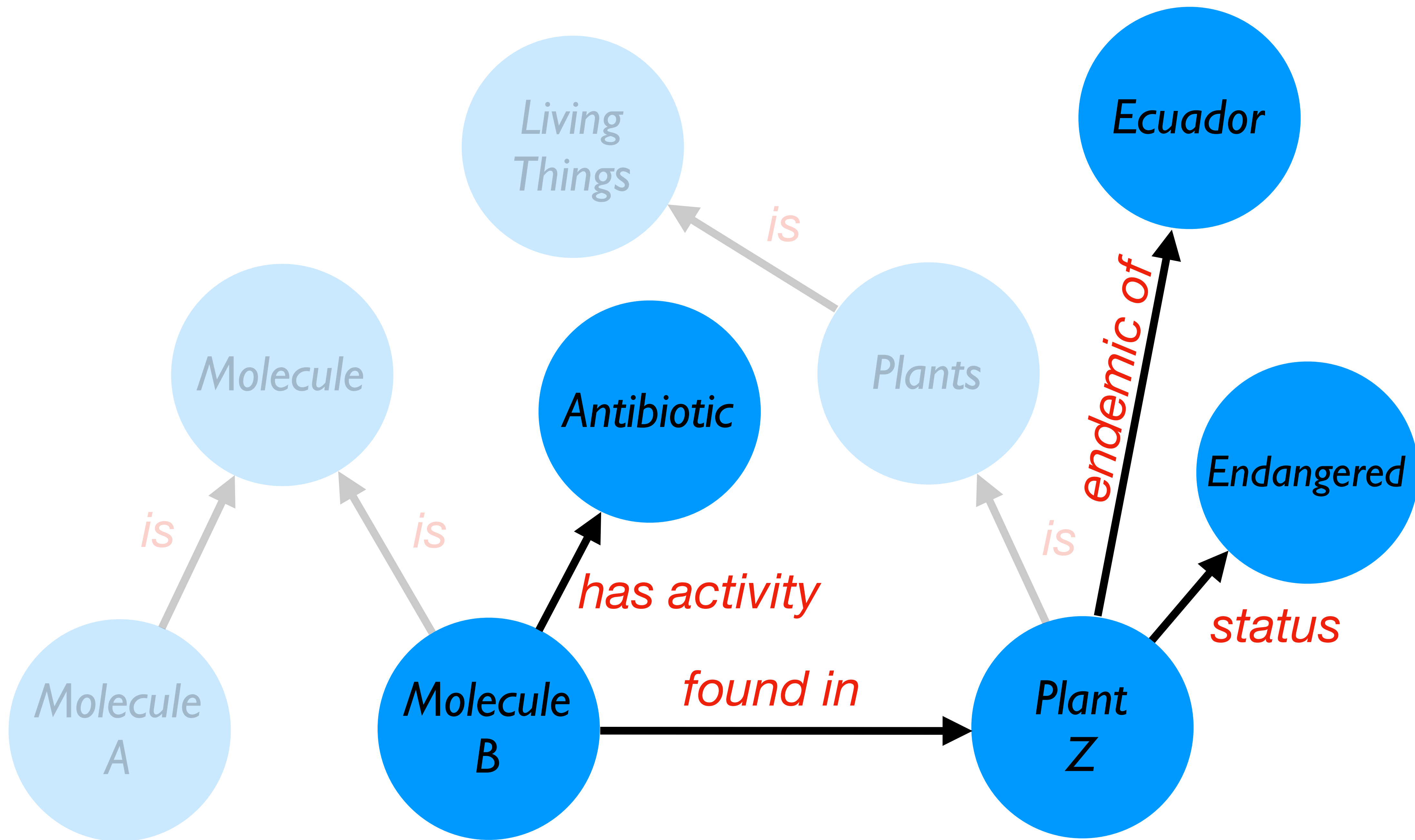


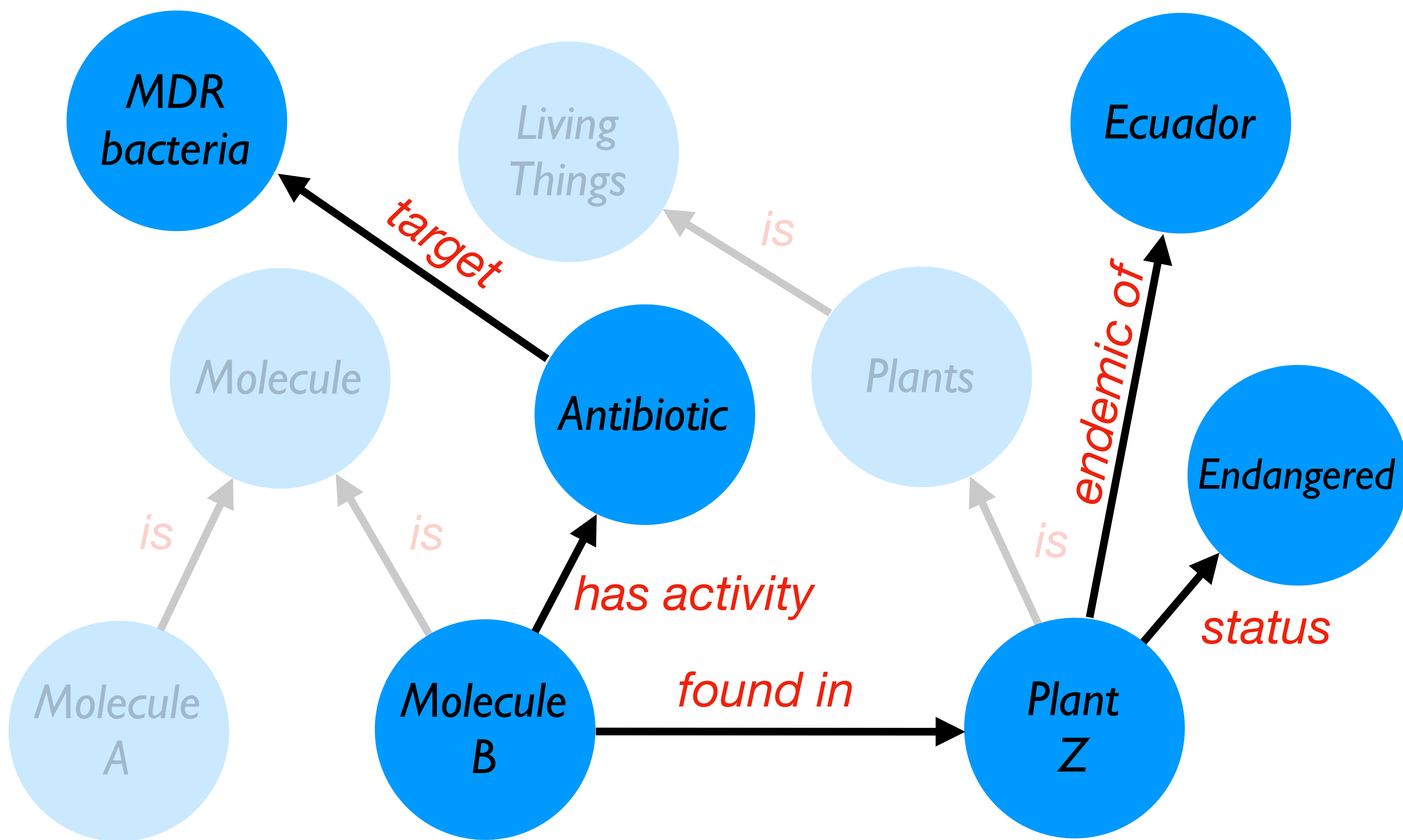


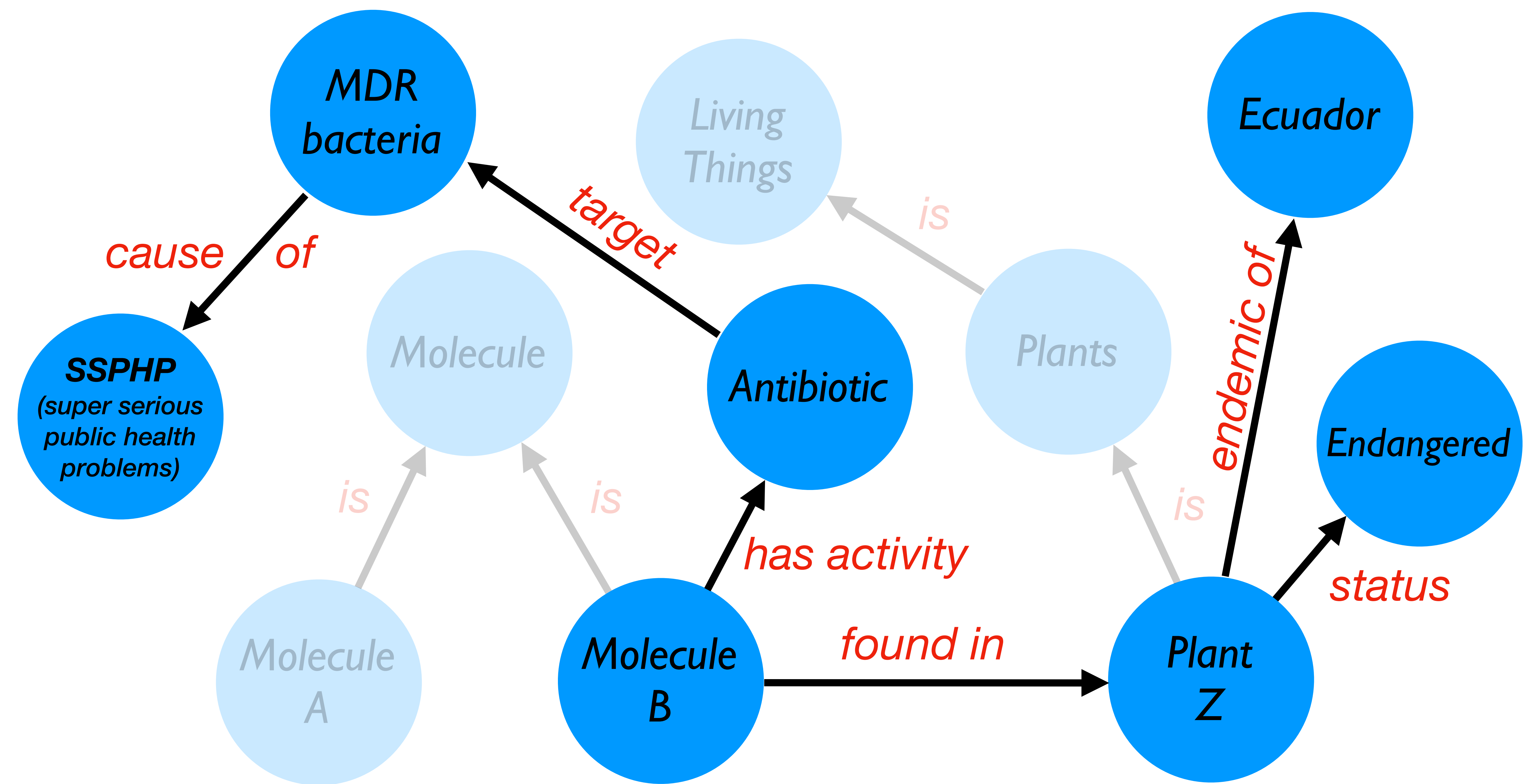












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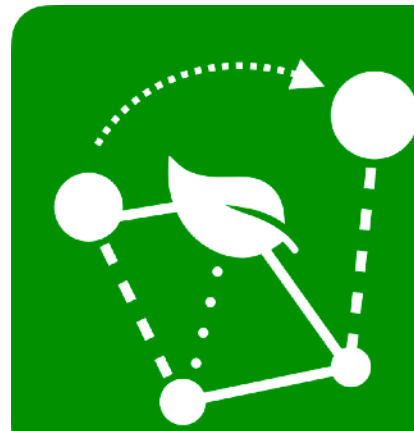


Article Recommendations



Supporting Information

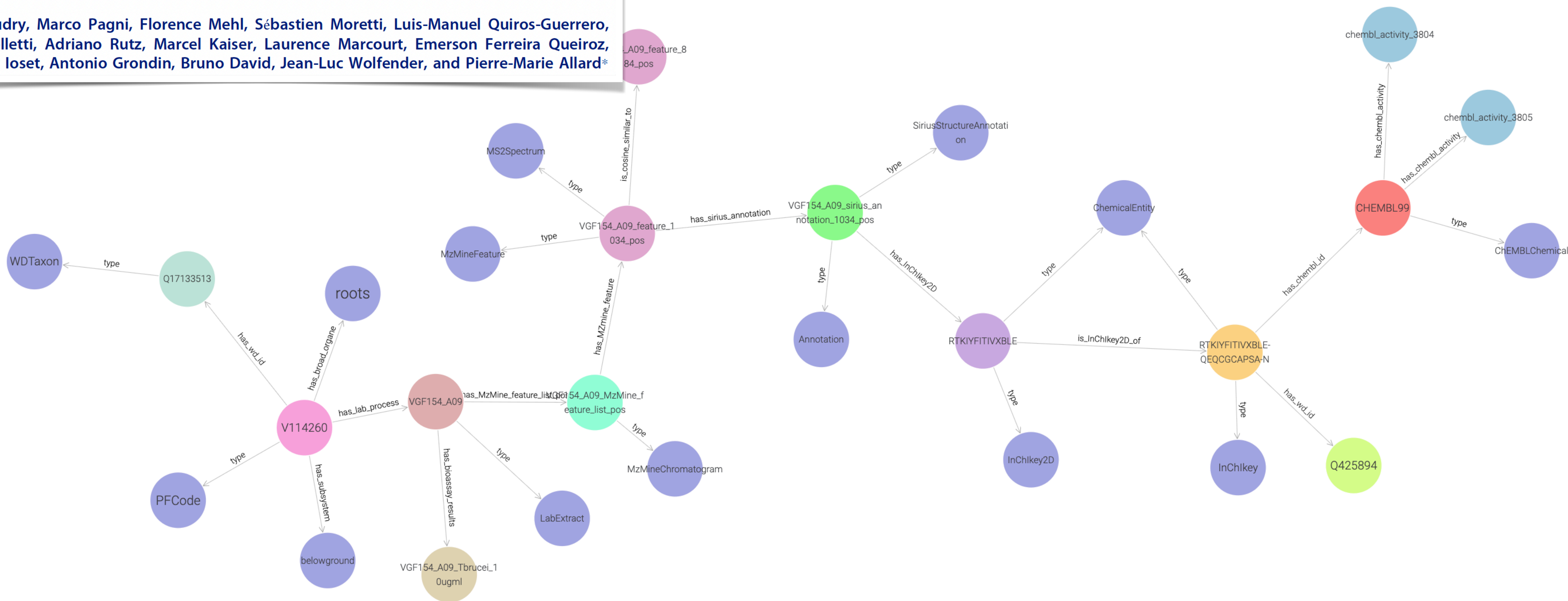
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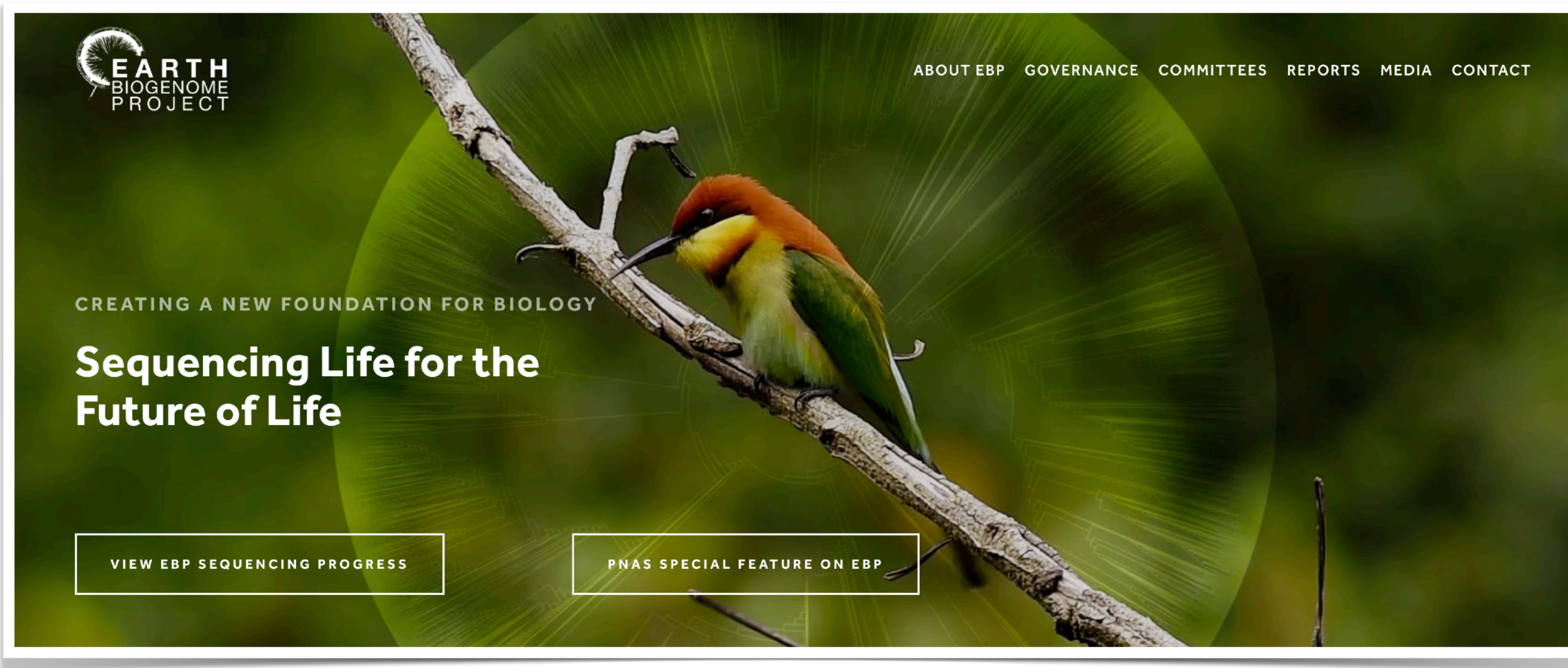
Experimental Natural Products KnowledgeGraph

<https://enpkg.commonslab.org/graphdb/>

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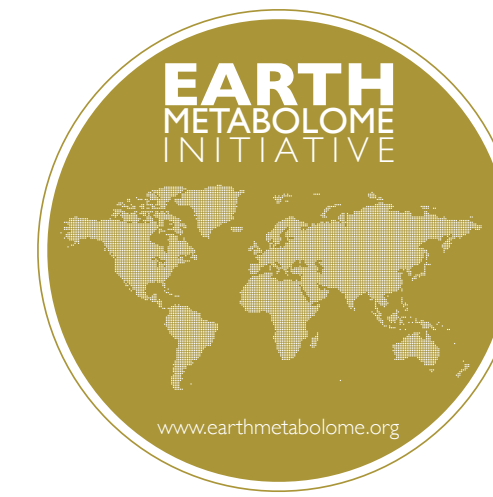
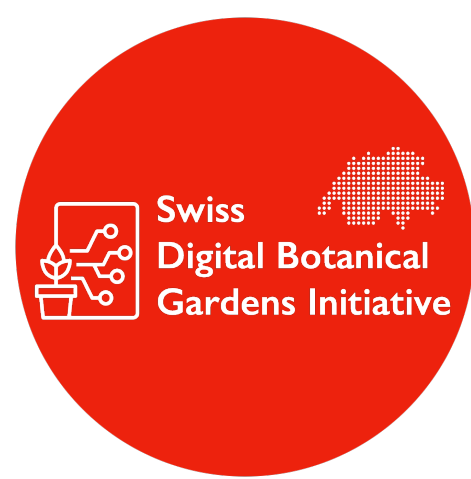






































































































































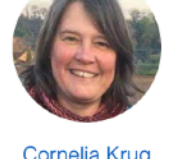

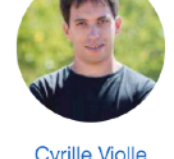

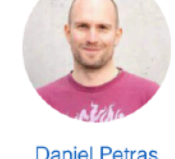













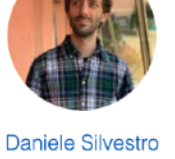

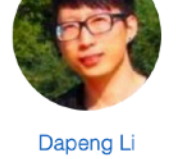





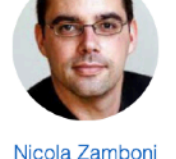









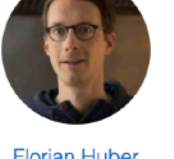

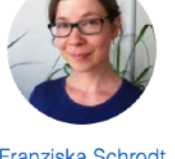





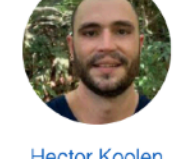

























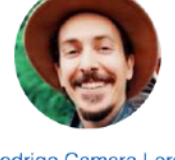



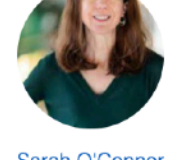

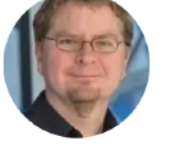









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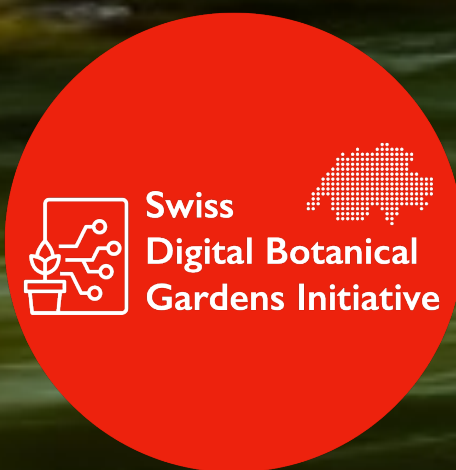
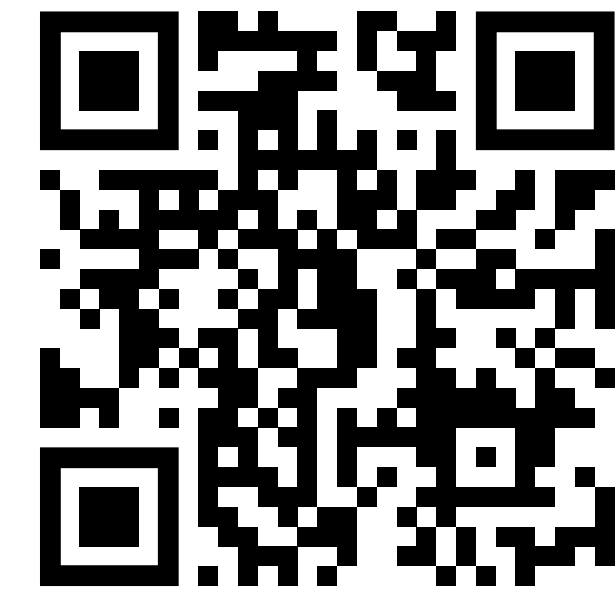
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