Living Technologies for Ecological Problems

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National Academy of Sciences

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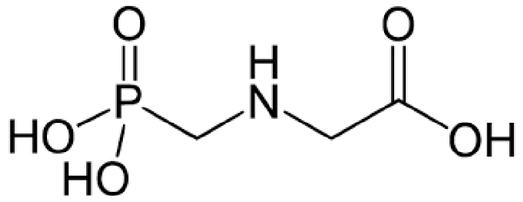
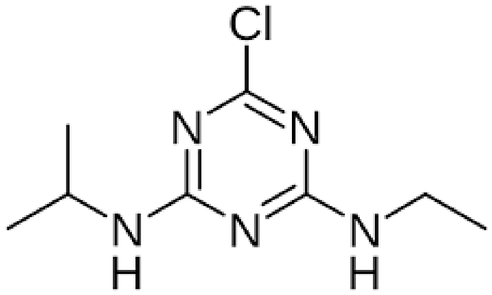
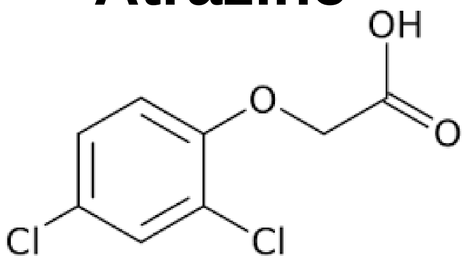
sculpting evolution



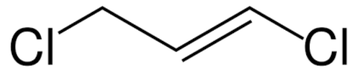
Glyphosate



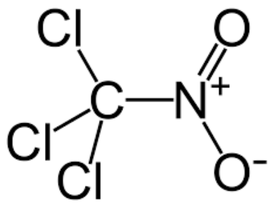
Atrazine



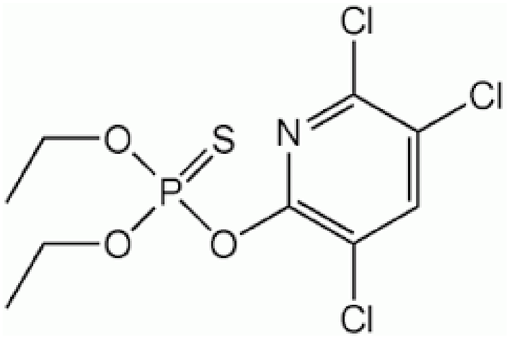
2,4-D



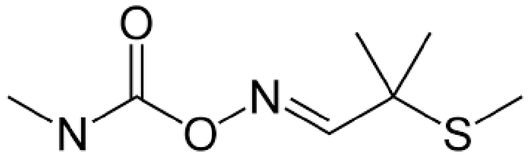
Dichloropropene



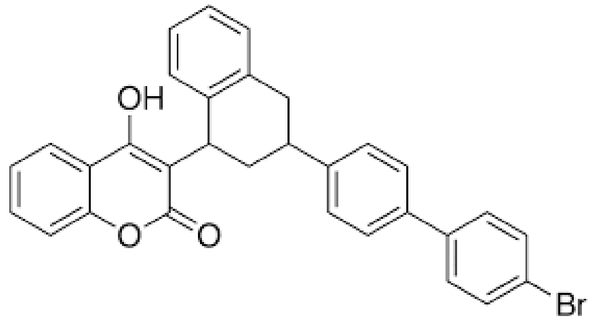
Chloropicrin



Chlorpyrifos



Aldicarb



Brodifacoum

Imagine a world that solves ecological problems using biology…

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Preventing Tick-Borne Disease

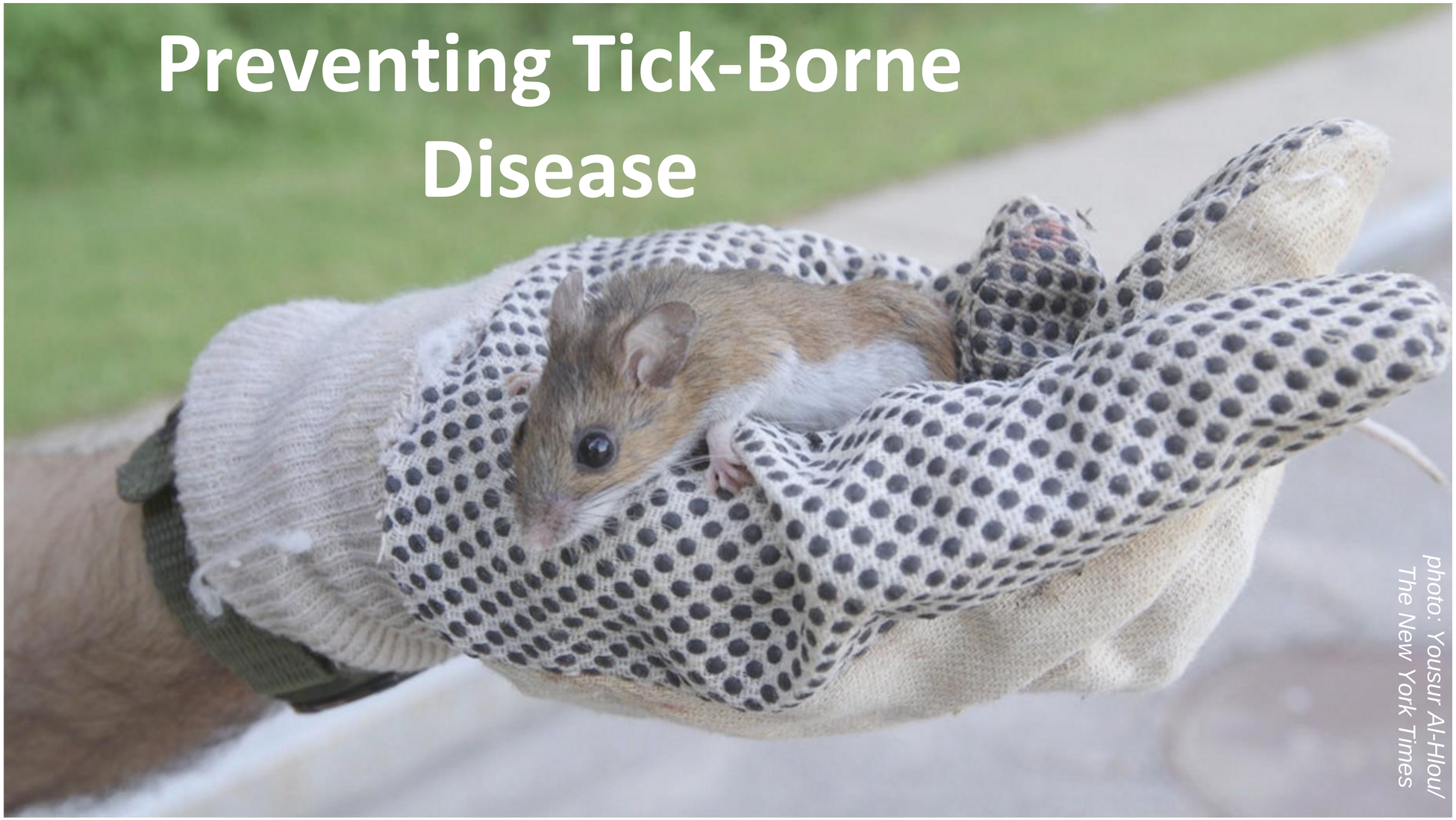

photo: Yousur Al-Hlou/ The New York Times

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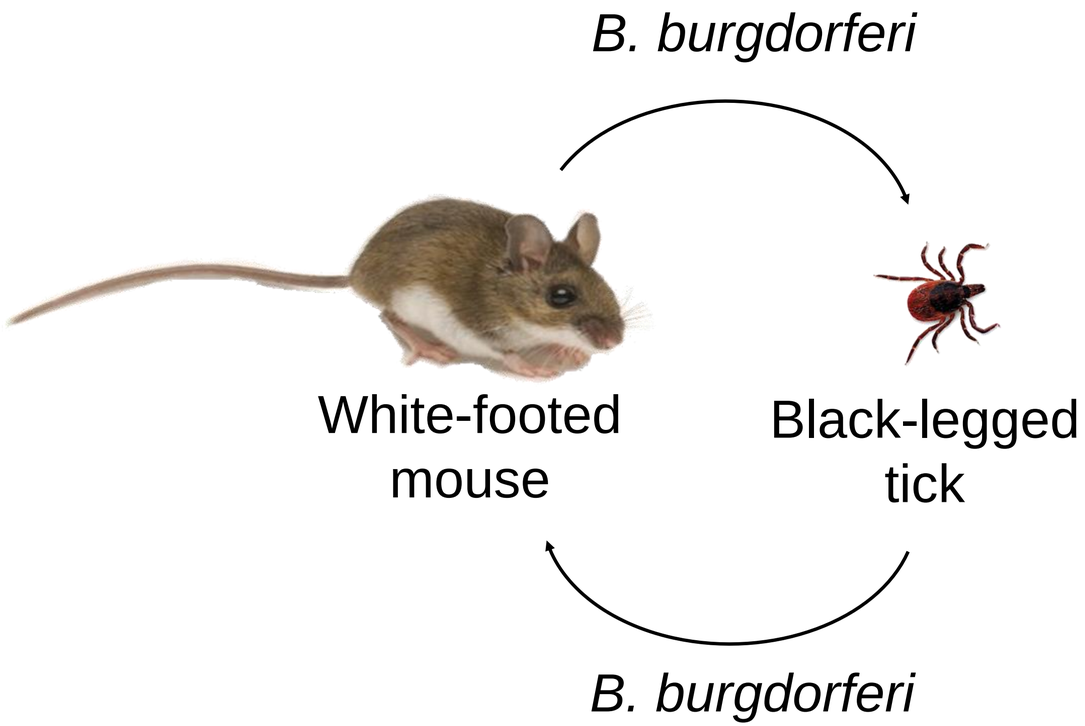
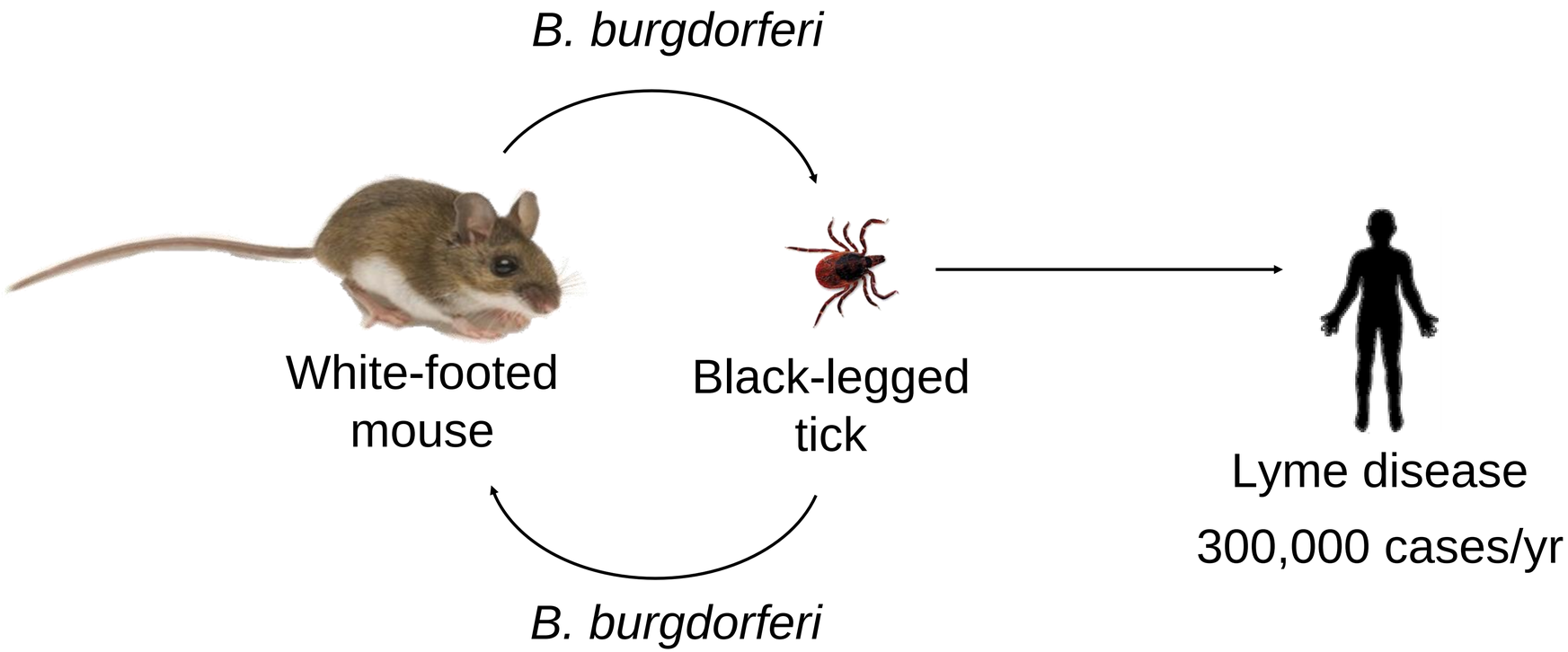
Tick-borne disease is an ecological problem



The spirochetes that cause Lyme disease persist by moving between mice and ticks

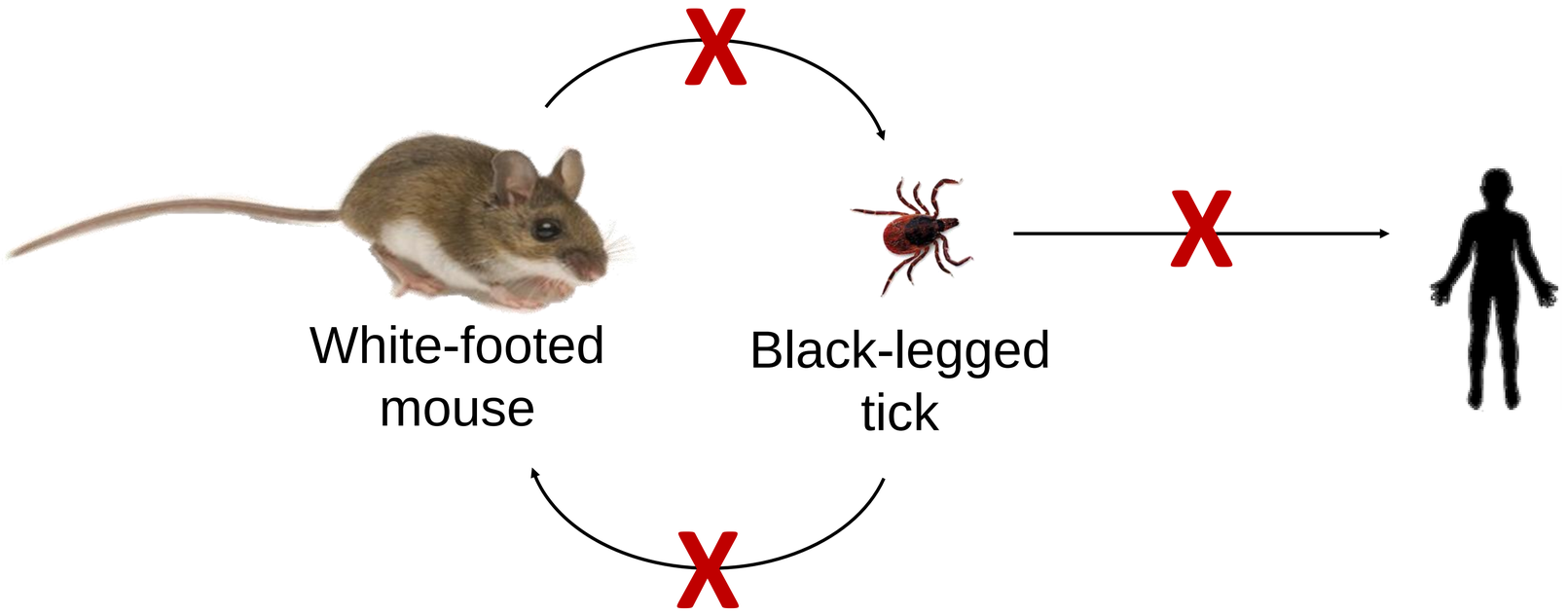
Tick-borne disease is an ecological problem



Ticks pass the spirochetes to humans, causing Lyme disease

(a similar cycle holds for other tick-borne diseases)

Tick-borne disease is an ecological problem



What if white-footed mice couldn’t become infected?

Ecological Vaccination

White-footed mice

What is the smallest possible change that can solve the problem?

Start local

Scale up if it works

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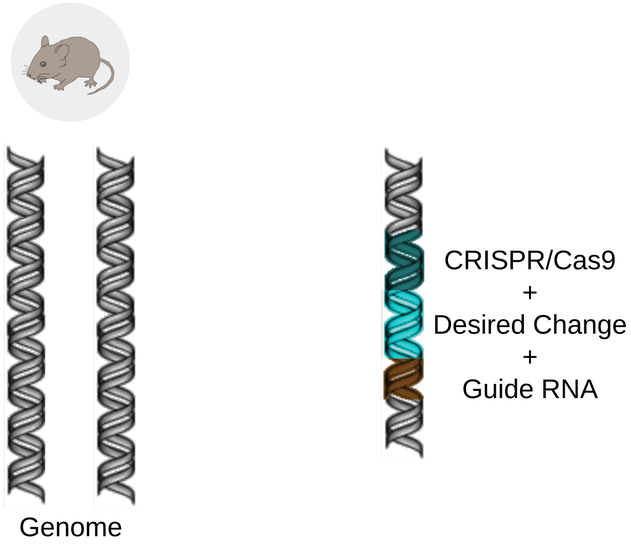
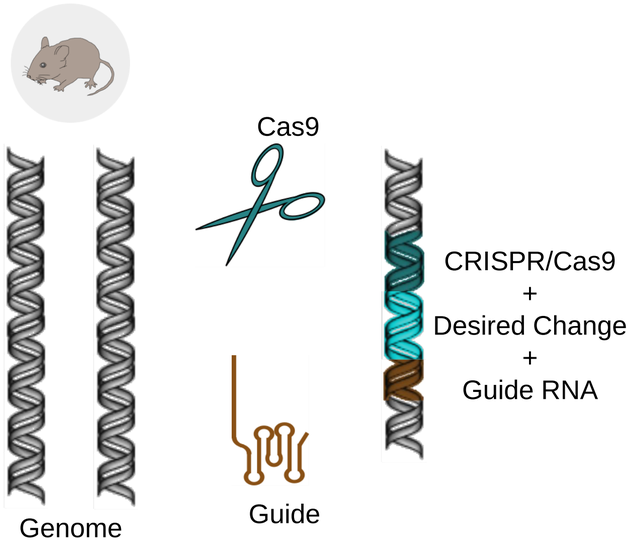
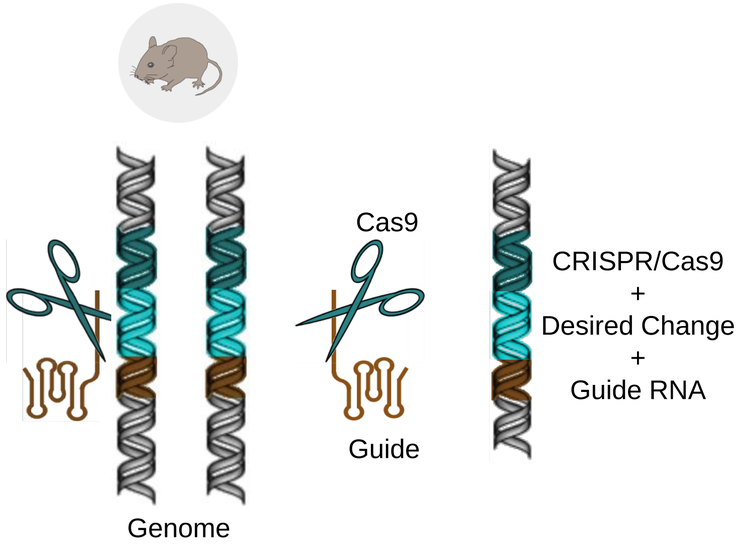
Global Gene Drive



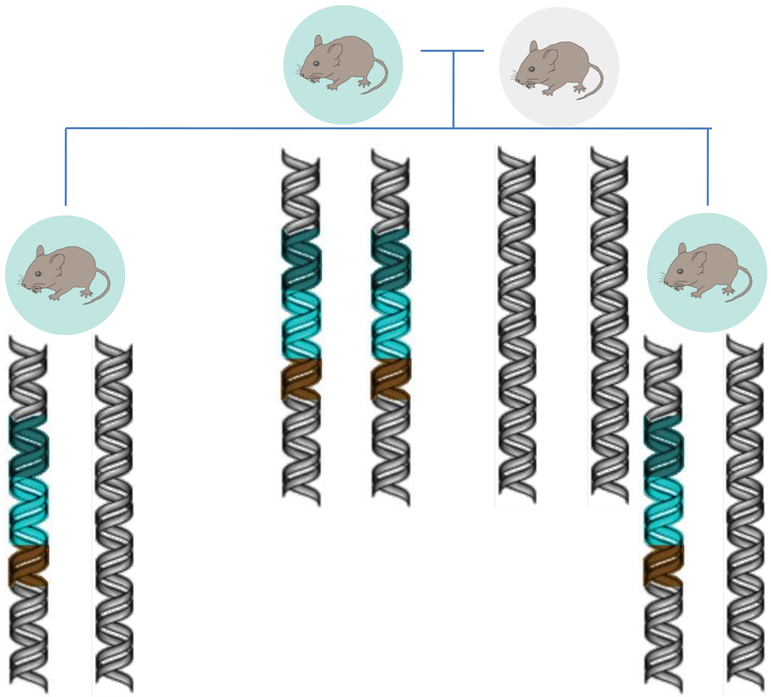
Global Gene Drive



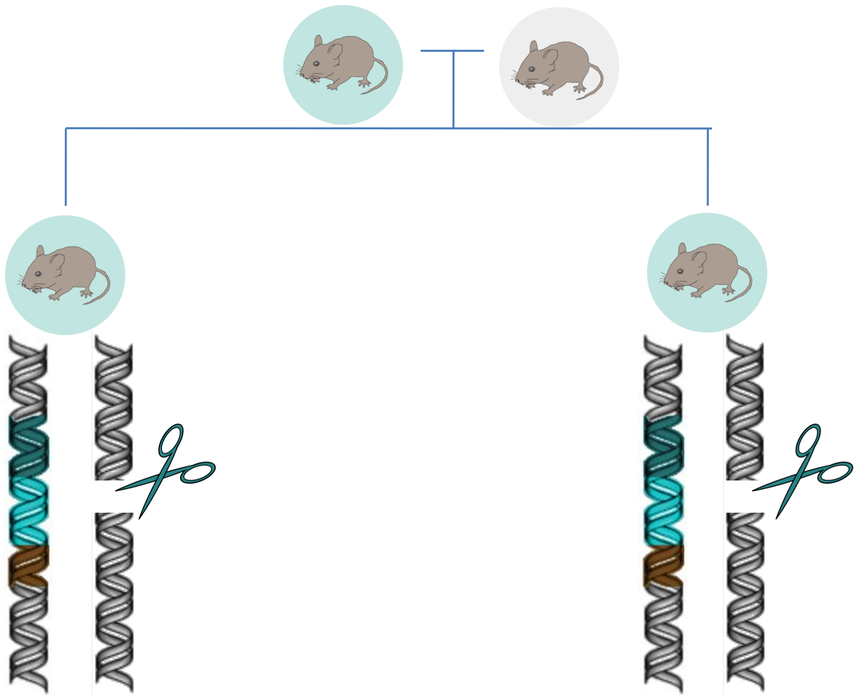
Global Gene Drive



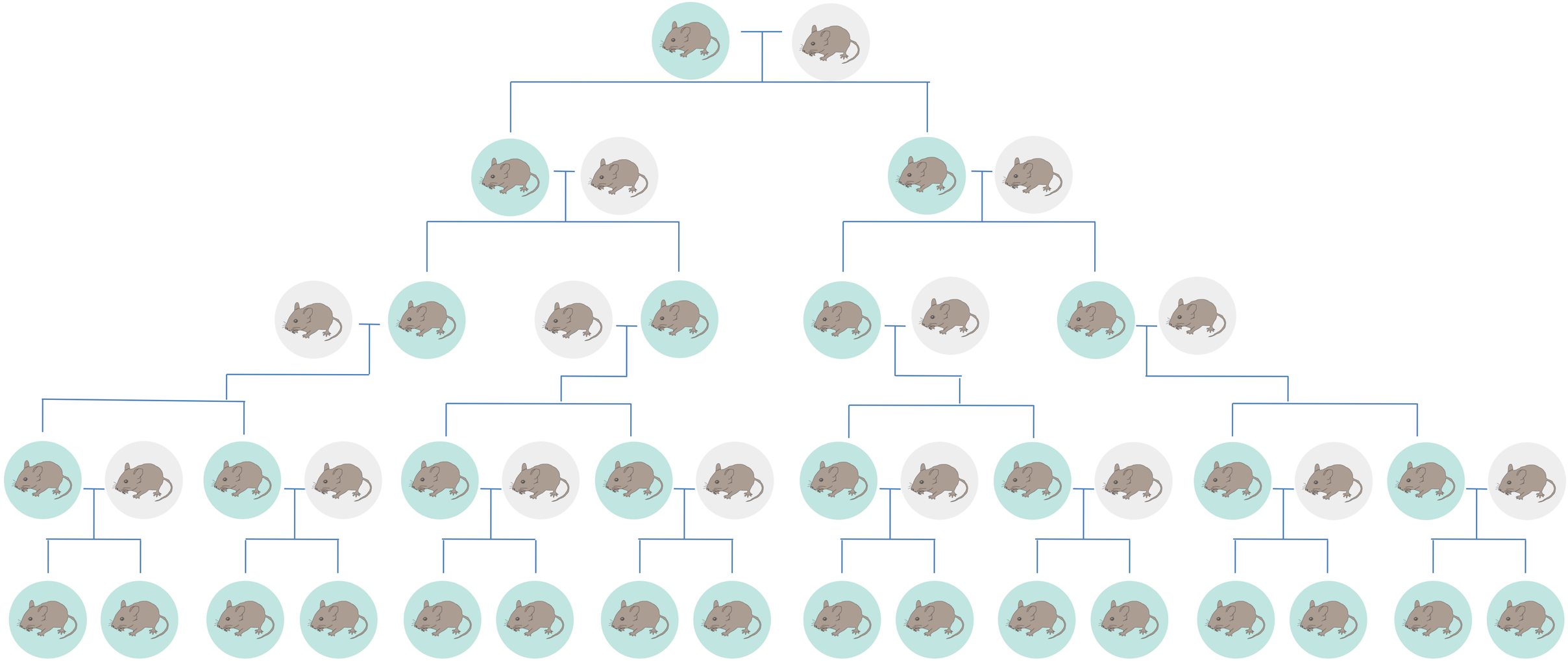
Global Gene Drive



Global Gene Drive



Global Gene Drive



What is the smallest possible change that can solve the problem?

Start local

Scale up if it works

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How do you make a local CRISPR-based drive system?

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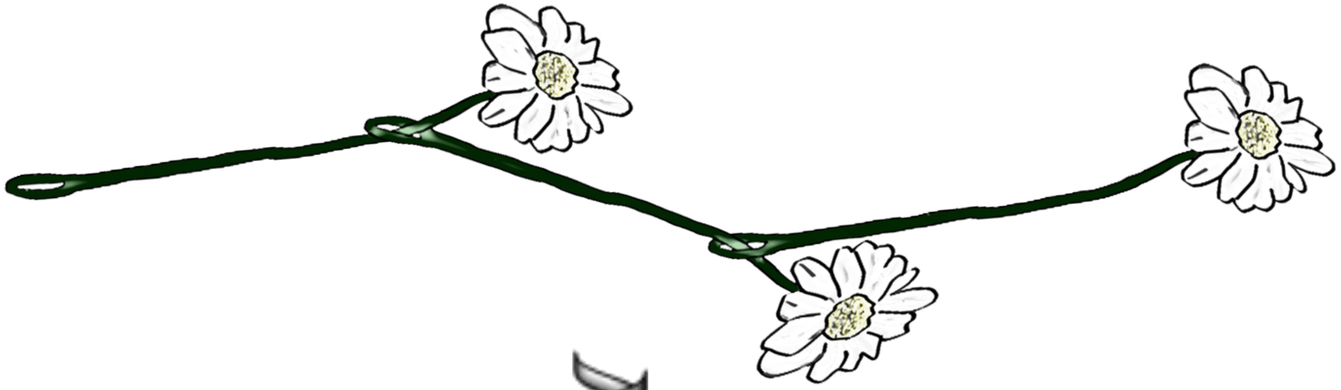
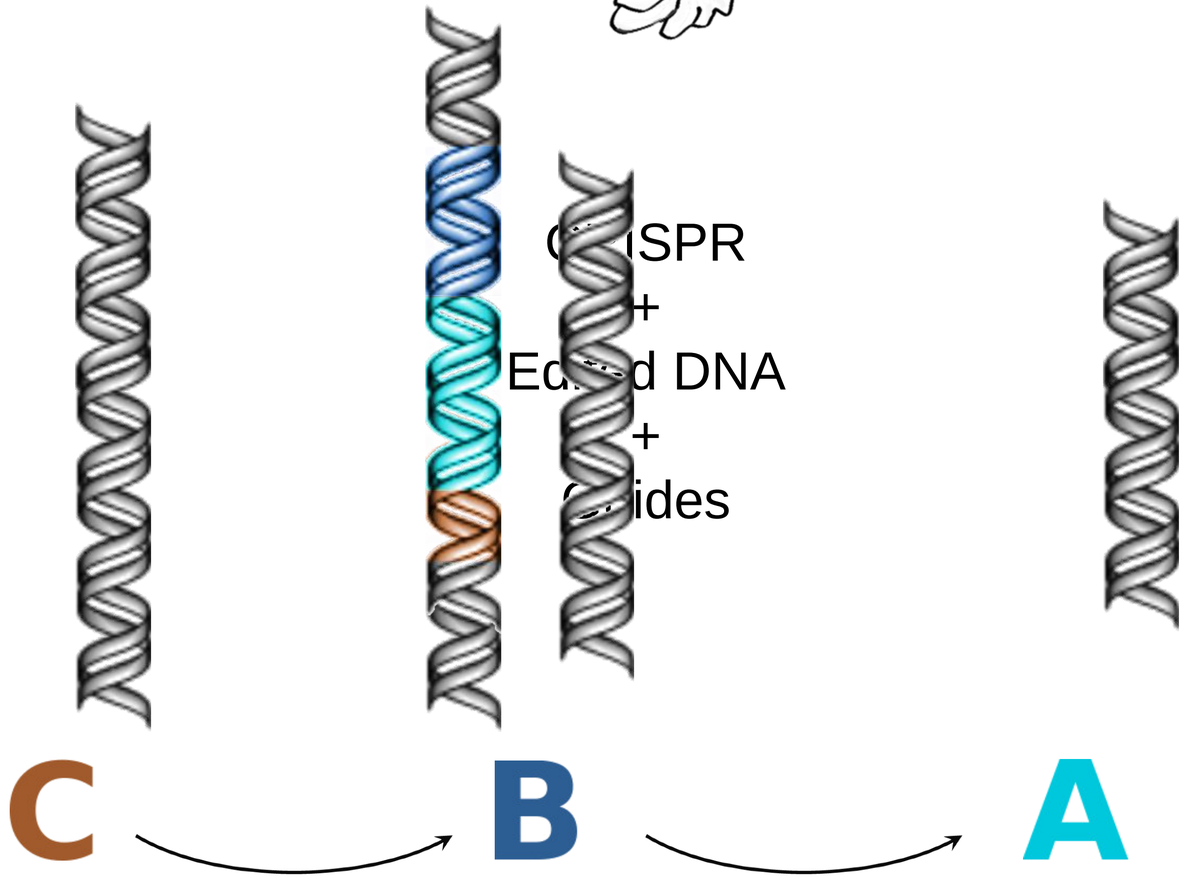
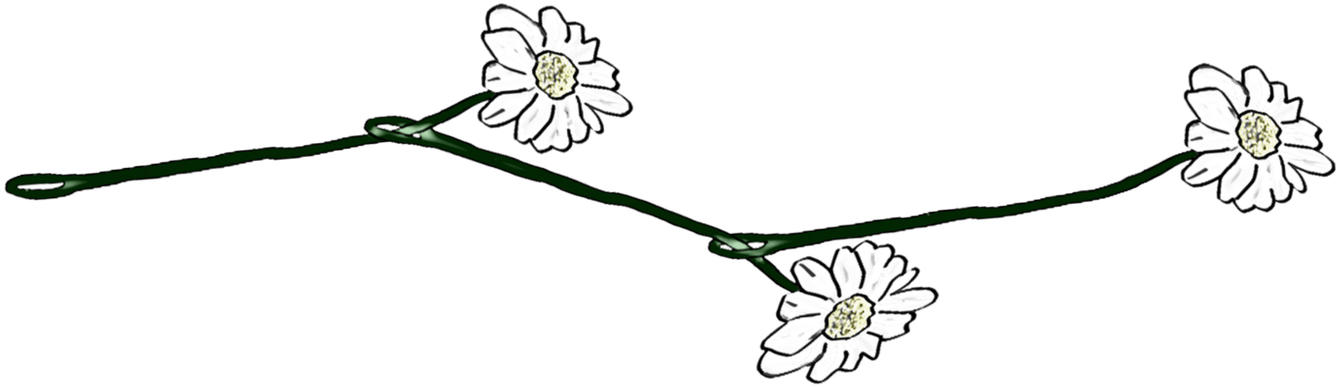
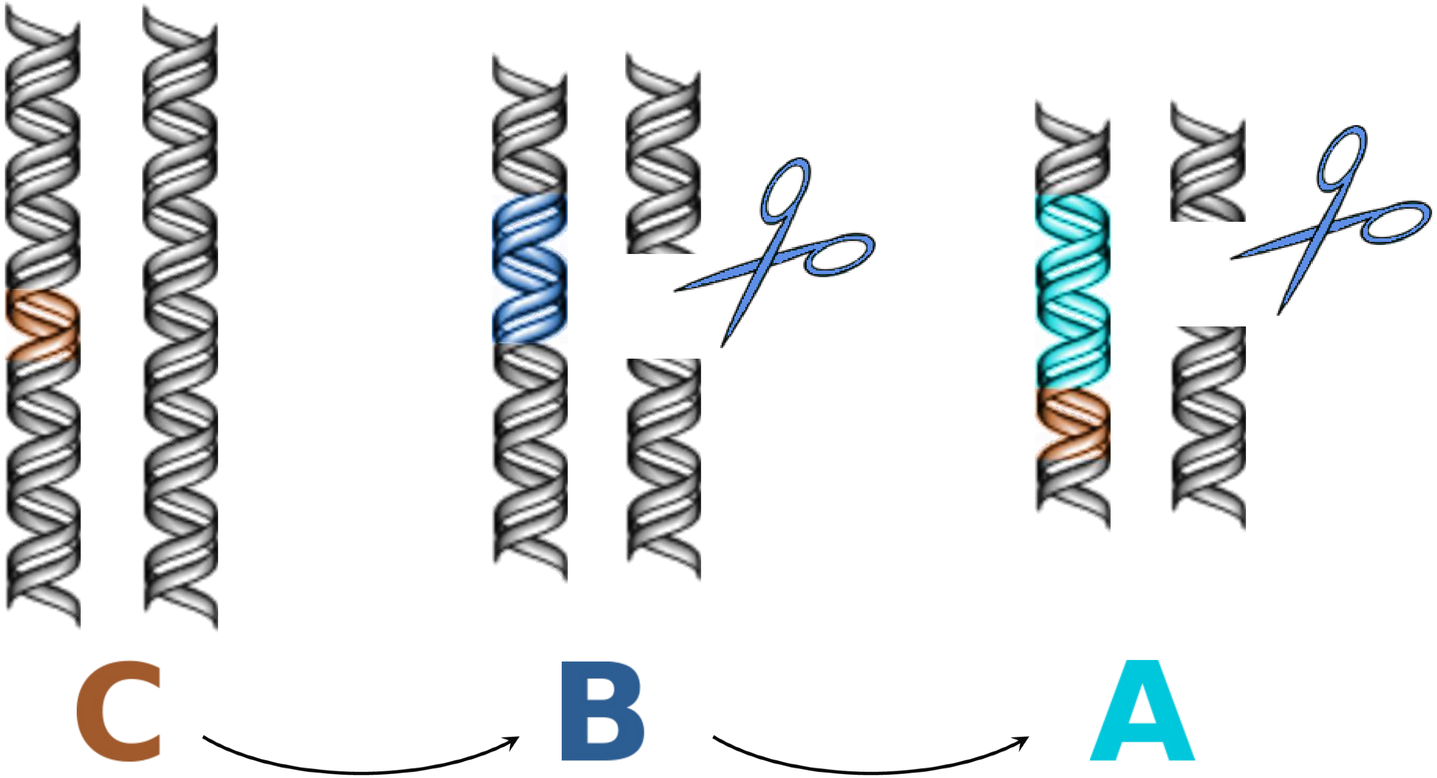
Daisy Drive



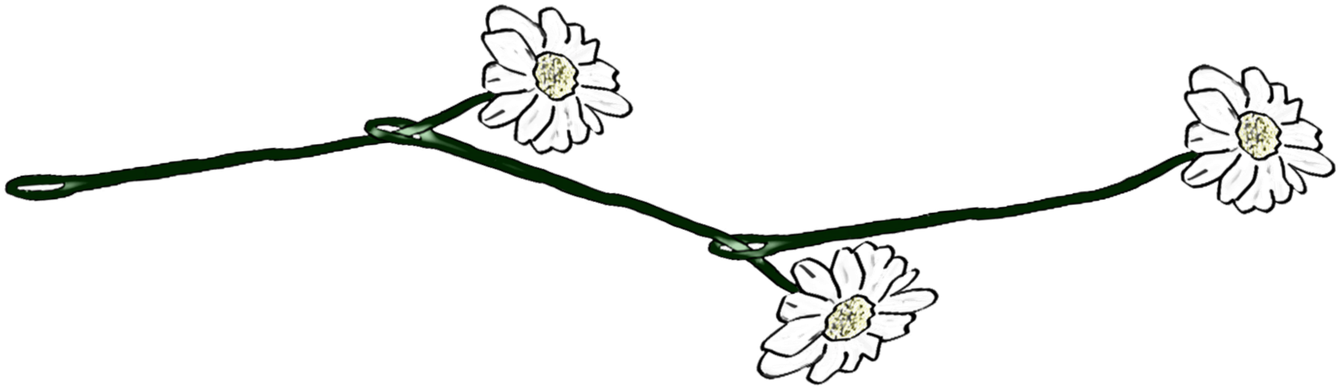


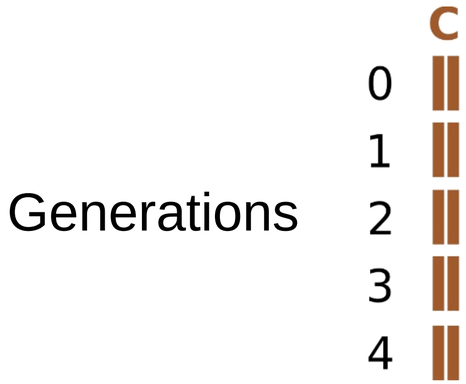
Daisy Drive





Daisy Drive





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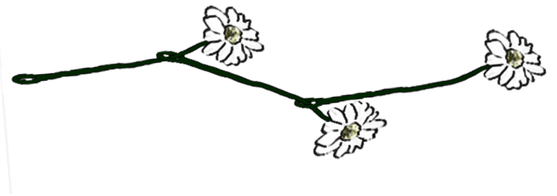
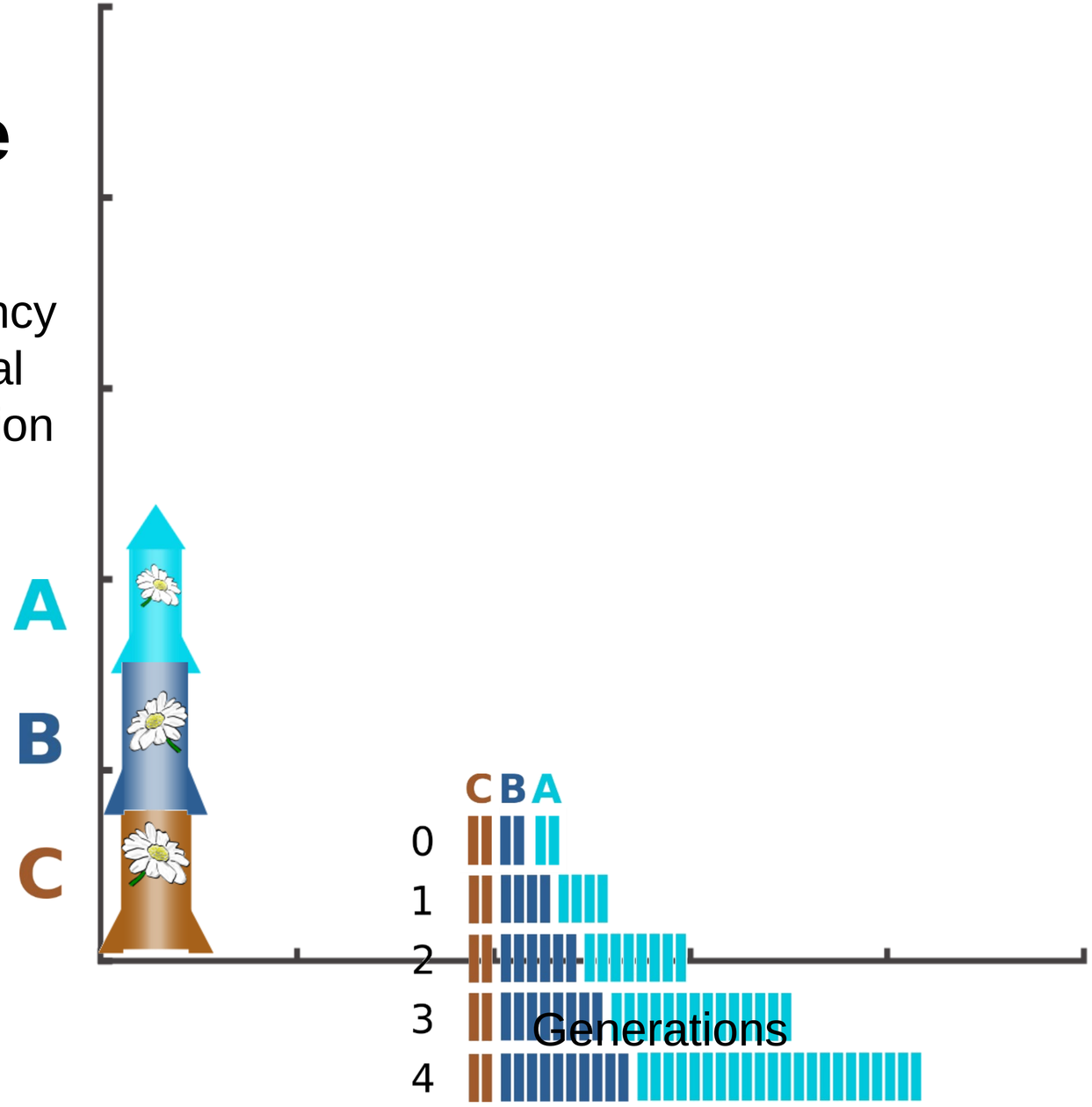
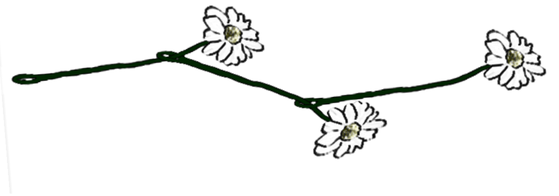
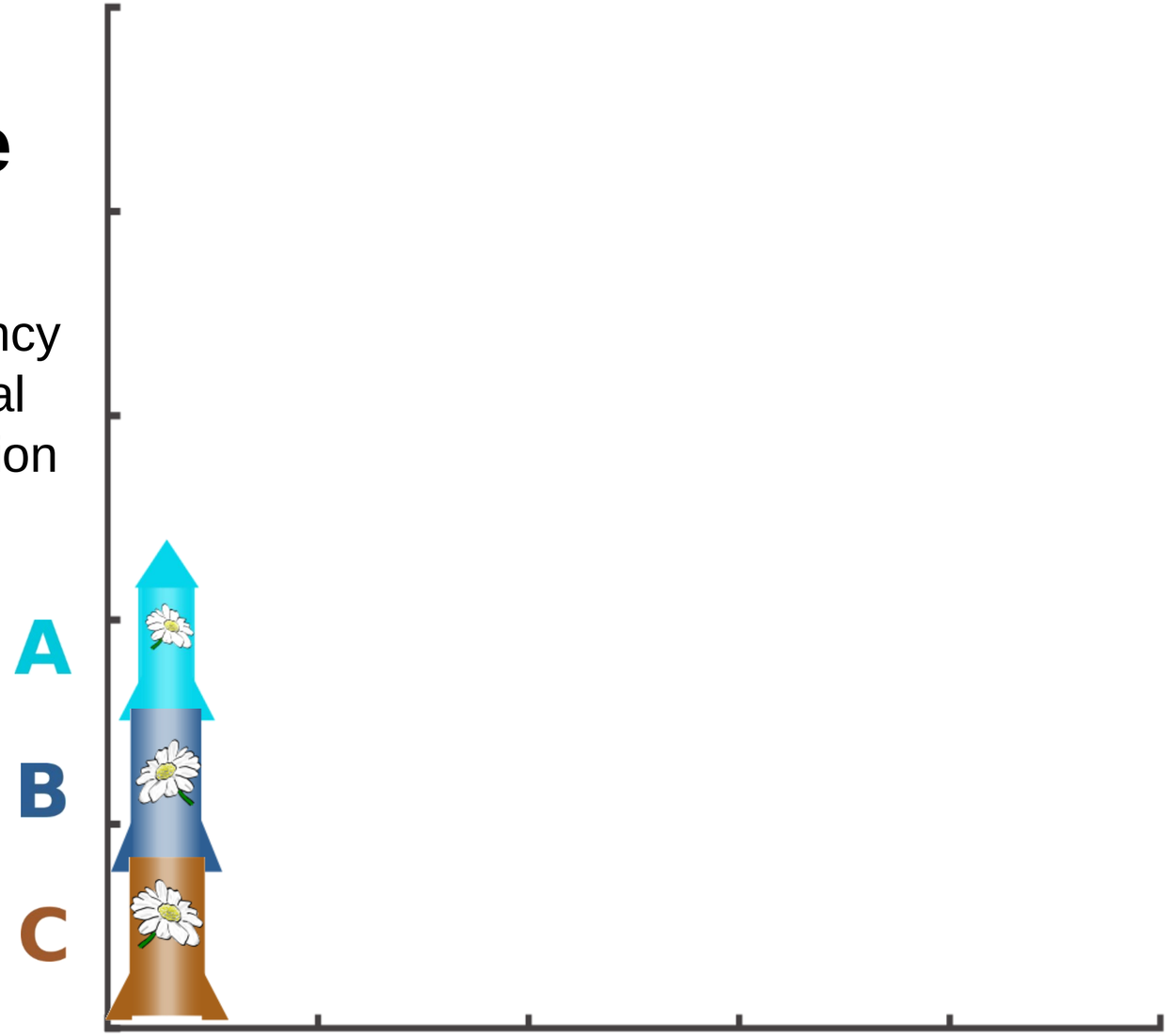




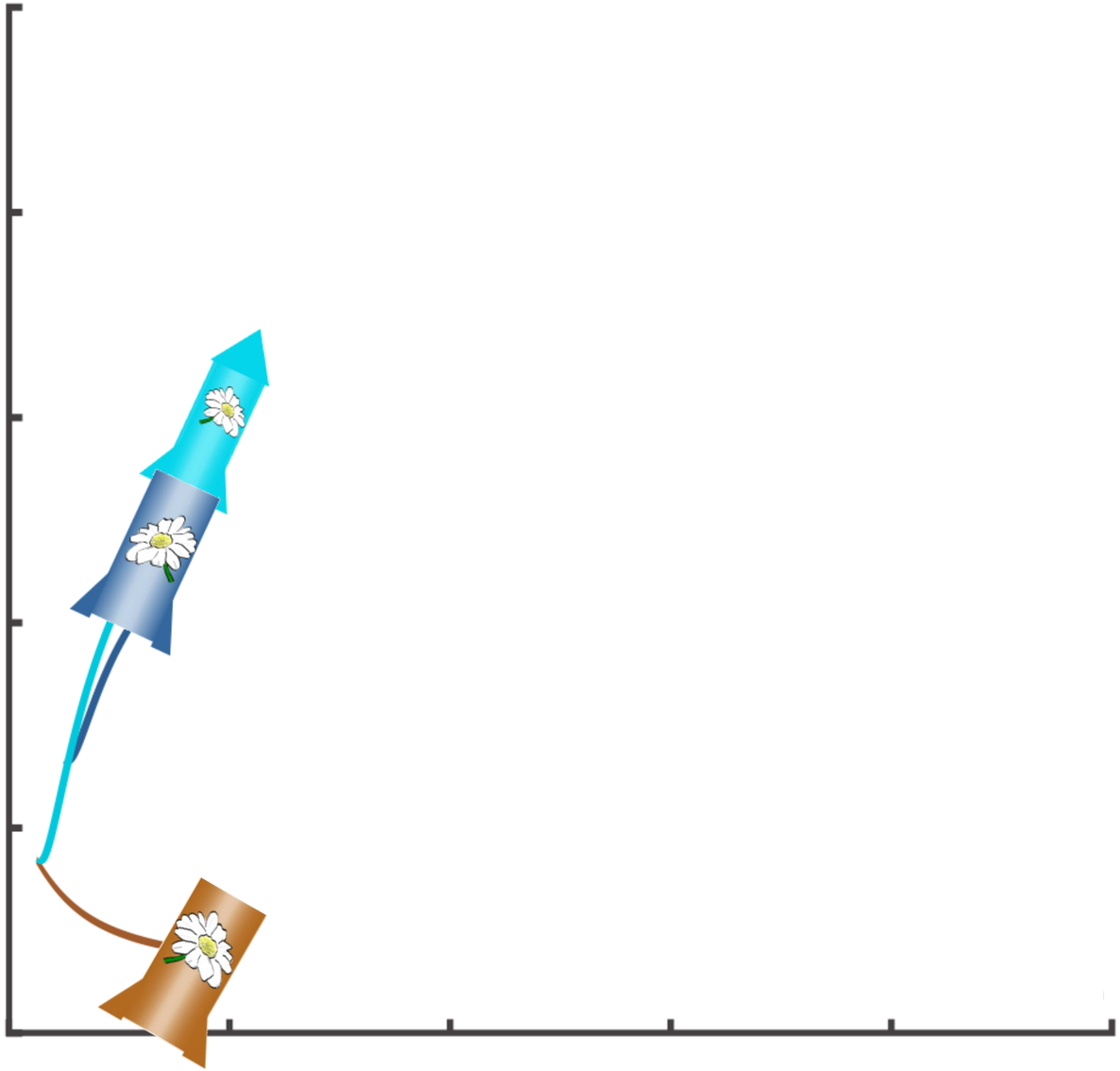
Daisy Drive



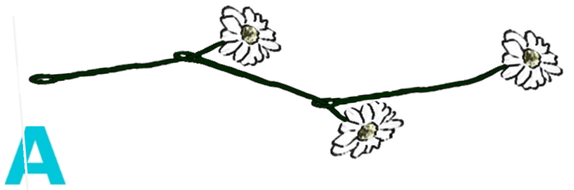


Daisy Drive

Frequency in Local Population



Generations



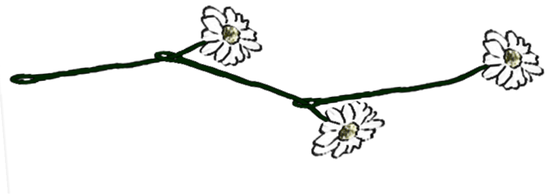
A

B

C

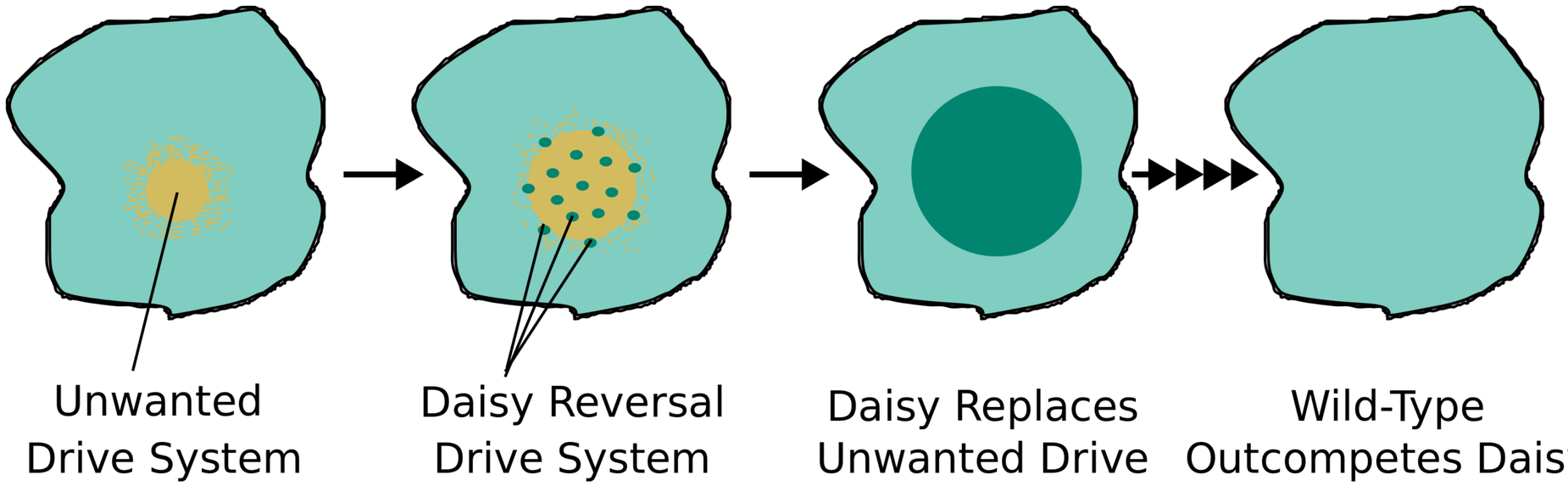
Daisy Drive

Maximum Frequency

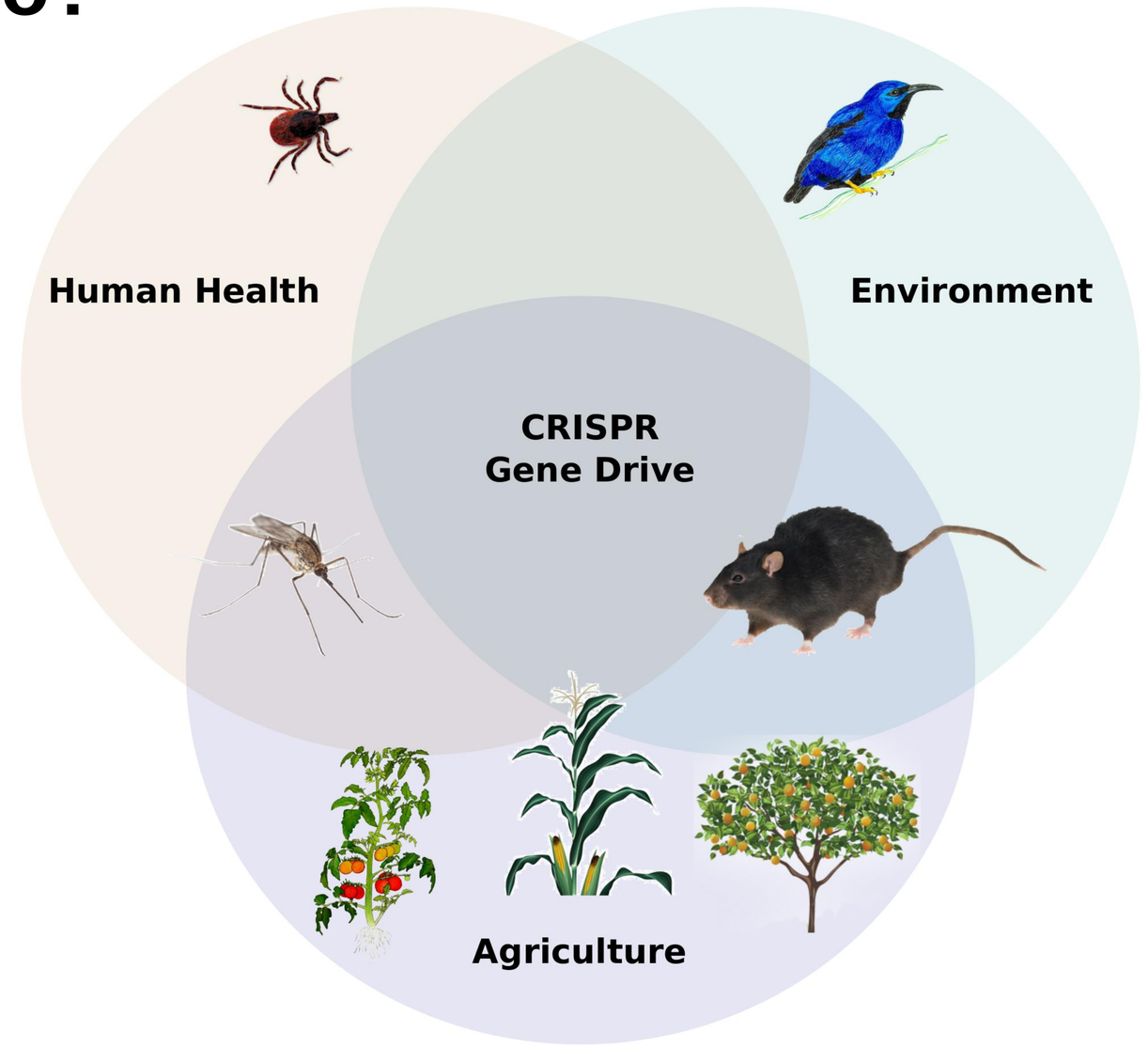


# of Daisy Elements

Daisy Drive – Perfect Restoration to Wild-Type



What can we do?



“The best course of action is to ensure that the people who could be affected by a proposed project or policy have an opportunity to have a voice in decisions about it.”

Gene drive technology cannot be developed in secret

“Experts acting alone will not be able to identify or weigh the true costs and benefits of gene drives.”

- The U.S. National Academies report

We are working with funders, journals, and IP experts to ensure openness

Open science is faster, safer, and more trustworthy

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Local, Open, Responsive Science

- Aim to make the smallest possible change
- Openly share proposals before experiments begin
- Actively invite concerns
- Request community guidance
- Arrange for independent assessment
- Start local and scale up

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Acknowledgements

Ecological Immunization

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CRISPR Gene Drive (Esvelt et al, Oye et al 2014)

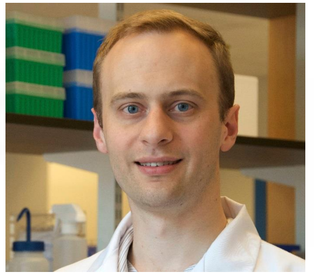
Andrea Smidler Kenneth Oye Tod Kuiken
Flaminia Catteruccia Shlomiya Lightfoot Evan Appleton
George Church James P. Collins Julie McNamara

Daisy Drive (Noble, Min et al 2016)

John Min *Joanna Buchthal* *Erika DeBenedictis*
Charleston Noble George Church Andrea Smidler
Alex Chavez Martin Nowak Jason Olejarz

Responsive Science

Joanna Buchthal Sam Weiss Evans
Shlomiya Lightfoot Travis Rich
Ariel Conn Jeantine Lunshof



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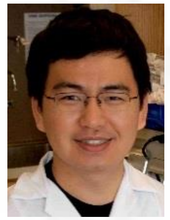
sculpting evolution

exploring evolutionary and ecological engineering

Georgiana Ujomu



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