Resistance, IR mechanisms, and how (not) to start statewide surveillance

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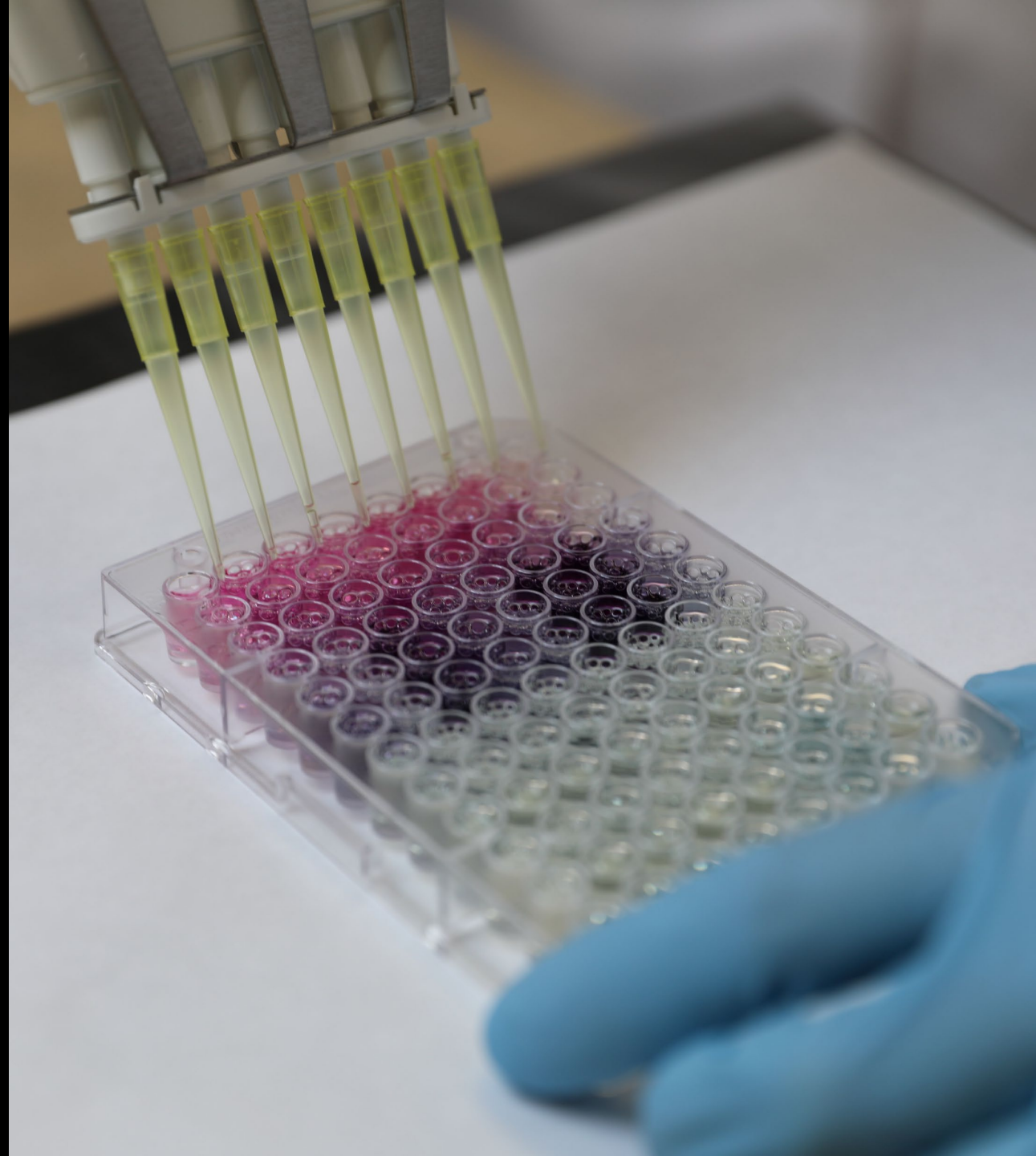
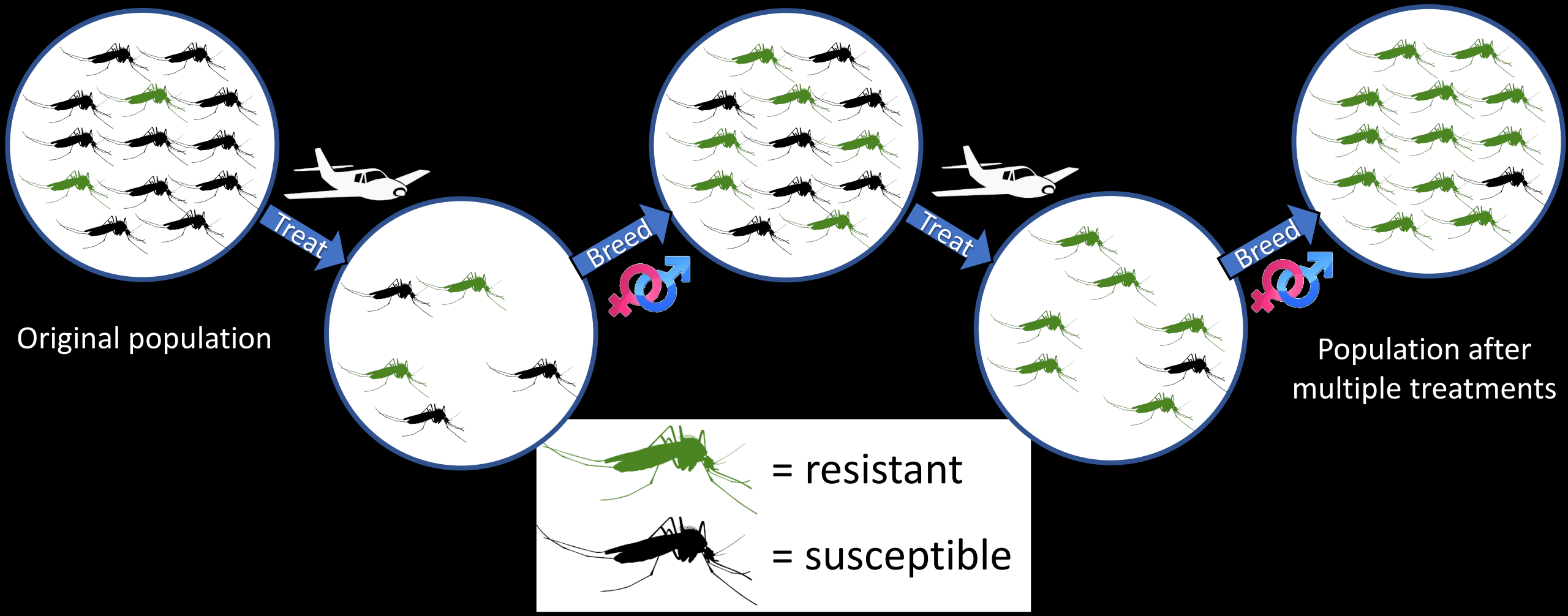


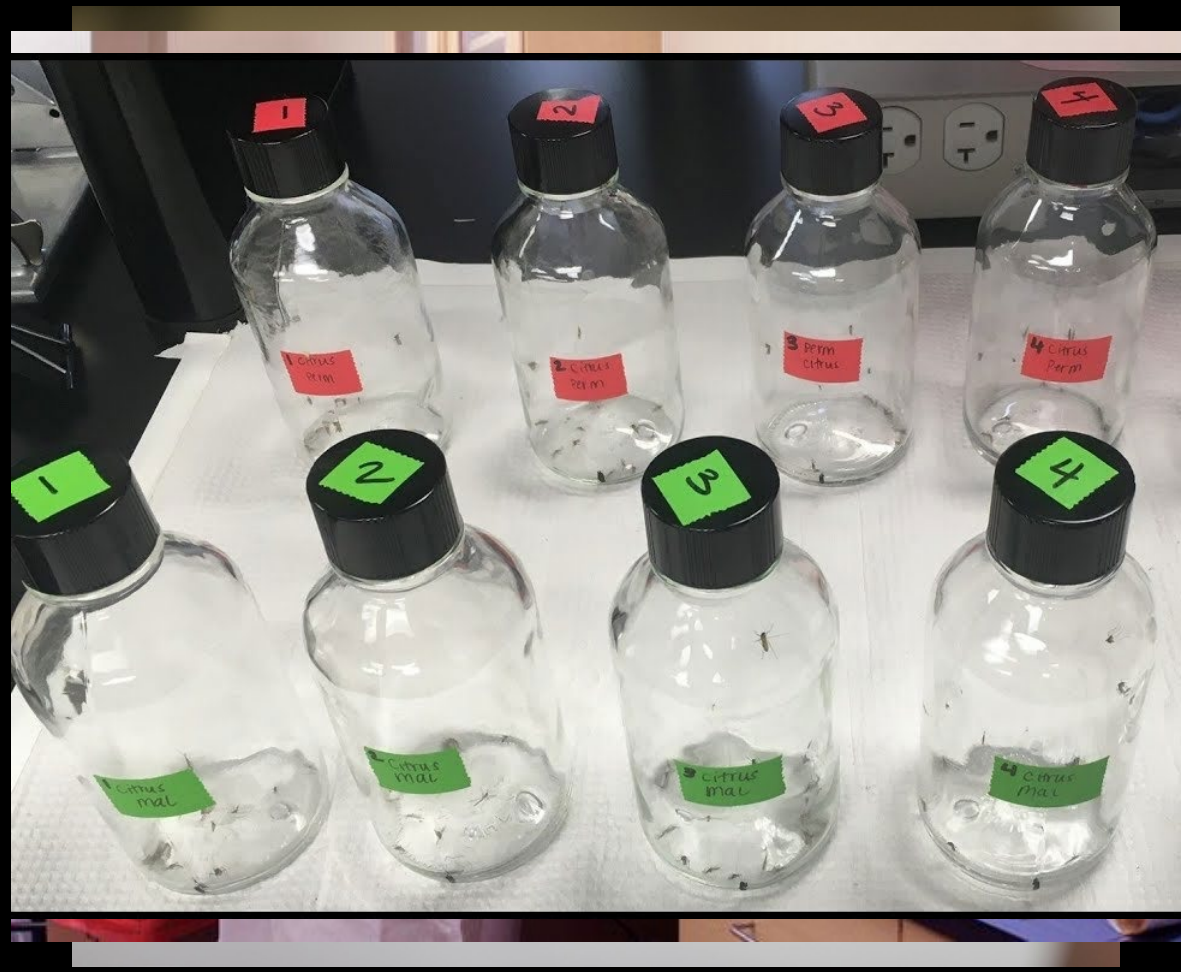
Insecticide resistance

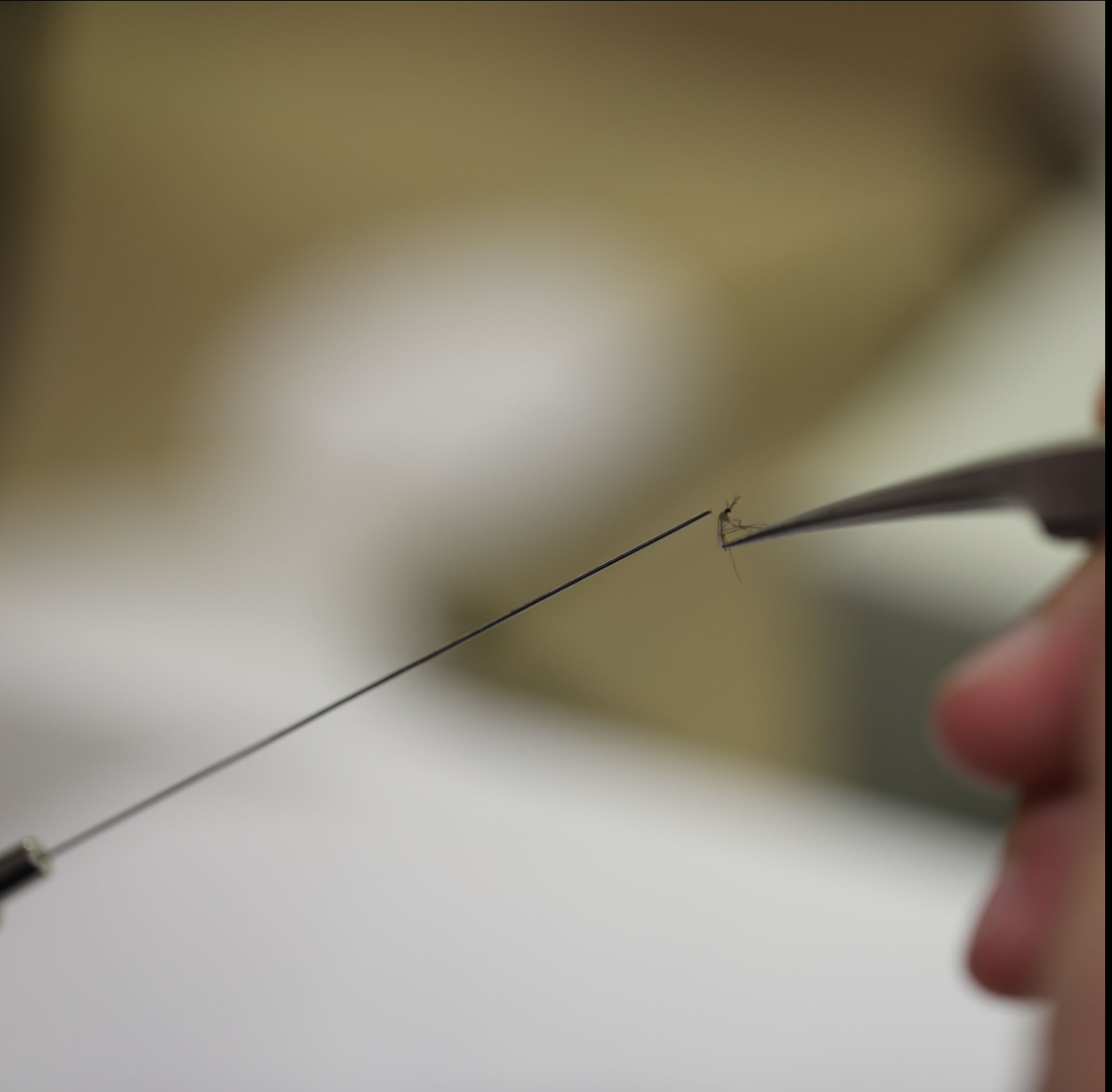
Loss of insecticide efficacy due to selection of heritable traits



Detecting resistance

- Topical bioassay
- Genetic assay (KDR, ACHe)
- Bottle bioassay





Topical bioassay

How much insecticide (in grams) does it take to kill your average mosquito? (LD_{50})

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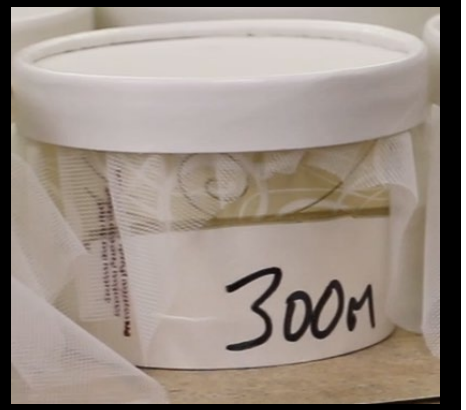
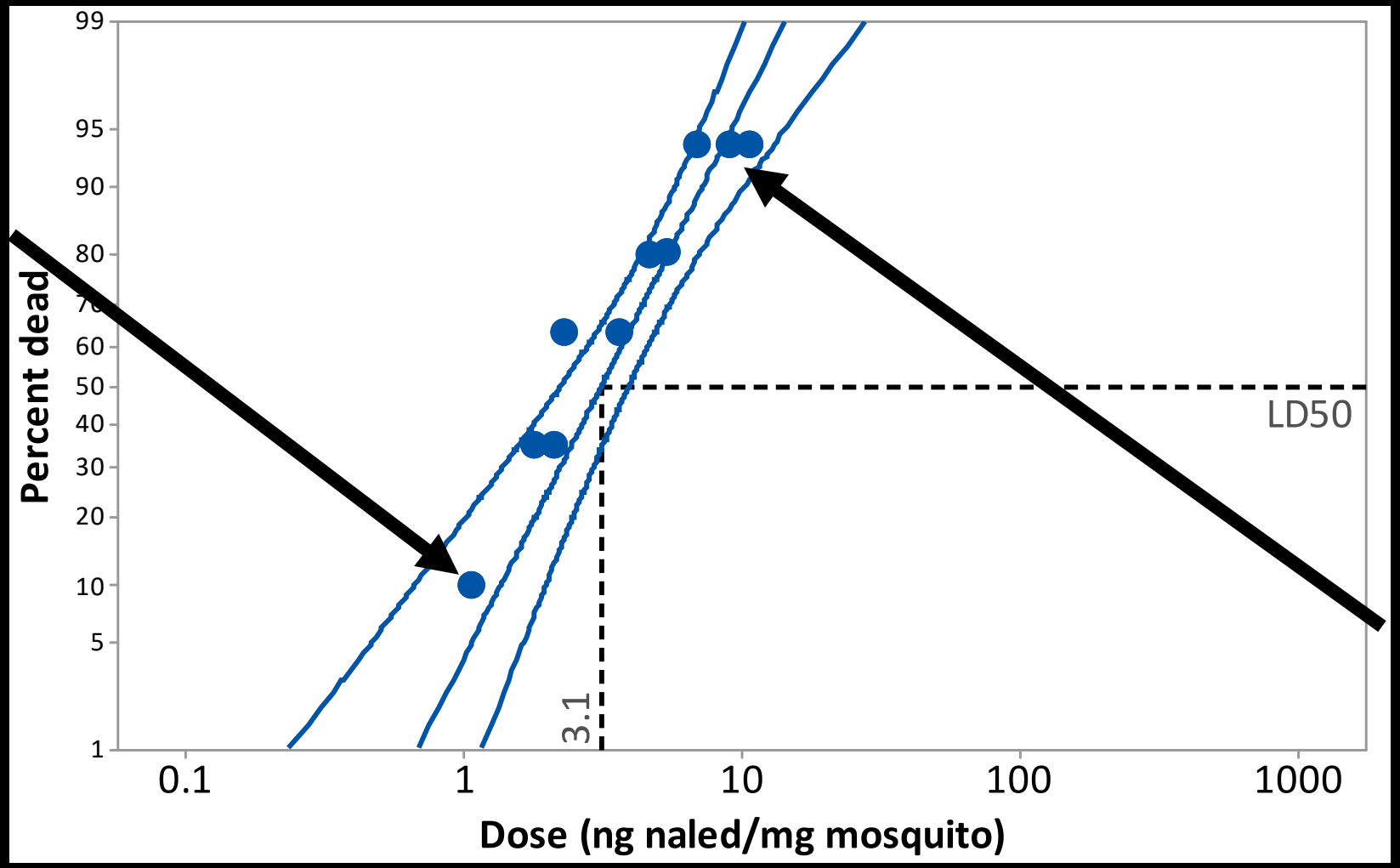
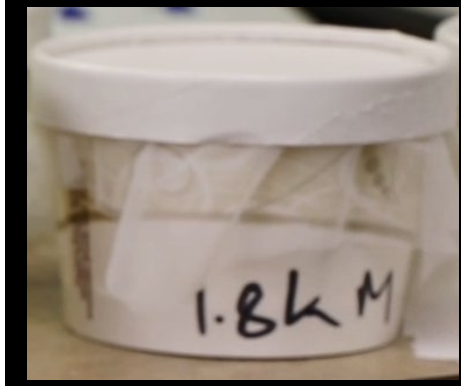
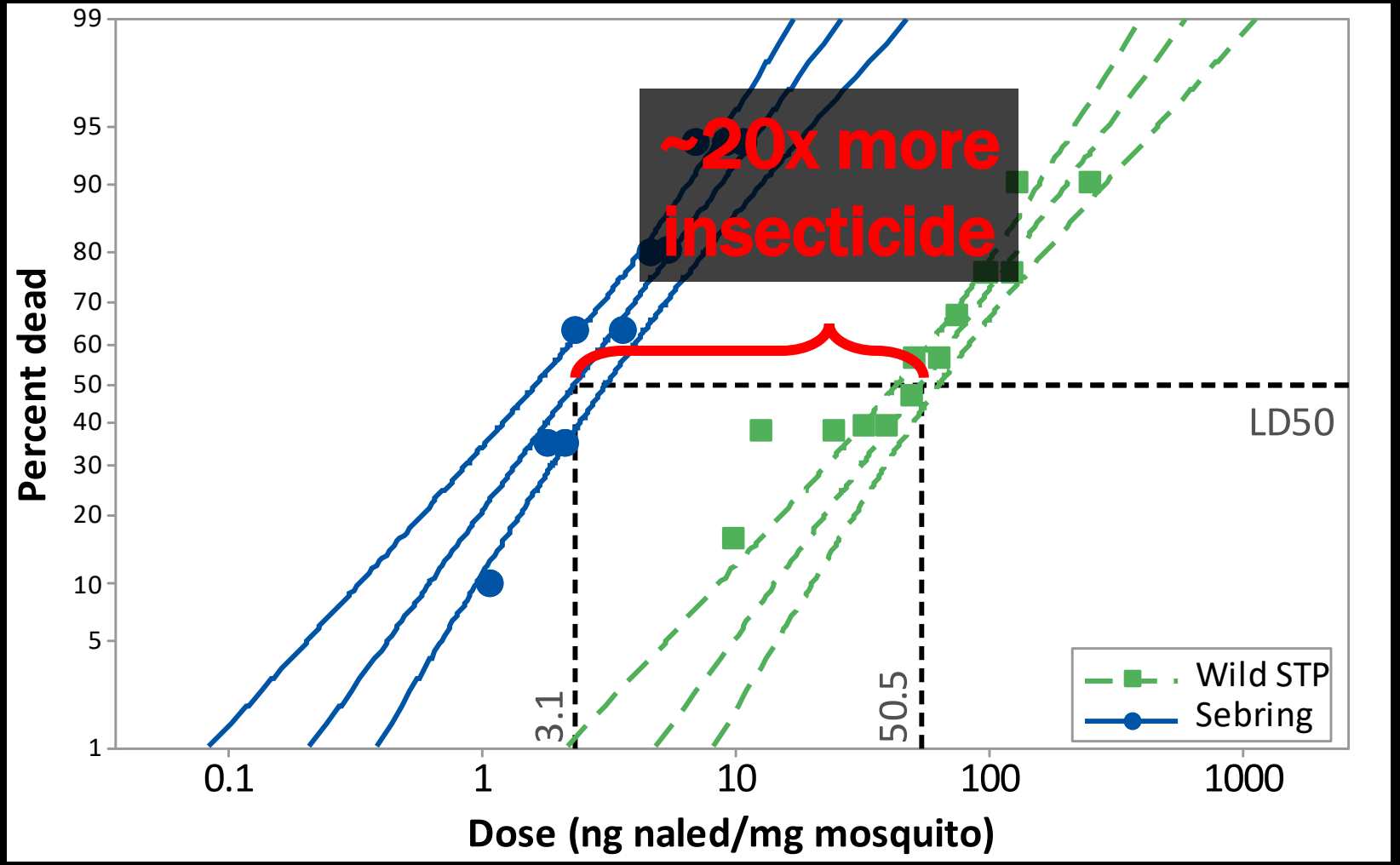
Measuring resistance with dose response lines







Measuring resistance with dose response lines



More susceptible

More resistant

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Resistance and St. Tammany

- **On average our *Cx. quinks* require:**
  - 20x more naled to kill
  - 200x more resmethrin to kill
- **Resistance led to operational changes:**
  - Deltamethrin in rotation
  - Increased spray thresholds
  - Increased retreatment intervals

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Resistance mechanisms

Random mutations that gave rise to resistant phenotypes

Target site mutation

- Nucleotide mutations
- Altered 3’ or 4’ protein structure
- Primary in *Aedes**

Amplified detox

- Enzymatic
- Sequester & excrete
- Primary in *Culex**

Cuticle penetration

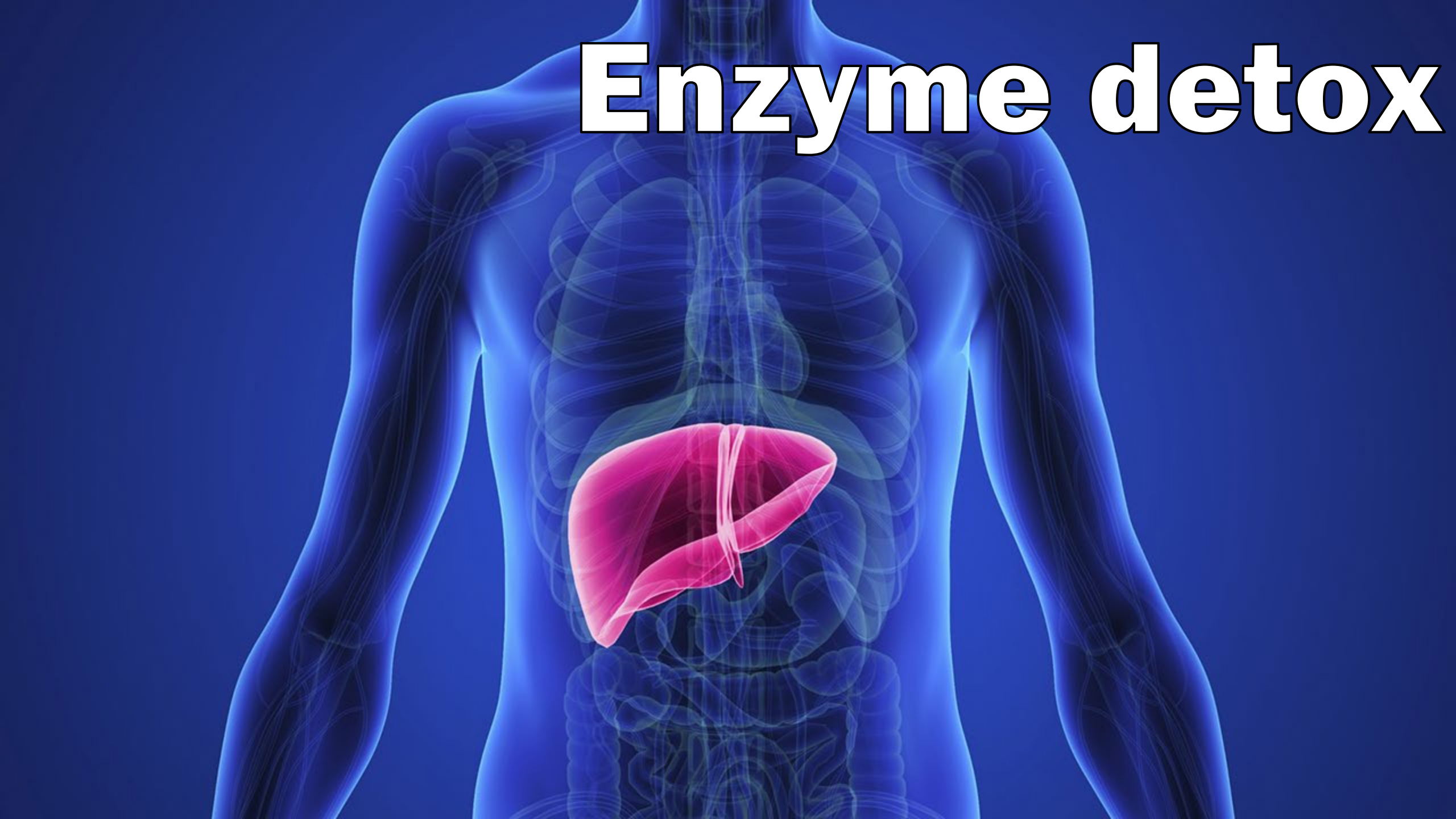
- Poor absorption due to altered cuticle
- Not common

Target site example: KDR

- Knockdown resistance (KDR)
  - Adulticides cause temporary knockdown instead of death
- Genetic origin at specific base pairs of the sodium channel
- Sodium channel mutations prevent binding of pyrethroids (I & II)
  - Codon 1016 valine -> isoleucine
  - Codon 1534 phenylalanine -> cysteine

...and more!

Enzyme detox



One (bad) analogy for amplified enzymes

Bad stuff

Bad stuff

Bad stuff

Bad stuff

Selection

Bad stuff

Bad stuff

Bad stuff

Bad stuff

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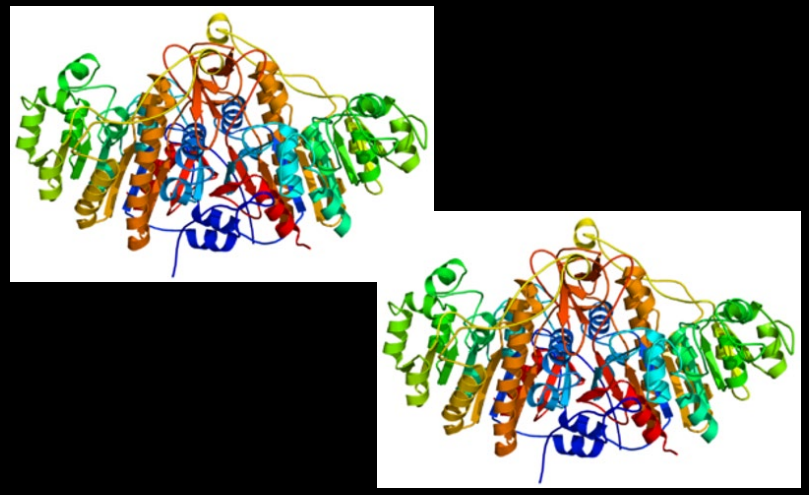
One (bad) analogy for amplified enzymes

OP

OP

OP

OP



Selection

OP

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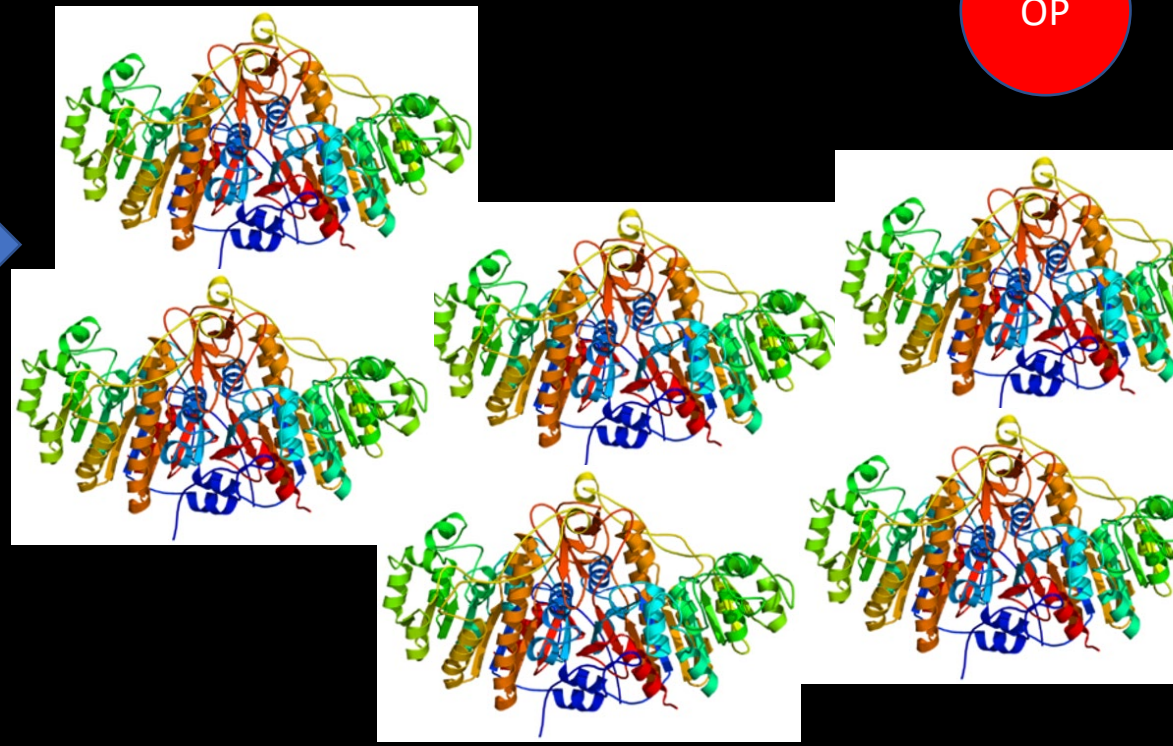

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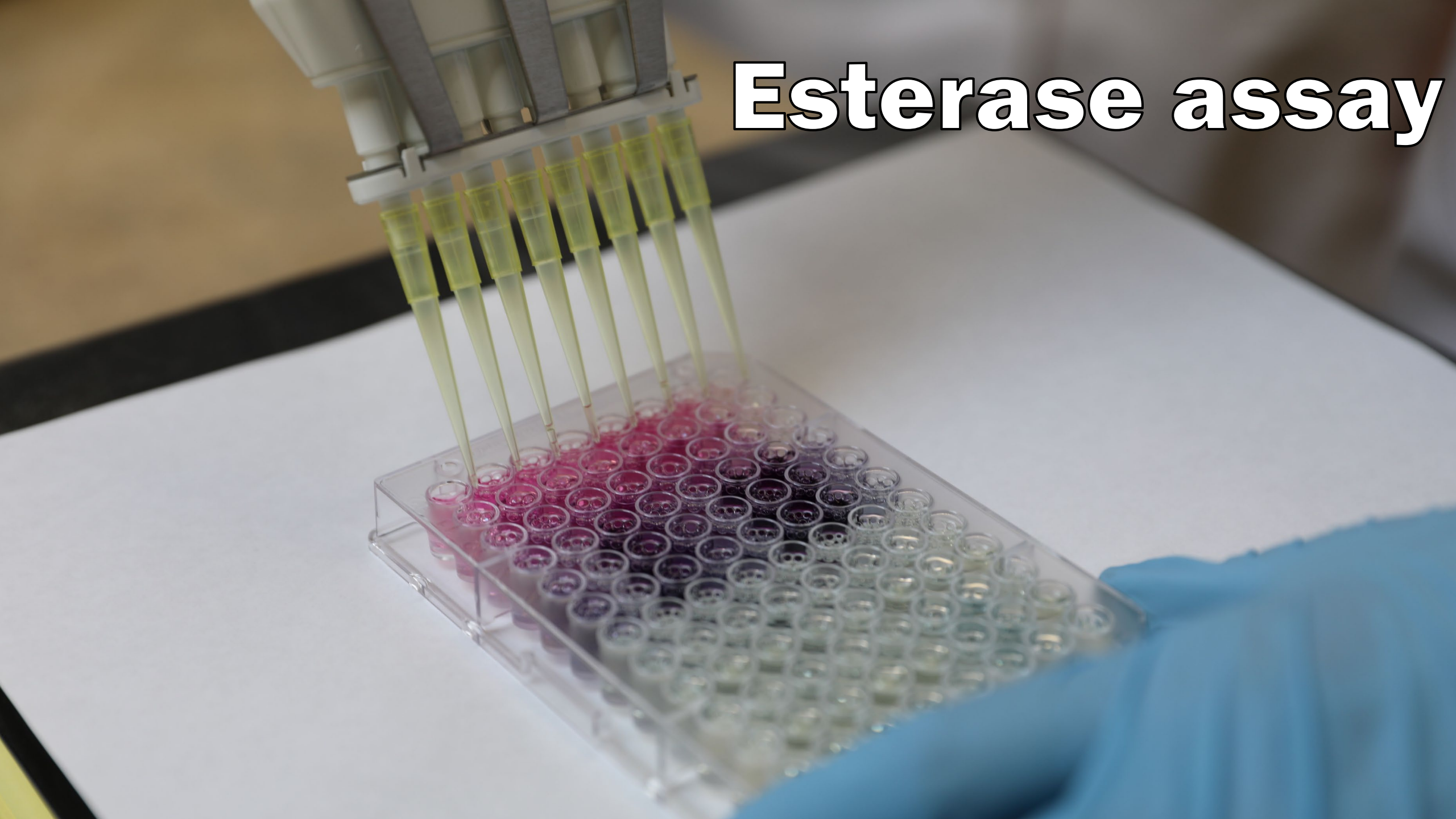
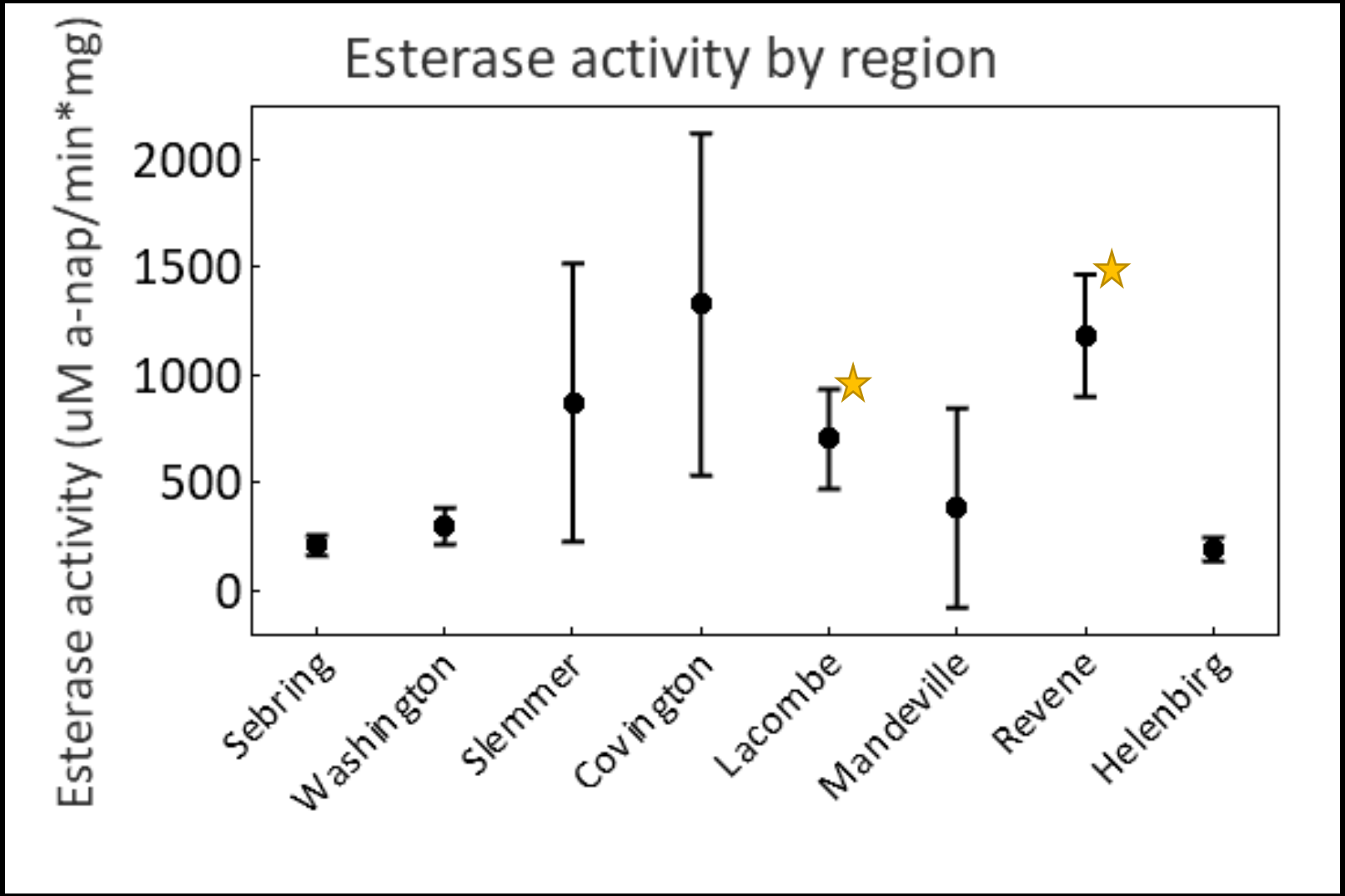

Esterase assay

Esterase activity across St. Tammany



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30 individuals/population (ANOVA)
dF = 7, H-Value = 48.81, P-Value<0.001

IR Surveillance & Mechanisms Summary

- Resistance is already there – how well are you selecting for it?
- Focusing on *Aedes* resistance? KDR a likely suspect
  - Rotate with an OP!
- *Culex* resistance? Probably enzymatic detoxication
  - Rotate! Introduce a synergist!
- Mosquitoes know no borders – resistance might still creep in

LMCA statewide resistance program

Build statewide IR database

Provide IR data for smaller parishes

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Statewide IR summary

State-funded

Performed at central University (LSU)

KDR genetic testing*

Bottle bioassays

***Cx. quinquefasciatus* only**

KDR Genetic Participation

- **Over 9,000 (!) mosquitoes tested in 2020**
- **Was a huge success! Until…**
- **Zero mosquitoes tested in 2021**
- **USDA Florida found *Culex* resistance & KDR poorly linked**
- ***Culex* resistance appears to favor enzymatic mechanisms**
  - Exceptions aplenty!

Bottle Bioassay Participation

- 30 bottle bioassays performed in 2020
- < 10 performed in 2021
- Not a huge success!
- Requires significant unpaid labor (insectary, rearing, delivery…)
- Changes underway in 2022

2022 – 23 Statewide IR Plan

- Contract university students for collection, rearing, and delivery
- Visit two parishes (districts) per week from May – July
- Test for IR using the bottle bioassay

Future plans

- Switch to topical bioassays!
- Find pyrethroid resistance? Test for enzymes!

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Statewide IR Takeaways

- Don’t start in-depth collaborations during a pandemic
- Participation is not guaranteed
- Shipping mosquitoes for KDR from across a state works well
  - …but KDR does not work well for *Culex* ☹
- Want IR data? Need to collect it yourself!
- Consider hiring help to collect/rear mosquitoes for your state

Questions? ndelisi@stpmad.org

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