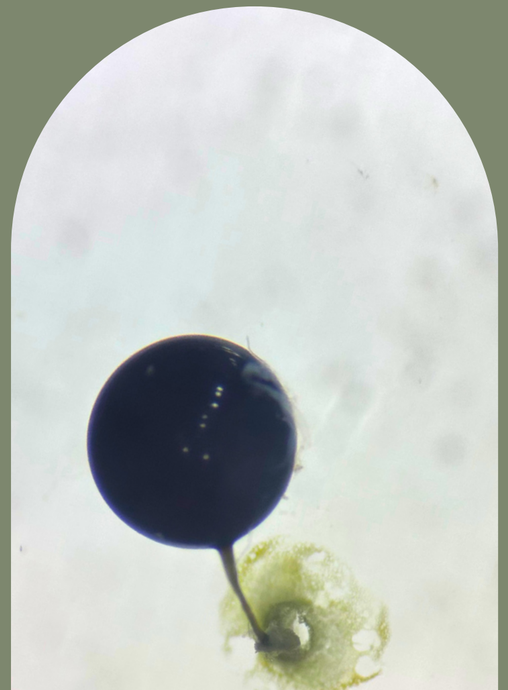
MITIGATING CADMIUM TOXICITY ON PLANARIAN HEAD REGENERATION

By Natalie Gonzalez



CADMIUM - Cd

What is it?

- Toxic heavy metal

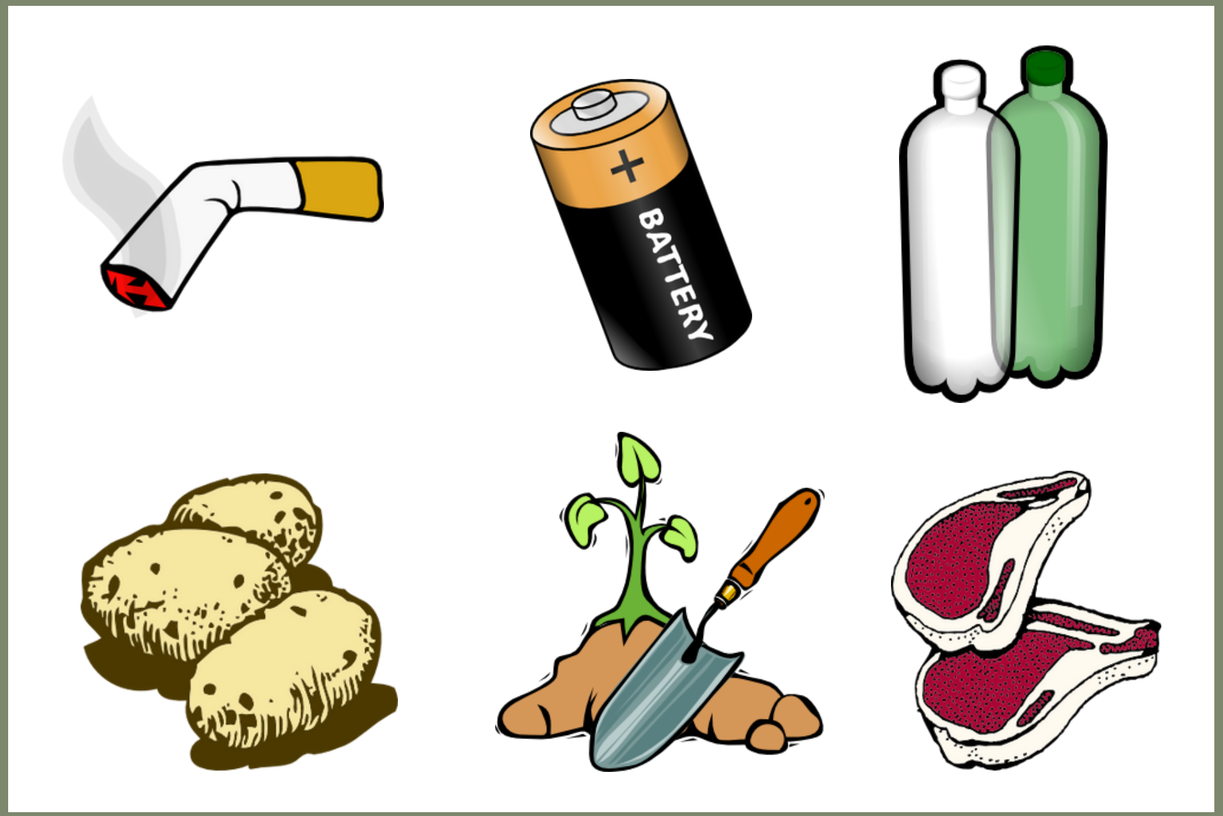
What does it do?

- Induces the production of reactive oxygen species and oxidative stress (Wu et al., 2011)

Effects:

- Organ damage
- Respiratory and reproductive toxicity
- Neurological defects
- Cancer

Common Sources

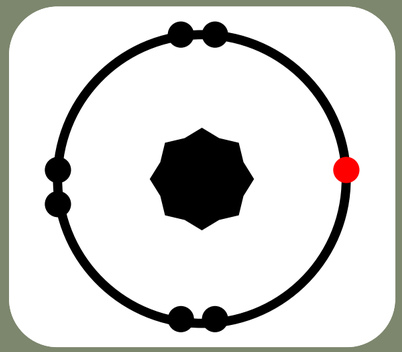


(Rolera LLC, 2023)

REACTIVE OXYGEN SPECIES – ROS

Free Radicals

Unstable molecules with an unpaired electron



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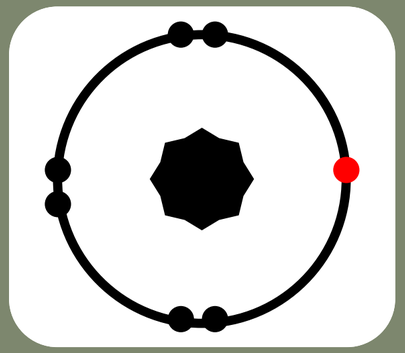
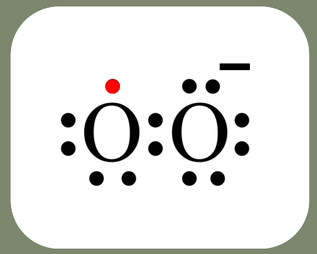
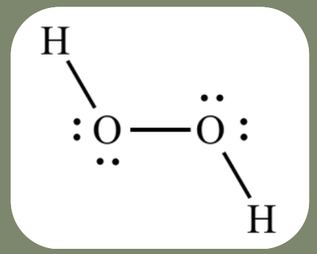


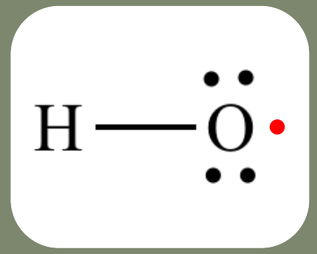
Superoxide Anion



Hydrogen Peroxide



Hydroxyl Radical



(Wikimedia Foundation, 2024)

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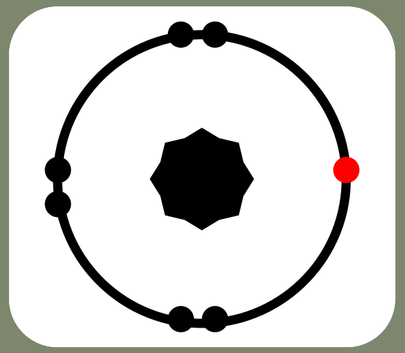

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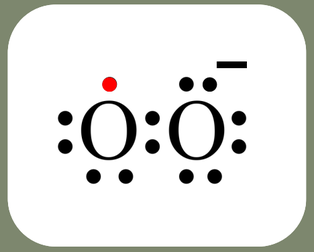

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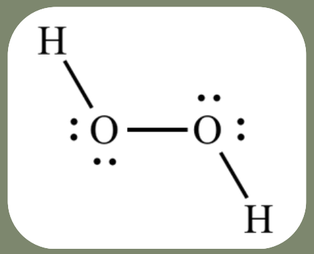

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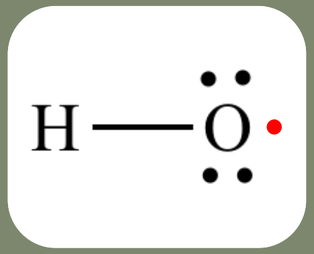
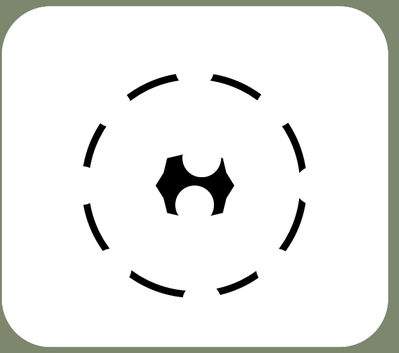
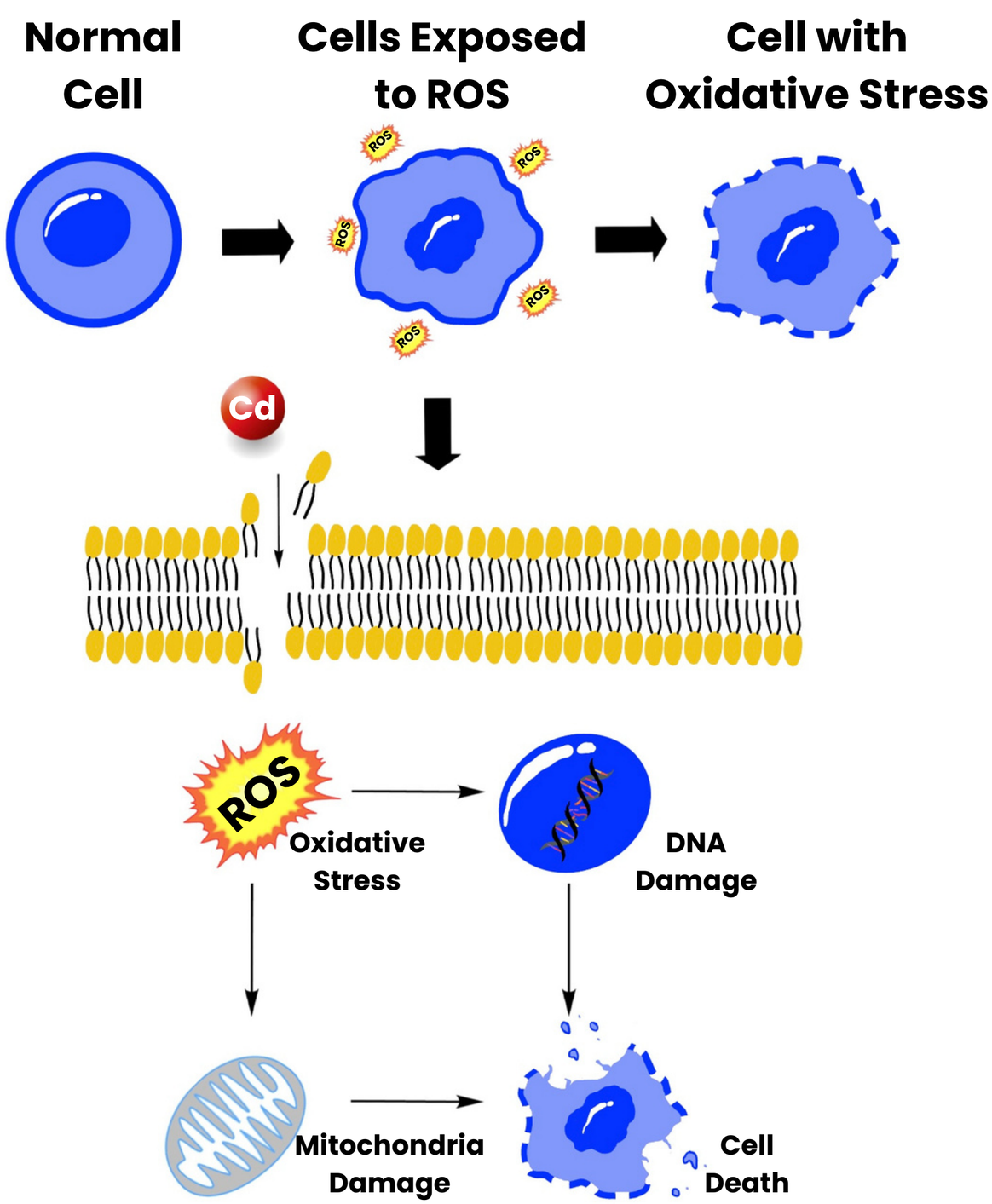


Oxidative Stress

Imbalance between ROS production and the cell's ability to repair damage

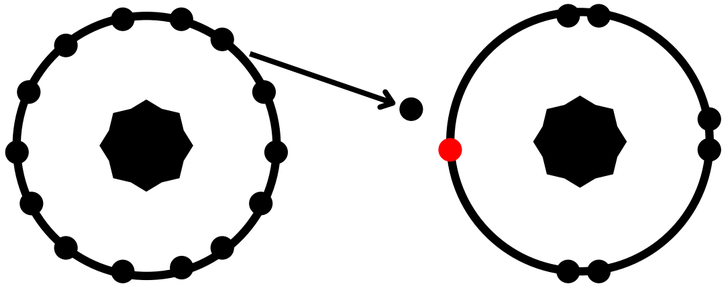


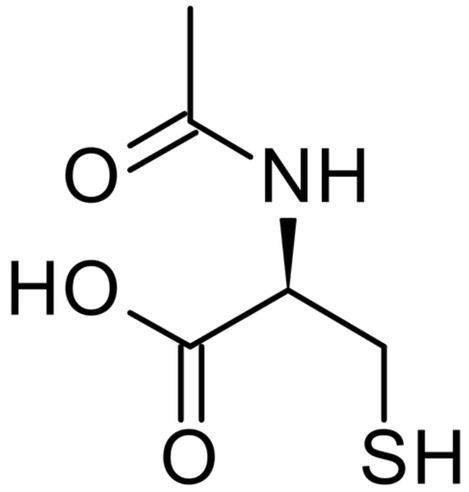
(Wikimedia Foundation, 2024)

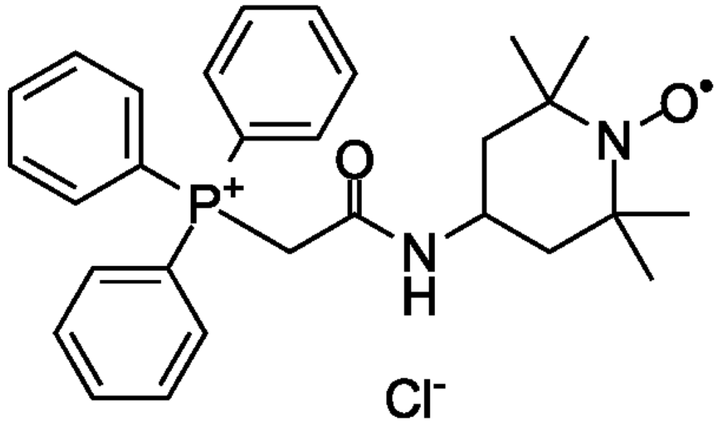


(Gonzalez, 2024)

Antioxidants	NAC	MitoTEMPO
• Prevent oxidation • Hunt free radicals • Reduce the damaging effects of metal exposure	• Directly interacts with radicals, donating electrons and converting them to water • Enhances enzymatic activity in the cell	• Mitochondria targeted • Mimics enzymatic activity • Reinforces cellular defenses







(Wikimedia Foundation, 2024)

PLANARIA

What are they?

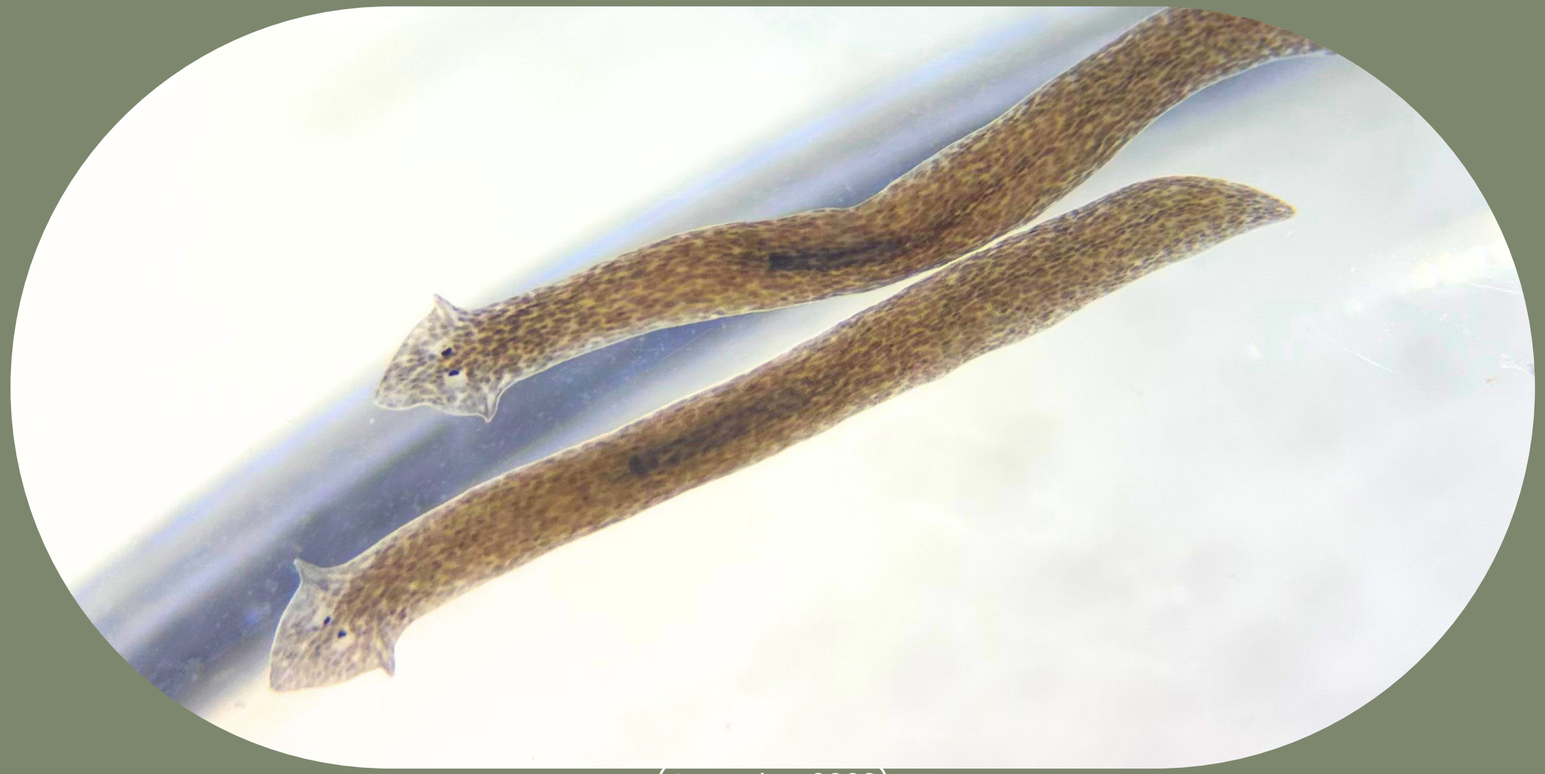
- Free-living freshwater flatworms

Characteristics:

- Primitive nervous system
  - Ocelli (eyespots)
  - Auricles (chemoreceptors)
- Susceptible to harmful chemicals and drugs
- Regeneration

Species:

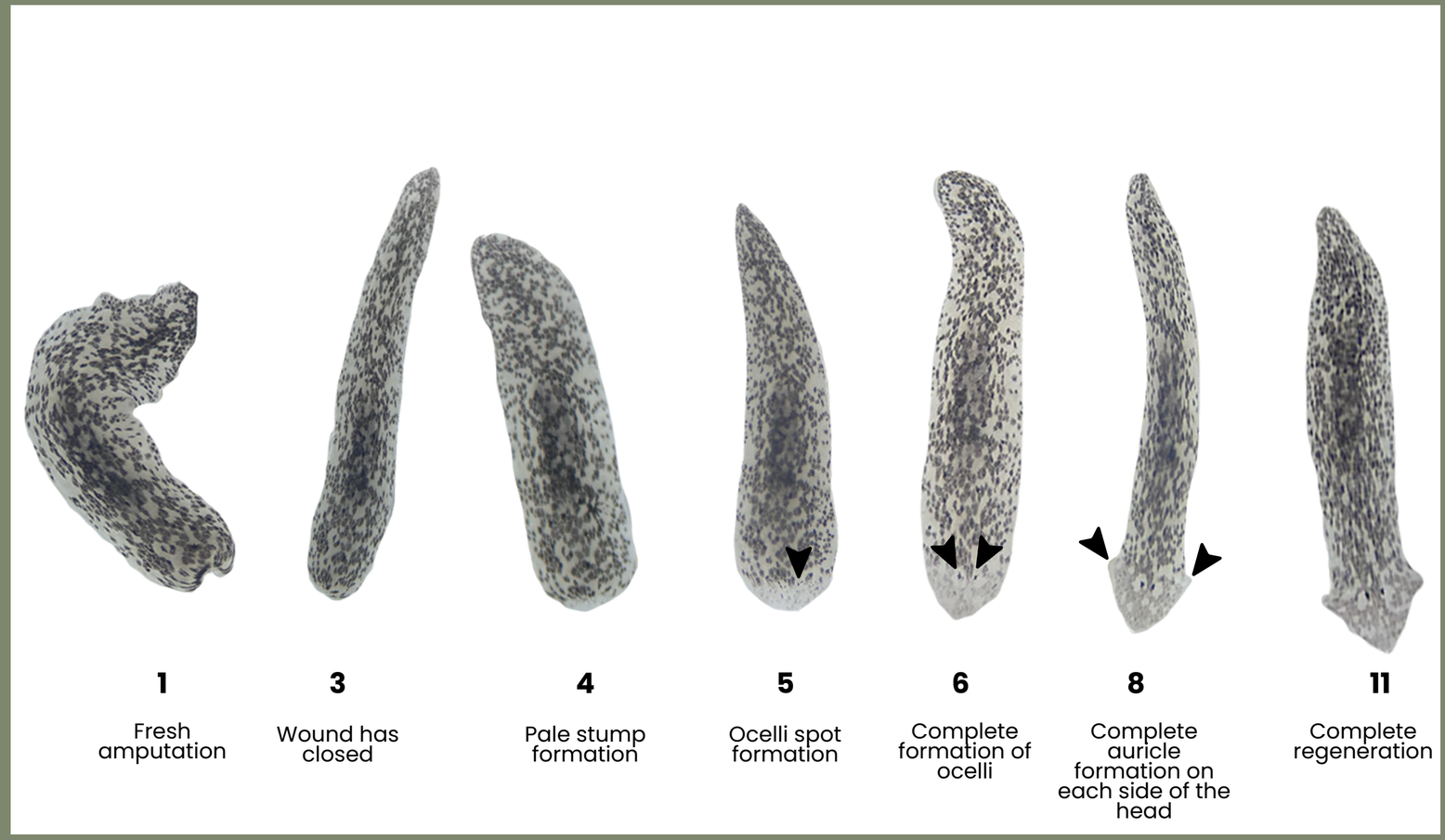
- *Girardia dorotocephala*



(Gonzalez, 2023)

NORMAL PLANARIAN HEAD REGENERATION

Score	Tail Fragments
0	Death
1	Fresh amputation
2	Wound contraction has occurred
3	Wound has closed
4	Pale stump has formed
5	Ocelli spot formation
6	Complete formation of two ocelli
7	Auricle formation
8	Complete auricle formation on each side of the head
9	Partial pigmentation
10	Full pigmentation in all of the body
11	Complete regeneration



(Gonzalez, 2024)

WHY IS THIS IMPORTANT?

Health Implications:

- Essential in preventing and treating associated health risks
  - Impaired wound healing, tissue damage, organ dysfunction, etc

Environmental Concerns:

- Metal pollution is a major environmental issue
  - Contaminates our soil, water, and air
  - Impacts the health of our ecosystems

WHAT WE KNOW

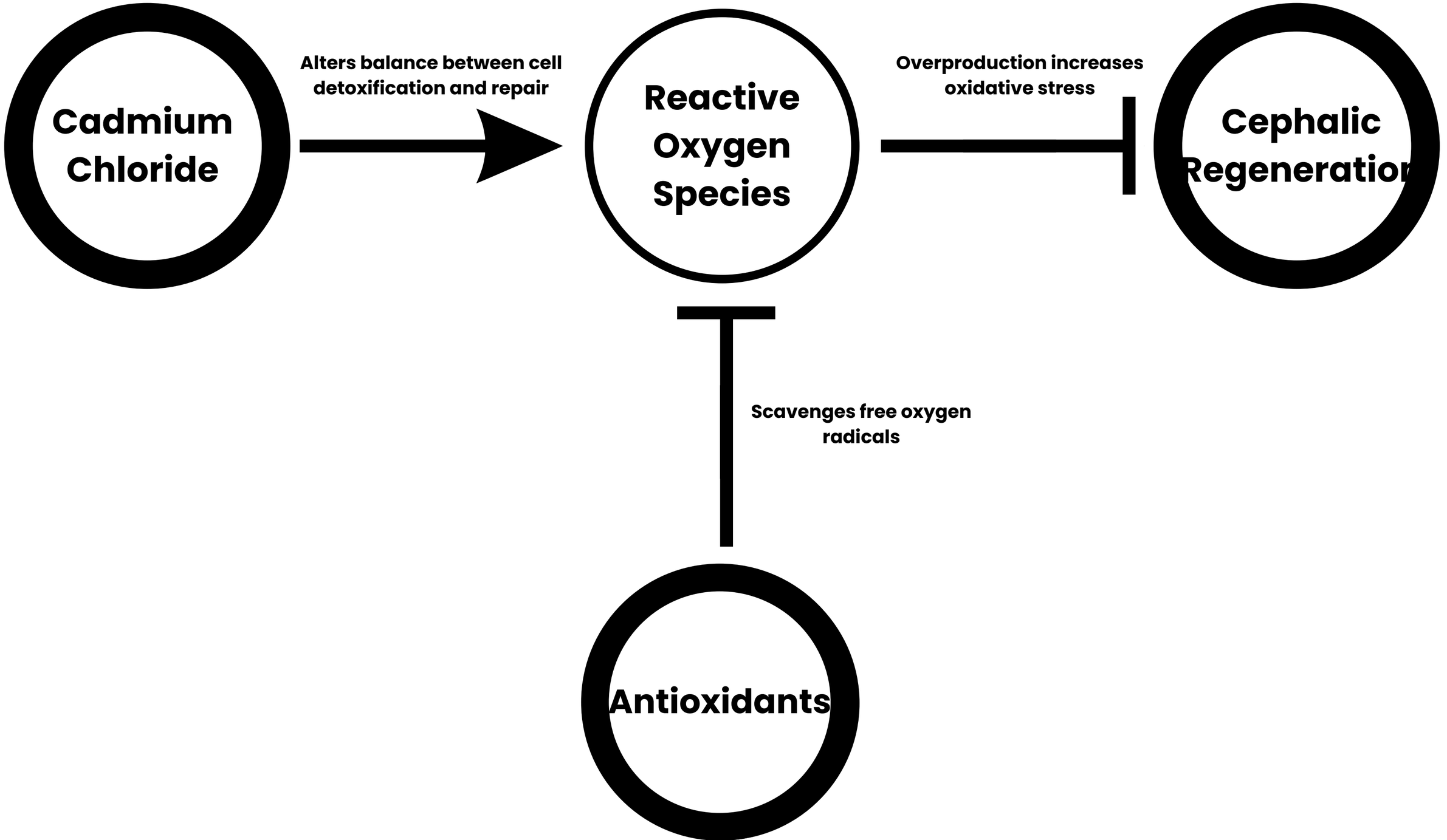
- Limited research on the the relationship between Cd and antioxidant exposure on regenerative capabilities of *G. dorotocephala*

RESEARCH QUESTIONS

- What is the effect of Cd exposure on *G. dorotocephala*?
- Can antioxidant exposure help stop the buildup of ROS and promote tissue regeneration in planaria?

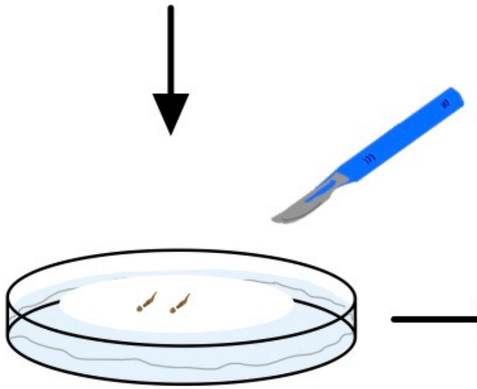
RESEARCH HYPOTHESIS

- Exposure to $CdCl_2$ will block head regrowth by ROS production, however, NAC and MitoTEMPO will reduce the harmful effects and restore normal planarian regeneration

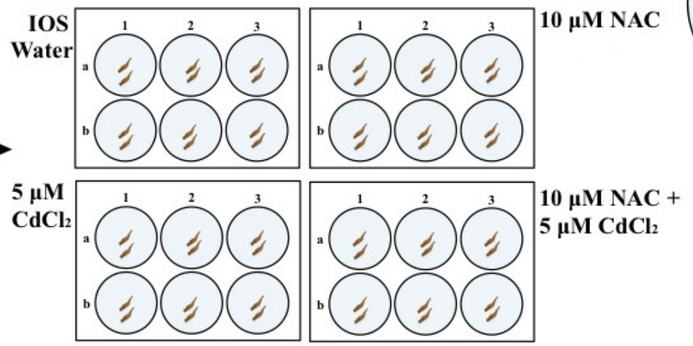

Cadmium Chloride
Alters balance between cell detoxification and repair
Reactive Oxygen Species
Overproduction increases oxidative stress
Cephalic Regeneration
Scavenges free oxygen radicals
Antioxidants

ANTIOXIDANT TREATMENT

24 hr Antioxidant Pretreatment



Amputation



Tail fragments in 6-well plate

Observations via stereo microscope and camera

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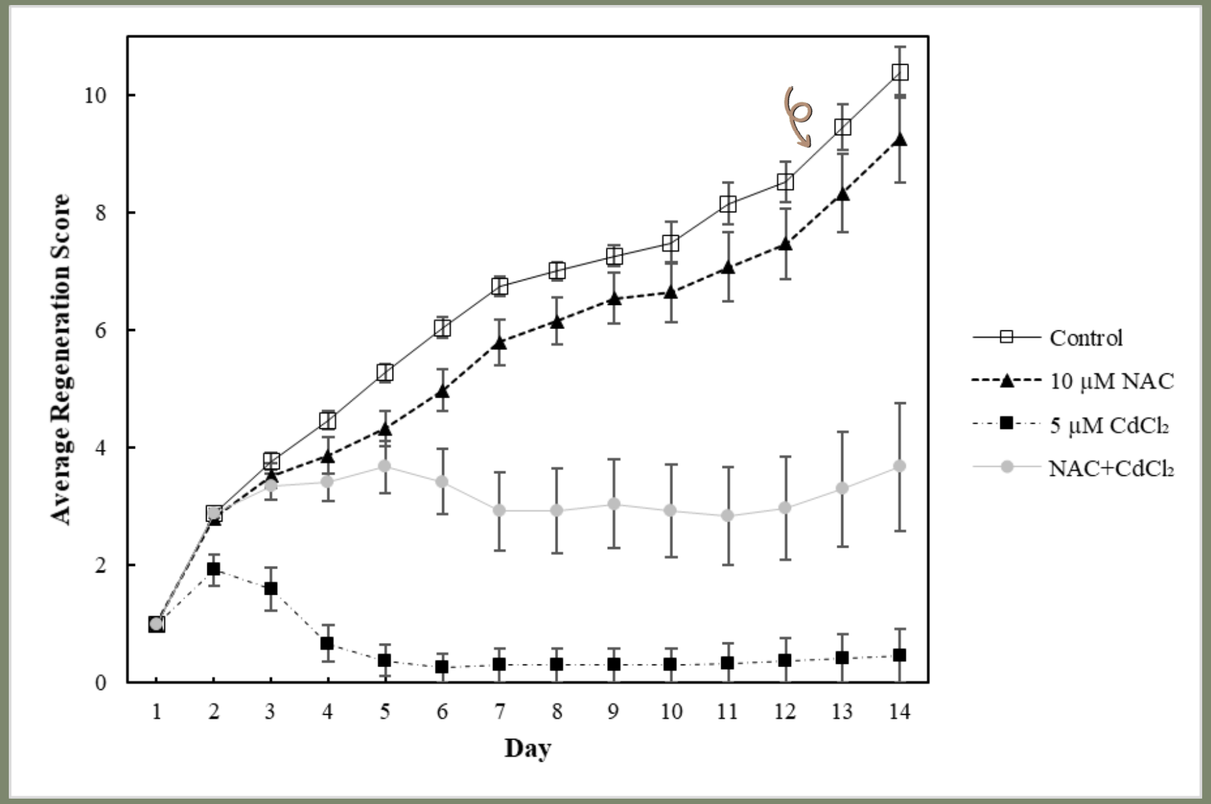
Planaria scored everyday for two-weeks

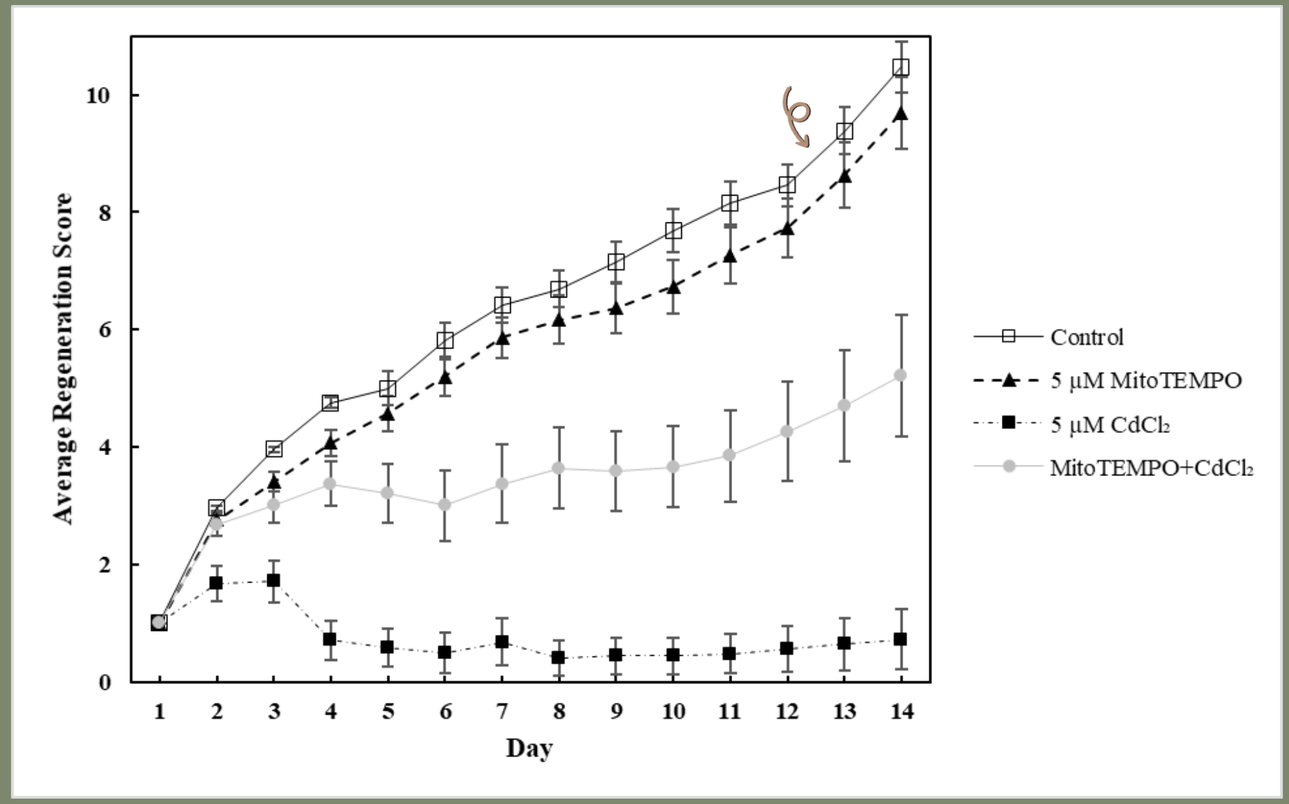
Effect of Antioxidants on Average Regeneration Score

NAC



Kruskal-Wallis Test:
* $p<0.001$
∞ $p<0.0046$
n=24-28 per treatment

MitoTEMPO



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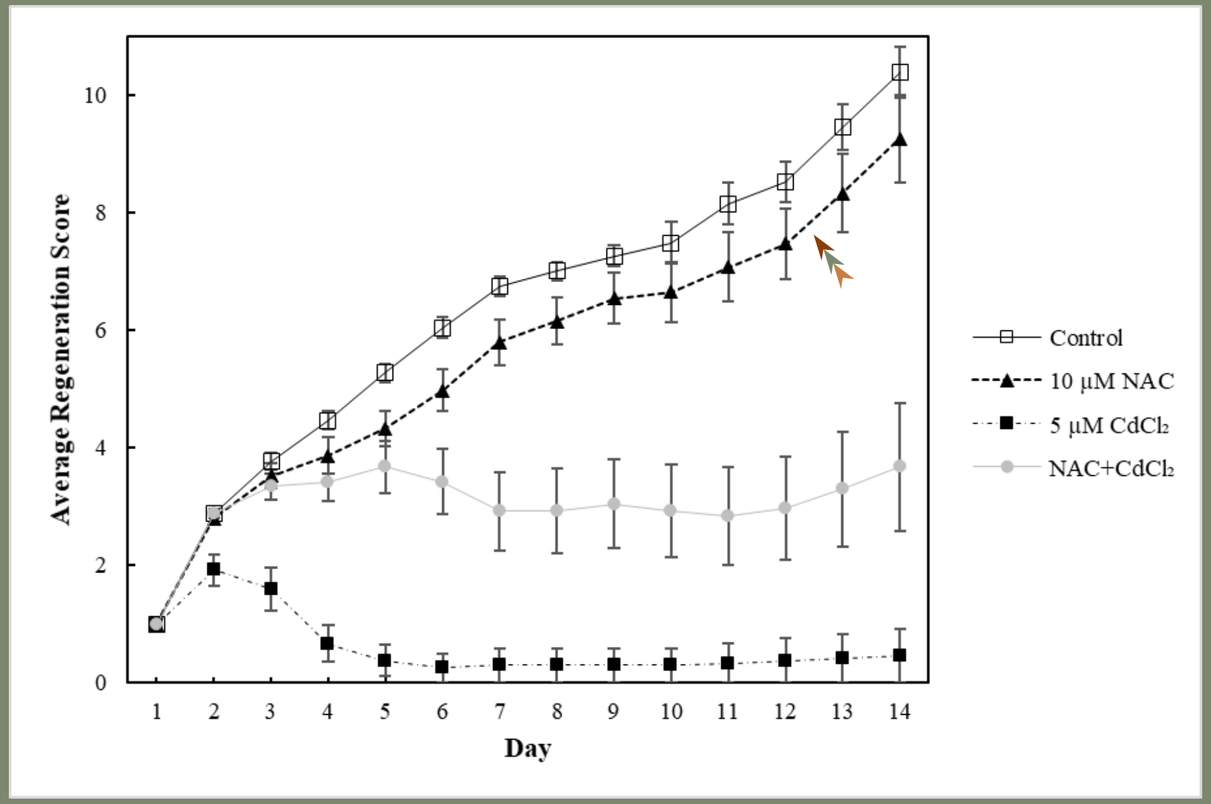

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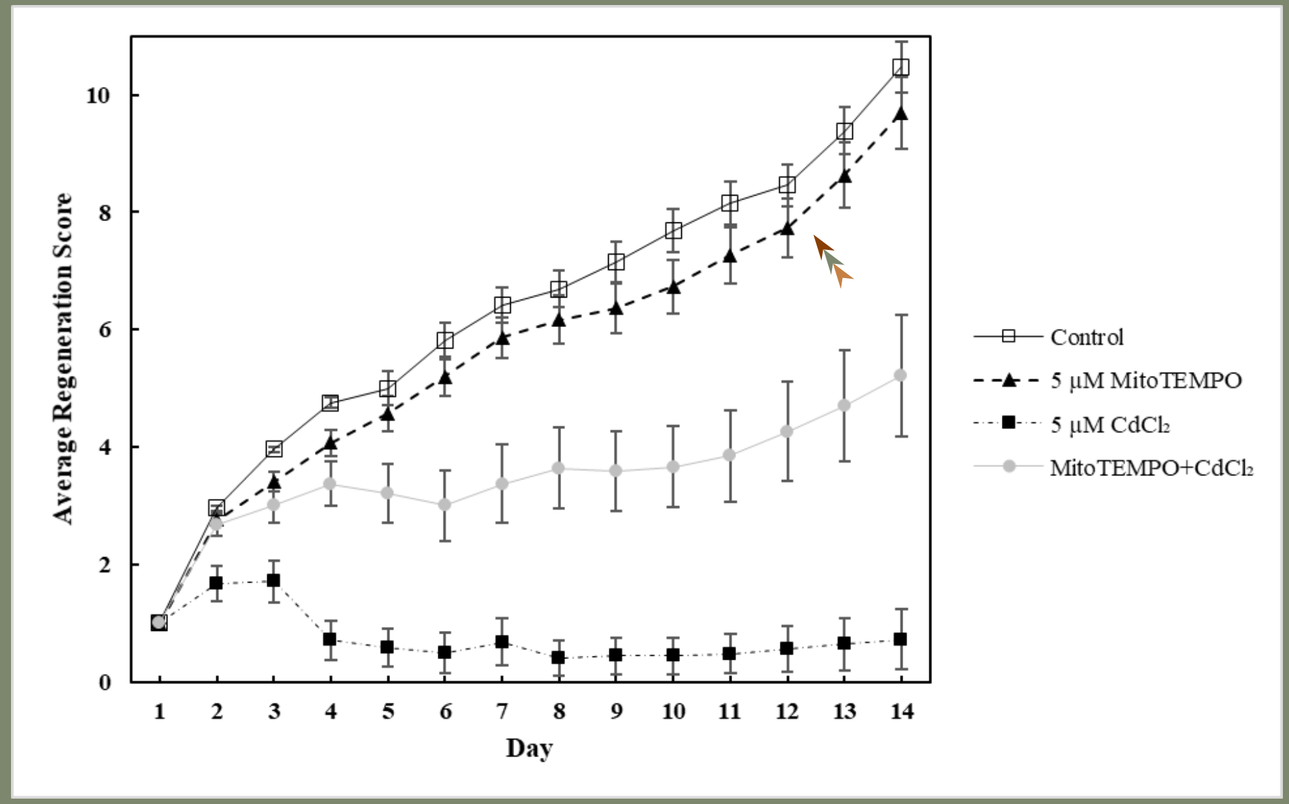

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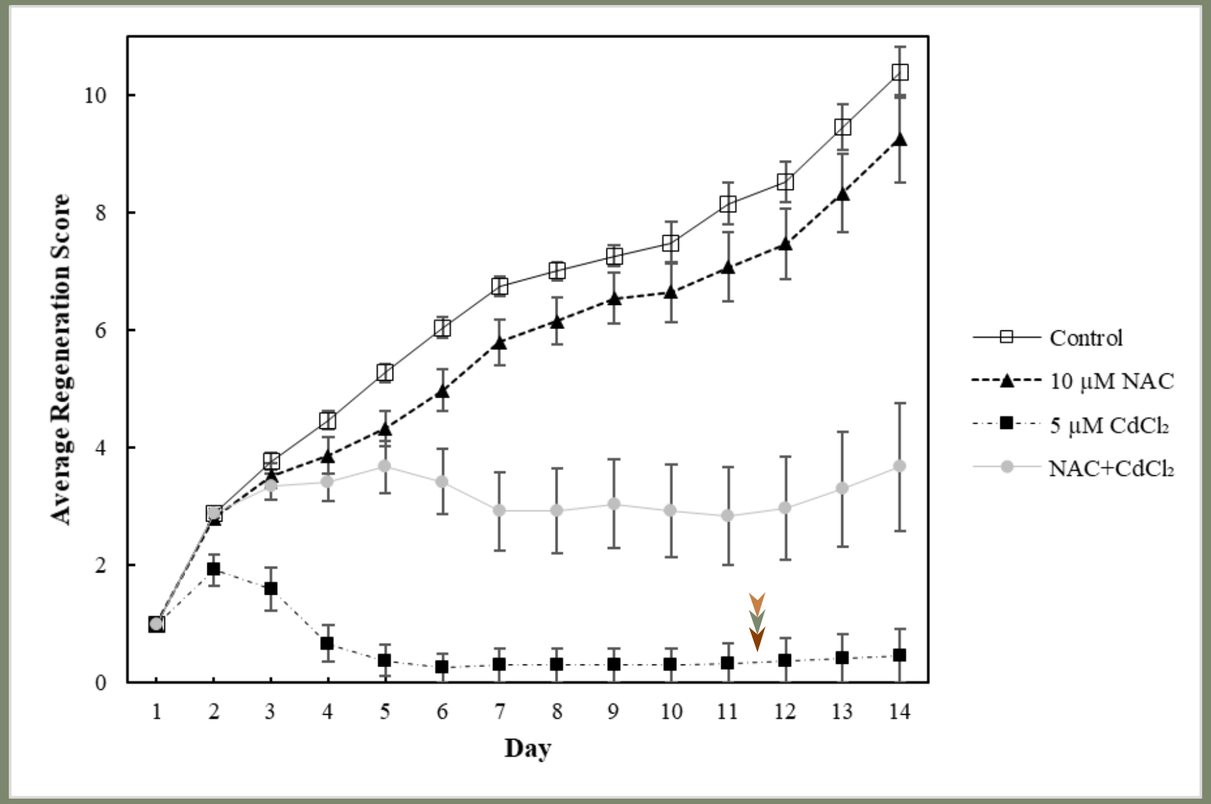

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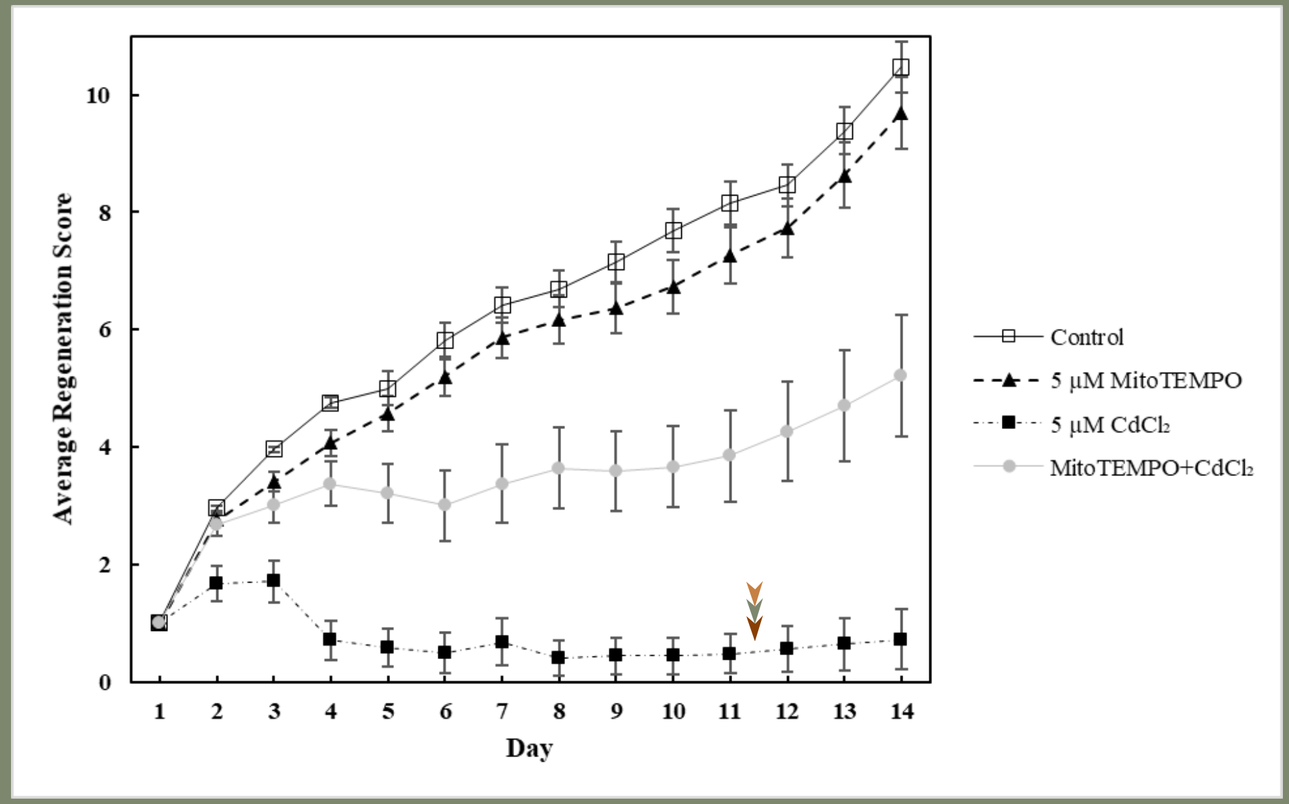

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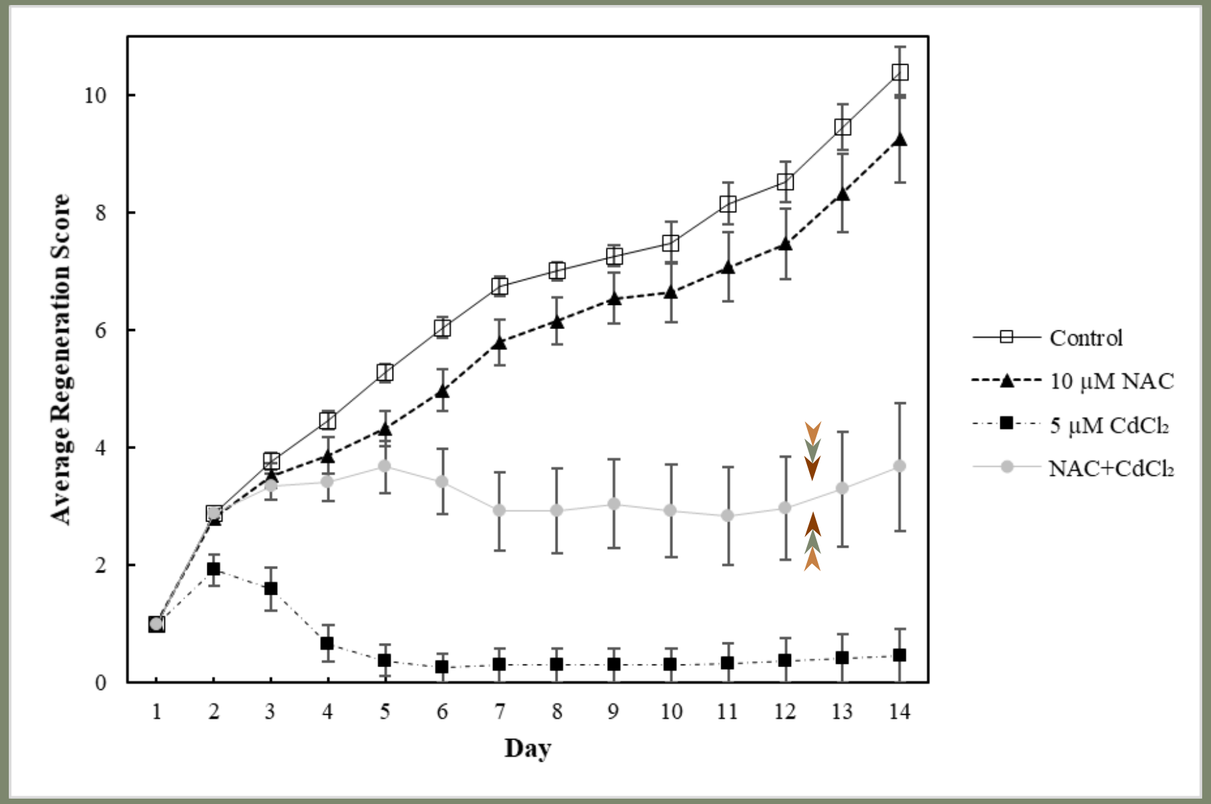

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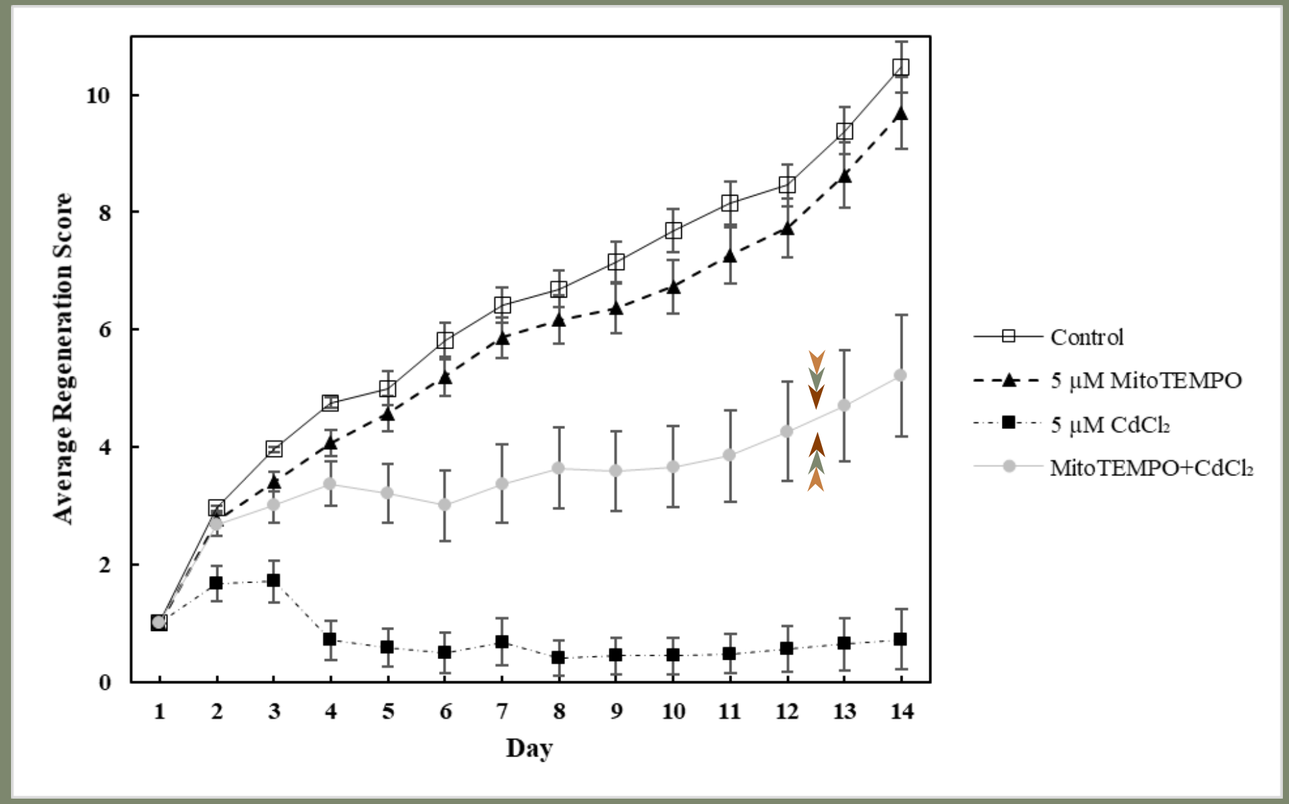

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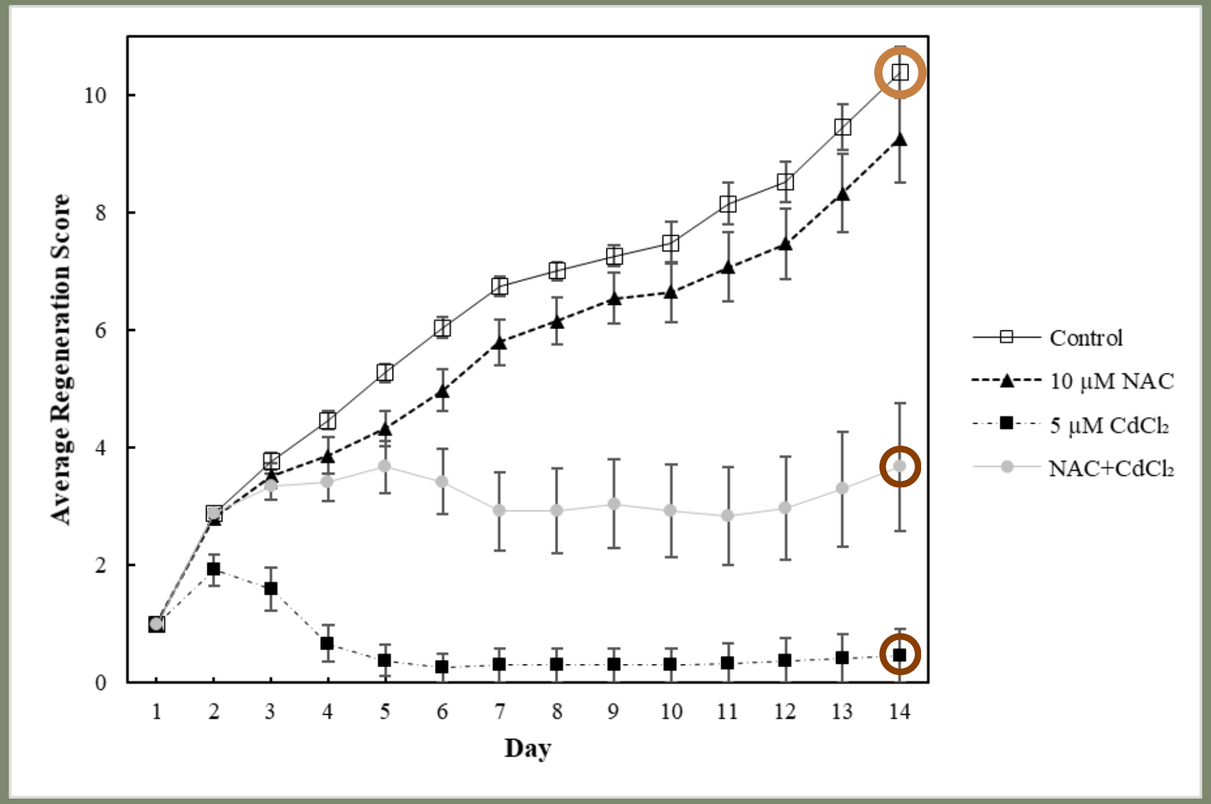

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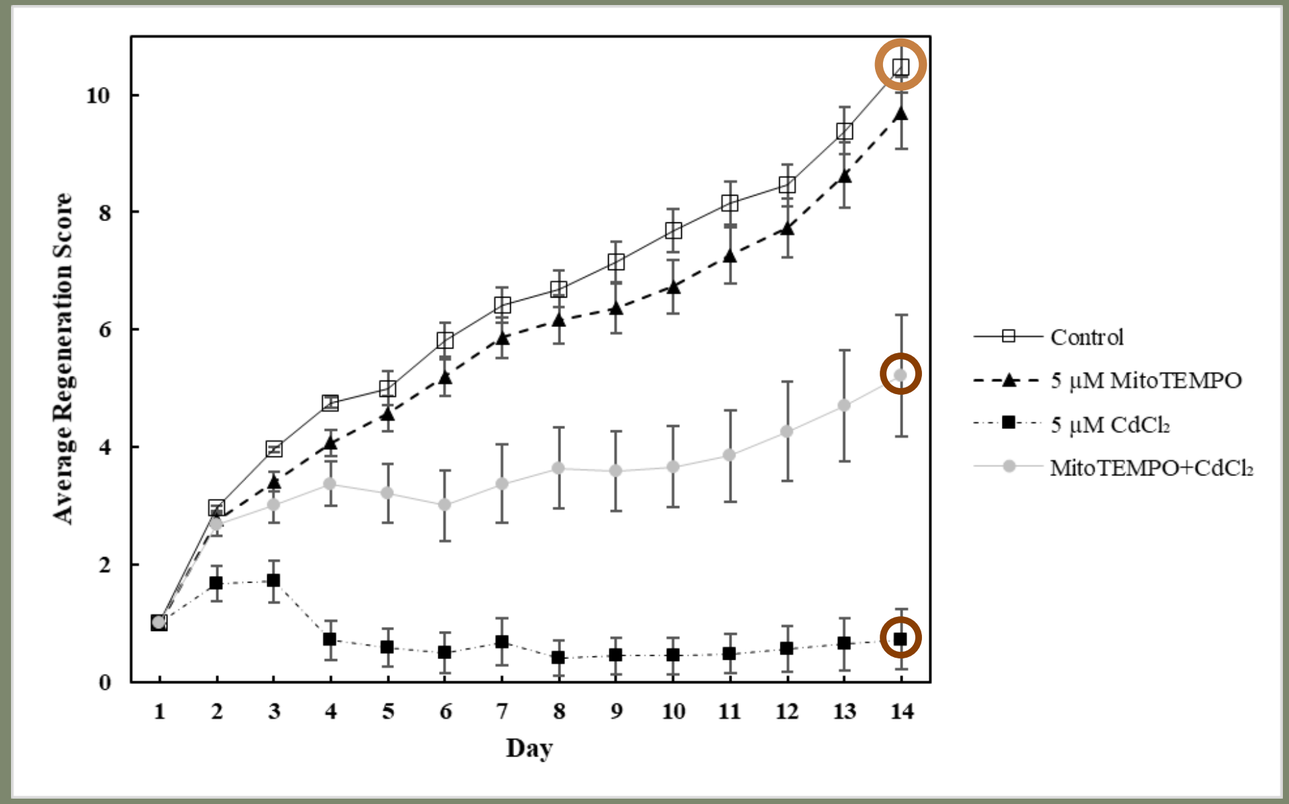

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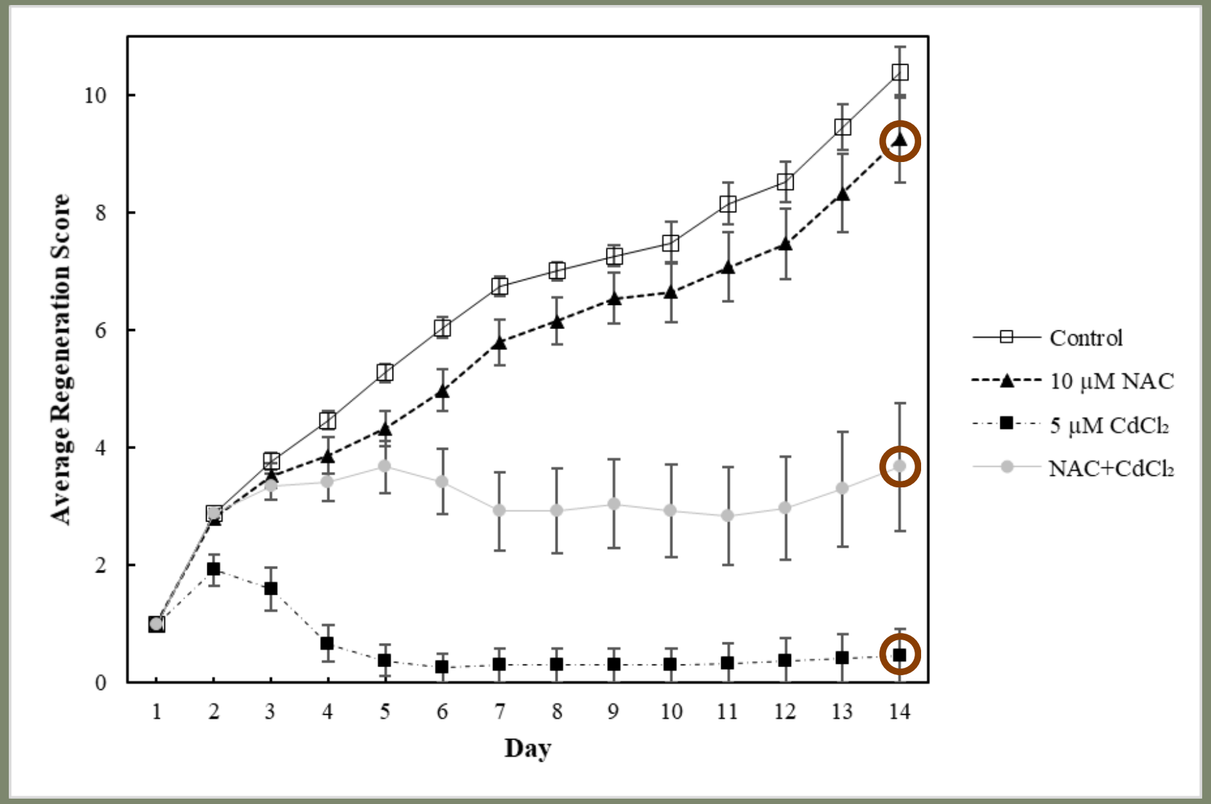

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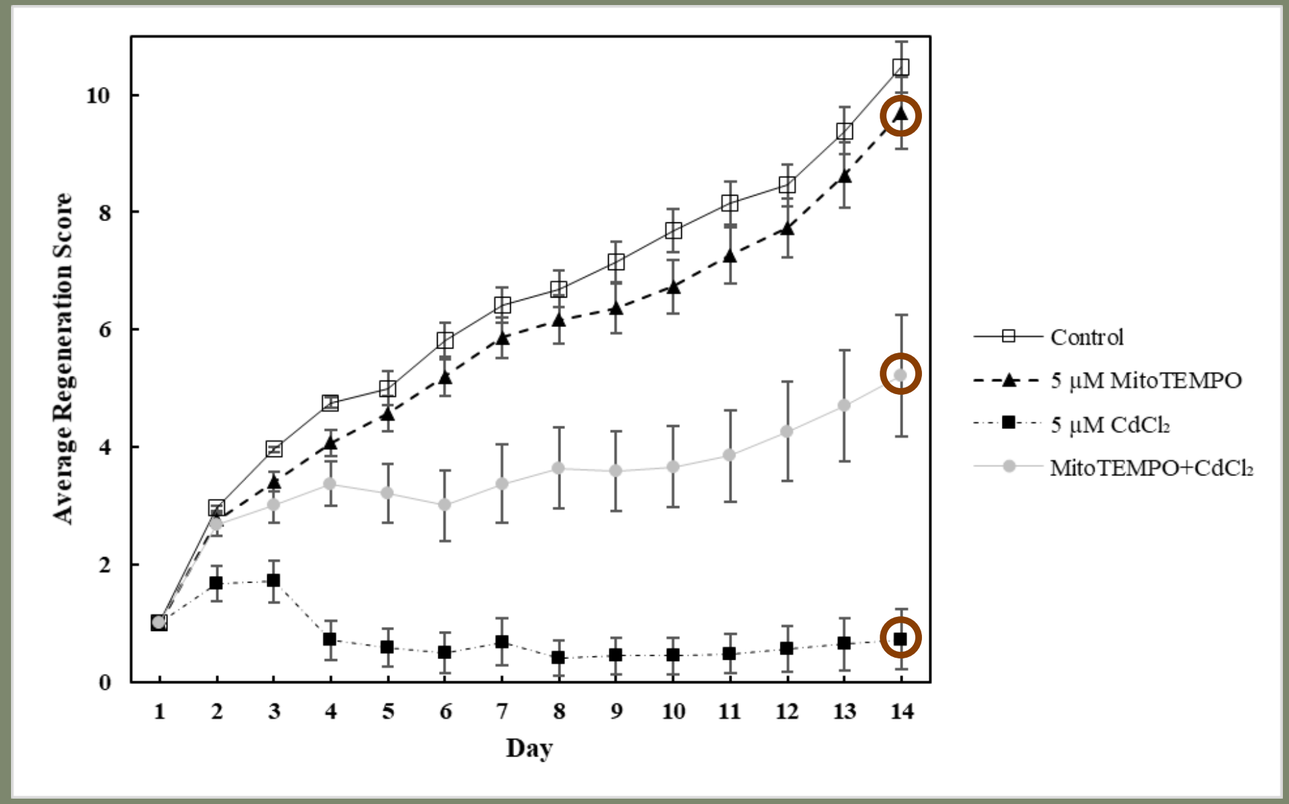

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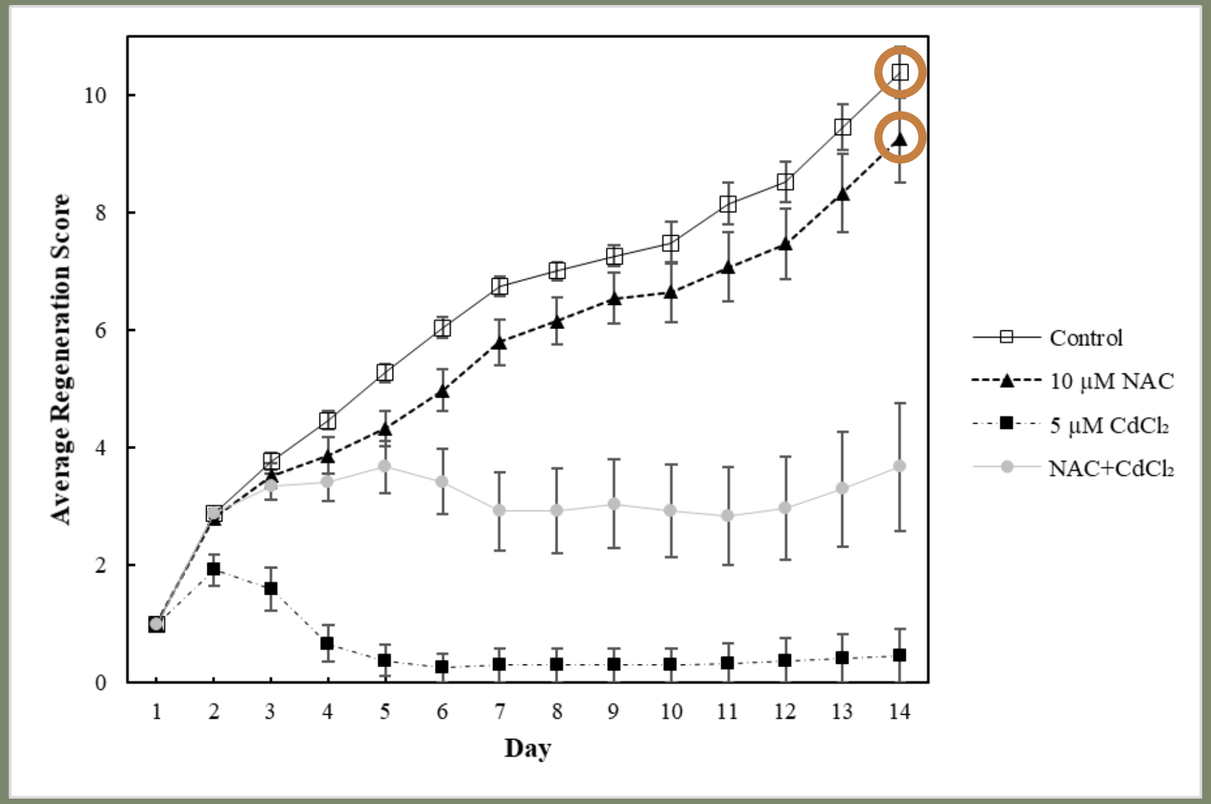

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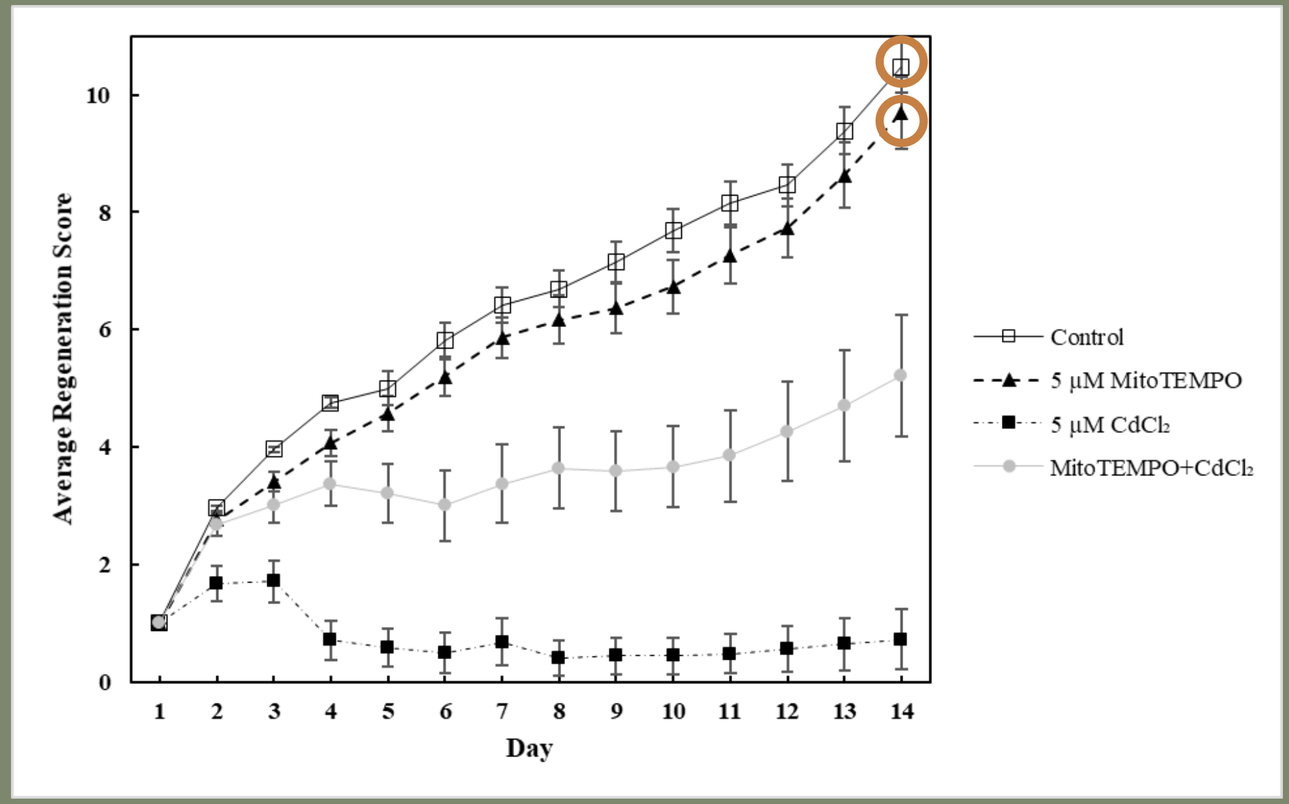

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DISCUSSION

Antioxidant partial rescuing response:

- NAC
  - Enzymatic activity helped regulate the cell's natural defense and detoxification system
  - Hunted ROS snd reduced oxidative damage

- MitoTEMPO
  - Targeted ROS in the mitochondria
  - Protected mitochondrial function for cellular energy in tissue regeneration

Variation among trials:

- Control groups exhibited stress
- Antioxidant Exposure
  - 5 μM $CdCl_2$ exhibited stress
  - Average regeneration score was very low throughout the two weeks
- Alternative mechanisms may have taken place

SPONTANEOUS DROPPING TAILS

(Gonzalez, 2024)

What is it?

- Form of asexual reproduction
- Defensive tactic against unfavorable environmental conditions (Ward's Science, 2005)

Potenital Causes:

- Disruption in signaling pathways
  - Dysregulated injury response
  - Delayed tissue regeneration

SPECIES DIFFERENTIATION

(Gonzalez, 2024)

FUTURE WORK

ROS Scavenging:

- Fluorescence microscopy
  - Directly visualize interactions between ROS and neutralizing molecules
- Biochemical assay
  - Measure ROS levels and check how well neutralizing agents reduce harm caused by them

Planaria:

- Precise speciation
  - Genetic testing
- Run trials at the same time
  - Reduce the risk of any seasonal sensitivity

IMPORTANCE

Our results underline the effects of $CdCl_2$ and antioxidants on regenerative processes to ongoing research in regenerative biology

Offers potential avenues for the development of novel therapuetic interventions

Improves public health outcomes

ACKNOWLEDGEMENTS

Lynn University:

College of Arts and Sciences

Mentor:

Dr. Cassandra Korte

Committee Members:

Dr. Erika Doctor

Dr. Alanna Lecher

Planarian Research Group:

Alexis Galindez

Logan-Marie Torry

Jonathan Newman

Anden Velez

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QUESTIONS?

Thank you!