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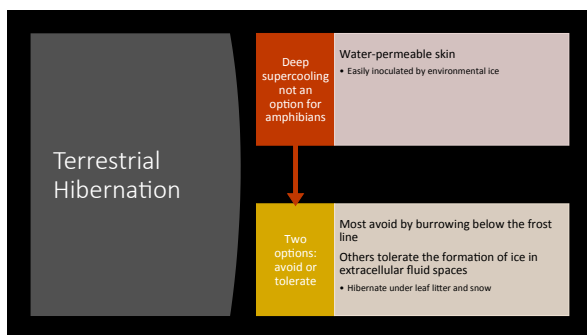
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### Freeze Tolerance Biology

Mostly seen in invertebrate groups, plants

- Insects, snails, barnacles, mussels

Vertebrates

- Four species of frog
- One salamander species
- Hatchlings of the midland painted turtle (*Chrysemys picta marginata*)

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### Freeze Tolerance Biology: Basic Strategy

Initiation of extracellular freezing at high subzero temp (> -10°C)

Withdrawal of pure water into ice

Cells shrink and dehydrate

Minor osmotic adjustments with subsequent temp changes

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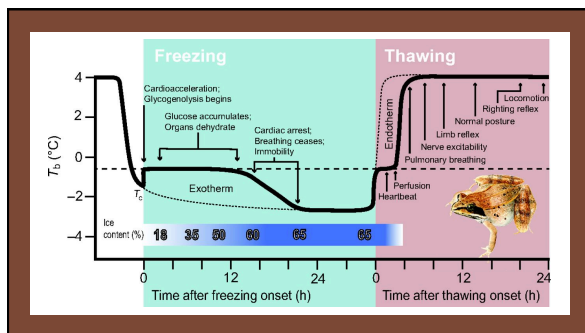
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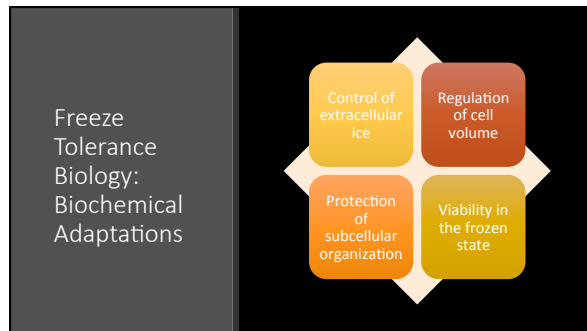
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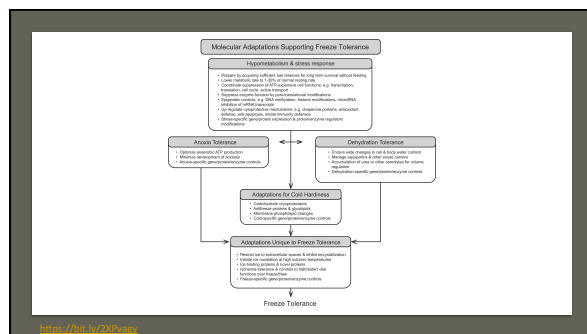
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**Example Species**

- Lithobates sylvaticus* – Wood frog
- Hyla versicolor* – Gray treefrog
- Hyla crucifer* – Spring peeper
- Pseudacris triseriata* – Western chorus frog
- Salamandrella keyserlingii* – Siberian salamander

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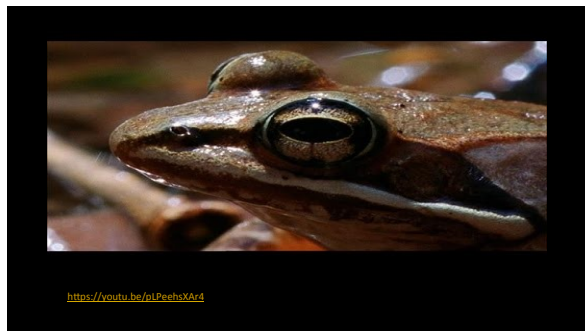
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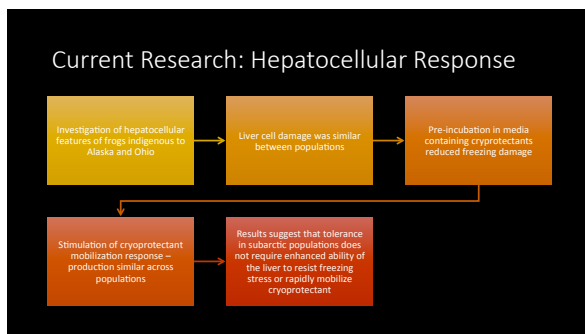
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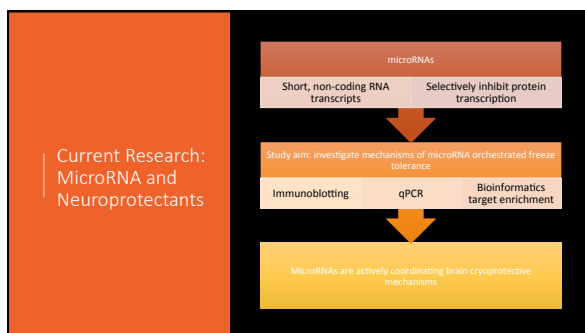
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Future Research

Efficacy of urea as a cryoprotectant

Relative abundance of adrenergic receptors

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Kahoot!

- <https://create.kahoot.it/share/freeze-tolerance-in-amphibians/5bb8befb-de62-42dd-a375-d8fb70189479>

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