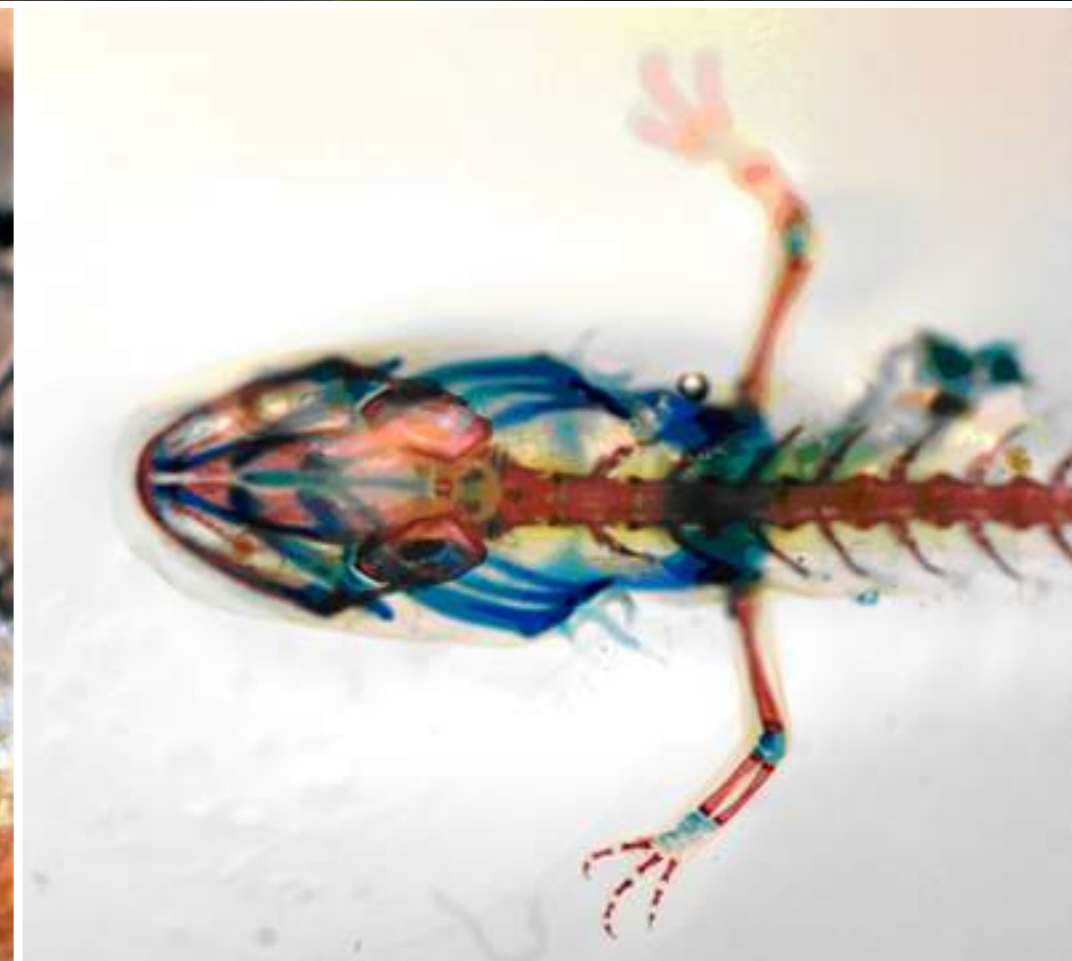


Amphibian Physiology



Announcements

- **Whoops!** Correction: *Necturus maculosus* belongs in the salamander family Proteidae, NOT Cryptobranchidae (thanks Matt!)
- Should have gotten project proposals returned
- Guidelines and exemplar introduction and methods are posted on the eebedia page

Introduction & Methods Draft

- Draft of the following sections due **WEDNESDAY** at 11:59pm (I wanted to give you more time with the guidelines)
- Formatting the same: Times New Roman, 12 pt font, 1 inch margins, **at minimum 2 double spaced pages**
- **Introduction**
 - **Background:** Introduce your scientific question, give background on scientific question
 - **Study Species:** Background on study species and how it can be used to answer your scientific question
 - **Hypothesis:** State your hypothesis (or hypotheses), and predict the answer to your scientific question
- **Materials and Methods**
 - **Field Methods:** State how you will (or how you are) sampling your study species (different sites? different locations within sites? how many?), what you're measuring (counting? SVL? environmental factors?), etc.
 - **Lab Methods:** You can't use lab methods for this project
 - **Data Analysis:** Once you've collected your data, you should test it for correlation and/or significance (can I fit a line to my data? can I test for deviation from neutral expectations?)
- **Literature Cited**
 - You should be citing your work as you progress
 - I don't expect citations to be completed
 - Suggested resources: your field guide, DEEP fact sheets posted online, Google Scholar
 - **No Wikipedia:** try the citations at the bottom of the wiki page, but beware of plagiarism



What kind of herp is this?



What kind of herp is this?

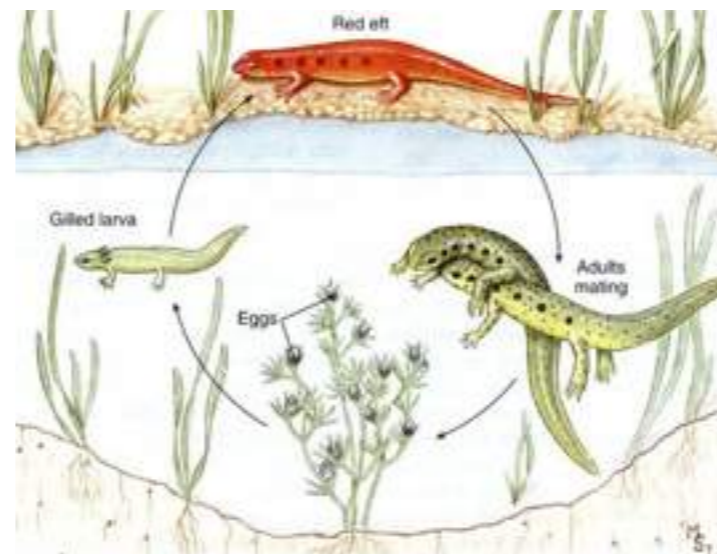


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What kind of herp is this?

What is Physiology?

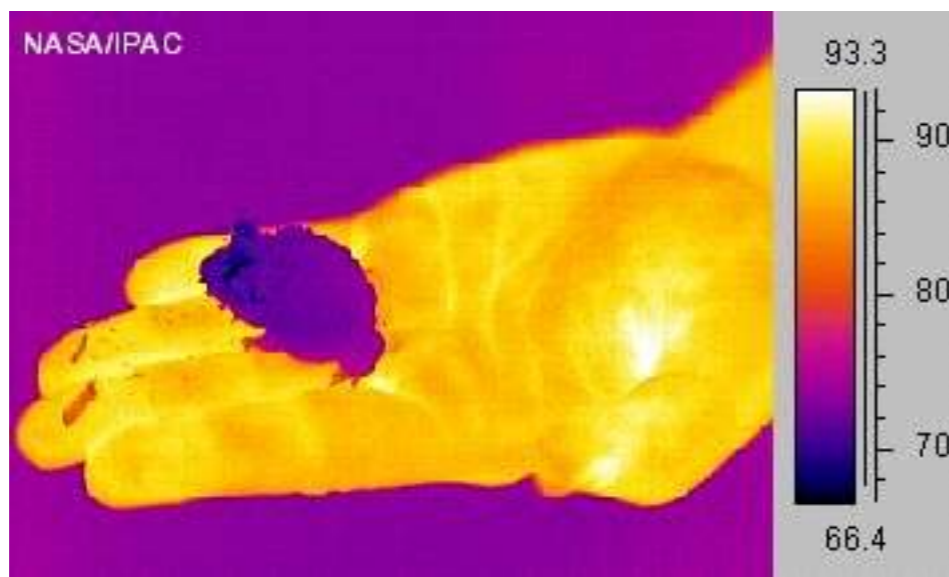
- The study of **chemical** and **physical processes** in the organism
- Aspects of the physiology can be informative for understanding organisms in their environment
- Thermoregulation
- Water Regulation
- Development



Thermoregulation

- All amphibians and reptiles are **ectotherms**
 - Their body temperature is governed by the environment.
- Changes in temperature have cascading effects throughout the body
 - Brain function
 - Muscle function
 - Digestive function

Optimal functions occur at T_o



Amphibian Thermoregulation

- Amphibians, for the most part do not bask to warm their bodies
 - Salamanders - no evidence
 - Frogs - perhaps *R. catesbiana*?
- However, some amphibians will move to accommodate changes
 - Salamanders - Movement between underground (cold nights) and cover objects at the surface (warm days)
 - Frogs - Movement between middle of the pond (cold nights) and the shore (warm days)



Amphibian Thermoregulation



- **Plethodontids** are especially adept for life at cold temperatures
 - Lungless
 - Cold water carries more oxygen (even in moist soils)
 - Specialized feeding structures
 - Gets around the “cold muscle” problem

Overwintering

Moving to Warm Habitat

- Frogs - hibernate
 - Terrestrial hibernators (e.g. *Bufo*, *Scaphiopus*)
 - Aquatic hibernators (e.g. *Rana catesbeiana*, *Rana clamitans*, *Rana pipiens*, etc.)
- Salamanders - reduced activity
 - Underground burrowers (e.g. *Plethodon*, *Ambystoma*, *N. viridescens* red-eft)
 - Active in aquatic habitat (e.g. *N. viridescens* adults)



Overwintering

Freeze Tolerant Frogs



- Some species are specially adapted to freeze
 - *Pseudacris crucifer*
 - *Hyla versicolor*
 - *Rana sylvatica*
- Possess large carbohydrate stores in their liver, which is converted to glucose or glycerol in the winter, serving as an antifreeze
- Allows a head-start before other frogs come out of hibernation at the bottom of ponds

Water Regulation

- Proper water balance is one of the most critical factors in **habitat choice**.
- However, the fact that amphibians are “shackled” to the water is largely overblown; there are important...
 - adaptations for very dry conditions
 - adaptations for very wet conditions



Dry Condition Adaptations

- Moist skin is a huge vector for water loss in terrestrial amphibians
 - Habitat choice
 - Skin anatomy
 - Warty skin (*B. americanus*)
 - Mucus (*P. glutinosus*)
 - Water storage in urinary bladder
- Many amphibians can take up water through the skin
- Adaptations NOT seen in CT:
 - Cocoon frogs
 - “Waterproof” frogs

I am **chugging** this water right now.



Wet Condition Adaptations

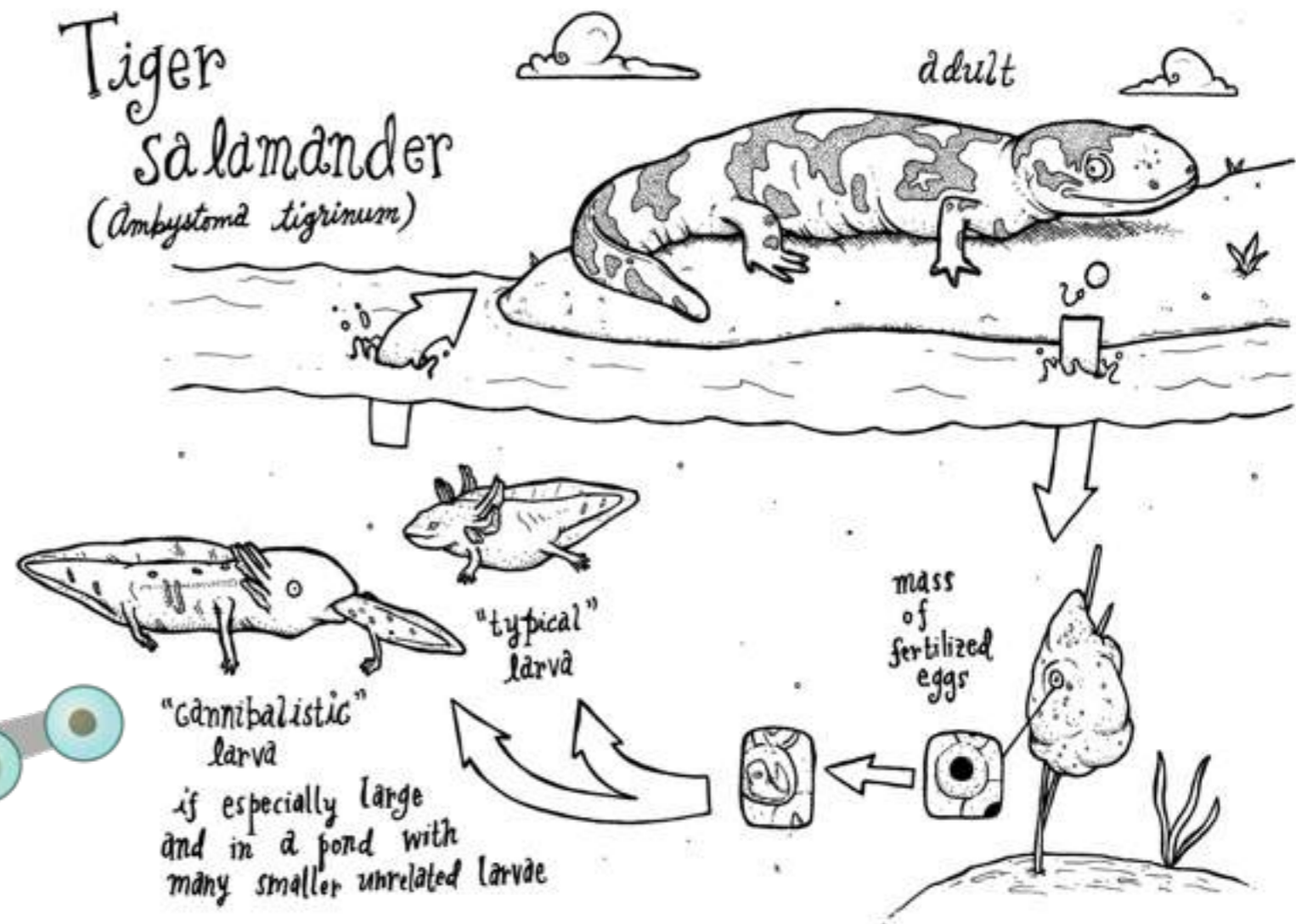
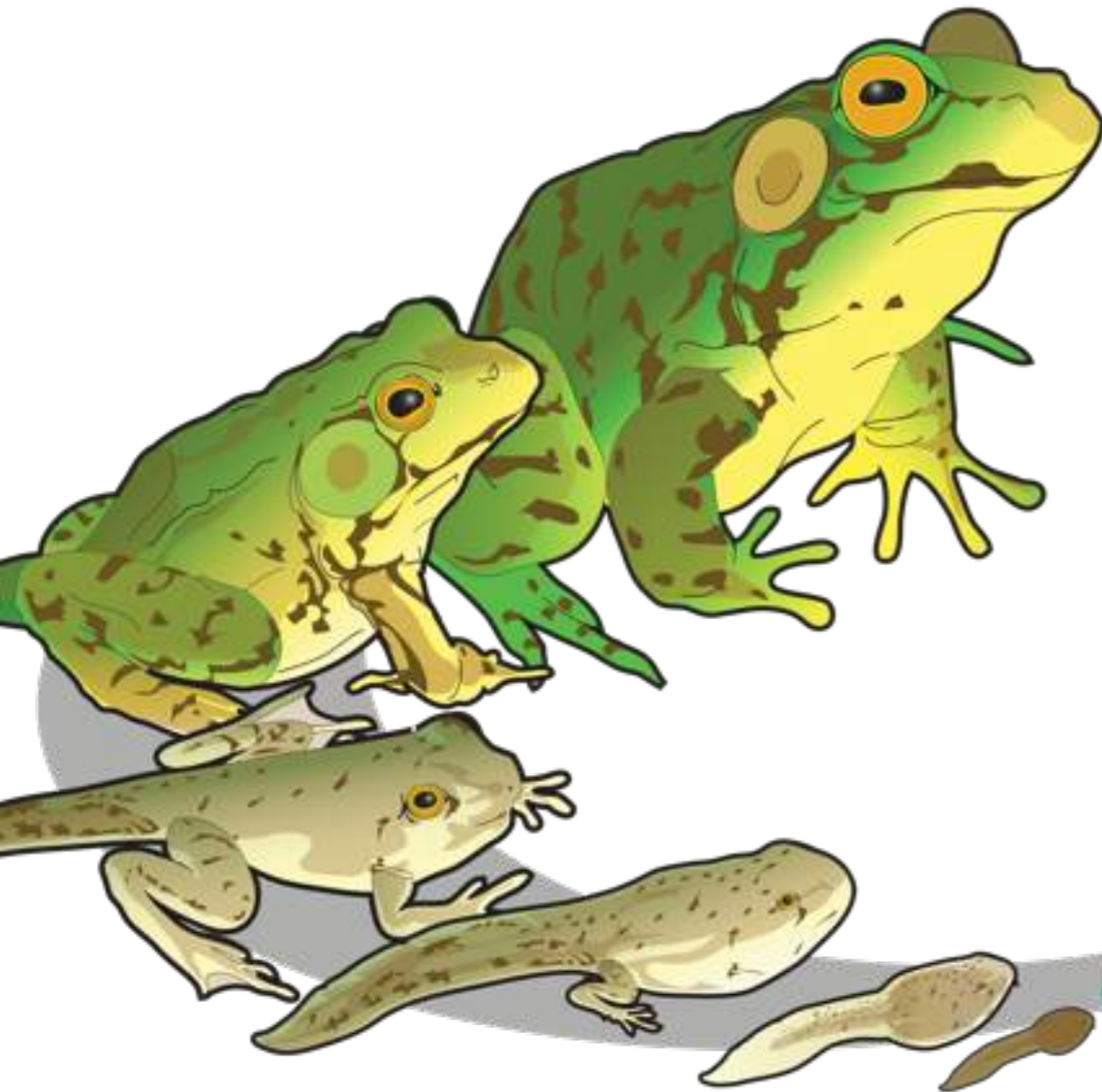


- Smooth skin makes drinking via skin slower
- Fluctuating blood ion concentrations
 - Keep blood ion concentration low, so water flows out (opposite is true for terrestrial species)
- Excrete nitrogenous waste via ammonia, which is toxic but very water soluble
- Secreting fungicidal chemicals and antibacterial agents to keep the skin clean and healthy

Development

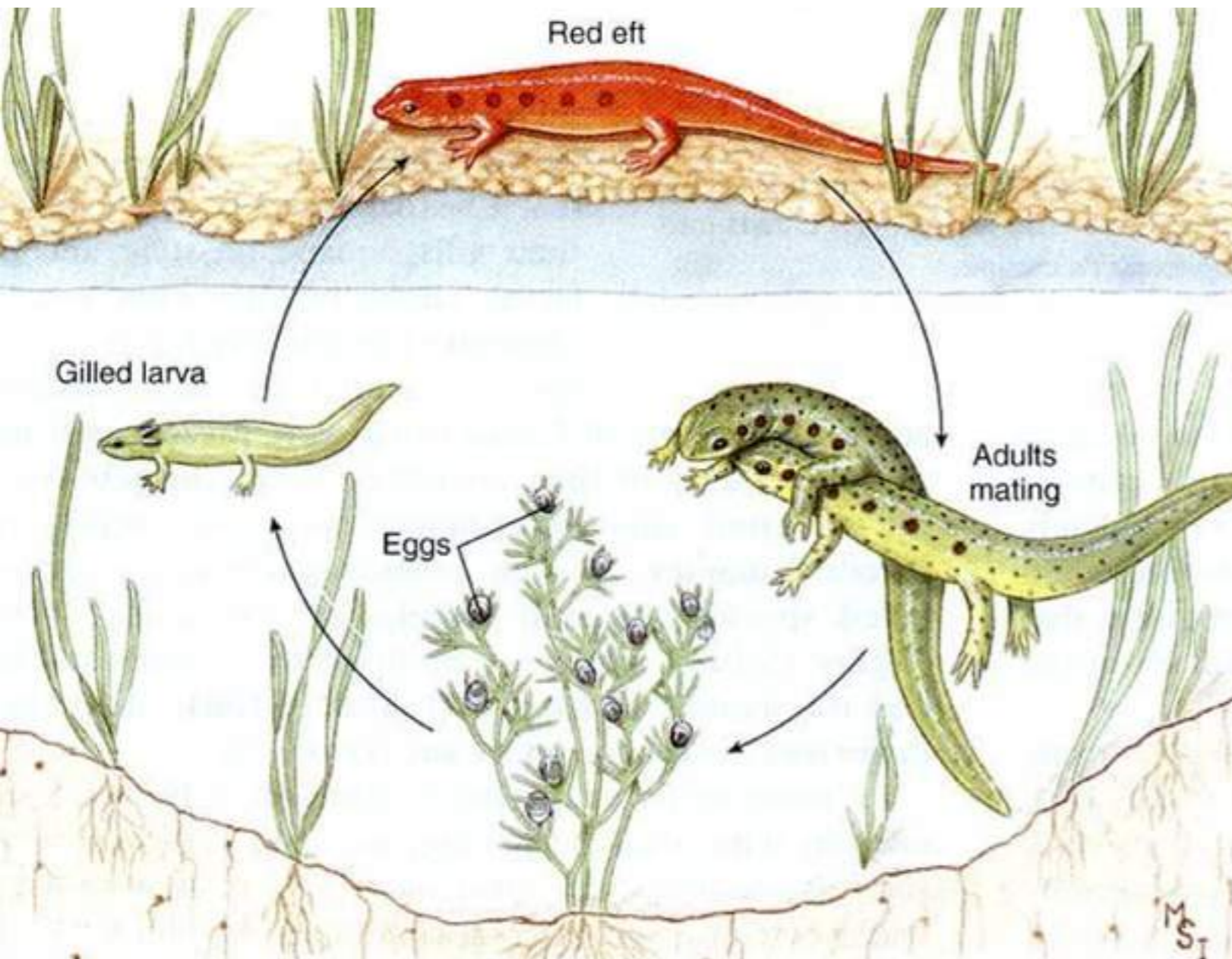
- **Ontogeny** is the process of creation and development of an organism; the growth of an organism from embryo to mature adult
 - “Normal development”
 - Regeneration
- Amphibians in CT have **four** different ontogenies

Ontogeny 1: Egg, Aquatic Larvae, Adult



- All CT frogs
- All CT salamanders except for *Plethodon* and *Necturus maculosus*

Ontogeny 2: Egg, Aquatic Larvae, Terrestrial Subadult, Aquatic Adult



- *Notophthalmus viridescens*
- “Adds another step”

Ontogeny 3: Egg, Terrestrial Subadult, Terrestrial Adult

- *Plethodon cinereus* and *Plethodon glutinosus* salamanders
- “Skips aquatic larvae”



Ontogeny 4: Egg, Aquatic Larvae, Sexually Mature Aquatic Larvae

- *Necturus maculosus*
- “Skips adult stage”

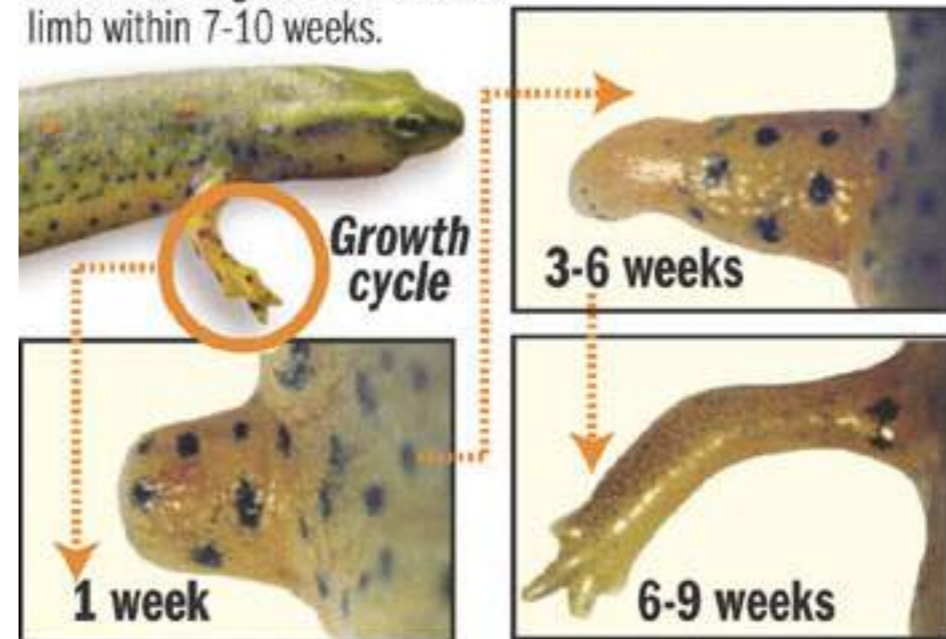


Limb Regeneration

- Salamanders

- Appear to retain this ability throughout their lifespan
 - Tails
 - Limbs
- They get **everything** back, bone, muscle, and nerves!

A newt can regenerate an entire limb within 7-10 weeks.



- Frogs

- Tadpoles capable of regenerating tail, but adult frogs cannot regenerate
- Can only regenerate the notochord

Tail regeneration

