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- Outline**
- What is a life history strategy?
  - Diversity of life cycles
    - Stage structure
    - Participants
    - Evolutionary Implications
    - (Conservation implications)
  - Heterocrony
    - Paedomorphism
    - Paedogenesis

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**What's a life history strategy?**

- "Life history strategies describe the anatomical, physiological, and behavioral adaptations controlling how individuals invest in reproduction and self-maintenance [growth and survival] in response to environmental conditions."

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- Mode of reproduction
- Breeding phenology
- Mate attraction/recognition
- Mode of fertilization
- Egg size/nutrient investment
- Clutch Size
- Parental Care
- Stage Structure
  - Number of stages
  - Aquatic/terrestrial
  - Age/Stage of sexual maturity
  - Length of time in stages
- Post-reproductive behavior
- Lifespan/senescence

Ultimately, all of these traits correspond to variation of investment to growth, reproduction, and survivorship.

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**Why a complex life history?**

- “... a complex life cycle with metamorphosis can be seen as an adaptation that permits independent responses of different life history stages to selective pressures in different environments.” (Wells, 2008)

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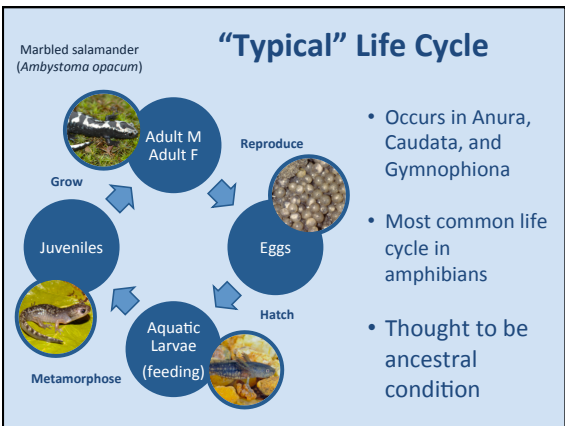
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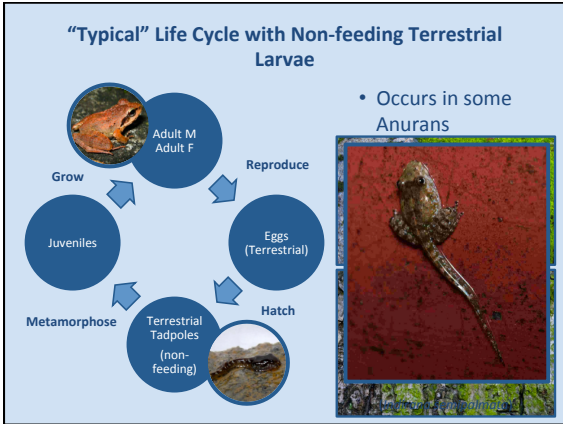
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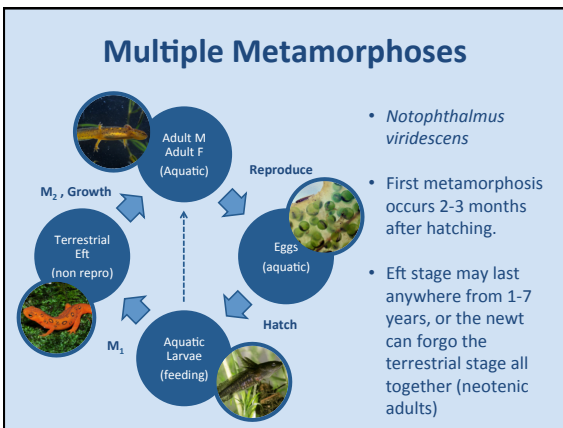
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### Direct Development

- "If an animal after [live] birth or emergence from an egg differs from the adult in comparatively minor details (apart from not having functional sex organs), the development is said to be direct. **There is no larval stage and no metamorphosis.**"  
(Encyclopedia Britannica)
- Important survival implications.
  - Water availability is variable
  - Fierce aquatic predation

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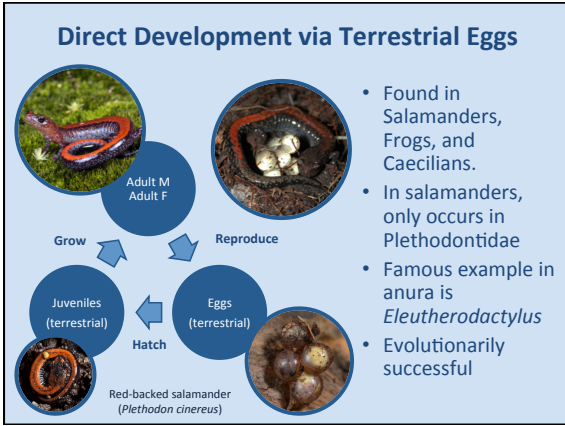
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Horned marsupial frog (*Gastrotheca cornuta*)  
Dorsal Brood Pouch, toadlets emerge.

**DIRECT DEVELOPMENT**

Andean marsupial tree frog (*Gastrotheca riobambae*) Dorsal Brood Pouch, tadpoles emerge in water and metamorphose.

**NOT DIRECT DEVELOPMENT**

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### Direct Development via Live Birth

Adult M  
Adult F

Birth

Juveniles

Grow

Western Nimba toad  
(*Nimbaphrynoides occidentalis*)

- Found in an extinct *Eleutherodactylus* and a few African toads.
- Viviparous or ovoviviparous

The diagram shows a circular life cycle. On the left, a blue circle contains the text 'Adult M' and 'Adult F'. An arrow labeled 'Birth' points to a blue circle on the right containing the text 'Juveniles'. A smaller image of a toadlet is shown next to this circle. An arrow labeled 'Grow' points back to the 'Adult M' and 'Adult F' circle. A small image of an adult toad is shown next to this circle.

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### Live Birth With Aquatic Larval Stage

Fire salamander  
(*Salamandra salamandra*)

Adult M  
Adult F

Birth

Aquatic Larvae

Metamorphosis

Juveniles

Growth

- Found in 2 Caudate genera
- May be ovoviparous, or viviparous (oophagy or adelphophagy) or a combination of the two even within the same species.
- In very rare instances, may give birth to fully metamorphosed juveniles (DD).

The diagram shows a circular life cycle. At the top, a blue circle contains 'Adult M' and 'Adult F'. An arrow labeled 'Birth' points to a blue circle on the right containing 'Aquatic Larvae' and a small image of a salamander larva. An arrow labeled 'Metamorphosis' points to a blue circle on the left containing 'Juveniles' and a small image of a salamander juvenile. An arrow labeled 'Growth' points back to the 'Adult M' and 'Adult F' circle.

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Fire Salamander (*Salamandra salamandra*)

The image shows a single, oval-shaped egg with a translucent, greyish outer shell and a bright blue, circular spot in the center. The egg is positioned in the center of a light blue rectangular frame. Below the frame, two small upward-pointing arrows are visible.

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### Hemotrophic Nutrient Exchange

- 2 species of toads (*Nectophryn* *occidentalis* and *N. liberiensis*)
- Viviparous
- Pregnancy can last up to nine months
- Tadpoles develop inside the oviducts and first use up their yolk reserves and then feed of “uterine milk” secretions produced by glands in the oviduct walls. (Xavier, 1986)




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### Alpine Salamander

(*Salamandra atra*)

- Uterine eggs (ovoviviparous) large and numerous but only one will develop. Rest dissolve to form nutritive vitelline mass. Pregnancy lasts 2-3 years.

1. Still enclosed within their own yolk
2. Free, within vitelline mass, feed directly by mouth
3. Possesses long external gills for an exchange of nutrients with maternal uterus (characteristic of mammalian egg)




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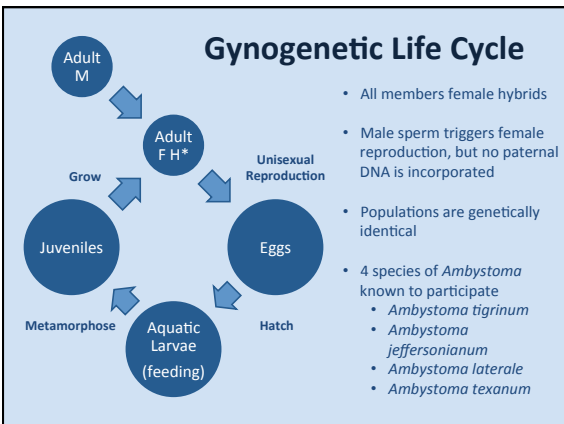
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## Heterochrony

- Changing in timing or rate of growth of a trait with respect to an ancestral trait.
- Differences in morphology between species can be explained by changes in ontogeny.
- Important in amphibians are 2 types
  - Paedomorphosis
  - Paedogenesis
- Usually used in context in which sexual maturity is achieved while larval characteristics are retained

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## \*\*Paedomorphosis\*\*

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## Paedomorphosis

- An interspecific process reflecting change over evolutionary time.
- Compare a paedomorphic taxon with its immediate non-paedomorphic ancestor.
  - Paedomorphic if we observe truncation; if a trait fails to develop to the point observed in an ancestral species.
- “Retention in adults of any traits that occur only in earlier developmental stages in an ancestral species” (Wells, 2008)
- “Full metamorphosis” never occurs.

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**Paedogenesis (Neoteny)**

- An intraspecific process reflecting change over ecological time.
- Individuals within populations of a species retain larval characteristics while achieving sexual maturity, and may or may not undergo “complete” metamorphosis, depending on environmental conditions.
- Sympatric populations of “larval” adults and fully metamorphosed adults.

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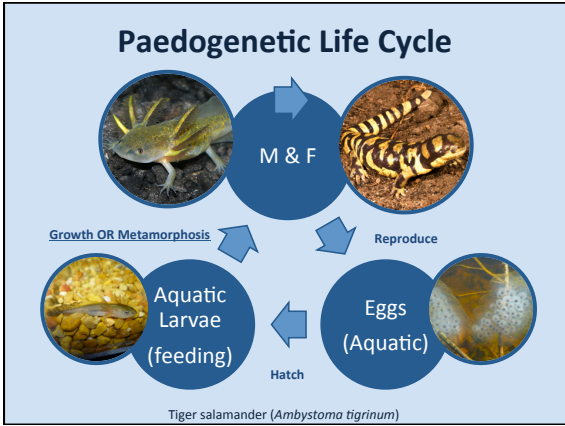
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- Paedogenesis example
- <https://www.youtube.com/watch?v=asOCVEAwsCA>
- 1:37 - 3:35

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### References

- Encyclopedia Britannica: Direct Development
- Dr. Ecternacht's lecute (thanks!)

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