Evolution of Animal Form & Function
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News/Updates:
1) First Exam: Feb 18th
2) Questions posted by Feb 14th
3) No class next Tuesday, Feb 11th

Many more ways to be dead than alive

Typical protein ~ 500 amino acids
20 amino acids
(Theoretical) protein universe = \(20^{500}\)

Particles in Universe:
\(3.28 \times 10^{80}\)

New you:
By ECOL 330 finals (early May) you will have completely replaced your:
1) Skin: 8 times
2) Blood (RBC): once
3) Intestine surface: 30 times
4) Liver: 1/2
5) All sperm cells: 40 times (2 full cell lineages, ~27 billion)
6) Skeleton: ~5% completely
7) Only 2-3 of your tissues will have ALL cells that witnessed today’s lecture.

— How do stem cells retain their capacity to form new structures?
Seven general questions in evolution and development:

6) The question of evolution
Evolution involves inherited changes in development.

—What evolutionary changes are allowed by development?
—How do changes in development create new body forms?

Where in developmental hierarchies do these changes reside?

White Wolf | Black Wolf
Seven general questions in evolution and development:

7) The question of environmental integration

The development of all organisms is influenced by environment.

How are environmental cues integrated into development?
Ma le nestling are more affected by mite-infestation

Tucson, AZ

Survival

No. of mites per nestling

Days spent in nest

Nestling tenure, ds

Bone Morphogenic Proteins (BMP) control ossification

Do maternal stress hormones influence nestling growth?

injection of eggs from mite-free period

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7) **The question of environmental integration**

Evolution (from Latin: evolutio, unrolling) was first applied in 1774 to the "unfolding" of an individual during embryonic development.

"... there is, in fact, included in the egg a perfect little human machine... All human bodies were fully formed and folded up in the ovary of Eve and these bodies then were gradually distended until they grew to the form and the size...".

**Evolution and Development**

Albrecht von Haller (1708-77): Child prodigy, poet, lawyer, botanist, linguist, physiologist; lifetime writings > 650 articles, books, stories, poems

Two major theories:

- **Preformation** view: the unfolding and growth of structures already present (e.g., in the egg).
- **Epigenesis** view: the gradual and progressive appearance of new structures, each dependent on preceding structures, processes, and environments.

Preformation

**Ovists** (17-18th centuries) maintained that the organisms were preformed in eggs (ova).

Sperm – discovered in 1677 – are thought to be parasites and played no role in development

Antonie van Leeuwenhoek (1678): spermatozoon (Gr: animals living in sperm)

"scrapings from tooth reveal numerous minute and highly vigorous organisms under the microscope"
Letter to the Royal Society*:

“What I investigate is only what, without sinfully defiling myself, remains as a residue after conjugal coitus. And if your Lordship should consider that these observations may disgust or scandalize the learned, I earnestly beg your Lordship to regard them as private”.

Leeuwenhoek 1678

*published 2 years later, resulted in several people publishing similar observations

Lazzaro Spallanzani (1729-1799)
Filtered toad semen does not fertilize eggs, but still thought that spermatozoa were parasites

J.L. Prevost and J.B. Dumas (1824)
Absence of spermatozoa in the sterile mule, very young and very old animals

“...there exists a puzzling but intimate relation between spermatozoa presence and the fecundating ability of the animal…”

Preformation

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Fabricius (1537-1619)
Females are fertilized by “spiritual iradiation”

Preformation

Spermatists (18-19th centuries) maintained that the organisms were preformed within sperm

Nicolaas Hartsoeker (1656 – 1725)
Adult body fully formed in miniature as “seen” in human sperm by Hartsoeker in 1694

Contraceptive trousers from pig bladder

Perturbation

Marin Scharig (1656–1733) publishes Spermatozophila Historica-Antiqua, suggests that semen is produced in the brain as did Hippocrates in the 6th century BC

Antonio Vallisneri (1661–1730) shows mammals have eggs produced by ovary; claims semen has no effect on reproduction

Stephan Ludwig Jacob (1708–7) develops technique of stopping and artificial fertilization of trout and salmon eggs

John Hunter (1728–1793) orchestrates successful artificial insemination of human patient (late 1780s)

Lazzaro Spallanzani (1729–1799); Figure 9 successfully performs artificial insemination on a dog

Spallanzani fertilizes frog eggs from material including sperm filtered from semen but not from urine but reaches dog that sperm involved in fertilization

Hartsoeker draws drawing of sperm containing tiny human, representing what he thought he might see

Onderpijls/François de Plantade (1670–1749) publishes Ondertien faam en grootte van spermen, demonstrated as a hoax
Preformation

Backing of 18th century science, religion, and philosophy:

1) If all organs prefigured, development merely requires growth, not the formation of new ones. No extra force.

2) Just as the adult organisms were prefigured in the germ cells, another generation existed in a prefigured state within the germ cells of the first prefigured generation, etc. No lower limit on cell size – Bonnet 1684: “Nature works as small as it wishes.”

Importantly – this insured ENCAPSULATION – that species would remain constant.