Lecture XII – Origin of Animals – Dr. Kopeny

Delivered 2/20 and 2/22

Origin of Animals and Diversification of Body Plans
Animalia is hypothesized to be monophyletic based on shared derived characters including:
- rRNA
- cell junctions
- matrix proteins
Animals are generally characterized by the organization and specialization of cells into tissues and organs, which derives from a unique developmental program that includes "gastrulation."
Body Plan are Basic Structural Designs

Virtually each animal phylum represents a fundamentally distinct body plan.

Body plan refers to major characteristics of an organism’s structural and functional design; its basic architecture and the integrated functioning of its components.

General trend towards increased complexity in body plans

Aspects of body plan include

- body symmetry
- presence of embryonic tissue layers are resultant tissues and organs
- organization of nervous tissue - eg cephalization
- skeletal support - eg hydrostatic skeleton
- presence/nature of a body cavity
Animals originated some 580 mya. Over the relatively short course of 60-70 million years, virtually all phyla and major body plans arose.
Protistan Choanoflagellate

Sponge (Porifera)

Water current out of sponge

Water current into sponge

Choanoflagellate cell

Sponge feeding cell

Food particles

Asymmetrical body plan: brown volcano sponge
(\textit{Brachioma} sp.), Roatan, Honduras. Copyright David J.
Wrobel/BPS.
Phylogeny of animals based on morphology

Phylogeny of Animals based on rRNA sequences

blue branches differ from morphology-based phylogeny
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- Porifera
- Cnidaria
- Ctenophora
- Platyhelminthes
- Nematoda
- Arthropoda
- Annelida
- Mollusca
- Echinodermata
- Chordata

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Lophotrochozoans; includes phyla with lophophore feeding structure or a trochophore larva stage in life cycle

Ecdysozoans; includes animals that molt, via a molting hormone called “Ecdysone”
Lophotrochozoans
- grow by increasing size of skeletal elements
- use cilia for locomotion
- many have a free-living larva called a "trochophore"

Ecdysozoans
- increase body size by molting (molt hormone is called "ecdysone")
- don't use cilia for locomotion
- share a common set of homeobox genes

Bryozoaons are colonial lophophorates
Annelids are spiralians

Lophotrochozoans are spiralians
- grow by increasing size of skeletal elements
- use cilia for locomotion
- many have a free-living larva called a "trochophore"
Most of the basic body plans of animals derive from variations in a relatively few design and construction features:

- Embryonic tissues
- Symmetry
- Body cavity
- Early development
Embryonic tissue layers

Tissue
Group of similar cells organized into a functional unit and usually integrated with other tissues to form part of an organ

Characterization of Phyla by presence or absence of tissue layers

Diploblasts  Two embryonic tissue layers; endoderm and ectoderm.

Triploblasts  Three layers -- above two and an intervening mesoderm

Functional and structural significance; tissues and organs derived from embryonic tissue layers in triploblasts

Endoderm  digestive tract (gut)

Mesoderm  connective tissue (muscle, bone)

Ectoderm  outer covering, nervous system
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**Body Symmetry**

Symmetry refers to the number of imaginary planes that would divide an organism into identical sections.

- **Asymmetry**
- **Spherical symmetry**
- **Radial symmetry** (spoke-like)
- **Bilateral symmetry** (identical halves)

**Relating function to radial symmetry**

Most radially symmetric animals are aquatic and live either planktonic or sessile (or both) lifestyles.

Lack directed (unidirectional) movement; have ability to react to predators or prey approaching for any direction.

Free-swimming cephra of *Aurelia aurita*. 
Relating function to Bilateral symmetry

All bilaterally symmetric animals are **triploblastic**

Bilateral symmetry is widespread, so assumed to be **highly adaptive**; efficient unidirectional movement for finding and securing food, and avoiding predators, driven by well-differentiated head and tail (trunk) region

**Cephalization; nervous system development; anterior concentration of brain and sensory structures**

**Trunk or tail region** largely involved in movement, which derives from musculature and skeleton

Evolution of third tissue layer -- **mesoderm**, allowed for evolutionary innovations not only in musculature and mesodermal tissues and organs, but in differentiation and specialization of ectoderm - nervous system

A triploblastic, bilaterally symmetrical body has great potential for evolution of efficient and effective lifestyles
Body Cavity (coelom)

Fluid-filled body cavity has great evolutionary potential
- creates medium for circulation
- creates space and protected environment for internal organs
- gives rise to potential for operation of hydrostatic skeleton

Diploblasts lack fluid-filled cavity other than central canal
All triploblasts, except flatworms have fluid-filled body cavity
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Diploblasts lack fluid-filled cavity (acoelomates) other than central canal

All triploblasts, except flatworms have fluid-filled body cavity
Of all lineages with fluid-filled cavities, in all except the nematodes and rotifers (pseudocoelomates) the cavity lies entirely within mesoderm (coelomates)

Coelomates bear a more “advanced” design in that muscles, blood, etc can form on either side of the body cavity
Hydrostatic skeleton of a nematode

When muscles on one side contract, fluid-filled chamber does not compress - instead, the animal bends.
Coelomates are triploblastic and, except for echinoeards, bilaterally symmetrical. The great coelomate lineage includes two groups that differ based on early embryonic events and processes; protostome and deuterostome lineages.

A very large proportion of all animals are protostomes including arthropods, molluscs and annelids; chordates and echinoderms are deuterostomes.