

Diversity of Invertebrate Animals

Classification

- Dependent on physical, physiological and behavioral characteristics

Single-celled Organisms

- Single-celled (protozoans – animal-like protists) vs multicellular animals
- Single-celled organism must carry on all functions of the animal individually including feeding, reproduction and locomotion
 - Asexual reproduction is typical

Phylum Foraminifera

- Foraminiferans (shelled amoebae)
- Shell composed of CaCO_3 or cemented sand grains
- Typically benthic, some planktonic
- Have pseudopodia for feeding (trapping and conveying of food) and locomotion (unless attached)
- Contribute to geologic limestone and chalk

Foraminiferans (graphic)

Phylum Polycystina

- Radiolarians
- Shell usually from silica
- Primarily planktonic
- Have pseudopodia for food collection and increased surface area
- Previously foraminiferans and radiolarians together in Phylum Sarcomastigophora

Radiolarians (graphic)

Radiolarians (graphic)

Phylum Ciliophora

- Ciliates
- Have cilia for moving and feeding
- Many parasitic in gills, digestive tract and skin
- Some in sediments or attached to surfaces

Ciliates (graphic)

Multi-cellular Organisms

- Typical of animals though the transition is vague between colonial protozoans and loosely organized multicellular organisms
- Leads to tissue organization, e.g. contractile muscles and conducting nerve tissue; and further to organ systems

More Multi-cellular

- Includes sexual reproduction with meiotic production of haploid sex cells
 - Frequently includes larval stage (distribution for benthic organisms)
- Developmental formation of blastula - process of layering tissue

- Requires skeletal support - internal or external

Kindom Animalia (graphic)

Phylum Porifera

- Sponges – most marine
- Multicellular with minimum of cell specialization
 - Pinacocyte - exterior protection
 - Porocyte (pore cell) – line pores (ostia)
 - Choanocytes (collar cell) - interior water movement and food collection
 - Amoebocyte - establish the spongin and/or spicule skeleton and distribute nutrients
- Suspension/Filter feeder
 - Water flow in ostia; out osculum

Sponge Structure

- Flagella of choanocytes generate water flow

More Sponge Structure (graphic)

Suspension Feeders (graphic)

More Porifera

- Typically benthic
- Support by spongin and/or spicules (silica or calcium carbonate) in intermediate gelatinous layer
- Sexual reproduction with short-lived larval stage
 - Gametes not produced by gonads; derivative of other cells, e.g. choanocytes
- Also asexually reproduce by budding

Spicules (graphic)

Sexual Reproduction (graphic)

Sponge Cell Plasticity (graphic)

Any Relationship? (graphic)

Symmetry

- Radial vs. bilateral
- Some Porifera are radial, others not
- Phylum Cnidaria are the largest group that highlight radial symmetry
 - Class Hydrozoa - hydroids and man-of-war (colonies are not radial...individual specialization of responsibility)
 - Class Scyphozoa and Cubozoa- jellyfishes
 - Class Anthozoa - corals and anemones

Examples of Symmetry (graphic)

Phylum Cnidaria

- Or Coelenterata
- Usually have both medusa & polyp stages
- Sexual and asexual reproduction

- Blind-ended gut with oral and aboral surface
- Mouth surrounded by tentacles with nematocysts
- Nerve net controls movement
 - Some with simple sense, e.g. statocyst

Medusa and Polyp Stages (graphic)

Class Hydrozoa (graphic)

Class Hydrozoa

- Siphonophores – detached, drifting colonial forms

Siphonophore (graphic)

Class Scyphozoa (graphic)

Class Cubozoa (graphic)

Class Anthozoa (graphic)

More Symmetry

- Phylum Ctenophora also radial symmetry (all marine and usually planktonic)
 - Comb jellies
 - Ctenes – eight bands of cilia
 - Carnivorous plankton feeders
 - No nematocysts, instead colloblasts (sticky)

Phylum Ctenophora (graphic)

Bilateral Symmetry

- Platyhelminthes and above
- Left and right, front and back
- True body cavity - coelom
- Cephalization and increased development of sensory apparatus
 - Highlighted by the mollusks (cephalopods)
 - Simplest forms are a range of small or microscopic benthic worms (seven phyla)

Phylum Platyhelminthes

- Flatworms
- Presence of simple organs
 - Including nervous system and small brain to control muscle movement
- Third layer of tissue replaces gelatinous layer – mesoderm
- Free living types are turbellarians, but many are parasitic
- Hermaphroditic, but many can reproduce by budding too

Platyhelminthes (graphic)

Phylum Mollusca

- Complete digestive tract with mouth and anus
 - Chitinous radula (absent in bivalves) and digestive enzymes
- Open circulatory system except in cephalopods
- Trend toward more centralized nervous system
- Variation in reproduction but usually separate sexes

Class Polyplacophora (graphic)**Class Gastropoda (graphic)****Class Bivalvia (graphic)****Class Cephalopoda (graphic)****More Bilateral Symmetry**

- Skeleton - external, hydrostatic (two layers of muscle), internal
 - Hydrostatic skeleton based on two layers of muscle surrounding a space - sipuncula (peanut worms) - all marine, benthic and usually intertidal
- Segmentation (Annelida and above)

Phylum Annelida

- Polychaetes
 - 10,000 in class, most marine
 - Parapodia with setae
 - Gills on parapodia
 - Closed circulatory system
 - Some are deposit feeders, some filter feeders

Class Polychaeta (graphic)**Deposit Feeders (graphic)****Class Polychaeta (graphic)****Even More Bilateral**

- Arthropods
 - Class Insecta - few related to marine environment
 - Class Merostomata - Horseshoe crab
 - Subphylum Crustacea - two pairs of antennae and gills (barnacles, crabs, shrimps, lobsters)
 - Subclass Copeopoda

Phylum Arthropoda

- Evident segmentation
- Exoskeleton made of chitin – molting
- Developed sensory function
- Complete digestive tract
- Open circulation

Subphylum Crustacea (graphic)**Subphylum Crustacea (graphic)****Subclass Copepoda (graphic)****Still More Bilateral Symmetry**

- Echinoderms secondarily radial (pentaradial or pentamerous)
 - Class Echinoidea - sea urchins and sand dollars
 - Class Crinoidea - sea lilies
 - Class Ophiuroidea - brittle stars
 - Class Holothuroidea - sea cucumbers
 - Class Asteroidea - starfishes

Phylum Echinodermata

- Much more advanced than other radial animals
- Endoskeleton (even sea urchins – test)
- Complete digestive tract (except brittle stars)
- Tube feet system for locomotion, respiration, excretion and sensation
- Larval forms that are bilateral
- Usually separate sexes
- Some capable of regeneration

Phylum Echinodermata (graphic)

Echinodermata (graphic)

Phylum Chordata

- Notochord, hollow dorsal nerve cord, pharyngeal arches, and post-anal tail
 - Subphylum Urochordata (tunicates)- sea squirts and salps
 - Subphylum Cephalochordata - lancelet (*Branchistoma*)
 - Subphylum Vertebrata - spinal column (with hollow nerve tube)replaces notochord, pharyngeal pouches, sensory structures and brain

Sponge Look-alike? (graphic)

Overview of Invertebrates (graphic)