Flatworms, Mollusks, Annelids

Embryonic Development

Review

Review of *Embryonic Development in Animals*

Below: The blastula, gastrula, and larva of a sea star (Phylum Echinodermata) can be seen.
**blastula** - hollow ball of cells

**gastrula** - an indentation has occurred

**blastopore** - the opening in the gastrula

**Review of Embryonic Tissue Types**
Cleavage in the early embryo

Protostomes Vs Deuterostomes

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<th>Protostomes</th>
<th>Deuterostomes</th>
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<td>flatworms, mollusks, annelids, roundworms, arthropods</td>
<td>echinoderms and chordates</td>
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<td>Cleavage</td>
<td>spiral, fate is determinate (fixed)</td>
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<td>Blastopore</td>
<td>becomes mouth</td>
<td>becomes anus</td>
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<td>Coelom</td>
<td>mesoderm arises from cells near the blastopore, with splitting forming the coelom</td>
<td>paired mesodermal pouches form from the primitive gut wall; they enlarge and fuse to form the coelom</td>
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Evolutionary Relationships
Flatworms (Phylum Platyhelminthes)

Characteristics

Flatworms are flattened and have bilateral symmetry.

They are triploblastic (have 3 embryonic tissue layers: ectoderm, mesoderm, and endoderm) and therefore have organ-level of organization. There is no body cavity, so they are acoelomate.

Flatworms have a gastrovascular cavity with one opening (a sac-like gut).

Free-living Species

Example: Dugesia - a freshwater planarian

Planarians have a branching sac-like gut (one opening).

The main function of the excretory system is for water regulation. It consists of two structures called protonephridia. Each protonephridium contains flame cells that move excess water into tubes that open to the outside.

Planarians have a head region with sense organs. The nervous system of Dugesia is somewhat more complex than the nerve net of Cnidarians. It consists of a brain and nerve cords arranged in a ladder-like configuration.

Planarians have ocelli (eyespots) allow the presence and intensity of light to be determined. These structures are covered but have an opening to one side and forward. They can tell the direction of light because shadows fall on some of the receptor cells while others are illuminated. They move away from light.

Planarians are hermaphroditic, that is, they contain both male and female sex organs. They can reproduce asexually simply by pinching in half; each half grows a new half.
Movement is accomplished by the use of cilia and also by muscular contractions.

**VIDEO - Planarian movement (Dugesia) (1.83 MB)**

**Trematodes**

Members of this group are primarily parasites (feed on a host species).

Parasitic forms lack cephalization.

The reproductive cycle typically involves two host species, a primary host and a secondary (or intermediate) host. Adults live in the primary host and larvae develop in the secondary host. The life cycle often alternates between sexual and asexual reproduction.

Liver flukes are found in vertebrate livers.

Nearly half of people in the tropics have blood flukes. **Schistosomiasis** is a blood fluke that afflicts 200 million people in the world. The secondary host is a snail.

**Tapeworms**

Tapeworms live in the intestines of vertebrates.

They may reach 10 m in length (>30 feet). They have no digestive or nervous tissue. Attachment to the intestinal wall is by a scolex, a structure that contains hooks and suckers.

Below: *Taenia* scolex X 40
Tapeworms are harmful because they excrete toxic wastes, absorb nutrients, and may block the intestine.
The segments (proglottids) each contain male and female reproductive organs. Eggs are fertilized from sperm, which often come from other proglottids of the same individual. After fertilization, other organs within the proglottid disintegrate and the proglottid becomes filled with eggs.

The intermediate hosts are usually pigs or cattle. They can become infected by drinking water contaminated with human feces.

Tapeworms can be passed to humans in undercooked meat, especially pork.

The photographs below show the scolex and proglottids at increasing distances from the scolex. Those segments closest to the scolex (on the left) are the smallest. Those furthest away (on the right) become filled with zygotes, break away, and pass out with the feces.
Mollusks (Phylum Mollusca)

Mollusks include squids, octopuses, clams, scallops, oysters, snails, and slugs.

They are bilateral, coelomate, protostomes (see above).

Characteristics of Mollusks

All mollusks have a visceral mass, a mantle, and a foot. The visceral mass contains the digestive, excretory, and reproductive organs. The mantle is a covering. It may secrete a shell. The foot is muscular and is used for locomotion, attachment, and/or food capture.

The mantle and foot can be seen in the photograph below. The visceral mass is underneath the gill.
There may be a radula, a structure that resembles a tongue but contains hard plates and is often used for scraping food.

The coelom is reduced and limited to the region near the heart.

Most mollusks have an open circulatory system but cephalopods (squids, octopus) have a closed circulatory system.

The blood pigment of mollusks is hemocyanin, not hemoglobin.

The heart of a clam can be seen in the photograph below.

Bivalves have three pairs of ganglia but do not have a brain.

Most mollusks have separate sexes but most snails (gastropods) are hermaphrodites. Some marine mollusks have a ciliated larval form called a trochophore.

**Chitons (Class: Polyplacophora)**

Chitons have a dorsal shell composed of 8 plates.
A ventral foot is used for locomotion and for attachment to rocks. It pulls itself close to rocks for protection.

Below left: chiton, dorsal surface; right: ventral surface

Chitons are marine animals. They use a radula to scrape algae for food.

**Snails and relatives (Class: Gastropoda)**

Gastropods have an elongated, flattened foot and usually a head and shell although nudibranchs (sea slugs) and terrestrial slugs lack a shell.

Most are marine but there are also numerous freshwater and terrestrial species.

Herbivorous gastropods use a radula to scrape food from surfaces. Carnivores may use a radula to bore a hole through surfaces such as bivalve (clam) shells.

Some gastropods such as the slug (below) do not have a shell.
The larvae undergo torsion during development. It is a twisting that positions the visceral mass so that the anus is above the head. It is due to one side of the visceral mass growing faster than the other. The advantage (or function) of torsion is uncertain but it may be to balance the animal or it may be to allow the head to be withdrawn into the shell first when predators approach.

**Gas Exchange (Respiration)**

Some gastropod species are terrestrial and have lungs for gas exchange, others are aquatic and use gills.

The space near the entrance to the shell that is bound by the mantle is the mantle cavity. Aquatic gastropods have gills located in the mantle cavity. The mantle of terrestrial gastropods functions as a lung.

**Clams and relatives (Class: Bivalvia)**

Bivalves have two shells (valves) held closed by powerful muscles. The shell is produced by the underlying mantle; it grows along the outer margins.

They use their foot for burrowing. Mussels use their foot for the production of threads for attachment.

The gills are large because they are used for filter-feeding as well as respiration. Food is trapped by mucus on the gills and moved by cilia. Water enters and exits through siphons.

Bivalves do not have a brain but have 3 pairs of ganglia.
Squid, Octopus, Nautilus, and Relatives (Class: Cephalopoda)

Cephalopods are predators and live in a marine environment.

A closed circulatory system allows them to move rapidly in pursuit of prey.

They move by jet propulsion; water in the mantle cavity is squirted rapidly through a siphon.

The foot has evolved into tentacles around head.

Cephalopods have a powerful beak-like structure to tear apart prey.

The sense organs of cephalopods are well developed.

Mollusks are the simplest animals with eyes. Some mollusks have lenses and therefore are capable of forming clear images. The camera-type eyes of some cephalopods (squid, octopus) are capable of focusing and forming clear images. Cephalopods are fast-moving predators and well-developed camera-type eyes help them catch prey.

Well-developed brains (especially in octopuses) give them a high learning capacity.

Cephalopods can hide from enemies by releasing a dark colored fluid from ink sacs.

Shells

The shell of a nautilus encloses the animal. A squid's shell is small and internal. Octopuses do not have shells.

Segmentation

Segmented animals have repeating units. This has led to specialization of parts over evolutionary time because the different segments could become specialized for different purposes. Notice the variety of specialized structures near the anterior end of the clam worm in the photograph below.

Molecular data suggests that segmentation evolved independently in the annelids, the arthropods, and the chordates because ancestors to each of these three groups were not segmented.
Segmented Worms (Phylum Annelida)

Annelids are bilateral, coelomate protostomes.

The coelom is partitioned by septa (crosswalls).

The fluid-filled coelom acts as a hydrostatic skeleton. When the circular muscles that surround each segment contract, the segment becomes thinner and longer. When the longitudinal muscles that extend from one end of the segment to the other contract, the segment becomes shorter but thicker.

![Circular Muscle Longitudinal Muscle](image)

Because muscles can only contract and cannot lengthen, other muscles are used to lengthen them. In annelids, when circular muscles contract to lengthen the segment, the longitudinal muscles are lengthened. When the longitudinal muscles contract to make the segment shorter and thicker, the circular muscles become lengthened.

Setae are bristles on the skin that anchor or help move the animal. Movement occurs when waves of contraction of longitudinal muscles cause a "bulge" to progress from the anterior end to the posterior end.

Annelids exhibit specialization of the digestive tract. Some of these structures are the pharynx, crop, gizzard, intestine, and accessory glands.

Annelids have a closed circulatory system.
A pair of cerebral ganglia function as a simple brain. A ventral nerve cord extends the length of the animal and connects to a pair of fused ganglia (mass of nervous tissue) in each segment. The ganglia within each segment function to coordinate muscle contractions.

**Excretory System**

When animals digest protein, nitrogen is often released as a waste product. Some forms of nitrogen are fairly toxic (ex: ammonia) and must be removed immediately from the body. Other forms (ex: urea and uric acid) are less toxic but still must be removed.

Most of the segments have two metanephridia that function to remove excess water (osmoregulation) and to rid the body of nitrogenous wastes. Each metanephridium consists of a coiled up, convoluted tubule with an opening that allows coelomic fluid to enter the tubule. The tubule passes through a network of tiny blood vessels (capillaries). As fluid moves through the tubule, water and solutes are reabsorbed into the capillaries but nitrogenous wastes are left in the tubule. The tubule carrying wastes exits to the exterior of the animal.

**Class Oligochaeta - Earthworms and Leeches**

**Earthworms**

Gas exchange occurs across the skin, so the body must remain moist.

Earthworms are hermaphroditic but cross-fertilize with another individual. Sperm are produced by testes located within seminal vesicles. Sperm is stored within the seminal vesicles. Sperm from another individual is stored in a seminal receptacles.

After mating, the clitellum produces a slime tube that slides forward toward the anterior segments. As it passes along, it receives deposits of eggs and sperm from another individual that has been stored in the seminal receptacles. Fertilization occurs within the mucous cocoon, which is then deposited in the soil.
Earthworms feed by passing soil through their bodies and digesting organic matter in the soil. They are important in soil ecology because their activities mix and aerate the soil.

Food enters the body through the pharynx (see the diagram above) and is stored in the crop. Muscular action within the gizzard grinds food into smaller particles. Chemical digestion and absorption of digested food occurs in the intestine.

**Leeches**

Most leeches are freshwater predators or parasites. Parasites have oral and posterior suckers used to attach to the host.

Bloodsucking leeches produce hirudin, a powerful anticoagulant, in their saliva.

When surgeons reattach severed human fingers, they occasionally use laboratory-raised leeches during the patient’s recovery. The leeches remove blood from the tissues around the reattachment sites, release anesthetics and anticoagulants, and thereby relieve pressure and decrease pain. Removal of fluids from the area by the leech enables fresh fluids to move into the area.

**Class: Polychaeta - Marine Annelids**

The largest class of annelids is polychaeta.

Polychaetes have parapodia, fleshy, paddlelike lobes on each segment. Parapodia function in locomotion and gas exchange.

Setae are located on the parapodia.
Feeding

Many Polychaetes are predators.

Tubeworms are sessile filter feeders that live in tubes constructed from sediment from the ocean floor. Cilia on their tentacles create water currents that enable them to filter food from the water.

Contributors

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