Taxonomy

cellular organisms - Eukaryota - Fungi/Metazoa group - Metazoa - Eumetazoa - Bilateria - Coelomata - Deuterostomia - Chordata - Urochordata - Asciidiacea - Enterogona - Phlebobranchia - Cionidae - Ciona - Ciona intestinalis

Brief facts

- *Ciona intestinalis* is a large solitary sea squirt which grows up to 15 cm in length.
- The body is soft, retractile and a pale translucent greenish/yellow, through which the internal organs are visible.
- *Ciona intestinalis* prefers habitats with low wave exposure and some water flow. It grows not only on bedrock and boulders but also on artificial surfaces such as metal and concrete. Other organisms, such as algae, are also used as substrata. *C. intestinalis* is the only species of a cosmopolitan ascidian.

Importance as a model organism
Tunicates have some of the smallest bilaterian genomes: the haploid content is only about 0.196 pg DNA.

Many characteristics make *Ciona* a highly tractable model: *Ciona* has only 2,500 cells in the late larva; cell fates are determined very early in embryogenesis compared to those of other animals, and developmental genes have concomitantly altered functions in patterning the embryo.

Two contrasting modes of early embryogenesis were proposed: (1) **mosaic (cell-autonomous) mode** where the egg is organized by way of localized and inherited maternal factors that are responsible for the development of parts of the embryo and adult and where each cell fate is predetermined and restricted; (2) **inducer or "organizer" (non-cell-autonomous) mode** where some isolated parts of the embryo can compensate and make a full larva in a process of self-regulation, also, some parts of the embryo, when transplanted, are capable of inducing development in the surrounding cells. Although ascidian embryogenesis was long considered as "text-book" example of mosaic development, recent studies show that it also involves inductive events and that both modes interact with each other.

There are striking parallels between the tunicate, *Ciona intestinalis* and the nematode, *Caenorhabditis elegans*, in terms of reduction of the nuclear genome, rapid evolution of the mitochondrial genome, the acquisition of determinate development and simplification of the body plan. The recent genome sequencing of *Ciona intestinalis* will allow a broad comparative analysis of gene and genome histories in *Ciona, C. elegans*, and other organisms and will make a substantial contribution to the fields of evolutionary and developmental biology.

**Organs**

- **siphon**

  a tubular organ by which water is taken in or expelled

- **buccal siphon**
inhalant or incurrent siphon; it is situated at the end of the oval outline of the animal; water and food particles enter the buccal siphon and move to the pharynx lumen

- **atrial siphon**
  - exhalant or excurrent siphon; it is situated on the side of the body; digestive wastes, gametes, and the feeding current carried out of the atrium by the atrial siphon

- **body wall**
  - **tunic**
    - the outermost layer of the body wall; tunic serves as exoskeleton that grows as the animal grows and does not require molting; it consists of a matrix cellulose (tunicin), protein fibers, cells, and proteoglycan ground substance
  - **mantle**
    - the inner layer of the body wall consists of the epidermis, connective tissue, circular and longitudinal muscles

- **gonad**
  - gonads are hermaphroditic and consist of an ovary and testis on each side
  - **ovary**
- oviduct
- testis

- pharynx
  respiratory organ; large and thin, it underlines most of the mantle extending from the buccal siphon; pharyngeal wall is perforated by minute gill slits (stigmata)

- heart

- digestive
  - pyloric gland
  - gastrointestinal tract
    - esophagus
    - stomach
    - intestine

- endostyle
  a special organ in the pharynx of *Urochordata, Cephalochordata*, and *Cyclostomata*; it composed of ciliated and glandular cells; the glandular cells secrete an iodine-containing mucus net used for food capture by the branchial basket; the endostyle has a functional homology to the vertebrate thyroid gland

- nervous
• **cerebral ganglion** serves as a primitive brain

• **nerve** nerve cords that exit from each end of the ganglion and branch out

• **neural gland** contains no neurons and has no nervous role; homology with pituitary gland of vertebrates has been proposed
Life cycle

*C. intestinalis* can spawn year around. Generation time is about 2-3 months.

Life Cycle Stages
C. intestinalis is cross-fertile and very rarely self-fertile; fertilized eggs maintained at 20°C usually hatch in 14-16 hours after fertilization, or in 16 - 18 hours at 18°C.

- **fertilized egg** MeSH

- **embryo**

  - **cleavage** MeSH
    
    dividing egg; the first cleavage occurs in 1 h after fertilization at 18°C, after two more synchronous and four asynchronous cleavages, the embryo reaches the 110-cell stage, after which the gastrulation starts.

  - **gastrula** MeSH
    
    starts at ~ 5 h after fertilization; a single-cell layers of *endoderm* and *mesoderm* cells in the *vegetal pole* invaginate into the interior toward *animal pole* while the *ectoderm* migrates toward the vegetal pole to form a layer surrounding the embryo.

  - **neurula**
    
    neurulation begins soon after gastrulation is complete (~7 h after fertilization); during this stage the neural plate is folded up dorsally to form the *neural tube*; once it is closed, the tail becomes noticable; at the same time the notochord cells converge and extend along anterior-posterior axis.

  - **tailbud**
    
    ~9 h after fertilization; during this stage
the tail continues to elongate until the embryo is ready to hatch

- **larval**

  motile tadpole larva; tadpole larva consists of **trunk** ("tadpole's head") and tail, which has a **notochord** and a **dorsal nervous chord** (typical chordate features); the anterior end of the trunk has a **preoral lobe** with **stalk** and adhesive **papillae**, which are primary organs used for settlement of the ascidian; the larva also has a sensory vesicle with both a statocyst and a light-sensitive organ; the free-swimming period may last from 6 to 36 hours, usually more than 12 hours; during this period the larva is constantly evolving and passes many stages of its development until the attachment.

- **metamorphosis  MeSH**

  metamorphosis begins with attachment of the larva to the substrate; metamorphic events include loss of the tail and most of the nervous system, transformation of heart and digestive system; this stage takes about 1-2 days; at day 3 after hatching, the buccal siphon begins to contract in response to stimuli, and ascidians become able to feed by filtration and atrial siphon also becomes functional (for excretion).

- **juvenile**

  - **1st ascidian stage**
attached (sessile) zooid with underdeveloped gill slits; starts from early stage with only 2 protostigmata on each side in the pharynx and lasts until the two pre-atrial siphons fuse

- **2nd ascidian stage**
  starts from 6 rows protostigmata and fused pre-atrial siphons and continues until all adult organs including gonads are fully developed; late stage is essentially undersized sexually immature zooid

- **adult**
  sexually mature and ready to spawn zooid; under ideal laboratory conditions sexual maturity is attained at about 2 months of age at size of 50-60 mm; life span is about 6 months

**References**

**PubMed articles**


PMID: 15840003


- MICHAEL J. KATZ. COMPARATIVE ANATOMY OF THE TUNICATE TADPOLE, CIONA INTESTINALIS MICHAEL J. KATZ Free full text

Free full text articles: major topic Ciona intestinalis

Websites and other references

- Wikipedia: Ciona intestinalis

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