

B. Sc.- II

Paper : 1 Embryology & Histology

Chapter: Development of *Ascidians*

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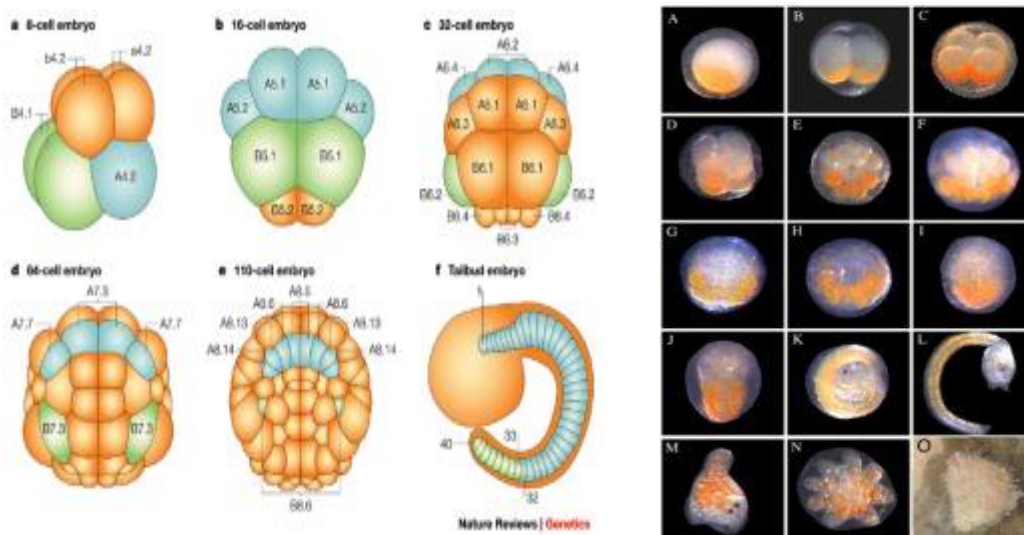
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Introduction

Ascidacea (*Ascidians* or Sea squirts) is a class in the Tunicata sub phylum of sac like marine invertebrate filter feeders. Ascidians are characterised by a tough 'tunic' made of the polysaccharide tunicin. Ascidians are found all over the world, usually in shallow water with salinities over 2.5%. Sea squirts are sessile animal; they remain firmly attached to substratum such as rocks and shells. Ascidians show a peculiar type of metamorphosis called Retrogressive Metamorphosis (which converts an advanced larva into a primitive adult animal).

Almost all ascidians are hermaphrodites. The gonads are located in the abdomen or post-abdomen, and include one testis and one ovary, each of which opens via a duct into cloaca. Ascidians are oviparous and fertilization occurs in sea water, external to the animal body. Self fertilization does not occur due to protogyny (female gametes become matured and discharged earlier than male gametes of the same individuals). Therefore mature sperms of older individuals and mature ova of younger individuals through cloaca in to surrounding sea water where cross fertilization takes place. A fertilized egg spends 12 h to a few days developing into a free-swimming tadpole larva. Which then takes not more than 36 h to settle and metamorphosis into a juvenile.



The cleavage is holoblastic and approximately equal due to little amount yolk. The first cleavage is vertical, meridional. Second cleavage is also vertical but at right angle to the first (Sach's Law- Equal daughter cells and each new division at right angle). The third cleavage is horizontal and passes above the equator which divides the blastomeres into 8-cells arranged into 2 tiers. The 8-cells embryo undergoes 3 more sets of cleavages and consequently 64-celled compact blastula is produced. Gastrulation by invagination occurs sixth cleavage and is completed by the time of the seventh cleavage between 64-128-cells (mid-gastrula 76-cell).

Embryonic Induction-

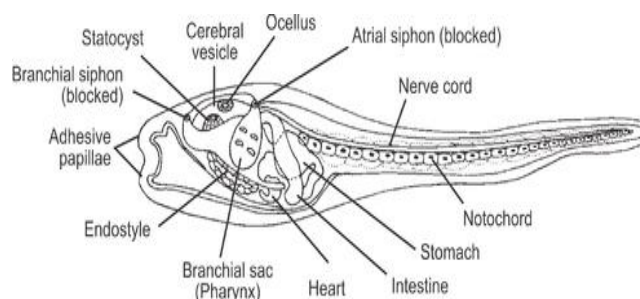
In ascidians different blastomeres of 8-cell stage have the following presumptive fates-

- i- The two anterior animal pole blastomere produced head, epidermis, palp and the brain with two pigmented sensory structure.
- ii- Two posterior animal pole blastomere produce epidermis.
- iii- Two anterior vegetal pole blastomere produce notochord, spinal cord and part of the intestine.
- iv- Two posterior vegetal cells produce mesenchyme, muscle and part of the intestine.

Raverberi (1960) stated that the formation and differentiation of brain by the two anterior animal pole blastomeres is dependent on the induction of two anterior vegetal blastomere acts as neural inducers. It was further concluded that two anterior vegetal blastomere gave rise to the diverse tissues, namely endoderm, notochord and spinal cord.

Retrogressive Metamorphosis

The tadpole larva selects and settles on appropriate substratum using receptors sensitive to light, orientation to gravity and tactile stimuli. When its anterior end touches a surface, papillae (finger-like nervous projection) secrete an adhesive for attachment. Since the larva is more advanced than its adult, this type of metamorphosis is called 'retrogressive metamorphosis'.



Tadpole Larva

Advanced chordate character

- a- There is a rod like notochord in the tail which is attached muscle band for swimming.
- b- There is dorsal hollow nerve cord which is enlarged to form brain at the anterior end and a photoreceptor ocellus and balancing organ statocyst (otocyst) are attached to brain.
- c- There are only two pairs of gill slits in pharynx, mouth is closed and intestine is rudimentary.
- d- Endostyle on the ventral side is well developed which functions like thyroid gland and help in metamorphosis.
- e- Heart is on the ventral side of gut but non-functional.

Changes during metamorphosis

- a- Larva attaches to the substratum with the help of papillae, head downward and tail upward.
- b- Rapid growth takes place between the papillae and mouth and no growth on the opposite side of body. Due to rapid growth on one side, body rotate in such a way mouth gradually migrate to upper side.
- c- Intestine becomes functional.
- d- Both tail and notochord gradually degenerate. The hollow nerve cord is reduced into solid nerve ganglion on the dorsal side.
- e- Sense organ namely ocellus and statocyst are lost.

Molecular events in the development of Ascidians-

During the early development of ascidians Markert & Cowden (1965) studied the molecular basis of development of ascidians by studying the protein and nucleic acids metabolism during their early development. They employed actinomycin, puromycin and antimycin as the inhibitive agents of nuclear RNA translation, ribosomal transcription and mitochondrial electron transport, respectively. Although the synthesis of mRNA may be required for the initiation of new programmes in development, but synthesis of rRNA and tRNA is not immediately necessary as long as sufficient concentration remain free from oogenesis to sustain synthetic activity. It is significant to note that nucleoli and increasing levels of cytoplasmic RNA first appear in ascidian development after the swimming tadpole larval stage has been attained and during metamorphosis ascidian development is blocked at the tail bud stage by antimycin, which blocks mitochondrial function.

In *Ascidia* very little protein synthesis occurs during the development of tadpole larva, but the rate of protein synthesis becomes increased extensively at the onset of metamorphosis. In *Ascidia nigra*, a different biochemical process has been observed by Markert & Cowden. According to them, some protein synthesis occurs throughout the development but with the onset of the metamorphosis extensive degradation of protein to amino acids. It is followed by accelerated synthesis of many new proteins and ribosomes.

Significance of Ascidian embryology

- i- Ascidians provide best example mosaic eggs with well organised and well differentiated ooplasm and highly determinate type.
- ii- The egg cortex is the site of morphogenetic pattern relating to polar, bilateral and general organization of the developing egg.
- iii- The cleavage tends to segregate cytoplasmic territories having different histogenetic properties.
- iv- They are the only chordates which include retrogressive metamorphosis in their embryonic development.