

Urochordata

Introduction

Urochordata are invertebrate chordates which contain a tough outer covering, or tunic. The phylum Chordata contains three subphyla, Urochordata (tunicates), Cephalochordata (amphioxus), and Vertebrata (vertebrates). Chordate characteristics include:

1. A notochord during some stage of the life cycle.
2. A hollow, dorsal nerve cord.
3. Pharyngeal slits during some stage of the life cycle.
4. A muscular, post-anal tail.

Recent molecular phylogenies show that the Urochordates are the sister group to the rest of the chordates, while the echinoderms and hemichordates make up a separate clade (Cameron *et al.* 2000). The radical differences in adult morphology and range of life histories in the urochordates vs. cephalochordates + vertebrates suggest it might be appropriate to raise them to the phylum level (Swalla *et al.* 2000; Cameron *et al.* 2000). The urochordates are divided into three classes: the ascidians (sea squirts), larvaceans (appendicularians), and thaliaceans (doliolids, salps and pyrosomids).

Body Plans

The chordate characters are found in the urochordate tadpole larvae in the larvaceans and most ascidians (Jeffery and Swalla, 1997). However, ascidians undergo metamorphosis into a sessile adult which contains an endostyle and pharyngeal gill slits, while the appendicularians retain these structures and the tadpole body plan after metamorphosis into a planktonic adult (Bone, 2000). Salps and pyrosomids lack a tadpole stage and have a body plan similar to adult ascidians except that it is modified for planktotrophy (Bone, 2000). Recent molecular evidence suggests that larvaceans may be the sister group of the

rest of the urochordates, while the phlebobranch ascidians and thaliaceans may be closely related (Wada, 1998; Swalla *et al.* 2000).

Reproduction

All ascidians and most urochordates are hermaphrodites, producing both eggs and sperm that are either free-spawned or brooded. Most species are self-sterile, but some are self-fertile. Urochordates have diverged evolutionarily into a variety of adult forms, with some undergoing dramatic larval to adult metamorphosis, while others have reduced or eliminated the larval forms. A colonial lifestyle has evolved several times independently, suggesting the ancestral urochordate could be either solitary or colonial. The most successful present day life history appears to be that of the ascidians, which are cosmopolitan in the world's oceans. Colonial urochordates can reproduce either sexually or asexually by budding. The colonial larvae are brooded and tend to be much larger and more advanced, or adultated, than the solitary species. These same differences in reproductive modes and larval brooding are seen in the colonial hemichordates, the pterobranchs.

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