

## Quick guide

# Leeches

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### **Real worms don't eat bacteria.**

Leeches are segmented, eucoelomate worms of the phylum Annelida, distinguished from other annelids by anterior and posterior suckers used for locomotion and feeding — on blood or soft body parts of other animals. They are not to be confused with nematodes, which lack these (and most other) features. Leeches are mainly aquatic, but the Asian land leeches are well known to trekkers. Annelid systematics is messy, but leeches are clearly united with earthworms and their ilk into a monophyletic grouping of hermaphroditic annelids, Clitellata, named for the specialized midbody segments (clitellum) that secrete a cocoon to surround the eggs.

### **Blood sausage and escargot.**

Sanguivory evolved independently in different groups of leeches. Hirudinid species — traditionally used for bloodletting and still used to treat vasocongestion after reconstructive surgery — incise a delicate three-pronged wound, and are reared in the lab on heparinized blood presented in sausage casing or lambskin condoms. Glossiphoniid species have an evertable proboscis that penetrates more than a centimeter into the vertebrate host. Potent anticoagulants are secreted to assist in feeding in both groups. Other leeches prey on invertebrates, including crustaceans, snails and other annelids. Most leeches show clear species preferences in feeding, and some have strong preferences as to the anatomical site of attack — delicacy forbids further details.

**Why leeches?** Leeches have distinguished pedigrees as preparations for embryology and

neurobiology. C. O. Whitman, first director of the MBL (Woods Hole, Massachusetts), used glossiphoniid embryos for pioneering studies of embryological cell lineages in the 1870s, in part to test the predictions of Haeckel's Law — the notorious "ontogeny recapitulates phylogeny". Whitman found that leech embryos do not pass through a 'colonial stage', but instead develop via stereotyped lineages, so that cells can be uniquely identified from the first cleavage. Later that century, G. Retzius in Sweden drew neurons of the medicinal leech (*Hirudo*) with detail rivaling that obtained by modern intracellular dye injections.

**What have they done for us lately?** Beginning in the 1960s with standard electrophysiological techniques, and more recently using optical methods, scientists have been able to explain the sinuous swim movements and other leech behaviors in terms of networks of identified neurons in *Hirudo*. Studies of *Hirudo* neurodevelopment have revealed wonderful phenomena, including: baroque muscle scaffolding cells, each of which projects about 70 parallel growth cones obliquely to the animal's anteroposterior axis; and 'isoneuronal' avoidance, in which peripheral neurites of a developing sensory neuron avoid other processes of the same cell and yet fasciculate with those of equivalent neurons from other segments, apparently on the basis of synchronous activity in contiguous processes. Regeneration, and synapse formation by identified neurons in culture are also studied in *Hirudo*. Studies of early development resumed in the 1970s, using the large embryos of glossiphoniid species such as *Helobdella*. More unexpected phenomena include: stochastic expression of *notch* and *wnt* class genes in the two cell embryo, despite the unique identities of the cells; mitotic transcription of a *hes* class gene; and inductively regulated fusion

of endodermal precursor cells.

### **Amputated arthropods?**

Unlikely. Updated versions of Cuvier's (1817) 'Articulata hypothesis' hold that annelids and arthropods evolved from a segmented common ancestor. But recent molecular phylogenies suggest that arthropod and annelid lineages separated well before the Cambrian (more than 600 million years ago); annelids are assigned to a clade of largely unsegmented taxa, including mollusks, flatworms, brachiopods and other truly obscure phyla, collectively designated 'Lophotrochozoa'. While most biologists focus on Deuterostomes (such as vertebrates and echinoderms) or Ecdysozoans (arthropods, nematodes and so on), the Lophotrochozoans are a relatively unexplored 'third way' of bilaterally symmetric animals.

### **It's not how long you make it.**

Leeches make precisely 32 segments from five bilaterally paired stem cell lineages. Lineage tracing and ablation studies suggest 'no compartments', and analyses of *Drosophila* segmentation gene homologs provide little support for the Articulata hypothesis. In contrast to leeches, other annelids may add segments continuously throughout life, regenerate segments at one or both ends, or even reproduce by fission, continually respecifying segment identities. Rich grounds for comparative studies.

### **Where can I find out more?**

<http://mcb.berkeley.edu/labs/weisblat/>  
<http://www.biology.ucsd.edu/faculty/macagno.html>  
<http://www.biology.ucsd.edu/faculty/kristan.html>  
<http://www.biosci.utexas.edu/mcdbl/hankland.html>  
<http://www.umsl.edu/%7EBiosbiss/>  
<http://homepages.wmich.edu/~jellies/>  
<http://www.anat.ox.ac.uk/groups/sbla/ckshaw.htm>  
<http://calabreselx.biology.emory.edu/>  
<http://www.people.virginia.edu/%7EWof/home.html>

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