GEOL2317: Frontiers in Palaeontology

Session 1: Introduction

Welcome to the Frontier

This course aims to develop the critical analysis and communication skills that characterize effective thinkers.

By visiting the forefront of the discipline, we'll get to grips with the open palaeontological controversies that are exercising current researchers, and enter the frontier territory where there are no "right answers"!

What we'll do

By the end of this term, you and your group will construct a "microsite" that digs into a current palaeontological controversy, which you will summarize orally to your peers.

You will then be tasked with writing an essay that makes a convincing argument based on one of your peers' microsites, convincing a reader of your chosen perspective.

As such, your site must provide its audience with a complete introduction to the subject, so that students interested in tacking the controversy can appreciate the evidence behind the key arguments.

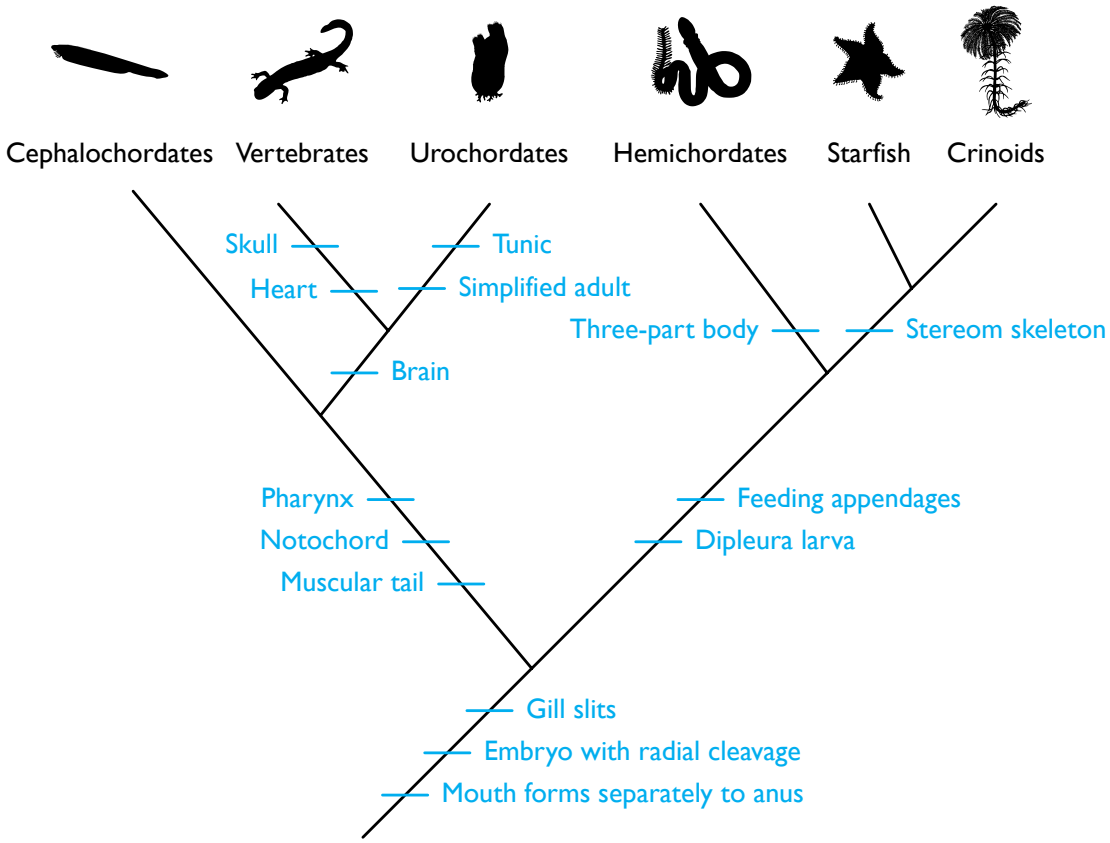
To equip you to engage with the primary literature in a critical fashion, we will start the term by addressing two current controversies as a class. For each topic, we'll start with an informal "primer" seminar introducing key background concepts. We'll then split into groups to discuss a key paper at the centre of the controversy. Your group will then find and read further papers to prepare to debate one side of the argument the following week.

Classroom exercise: Phylogenetic thinking

The adjacent figure is a schematic representation of relationships between the deuterostomes – our own subdivision of the animal kingdom.

You may not be familiar with all of these phyla. The questions below will help you to learn how to read and navigate this phylogenetic tree.

More on chordate relationships: Satoh *et al.* 2014 Chordate evolution and the three-phylum system. *Proc. R. Soc. B* 281: 20141729.



Silhouettes: Phylopic contributors

[2.1] Use the tree to identify at least four characters possessed by hemichordates.

A **clade** (also termed a **monophyletic group**) is a set of organisms comprising a single common ancestor and *all* of its descendants.

[2.2] On the image, mark the node corresponding to the single most recent common ancestor of echinoderms (starfish and crinoids).

[2.3] Mark all regions of the tree that correspond to descendants of this most recent common ancestor.

[2.4] True or false: Cephalochordates, Vertebrates, Urochordates and Hemichordates together form a clade.

» True
» False

Hint: What is the last common ancestor of these taxa?

[2.5] True or false: Echinoderms and Hemichordates together form a clade.

- True
- False

[2.6] Mark the chordates (the group comprising cephalochordates, vertebrates and urochordates) on the diagram. Identify at least four characters present in all chordates.

[2.7] Which of these characters are only *found in chordates?*

Characters that are unique to – and thus define – a given group are termed **synapomorphies**.

[2.8] According to the cladogram, which evolved first?

- Pharynx
- Tunic
- Gill slits
- Sterom
- Can't tell

[2.9] According to the cladogram, which evolved first?

- Pharynx
- Tunic
- Stereom skeleton
- Can't tell

[2.10] Which deuterostomes do not have a pharynx?

- Cephalochordates
- Vertebrates
- Urochordates
- Hemichordates
- Starfish
- Crinoids

[2.11] Which deuterostomes have a brain?

- Cephalochordates
- Vertebrates
- Urochordates
- Hemichordates
- Starfish
- Crinoids

[2.12] True or false: cephalochordates are ancestors of vertebrates

- True
- False
- Can't tell from tree

[2.13] True or false: cephalochordates are older than vertebrates

- True
- False
- Can't tell from tree

[2.14] Which group is most closely related to urochordates?

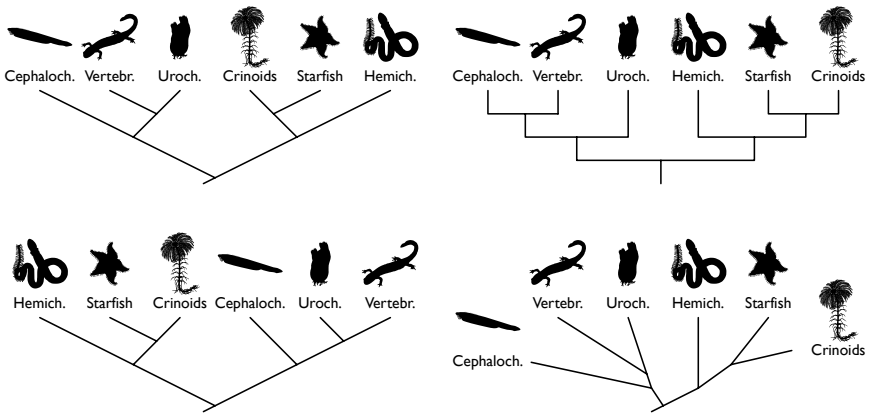
- Cephalochordates
- Vertebrates
- Urochordates
- Hemichordates
- Starfish
- Crinoids
- Echinoderms

[2.15] Which group is most closely related to hemichordates?

- Cephalochordates
- Vertebrates
- Urochordates
- Hemichordates
- Starfish
- Crinoids
- Echinoderms

[2.16] Which of these groups is the most evolved?

- Cephalochordates
- Vertebrates
- Urochordates
- Hemichordates
- Can't say

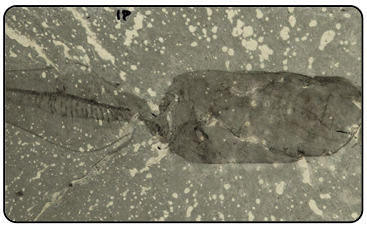


[2.17] Which one of these trees shows a different set of relationships to the others?

[2.18]
Gyaltsenglossus is a Cambrian fossil with a three-part body, comprising a proboscis, collar and trunk.

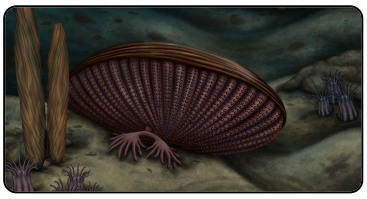
Where on the tree is it most likely to plot?

Banffia is another enigmatic Cambrian fossil from the Burgess Shale; it has a feeding appendage, but lacks a stereom or three-part body.



[2.19] Use stem-group and crown-group terminology to describe its most parsimonious phylogenetic positions.

Another problematic Cambrian fossil: *Rotadiscus* has a robust upper surface that has some similarity to the urochordate tunic. It lacks a brain, skull, stereom, three-part body, notochord or tail; and has gill slits and feeding appendages. Its other attributes are uncertain.



[2.20] Mark its most parsimonious phylogenetic position on the tree.

[2.21] What makes this position unparsimonious? What evolutionary scenario might account for the combination of characters observed?

The full story is interesting to explore!

Nectocaris is another Burgess Shale fossil; it has been interpreted as having a muscular tail, but lacks a notochord.

[2.22] Mark its possible phylogenetic position on the tree.

If hearts, brains and notochords are quick to decay, their absence could reflect non-preservation rather than an original biological absence.

[2.23] Mark the tree to indicate the possible position of Nectocaris if the original presence of these organs is equivocal.