

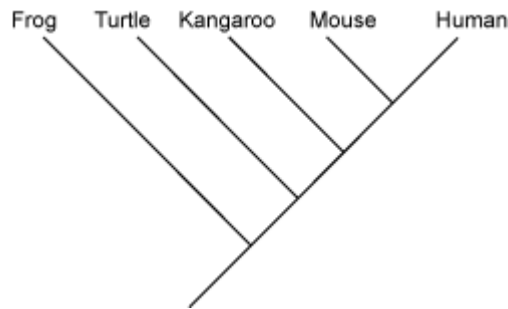
An Example of Cladogram Construction for Vertebrates

Trait	Outgroup (Lobe-finned fish)	Frog	Turtle	Kangaroo	Mouse	Human
Dorsal Nerve Cord	Yes	Yes	Yes	Yes	Yes	Yes
Legs	No	Yes	Yes	Yes	Yes	Yes
Nature of egg	Requires water	Requires water	Hard shell prevents drying	Develops inside the mother	Develops inside the mother	Develops inside the mother
Nature of development	In egg	In egg	In egg	Marsupial	Placental	Placental
Hair	No	No	No	Yes	Yes	Reduced
Presence of pouch	No	No	No	Yes	No	No
Bipedal posture	No	No	No	Yes	No	Yes

In this example, frogs share all major traits with the outgroup (i.e., they show mostly ancestral or plesiomorphic traits), except that they have legs and slightly enlarged brains. These last two features are apomorphies that are widespread in the vertebrate lineage. Frogs are thus postulated to have branched from the main vertebrate lineage relatively early in the evolutionary process.

Turtles show further modifications from the outgroup, most markedly the presence of a hard shelled egg, as well as an increased tendency toward larger brain size; therefore we would suggest that their lineage branched next from the ancestral lineage.

All three of the remaining groups are characterized by an egg that develops inside the mother, suggesting that these three share a common ancestor not shared by frogs and turtles. Mice and kangaroos share similar hair amounts, while humans and kangaroos share a generally bipedal posture. So how do we know how to group these three organisms? Firstly, we would suspect that the possession of hair, even in reduced amounts, might link humans to kangaroos and mice. Secondly, we would look to the other traits possessed by these groups. Both mice and humans show placental development and thus lack a pouch. Thus we would tend to link these two groups together more closely and the kangaroo more distantly. We would thus conclude that the cladogram for this group of organisms (minus the outgroup, which is not usually shown in these figures) should look something like the one below.



Exercise 1: Constructing a Cladogram

Use the data below to order organisms and shared apomorphies in the following table into their correct position on the cladogram. Remember, the outgroup is not usually specifically shown in the cladogram.

Create a cladogram for the following species:

Trait	Outgroup	Arachnida	Merostomata	Pycnogonida
Number of pairs of legs	4	4	4	4
Cephalothorax a carapace-like shield	No	Yes	Yes	Yes
Telson	No	No	Yes	No
Abdominal appendages	Present	Reduced or modified	Present	Present
Tracheae	Absent	Present	Absent	Absent

Exercise 2 Again, use the data below to order organisms and shared apomorphies in the following table into their correct position on the cladogram.

	Uniramia (Outgroup)	Cephalocarida	Malacostraca	Remipedia	Maxillopoda	Branchiopoda
Mandibulate	Yes	Yes	Yes	Yes	Yes	Yes
Nauplius larva	No	Yes	Yes	Yes	Yes	Yes
2nd Antenna biramous	No	Yes	Yes	Yes	Yes	Yes
# segments in abdomen	Many segments; body not divided into 3 regions	11; body divided into 3 regions	6 or 7; body divided into 3 regions	Many segments; body not divided into 3 regions	< 8; body divided into 3 regions	< 9; body divided into 3 regions
Carapace present	No	No	Present but subsequently reduced	No	Present but subsequently reduced	Yes
Maxillipeds	No	No	Yes	No	Yes	No