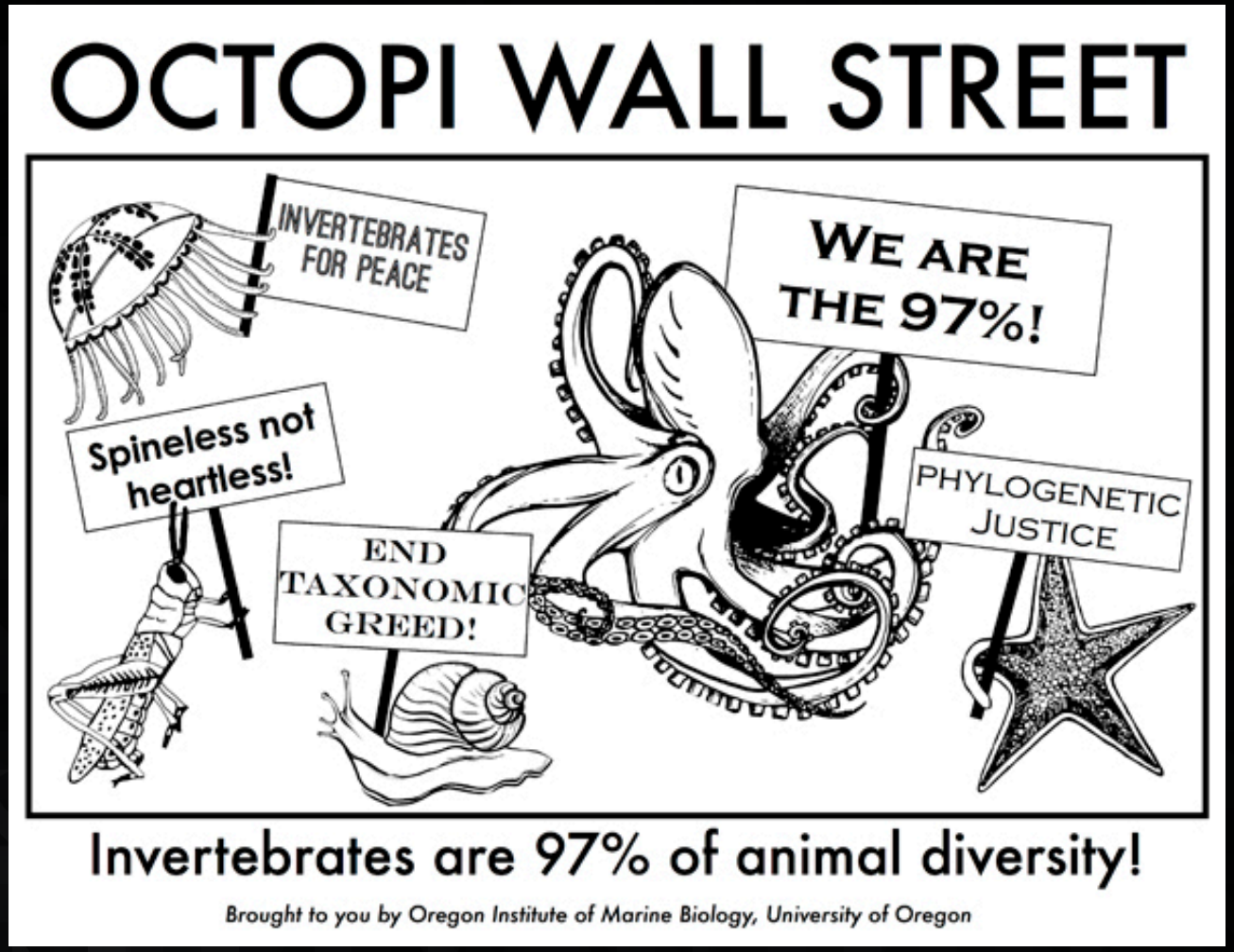
BIO 354: Invertebrate Zoology



Prof. Jonathan Puritz

Fall 2019

Outline for today

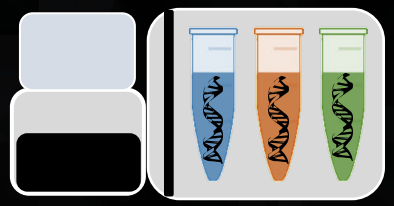
- Introductions
- Brief introduction to invertebrate zoology
- Overview of the syllabus
- Homework assignment

A little about Prof. Puritz

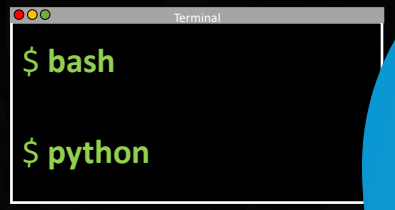
- Assistant Professor
  - Department of Biological Sciences
  - Marine Biology Faculty
- Newish to URI
  - Started in 2017
- Teaching
  - BIO 354 *Invertebrate Zoology*
  - BIO 425G *Origins of Marine Biodiversity*
  - BIO 594 *Population Genomics*

The Puritz Lab

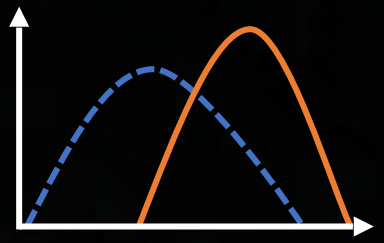
NGS



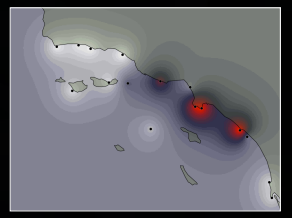
Bioinformatics



Selection

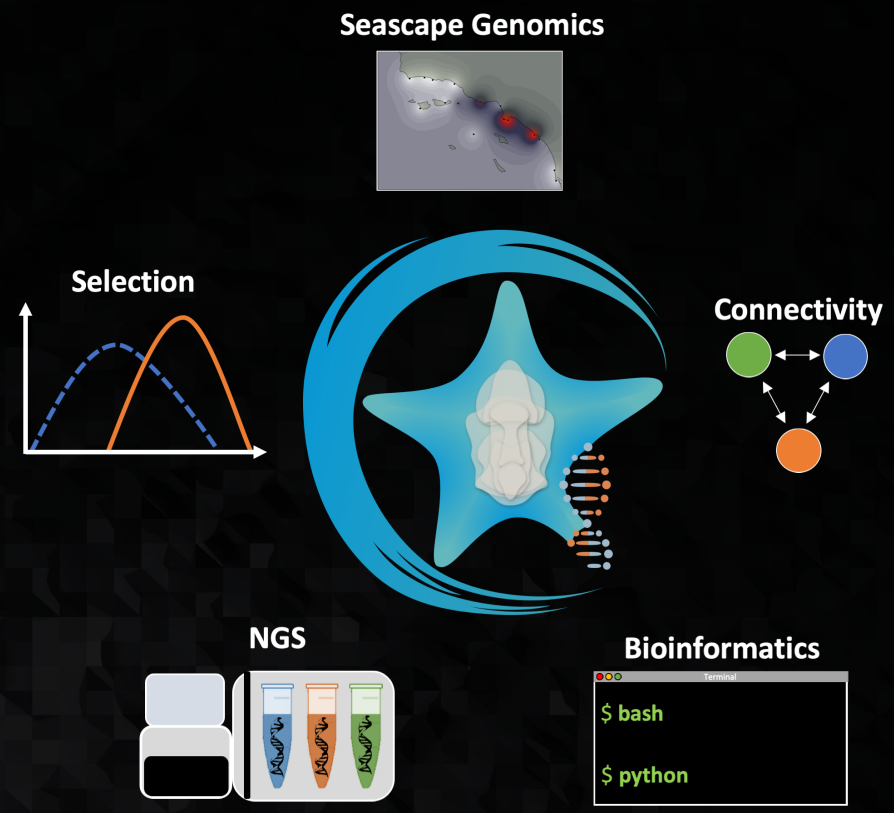


Seascape Genomics



A little about Prof. Puritz

- Research
  - How natural and anthropogenic processes affect the evolution of marine populations through the lens of larval dispersal.



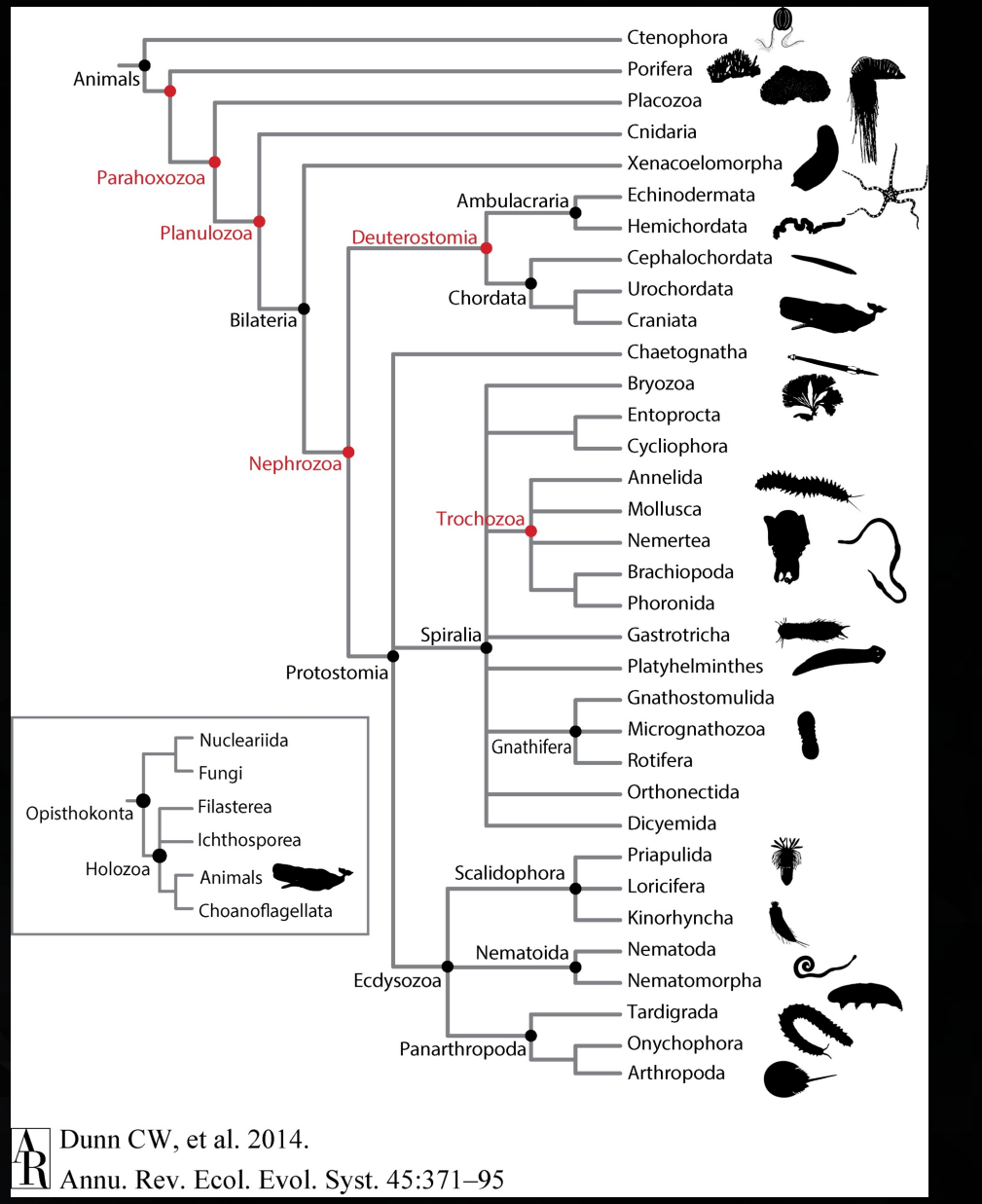
A little about Prof. Puritz

- Research
  - How natural and anthropogenic processes affect the evolution of marine populations through the lens of larval dispersal.


LARVAE ARE COMING

Invertebrate Zoology

- Study of invertebrate animals
- Inverts make up at least 97% of all extant (living) animal species on the planet



Invertebrate Zoology

- Study of invertebrate animals
- Inverts make up at least 97% of all extant (living) animal species on the planet
- Over 1,000,000 described spp. (species) on the planet (mostly insects)
- Estimated 10 to 30 million spp. have yet to be described

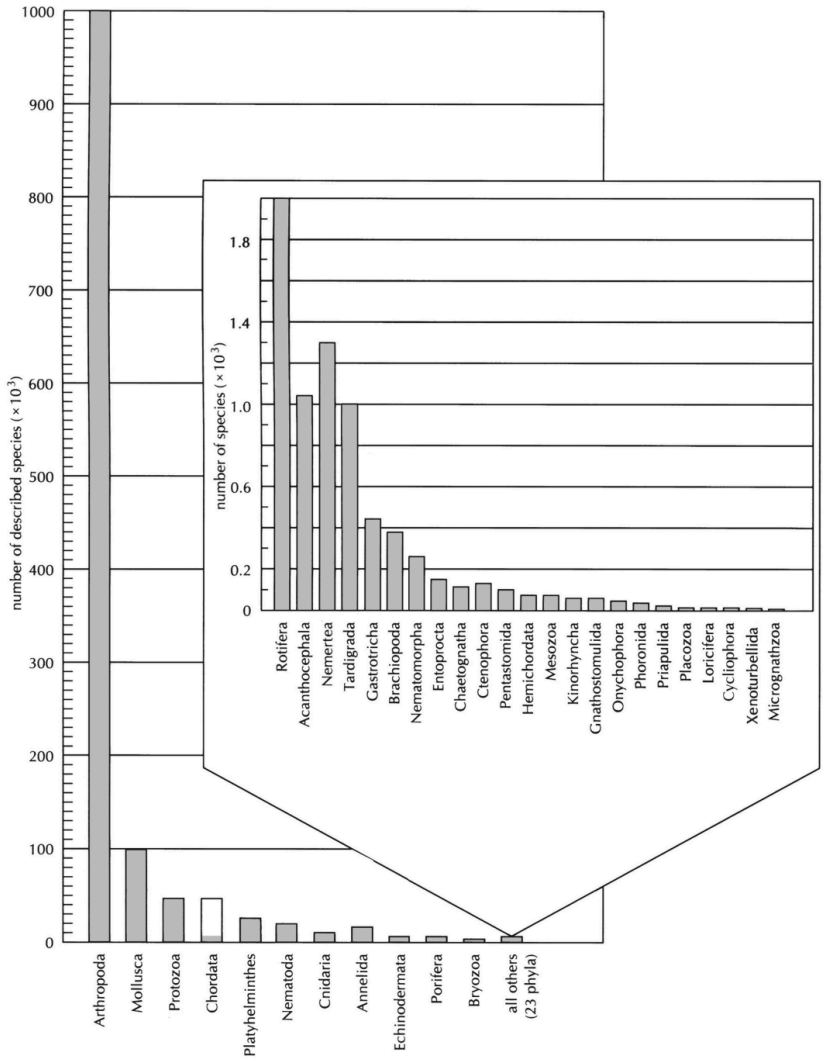
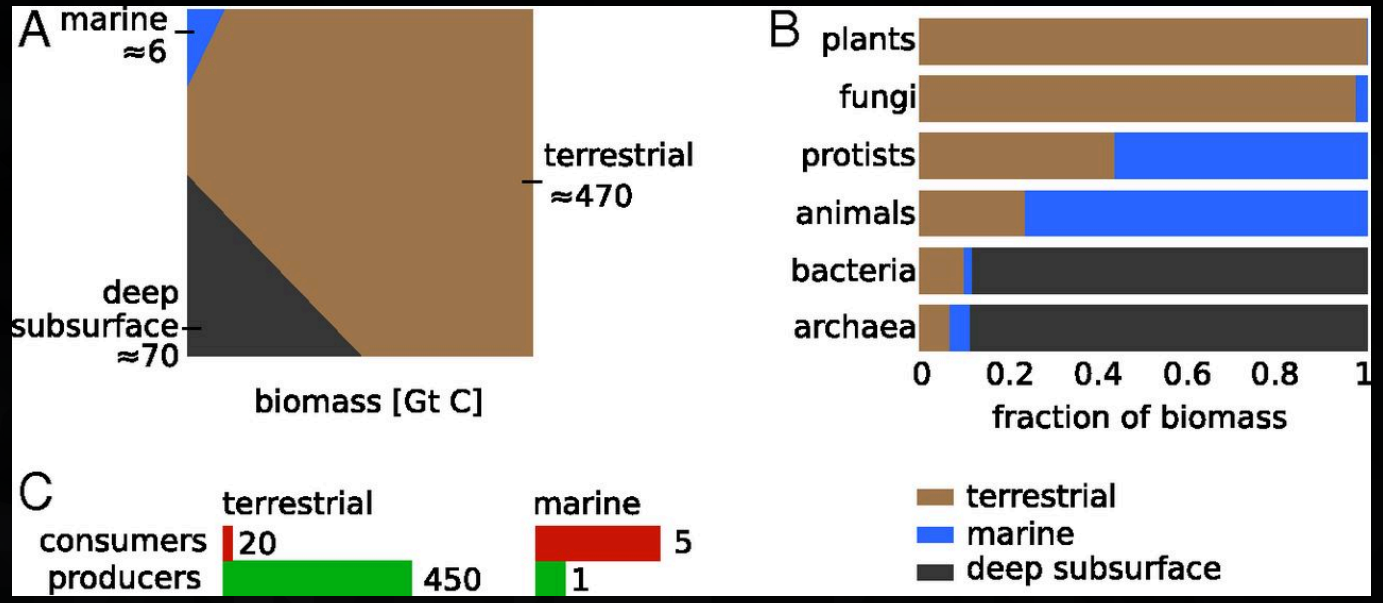
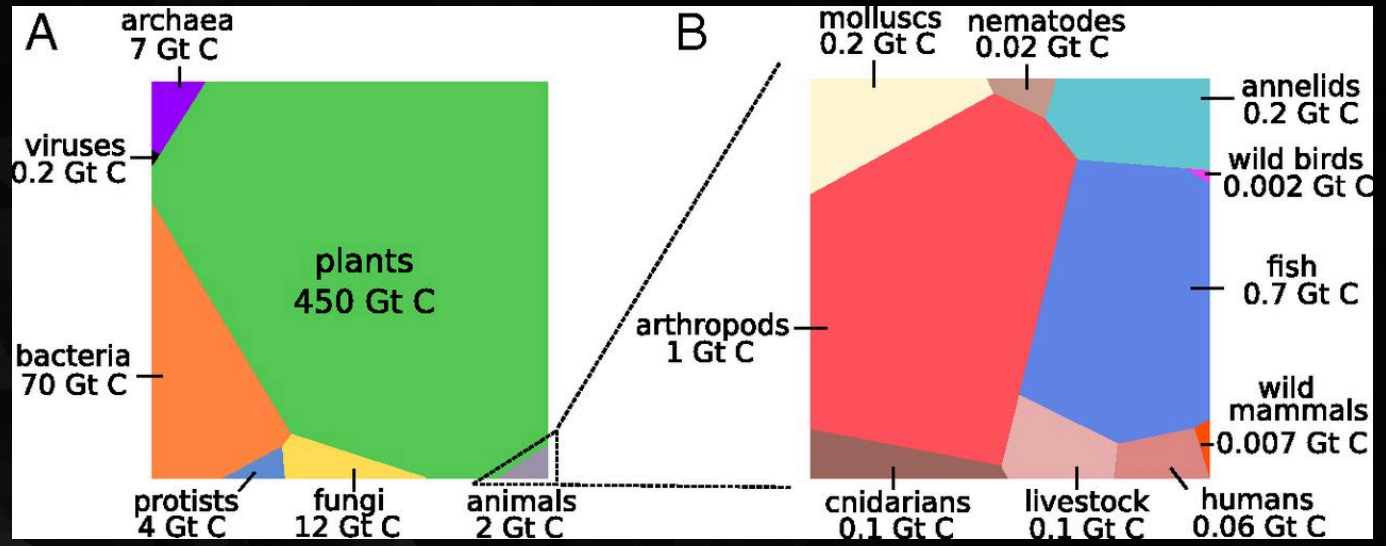


Figure 2.10

Graphic representation of the distribution of described species among the 33 major groups of invertebrates. In this text, protozoans are divided among more than one dozen phyla. Metazoan phyla containing fewer than 2000 described species are presented in the inset. Note the different scale on the Y-axis of the inset. The open (unshaded) area of the bar labeled "Chordata" represents vertebrate species. All other species in all other phyla are invertebrates.

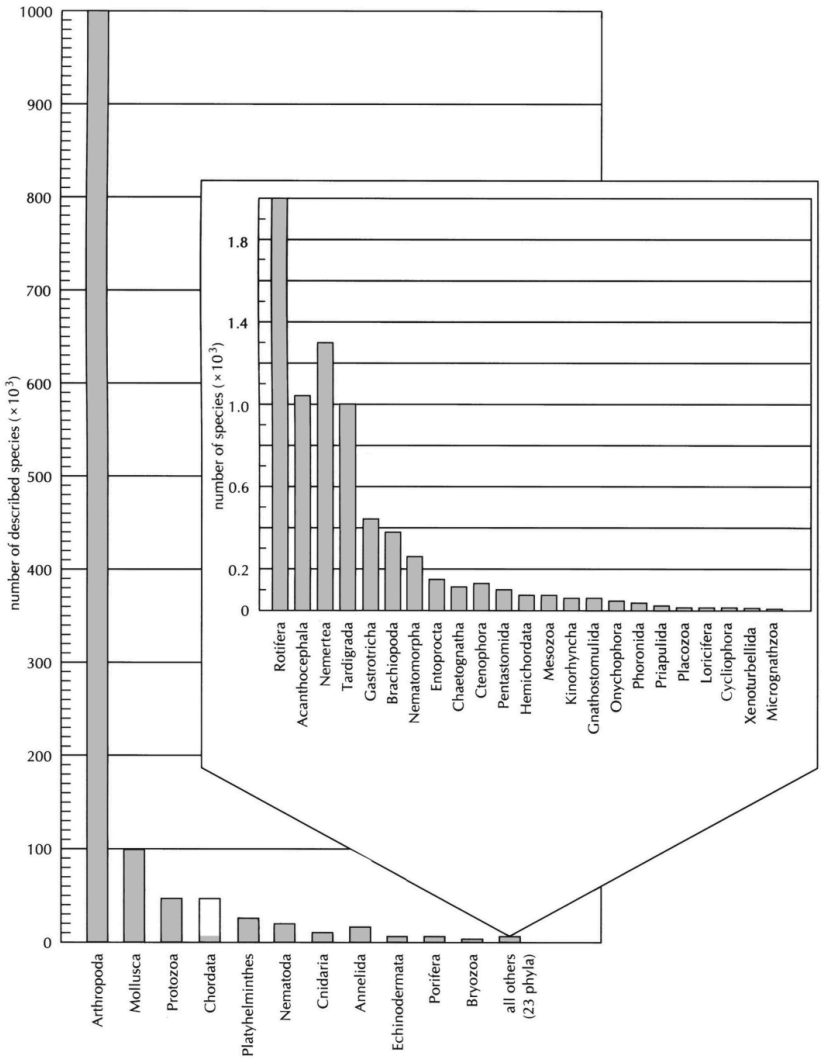
And biomass…


A
marine
≈6
terrestrial
≈470
deep
subsurface
≈70
biomass [Gt C]
B
plants
fungi
protists
animals
bacteria
archaea
0
0.2
0.4
0.6
0.8
1
fraction of biomass
C
terrestrial
marine
consumers
producers
20
450
5
1
terrestrial
marine
deep subsurface


A
archaea
7 Gt C
viruses
0.2 Gt C
plants
450 Gt C
bacteria
70 Gt C
protists
4 Gt C
fungi
12 Gt C
animals
2 Gt C
B
molluscs
0.2 Gt C
nematodes
0.02 Gt C
annelids
0.2 Gt C
wild birds
0.002 Gt C
fish
0.7 Gt C
arthropods
1 Gt C
wild
mammals
0.007 Gt C
cnidarians
0.1 Gt C
livestock
0.1 Gt C
humans
0.06 Gt C

Invertebrate Zoology

- Study of invertebrate animals
- Inverts make up at least 97% of all extant (living) animal species on the planet
- Over 1,000,000 described spp. (species) on the planet (mostly insects)
- Estimated 10 to 30 million spp. have yet to be described
- We will cover ~35 invertebrate phyla



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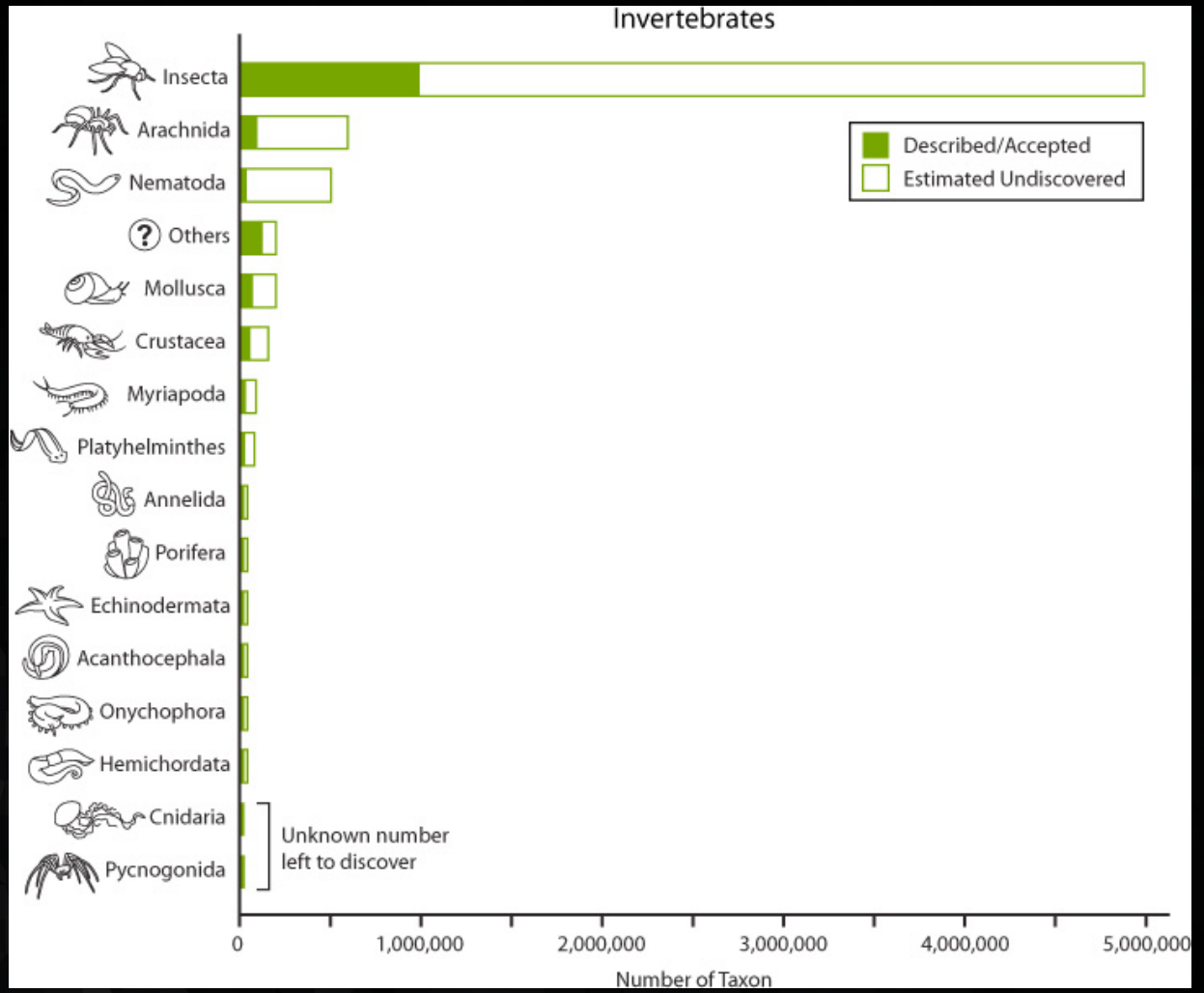
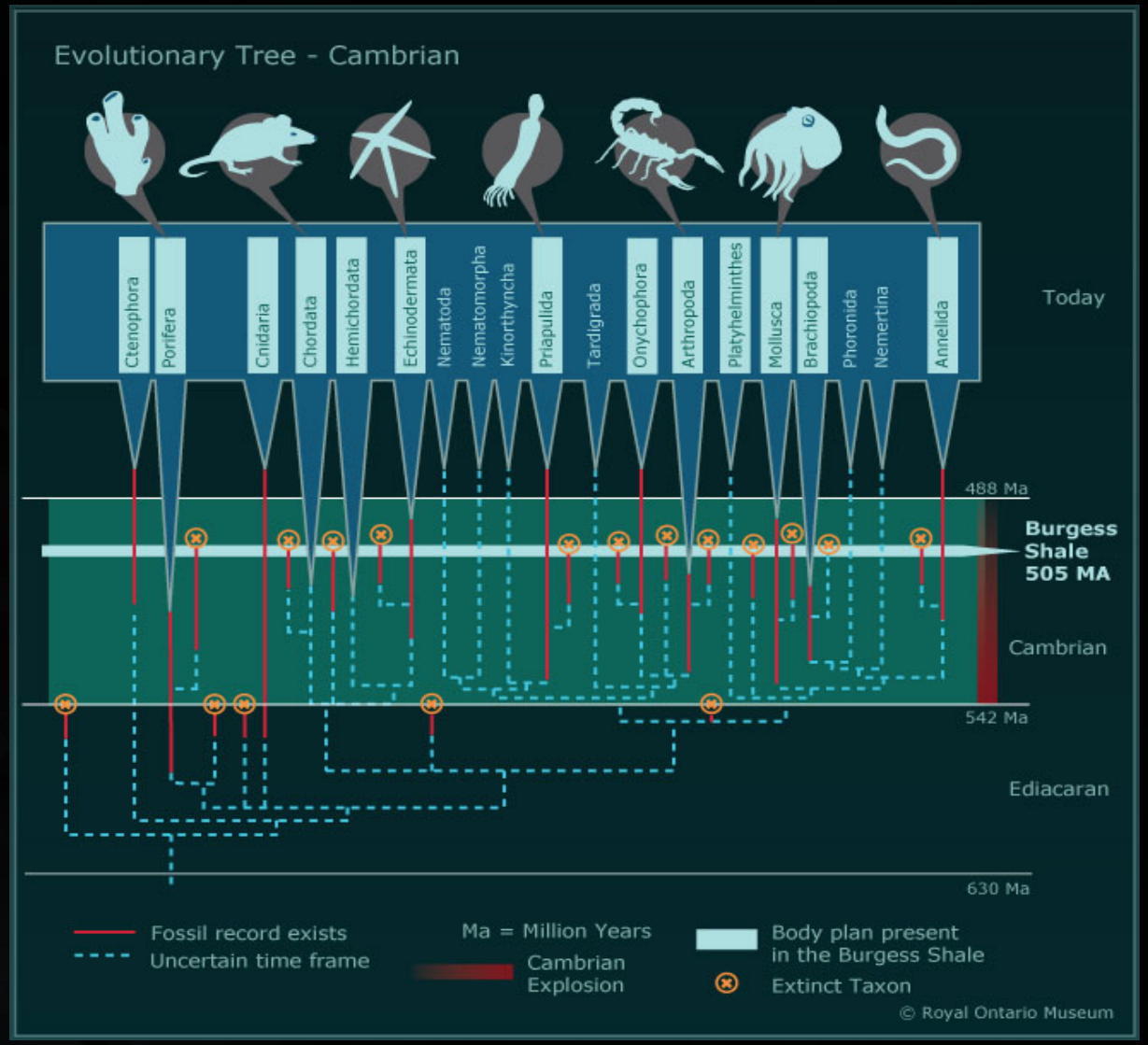
Invertebrate diversity is mostly UNDESCRIBED!



Invertebrates are old!

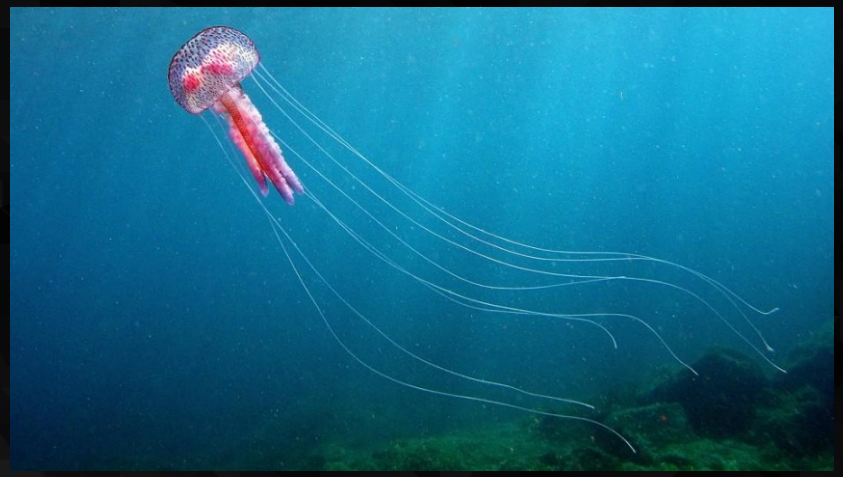
- Why are there so many invertebrates?
  - They've had a long time to evolve!
    - Earth = ~4.5 billion years
    - Life = ~3.5 billion (?)
    - Eukaryotes = 2-2.5 billion (?)
    - Animals probably evolved around 875 million years ago (?)
    - The **Cambrian Explosion** was approx. 543 million years ago - most animal **phyla** appear at this time



Invertebrates span orders of magnitude in size!

Earthworms (Annelida) exceeding 3 m in length!

Crabs (Arthropoda, Decapoda, Brachyura) with a leg span of 4 m!



Some jellyfish has tentacles that are 25 m long!

Phylum Loricifera is only 0.085 mm long

Invertebrates span orders of magnitude in size!

The giant squid *Architeuthis dux* (Mollusca, Cephalopoda) may be 19 m (62 ft) long, 500 kg, and swims at speeds up to 25 kph (15 mph)

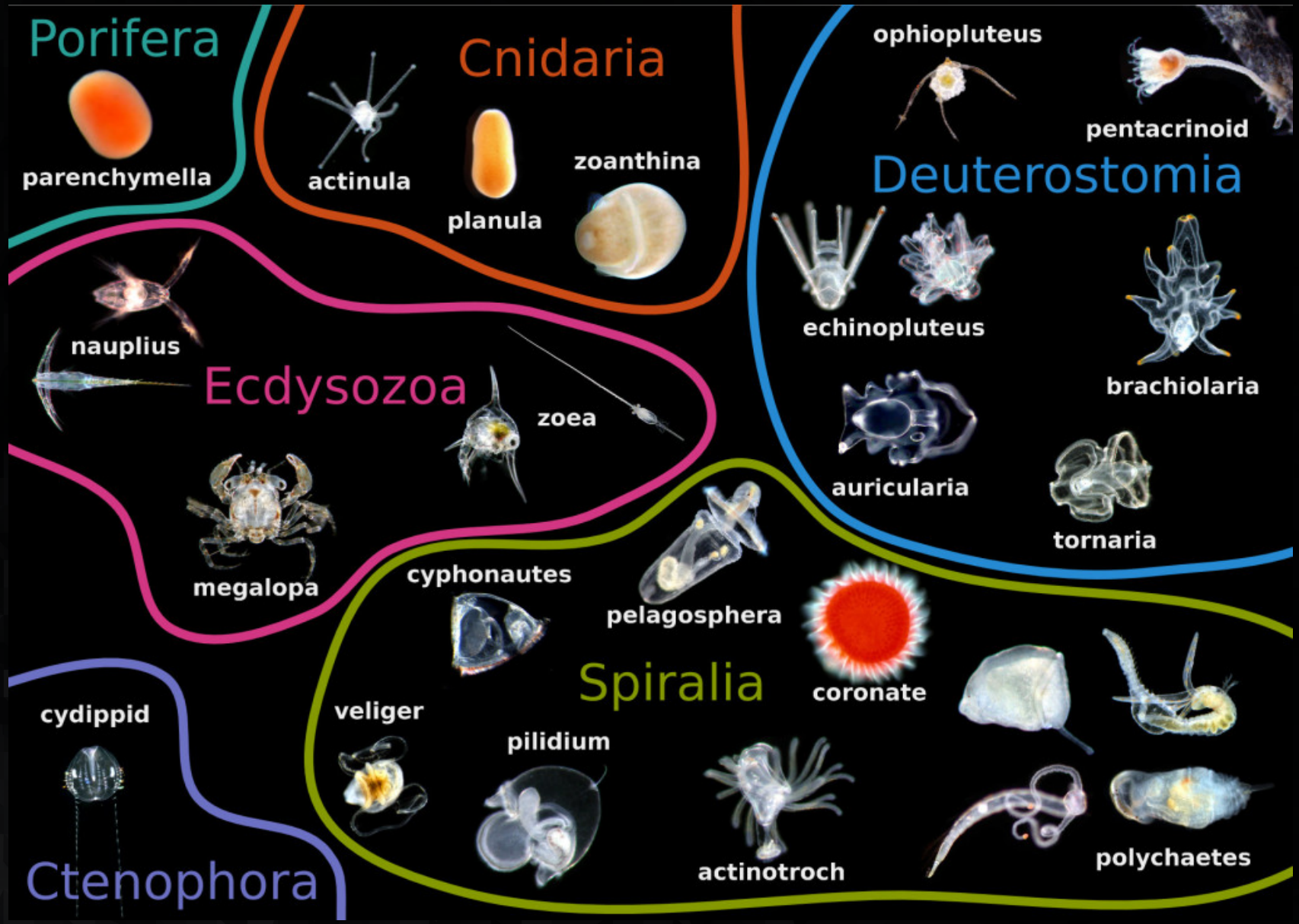
Invertebrates span orders of magnitude in size!

Most massive marine invertebrate:
Giant clam (400 kg)

Largest terrestrial invertebrate:
Coconut crab (4 kg)

Invertebrates are amazing cool!


miwa.b.uib.no


Porifera
parenchymella
Cnidaria
actinula
planula
zoanthina
ophiopluteus
pentacrinoid
Deuterostomia
echinopluteus
brachiolaria
auricularia
tornaria
nauplius
Ecdysozoa
zoea
megalopa
cyphonautes
pelagosphera
Spiralia
coronate
veliger
pilidium
actinotroch
polychaetes
cydippid
Ctenophora

“For magic consists in this, the true naming of a thing.”

-Ursula K. Le Guin

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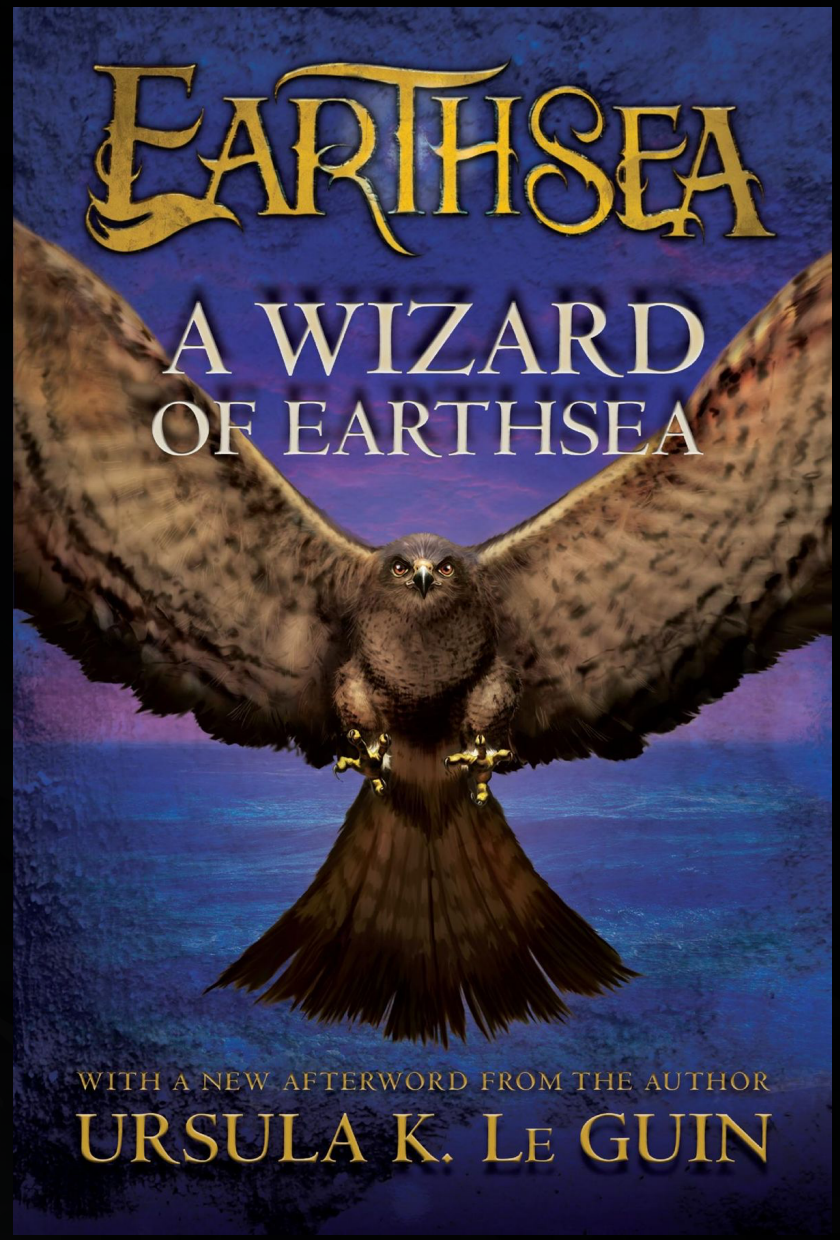
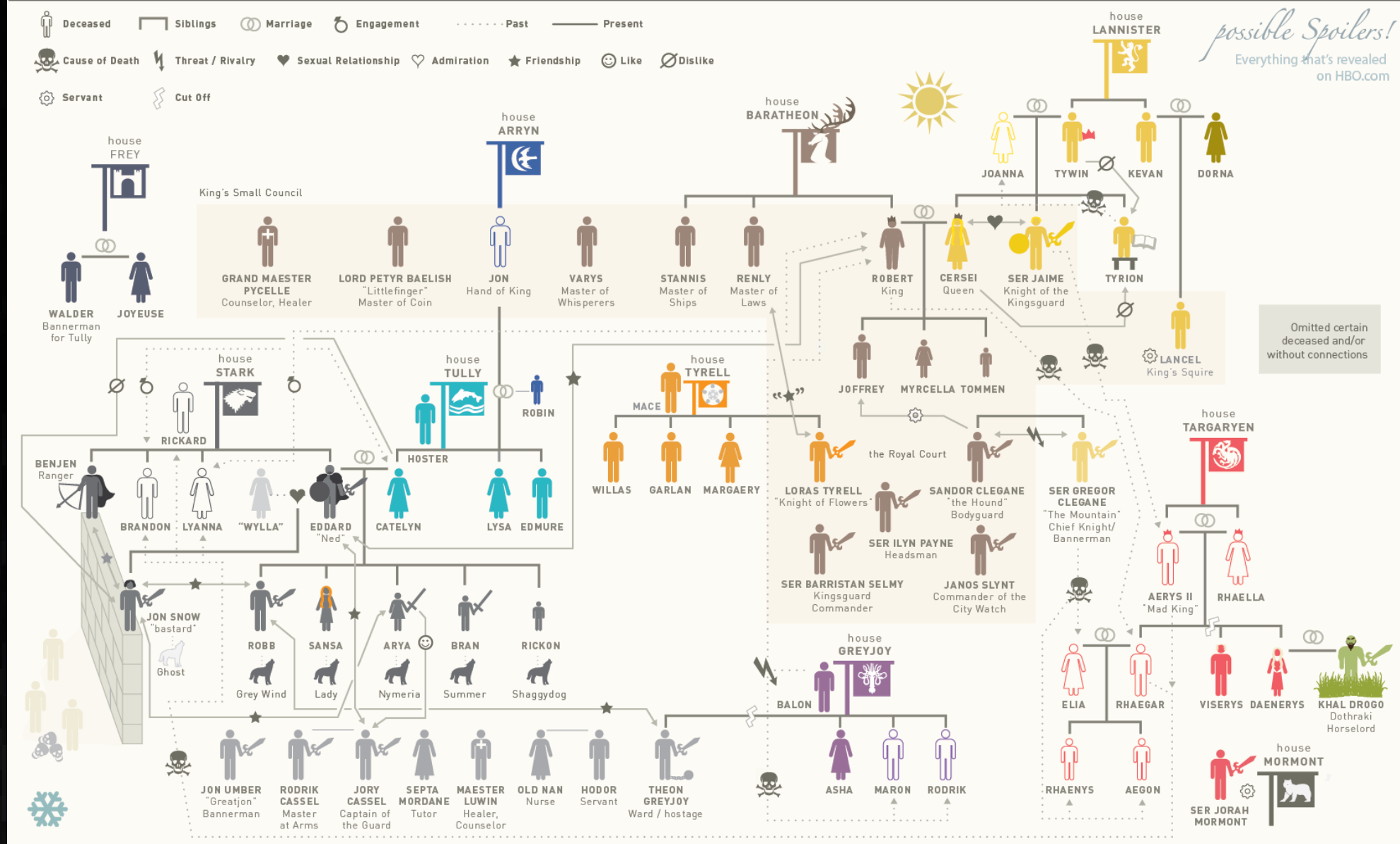


GAME OF

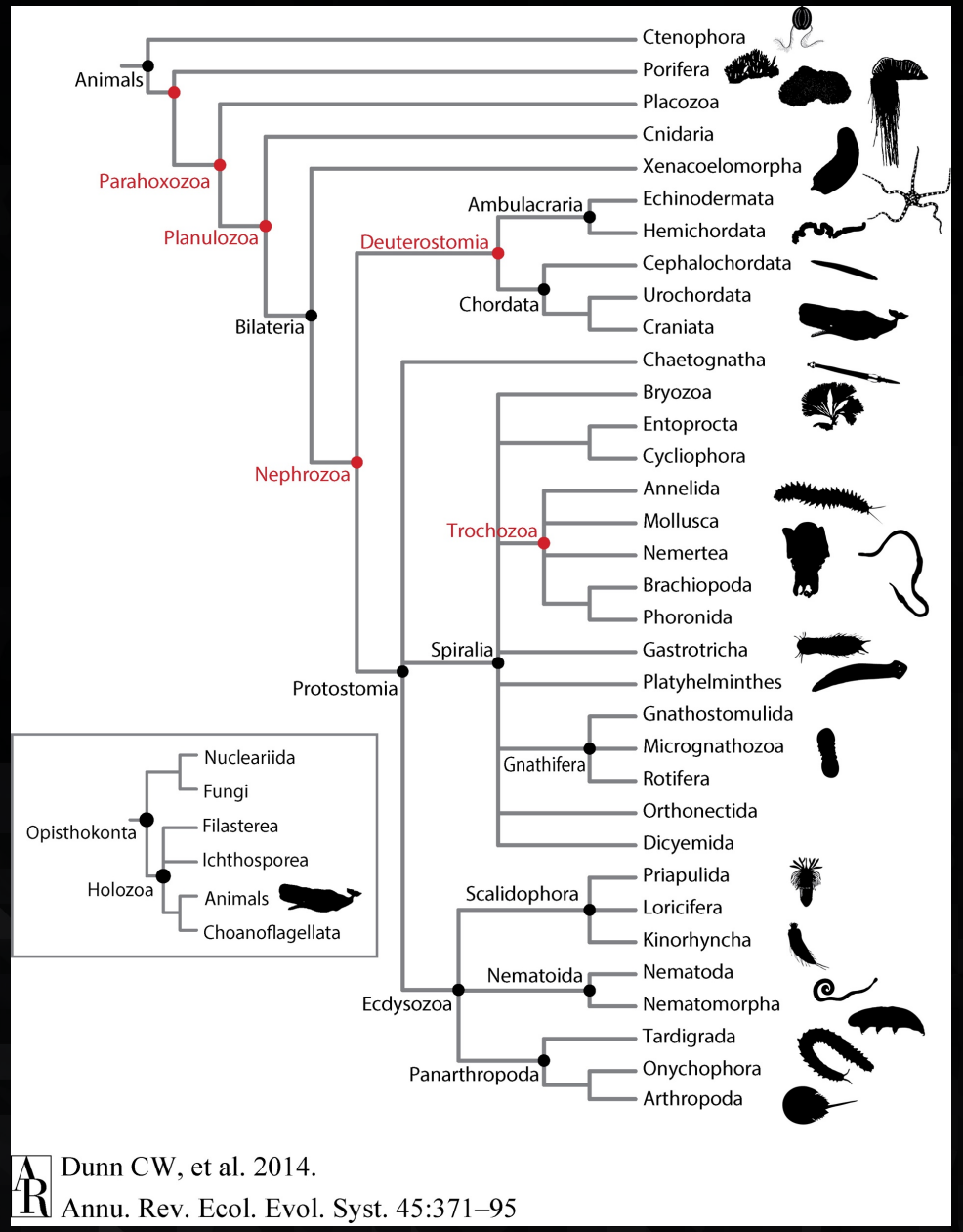
NO BACKBONES

HBO's Game of Thrones : Illustrated Guide to Houses & Character Relationships

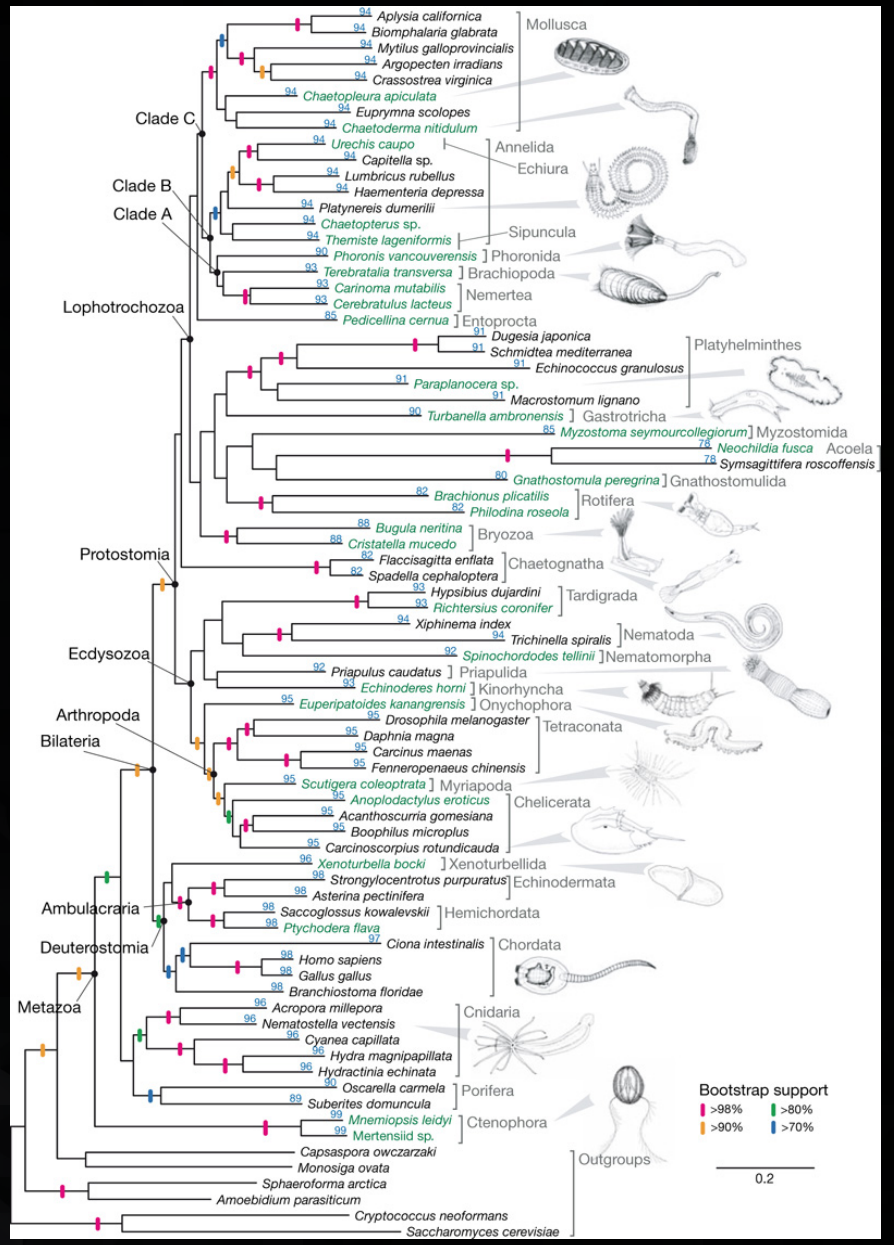


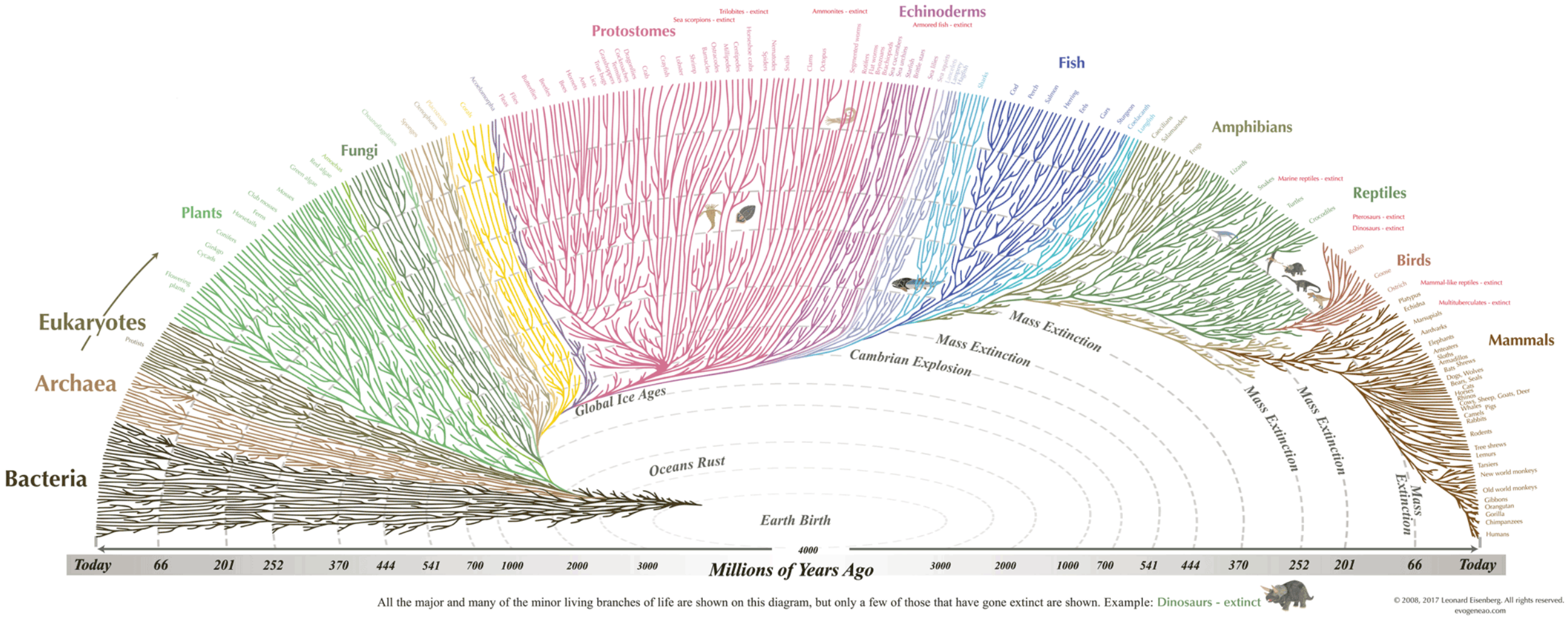
Source: http://www.hbo.com/game-of-thrones/

Created by Magdalena Maslowska http://hauteslides.com



Dunn CW, et al. 2014.
Annu. Rev. Ecol. Evol. Syst. 45:371–95





All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct

Focus more on process instead of product

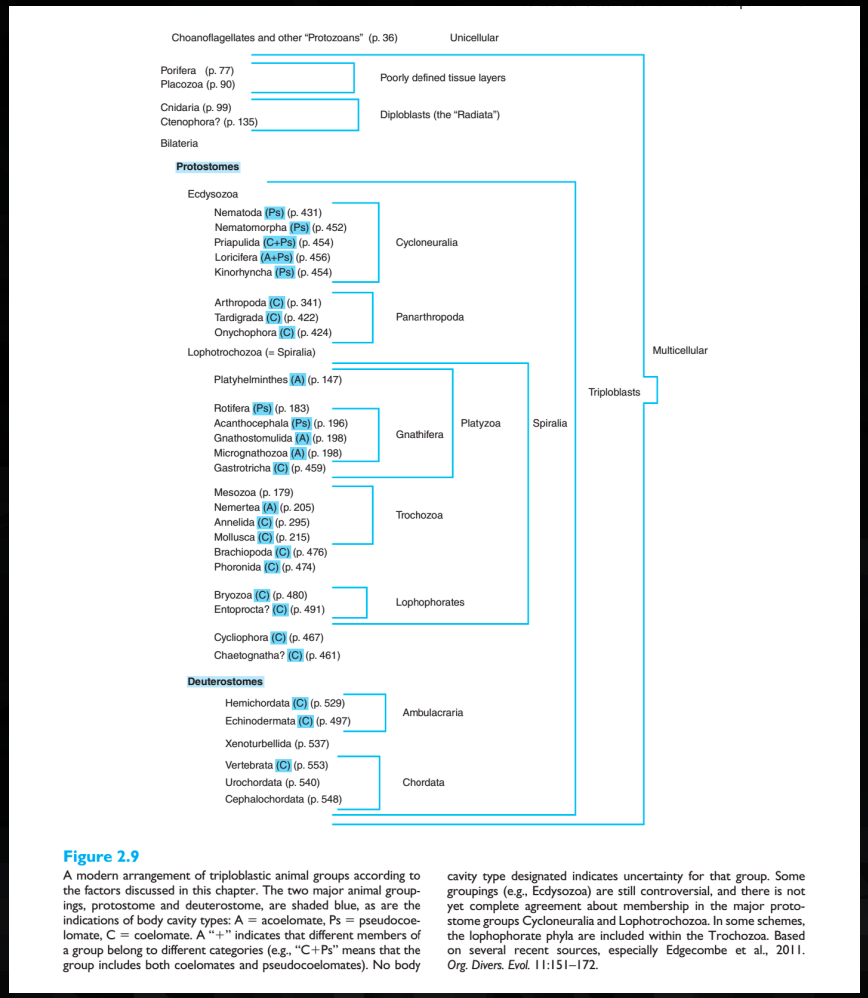
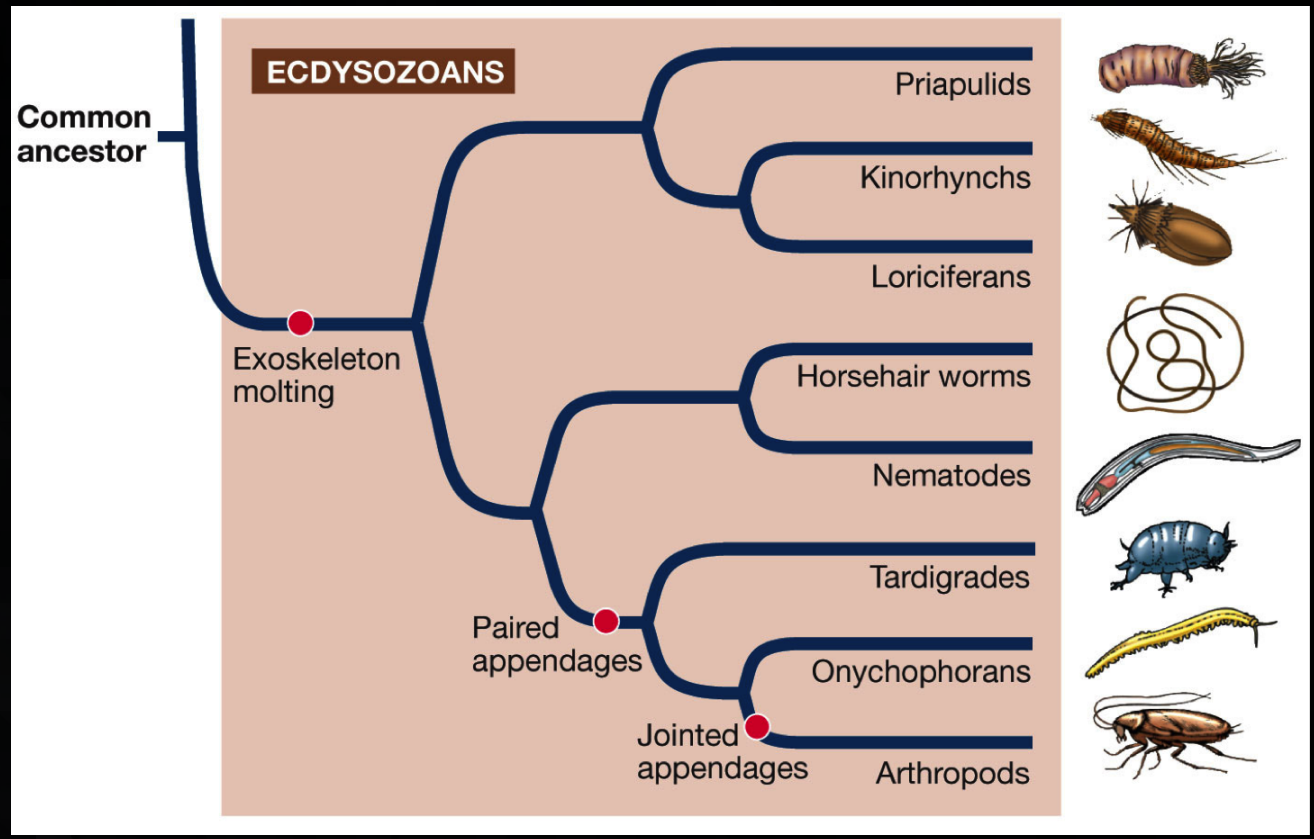
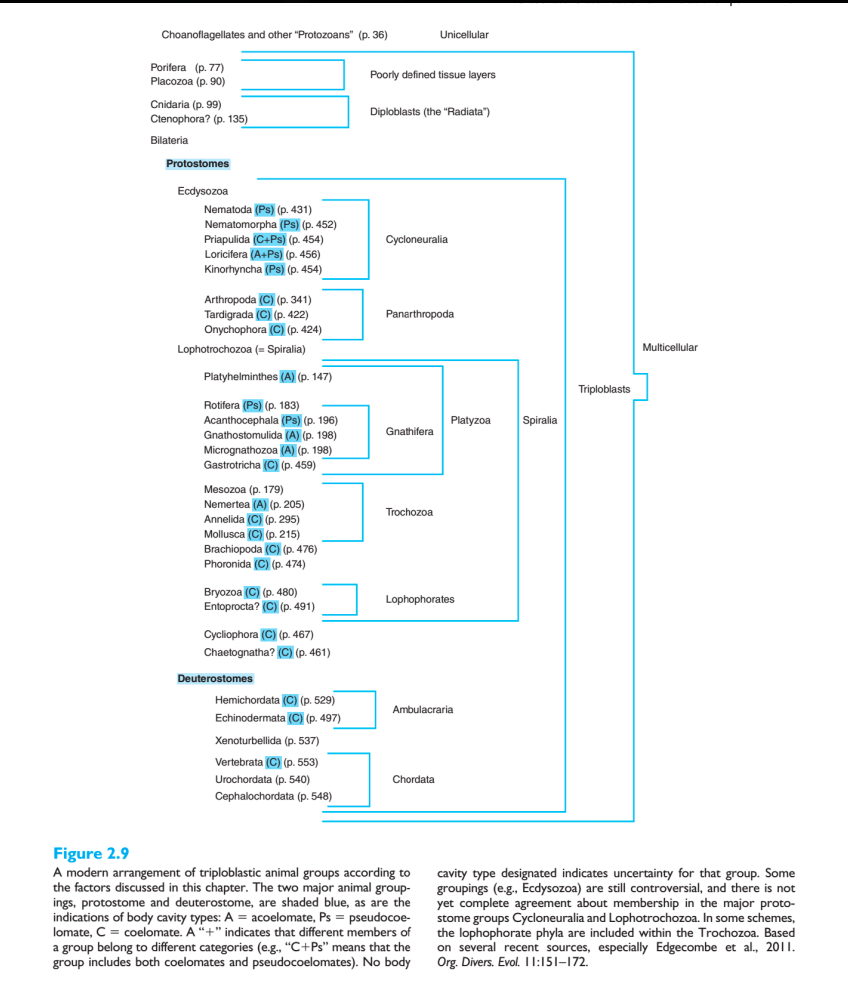


Figure 2.9
A modern arrangement of triploblastic animal groups according to the factors discussed in this chapter. The two major animal groupings, protostome and deuterostome, are shaded blue, as are the indications of body cavity types: A = acoelomate, Ps = pseudocoelomate, C = coelomate. A "+" indicates that different members of a group belong to different categories (e.g., "C+Ps" means that the group includes both coelomates and pseudocoelomates). No body cavity type designated indicates uncertainty for that group. Some groupings (e.g., Ecdysozoa) are still controversial, and there is not yet complete agreement about membership in the major protostome groups Cycloneuralia and Lophotrochozoa. In some schemes, the lophophorate phyla are included within the Trochozoa. Based on several recent sources, especially Edgecombe et al., 2011. *Org. Divers. Evol.* 11:151–172.



Focus more on process instead of product



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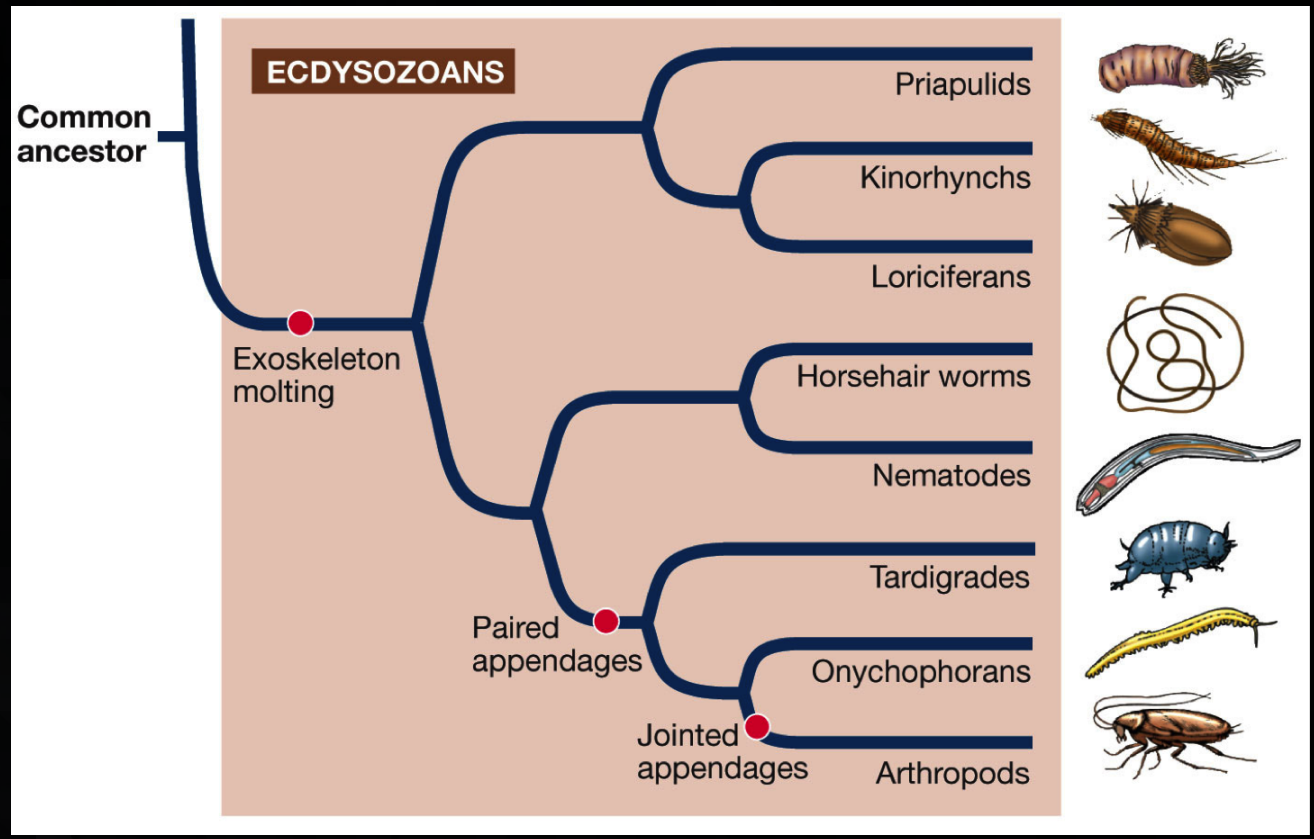
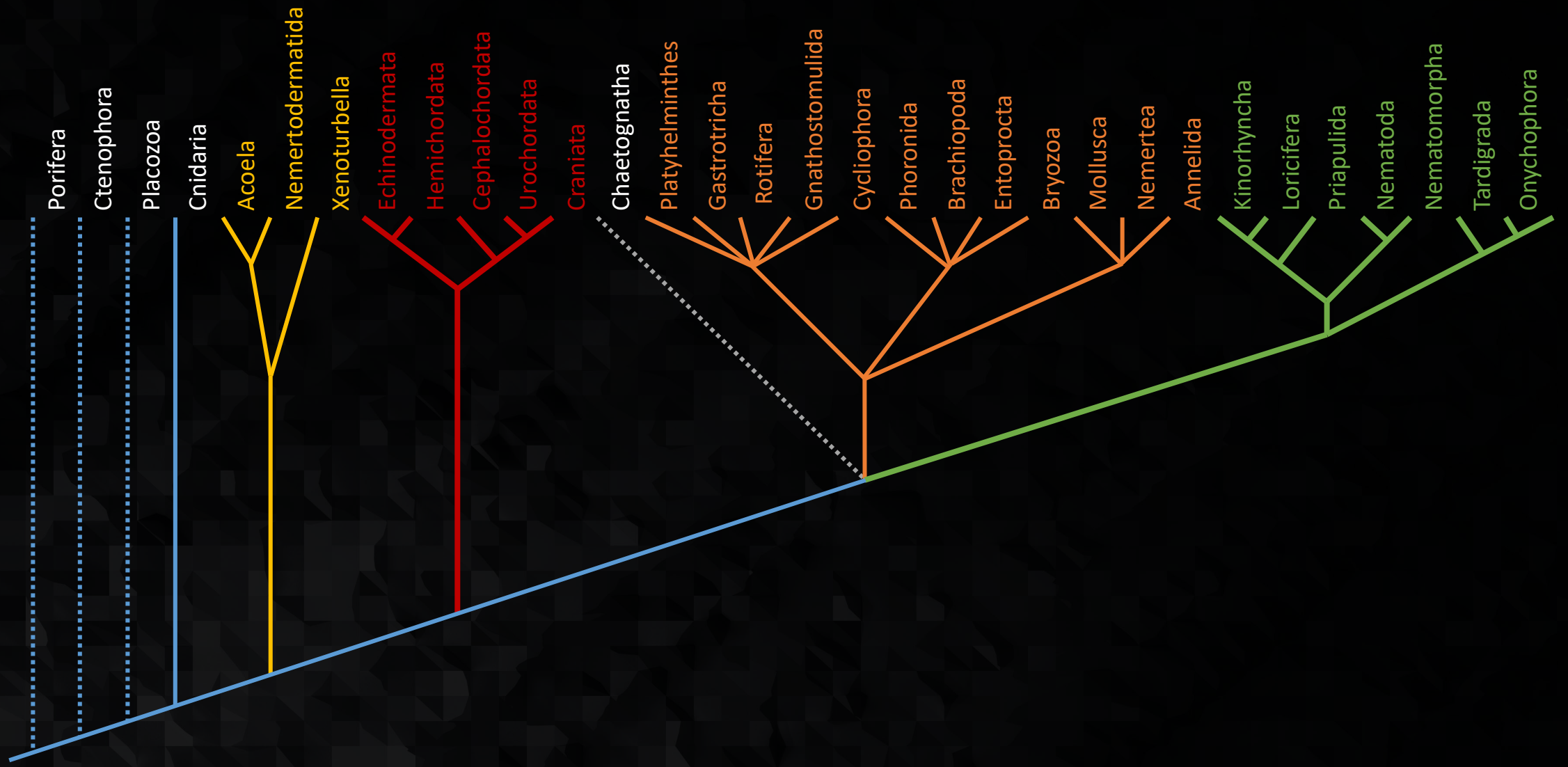
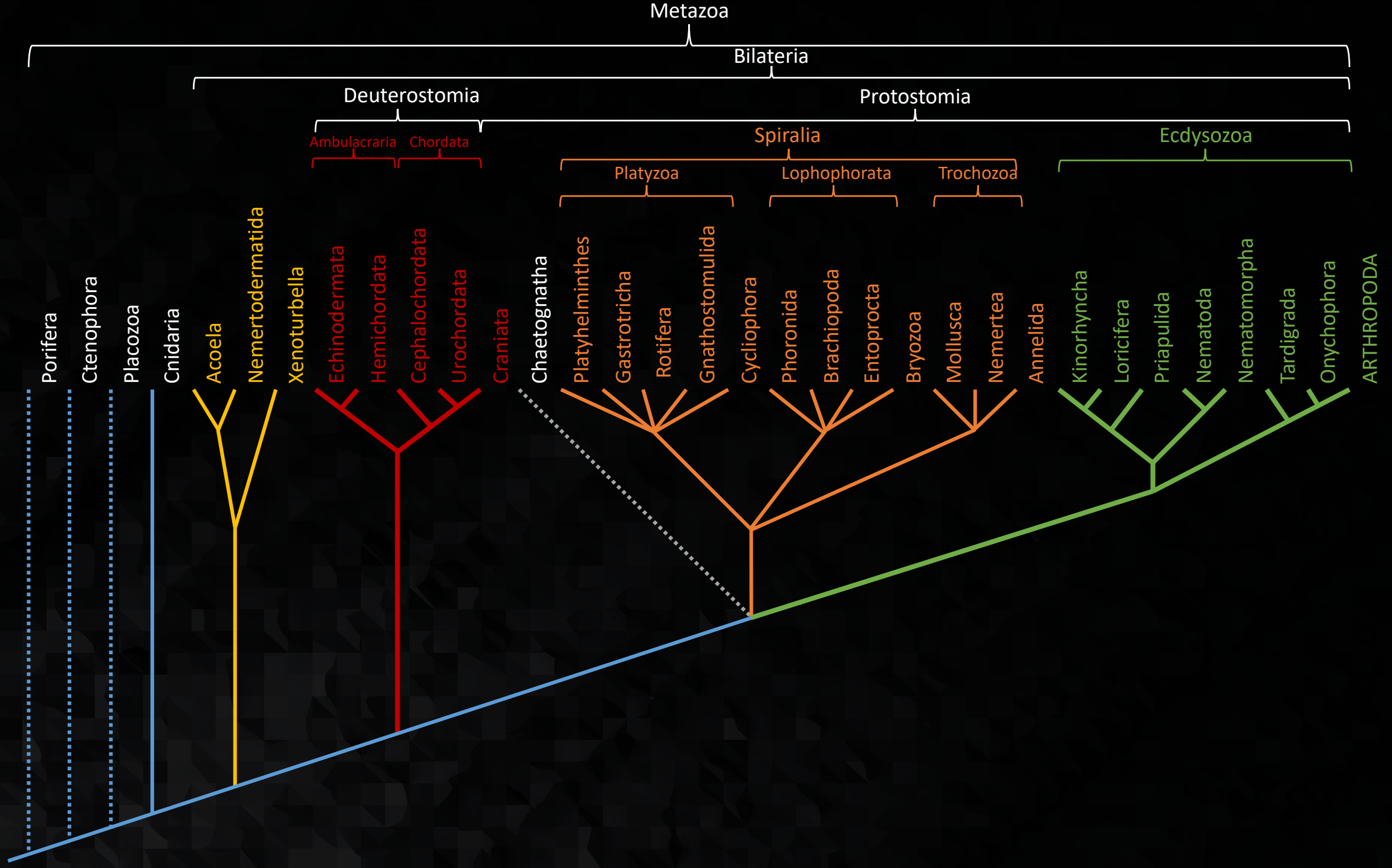
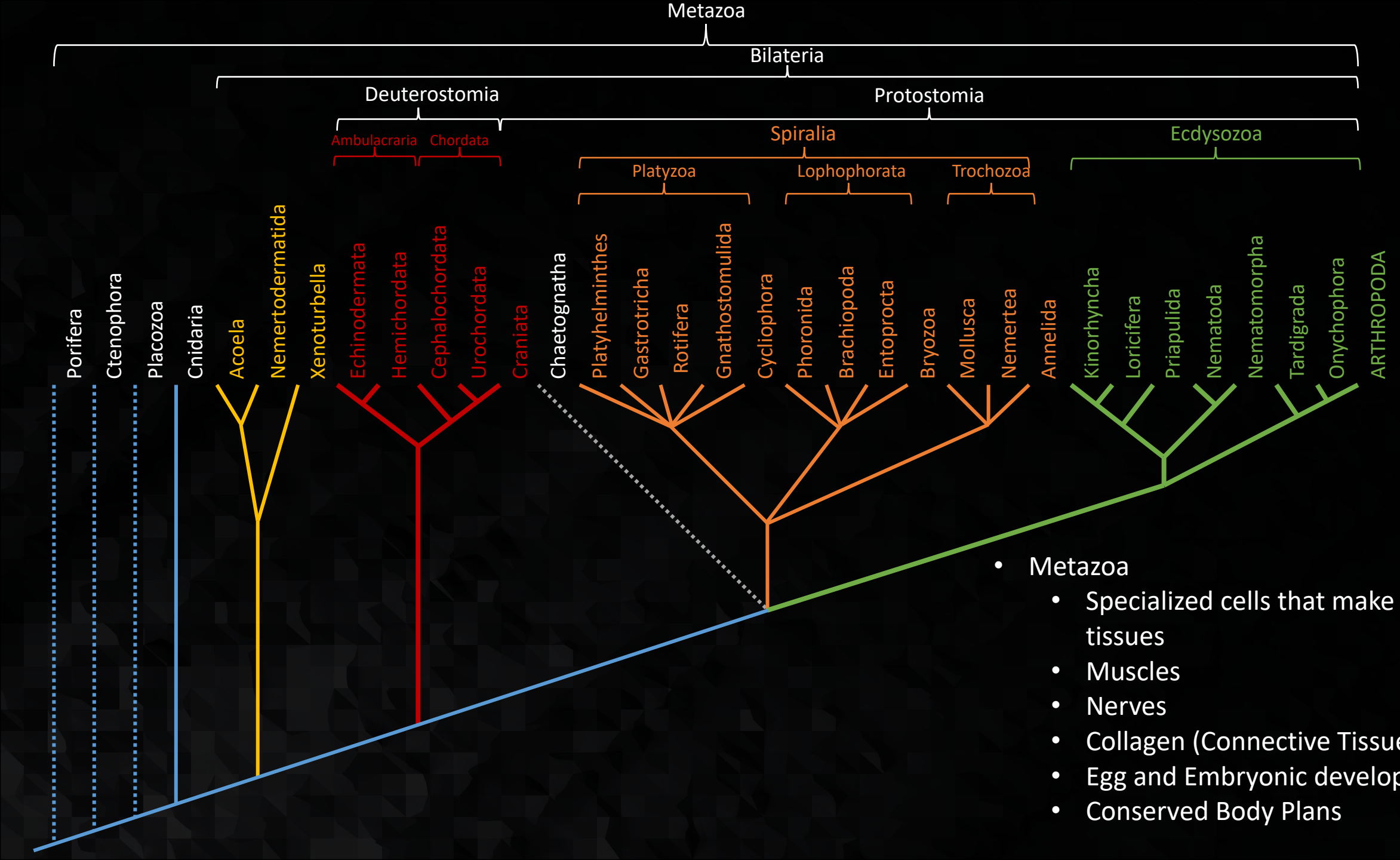


Taxonomic names and proposed evolutionary relationships change frequently as new information is discovered!

The Metazoa


Porifera
Ctenophora
Placozoa
Cnidaria
Acoela
Nemertodermatida
Xenoturbella
Echinodermata
Hemichordata
Cephalochordata
Urochordata
Craniata
Chaetognatha
Platyhelminthes
Gastrotricha
Rotifera
Gnathostomulida
Cycliophora
Phoronida
Brachiopoda
Entoprocta
Bryozoa
Mollusca
Nemertea
Annelida
Kinorhyncha
Loricifera
Priapulida
Nematoda
Nematomorpha
Tardigrada
Onychophora
ARTHROPODA

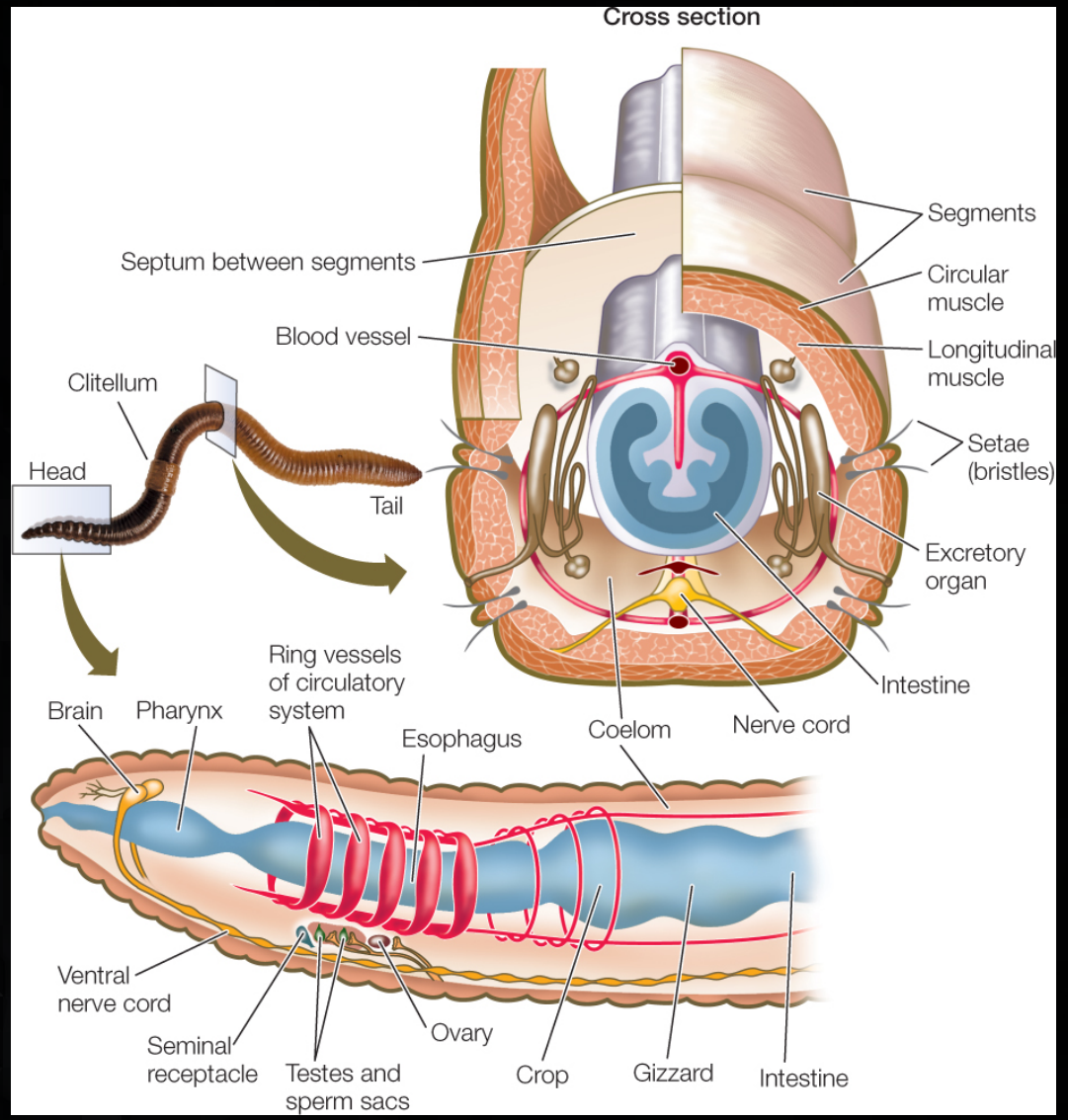

Metazoa
Bilateria
Deuterostomia
Protostomia
Ambulacraria
Chordata
Spiralia
Ecdysozoa
Platyzoa
Lophophorata
Trochozoa
Porifera
Ctenophora
Placozoa
Cnidaria
Acoela
Nemertodermatida
Xenoturbella
Echinodermata
Hemichordata
Cephalochordata
Urochordata
Craniata
Chaetognatha
Platyhelminthes
Gastrotricha
Rotifera
Gnathostomulida
Cycliophora
Phoronida
Brachiopoda
Entoprocta
Bryozoa
Mollusca
Nemertea
Annelida
Kinorhyncha
Loricifera
Priapulida
Nematoda
Nematomorpha
Tardigrada
Onychophora
ARTHROPODA

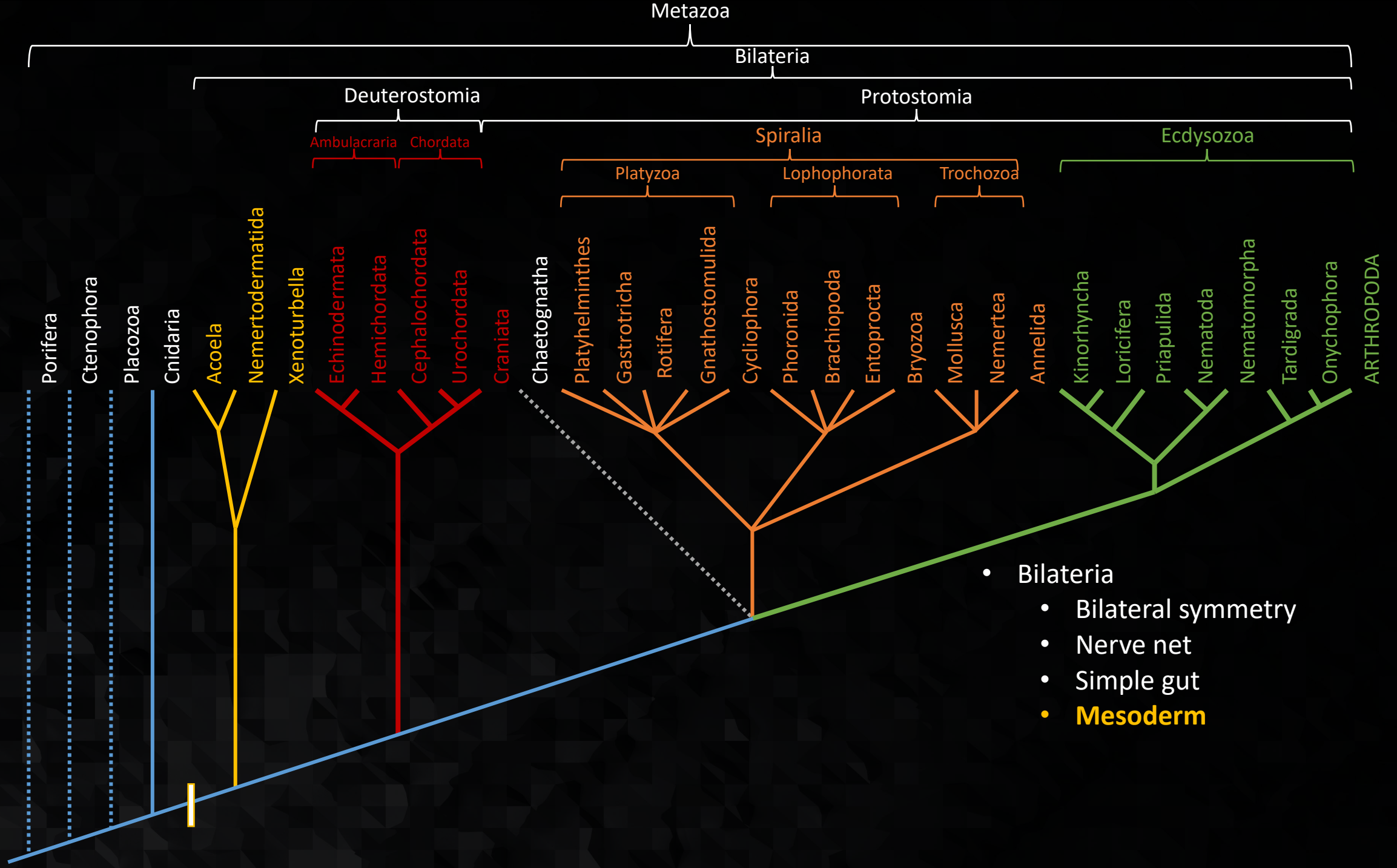


- Metazoa
  - Specialized cells that make up tissues
  - Muscles
  - Nerves
  - Collagen (Connective Tissue)
  - Egg and Embryonic development
  - Conserved Body Plans

Classification Toolkit: Morphology

- Body plan (Bauplan)
  - Symmetry
  - Development and tissue Layers
  - Osmoregulation
  - Circulation and respiration
  - Nervous system
  - Skeleton and muscles
  - Skeleton, musculature, and locomotion
  - Feeding
  - Reproduction

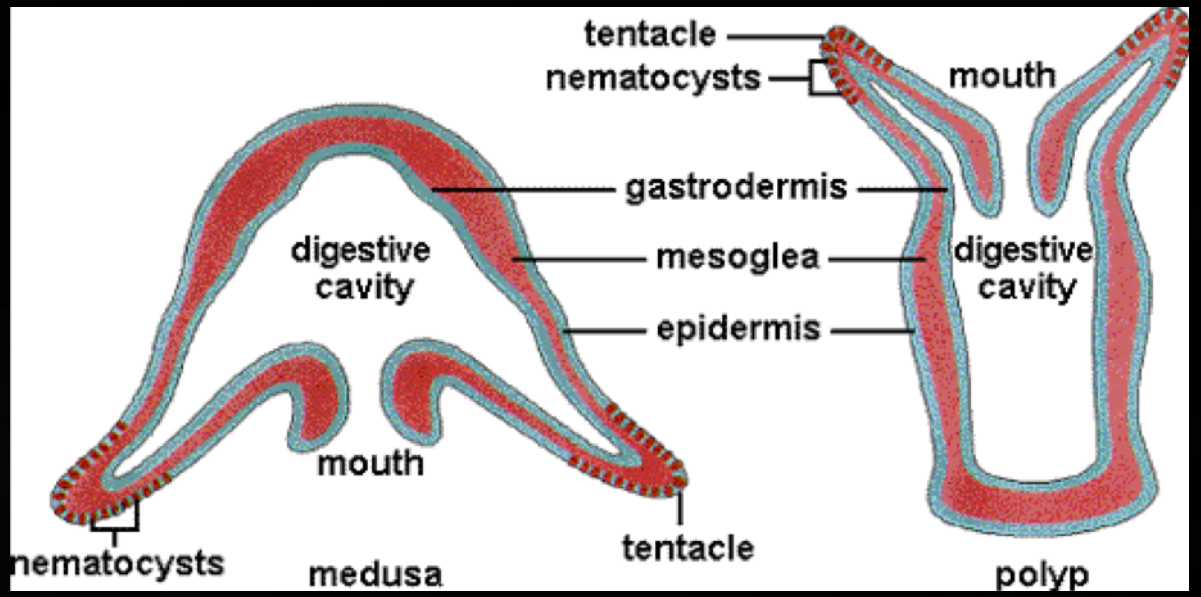




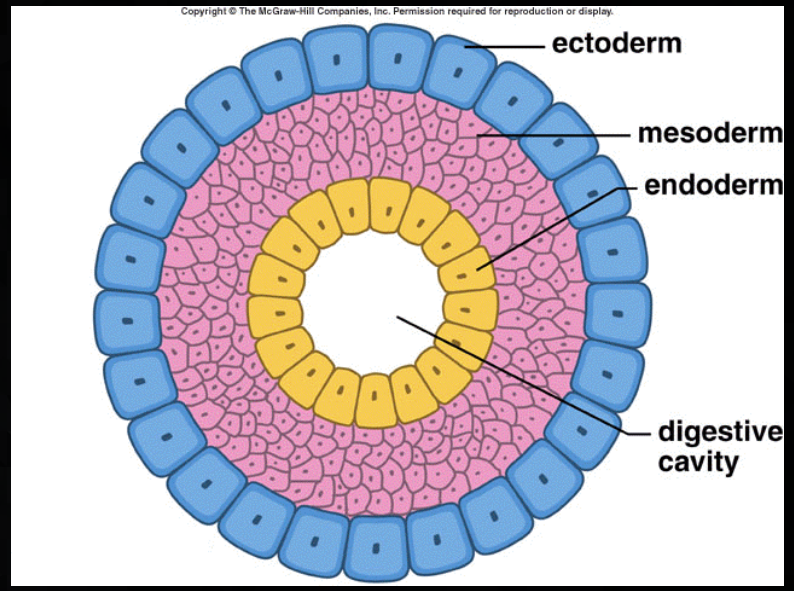
- Bilateria
  - Bilateral symmetry
  - Nerve net
  - Simple gut
  - **Mesoderm**

Classification Toolkit: Morphology

- Body plan (Bauplan)
  - Development and germ Layers
    - **Diploblastic**
      - Only has two germ layers
        - Ectoderm
        - Endoderm

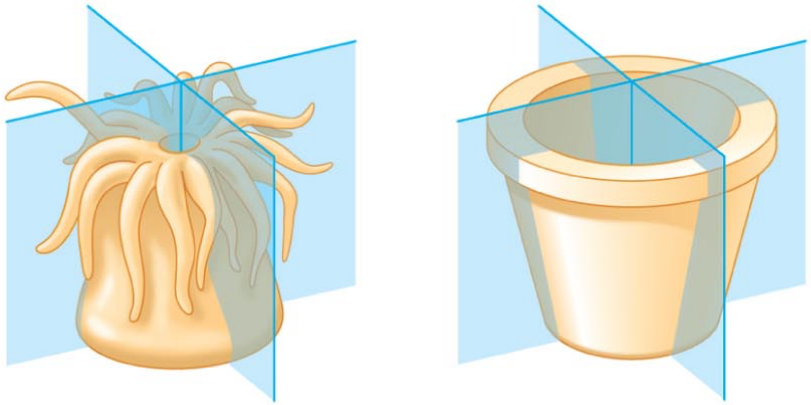


    - **Triploblastic**
      - Has all three germ layers

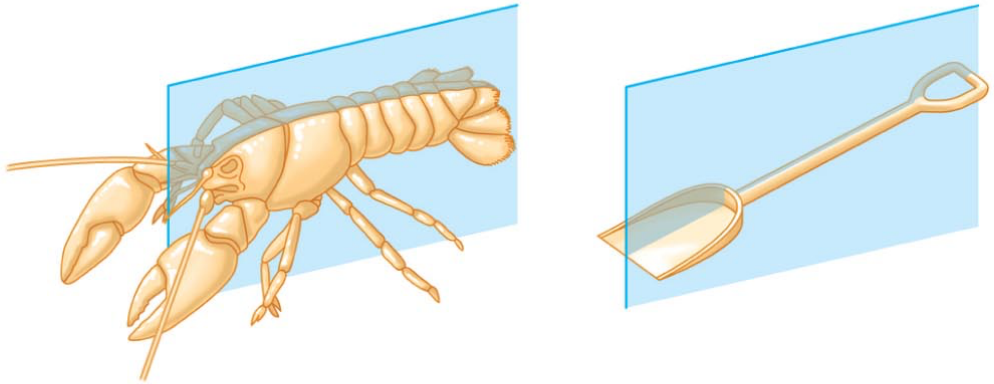


Classification Toolkit: Morphology

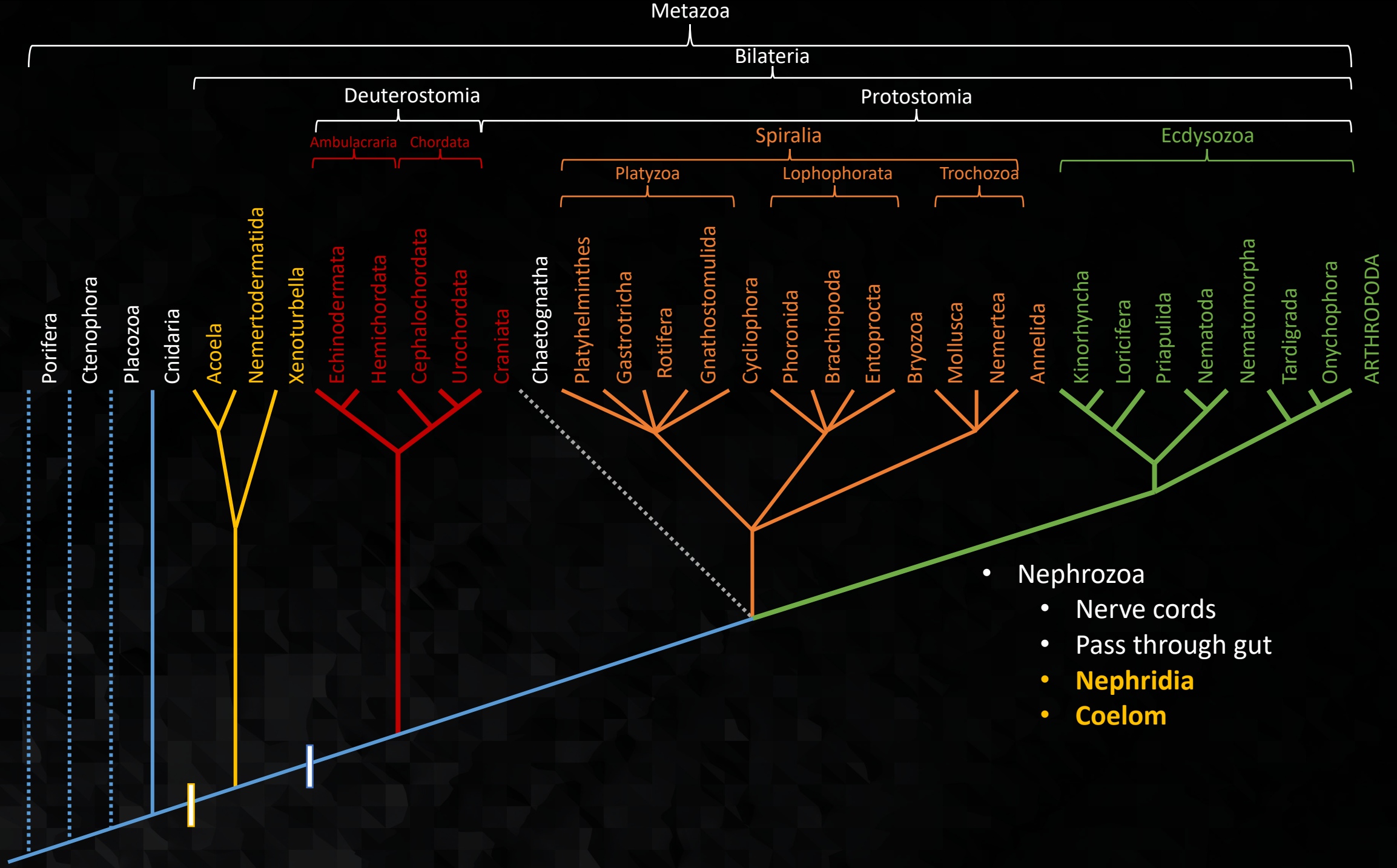
- Body plan (Bauplan)
  - Symmetry



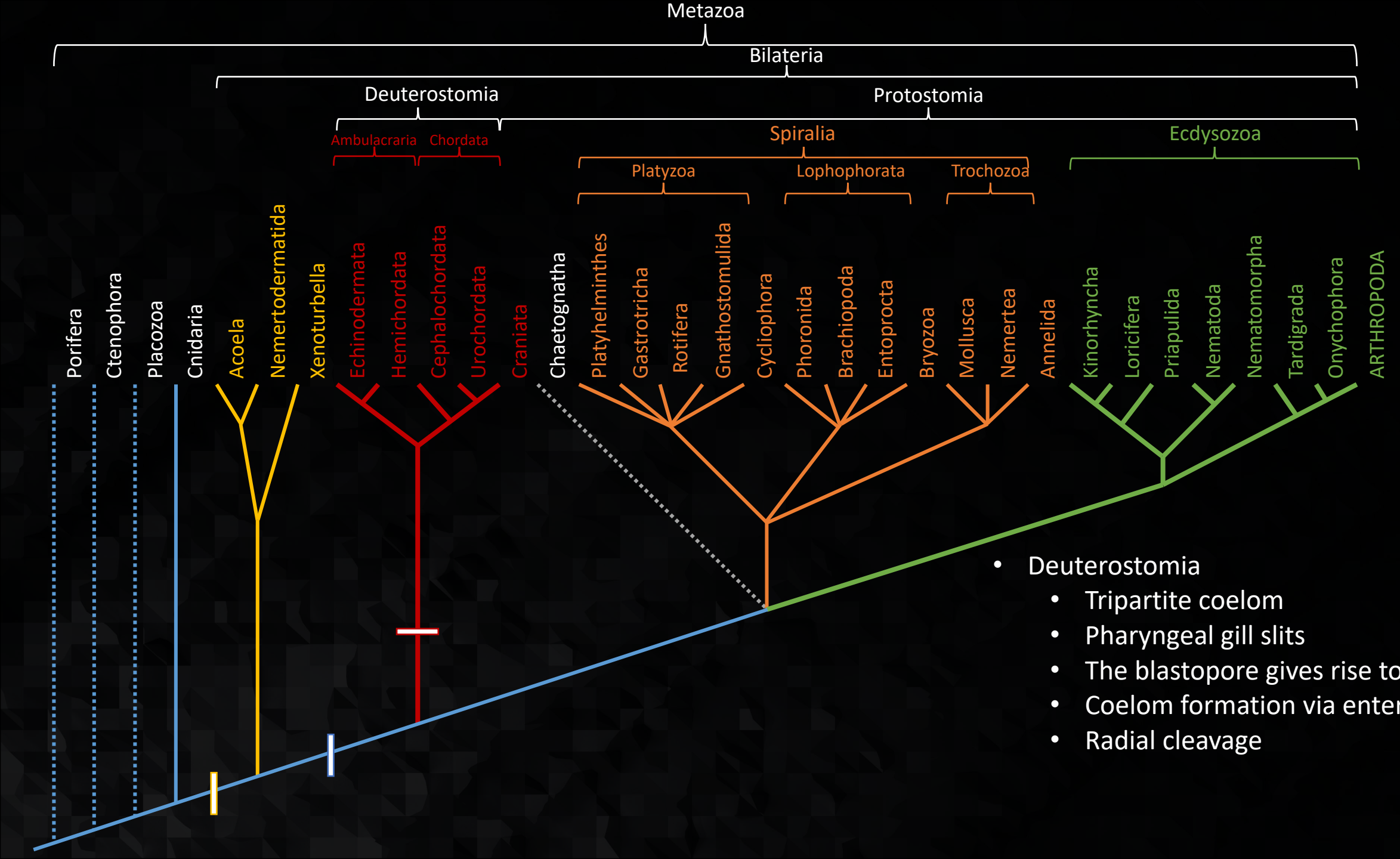
Radial symmetry. Parts radiate from the center, so any slice through the central axis divides into mirror images.



Bilateral symmetry. Only one slice can divide left and right sides into mirror-image halves.



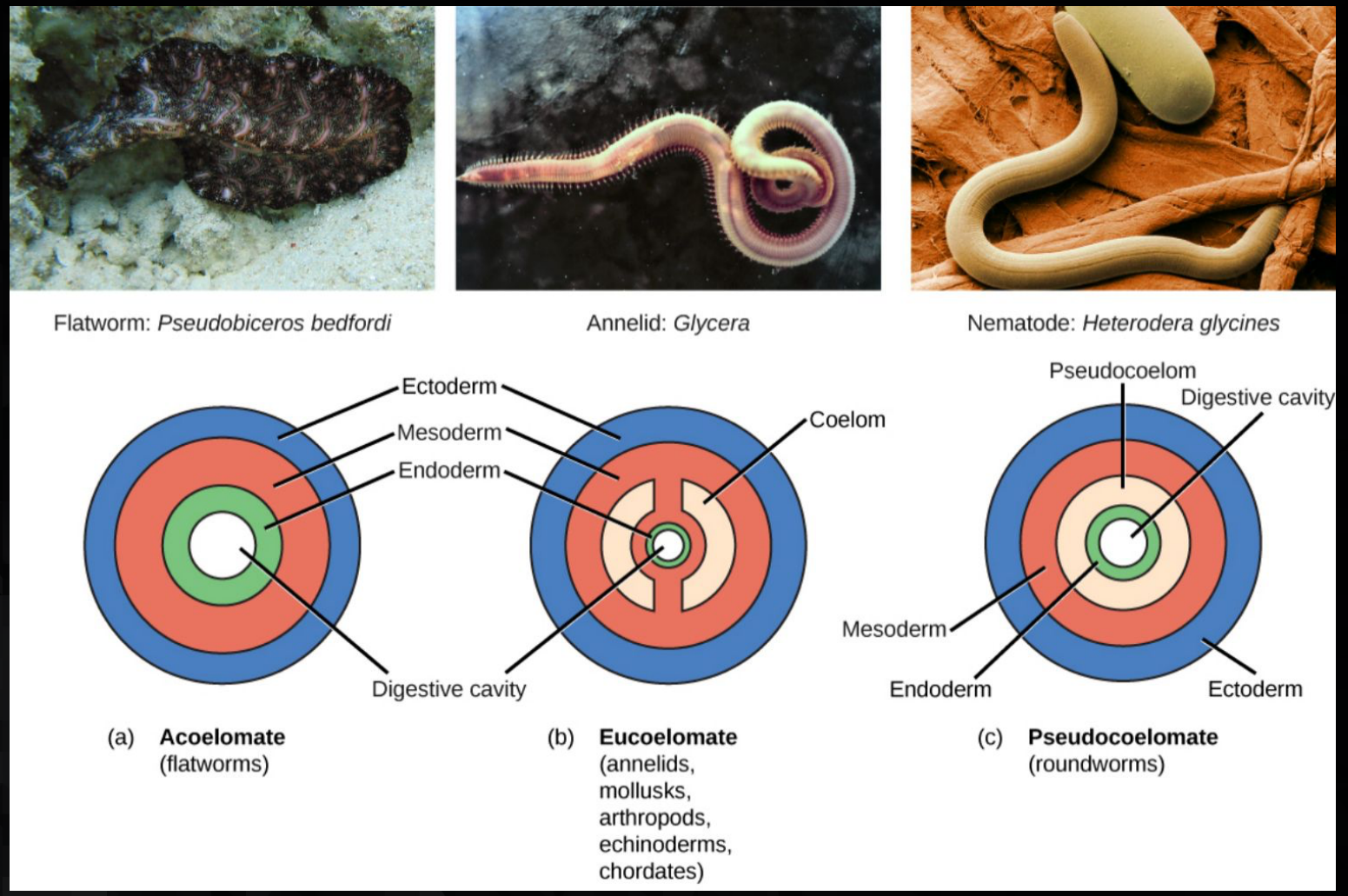
- Nephrozoa
  - Nerve cords
  - Pass through gut
  - **Nephridia**
  - **Coelom**

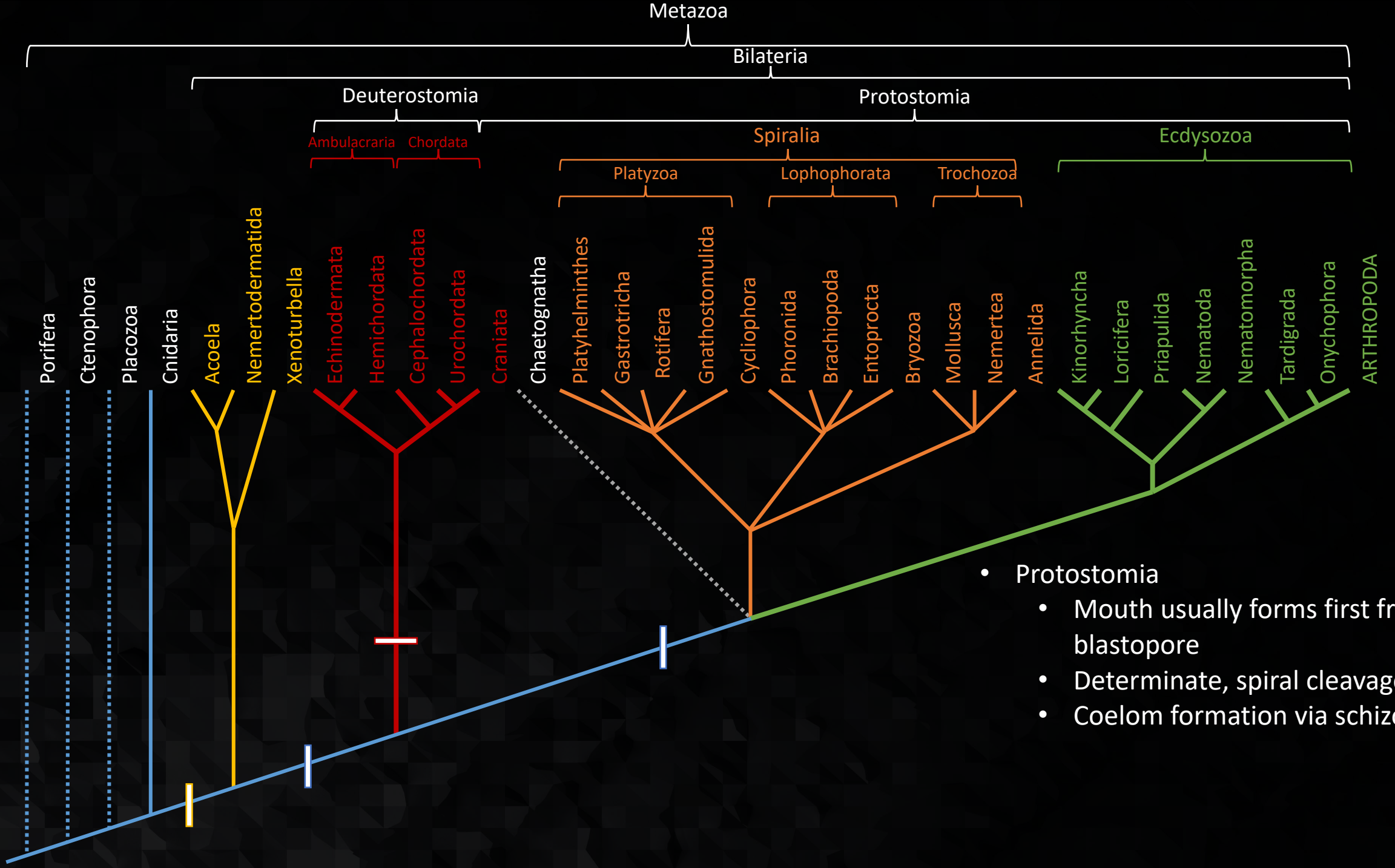


- Deuterostomia
  - Tripartite coelom
  - Pharyngeal gill slits
  - The blastopore gives rise to anus
  - Coelom formation via enterocoely
  - Radial cleavage

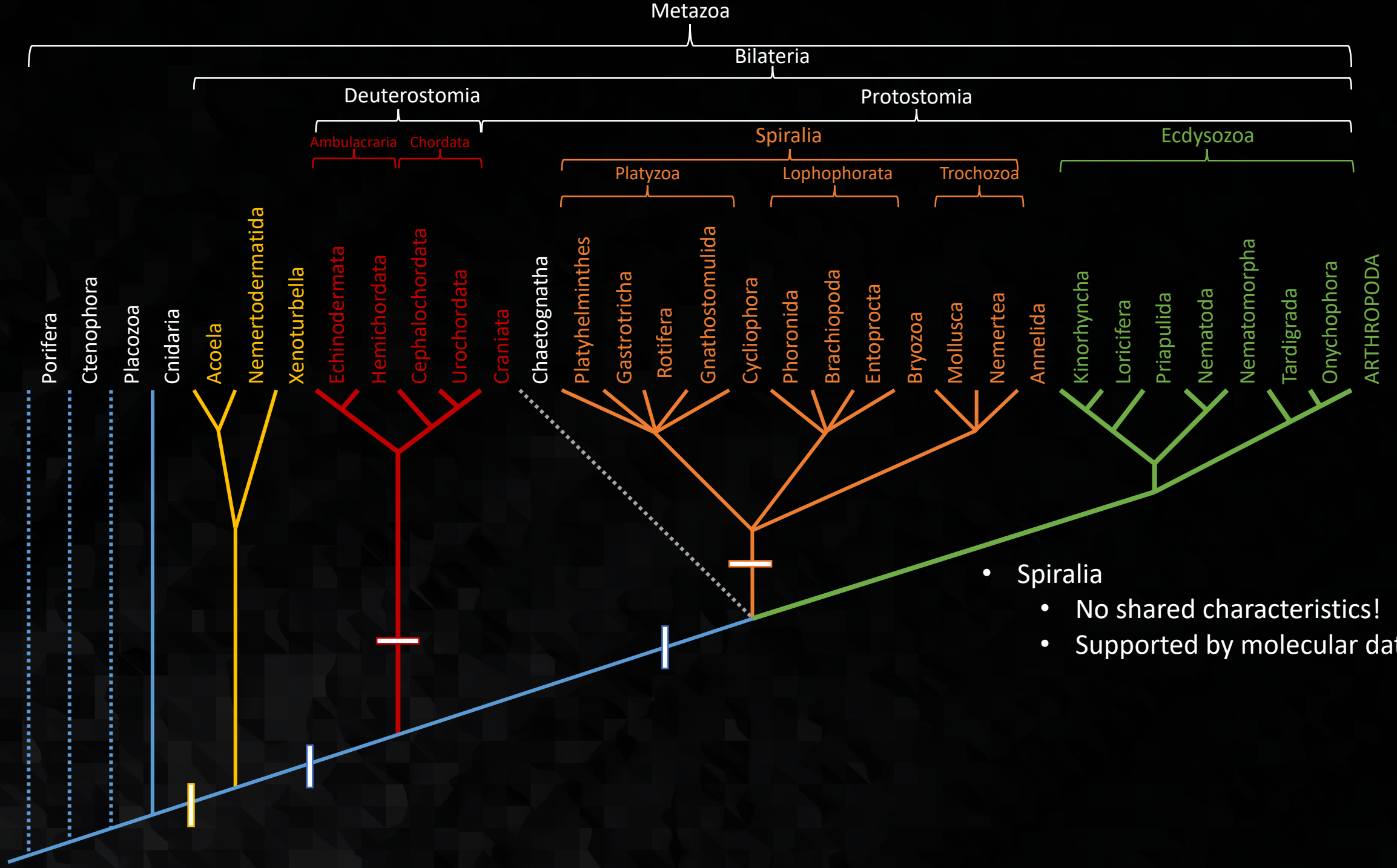
Classification Toolkit: Morphology

- Body plan (Bauplan)
  - Body cavity

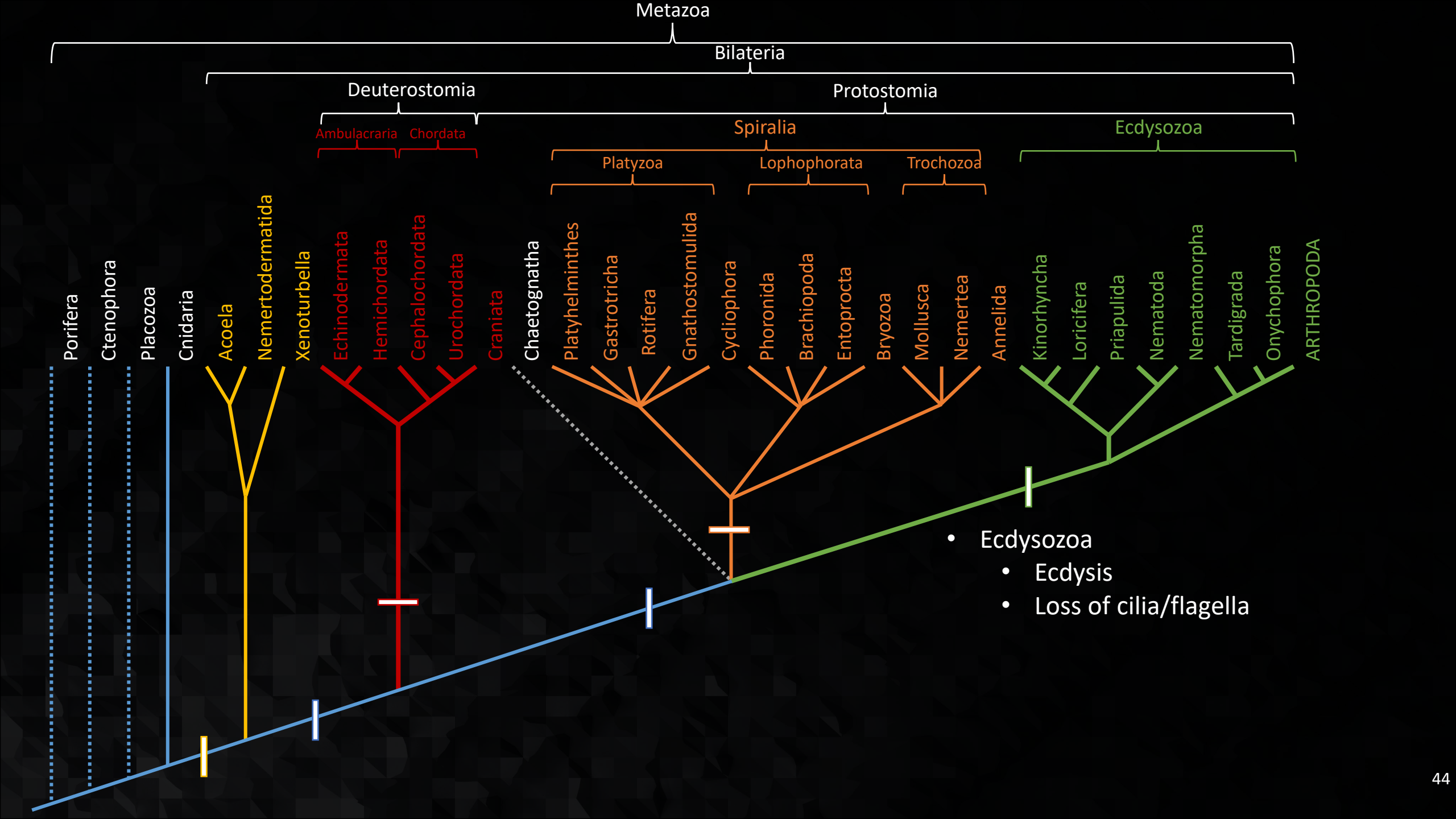




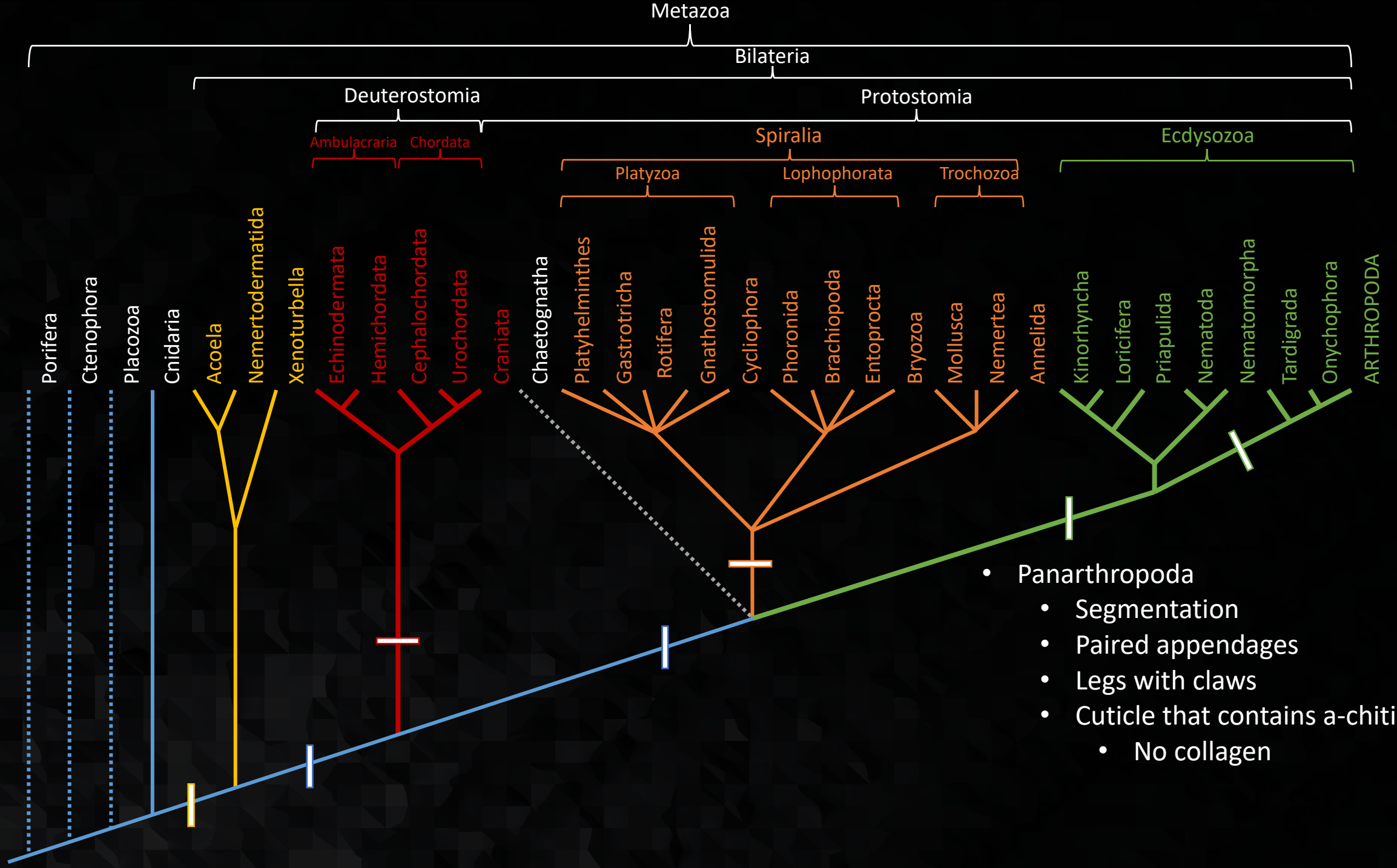
- Protostomia
  - Mouth usually forms first from blastopore
  - Determinate, spiral cleavage
  - Coelom formation via schizocoely



- Spiralia
  - No shared characteristics!
  - Supported by molecular data



- Ecdysozoa
  - Ecdysis
  - Loss of cilia/flagella



- Panarthropoda
  - Segmentation
  - Paired appendages
  - Legs with claws
  - Cuticle that contains a-chitin
    - No collagen

Homework assignment for Tuesday

- Send me an email (jpuritz@uri.edu)
- Include:
  - Your name
  - Preferred pronouns
  - Major
  - Year
  - Which group of invertebrates you are most excited to learn about
  - Any relevant facts about you as a student
    - I like hands-on learning activities
    - I dislike group activities
    - I'm red/green colorblind and have difficulty with laser pointers
    - I'm an athlete and may need to miss some class time
  - One interesting personal fact about yourself
    - I love SCUBA diving