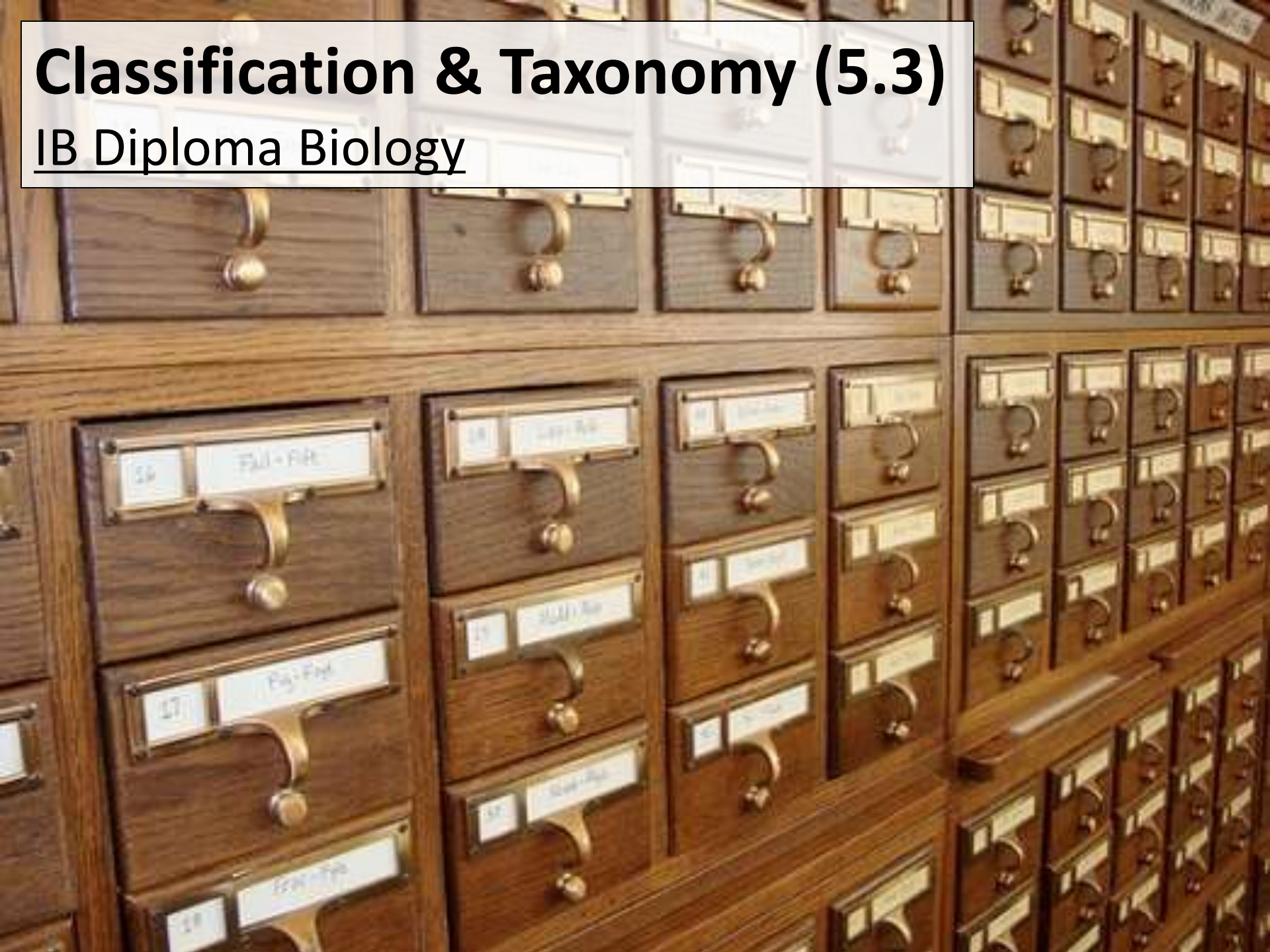


Classification & Taxonomy (5.3)

IB Diploma Biology





Life

Domain

Kingdom

Phylum

Class

Order

Family

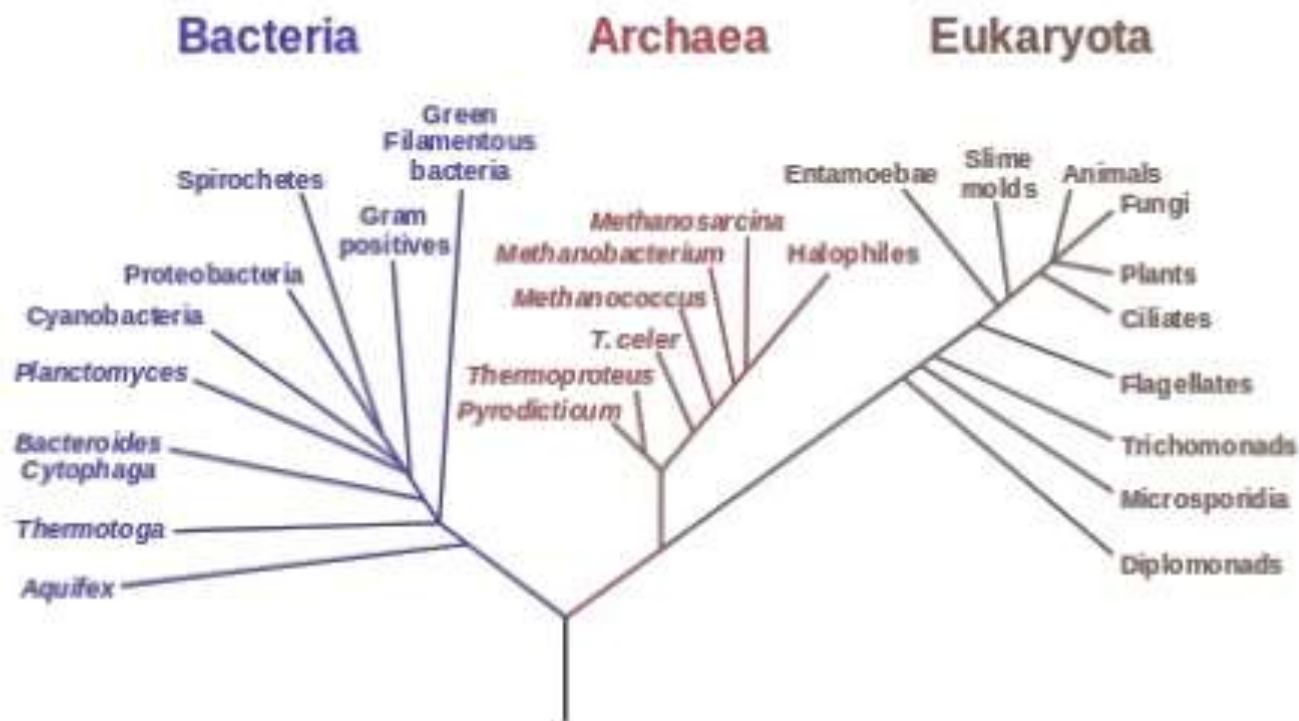
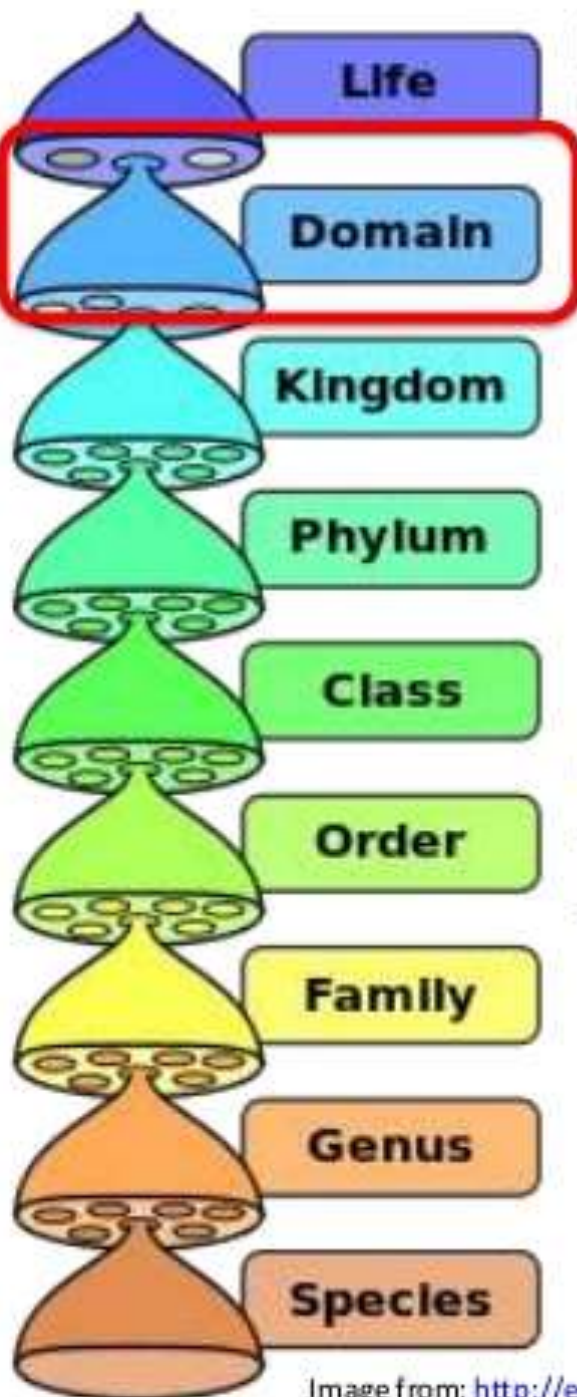
Genus

Species

Living MRS GREN: **M**ovement, **R**espiration, **S**ensitivity (to change), **G**rowth, **R**eproduction, **E**xcretion (of waste), **N**utrition

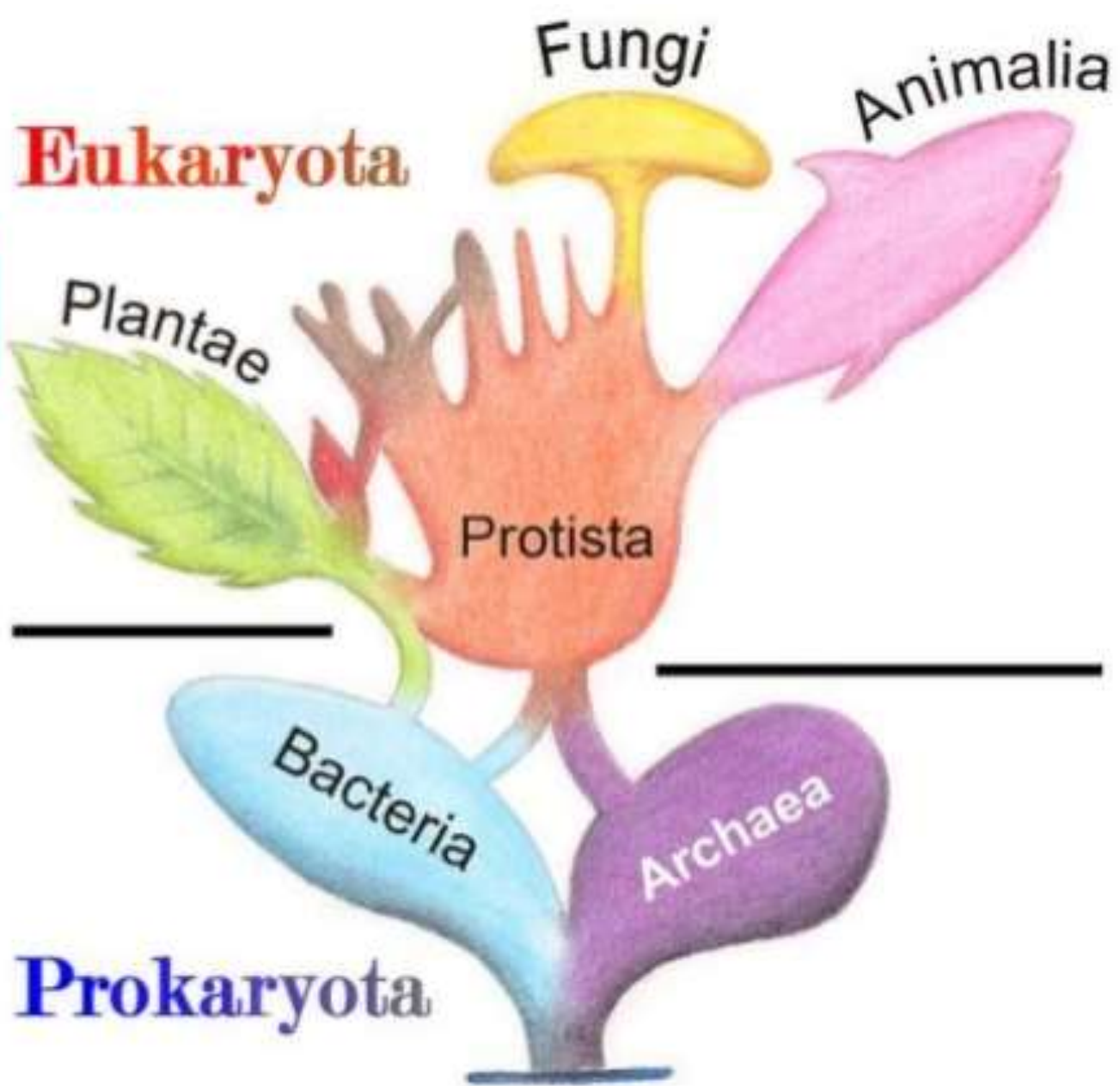
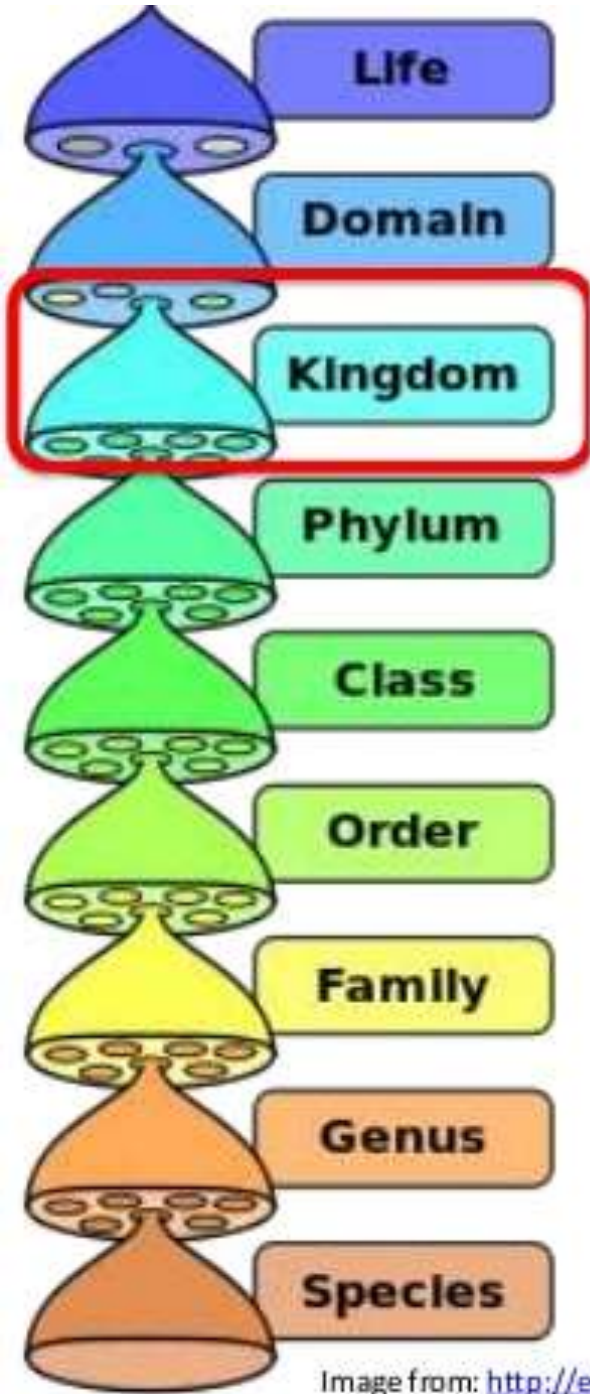
Living MRS GREN: Movement, Respiration, Sensitivity (to change), Growth, Reproduction, Excretion (of waste), Nutrition

Three main 'Domains' in the Phylogenetic Tree of Life



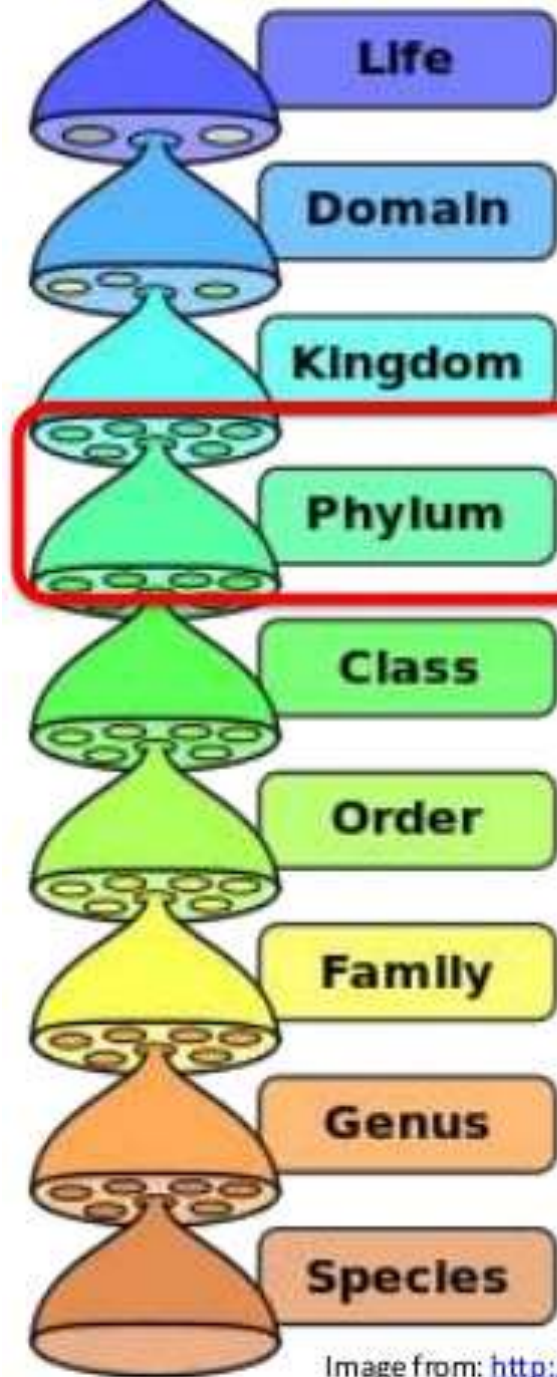
Tree of life from: http://en.wikipedia.org/wiki/Three-domain_system

Image from: http://en.wikipedia.org/wiki/Biological_classification



Six Kingdoms from: [http://en.wikipedia.org/wiki/Kingdom_\(biology\)](http://en.wikipedia.org/wiki/Kingdom_(biology))

Image from: http://en.wikipedia.org/wiki/Biological_classification



Some examples of Phyla we need to know

Kingdom Animalia

- Porifera
- Cnidaria
- Platyhelminthes
- Annelida
- Mollusca
- Arthropoda

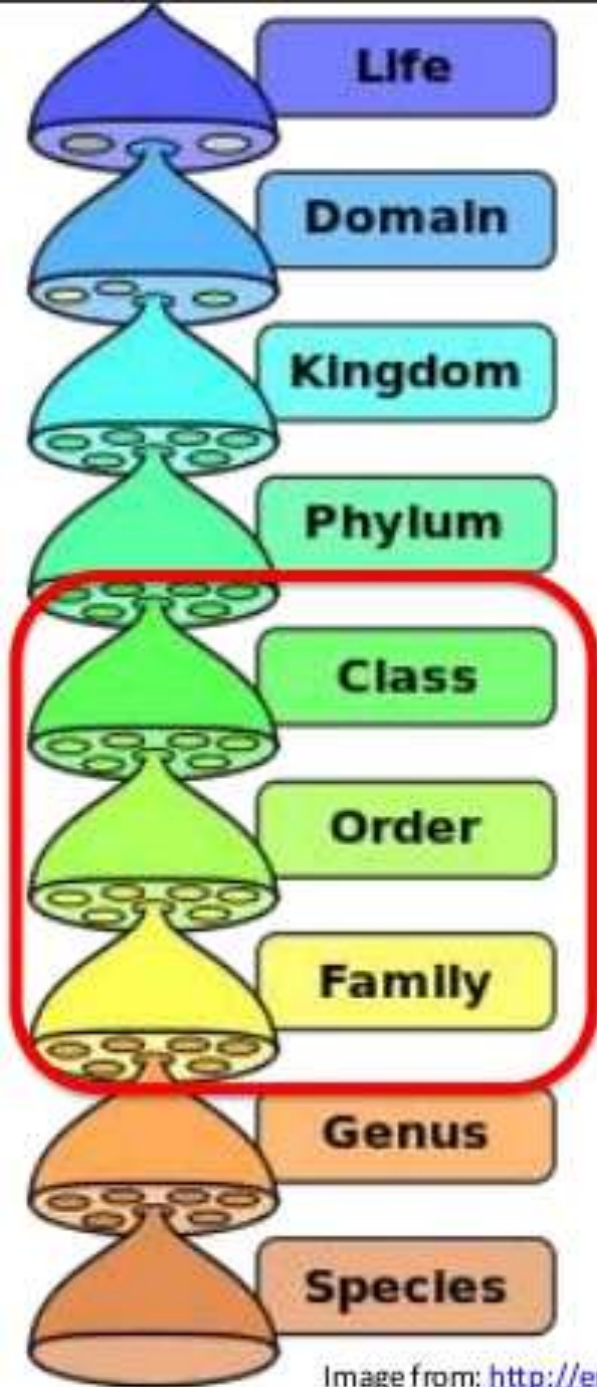
Kingdom Plantae

*(Plant phyla are better known as **divisions**)*

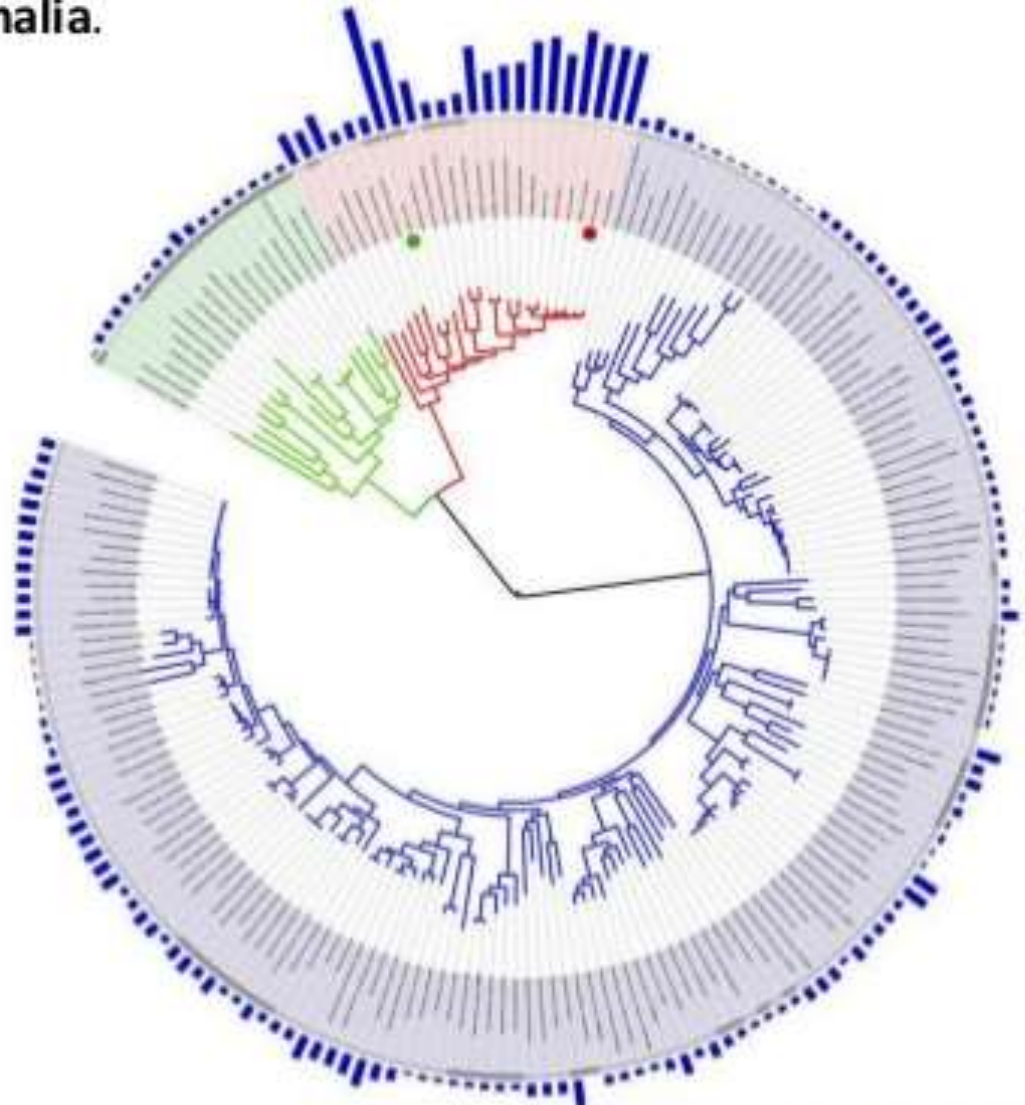
- Bryophyta
- Filicinophyta
- Coniferophyta
- Angiospermophyta

Six Kingdoms from: [http://en.wikipedia.org/wiki/Kingdom_\(biology\)](http://en.wikipedia.org/wiki/Kingdom_(biology))

Image from: http://en.wikipedia.org/wiki/Biological_classification



As we move down the taxonomic levels, groups become smaller and more closely related. For example, the **Phylum Chordata** includes the Classes: **Amphibia**, **Reptilia**, **Aves**, **Mammalia**.



Tree of life, from: http://en.wikipedia.org/wiki/Phylogenetic_tree

Image from: http://en.wikipedia.org/wiki/Biological_classification

[Click here for full size.](#)

5.3.1 The binomial system of names for species is universal among biologists and has been agreed and developed at a series of congresses.

What's the common name for **this species** in your mother tongues?

Human

人間
Ningen

manusia

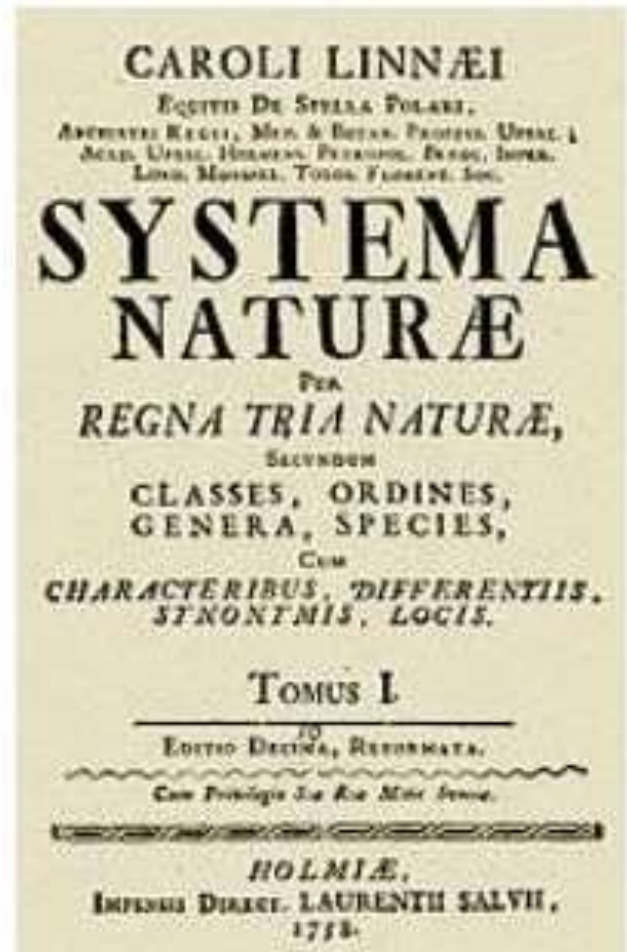


Linné



Binomial Nomenclature

Carolus Linneus (Carl von Linné)
1707-1778



5.3.2 When species are discovered they are given scientific names using the binomial system.

Binomial Nomenclature

“Two-name naming system”

Homo sapiens

Genus name is
capitalized

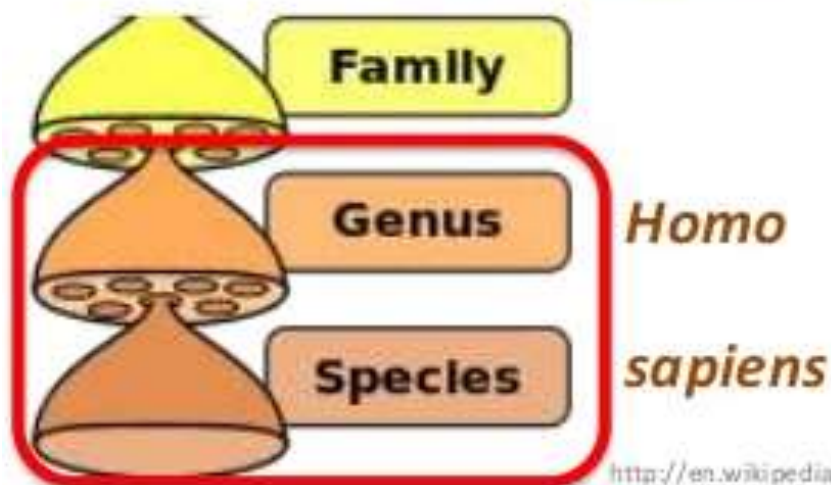
species name is
NEVER capitalized

If it has been used in your piece of work
already, the name can be abbreviated to:

H. sapiens
(or *H. sapiens*)







typed binomial names MUST be
italicized

handwritten binomial names
MUST be *underlined*



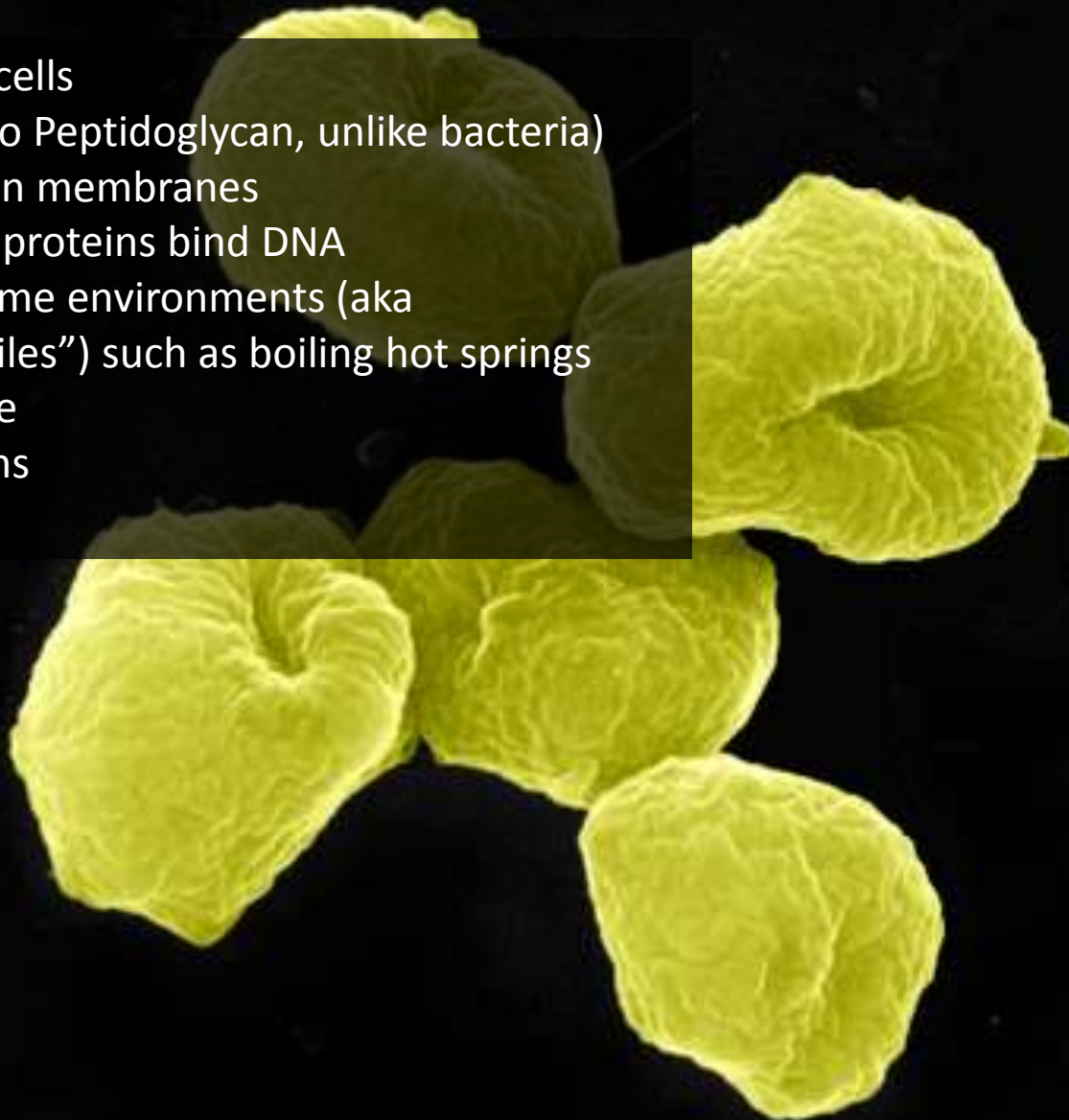
5.3.4 All organisms are classified into three domains.

Domains and Kingdoms

Domain	Bacteria	Archaea	Eukarya			
Kingdom	Bacteria	Archaea	Protista	Fungi	Plantae	Animalia
Example						
Characteristics	Bacteria are simple unicellular organisms.	Archaea are simple unicellular organisms that often live in extreme environments.	Protists are unicellular and are more complex than bacteria or archaea.	Fungi are unicellular or multicellular and absorb food.	Plants are multicellular and make their own food.	Animals are multicellular and take in their food.

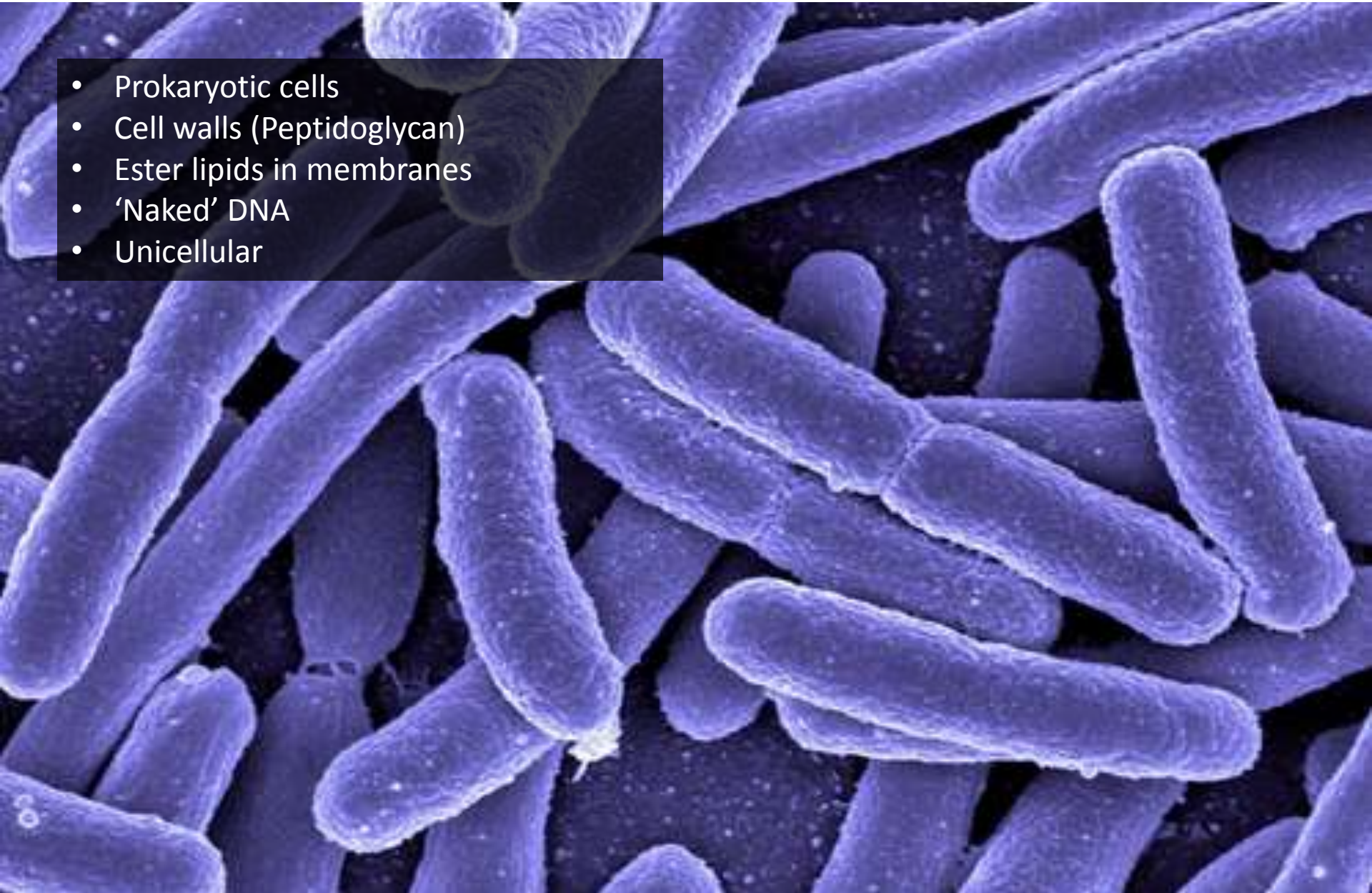
Archaea

- Prokaryotic cells
- Cell walls (No Peptidoglycan, unlike bacteria)
- Ether lipids in membranes
- Histone-like proteins bind DNA
- Live in extreme environments (aka “Extremophiles”) such as boiling hot springs and arctic ice
- Methanogens
- Unicellular



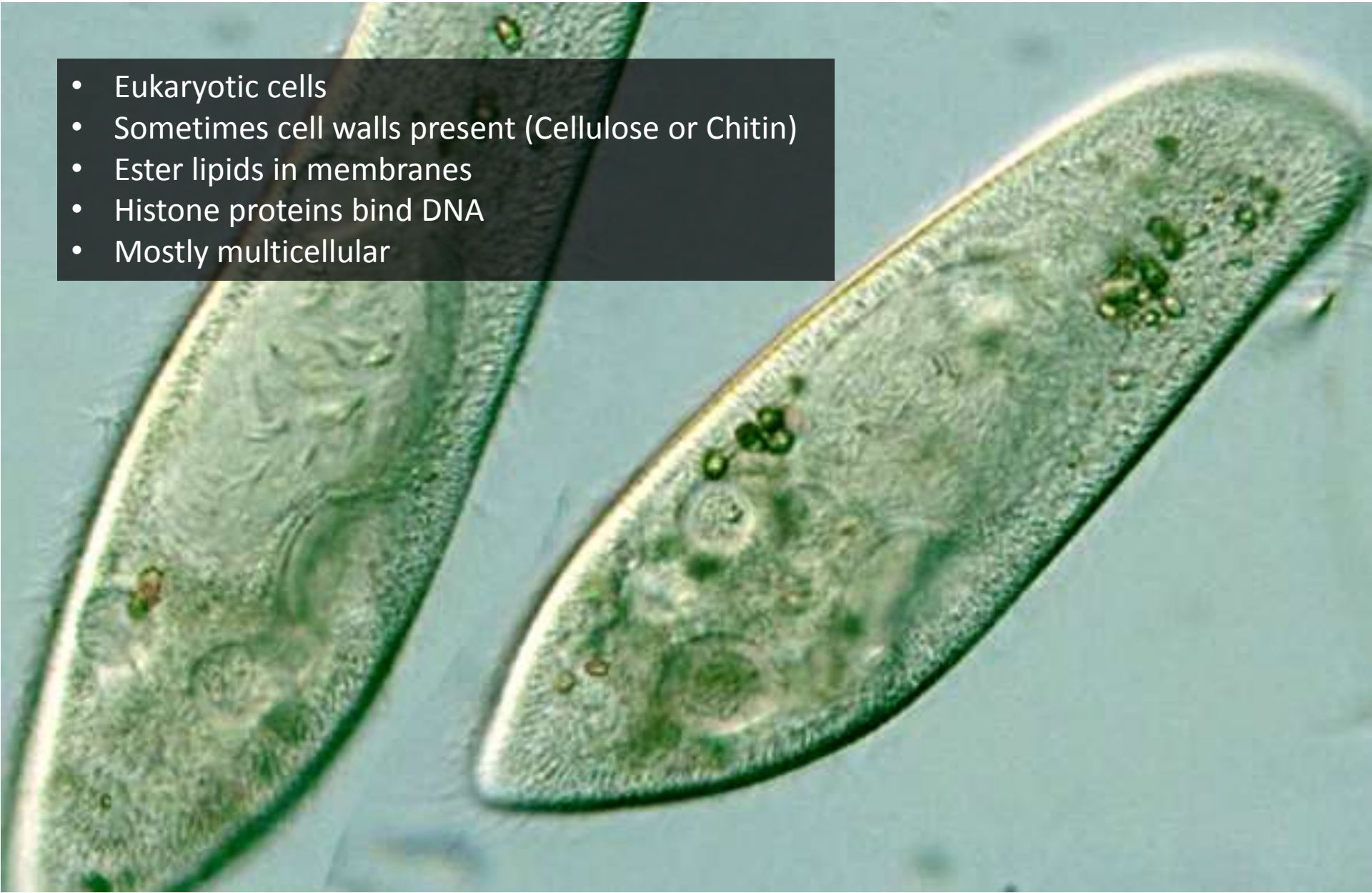
Bacteria

- Prokaryotic cells
- Cell walls (Peptidoglycan)
- Ester lipids in membranes
- 'Naked' DNA
- Unicellular



Eukarya

- Eukaryotic cells
- Sometimes cell walls present (Cellulose or Chitin)
- Ester lipids in membranes
- Histone proteins bind DNA
- Mostly multicellular



5.3.3 Taxonomists classify species using a hierarchy of taxa / 5.3.5 The principal taxa for classifying eukaryotes are kingdom, phylum, class, order, family, genus, and species.

DOMAIN

Kingdom

Phylum

Class

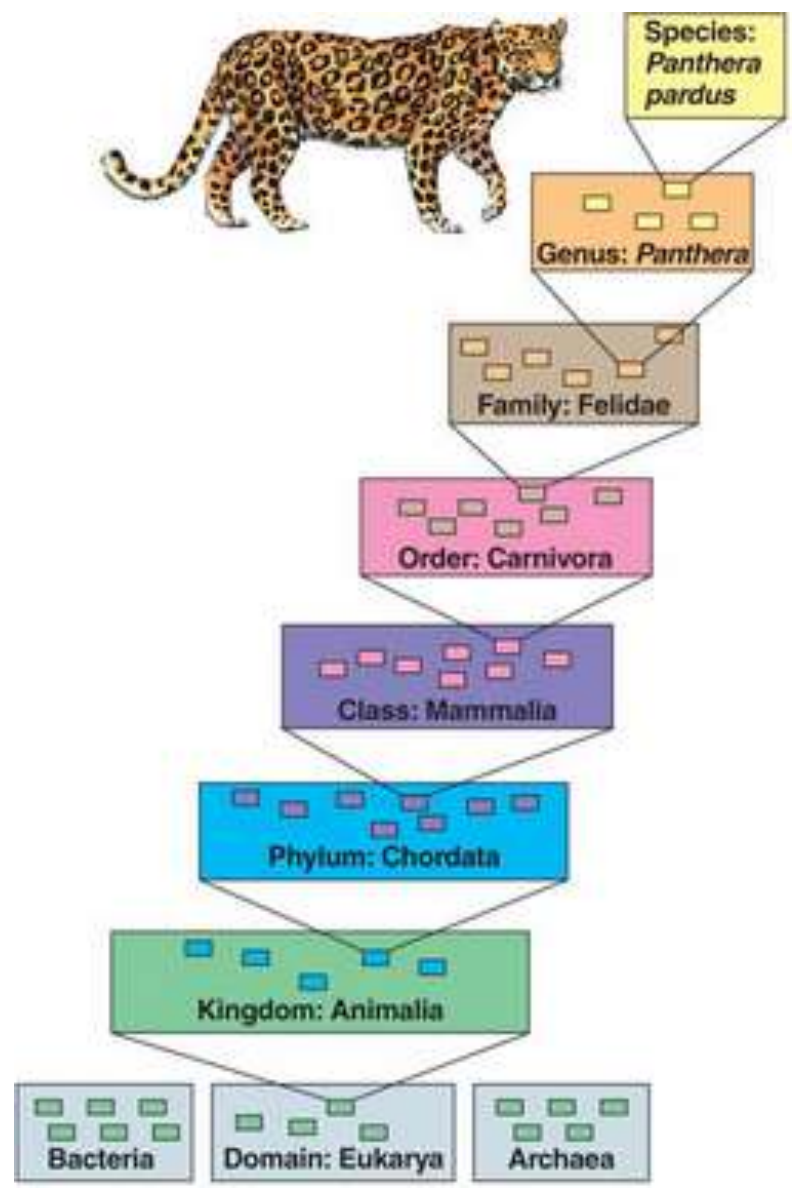
Orders

Family

Genus

species

subspecies



DOMAIN

Kingdom

Phylum

Class

Order

Family

Genus

species

subspecies

Mnemonic (memory aid)

D Did _____

K King _____

P Philip _____

C Come _____

O Over _____

F For _____

G Great _____

S Soup? _____

Taxonomy is the practice and science of classification.

Seven levels of classification

As we move from kingdom to phylum, all the way to species, organisms share more and more characteristics.

This system allows us to group organisms whilst also assigning unique species names and is very helpful in identifying and naming new species.

smallest

largest

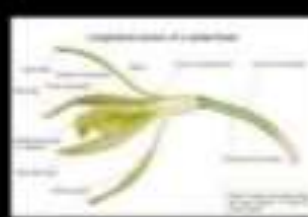


<i>planifolia</i>	<i>ocellaris</i>
<i>Vanilla</i>	<i>Amphiprion</i>
Orchidaceae	Pomacentridae
Asparagales	Perciformes
Liliopsida	Actinopterygii
Magnoliophyta	Chordata
Plantae	Animalia

[http://en.wikipedia.org/wiki/Kingdom_\(biology\)](http://en.wikipedia.org/wiki/Kingdom_(biology))



http://evolution.berkeley.edu/evolibrary/images/evo/3domains_200.gif



5.3.9 Classification of one plant and one animal species from domain to species level.

Taxon	Grey Wolf	Date palm
Kingdom	Animalia	Plantae
Phylum	Chordata	Angiospermophyta
Class	Mammalia	Monocotyledoneae
Order	Carnivora	Palmales
Family	Canidae	Arecaceae
Genus	<i>Canis</i>	<i>Phoenix</i>
Species	<i>lupis</i>	<i>dactylifera</i>



Which two species of reef sharks are most closely related?
How do you know?



Carcharhinus melanopterus
Black-tip reef shark



Triaenodon obesus
White-tip reef shark



Carcharhinus perezii
Caribbean reef shark

Which two species of reef sharks are most closely related?
How do you know?



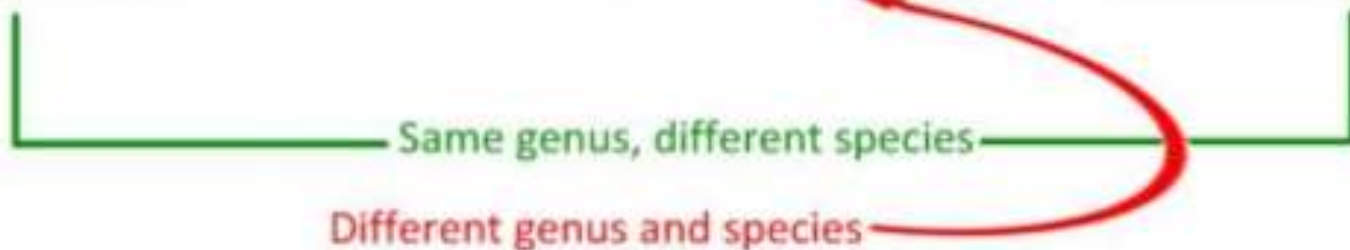
Carcharhinus melanopterus
Black-tip reef shark



Triaenodon obesus
White-tip reef shark



Carcharhinus perezii
Caribbean reef shark



Which two are most closely related?



Canis lupus familiaris
Domestic dog



Canis lupus laniger
Tibetan wolf



Canis rufus
Red Wolf

Which two are most closely related?



Canis lupus familiaris
Domestic dog

Canis lupus laniger
Tibetan wolf

Canis rufus
Red Wolf



Same species, different subspecies



Same genus, different species

(*Homo sapiens*)

Which of the following are true these elephants?



Elephas maximus



Loxodonta africana

- i. They are two species in the same genus
- ii. They are two species in different genera
- iii. They are from two genera in the same family
- iv. They are two subspecies of the same species

- A. i only
- B. ii only
- C. ii and iii only
- D. iv only

<http://en.wikipedia.org/wiki/File:Asian-African-Elephant.png>

Which of the following are true these elephants?



Elephas maximus



Loxodonta africana

- i. They are two species in the same genus
- ii. They are two species in different genera
- iii. They are from two genera in the same family
- iv. They are two subspecies of the same species

- A. i only
- B. ii only
- C. ii and iii only
- D. iv only

<http://en.wikipedia.org/wiki/File:Asian-African-Elephant.png>

5.3.6 In natural classification the genus and accompanying higher taxa consist of all the species that have evolved from one common ancestral species.

Natural Classification

- Grouping organisms based on how they evolved / based on common ancestry.

Unnatural/ Artificial Classification

- Grouping organisms by common characteristics despite evolutionary descent
- *Example:* Birds, bats, and bugs grouping together since they all fly

5.3.7 Taxonomists sometimes reclassify groups of species when new evidence shows that a previous taxon contains species that have evolved from different ancestral species.

- New evidence (often genetic) can lead scientists to re-classify organisms into different taxa
- Dogs and Wolves had long been classified as separate species, but in 2005, scientists re-classified dogs and wolves into the same species (*lupus*). Dogs remain grouped in a separate subspecies, though (*familiaris*).
- Scientists currently debating whether Chimps should be reclassified into the Genus Homo alongside humans since they are more similar to humans than apes...



Advantages of Natural Classification:

1. It makes it easier to identify species. Unknown species can first be placed into a kingdom and then into increasingly specific taxa (phylum, order, etc...)
2. Because natural classification is based around common evolutionary ancestors, characteristics are shared. This allows biologists to predict properties of similarly-classified organisms (i.e. if one member of a plant genus produces an antibiotic compound, other plants in that genus might be expected to produce related compounds)

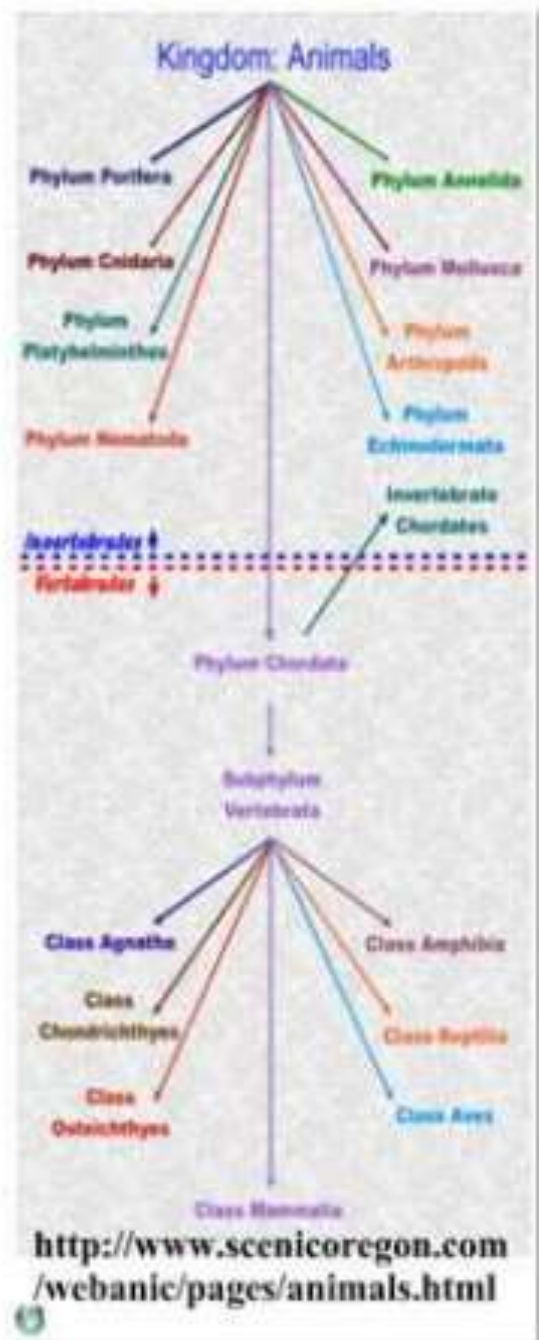
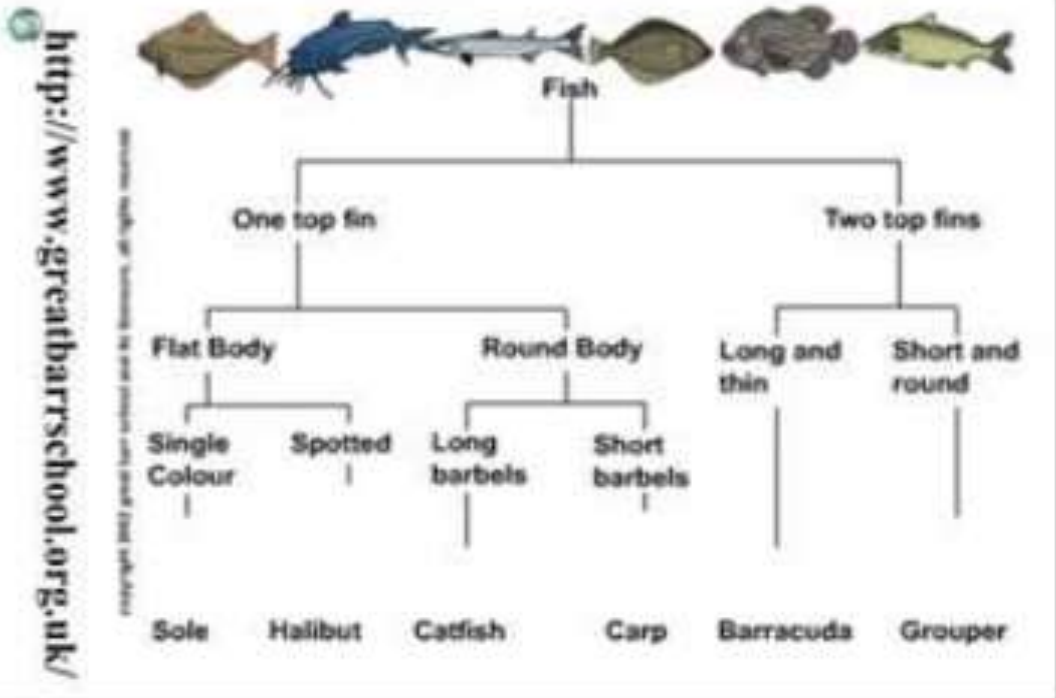
Using a dichotomous key

By a simple series of binary questions, we can identify an organism. To try it out, think of any animal and then click on this link:

<http://www.scenicoregon.com/webanic/pages/animals.html>

Now work through the questions - it will bring you to the class of animal you are imagining.

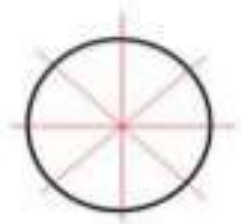
More specific keys are used to identify organisms at the species level. This key is more visual, yet still dichotomous:



Use this **dichotomous key** to identify the 6 main **phyla of invertebrates**

Give the common name and latin name of one example of each

- | | | |
|-----------------------|--------------------------------|--|
| 1. Is it symmetrical? | Yes
No | go to Q2
Phylum Porifera e.g. |
| 2. Symmetry is | Radial
Bilateral | Phylum Cnidaria e.g.
go to Q3 |
| 3. Gastric tube | Mouth & anus
Mouth, no anus | go to Q4
Phylum Platyhelminthes e.g. |
| 4. Segmentation | Yes
No, or not visible | Go to Q5
Phylum Mollusca e.g. |
| 5. Exoskeleton | Yes
No | Phylum Arthropoda e.g.
Phylum Annelida e.g. |



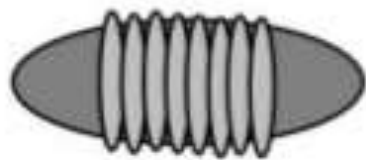
radial symmetry



bilateral symmetry



no symmetry



segmented



no segments

Dichotomous Key Practice

1. Cell walls:

Present:*Kingdom Plantae* go to Q2

Not present:*Kingdom Animalia* go to Q5

2. Vasculature

Present:Q3

Not present (too small):Phylum Bryophyta

3. Reproduction:

Spores in sporangia under leaves:Phylum Filicinophyta

Seeds Q4

4. Seeds in:

Female cones: Phylum Coniferophyta

Fruits: Phylum Angiospermophyta

5. Symmetry:

None:Phylum Porifera

Radial:Phylum Cnidaria

Bilateral:Q6

6. Segmentation

Visible: Q7

Not visible: Q8

7. Exoskeleton:

Present: Phylum Arthropoda

Not present: .. Phylum Annelida

8. Digestive tract:

Mouth, no anus: Phylum Platyhelminthes

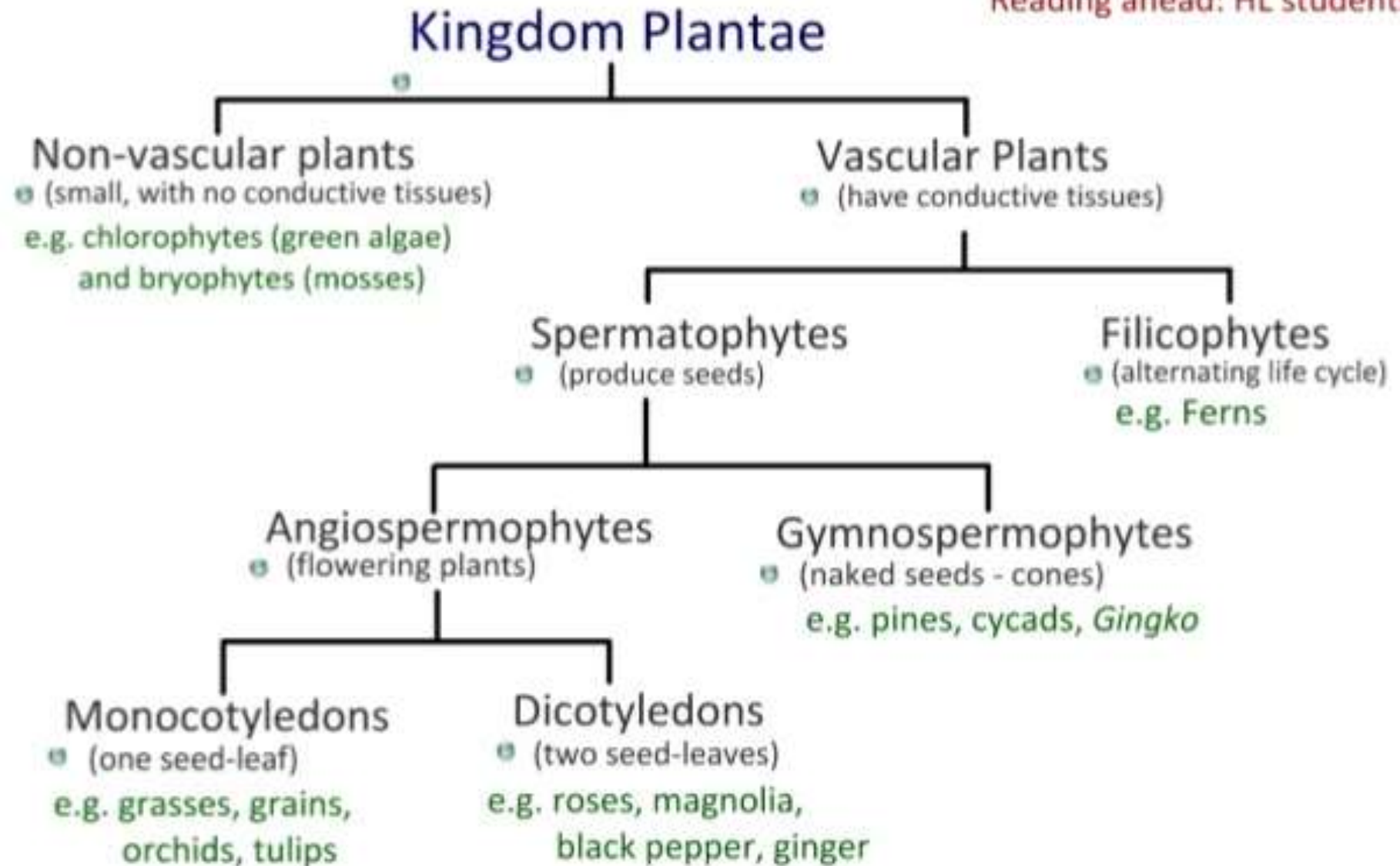
Mouth & anus: Phylum Mollusca

Practice with a partner and play 'guess who' with the 10 phyla you need to know.

- One partner picks a phylum at random
- The other uses the key to deduce the answer.
- Check each others' understanding.
- What other features can you remember about each phylum?

5.3.10 External recognition features of bryophytes, filicinophytes, coniferophytes, and angiospermophytes.

Reading ahead: HL students



This phylogeny is very simplified

Kingdom Plantae

photosynthetic,
cell walls

Non-vascular plants

Vascular Plants

Chlorophyta



aquatic algae

Bryophyta



mosses

Filicophyta



ferns

Coniferophyta



pinos

Angiospermophyta



flowering plants

Click on the images above to find out more about each division (phylum).

Images from wikipedia.

Appearance:

Very simple, small plants. (under 50cm)

Furry Appearance


Vasculature:

None: bryophytes absorb moisture from their humid surroundings and have minimally specialised structures.

Reproduction:

Spores released from stalk capsules (sporangia)

Bryophyta (mosses)

A photograph of a waterfall in a lush forest. The water is white and frothy as it falls over dark, moss-covered rocks. The surrounding vegetation is dense and green, with many mosses and ferns visible. The overall scene is vibrant and natural.



Vascular

Vascular tissues (xylem and phloem) are transport networks to carry resources and waste around the plant.

This allows the plant to be bigger, with more specialised parts.

Plants

Filicinophyta (ferns)



Appearance:

Roots, leaves, short stems
Max. height 15m.
Leaves in section &
may be curled up.

Vasculature:

Xylem & Phloem
Not woody.

Reproduction:

Spores released sporangia
(capsules under the leaves)

Coniferophyta (conifers)

Appearance:

Woody trees
Leaves are needles
Up to 100m

Vasculature:

Xylem & Phloem
Woody

Reproduction:

Female **cones** contain seeds

Image: I am in love with the green earth, Charles Lamb' Found on flickrcc.net
<http://www.flickr.com/photos/31246066@N04/4573554416>

Angiospermophyta

Flowering
plants

Appearance:

Flowering plants
Roots, stems, leaves
Up to 100m.

Vasculature:

Xylem & Phloem

Reproduction:

Seeds dispersed through fruits.
Pollination through flowers.



Distinguish between these *phyla* of plants.

	Appearance	Max. Size	Reproduction	Memorandum
Bryophyta (mosses)	Small, furry, no vasculature. Cover rocks, trees, etc. in wet areas.	50cm	Spores, from sporangia on stalk capsules.	Chlorophyte = <u>C</u> overs <u>p</u> h <u>l</u> oor (floor)
Filicinophyta (ferns)	Non-woody. Leaves in sections, may be curled up.	15m	Spores, from sporangia under leaves.	<u>F</u> ilicinophyta = <u>F</u> erns
Coniferophyta (conifers/pines)	Woody trees with needle-like leaves and cones.	100m	Seeds stored and released from female cones.	<u>C</u> onifer = <u>C</u> ones
Angiospermophyta (flowering plants)	Roots, stems and leaves. Produce flowers.	100m	Spores, distributed through fruits. Flowers for pollination.	Angiosperm = <u>P</u> ollen → flowers

5.3.11 Recognition of features of porifera, cnidaria, platyhelminthes, annelida, mollusca, arthropoda, and chordata.

Kingdom Animalia

heterotrophs,
animal cells

Invertebrates

Vertebrates

Porifera



sponges

Cnidaria



jellyfish
anemones

Platyhelminthes



flatworms

Annelida



segmented
worms

Mollusca



snails/slugs
octopus

Arthropoda



exoskeletons:
insects, spiders,
crustaceans,
millipedes

Porifera (sponges)



Symmetry

None

Digestion

No mouth or anus

Filter food from currents

Segmentation

None

Notes

Pore = hole

Attached to rocky surfaces

Symmetry

Radial

Digestion

Mouth, no anus

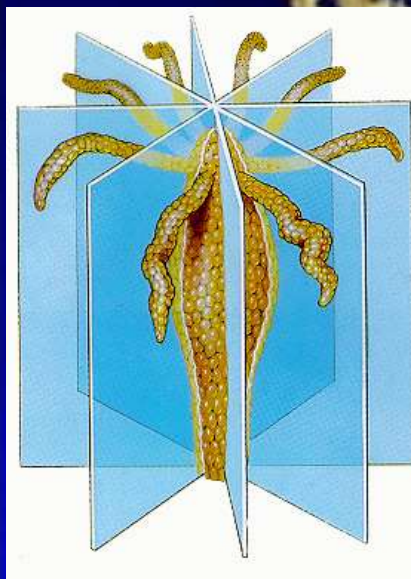
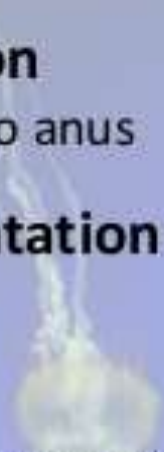
Segmentation

None

Notes

Tentacles around mouth

Many have stinging cells



Cnidaria (jellies & anemones)



Image: 'jellies01' Found on flickrcc.net

<http://www.flickr.com/photos/16863501@N00/15711291>

Image: 'Clownfisch/ Anemonenfisch (cc)' Found on flickrcc.net

<http://www.flickr.com/photos/45409431@N00/2039988461>

Platyhelminthes

(flatworms)



Symmetry

Bilateral

Digestion

Mouth, no anus

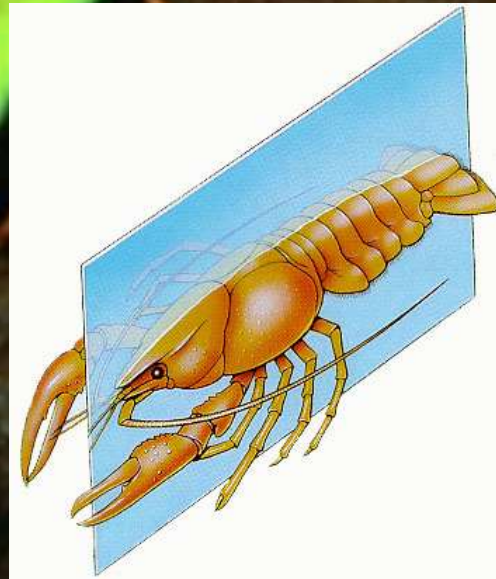
Segmentation

None

Notes

Ribbon-shaped

Many are parasites



Annelida (segmented worms)



Symmetry

Bilateral

Digestion

Mouth & anus

Segmentation

Yes – segmented

Notes

May be bristled

Includes earthworms, leeches

Image from:

http://en.wikipedia.org/wiki/Alitta_virens

Annelida (segmented worms)



Image from:

http://en.wikipedia.org/wiki/Alitta_virens

Mollusca



Symmetry

Bilateral

Digestion

Mouth & anus

Segmentation

Not visibly

Notes

Hugely diverse group

Image: 'slow down' Found on flickrcc.net
<http://www.flickr.com/photos/72093892@N00/4153613907>

Mollusca

A close-up photograph of a squid's head and tentacles. The squid's skin is covered in numerous small, dark chromatophores, giving it a mottled appearance. A large, prominent eye is visible on the left side of the head. The tentacles are long and thin, extending downwards. The background is dark, making the squid's features stand out.

Symmetry

Bilateral

Digestion

Mouth & anus

Segmentation

Not visibly

Notes

Hugely diverse group

Arthropoda



Symmetry

Bilateral

Digestion

Mouth & anus

Segmentation

Segmented, jointed

Notes

Exoskeleton, joints

Distinguish between these *phyla* of invertebrates.

	Symmetry	Digestive Tract	Segmentation	Other Features
Porifera (sponges)	None	No mouth or anus (filter feeders)	None	Porifera (porous), attached to rocks/ coral
Cnidaria (jellies & anemones)	Radial	Mouth, no anus	None	Tentacles around mouth, may have stinging cells
Platyhelminthes (flat worms)	Bilateral	Mouth, no anus	None	Many flatworms are parasites
Annelida (segmented worms)	Bilateral	Mouth & anus	Highly segmented	Often bristly Includes earthworms and leeches
Mollusca	Bilateral	Mouth & anus	Not visible	Very diverse, including snails, squid
Arthropoda	Bilateral	Mouth & anus	Segmented	Exoskeletons Jointed limbs

BIRDS

- Vertebrates
- Tetrapods
- Endothermic
- Feathers
- Bills
- Lightweight bones (either hollow or spongy)
- Four-chambered heart and high metabolic rates
- Produce large, richly provisioned external eggs
- Internal fertilization



MAMMALS

- Vertebrates
- Tetrapods
- Endothermic
- Hair
- Mammary glands
- Lower jaw consists of a single bone
- Three middle ear bones
- Diaphragm
- Four-chambered heart
- Internal fertilization



AMPHIBIANS

- Vertebrates
- Tetrapods
- Ectothermic (cold-blooded)
- Aquatic larvae
- First vertebrates to colonize terrestrial habitats
- Lay eggs in water / external fertilization



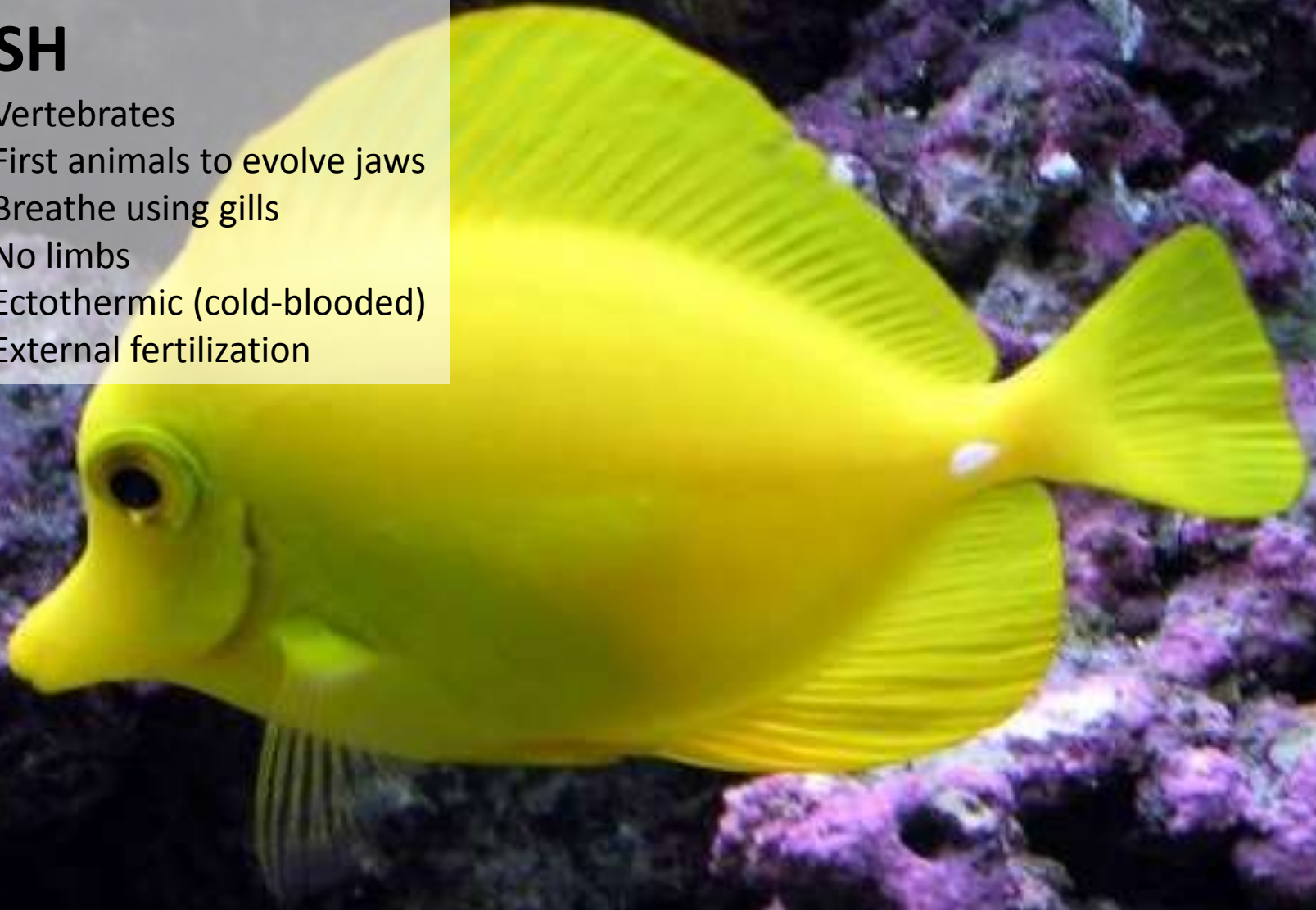
REPTILES

- Vertebrates
- Tetrapods
- Ectothermic (cold-blooded)
- Scales
- Three-chambered heart
- Hard-shelled amniotic eggs
/ Internal fertilization

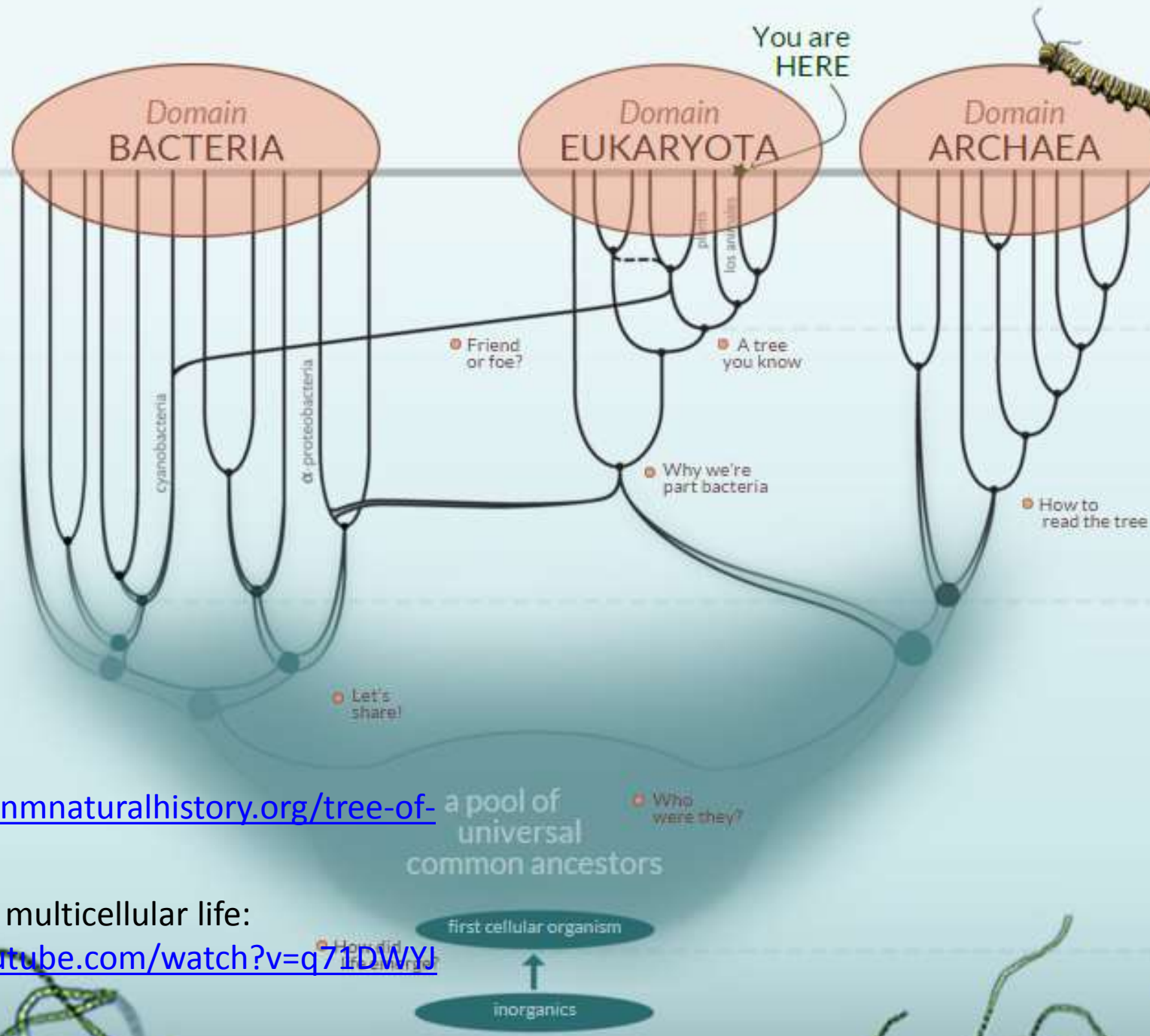


FISH

- Vertebrates
- First animals to evolve jaws
- Breathe using gills
- No limbs
- Ectothermic (cold-blooded)
- External fertilization



THE Tree OF Life



<http://treeoflife.nmnaturalhistory.org/tree-of-life.html>

The evolution of multicellular life:
<https://www.youtube.com/watch?v=q71DWYD-dI>

Bibliography / Acknowledgments

BioNinja

Your one-stop biology resource



[Jason de Nys](#)



[Chris Paine](#)

