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Evolution and the Natural World

Lecture 7

30/10/2021

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A BIT FROM THE LAST TIME

What processes shape the gene pool?

Quick recap

Quick recap

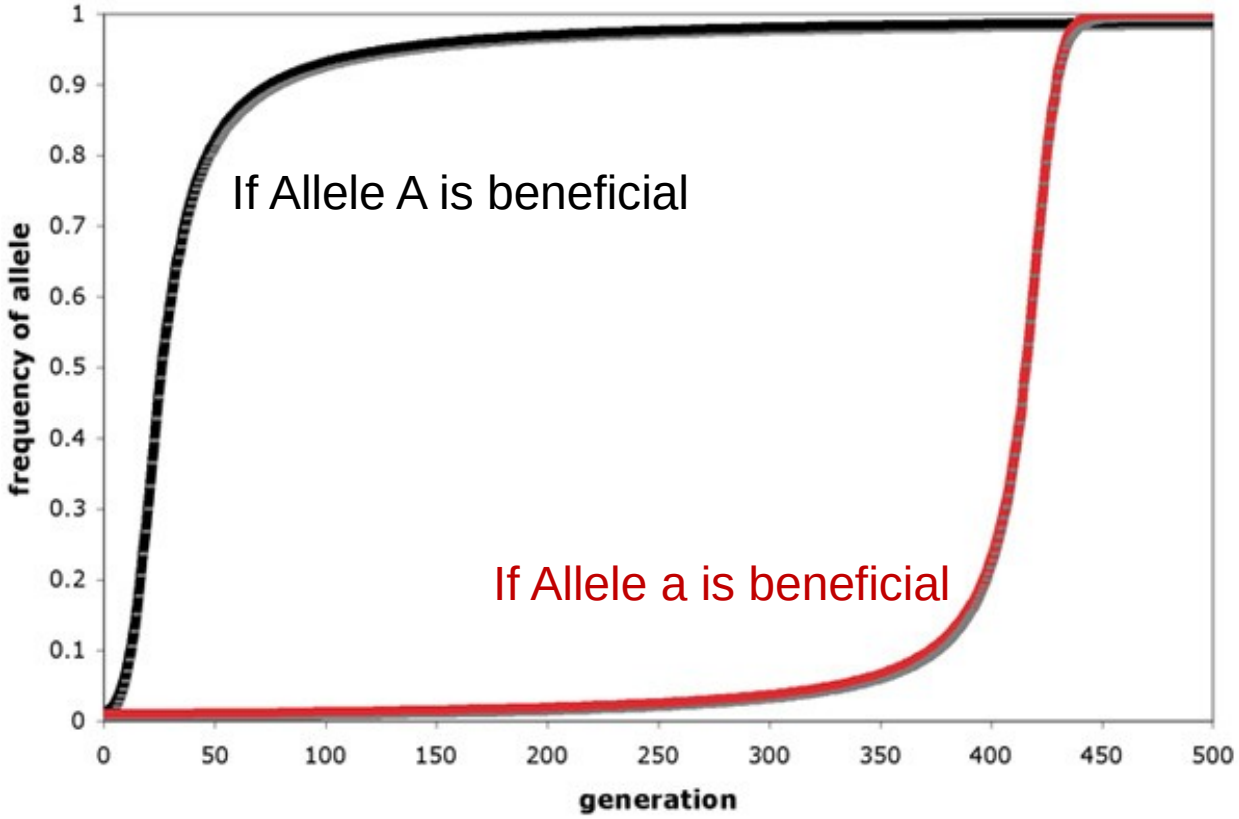
- Population is what evolves
- Evolution is the change of a populations gene pool over time
- Mutations create new alleles and genes
- Mutations happen randomly – not for the purpose of adaptation
- Sexual reproduction creates new combination thereof

Processes shaping the gene pool

- Mutations
- Recombination
- Natural selection
- Gene flow
- Genetic drift

Randomly create new alleles and combinations thereof

Natural selection



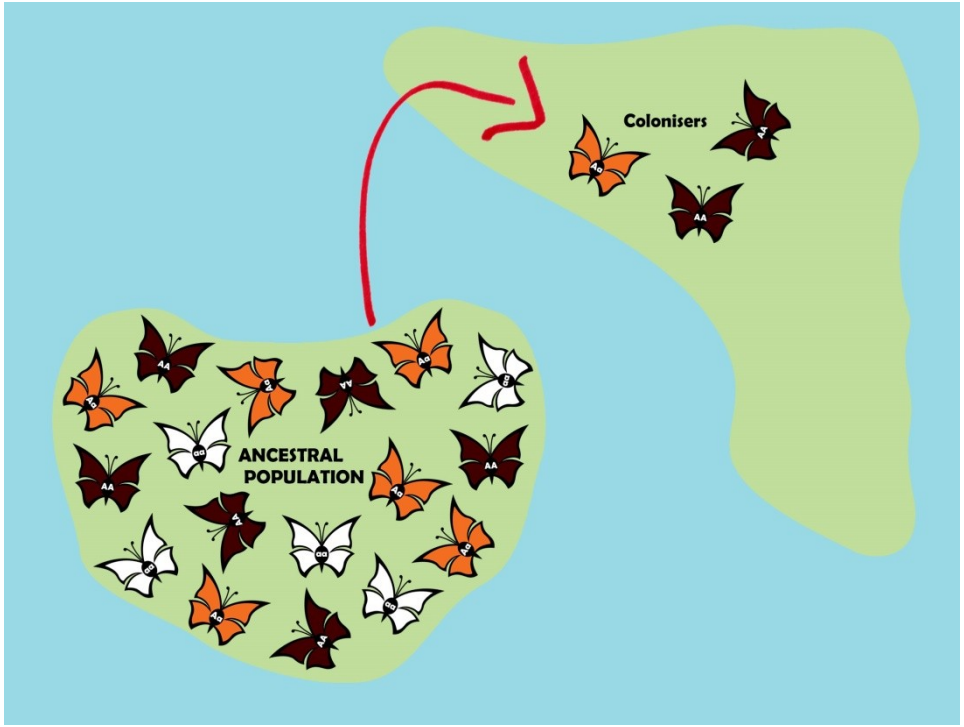
- Leads to an increase in frequency of beneficial alleles and reduction in frequency of harmful alleles

Genetic drift

https://evolution.berkeley.edu/evolibrary/article/evo_24

- Genetic drift is a random change in alleles frequencies, irrespective of the alleles' effect on fitness
- One potential reason: same phenotype but different genotypes

Genetic drift: population size matters



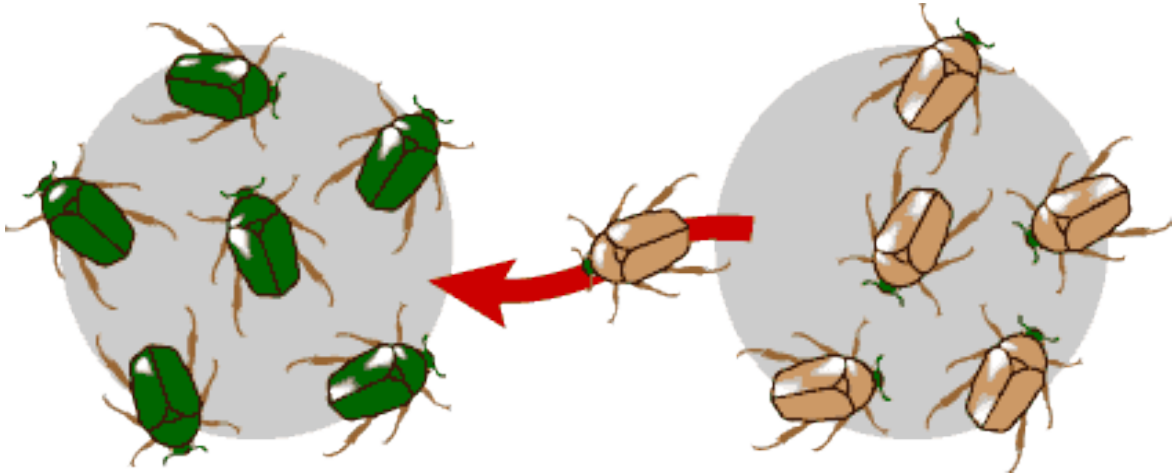
- The smaller the number of individuals, the stronger the effect of random processes
- Bottleneck and founder effects
- Small populations may have rather high frequencies of harmful alleles

https://www.pathwayz.org/Tree/Plain/FOUNDER+EFFECT

Genetic drift: population size matters

- Genetic drift is important for human genetics
- High frequencies of genetic disorders in populations that experienced a strong founder effect

Gene flow



- Changes the gene pool by bringing alleles and genes from other populations
- Additional source of diversity

https://evolution.berkeley.edu/evolibrary/article/evo_21

Population genetics: key points

- Allele frequencies change over time due to random processes (genetic drift) and because some alleles have phenotypic effects that increase the chances of that allele being passed over to the next generation (natural selection)
- Gene flow results in genetic exchange between populations; genetic exchange between species is also possible
- All those process together result in a change of the gene pool and population-average phenotype over time

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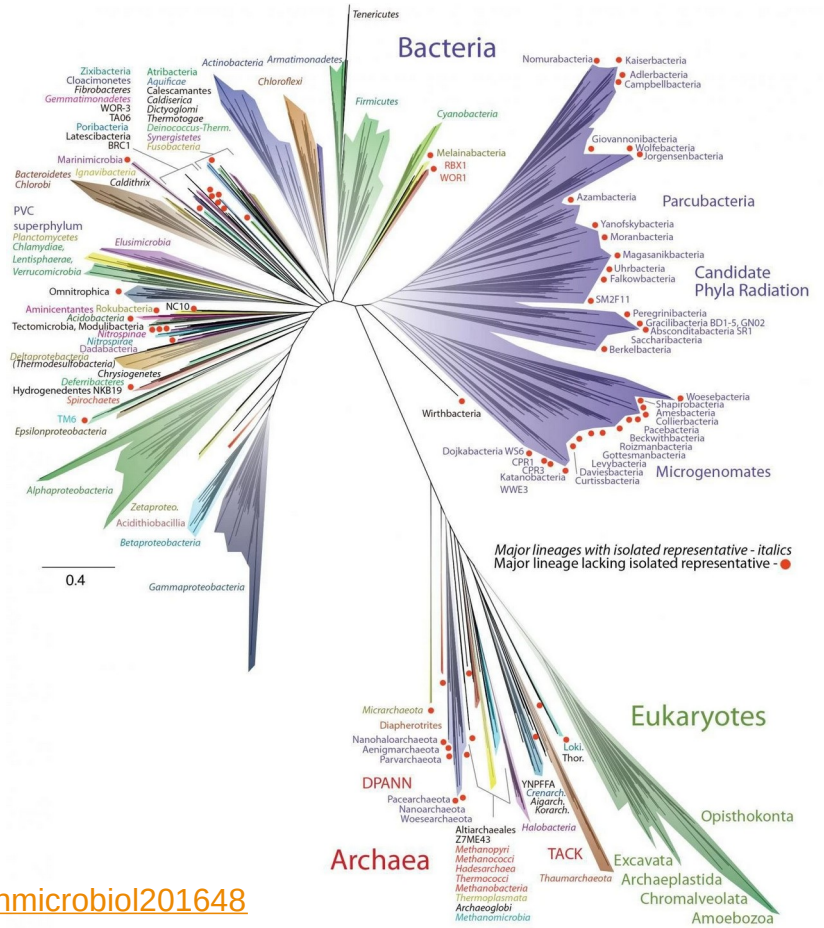
As the result of evolution

Diversity of life

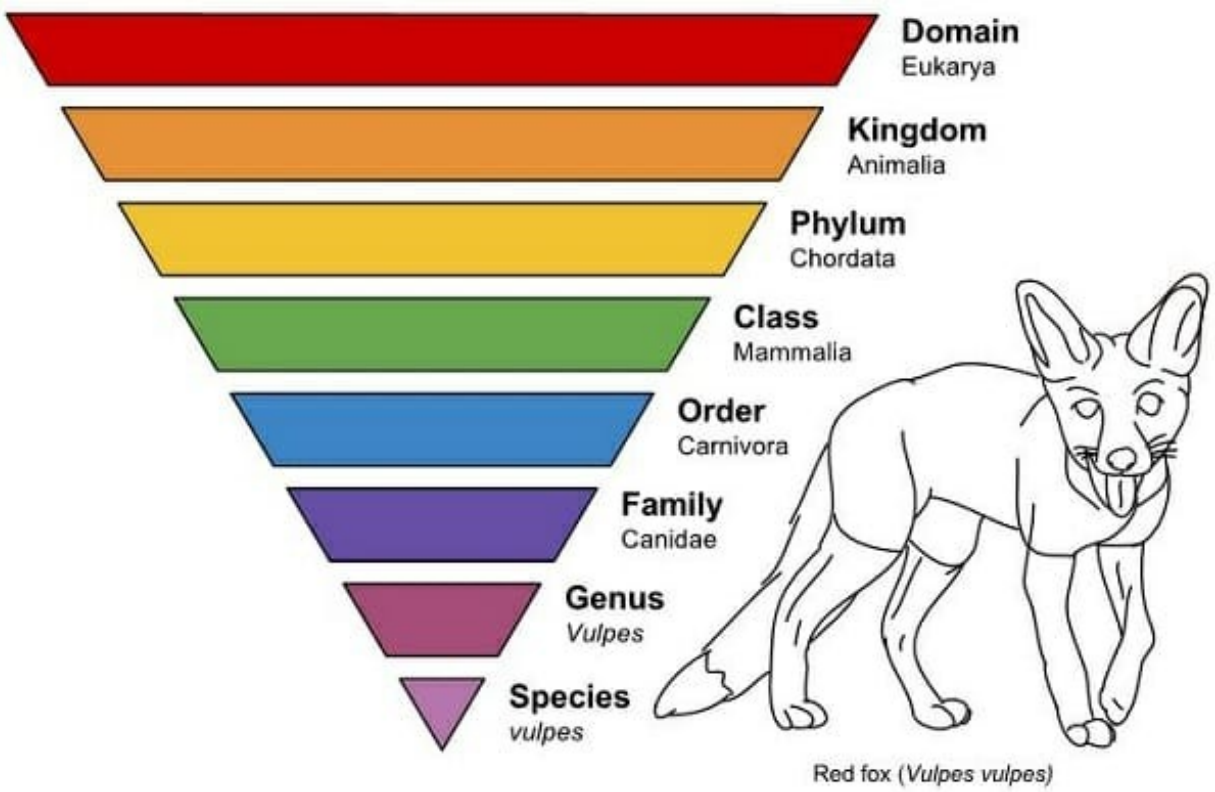
Life is enormously diverse

How do we make sense of this diversity?



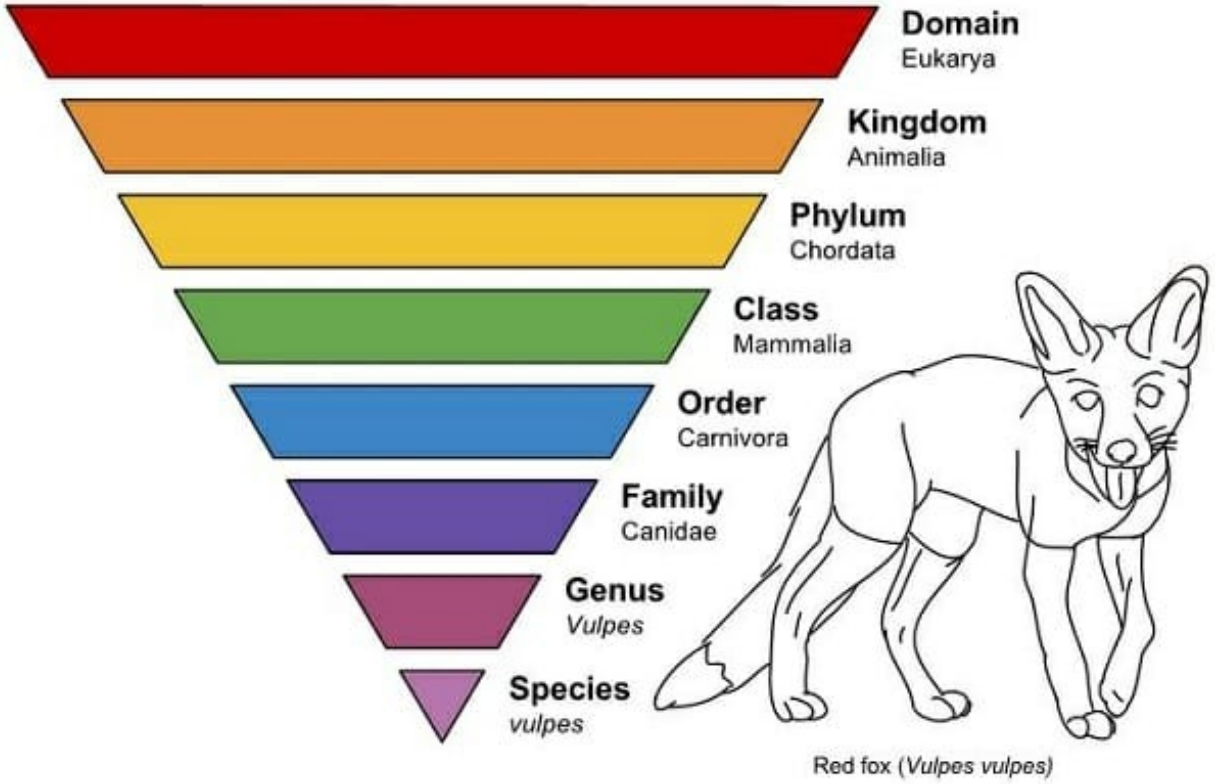
https://www.nature.com/articles/nmicrobiol201648

Taxonomy



https://biologydictionary.net/taxonomy/

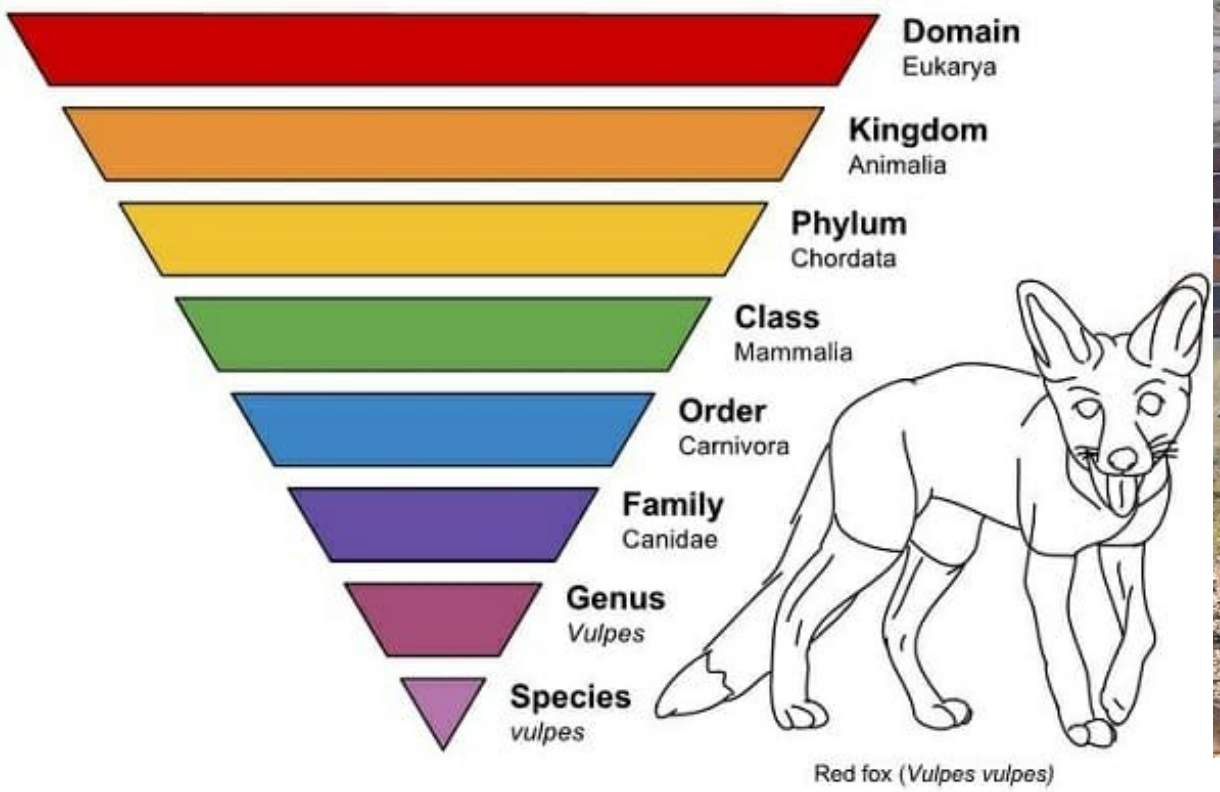
Taxonomy



?

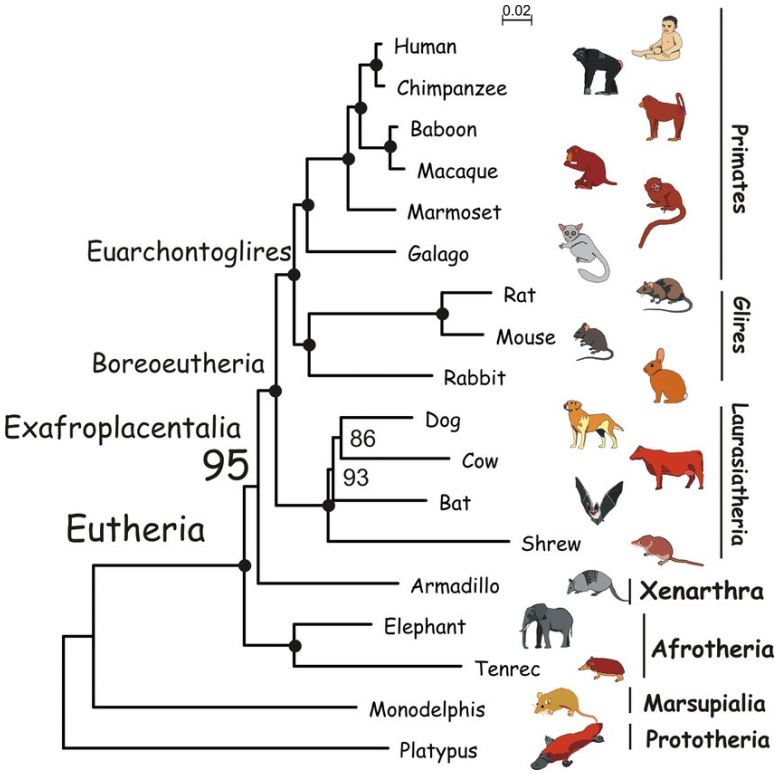
Fennec

Taxonomy



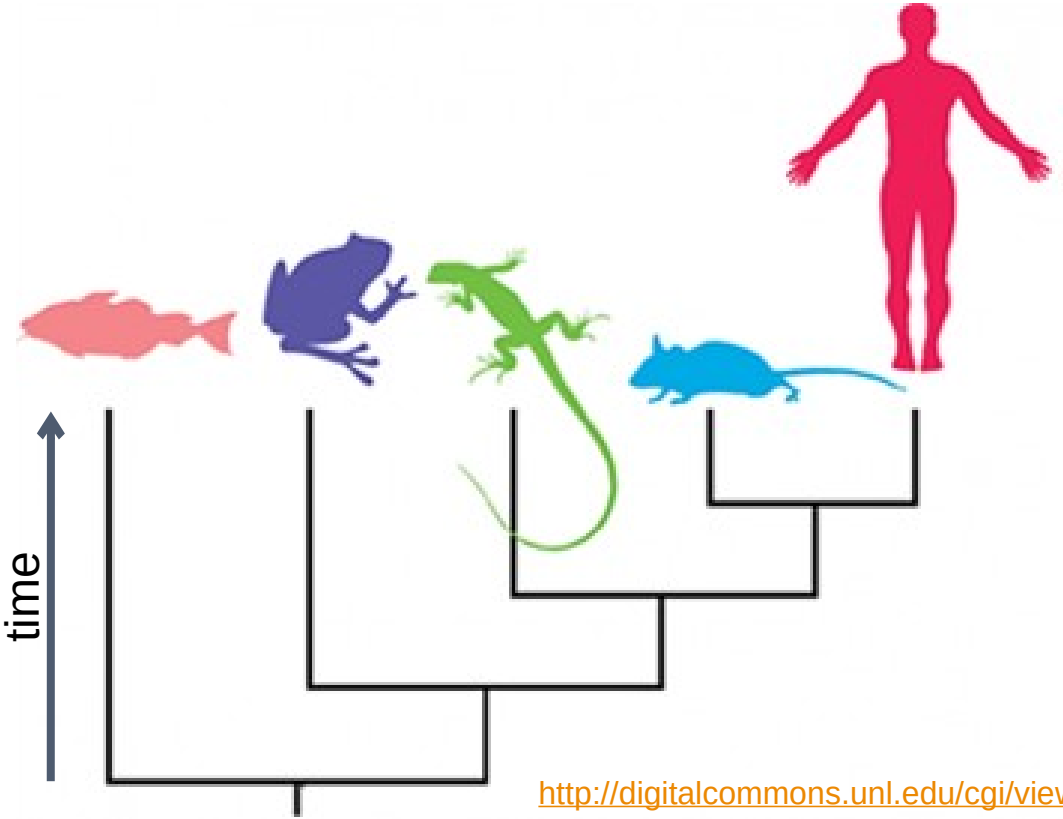
https://en.wikipedia.org/wiki/Vulpes#/media/File:Genus_vulpes.jpg

Treeness of Evolution



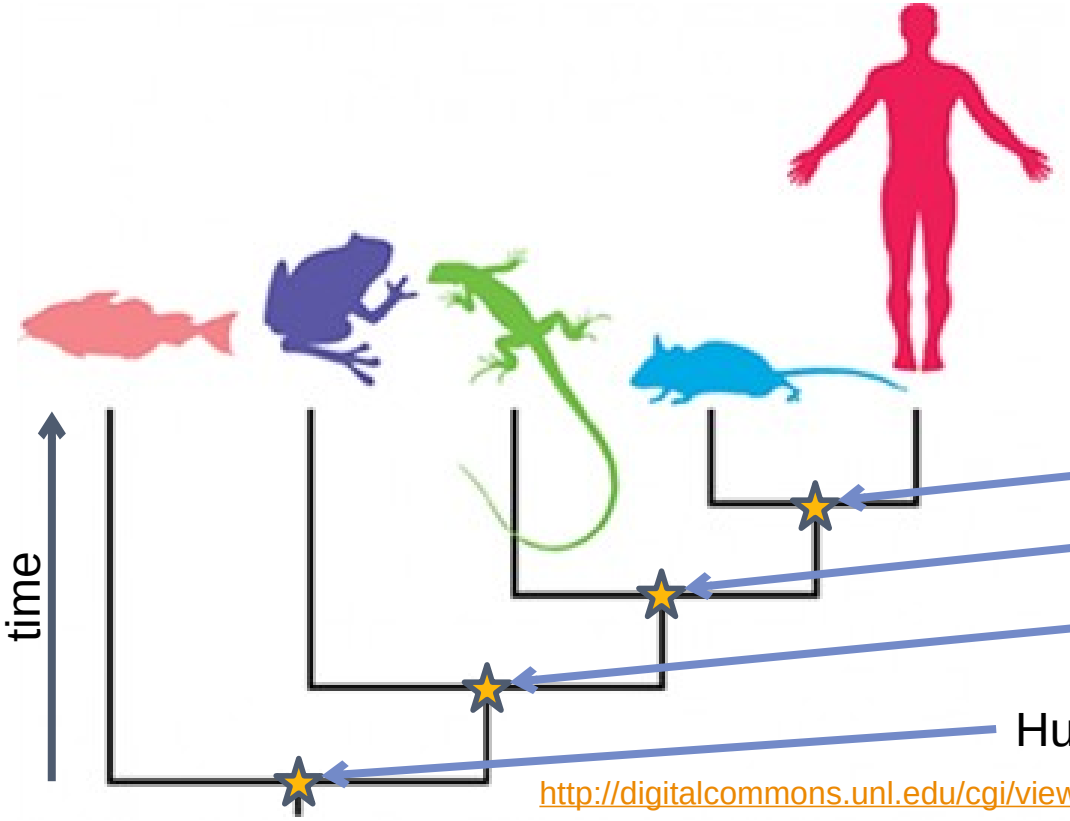
https://journals.plos.org/plosgenetics/article?id=10.1371/journal.pgen.0030002

Phylogenetic trees



http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1104&context=bioscifacpub

Phylogenetic trees



Internal node = MRCA (Most Resent Common Ancestor)

Human-Mouse

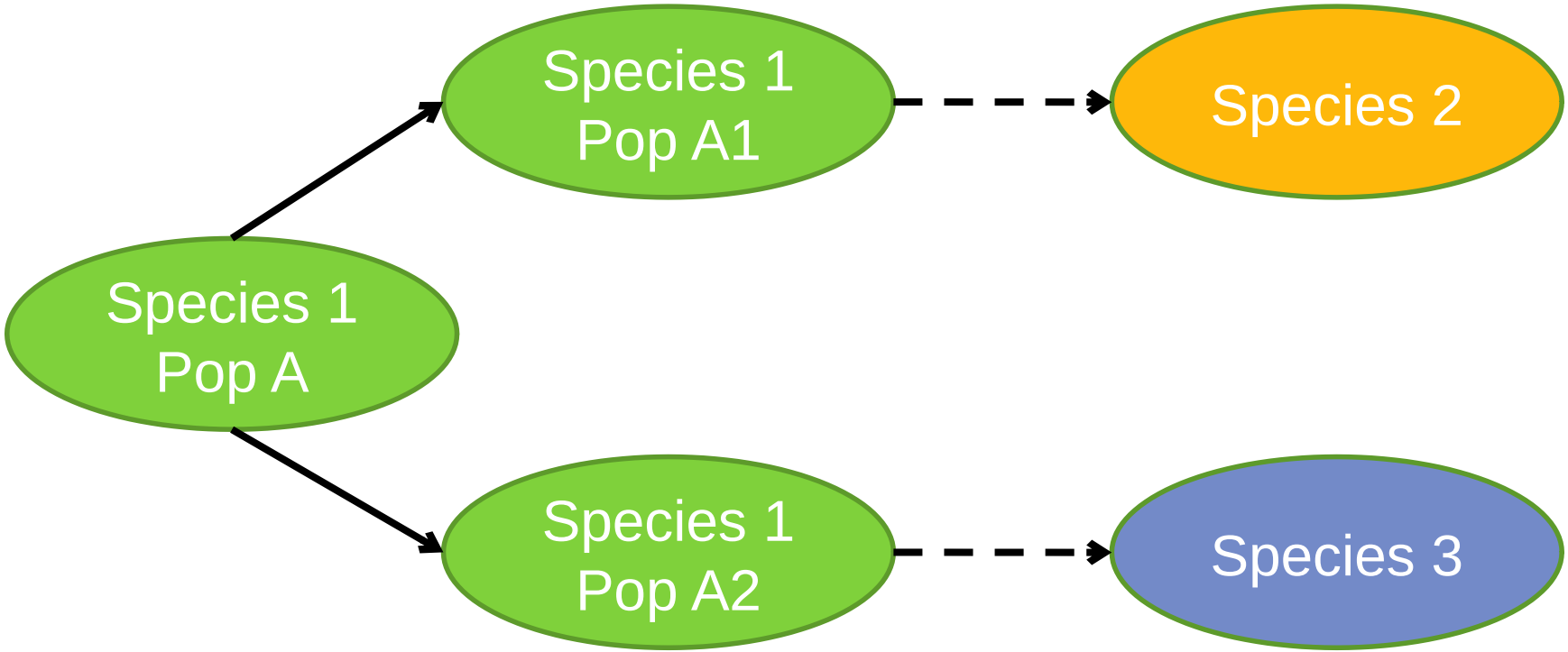
Human-Mouse-Lizard

Human-Mouse-Lizard-Frog

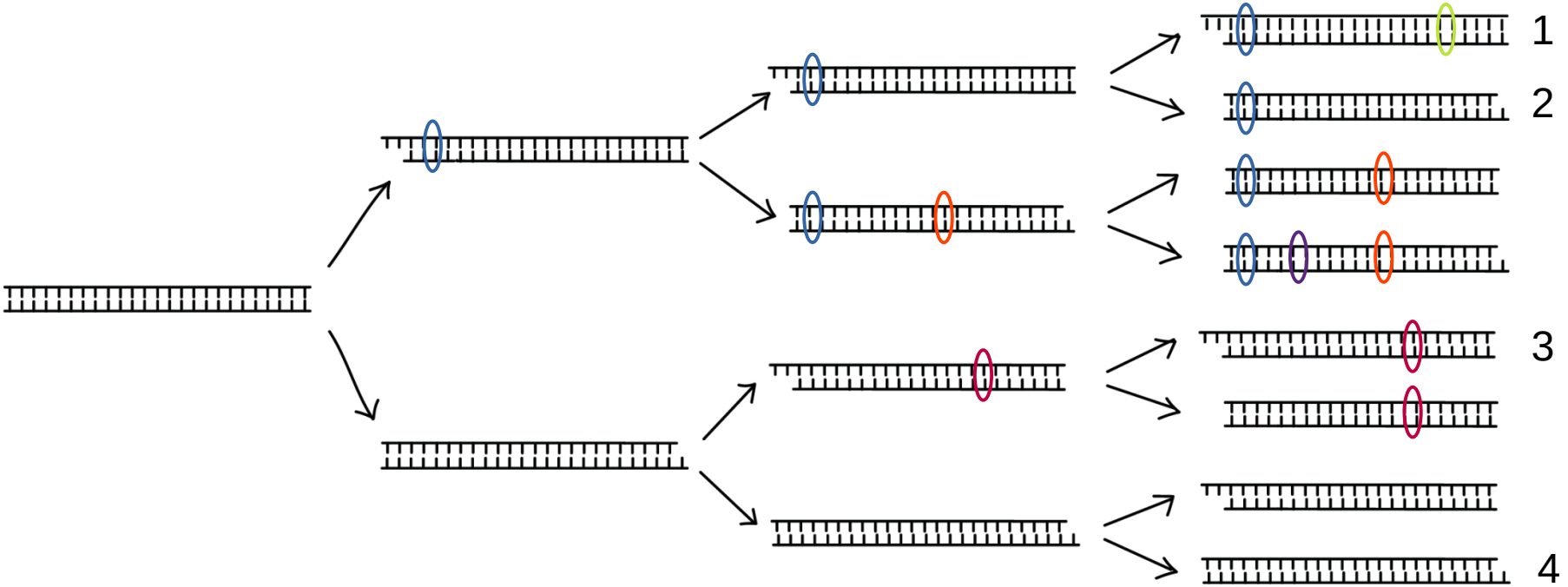
Human-Mouse-Lizard-Frog-Fish

http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1104&context=bioscifacpub

“Treeness” of evolution: Speciation



“Treeness” of evolution: DNA replication



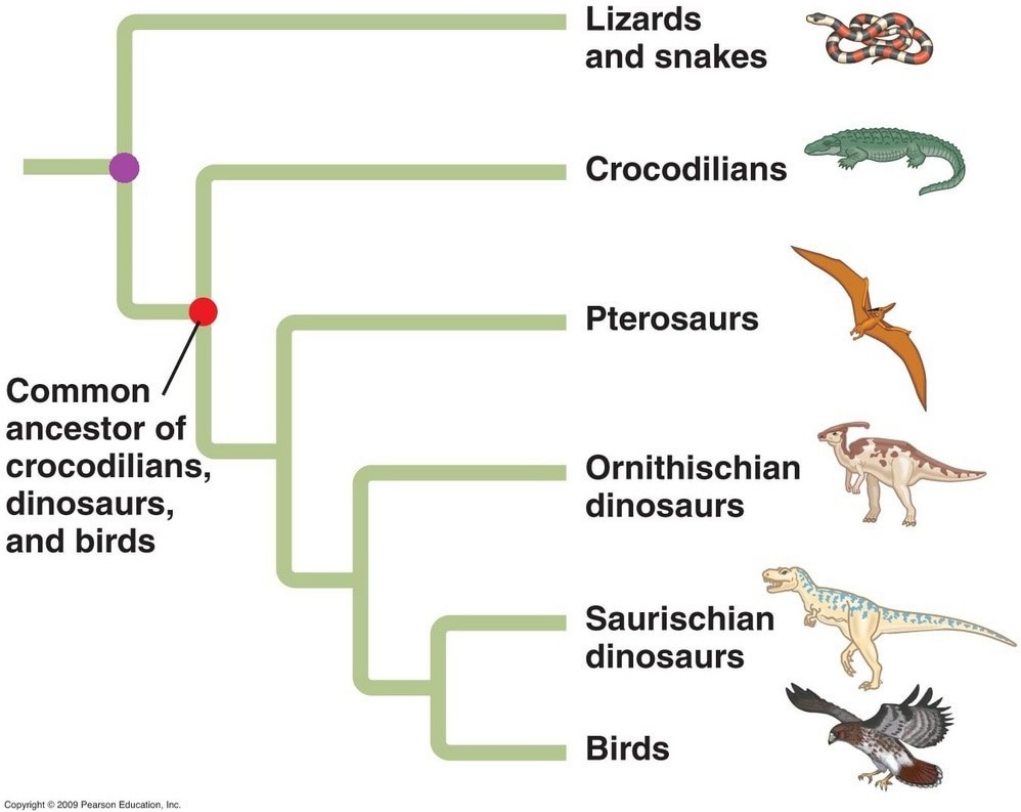
Is common slow-worm a snake?

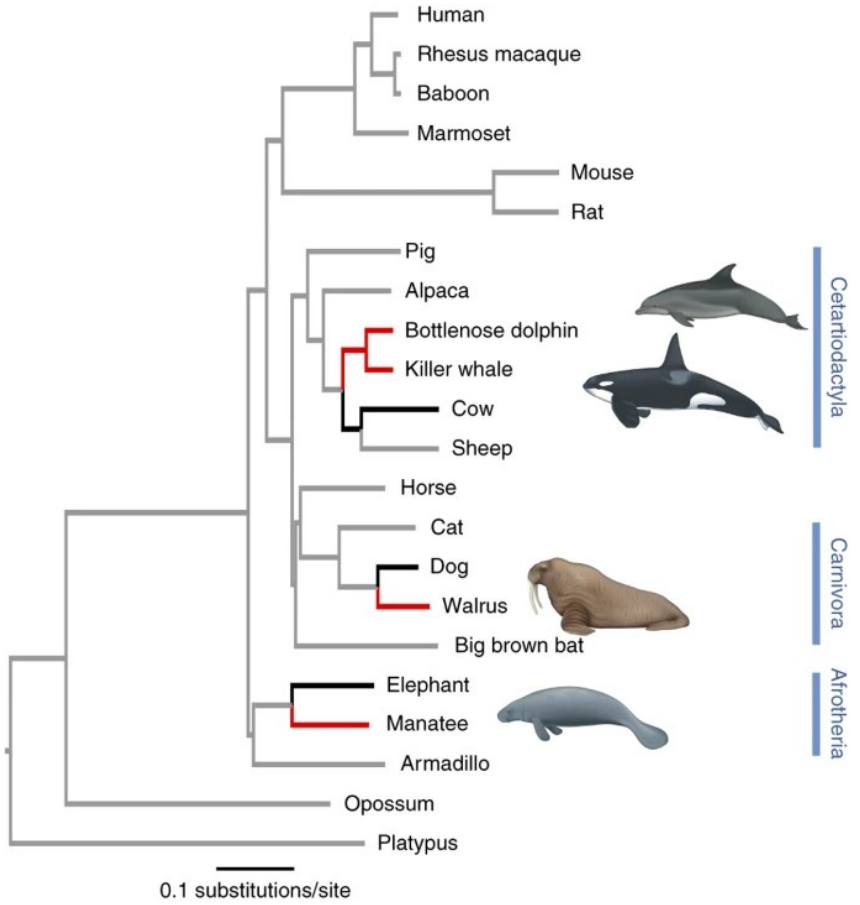
- No fused eyelids
- Can loose the tail
- Different structure of the jaw

- Parallel adaptation creates similarities between representatives of different taxa

Unicellular Eukaryotes

"Ancestral" traits are not very helpful for systematics





https://www.nature.com/articles/ng.3198

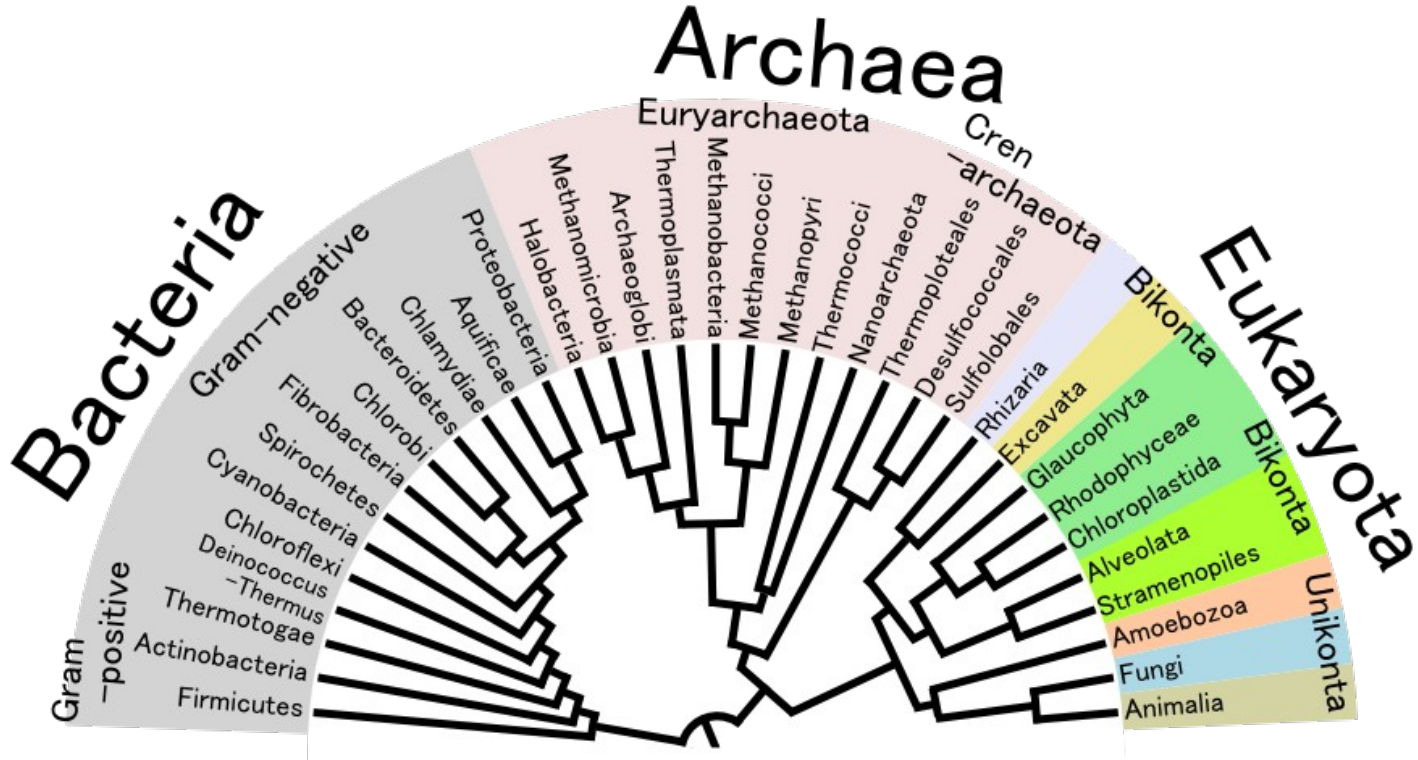
Evolution trees: key points

- Due to the branching pattern of DNA replication and speciation evolutionary relationships between DNA sequences or species can be described using trees
- To answer how close in evolutionary terms two DNA sequences (or species) are one has to look at their MRCA
- Evolutionary trees help to build evolutionary classification as well as to trace the evolution of traits
- Reconstructing evolutionary trees is hard due to parallel evolution and different rates of evolution in different lineages

BACTERIA AND ARCHAEA

An overview

Tree of Life: rRNA sequence



https://www.pinterest.com/pin/113504853078502673/

B&A: where to find them?

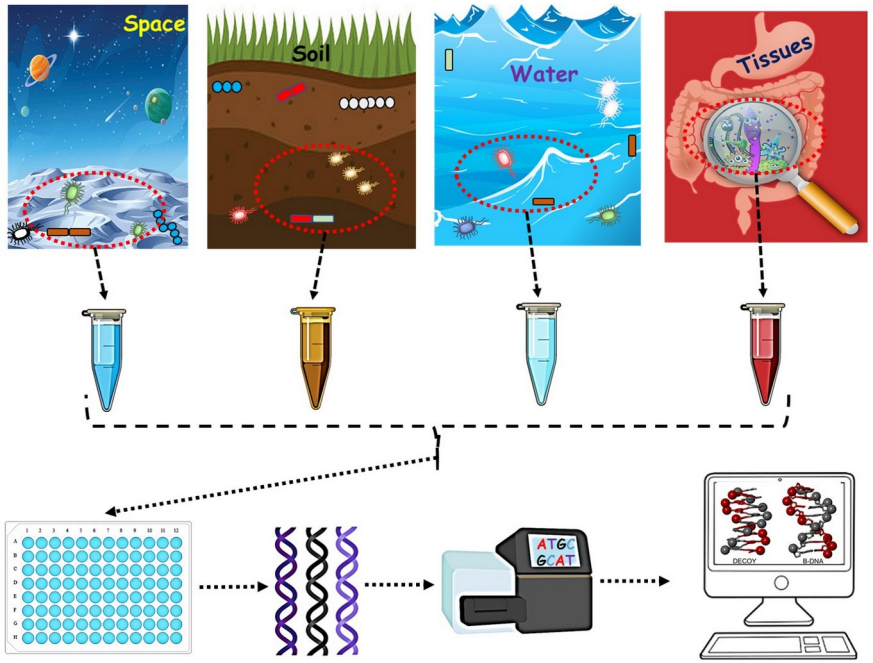
- Water (fresh and marine; cold and hot, acidic and alkaline)
- Soil
- Rock
- Snow and ice
- Rotting organics
- Bodies of animals, plants and so on (not only parasitic)
- ?Venus, Mars, Europa, comets?

Growing B&A in the lab

https://www.zymoresearch.com/blogs/blog/do-s-don-ts-of-plasmid-purification

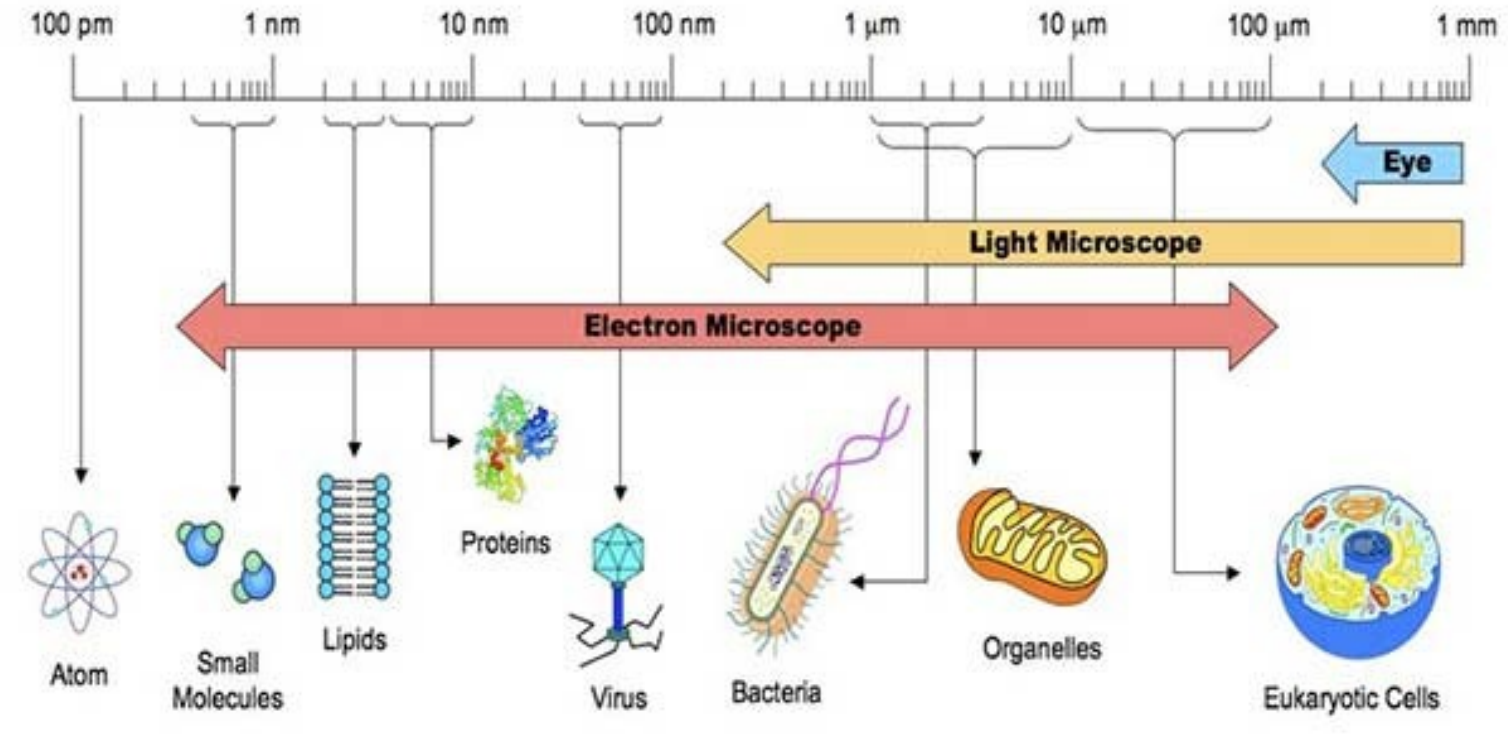
https://www.scienceprofonline.com/microbiology/bacterial-colony-morphology-identification-unknown-bacteria.html

NOT Growing B&A in the lab: metagenomics



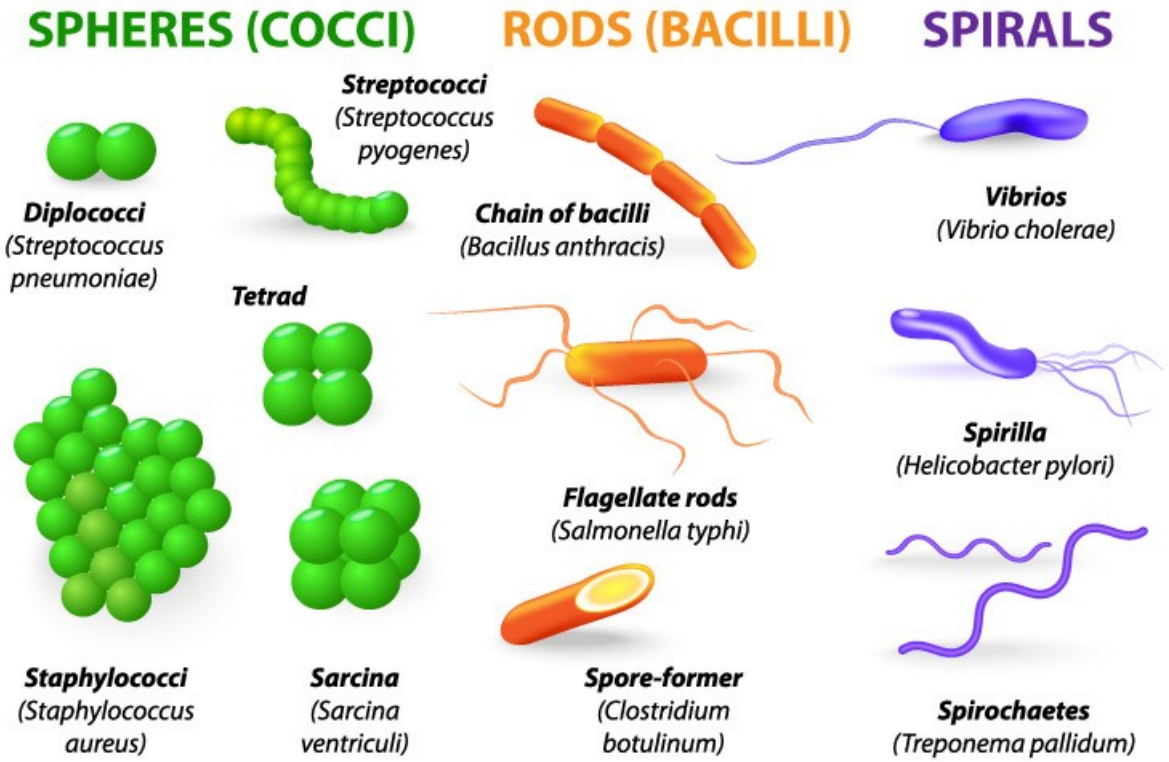
https://sciwri.club/archives/7530

B&A: size



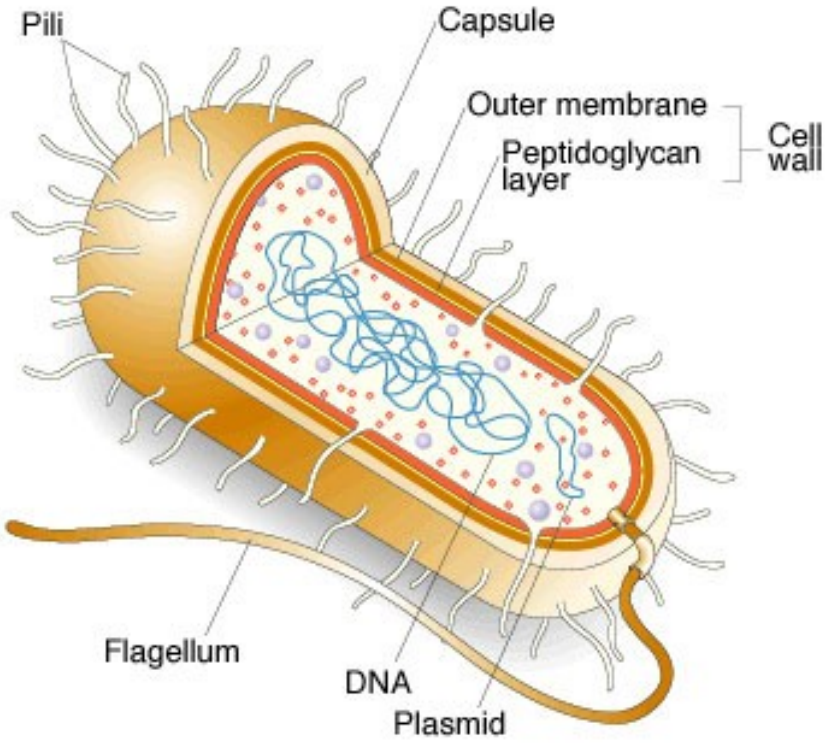
https://microbiologyinfo.com/different-size-shape-and-arrangement-of-bacterial-cells/

B&A: cell shapes



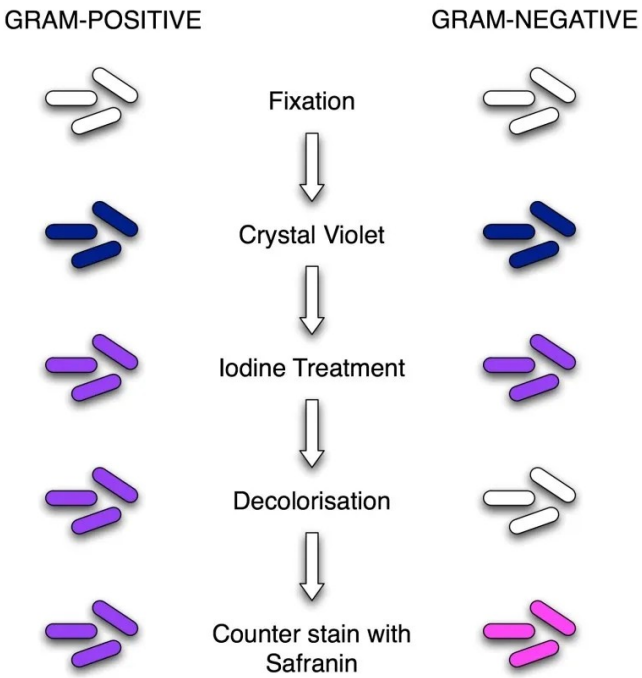
https://laboratoryinfo.com/various-shapes-and-arrangements-of-bacterial-cells/

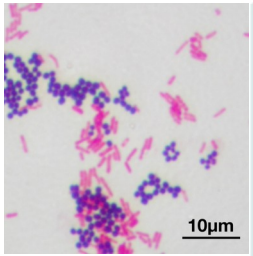
B&A: cell structure

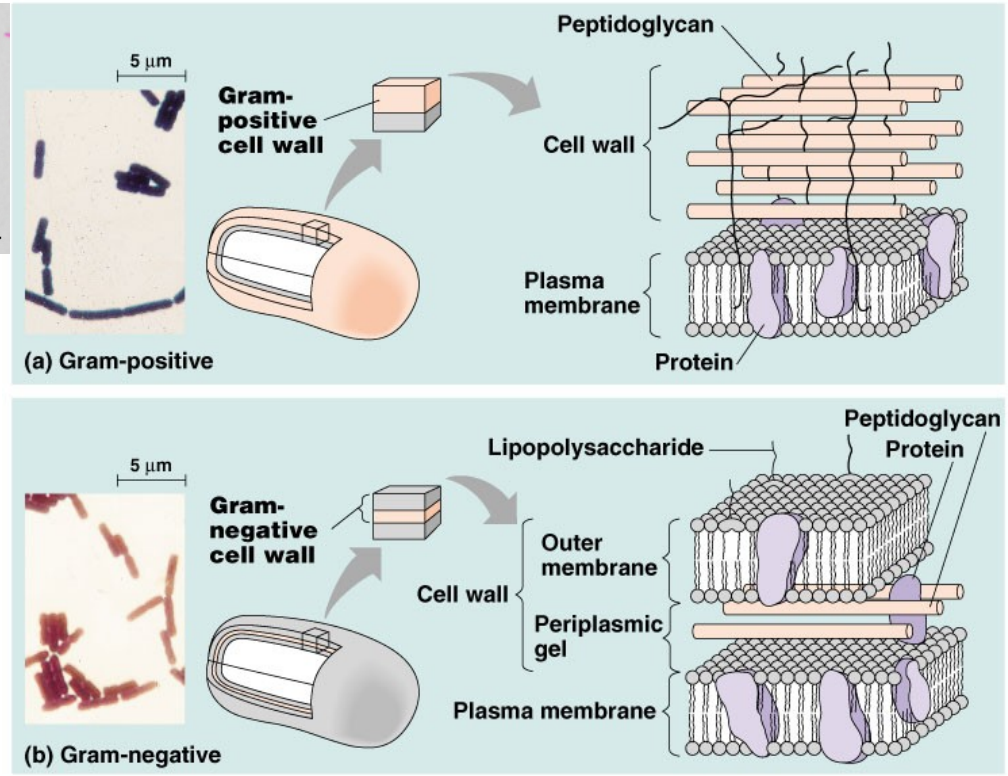


- No nucleus (DNA is directly in the cytoplasm)
- No organelles and intracellular membranes
- No microtubules and no phagocytosis
- Cell walls, but different from these of plants and fungi
- Flagella are also different
- No mitosis (simple cell division)

Bacteria: Gram staining







https://microbeonline.com/key-facts-about-gram-staining-techniques-that-you-might-not-know/

B&A overview

- Small unicellular organisms found almost everywhere
- Relatively simple cells compared to Eukaryotes but may have various structures like the cell wall, flagella, pili
- A lot of diversity in terms of cell size, shape and structure
- There potentially are a lot of B&A species we know almost nothing about