

"Bacterial" Genome Structures

4BIM - AMIG - INSA

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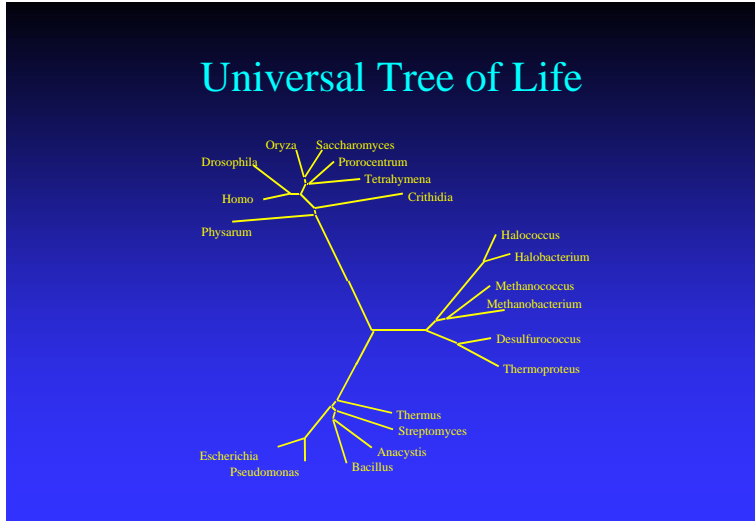
Outline

- 1 Introduction
- 2 Chromosomes Topology & Counts
- 3 Genome size
- 4 Replichores and gene orientation
- 5 Chirochores
- 6 G+C content
- 7 Codon usage

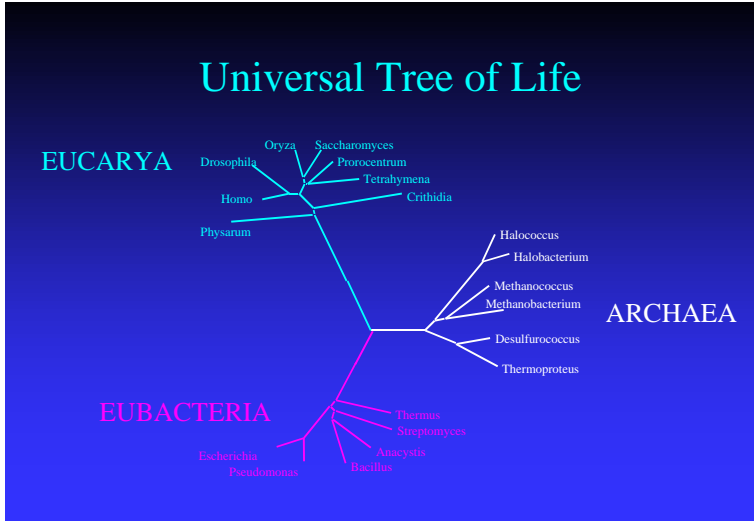
Introduction

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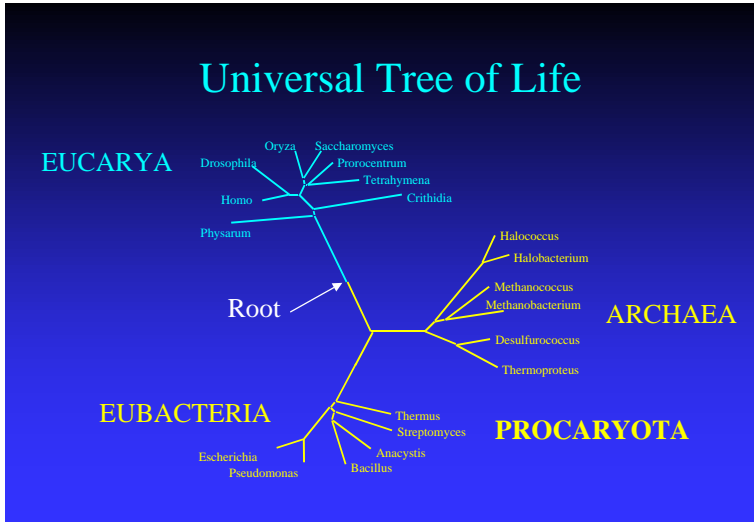
The three kingdoms



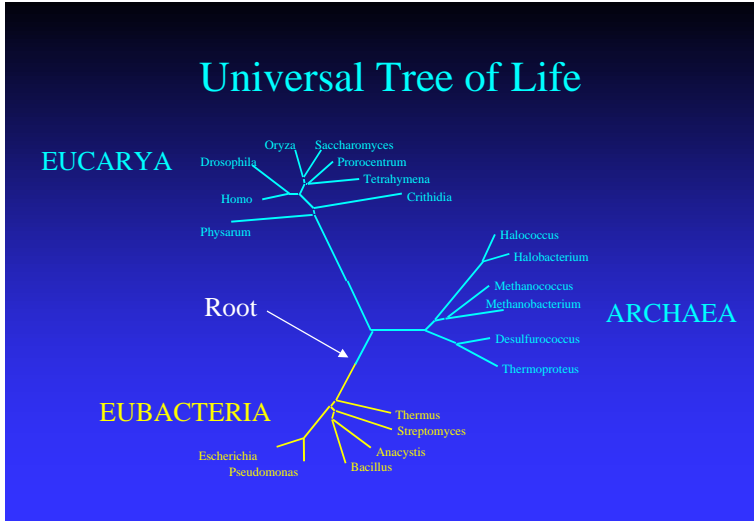
The three kingdoms: eucarya, archaea and eubacteria



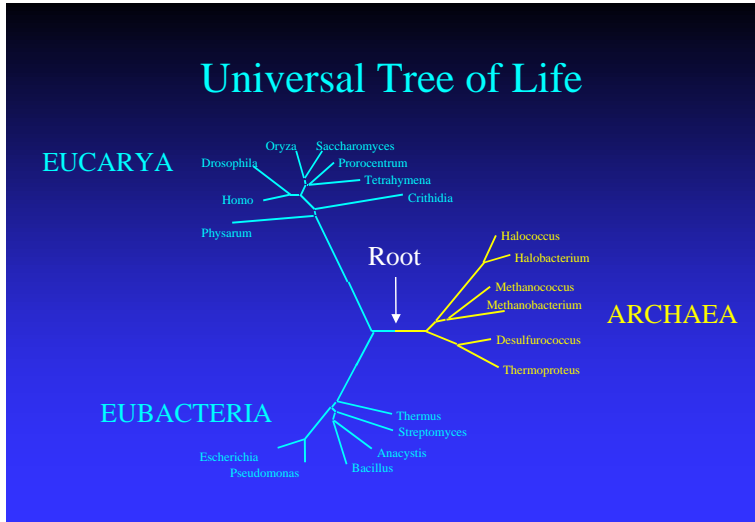
The three kingdoms: root 1



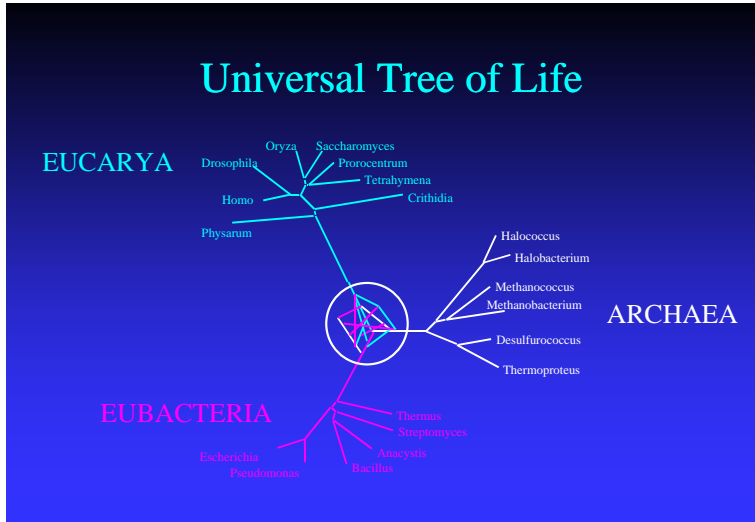
The three kingdoms: root 2



The three kingdoms: root 3



The three kingdoms: no root



Half of biomass on earth. . . but very few species

- Estimate : $5 \cdot 10^{30}$ bacterial cells on Earth
- Cell size : $\sim 1 \mu\text{m}^3 = 10^{-18} \text{m}^3$
- Total volume : $(17 \text{ km})^3 \Rightarrow$ Half of biomass on Earth

On $1.7 \cdot 10^6$ known species (Le Guyader & Lecointre, Classification Phylogénétique du Vivant)

- Bacteria : 5000 species
- Insects : 1 000 000 species
- Mammals : 4300 species

First species classification

An old trend

Aristotle (-384,-322)

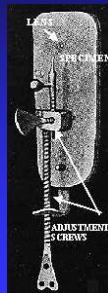


508 Eucaryota
0 Bacteria

Small bacteria

Little Bacteria

Antony van Leeuwenhoek (1632-1723)



$$0.1 \text{ mm} = 100 \mu\text{m}$$



Thickness $\approx 100 \mu\text{m}$.

1 M€ $\approx 1 \text{ m}$

1 G€ $\approx 1 \text{ km}$

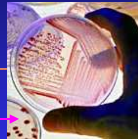
Bacterial cell size is in μm



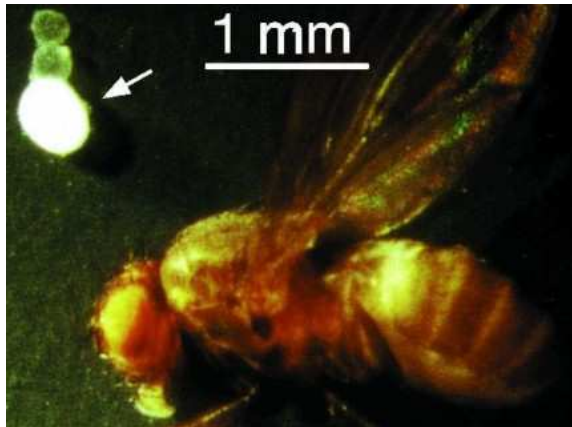
1 colony $\approx 10^6$ cells

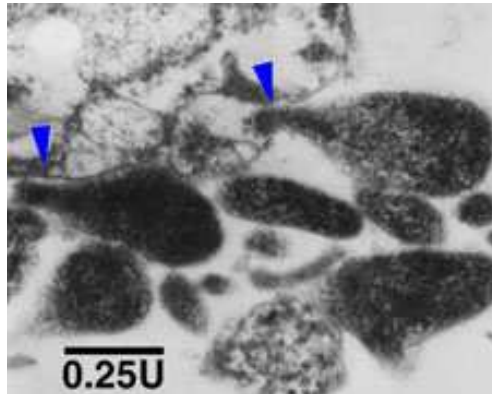
Little Bacteria

1 colony $\approx 10^6$ cells



A giant: *Thiomargarita namibiensis* can measure 750 μm



Mycoplasma genitalium

The bar is 25 μm long. So you can put $\left(\frac{750}{25}\right)^3 = 27000$ mycoplasmae in 1 big Thiomargarita.

Few morphological traits

Ugly Little Bacteria

The diagram illustrates the genetic distance between different species. At the top, a woman and a chimpanzee are shown with a double-headed arrow between them labeled 10^7 years. At the bottom, two scanning electron micrographs of bacteria are shown with a double-headed arrow between them labeled 10^9 years. The left bacterium is *E. coli* and the right is *B. subtilis*.

E. coli

B. subtilis

Bacterial classification

Classification of Bacteria

- Was based mainly on physiology and growth conditions



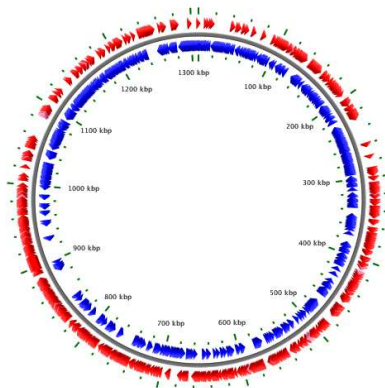
E. coli



Most bacteria defy cultivation...

Bacterial classification: "*Candidatus Pelagibacter ubique*"

Candidatus Pelagibacter ubique HTCC1062, complete genome



Accession: NC_007205

Topology: Circular; Length: 1,308,759 bp; Genes: 1,389



Bacterial classification: *Candidatus*

Candidatus examples:

- "*Candidatus* Arsenophonus triatominarum"
- "*Candidatus* Arthromitus"
- "*Candidatus* Blochmannia"
- "*Candidatus* Blochmannia floridanus"
- "*Candidatus* Blochmannia herculeanus"
- "*Candidatus* Burkholderia kirkii"
- "*Candidatus* Glomeribacter gigasporarum"
- "*Candidatus* Xiphinematobacter brevicolli"

Bacterial environments

Bacteria can live in very diverse environments:

- ground (*Streptomyces coelicolor*)
- on plants (*Bacillus subtilis*)
- in water (*Anabaena*)
- in cells (*Salmonella enterica*)
- on the surface of cells (*Escherichia coli*)

Bacterial environments (II)

But also:

A big example: Grand Prismatic Spring, Yellowstone, USA



Are all bacteria microbes?

Bacteria are often known as "microbes", which is partly true. Pathogen organisms can be bacteria, eukaryotic cells (fungi, parasites), or viruses.

Bacteria are indeed responsible for:

Are bacteria important for health?

Quiz (try first without Internet!) :

- How many human cells do the human body harbour?
- How many bacterial cells do the human body harbour?
- What is the major DNA in your body?
- What happens to organisms with no bacteria?