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IRB BARCELONA

XXIV Jornada de Biologia Evolutiva

Pervasive horizontal transfer and extensive gene duplication shape Asgard archaeal genomes

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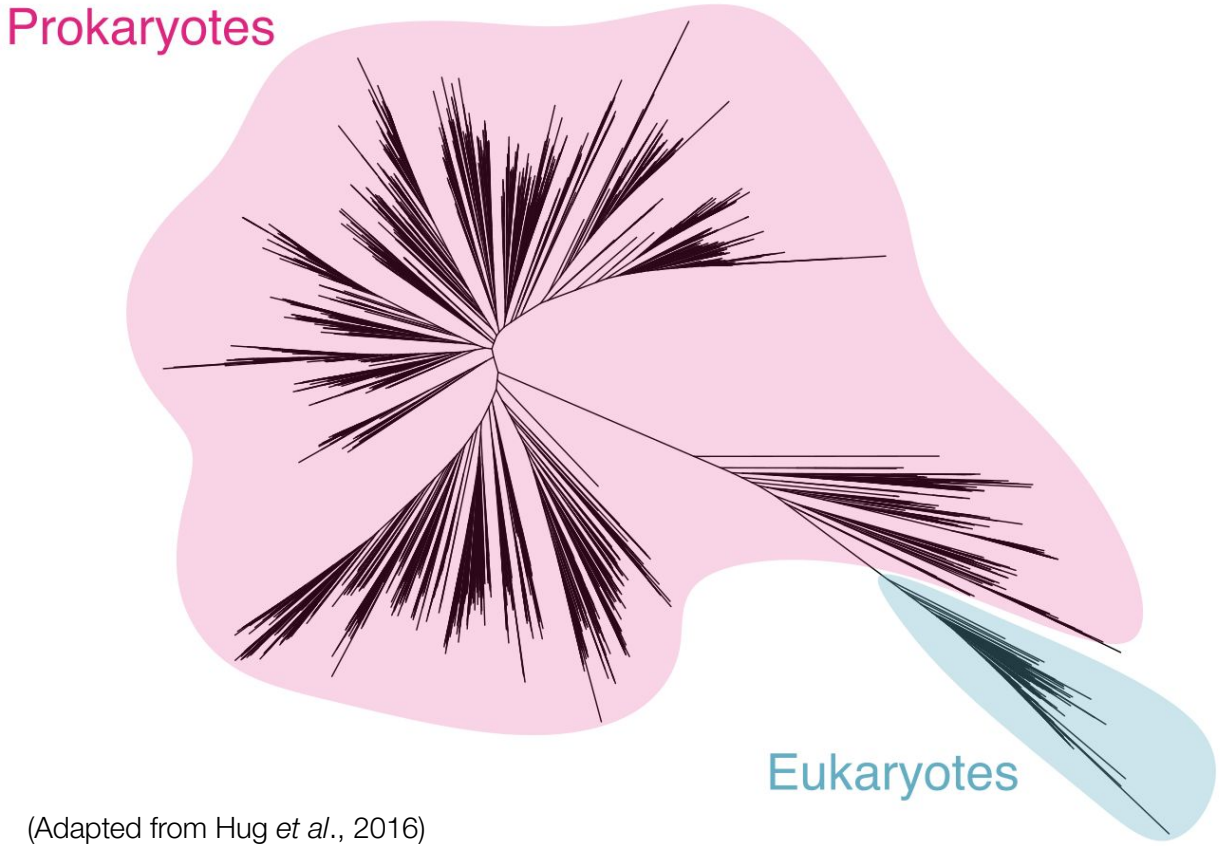
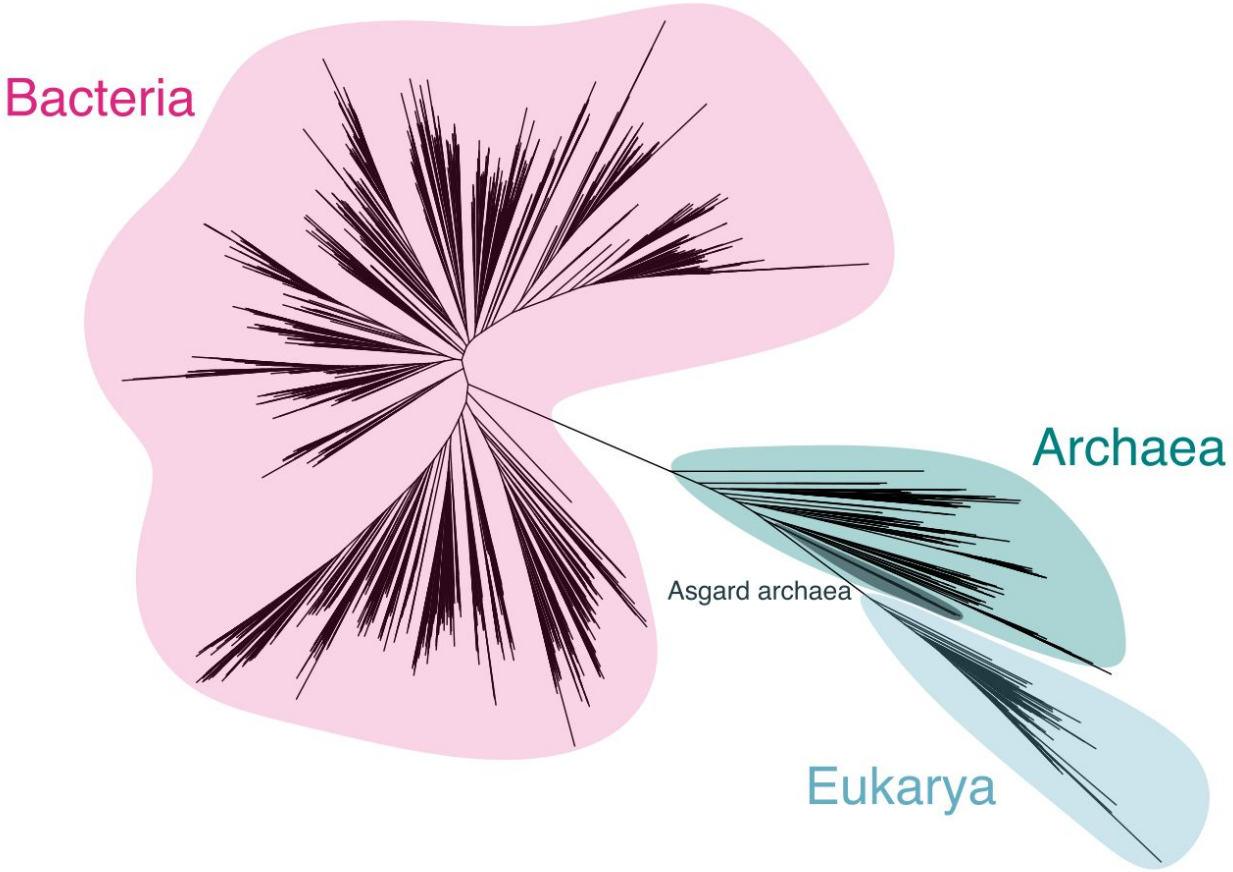
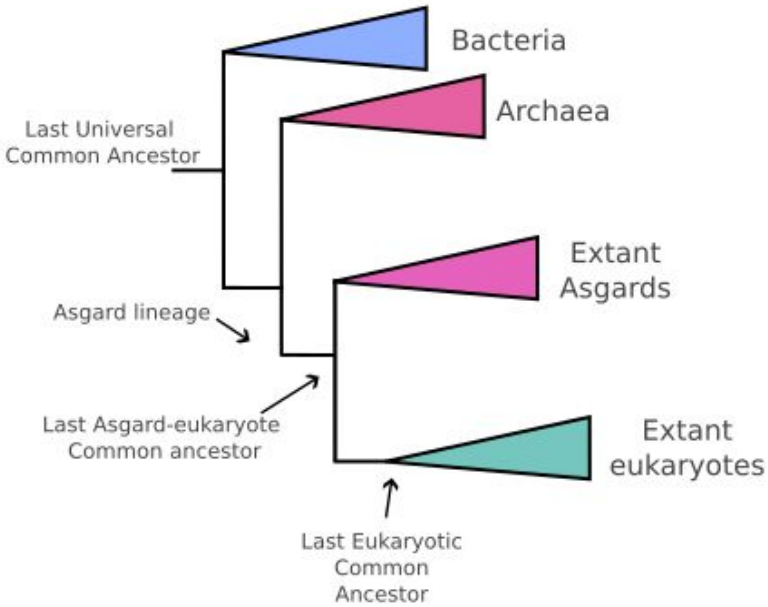


(Adapted from Hug *et al*., 2016)


Bacteria
Archaea
Asgard archaea
Eukarya

Asgard archaea have a unique phylogenetic placement and some eukaryote-like features



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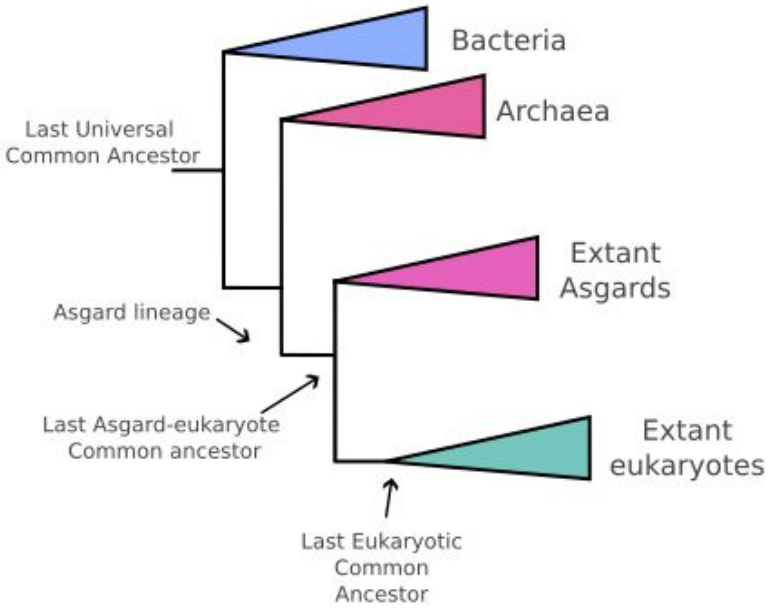
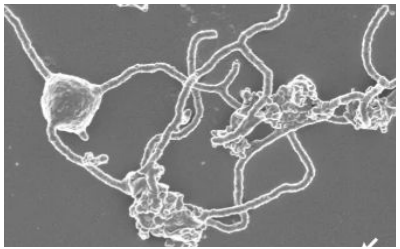
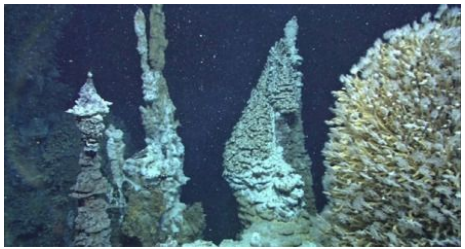
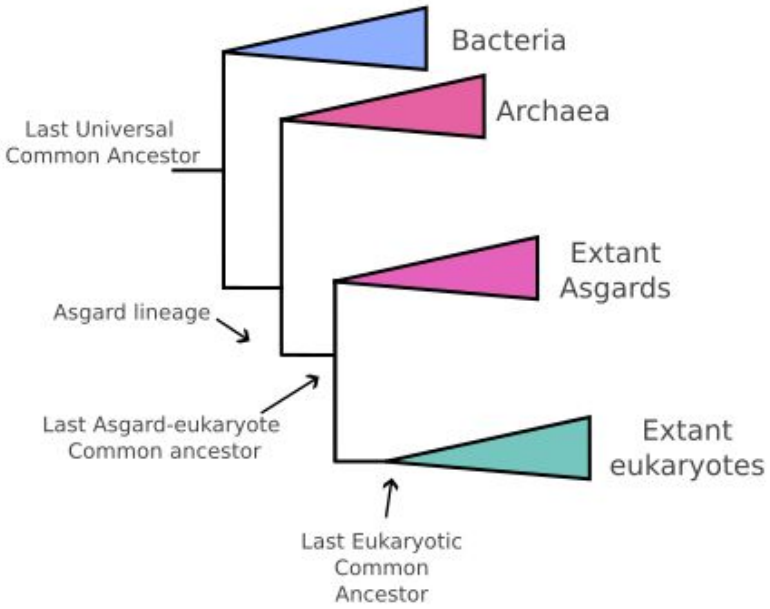


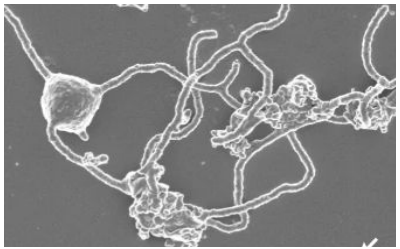


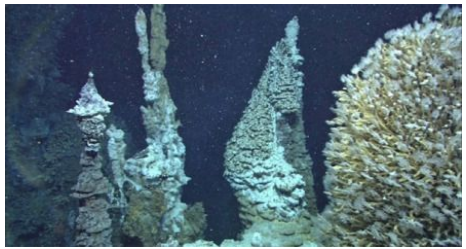


(Imachi *et al.* 2020)

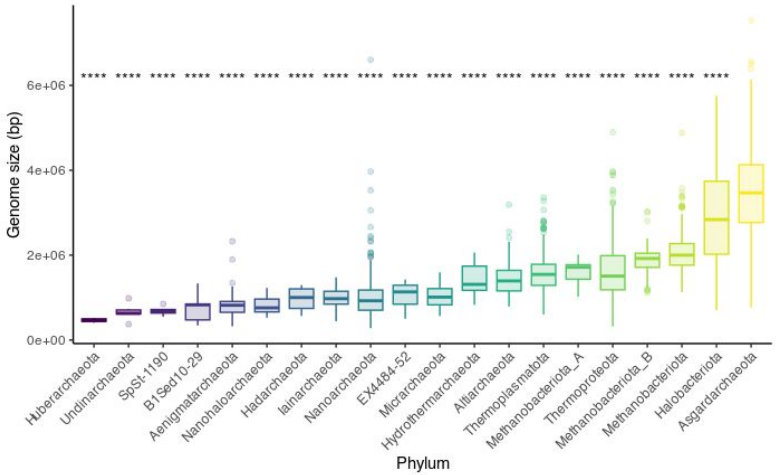
Asgard archaea have a unique phylogenetic placement and some eukaryote-like features





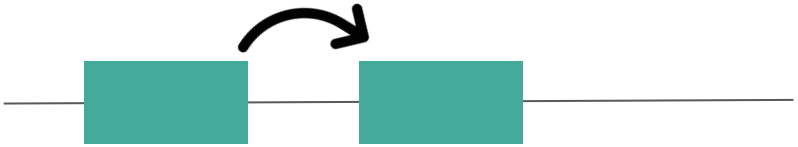


(Imachi *et al.* 2020)

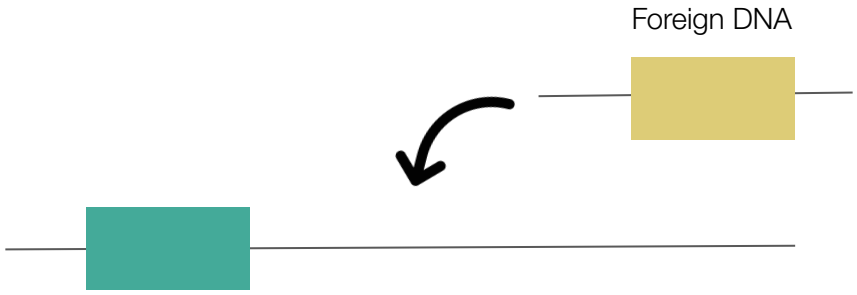


Genome evolution

Increase



Duplication



Transfer

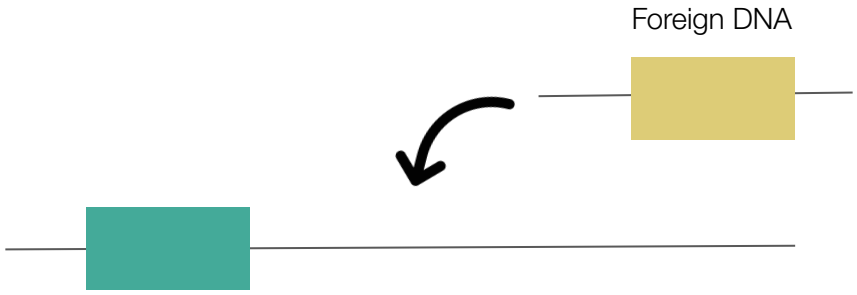
Decrease

Loss

Genome evolution

Increase

Duplication



Transfer

Common in **eukaryotes**

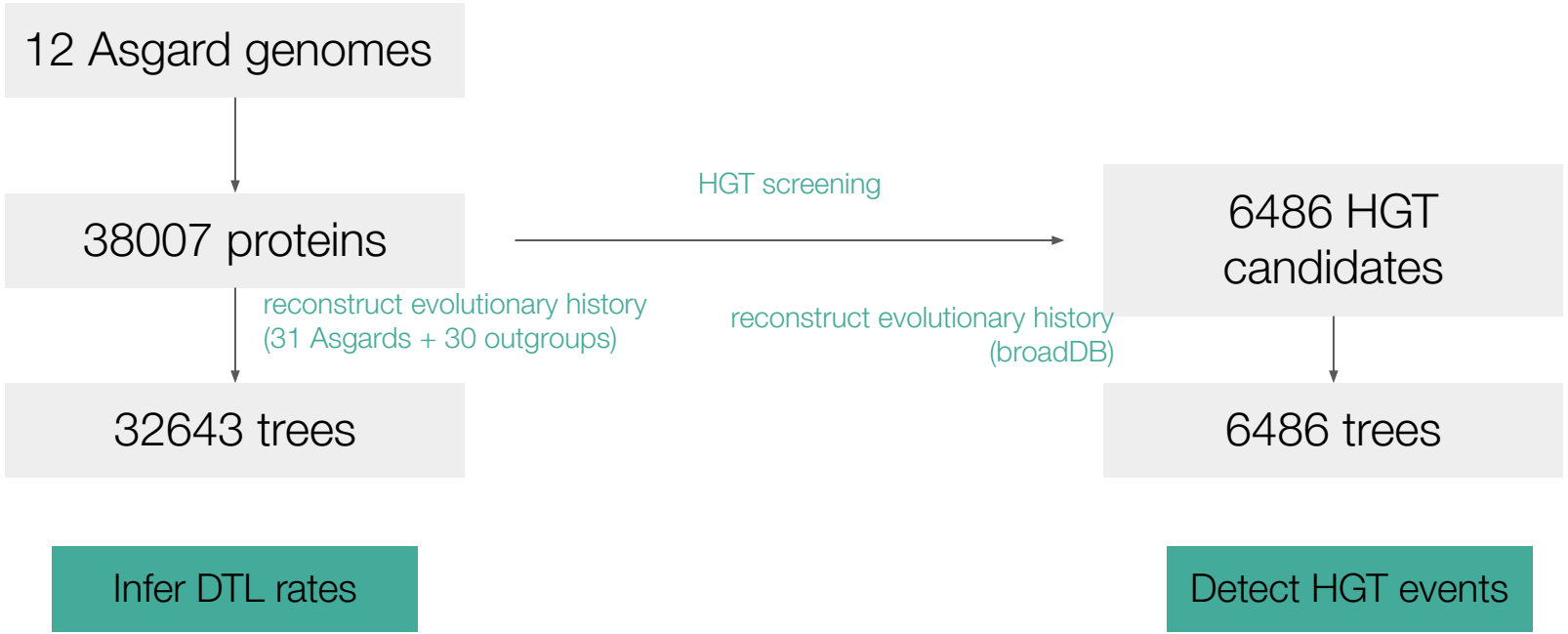
Common in **prokaryotes**

Did Asgards **expand** their genome in a **prokaryote-like** or **eukaryote-like** manner?

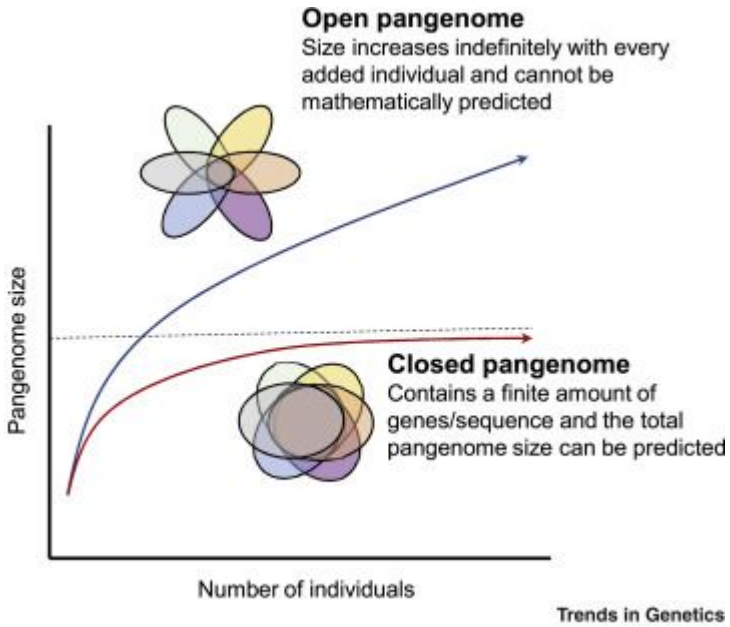
Open questions

- Interplay of HGT and gene duplication
- Functional assessment of duplicated/transferred proteins
- Integration of transferred/duplicated genes in genomes

Phylogenomics workflow

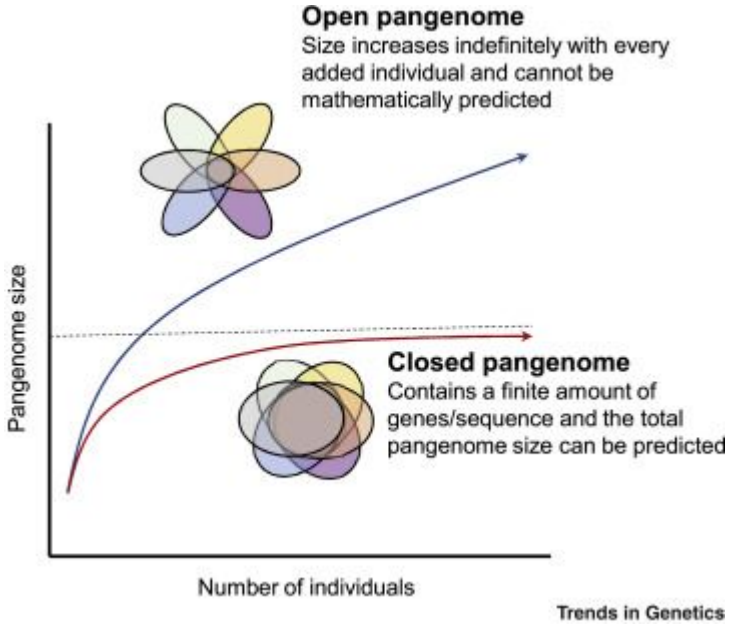


The Asgard pangenome



Azimuddin, Syed & Aslam, Huroom. (2023)

The Asgard pangenome

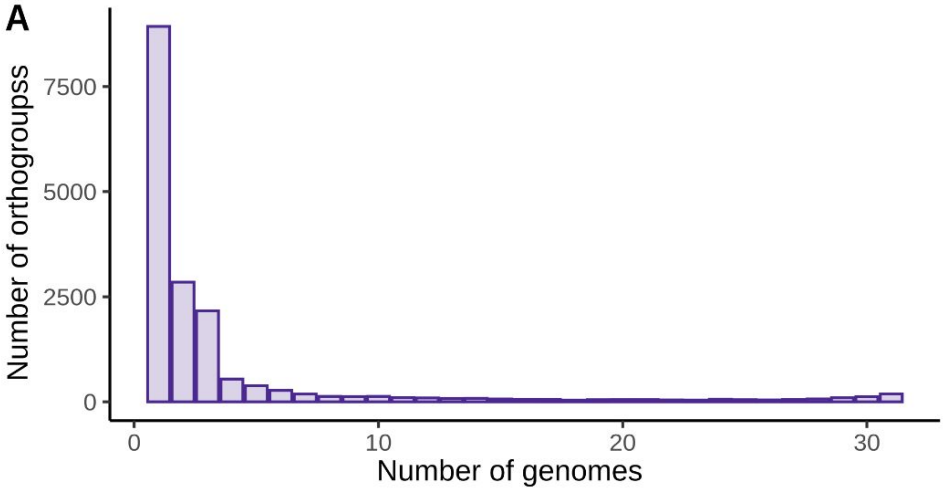


Azimuddin, Syed & Aslam, Huroom. (2023)

- How much of the Asgard diversity have we uncovered?
- Are there (many) more surprises to be expected?

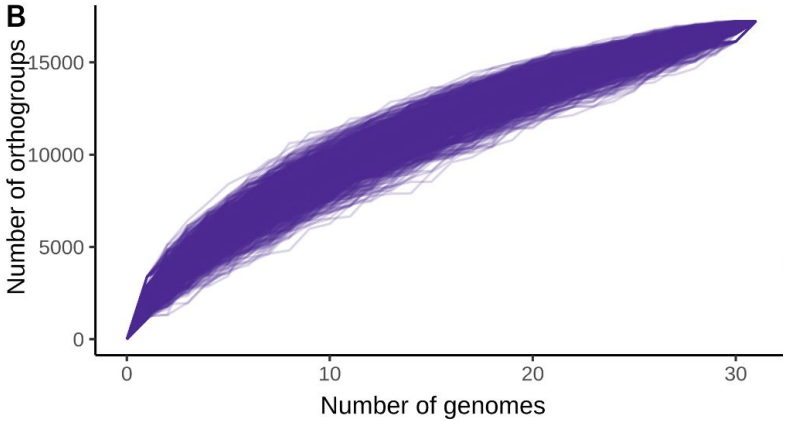
Asgard archaea have an open pangenome

Most of the OGs are very infrequent

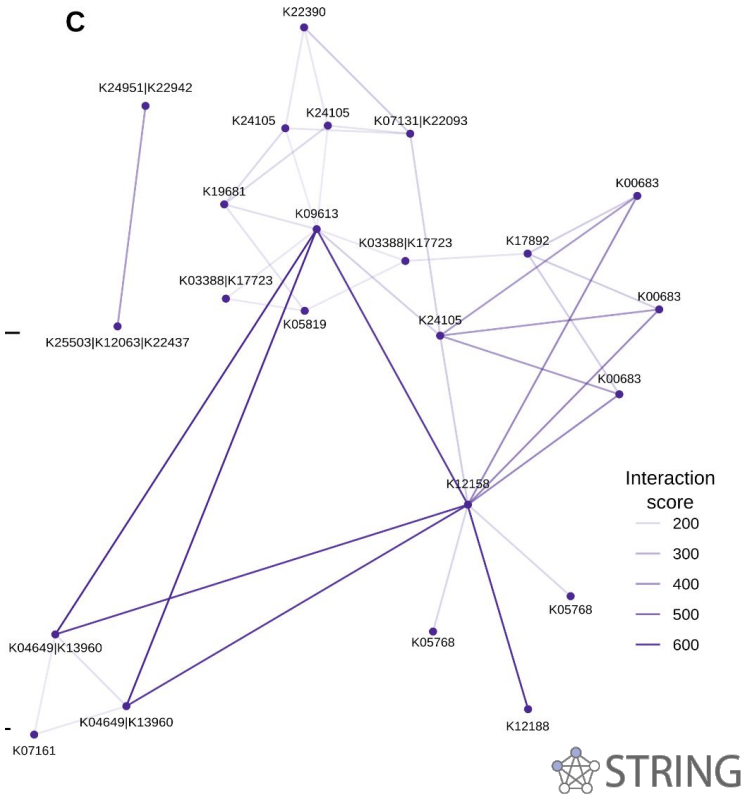


Asgard archaea have an open pangenome

The number of new OGs as function of new genomes doesn't plateau

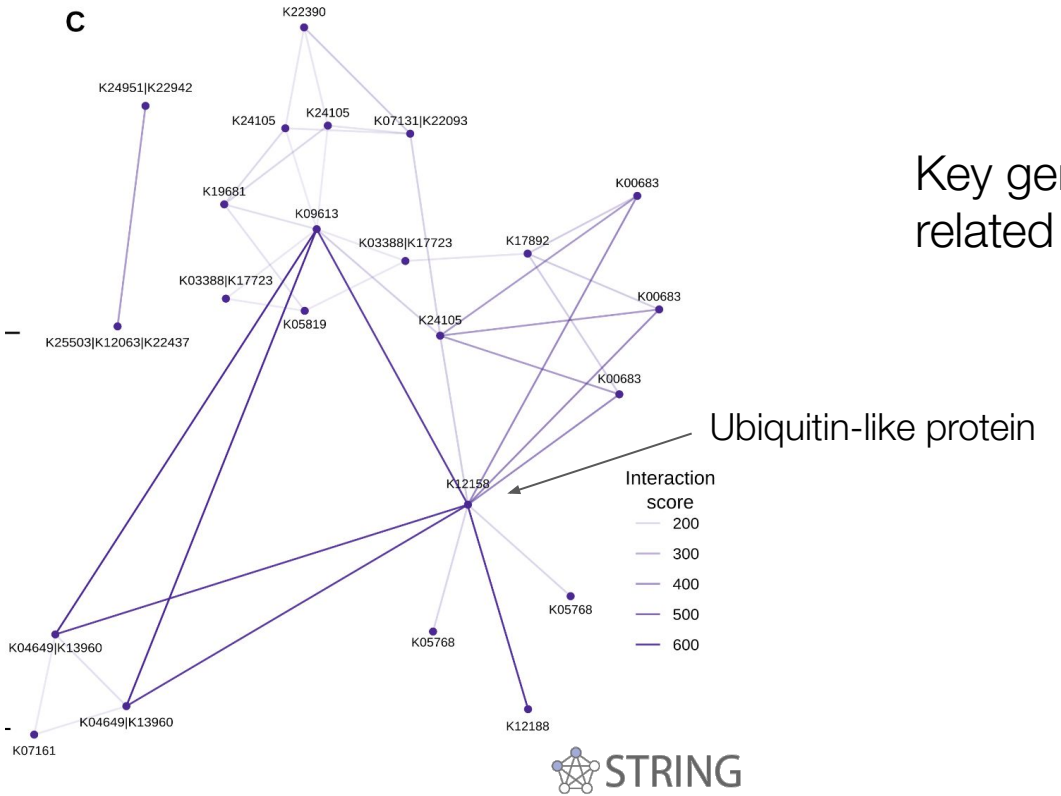


Asgard signature proteins are interconnected



Key gene families for “Asgardness” are related

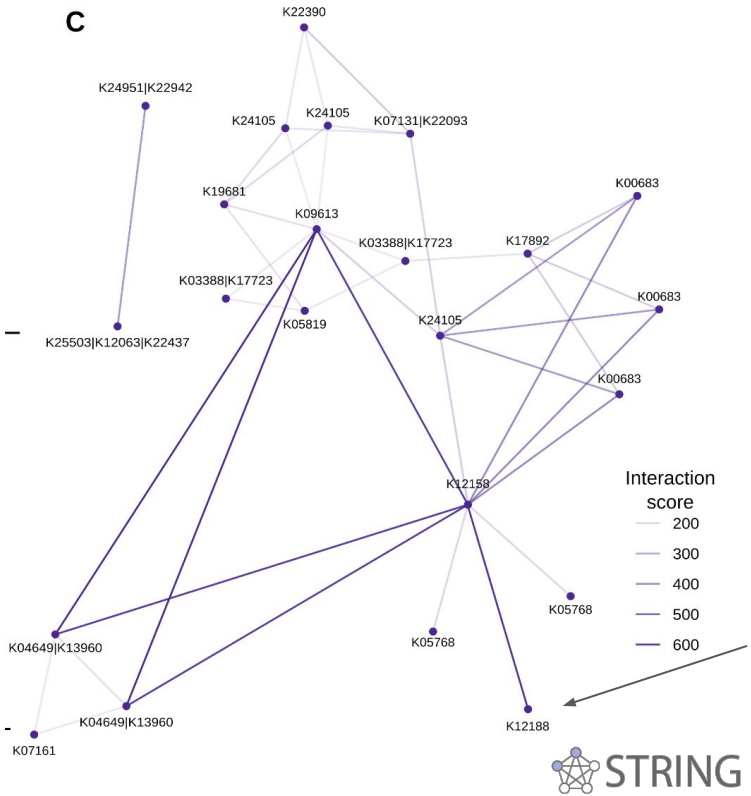
Asgard signature proteins are interconnected



Key gene families for “Asgardness” are related

Ubiquitin-like protein

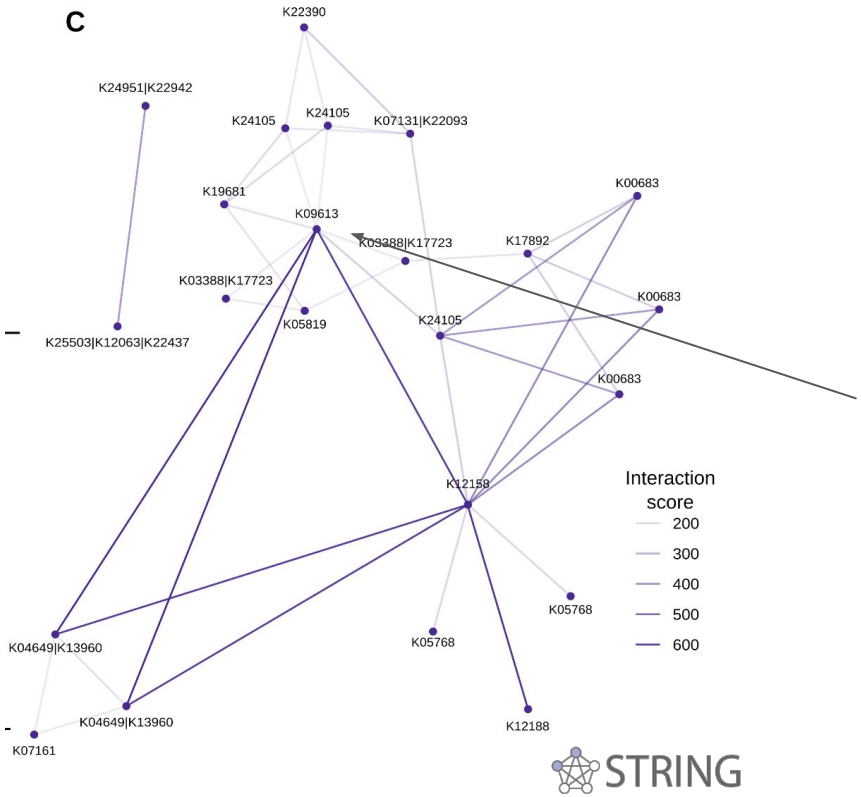
Asgard signature proteins are interconnected



Key gene families for “Asgardness” are related

ESCRT-II complex subunit VPS22

Asgard signature proteins are interconnected



Key gene families for “Asgardness” are related

COP9

12 Asgard genomes

↓

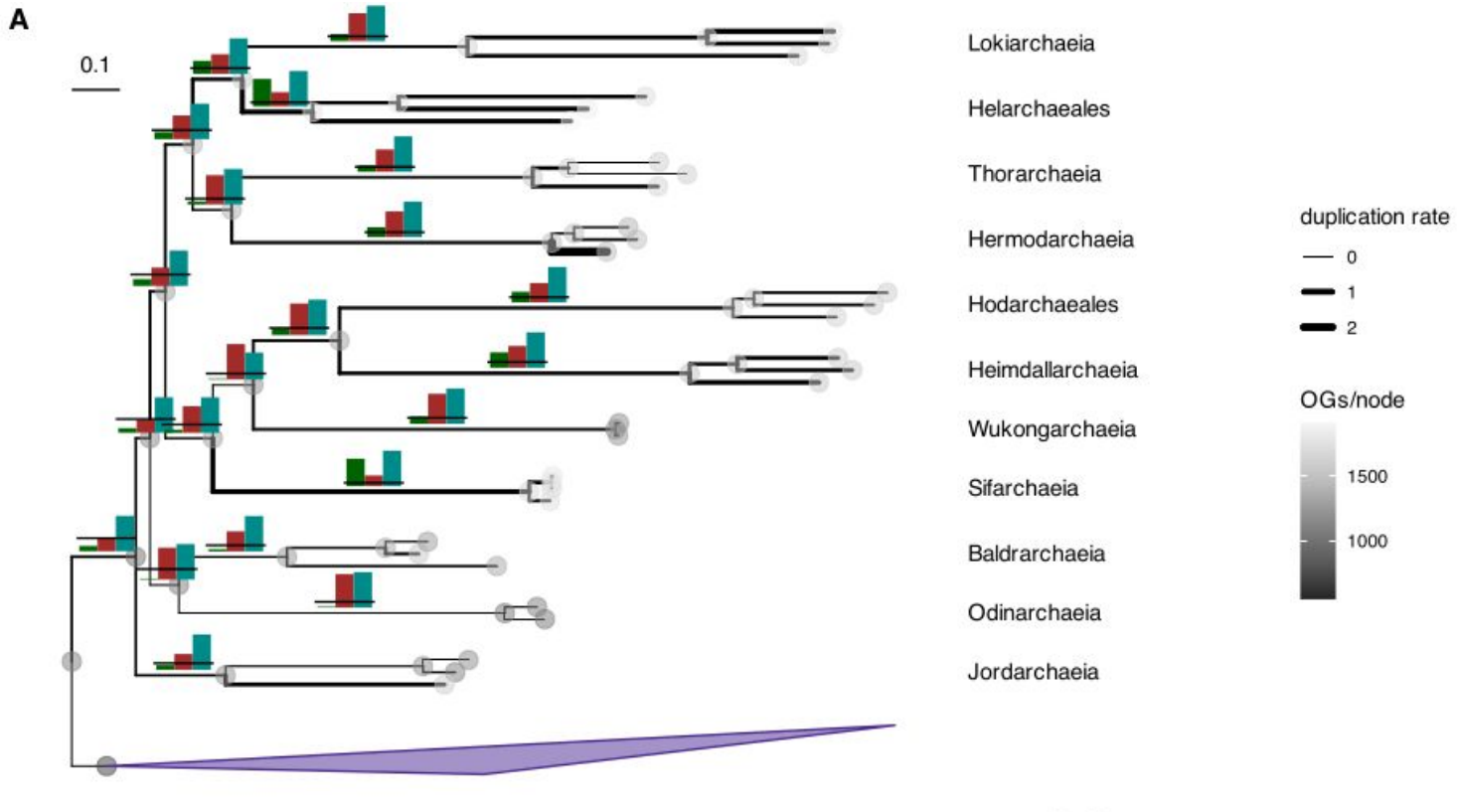
38007 proteins

↓ reconstruct evolutionary history (31 Asgards + 30 outgroups)

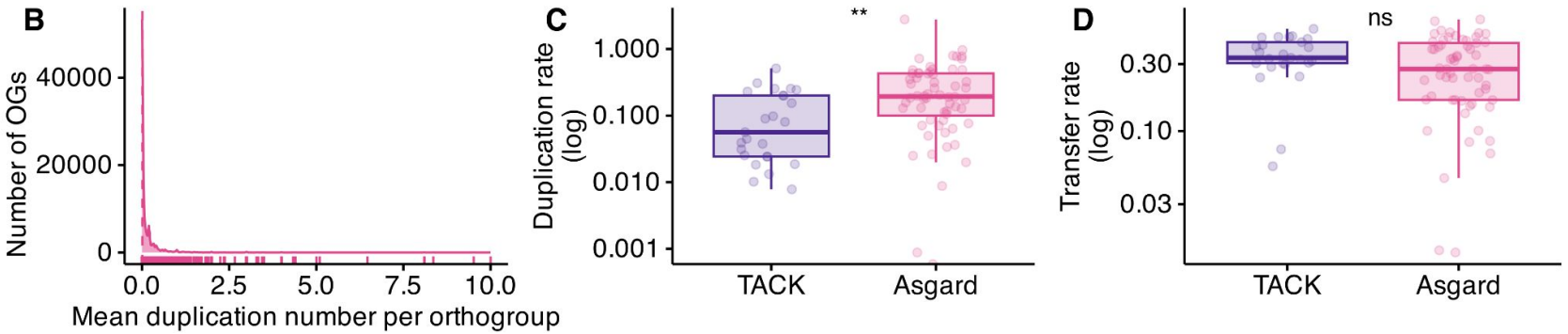
32643 trees

Infer DTL rates

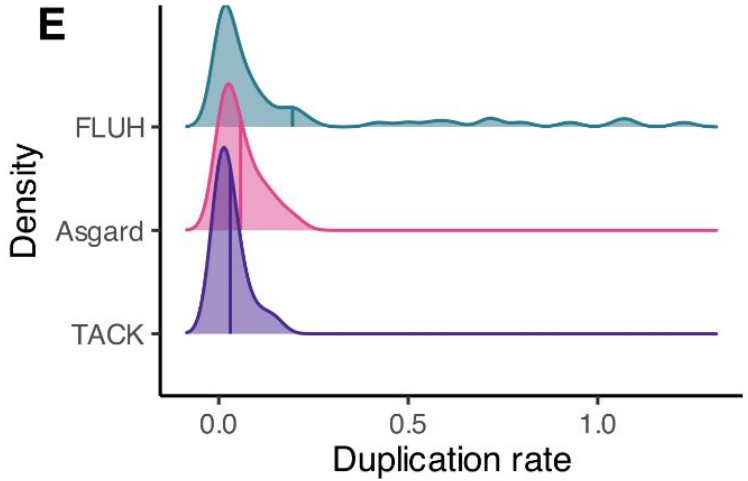
- Duplication
- Transfer
- Loss


A
0.1
Lokiarchaeia
Helarchaeales
Thorarchaeia
Hermodarchaeia
Hodarchaeales
Heimdallarchaeia
Wukongarchaeia
Sifarchaeia
Baldrarchaeia
Odinarchaeia
Jordarchaeia
duplication rate
0
1
2
OGs/node
1500
1000

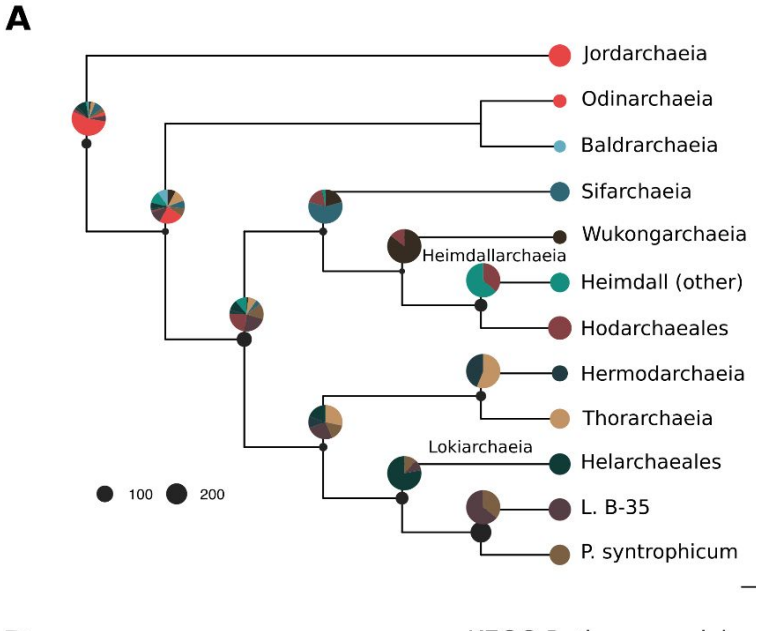
Asgards have significantly higher duplication rates than other prokaryotes



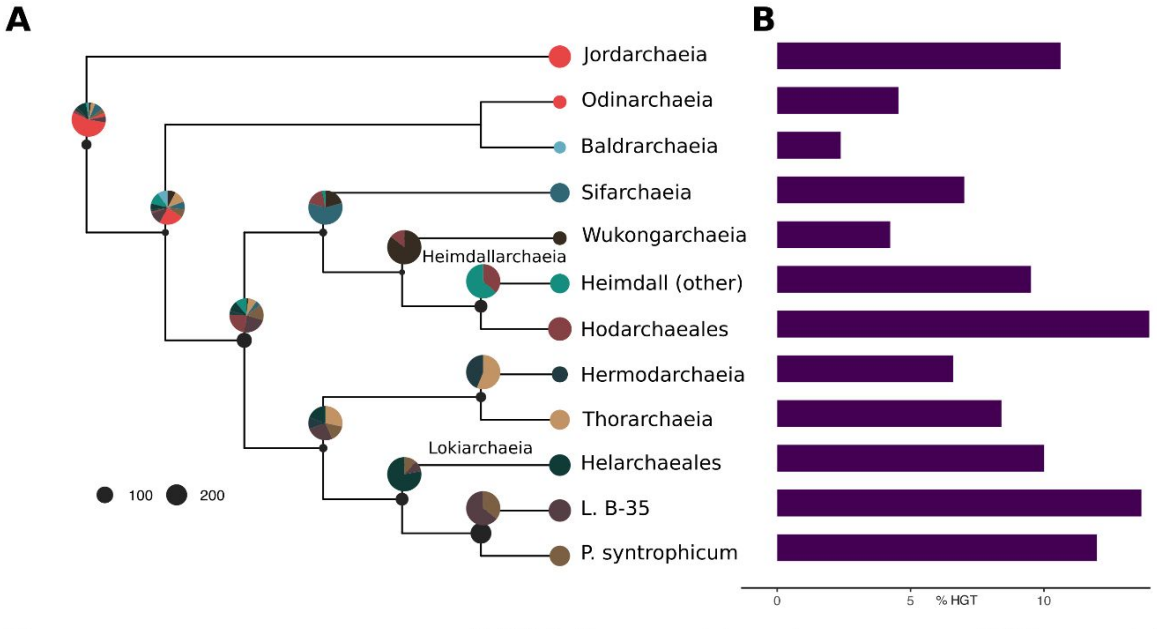
Asgards have significantly higher duplication rates than other prokaryotes and are and intermediate between them and eukaryotes



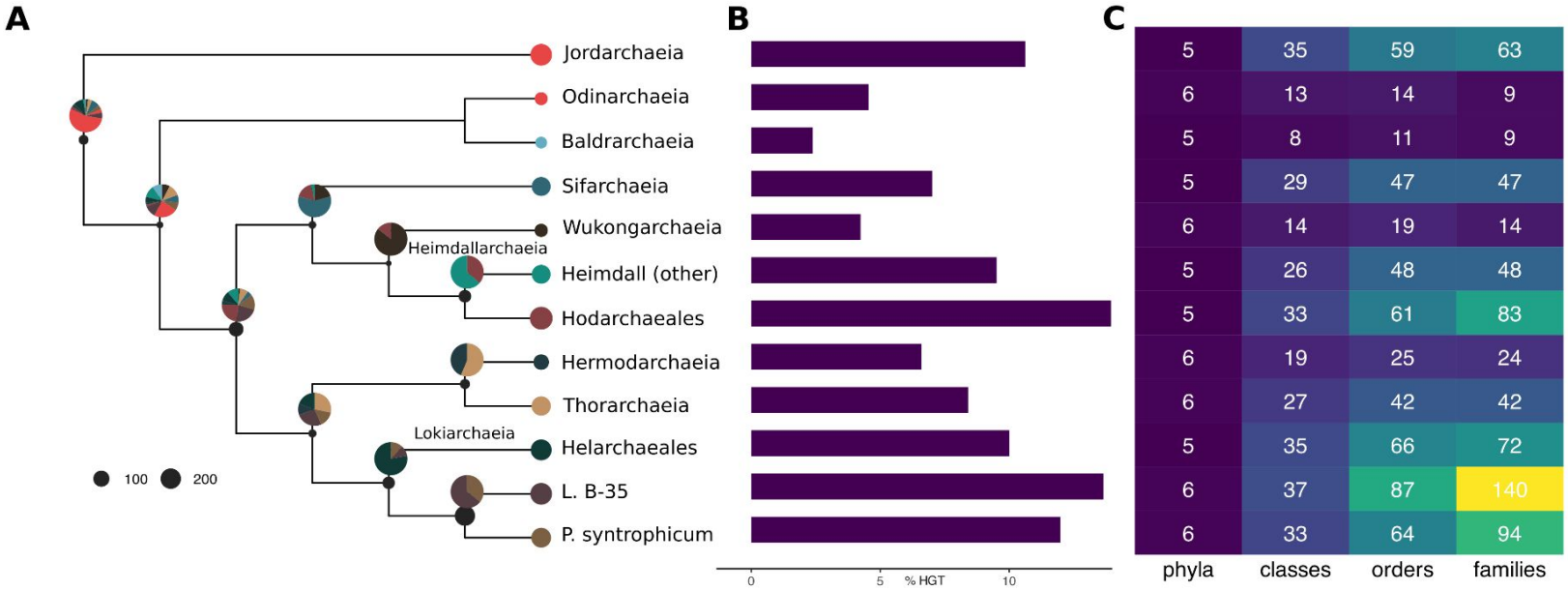
Bacteria-Asgard HGT has been a constant, on-going process across Asgard evolution…



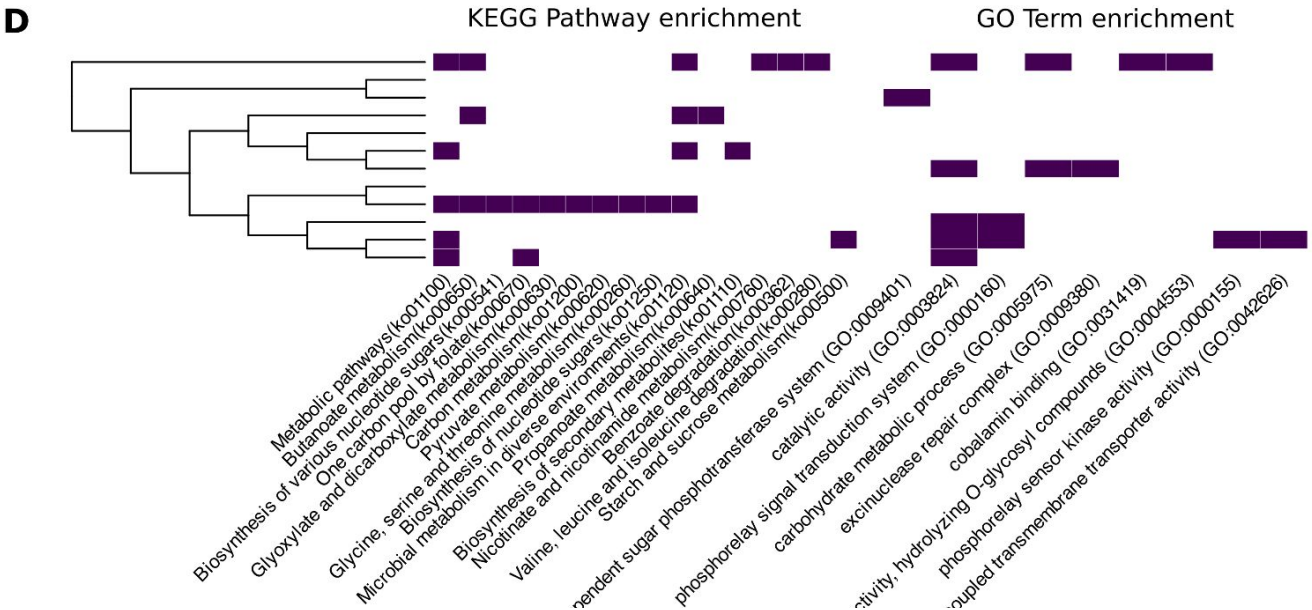
...leading to varying percentages of HGT-derived proteins across lineages…

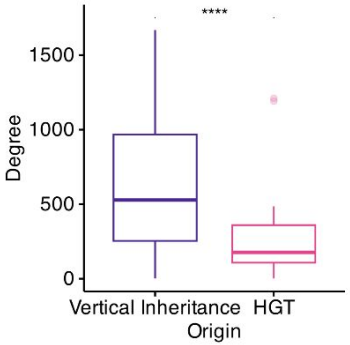


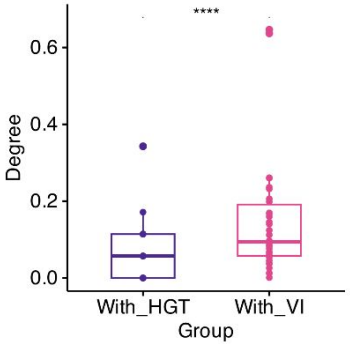
...from a variety of sources



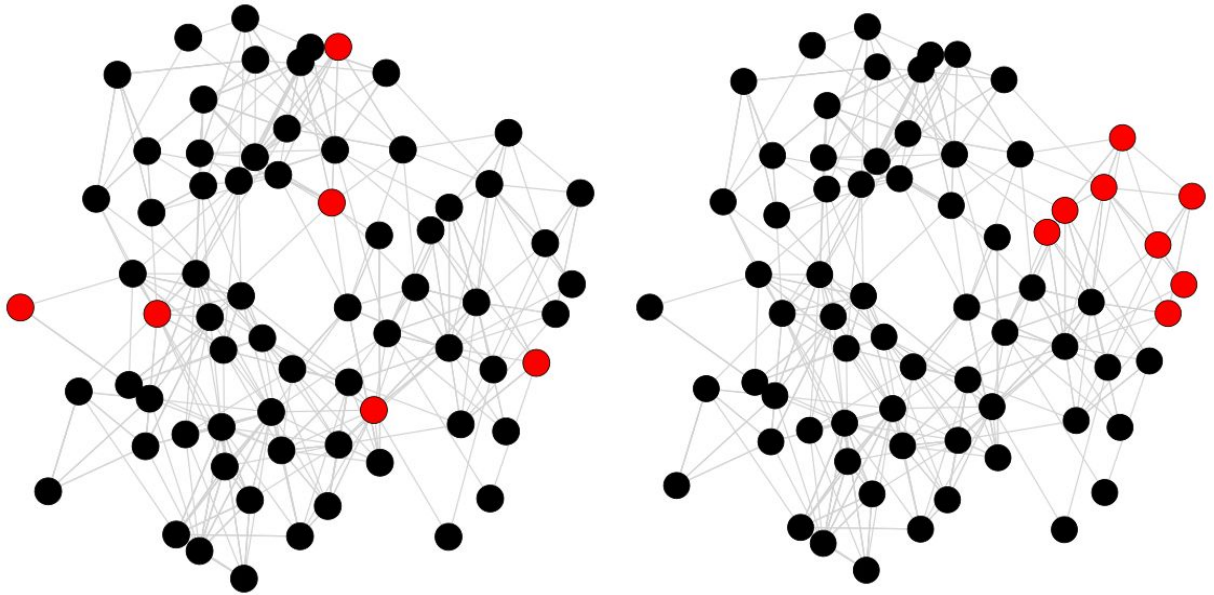
Genes of bacterial origin are enriched in metabolic functions

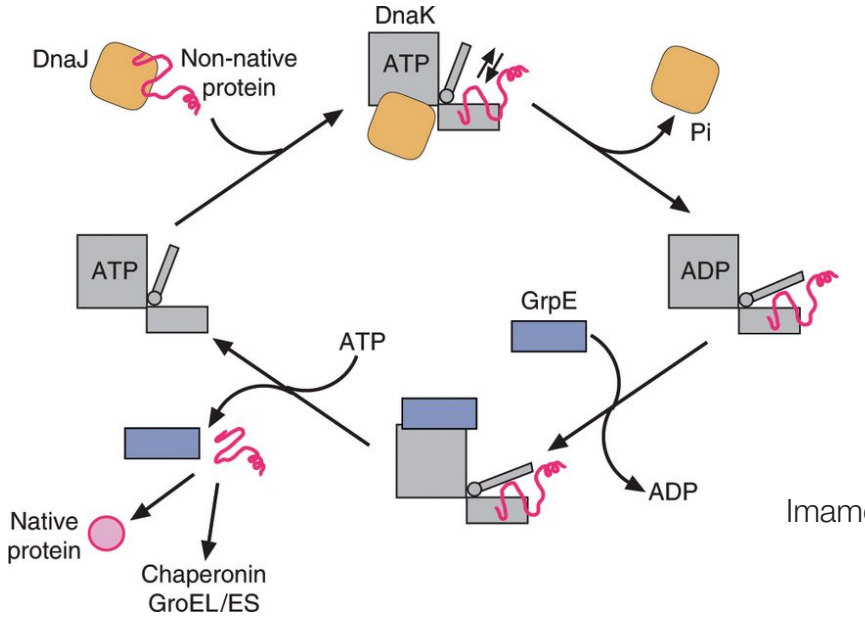






… and are connected to vertically inherited genes rather than being modular





Imamoglu et al (2019)

Take-home messages

- A role for both **gene duplication** and **gene transfer** in shaping Asgard archaeal genomes

Take-home messages

- A role for both **gene duplication** and **gene transfer** in shaping Asgard archaeal genomes
- Pervasive inter- and intra-domain **horizontal gene transfer** of **metabolic genes**
- Integration in **PPI** network

Comparative Genomics
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Moisès Bernabeu

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Comparative Genomics

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