

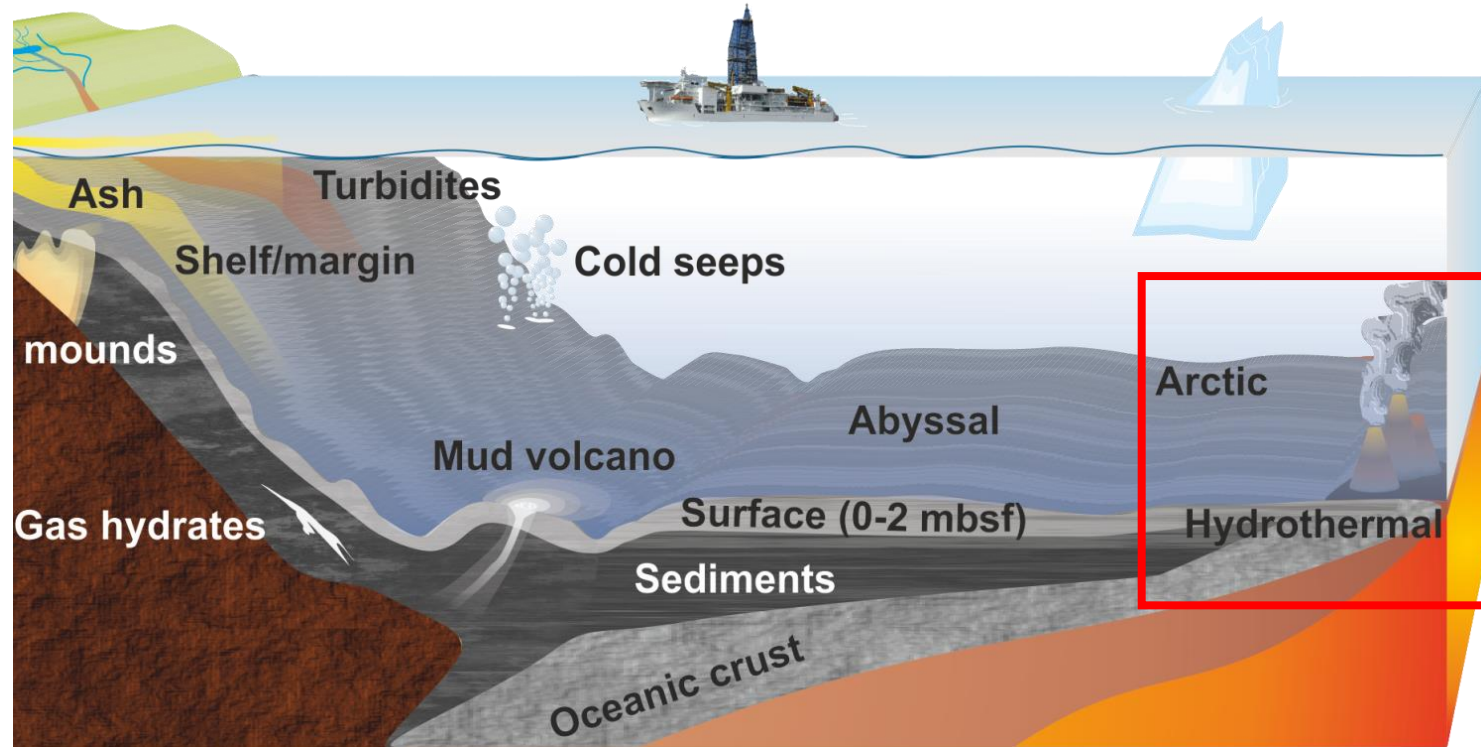


Characterizing two different ways of DNA replication in *Thermococcus barophilus*

Project supervised by **Didier FLAMENT** and **Rémi DULERMO** at the Laboratory of Biology and Ecology of Deep marine Ecosystems (BEEP)

Logan Mc Teer – 21/01/25 – 3rd year PhD in microbiology – REM meeting 2025

Deep sea hydrothermal vents:



(Parkes *et al.*, 2014. *Marine Geology* 352: 409-425)

- Unstable and dynamic
- Without light nor oxygen
- **Hydrostatic pressure**
- **Fluctuating temperatures**

Hydrothermal fluid $\approx 350^{\circ}\text{C}$



Sea water $\approx 4^{\circ}\text{C}$



- The lab has tools to approach these environmental conditions (P and $T^{\circ}\text{C}$).
- Better understanding of how microbial life is sustained in the abyss.



Biologist

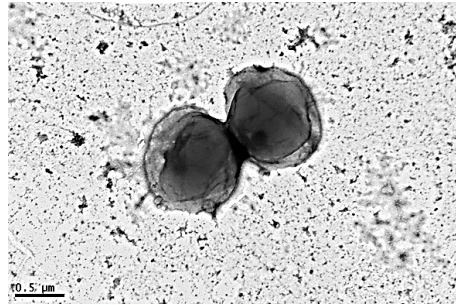


Microbiologist

Molecular
Biologist



Biologist

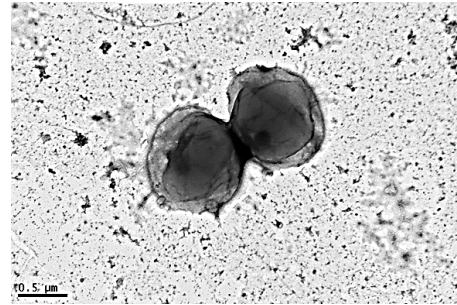


Microbiologist

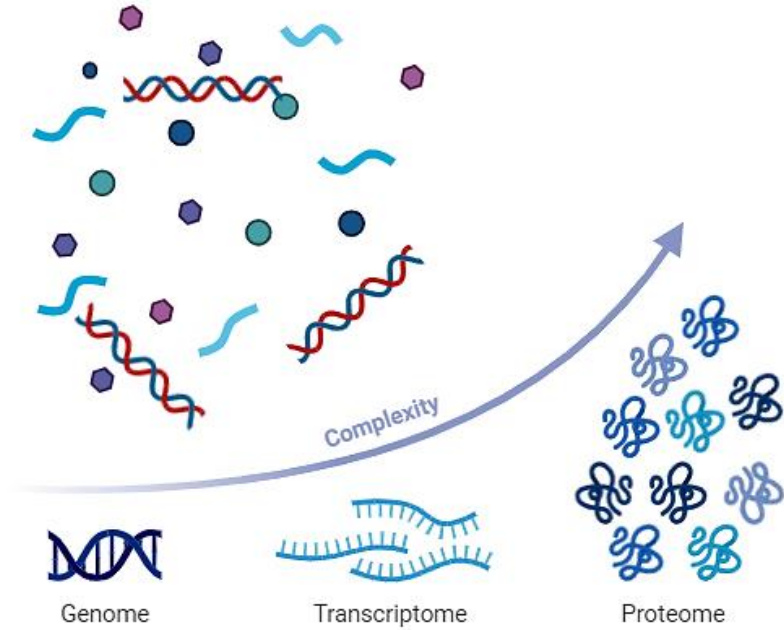
Molecular
Biologist



Biologist



Microbiologist



Molecular
Biologist

PROKARYOTES

EUKARYOTES

BACTERIA

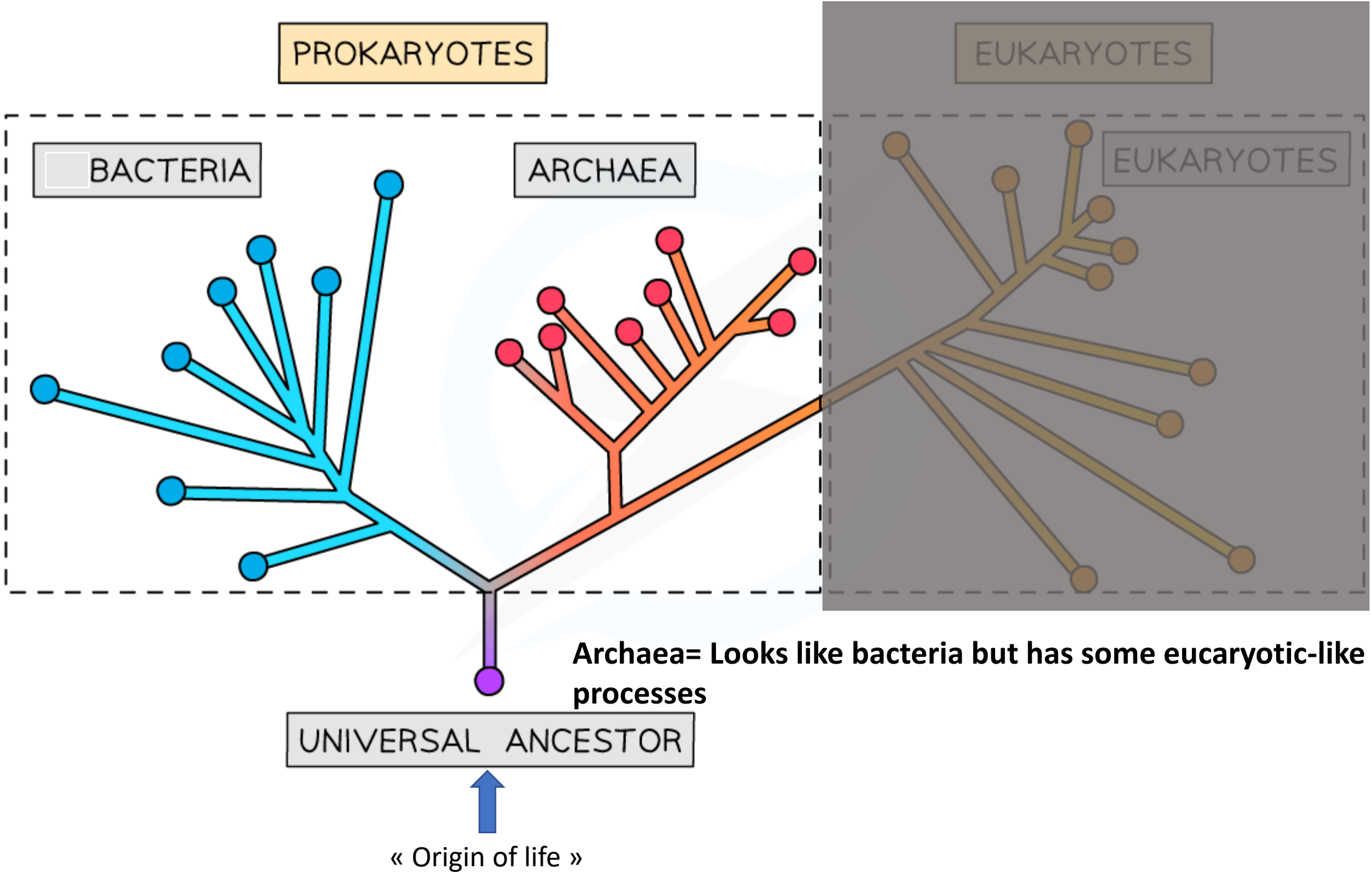
ARCHAEA

EUKARYOTES

UNIVERSAL ANCESTOR

« Origin of life »

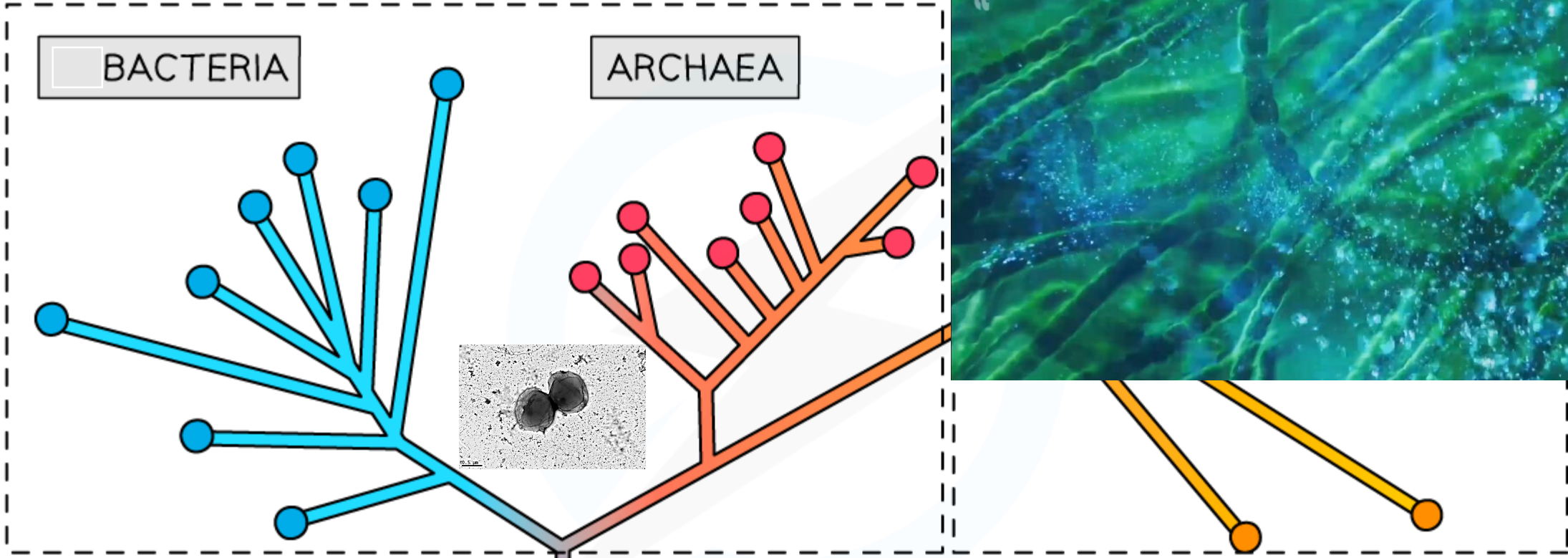
Archaea= Looks like bacteria but has some eucaryotic-like biological processes



PROKARYOTES

BACTERIA

ARCHAEA



UNIVERSAL ANCESTOR

« Origin of life »

Arte: « Les vrais maîtres de la Terre : Les micro-organismes »

Article: Imachi *et al.*, 2020

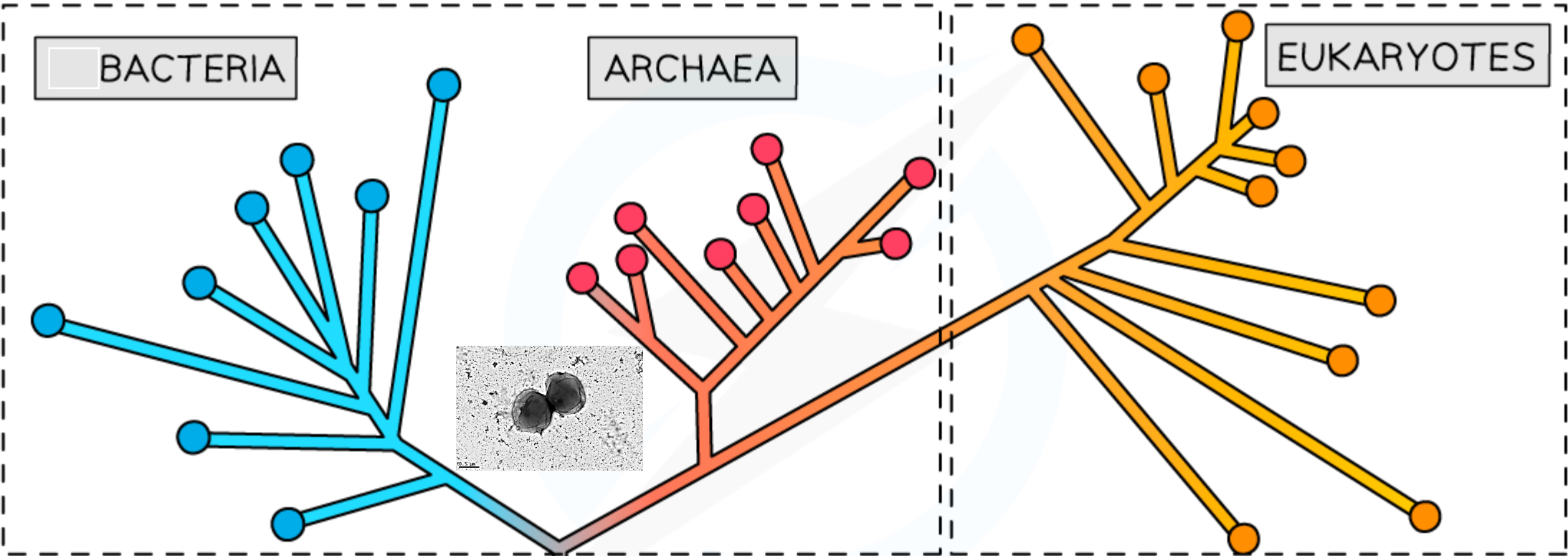
PROKARYOTES

EUKARYOTES

BACTERIA

ARCHAEA

EUKARYOTES



UNIVERSAL ANCESTOR

« Origin of life »

Why deep marine archaea ?

- Simple
- Adaptation to extreme environments (pressure and temperature)
- Study evolution
- Study Eucaryotic-like complex systems

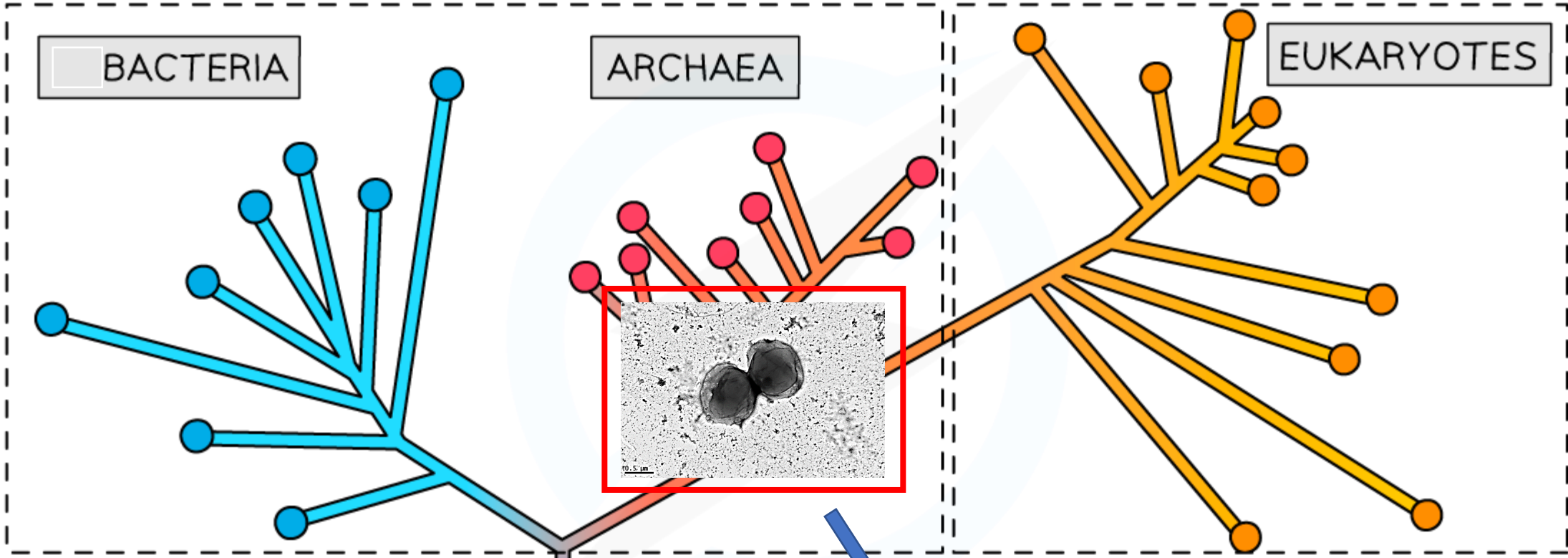
PROKARYOTES

EUKARYOTES

BACTERIA

ARCHAEA

EUKARYOTES



UNIVERSAL ANCESTOR

Thermococcus barophilus 😊

« Origin of life »

Thermococcus barophilus:

-Isolated from a deep-sea hydrothermal vent (Atlantic zone, Snake Pit) (3500 m depth) (Marteinsson *et al.*, 1999).

-**Hyperthermophilic** and **non obligate piezophilic** Archaea.

Thermococcus barophilus:

-Isolated from a deep-sea hydrothermal vent (Atlantic zone, Snake Pit) (3500 m depth) (Marteinsson *et al.*, 1999).

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→ from 48°C to 100°C, **opt. 85°C**.

→ from 0,1 to 85 MPa, **opt. 40 MPa (400 bars) (4'000m under sea level)**.

-**Strict anaerobe**.



Thermococcus barophilus:

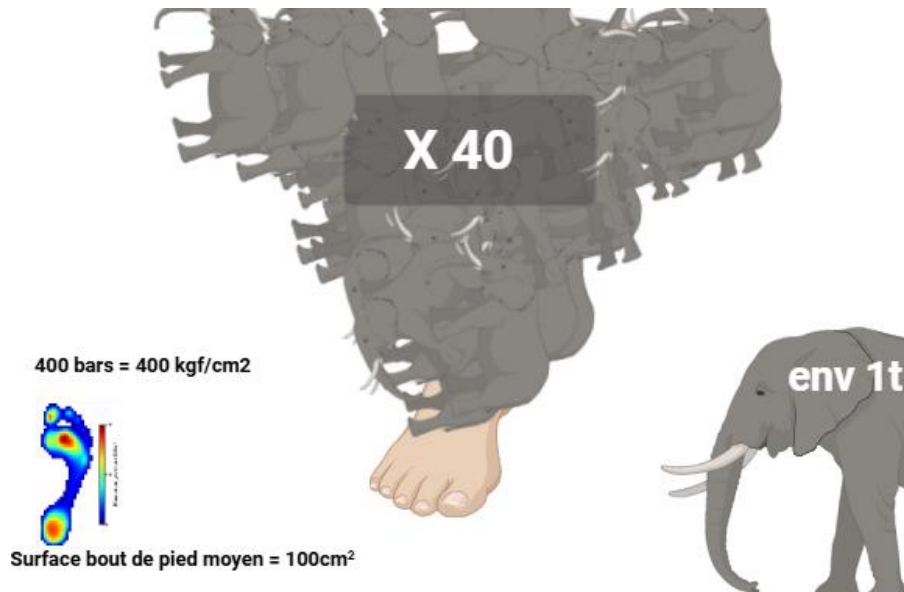
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Thermococcus barophilus:

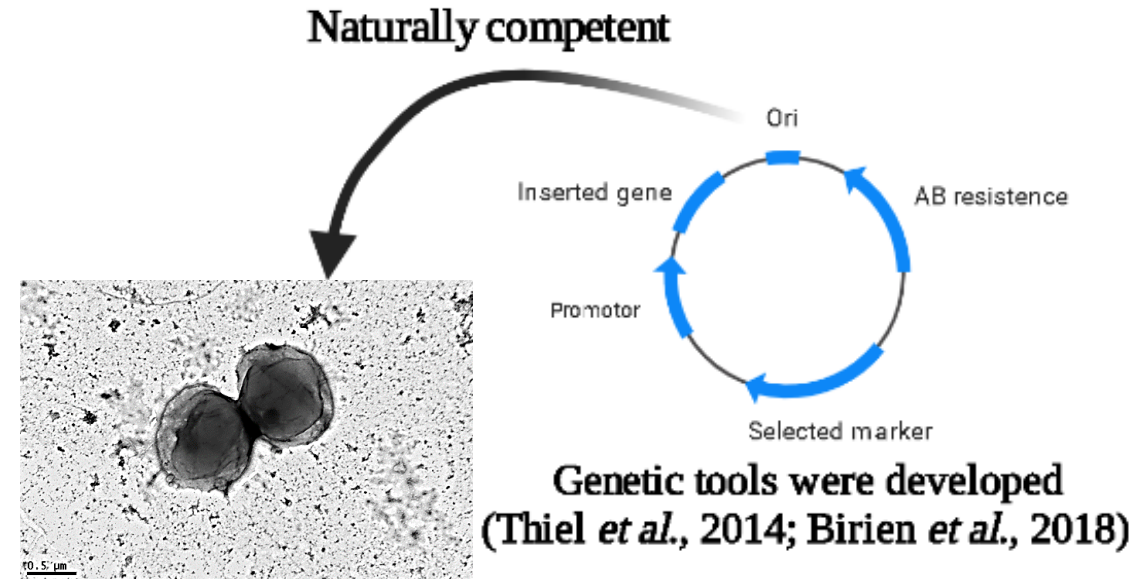
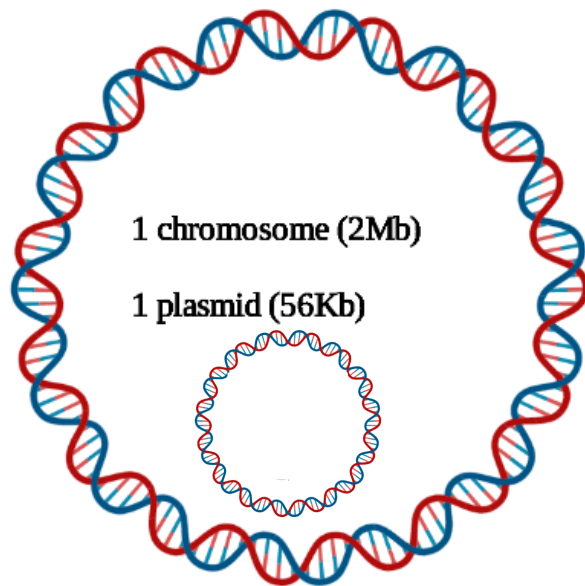
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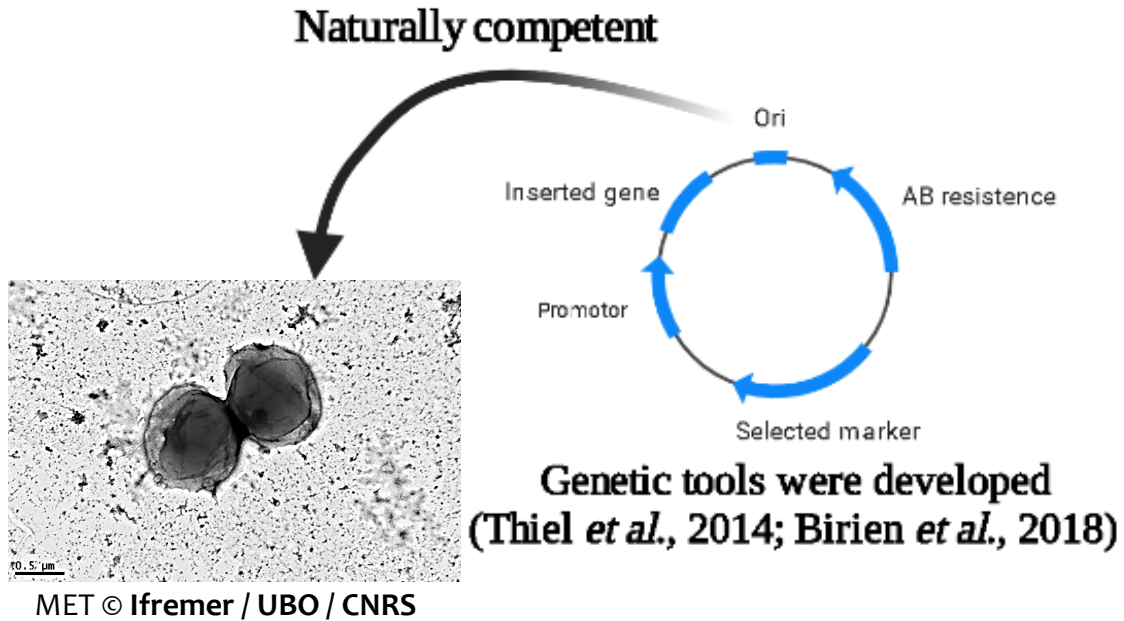
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MET © Ifremer / UBO / CNRS

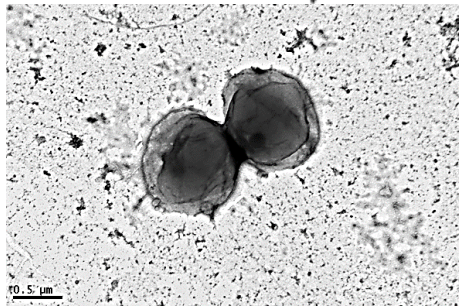
What's a genetic tool and why ?



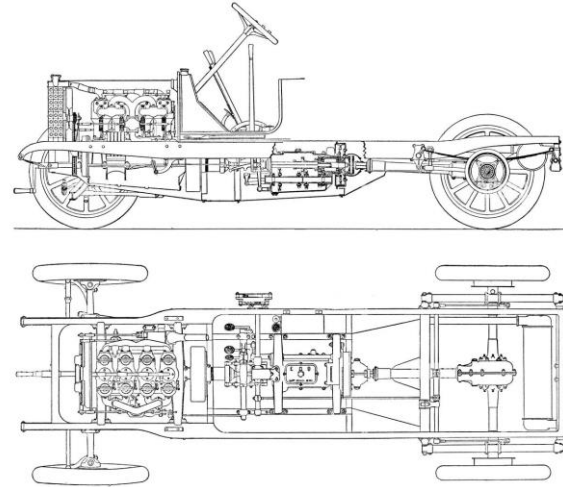
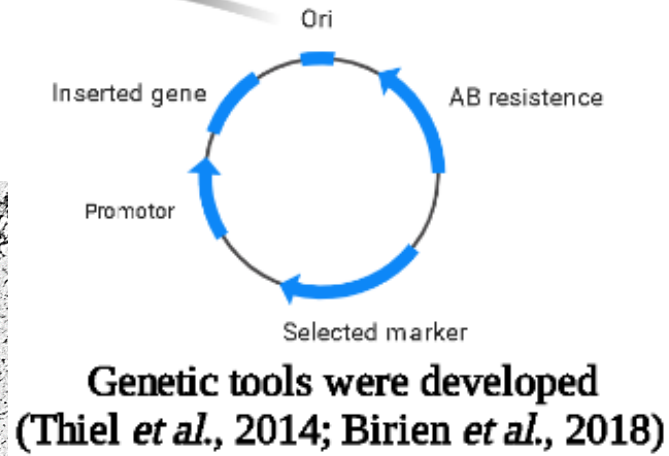
Thermococcus barophilus

What's a genetic tool and why ?

Naturally competent



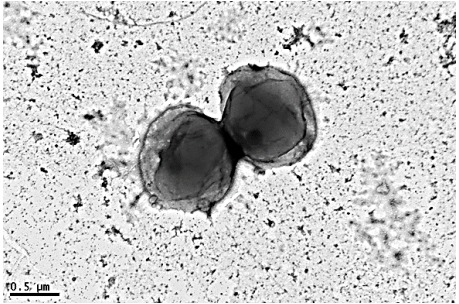
MET © Ifremer / UBO / CNRS



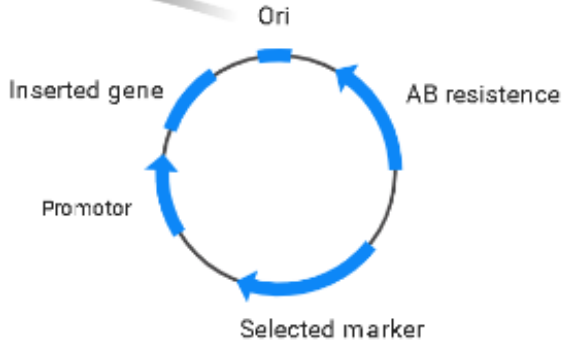
Thermococcus barophilus

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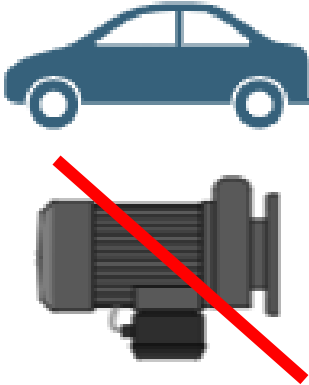
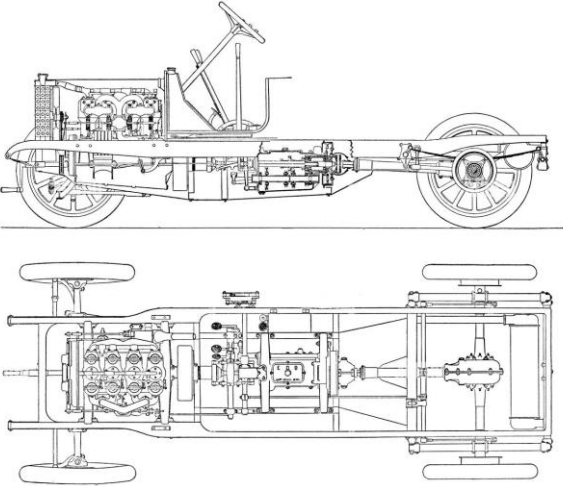
Naturally competent



MET © Ifremer / UBO / CNRS



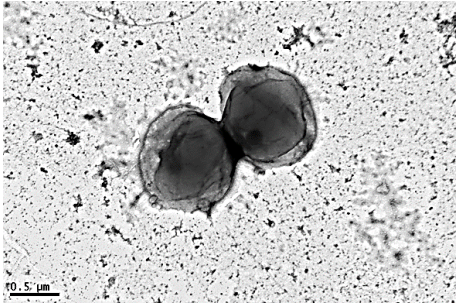
Genetic tools were developed
(Thiel *et al.*, 2014; Birien *et al.*, 2018)



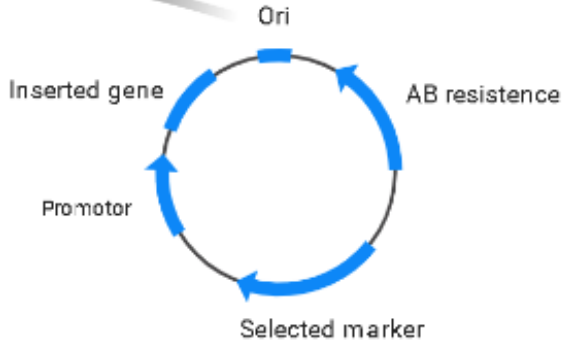
Thermococcus barophilus

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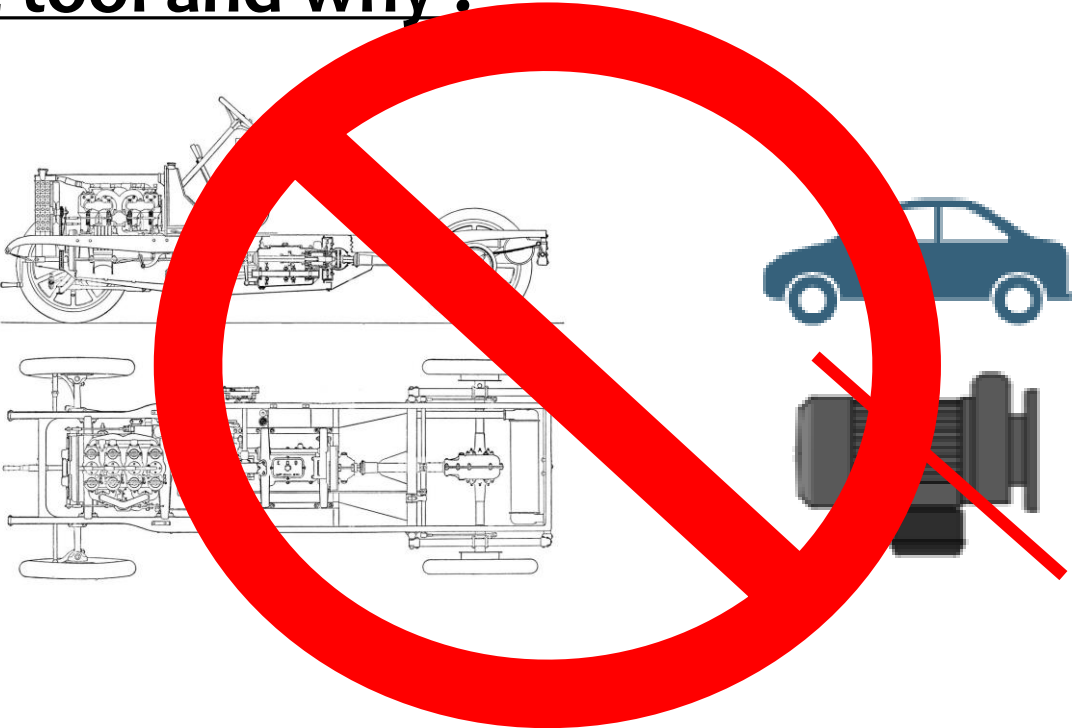
Naturally competent



MET © Ifremer / UBO / CNRS



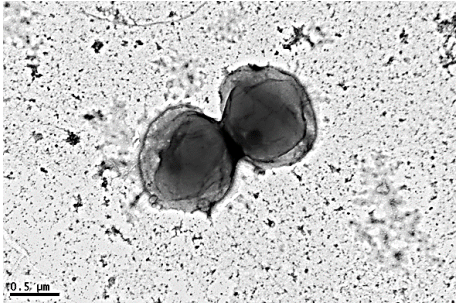
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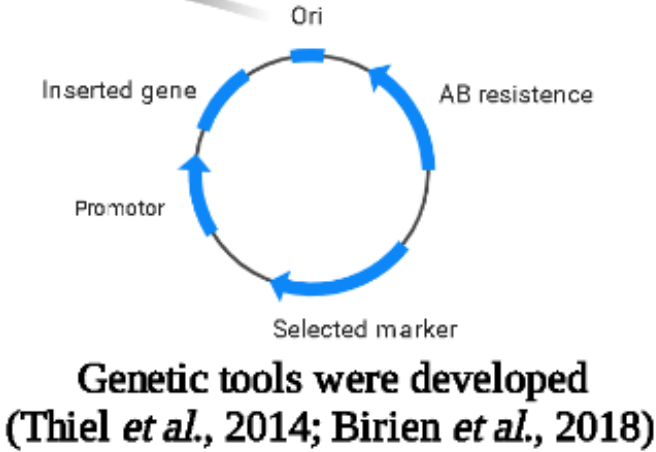
Thermococcus barophilus

What's a genetic tool and why ?

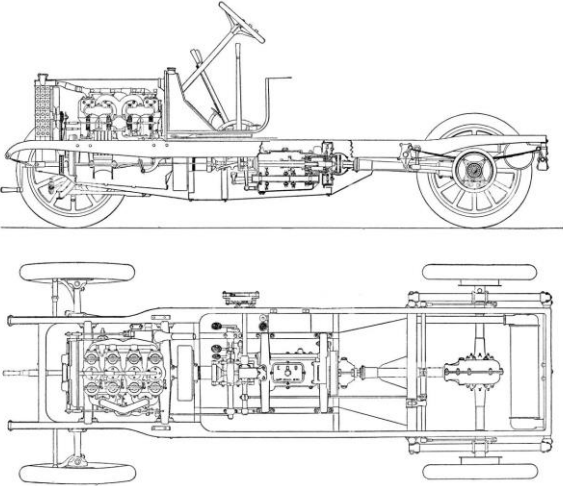
Naturally competent



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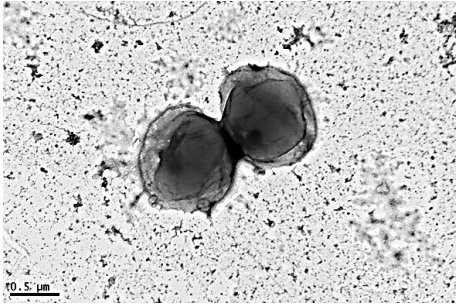
Genetic tools were developed
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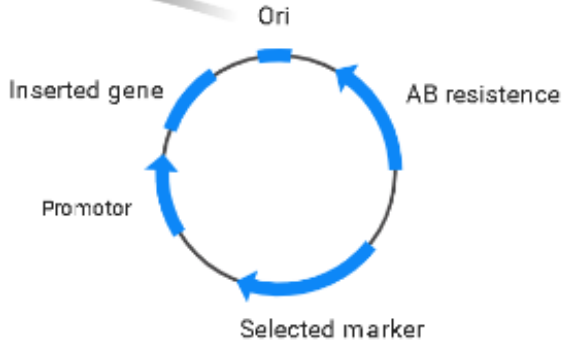
Thermococcus barophilus

What's a genetic tool and why ?

Naturally competent

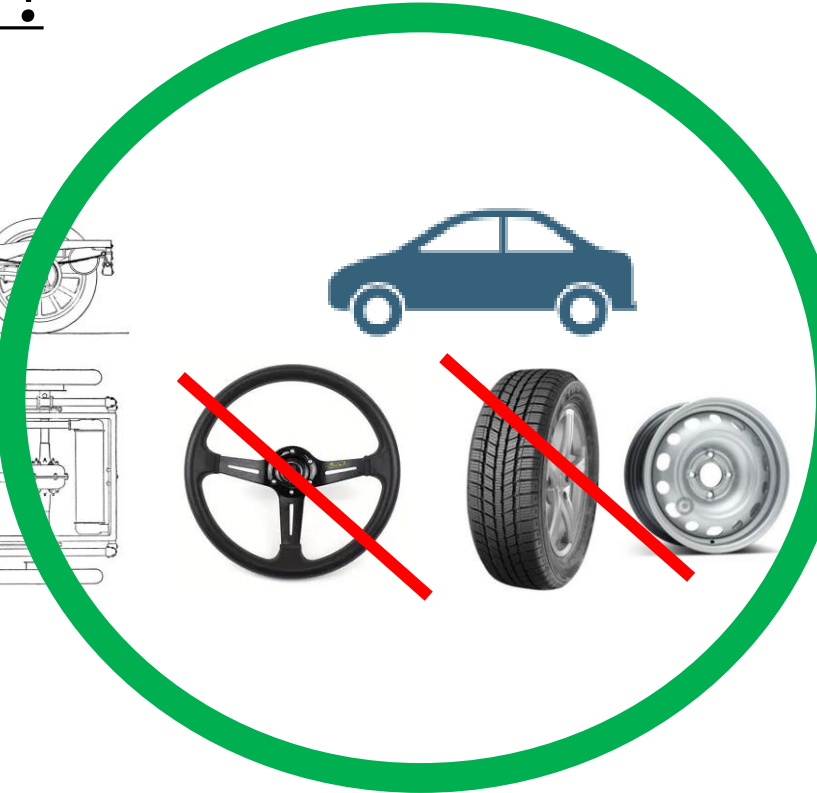
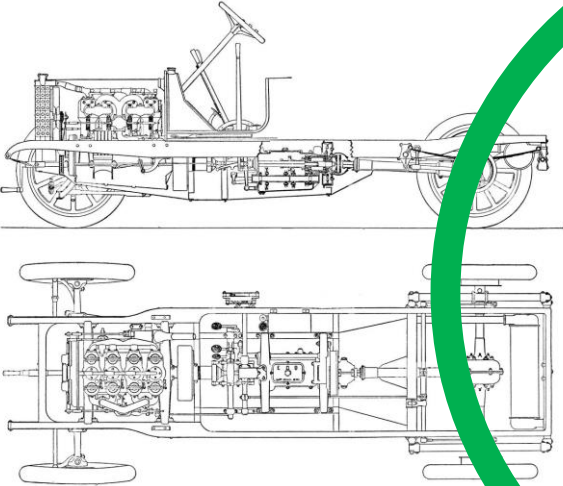


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Genetic tools were developed
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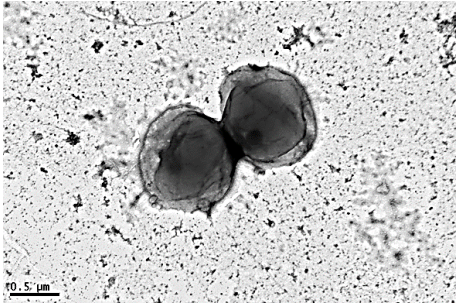
Thermococcus barophilus



OK... under conditions 😊

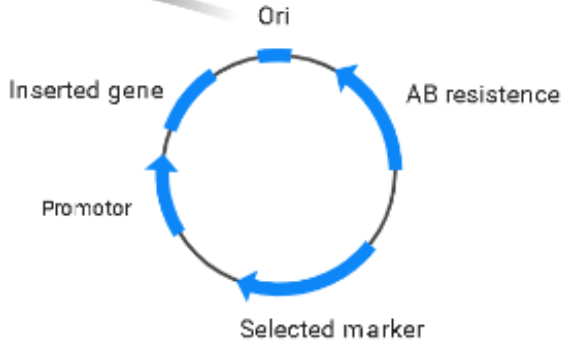
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Naturally competent



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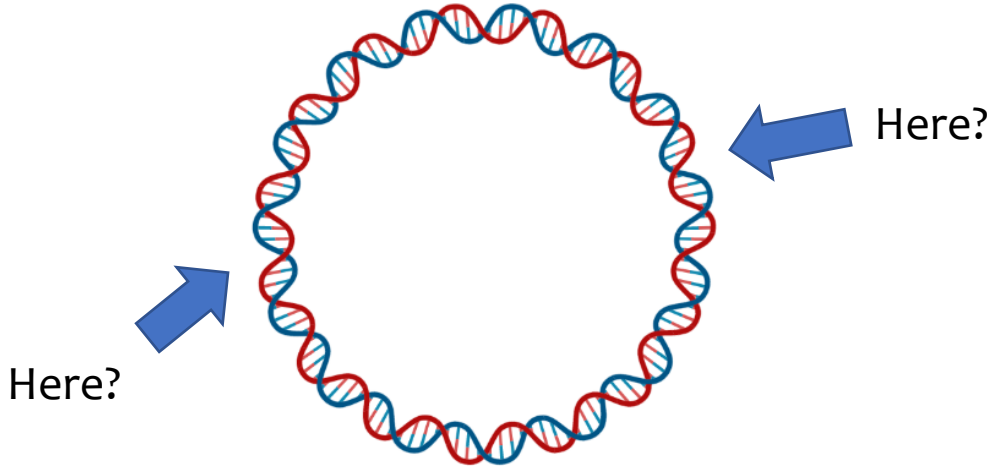
Thermococcus barophilus

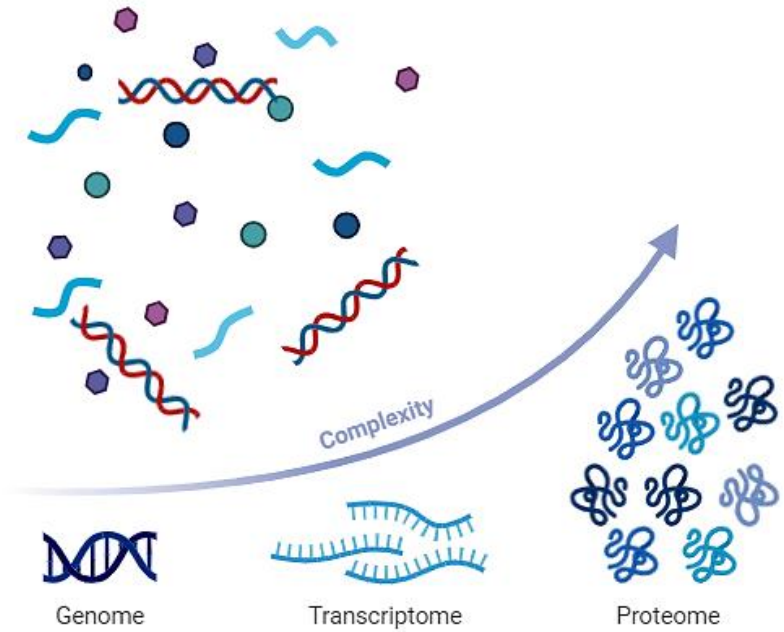
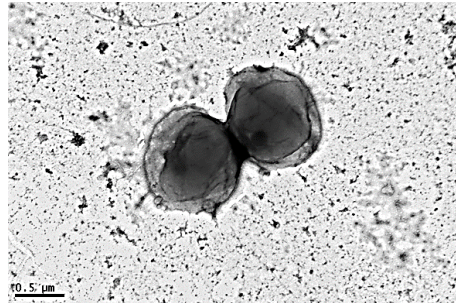


Genetic tools were developed
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Mutant = missing gene somewhere





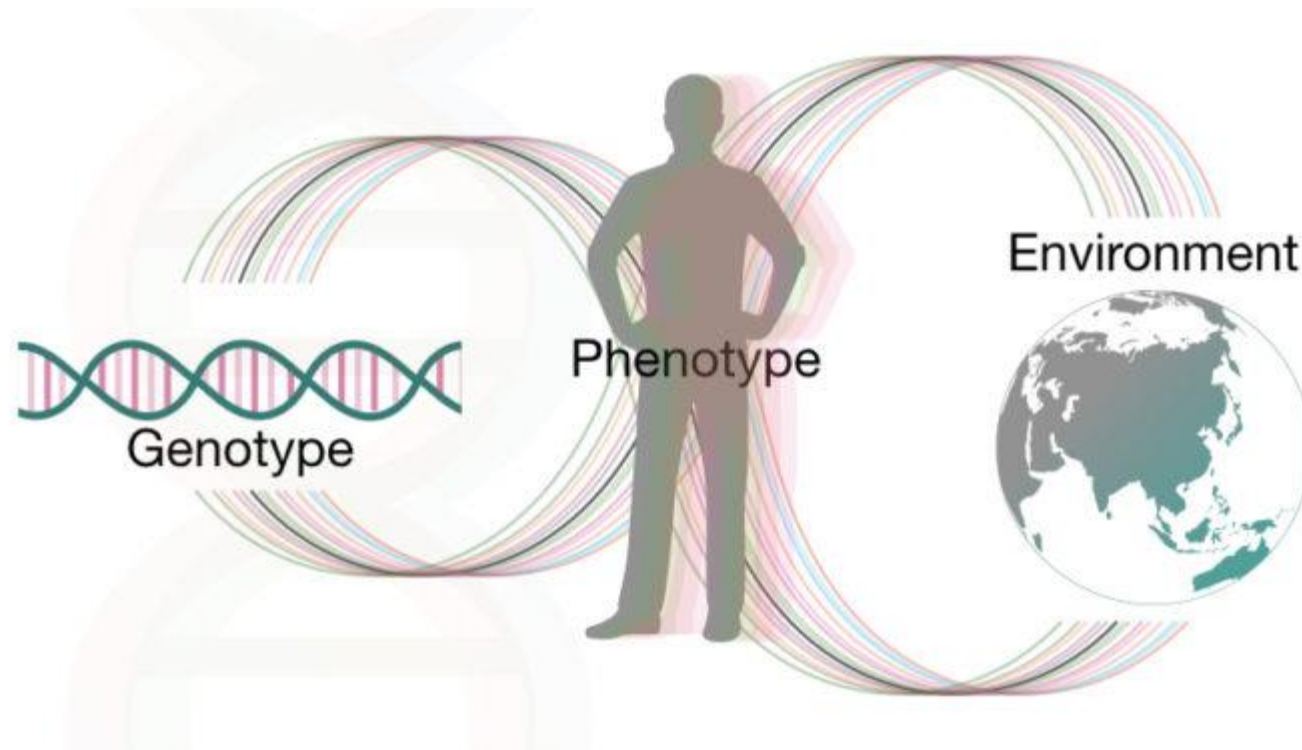
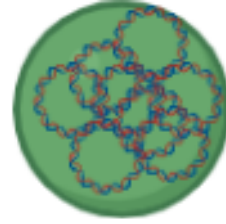
GENOMIC MAINTENANCE 😊

Biologist

Microbiologist

Molecular
Biologist

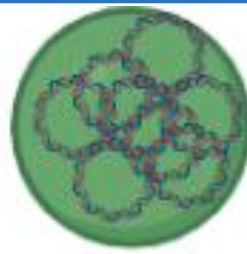
Genomic maintenance



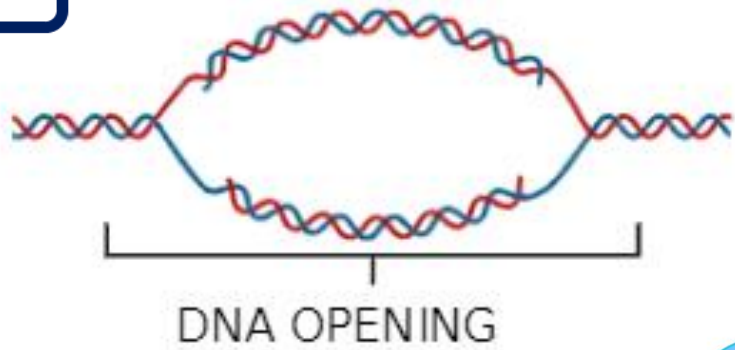
And adaptation...

Example : Deep Hydrothermal vents

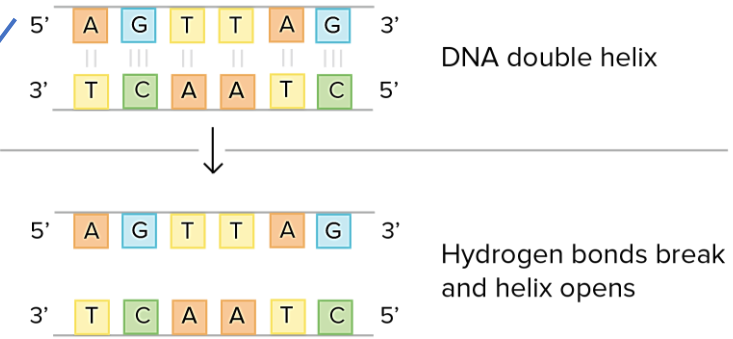
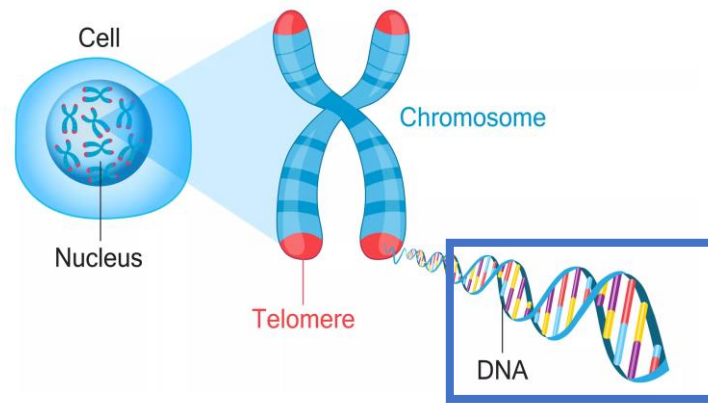
Genomic maintenance



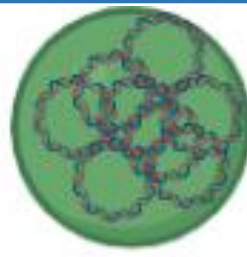
1 "Classic" REPLICATION



Fundamental and conserved process

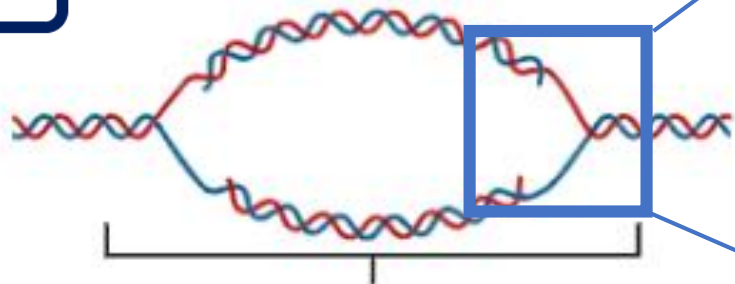


Genomic maintenance

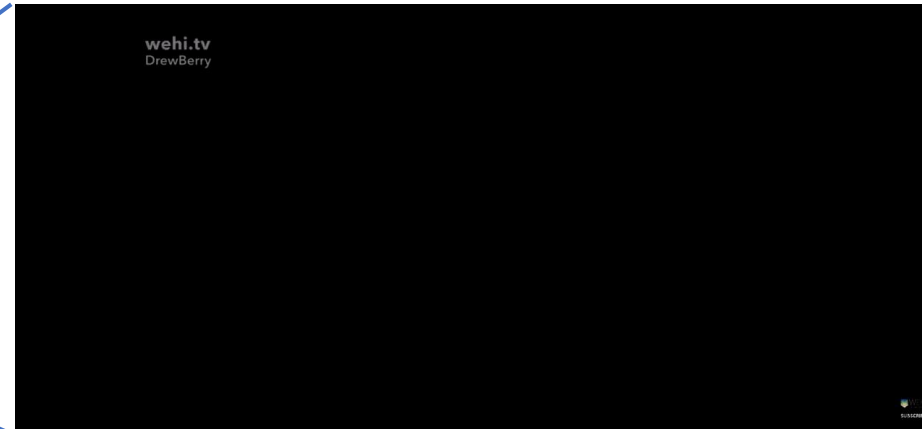


1

"Classic" REPLICATION



DNA OPENING



Fundamental and conserved process



This is happening in you !



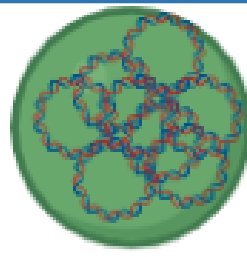
1 genome copy

=

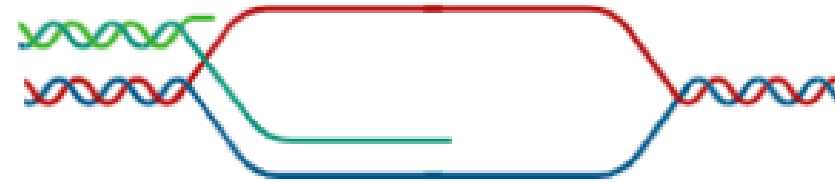


2 genome copies

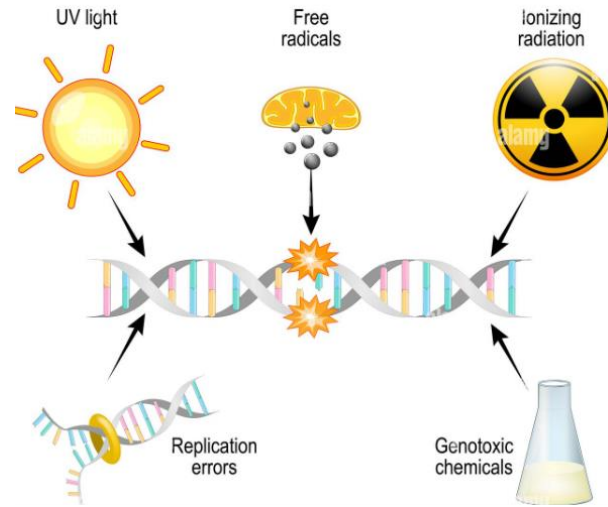
Genomic maintenance



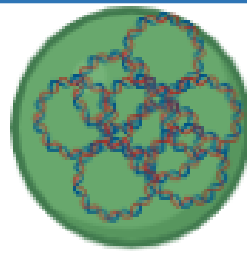
REPAIR (HR)



DNA damage



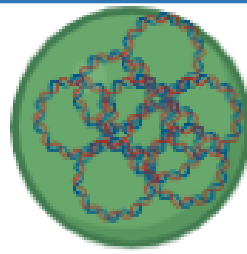
Genomic maintenance



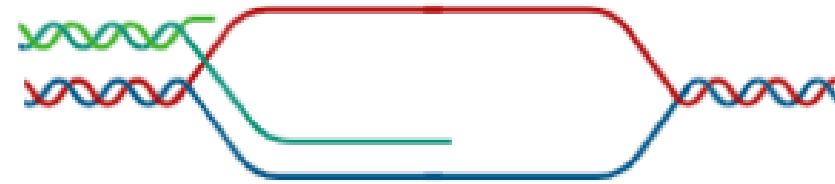
REPAIR (HR)



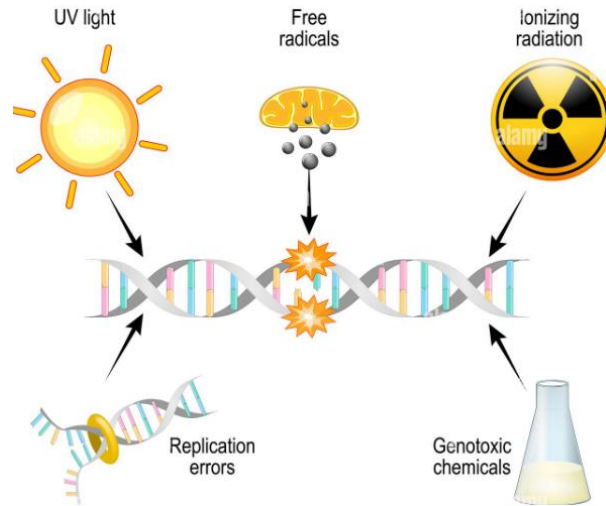
Genomic maintenance



REPAIR (HR)



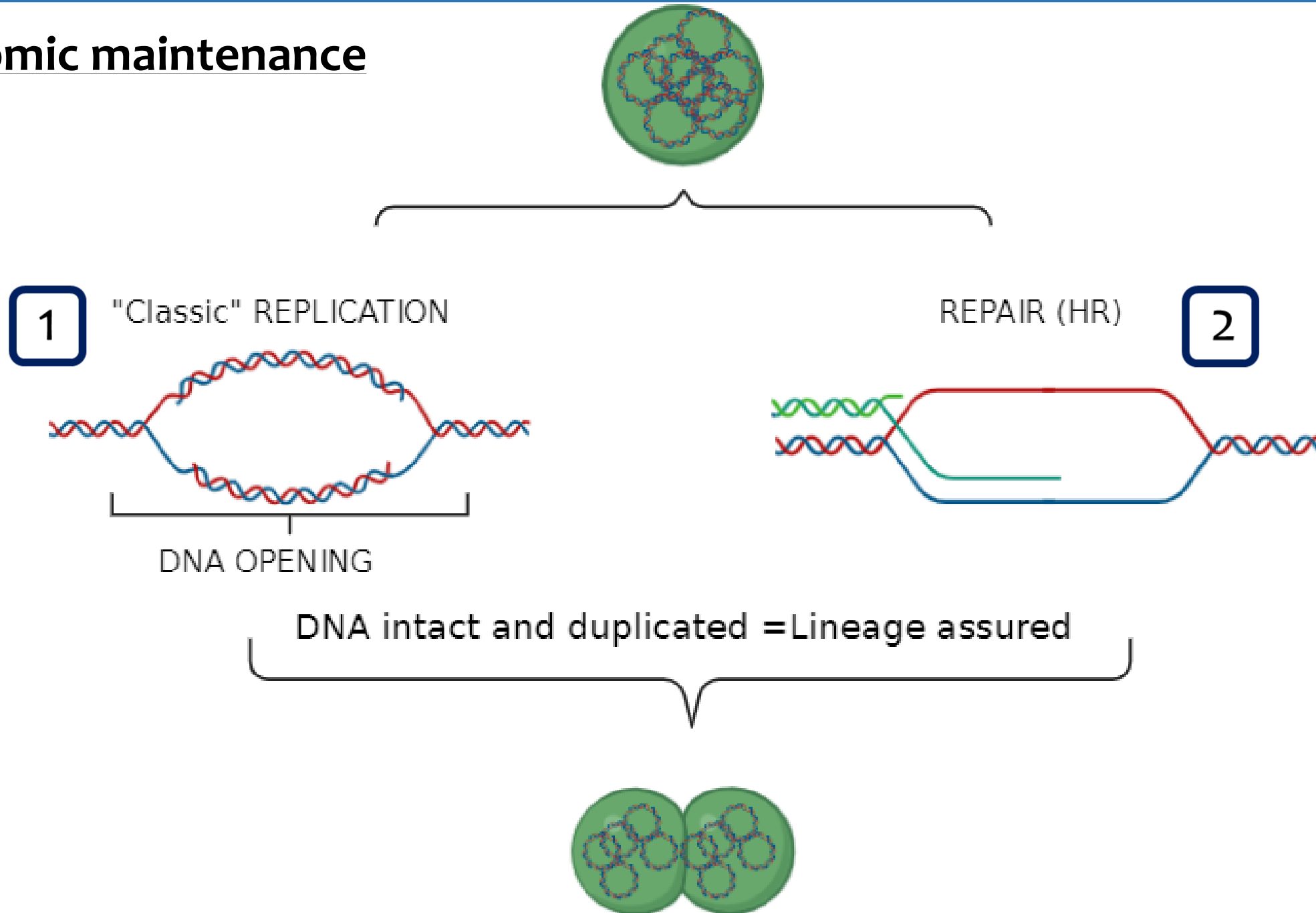
DNA damage



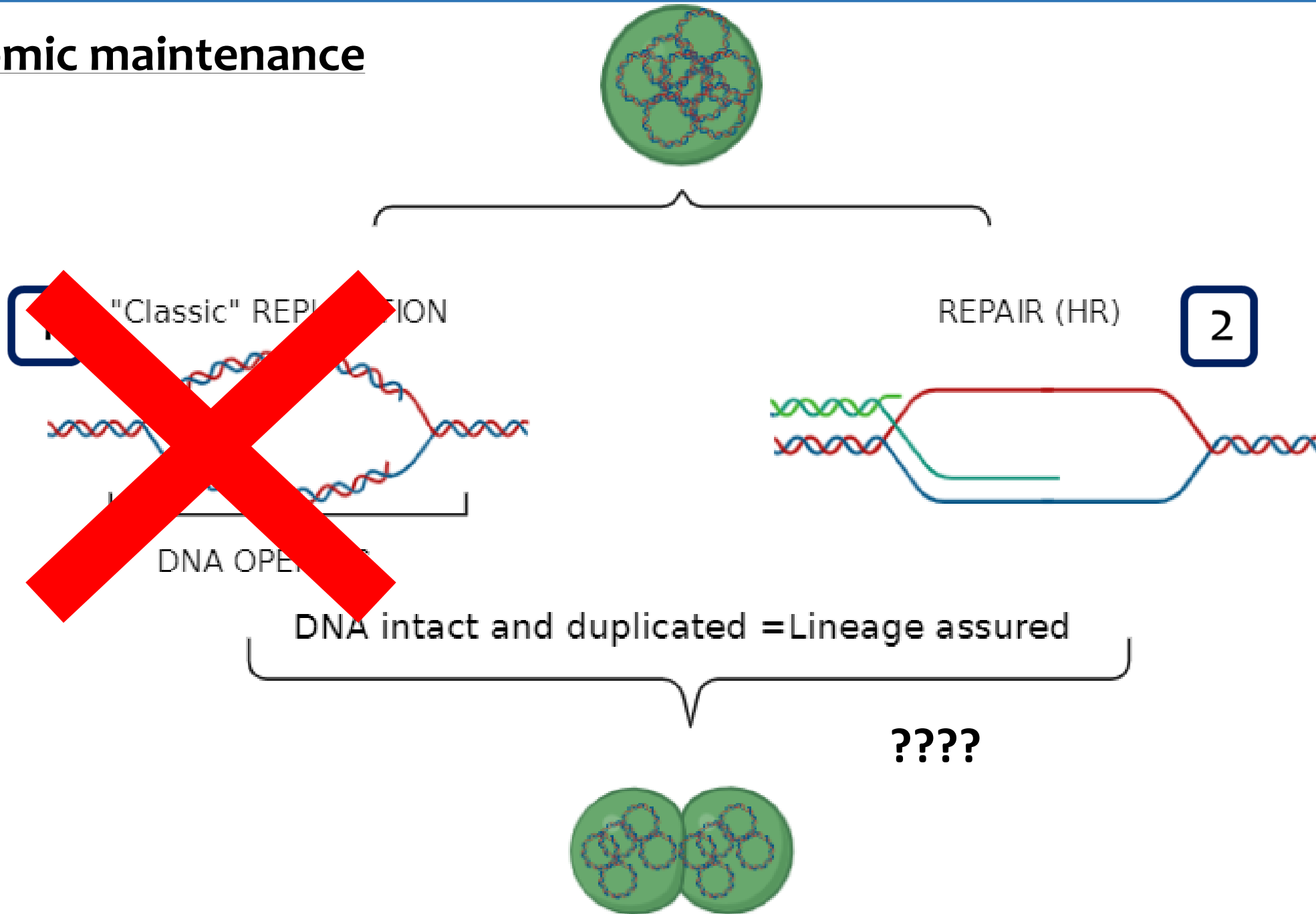
T°C variations
P variations
pH variations

Etc..

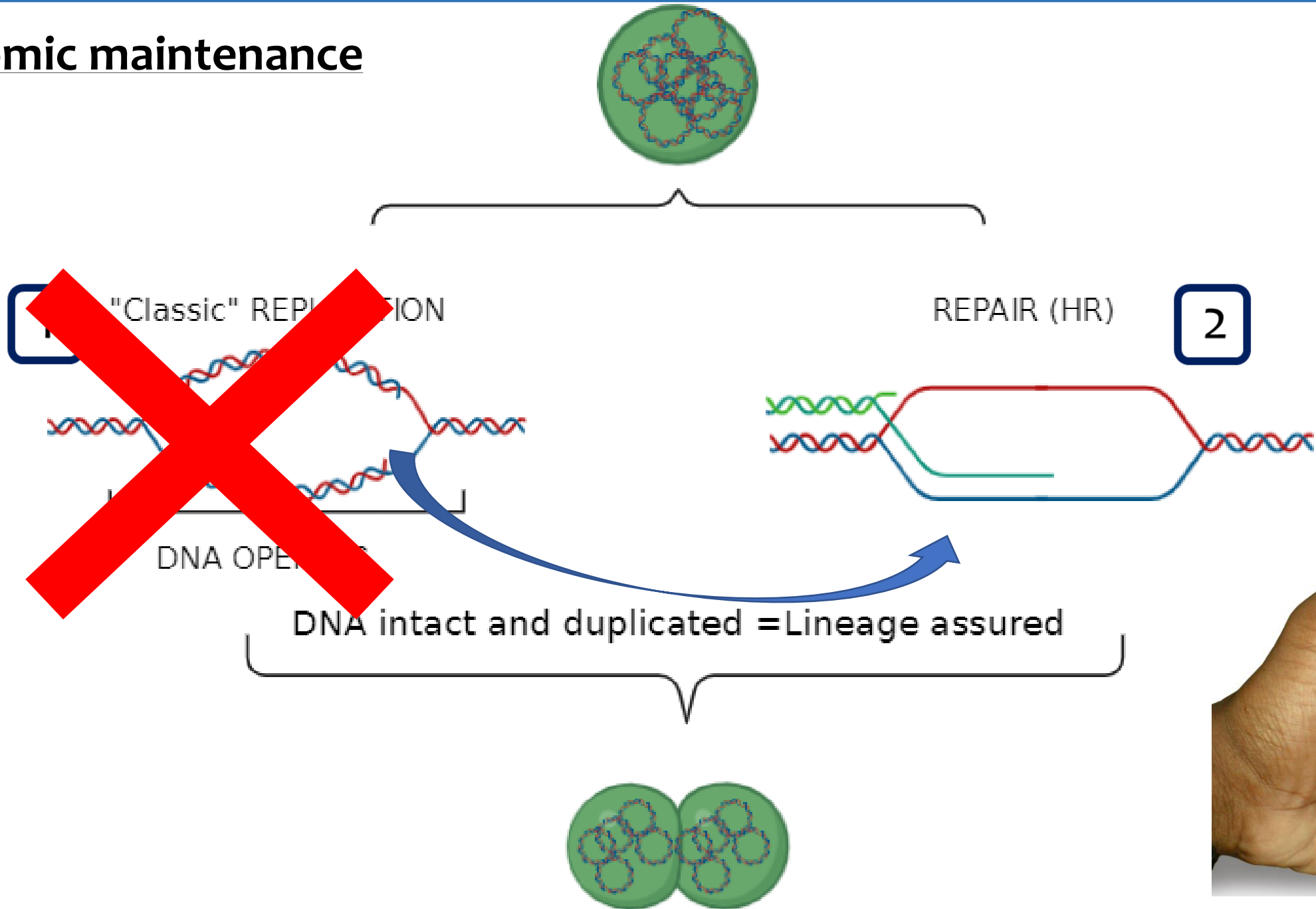
Genomic maintenance



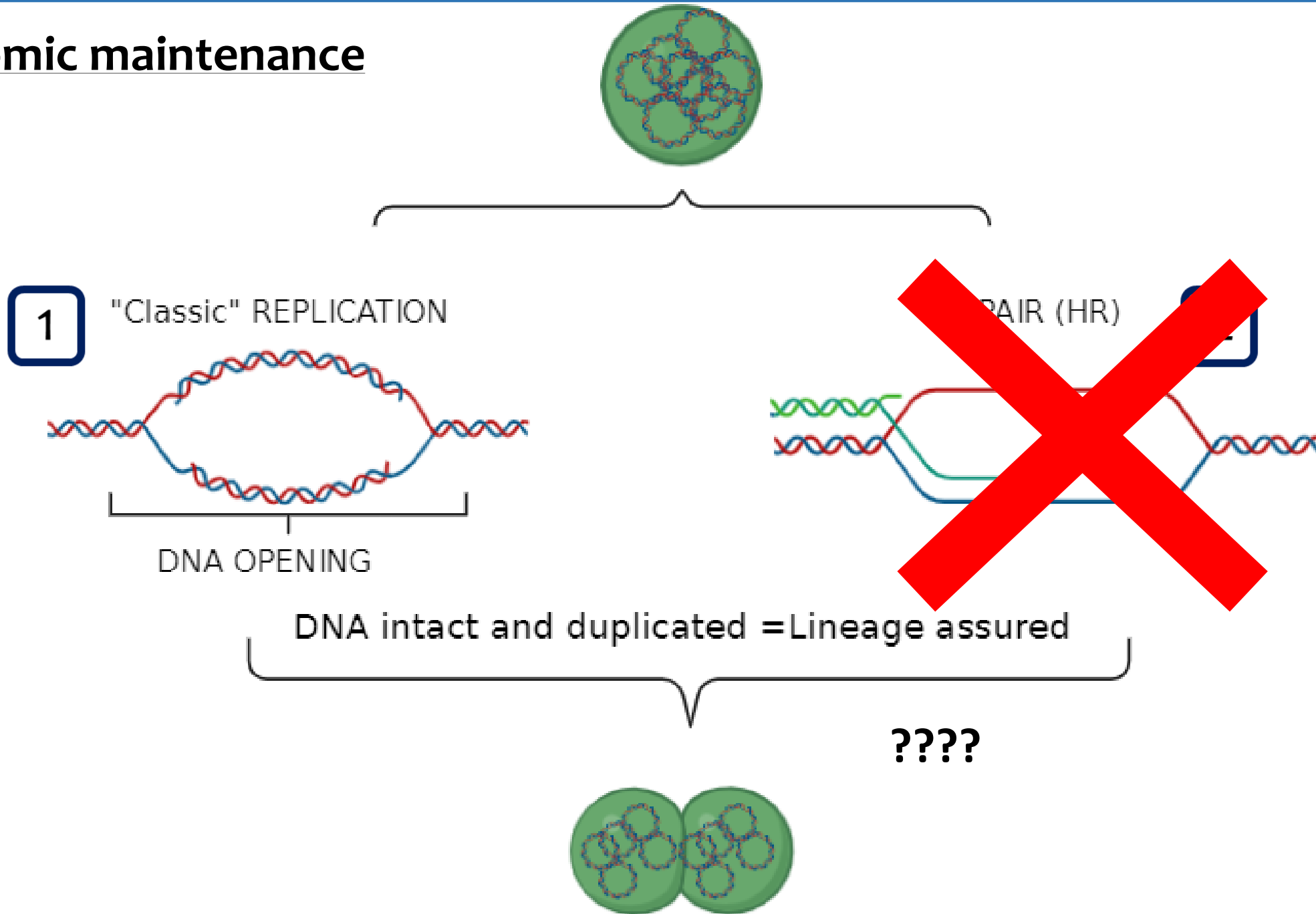
Genomic maintenance



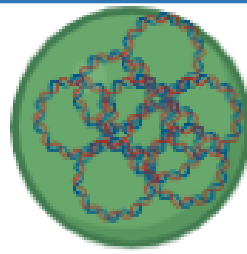
Genomic maintenance



Genomic maintenance

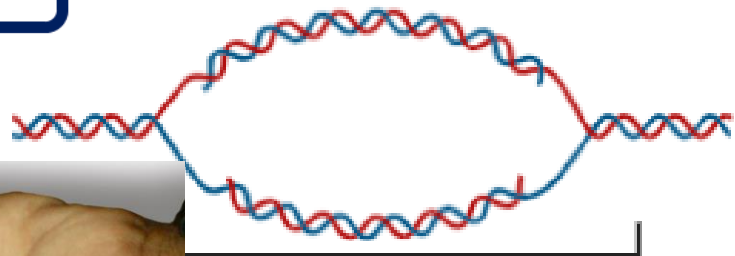


Genomic maintenance



1

"Classic" REPLICATION

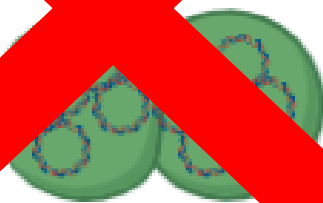


DNA OPENING

PAIR (HR)

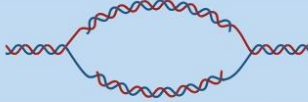




DNA intact and duplicated = lineage assured



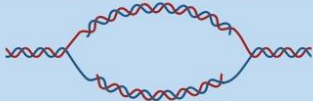




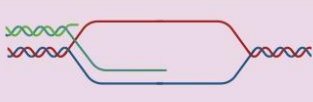
Main findings

"Cooperation of 2 modes for DNA replication - *Thermococcus barophilus*"

Genetic strain	Mode	Viability (85°C P.atm)
Reference (genetic tool)	1 	
	2 	

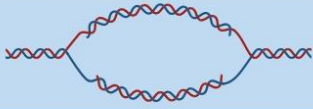




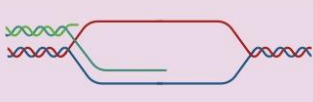

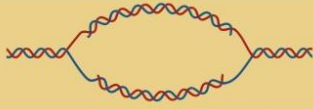


Main findings

"Cooperation of 2 modes for DNA replication - *Thermococcus barophilus*"

Genetic strain	Mode	Viability (85°C P.atm)
Reference (genetic tool)	1 	
	2 	
No classic REPLICATION	1 	
	2 	

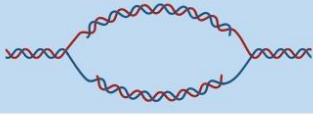

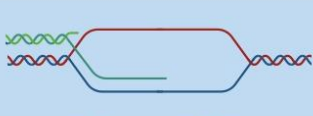


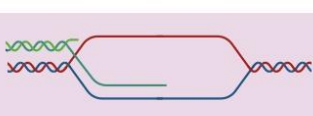
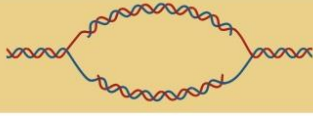





Main findings

"Cooperation of 2 modes for DNA replication - *Thermococcus barophilus*"

Genetic strain	Mode	Viability (85°C P.atm)
Reference (genetic tool)	1 	
	2 	
No classic REPLICATION	1 	
	2 	
Less REPAIR 	1 	
	2 	

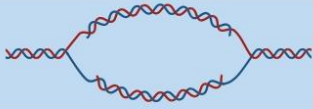


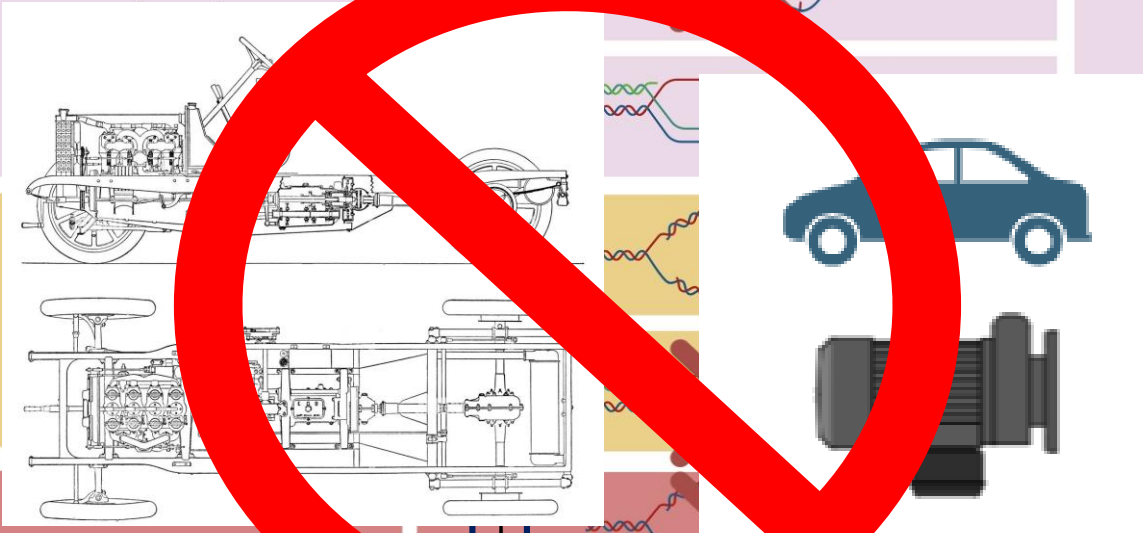
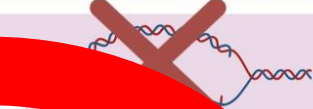

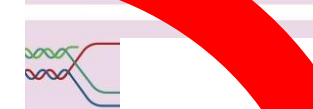





Main findings

"Cooperation of 2 modes for DNA replication - *Thermococcus barophilus*"

Genetic strain	Mode	Viability (85°C P.atm)
Reference (genetic tool)	1 	
	2 	
No classic REPLICATION	1 	
	2 	
Less REPAIR	1 	
	2 	
Double mutant	1 	
	2 	

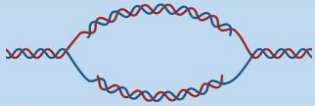





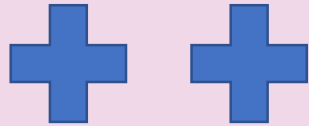

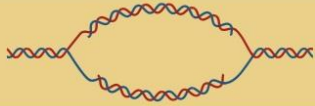






Main findings

"Cooperation of 2 modes for DNA replication - *Thermococcus barophilus*"

Genetic strain	Mode	Viability (85°C P.atm)
Reference (genetic tool)	1 	
	2 	
 Double mutant		
		
		
		

Main findings

"Cooperation of 2 modes for DNA replication - *Thermococcus barophilus*"

Genetic strain	Mode	Viability (85°C P.atm)	Growth (85°C; 40MPa)
Reference (genetic tool)	1 		
	2 		
No classic REPLICATION	1 		
	2 		
Less REPAIR	1 		
	2 		
Double mutant	1 		
	2 		



Cooperation between two modes for DNA replication initiation in the archaeon *Thermococcus barophilus*

Logan Mc Teer,¹ Yann Moalic,^{1,2} Valérie Cueff-Gauchard,¹ Ryan Catchpole,³ Gaëlle Hogrel,¹ Yang Lu,¹ Sébastien Laurent,¹ Marie Hemon,¹ Johanne Aubé,¹ Elodie Leroy,¹ Erwan Roussel,¹ Jacques Oberto,³ Didier Flament,¹ Rémi Dulermo¹

AUTHOR AFFILIATIONS See affiliation list on p. 14.

Paper Materials and Methods:

- *T. barophilus* cultivated at atmospheric pressure (0.1 Mpa) and optimal pressure (40MPa)

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Logan Mc Teer and Yann Moalic contributed equally to this article. Author order was determined alphabetically.

The authors declare no conflict of interest.

See the funding table on p. 14.

R.D. wants to dedicate this work to his mom, Monique Dulermo, who permitted him to become a scientist.

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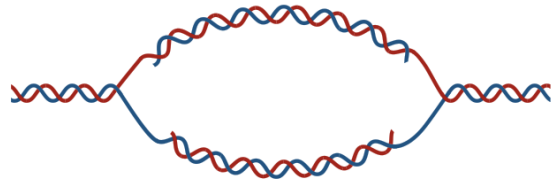
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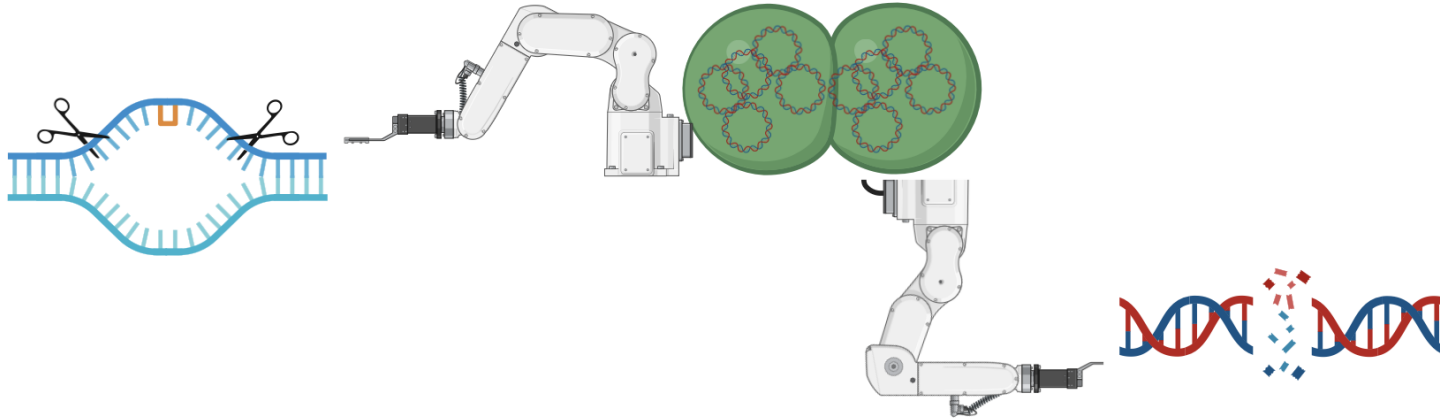


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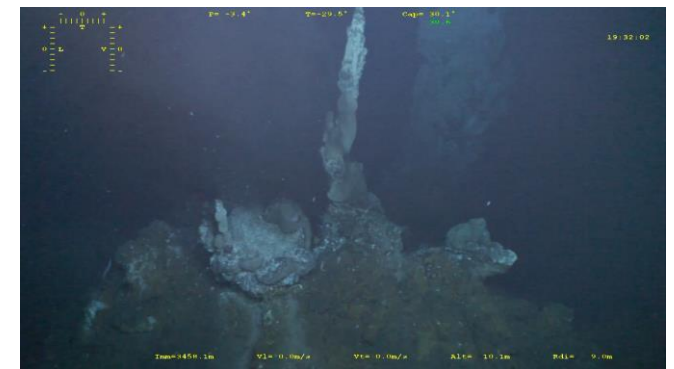
<https://doi.org/10.1128/mbio.03200-23>



Genomic maintenance *Thermococcus barophilus*



- Relies partly/mainly on **REPAIR** system for **REPLICATION** 😊
- Real cooperation of both modes to survive under pressure 😊
- To find out more: adaptation to changing environment and stress (cold, genotoxic, pH...)



@Ifremer 2014 (TAG & Snake Pit)

Thank you for your attention.
Special thanks to ->



Laboratory of Microbiology of the Extreme Environments Ifremer – IUEM

Supervisors: Didier Flament & Remi Dulermo

-Sébastien Laurent



-Mohamed Jebbar



-Yann Moalic



-Erwann Vince



-Erwan Roussel



-Trinetra Mukherjee



-Raphaël Brizard



-Marie Hemon



-Nadège Quintin



-Johanne Aubé



-Stéphane L'Haridon



-Gaëlle Hogrel



-Valérie Cueff-Gauchard



Other affiliations

-Ryan Catchpole



-Jacques Oberto



-Yang Lu



+ Replication team
(sorry for ppl not present)→

Advisor: "If you're stuck on a problem, ask your lab mate".

Me and my lab mate:



Thank you for your attention.
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Capsule de thèse – EDSML days 2024

