You Are What You Eat

Bacteria-Eukaryote Horizontal Gene Transfer (HGT): the Gene Transfer Ratchet Model

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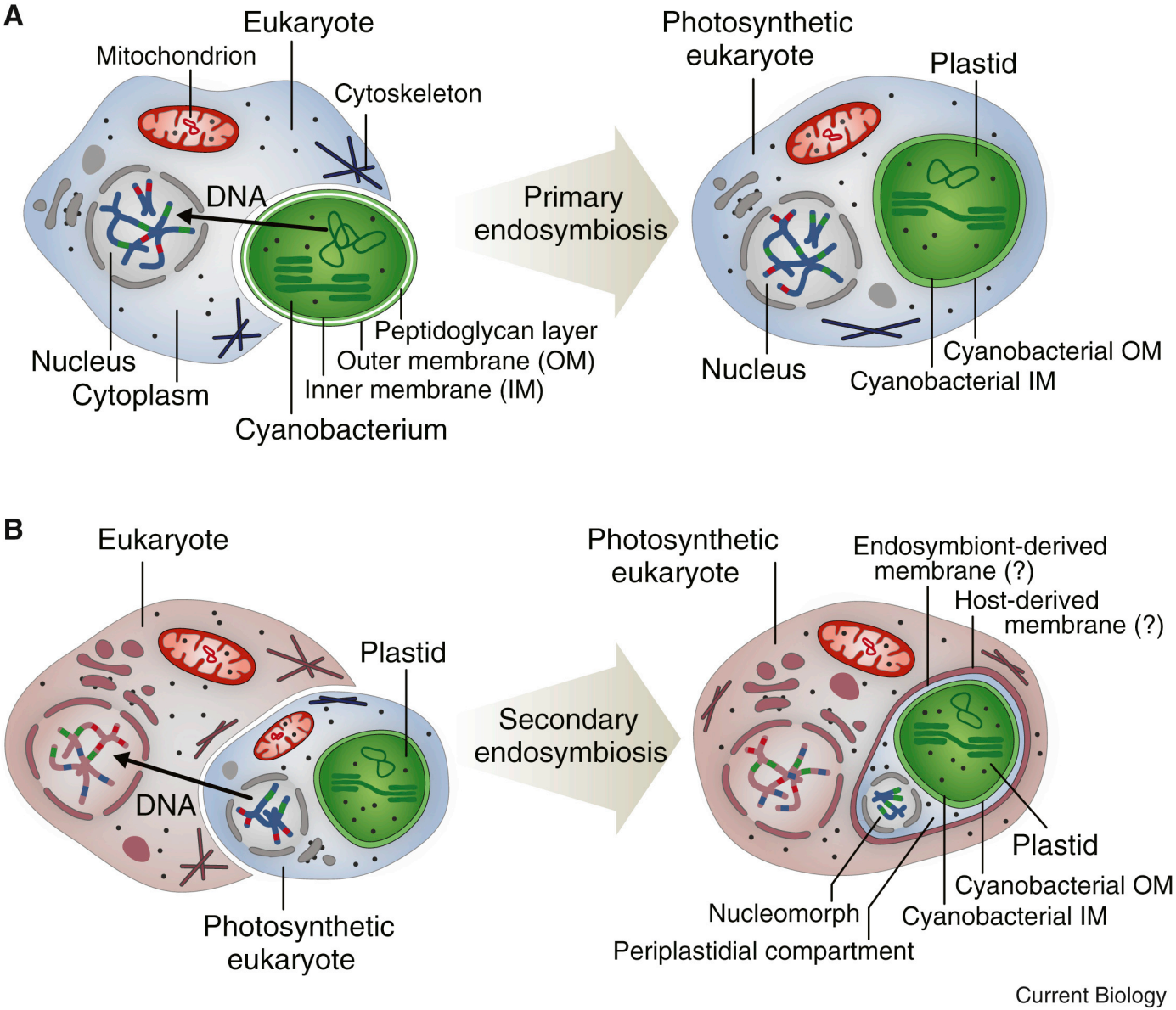
What's Brought?

1. Endosymbiosis
2. Bacteria-Eukaryote Horizontal Gene Transfer
3. The Gene Transfer Ratchet
4. Functions and Functionalization of Transferred DNA

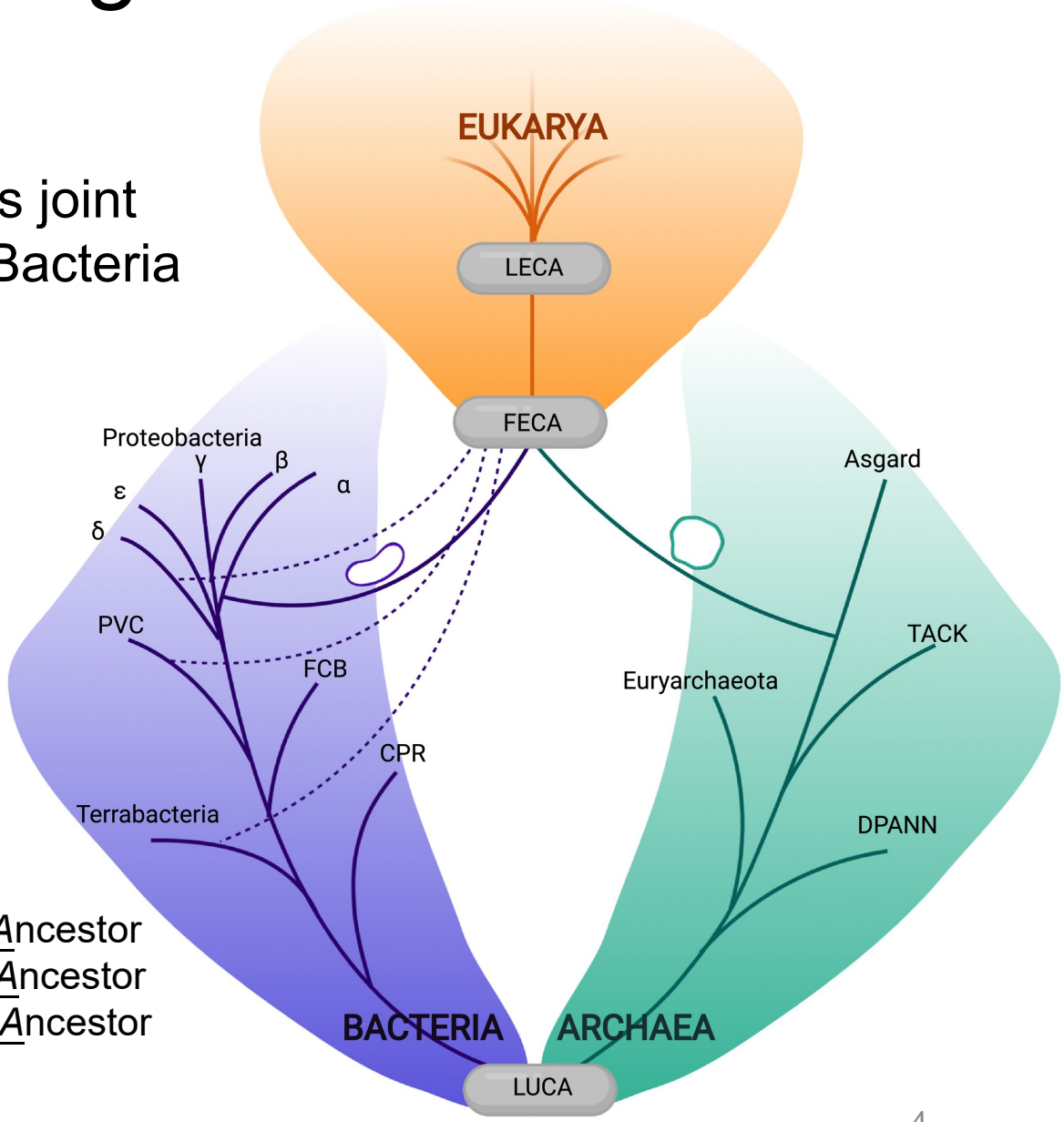
Endosymbiosis



Archibald, John M. *Current Biology* 25.19 (2015): R911-R921.

Phylogenic Tree

Findings: Eukarya shares joint evolutionary ancestors: Bacteria and Archaea



LECA: *L*ast *E*ukaryotic *C*ommon *A*ncestor
FECA: *F*irst *E*ukaryotic *C*ommon *A*ncestor
LUCA: *L*ast *U*niversally *C*ommon *A*ncestor

Nobs, Stephanie-Jane, et al. *Trends in Microbiology* 30.5 (2022): 421-431.

Trends in Microbiology

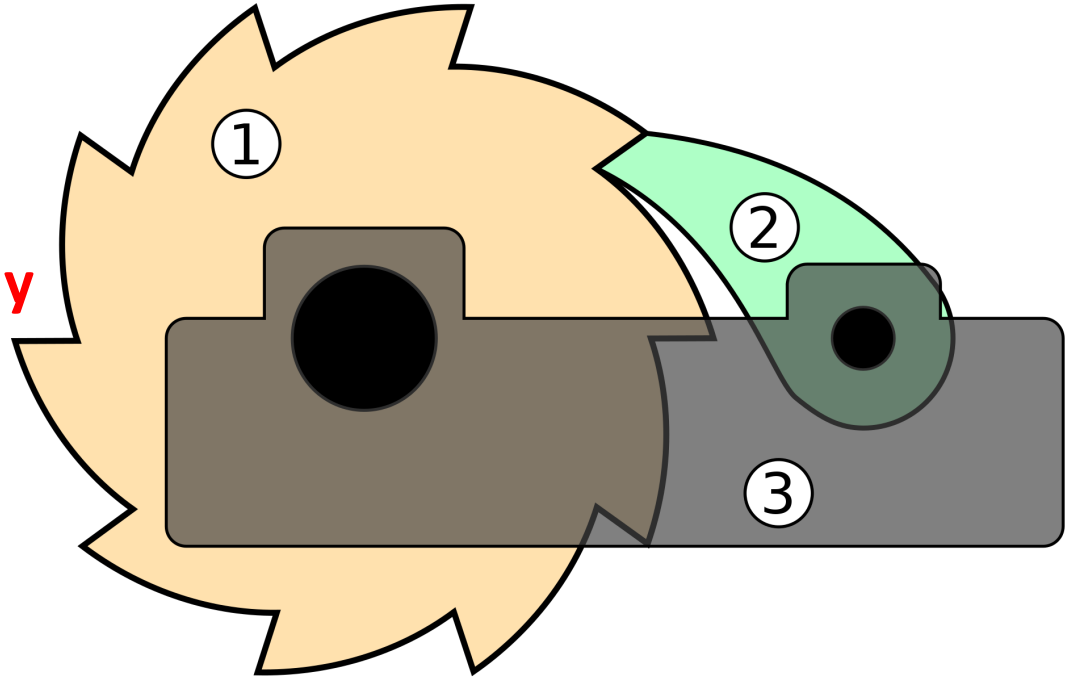
Bacteria-Eukaryote HGT

Horizontal genes transfer (HGT, *aka*. lateral gene transfer): gain of genetic material from other organisms but not parents.

Bacteria-Eukaryote HGT: HGT that occurs from bacteria to eukaryotic cells, regardless of animals, plants, fungi, *etc.*, which is the mostly reported inter-kingdom HGT

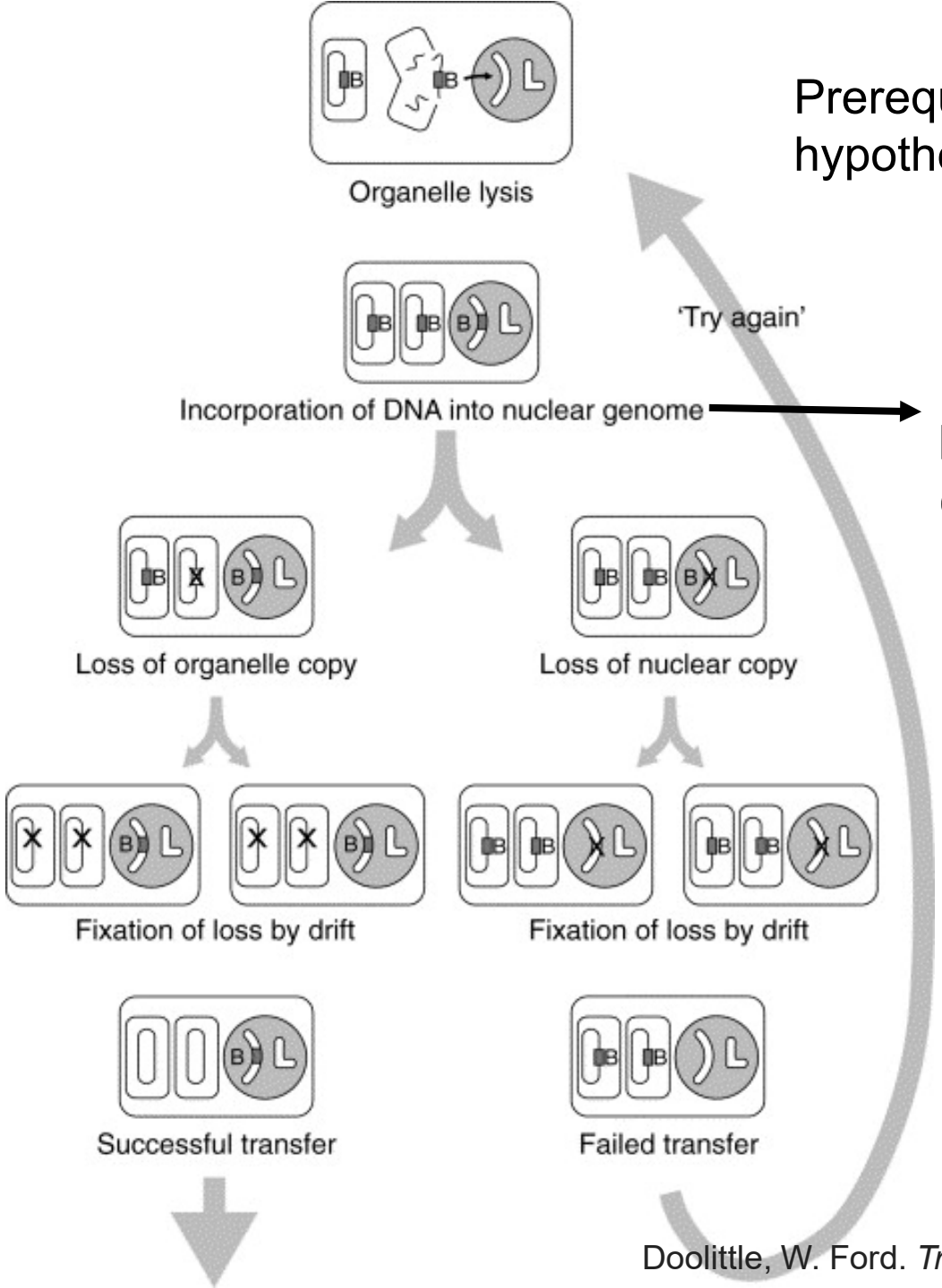
B-E HGT Model: Gene Transfer Ratchet

Outcome: the genes from endosymbionts are **inevitably** transferred to the host genome



"Ratchet" (Img. from Wikipedia)

Doolittle, W. Ford. *Trends in Genetics* 14.8 (1998): 307-311.



Prerequisite: the endosymbiosis hypothesis

Mainly via non-homologous end joining (NHEJ)

Scheme for gene transfer ratchet

Doolittle, W. Ford. *Trends in Genetics* 14.8 (1998): 307-311.

Functionalization of Transferred DNA

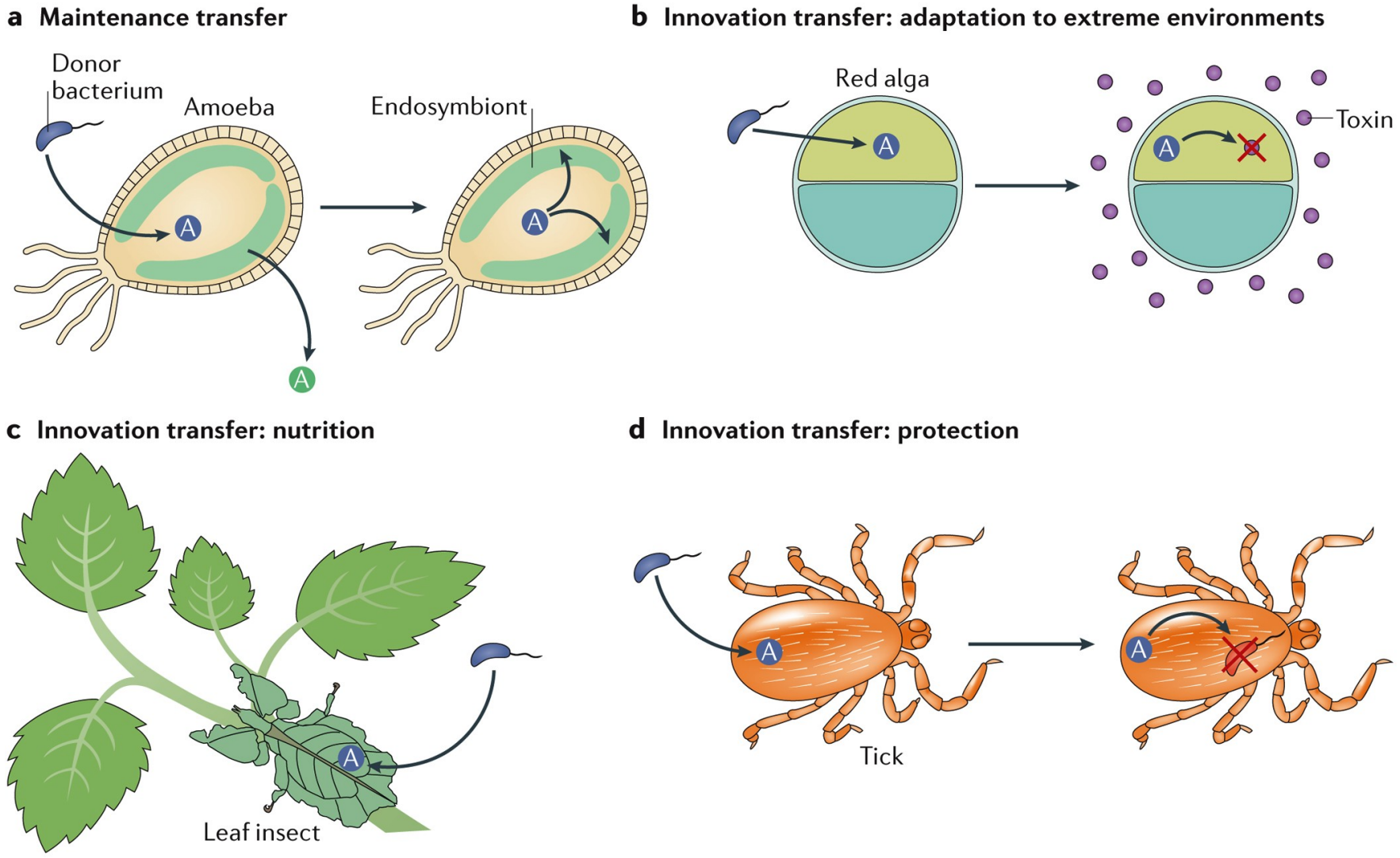
Functionalization: The retaining of functions of transferred genes in the host cells.

Factors for retaining functions:

1. Short but intact inserted DNA fragment;
2. Insertion into gene-poor regions, and preferably, dynamic region.

Husnik, Filip, and John P. McCutcheon. *Nature Reviews Microbiology* 16.2 (2018): 67-79.

Functions of Transferred DNA



Husnik, Filip, and John P. McCutcheon. *Nature Reviews Microbiology* 16.2 (2018): 67-79.

“You Are What You Eat”, *Concl.*

- Here, “You” = “Eukaryotes”
- Inter-kingdom gene transfer is universal and significant for evolution;
- The hosts inevitably obtain DNA from their endosymbionts, or in other word, their preys;
- The fragmentated DNA rarely retains its function, but the high frequency of uptake enhances the probability of functionalization;
- The integrated DNA either replace original genes (maintenance) or provide new function (innovation) to the hosts.

Reference

1. Archibald, John M. "Endosymbiosis and eukaryotic cell evolution." *Current Biology* 25.19 (2015): R911-R921.
2. Nobs, Stephanie-Jane, et al. "Eukarya the chimera: eukaryotes, a secondary innovation of the two domains of life?." *Trends in Microbiology* 30.5 (2022): 421-431.
3. Doolittle, W. Ford. "You are what you eat: a gene transfer ratchet could account for bacterial genes in eukaryotic nuclear genomes." *Trends in Genetics* 14.8 (1998): 307-311.
4. Husnik, Filip, and John P. McCutcheon. "Functional horizontal gene transfer from bacteria to eukaryotes." *Nature Reviews Microbiology* 16.2 (2018): 67-79.