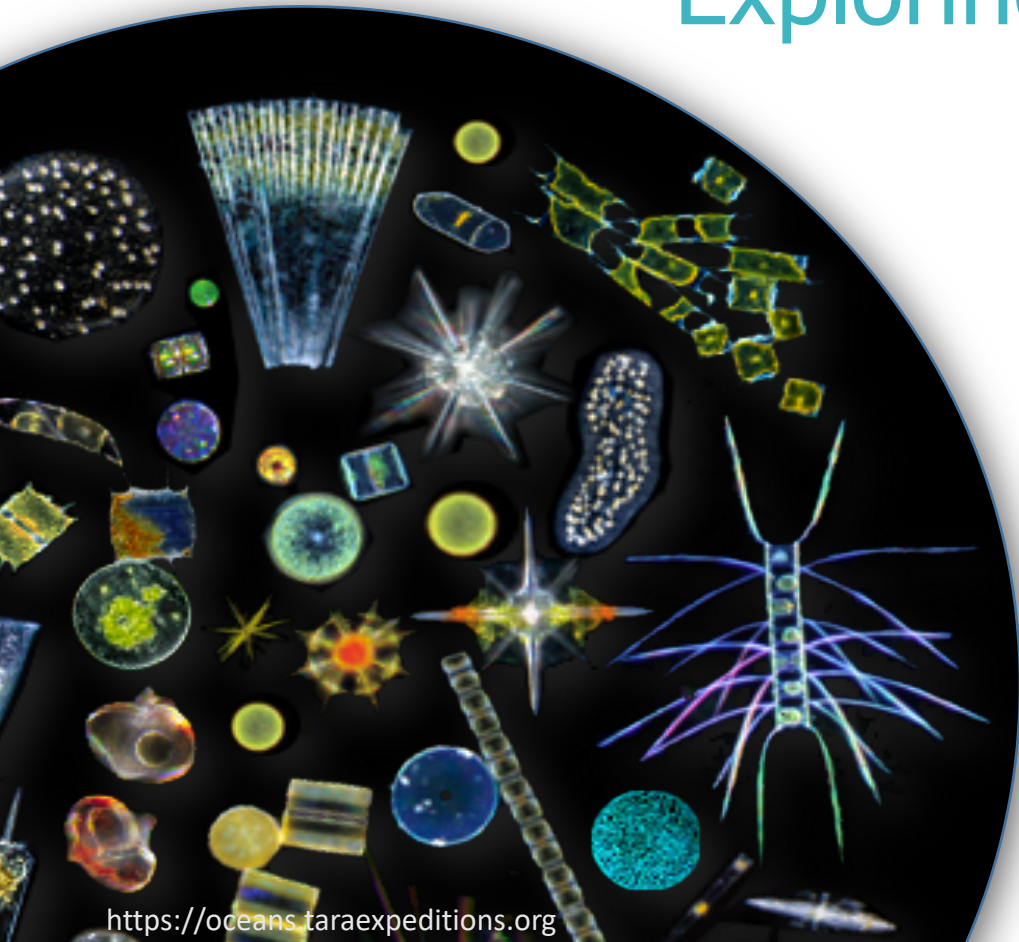


Exploring microbial diversity to understand the evolution of eukaryotic cell

Anna Karnkowska







Animals

Plants



Animals

Plants

Protists

Bacteria



Animals

Plants

Protists

Fungi

Bacteria



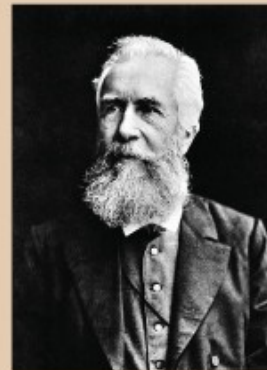
1758

Carolus Linnaeus



1866

Ernst Haeckel

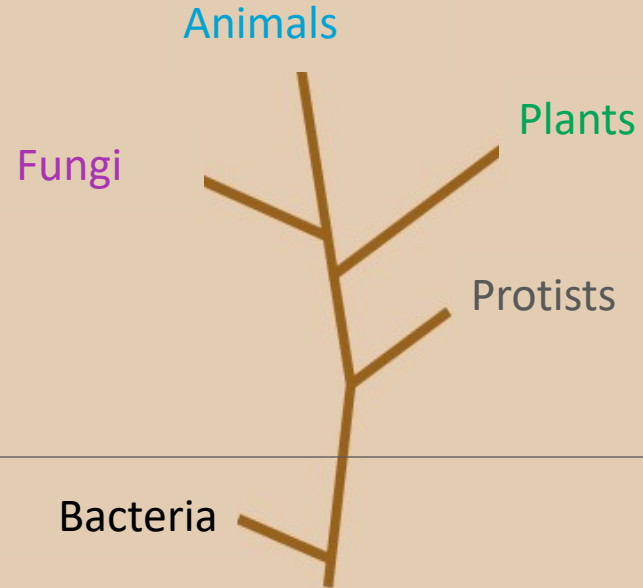
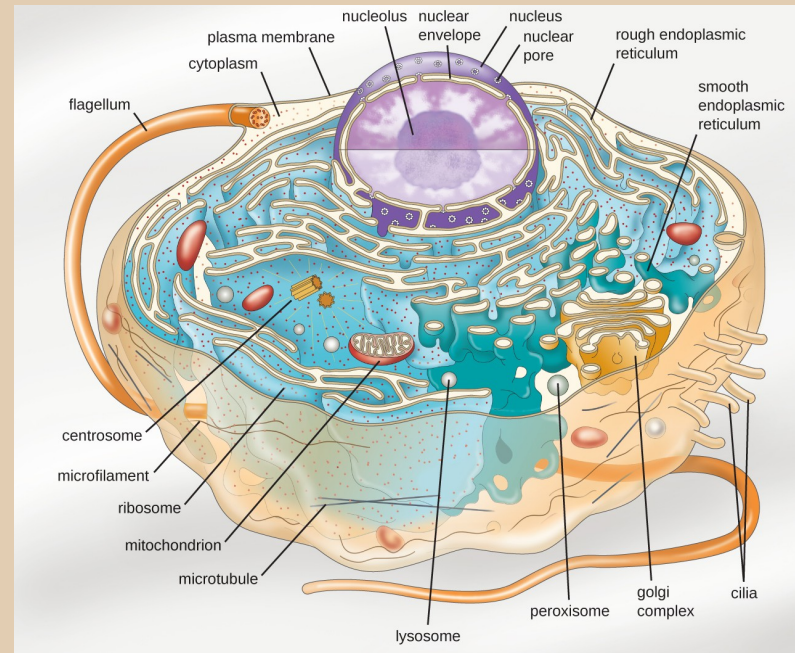


1969

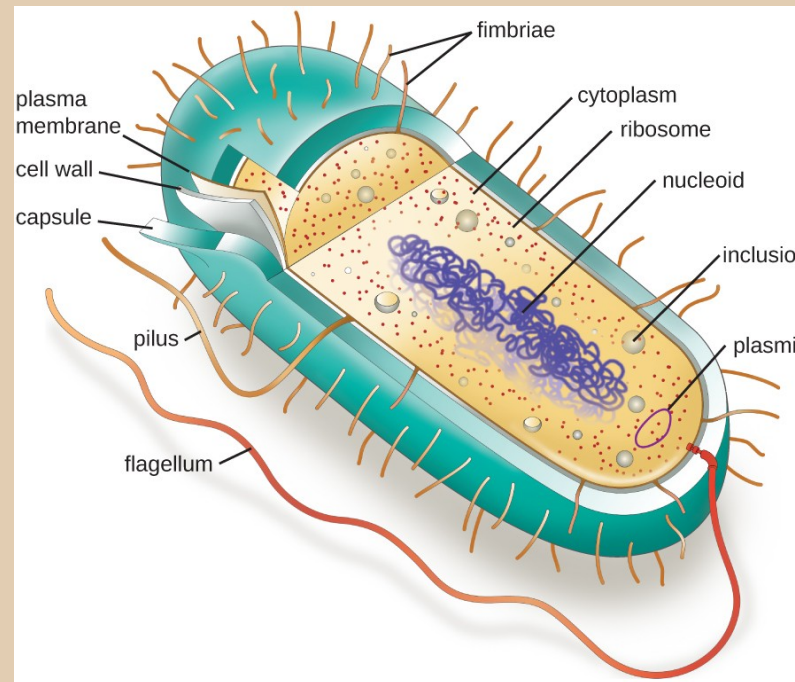
Robert Whittaker



eukaryotes



prokaryotes







multicellular
eukaryotes

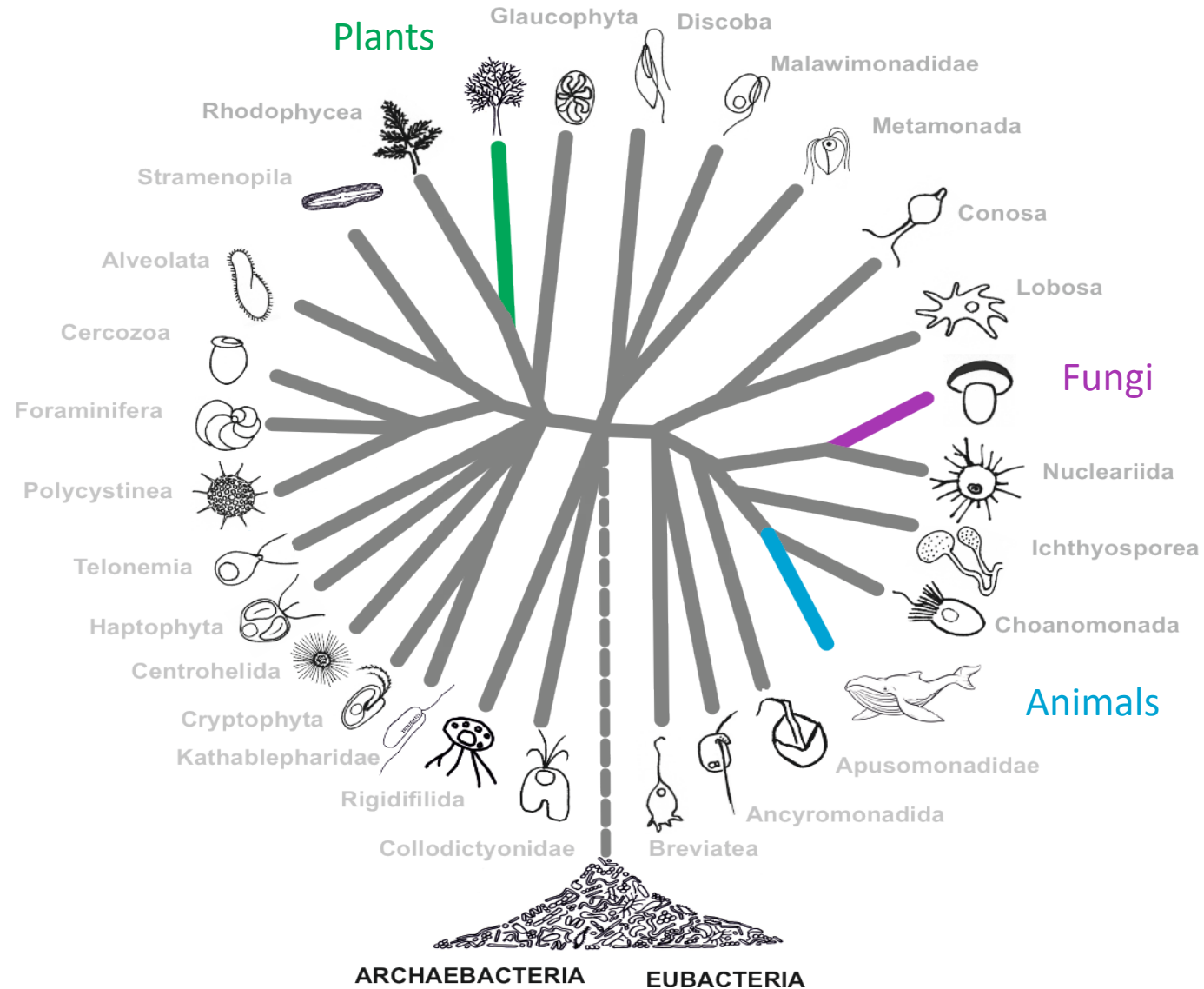
microbial eukaryotes

microbial eukaryotes = protists





diversity of eukaryotes

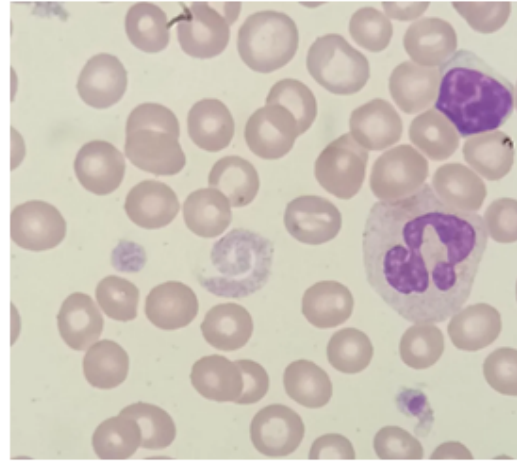


The view of a cell by:

a lab manager



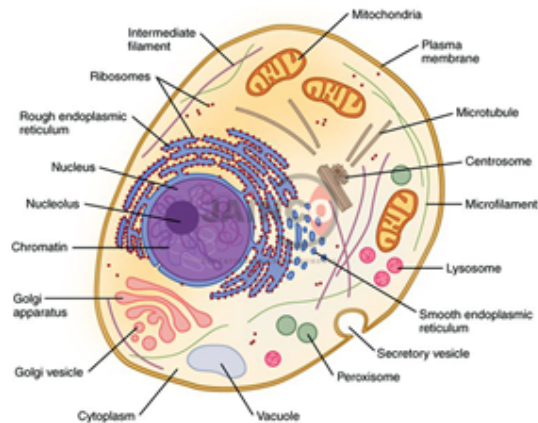
a med lab technician



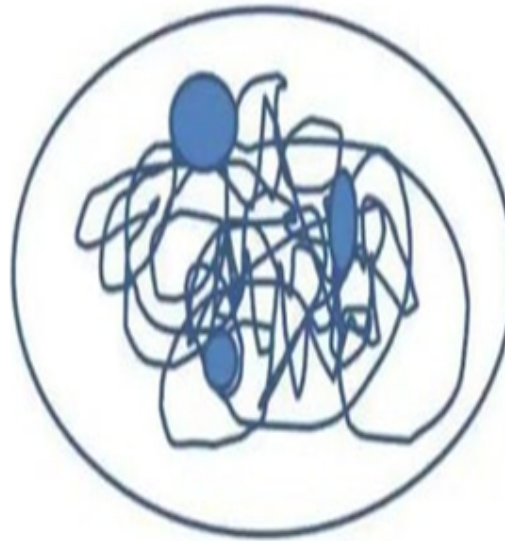
a microbiologist



a cell biologist

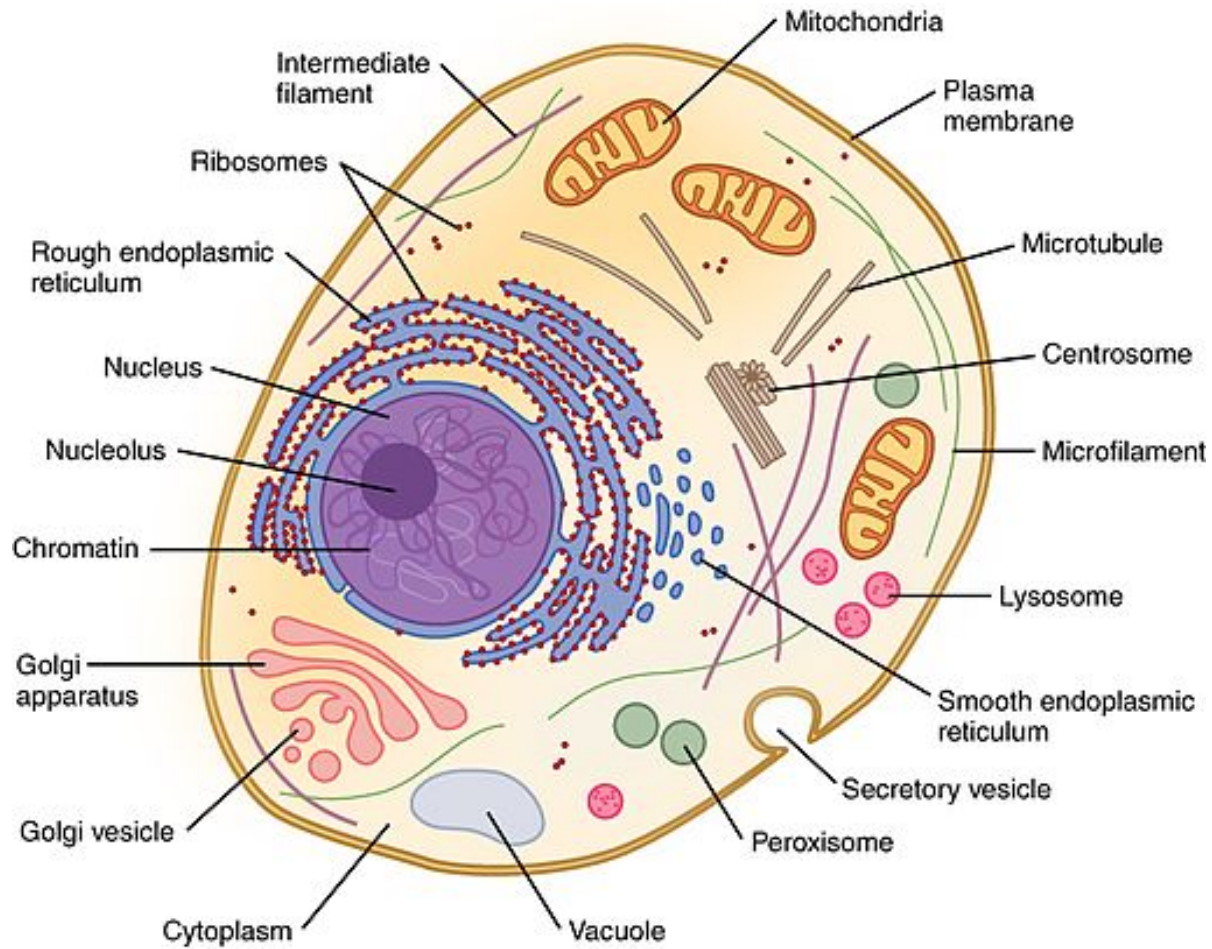


a chemist



a physicist

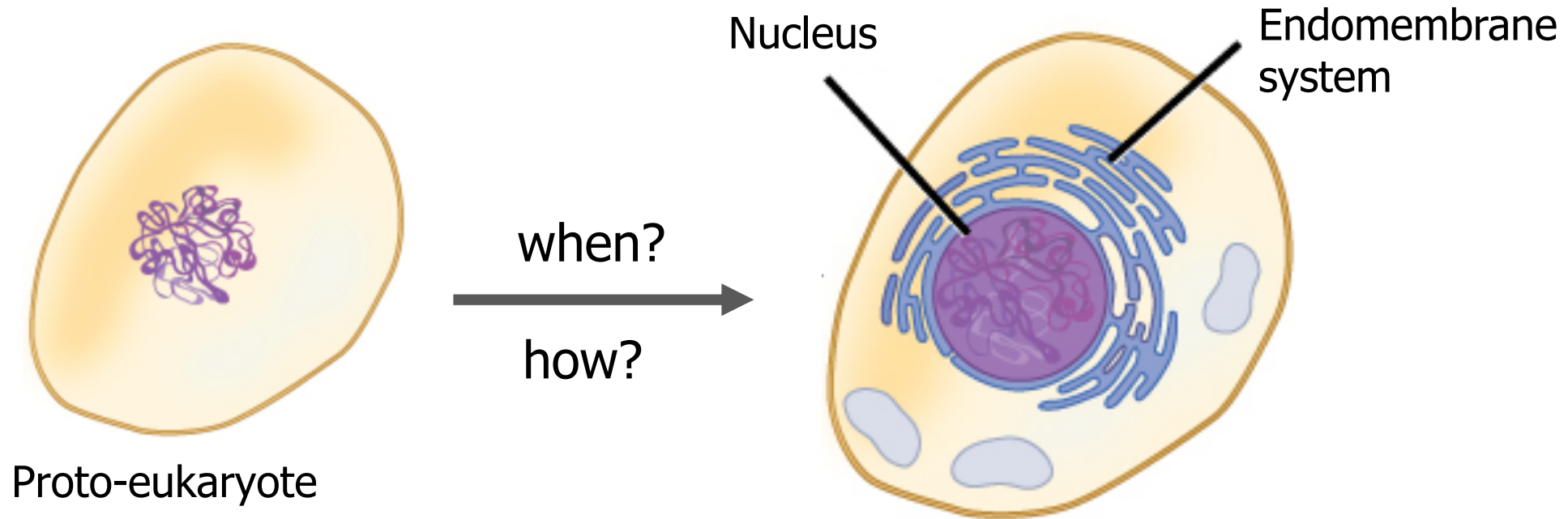




How the eukaryotic cell complexity evolved?

early evolution of eukaryotes

emergence of nucleus

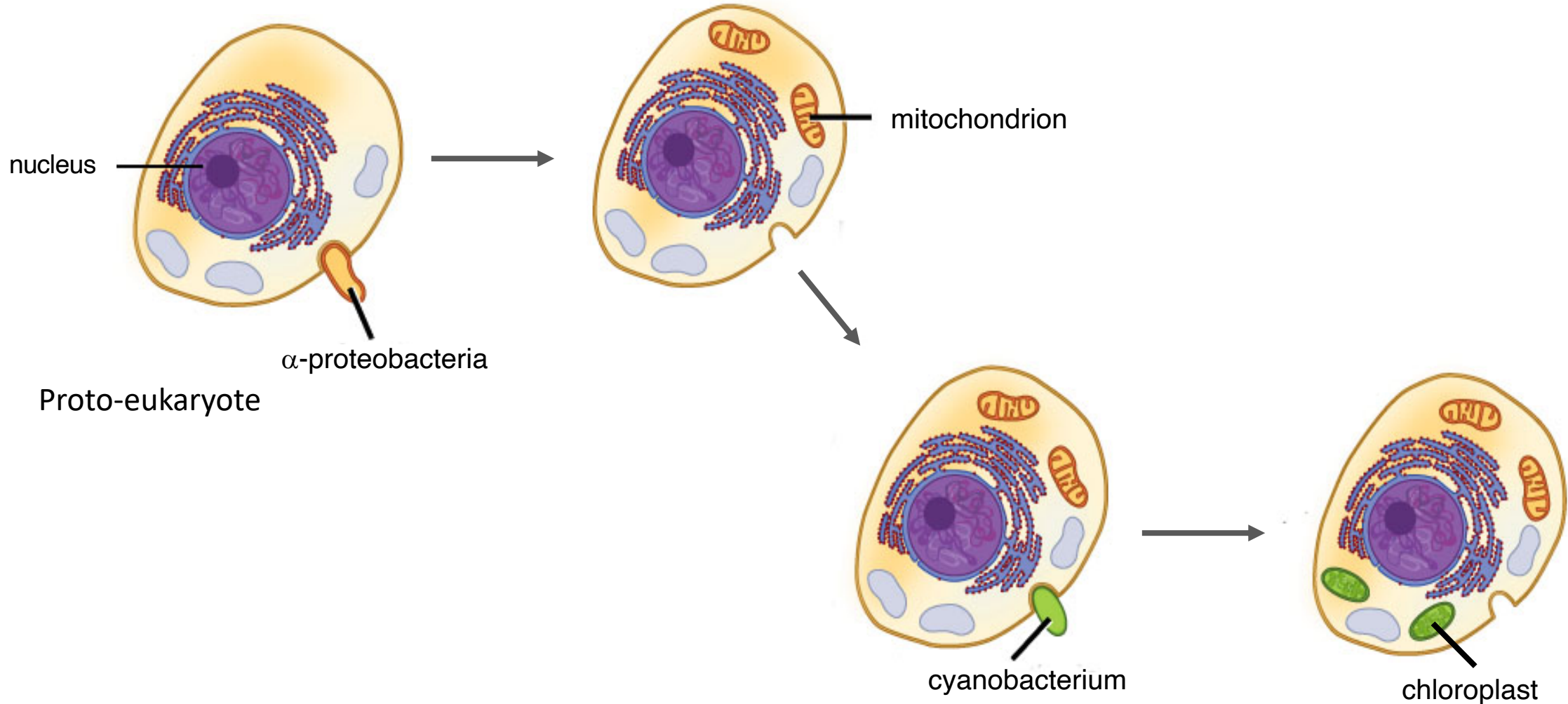


Which **came first**, the **nucleus** or the **mitochondrion**?

symbiosis



endosymbiotic origin of organelles



endosymbiotic organelles

mitochondrion



carbohydrates
metabolism

lipids
metabolism

Fe-S
synthesis

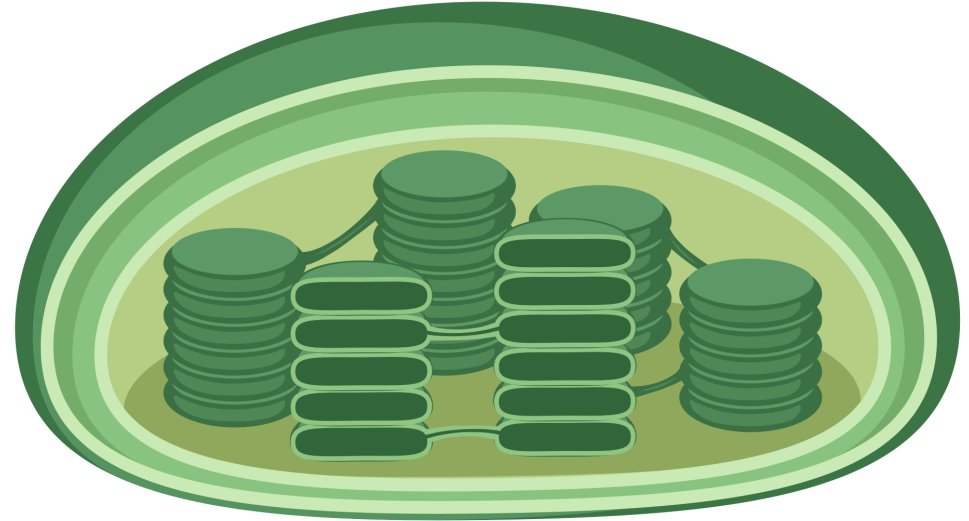


amino acid
metabolism

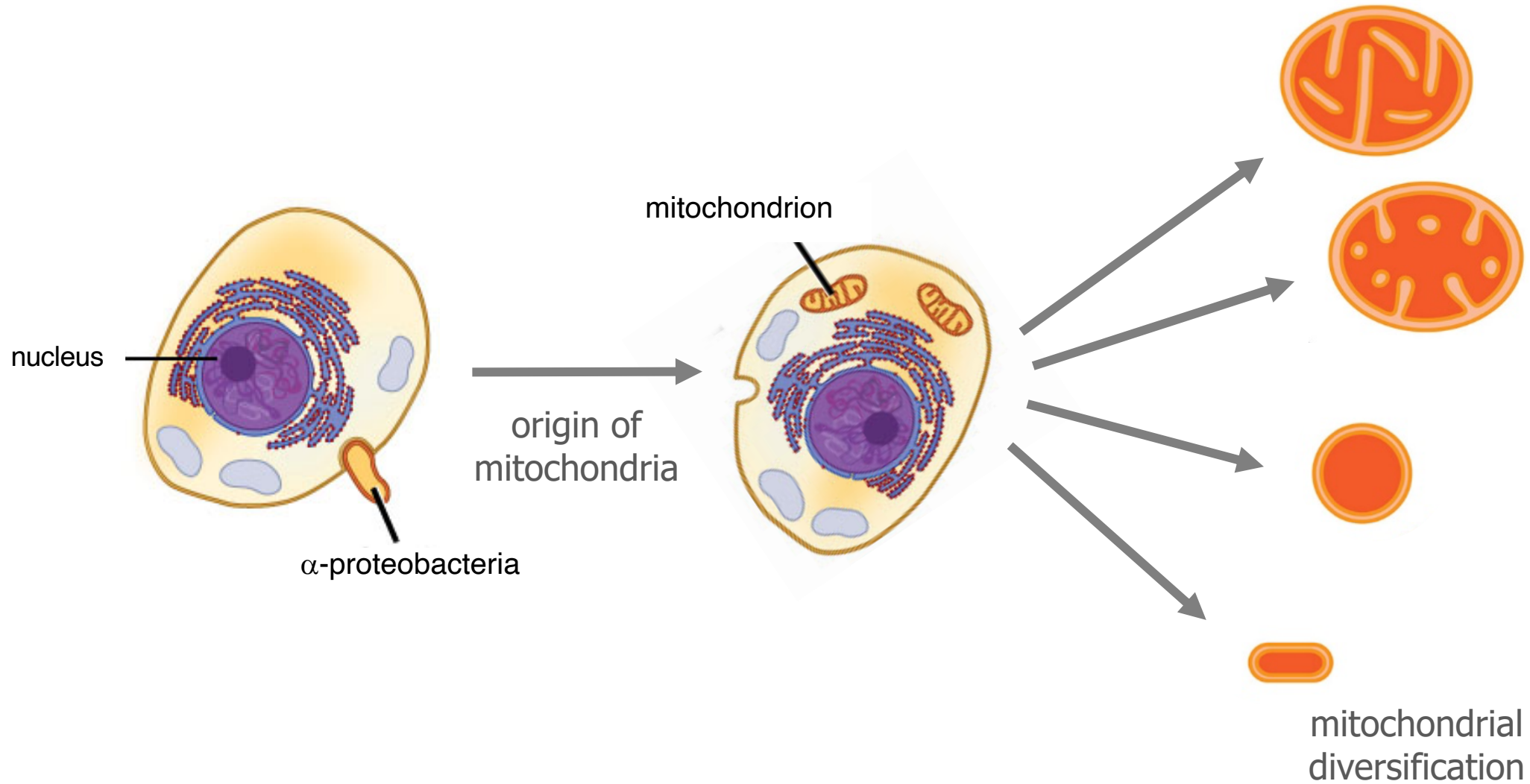
nucleotides
metabolism

Heme
synthesis

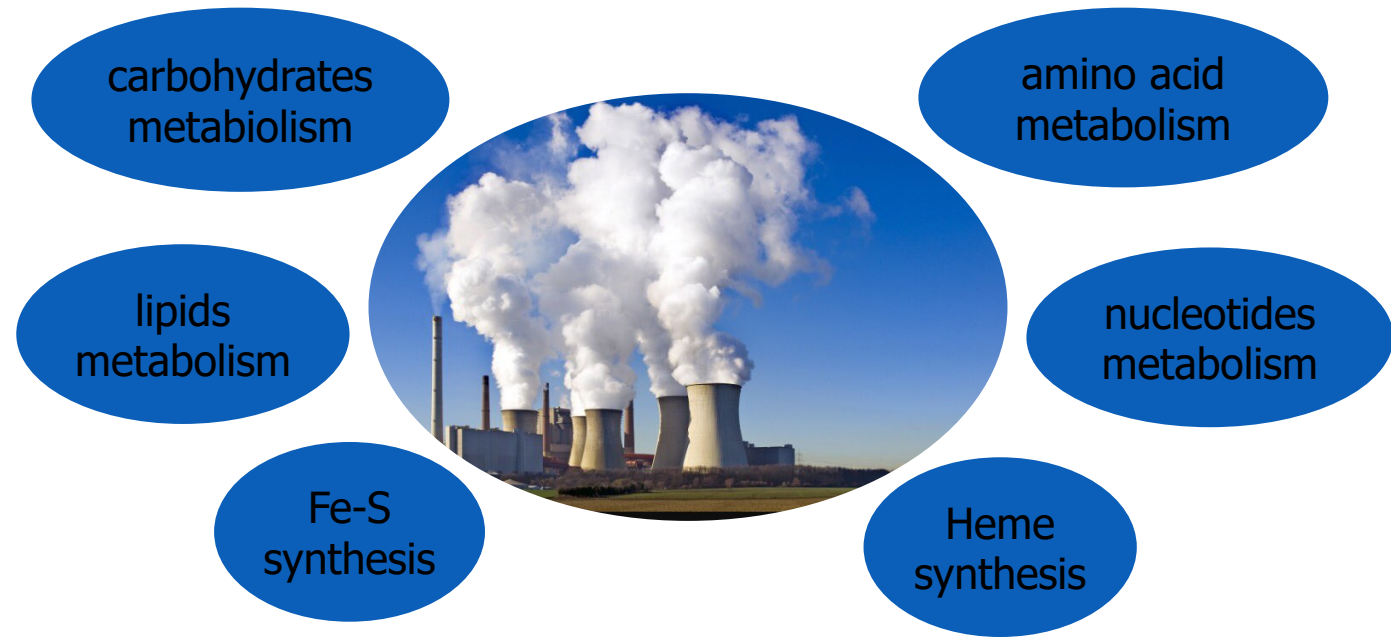
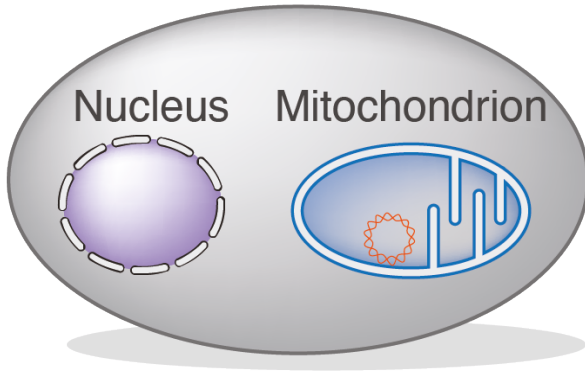
chloroplast



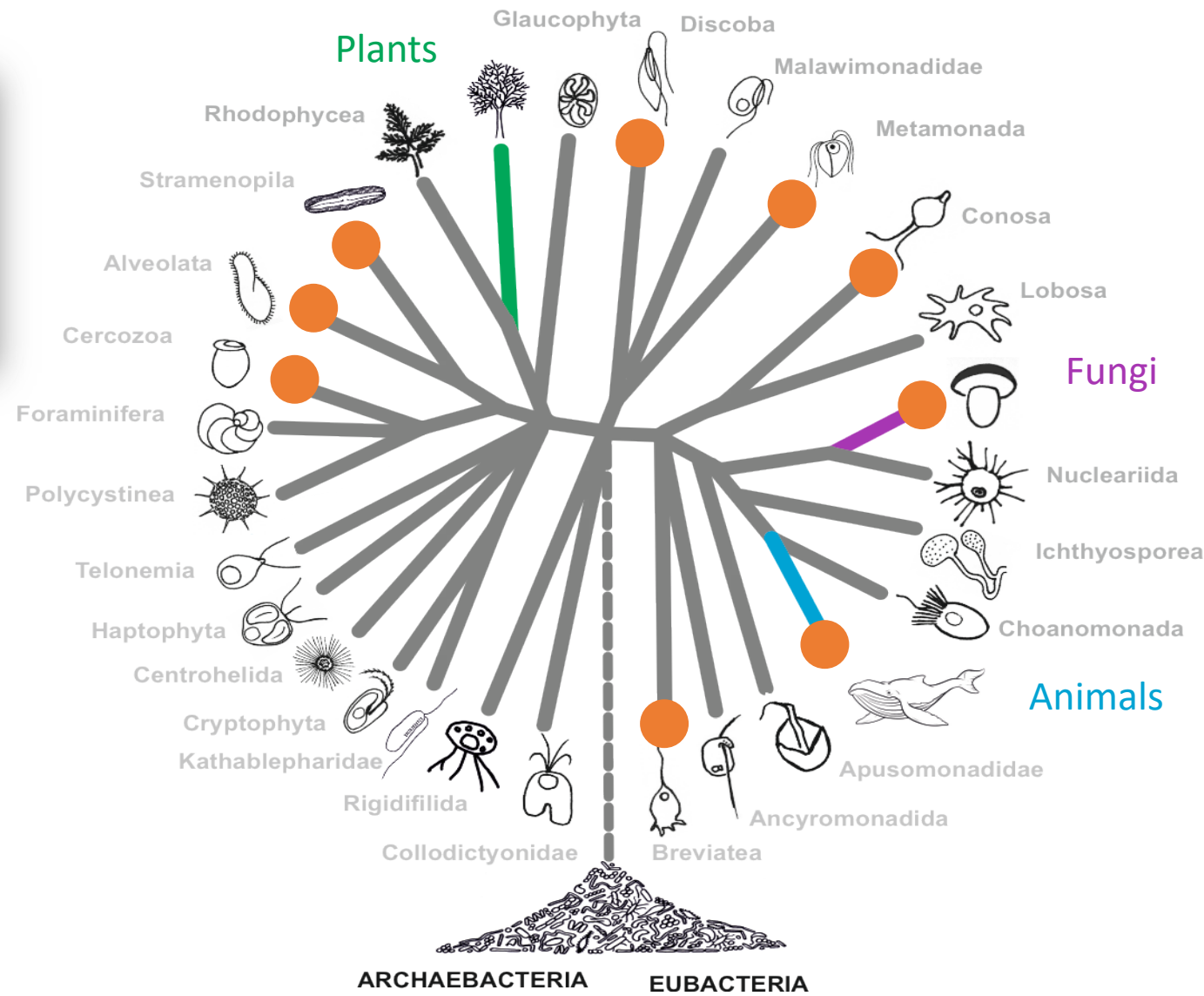
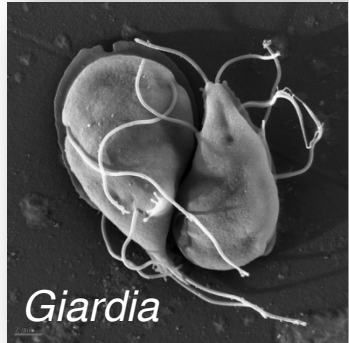
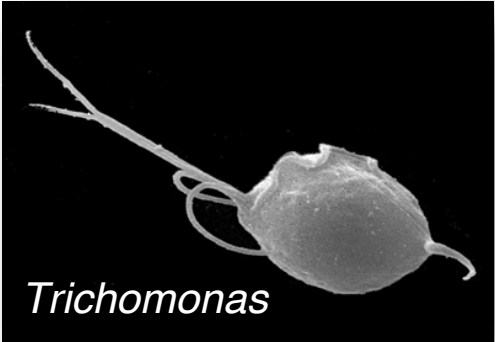
evolution of endosymbiotic organelles



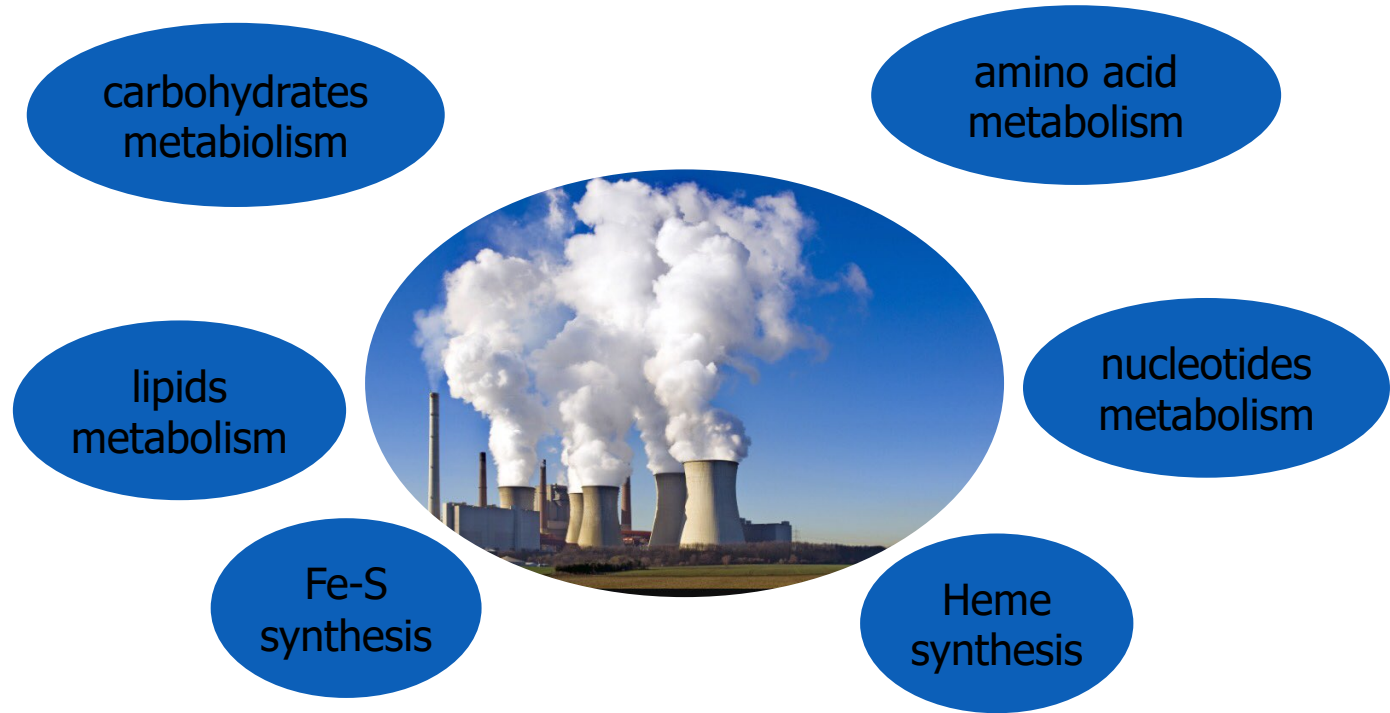
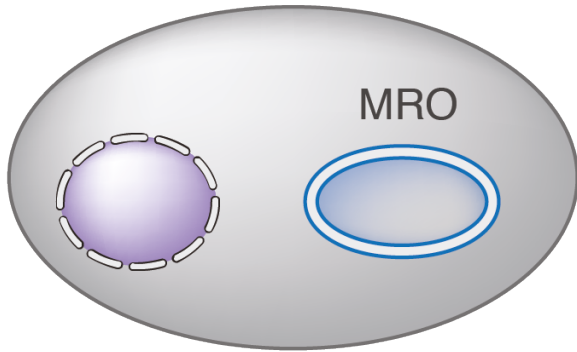
A eukaryotic cell with typical mitochondria



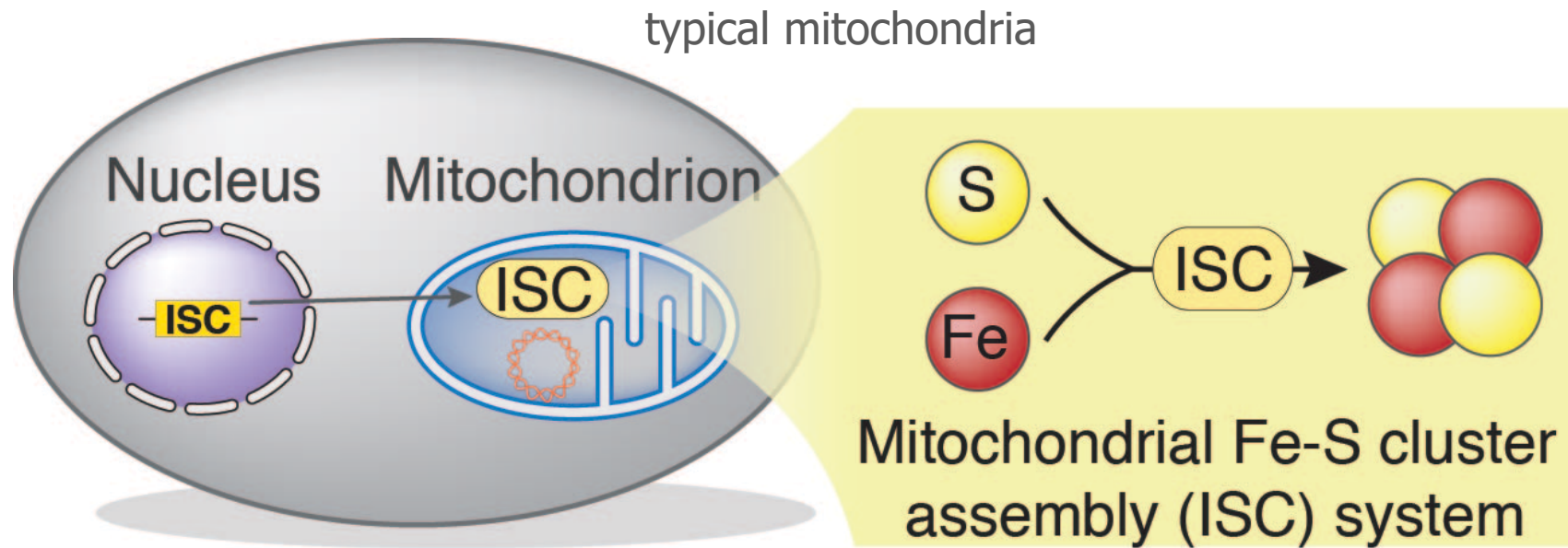
anaerobic eukaryotes



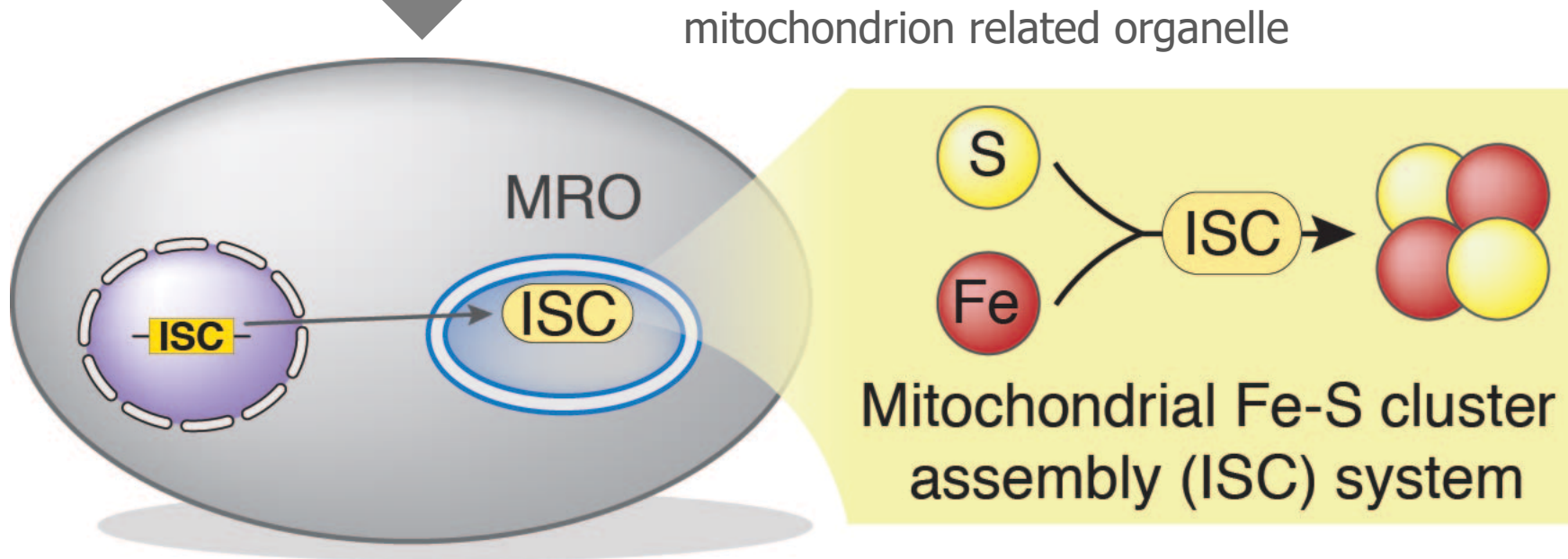
An anaerobic eukaryotes with mitochondrion related organelles (MROs)

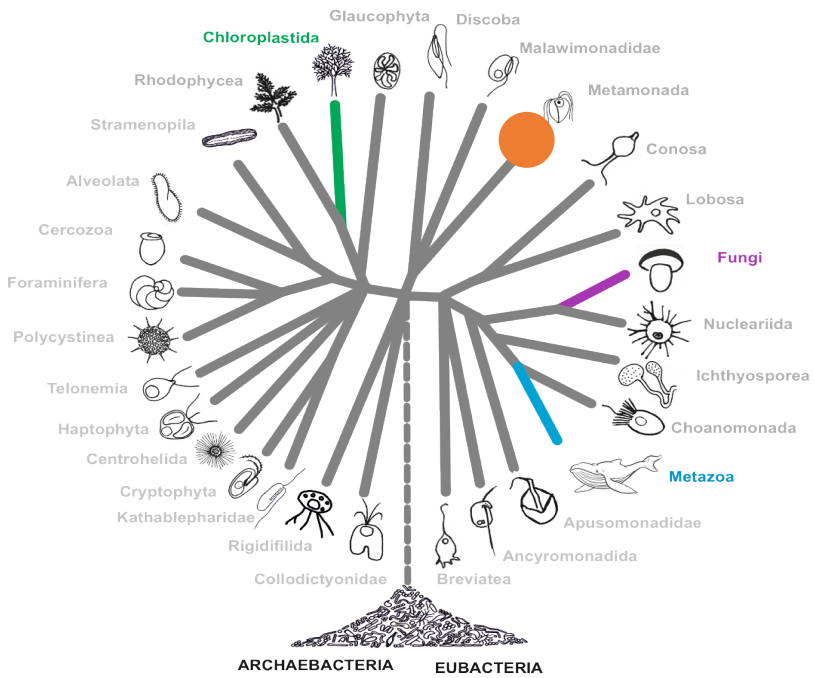


O_2

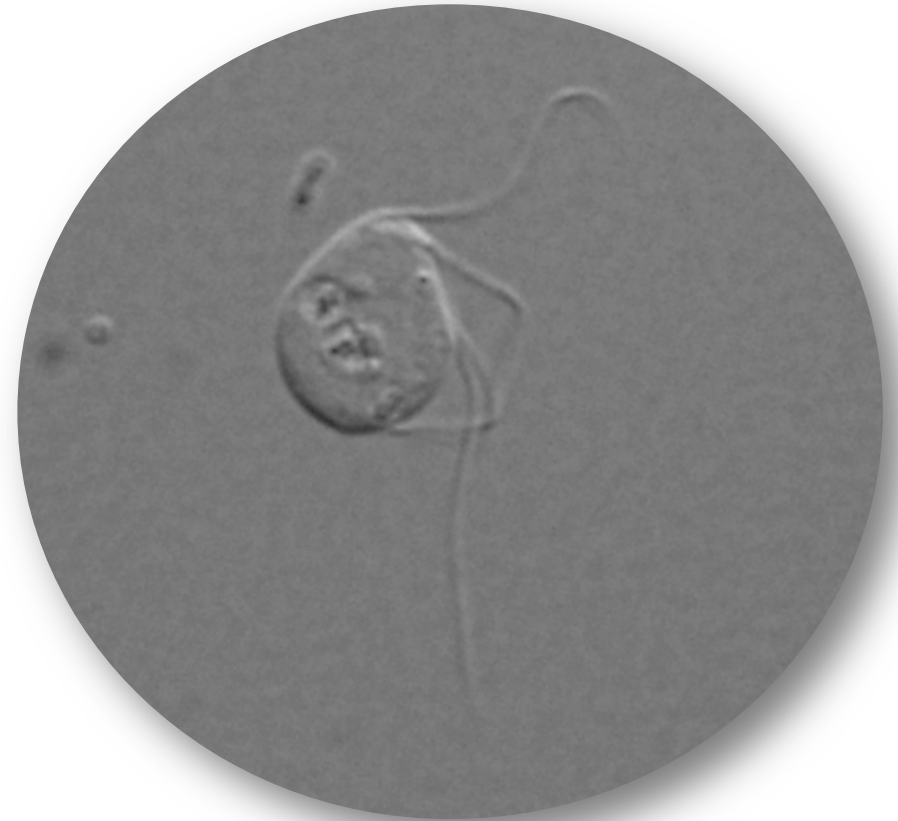


~~O_2~~

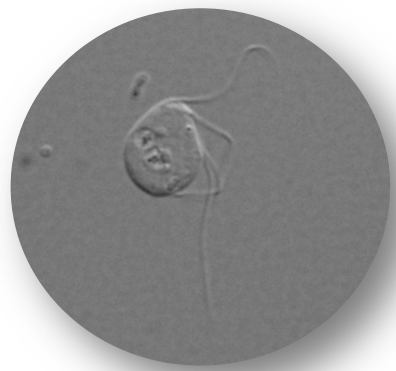




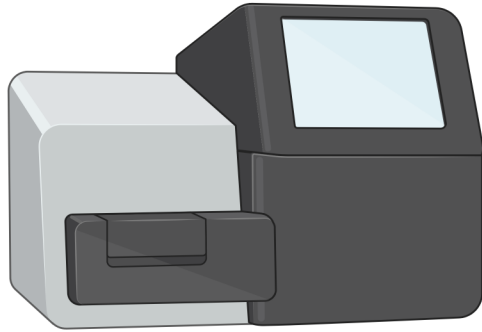
Monocercomonoides



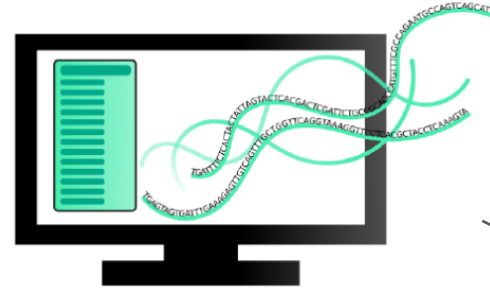
high-throughput genome sequencing & bioinformatics



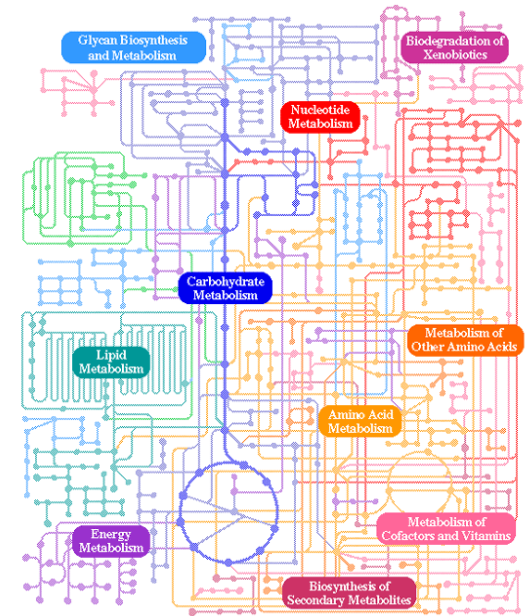
genomic DNA



sequencing

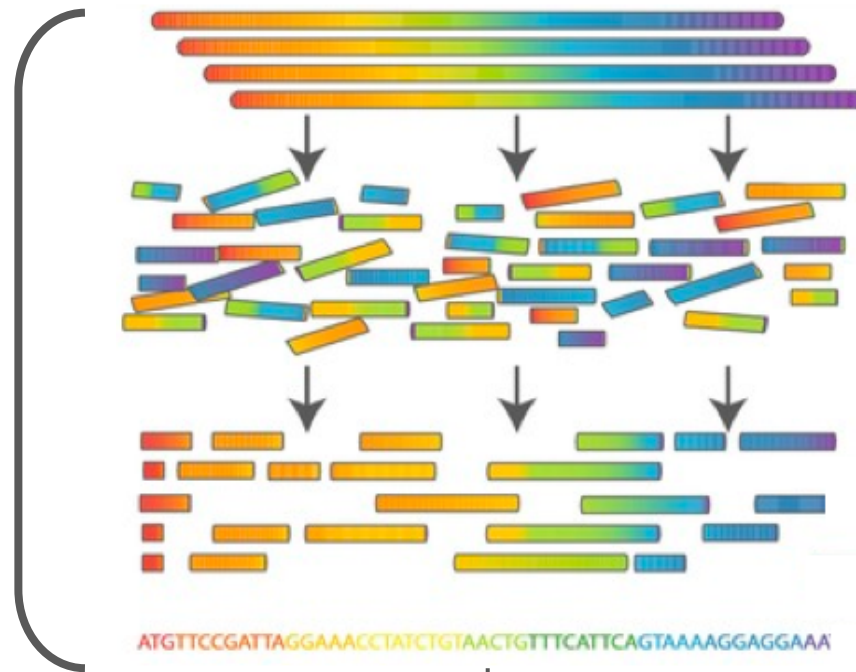


genome assembly
& annotation



reconstruction of the cell systems
& cell metabolism

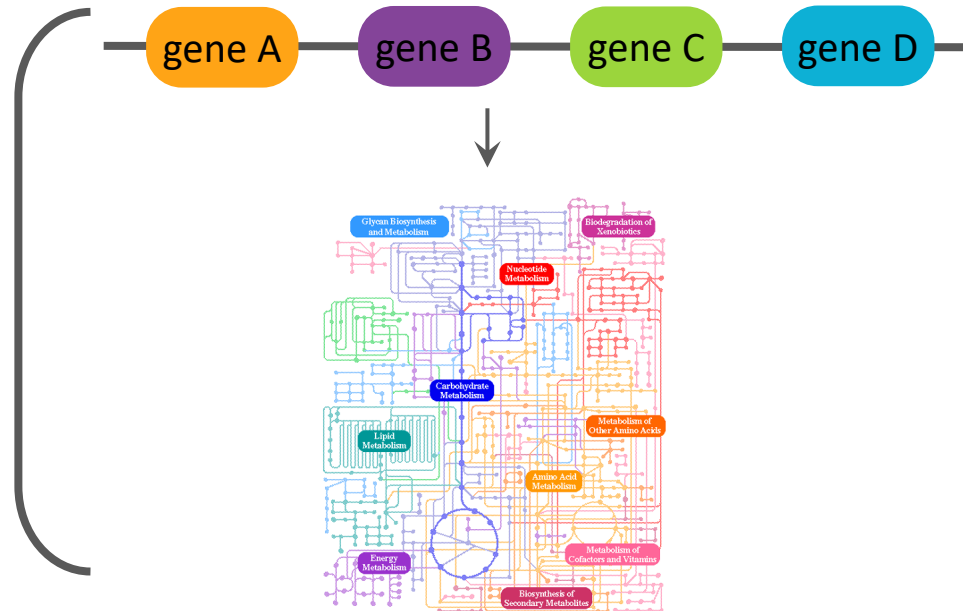
genome assembly



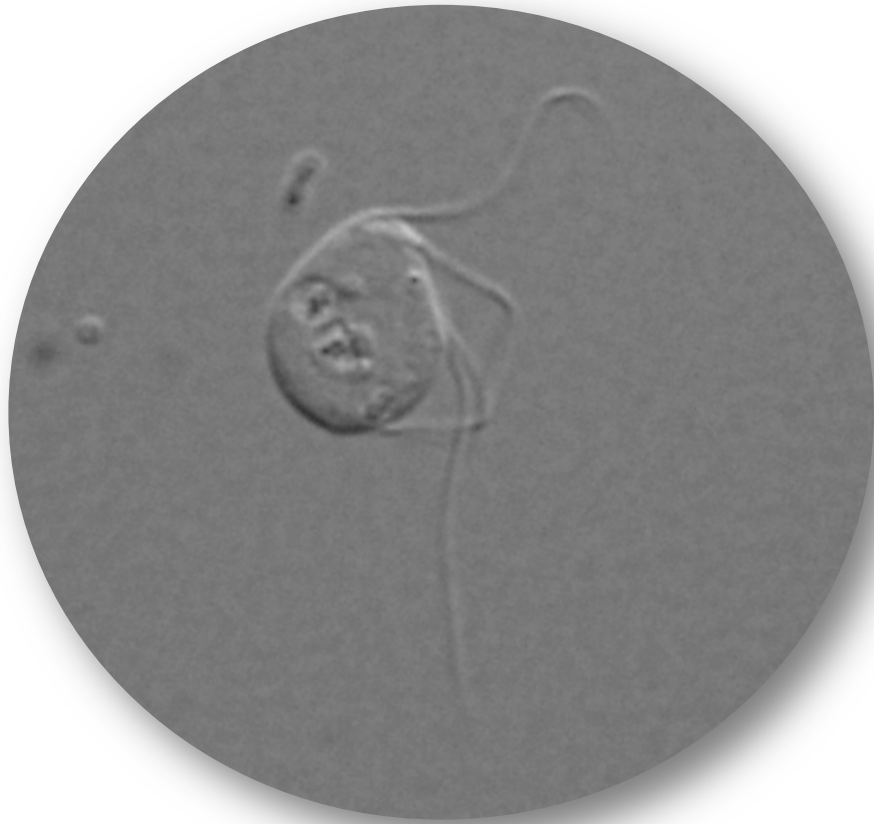
2095 scaffolds

75 000 000 base pairs

genome annotation

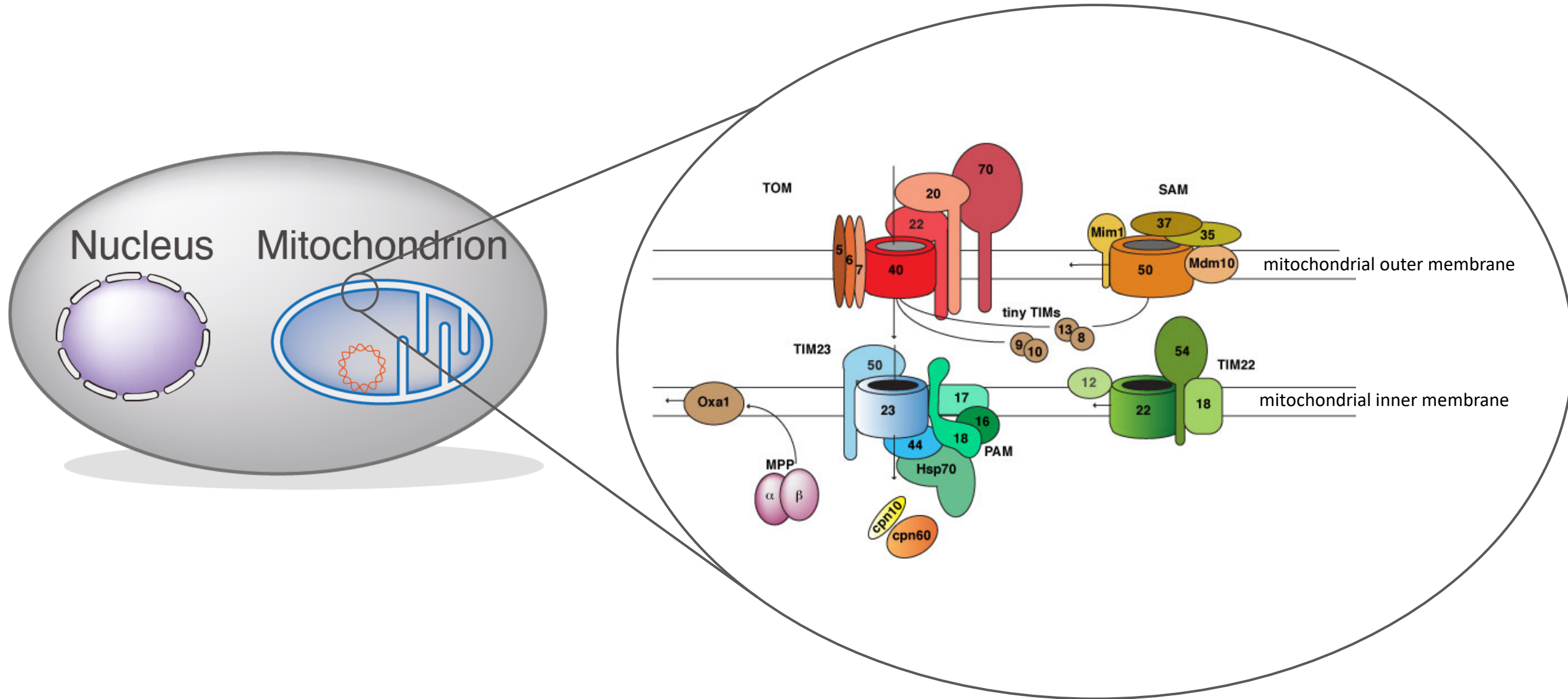


16 629 genes

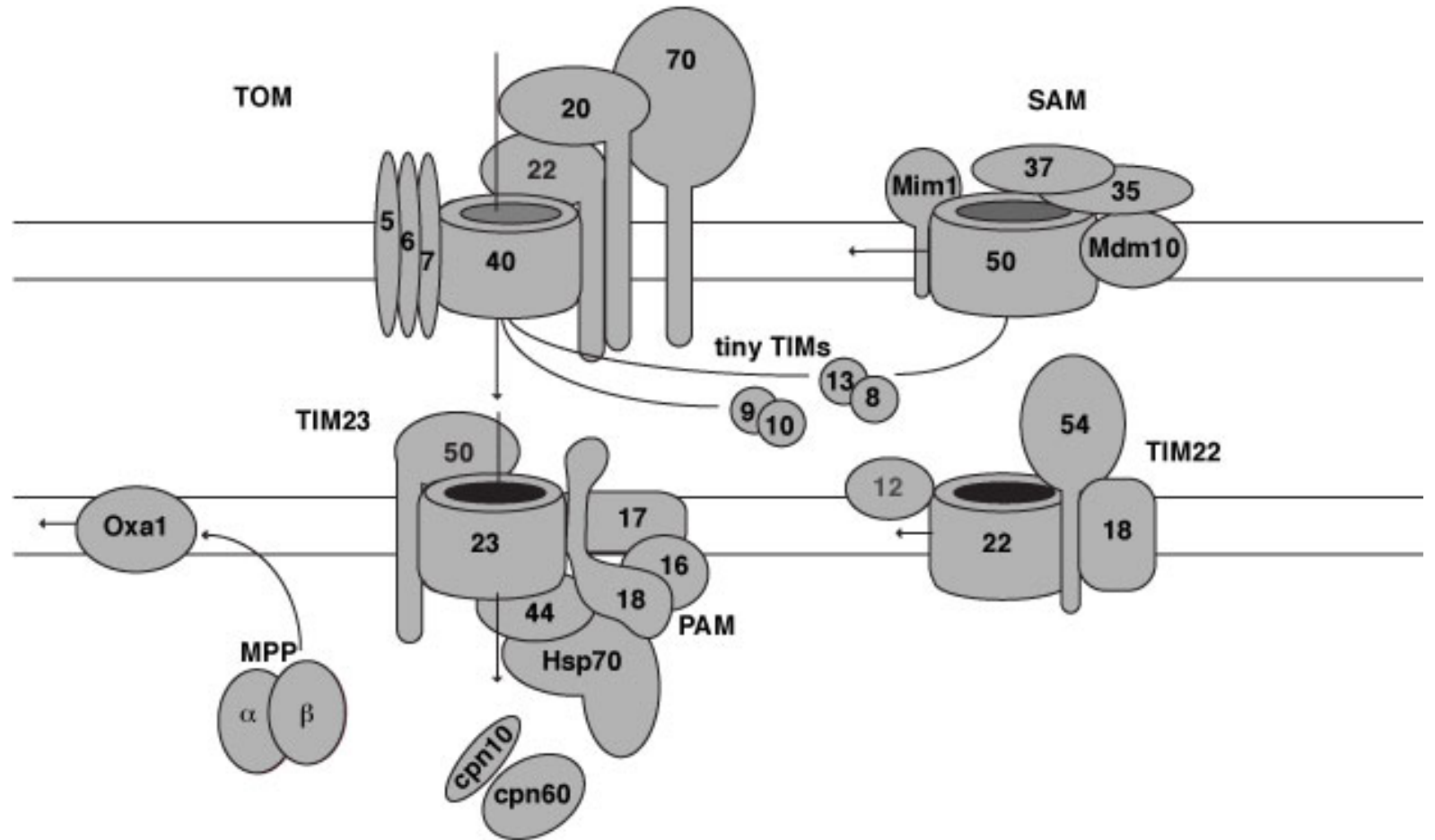
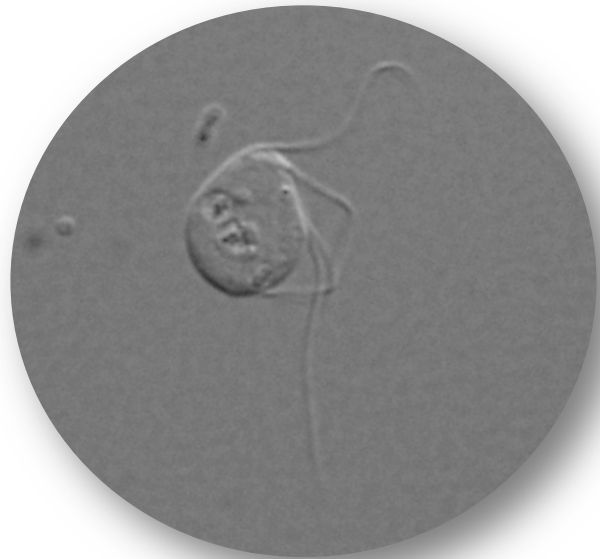


Monocercomonoides
searching for mitochondria

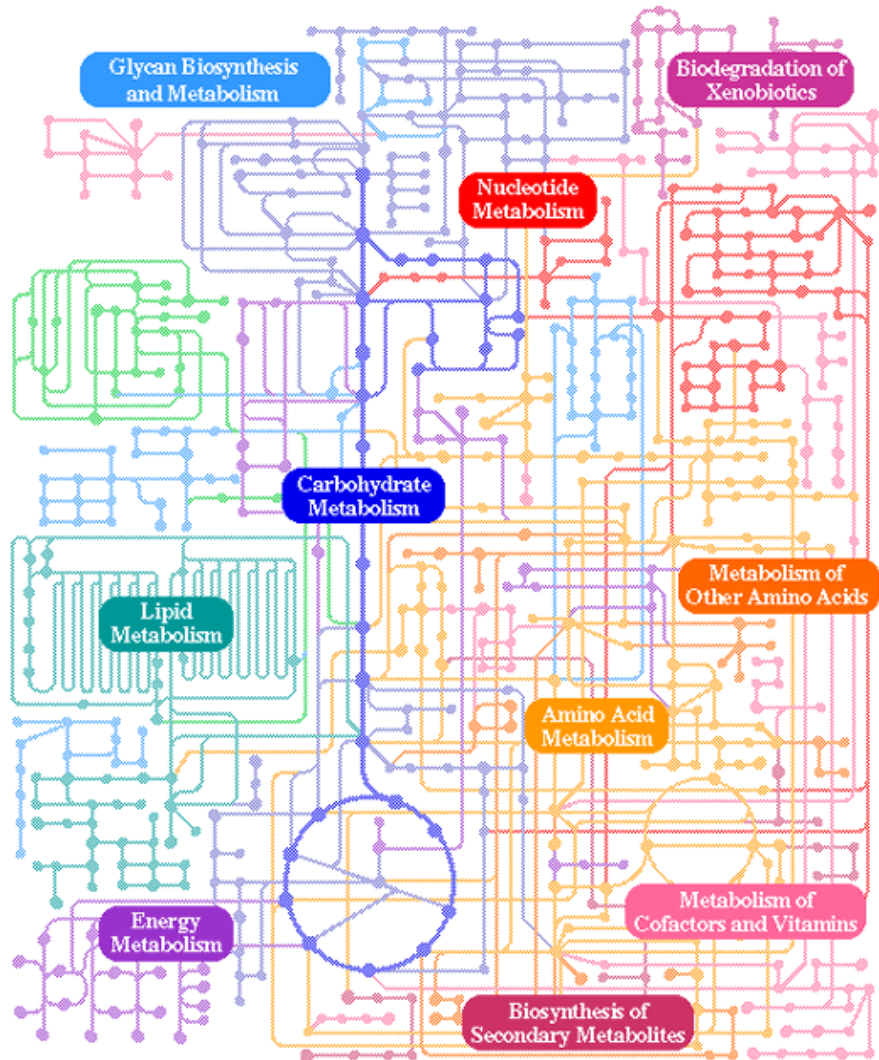
Searching for hallmark mitochondrial proteins



Searching for hallmark mitochondrial proteins



Searching for proteins involved mitochondrial metabolism



metabolic pathways in cytosol

transport from the host

carbohydrates
metabolism

amino acid
metabolism

lipids
metabolism

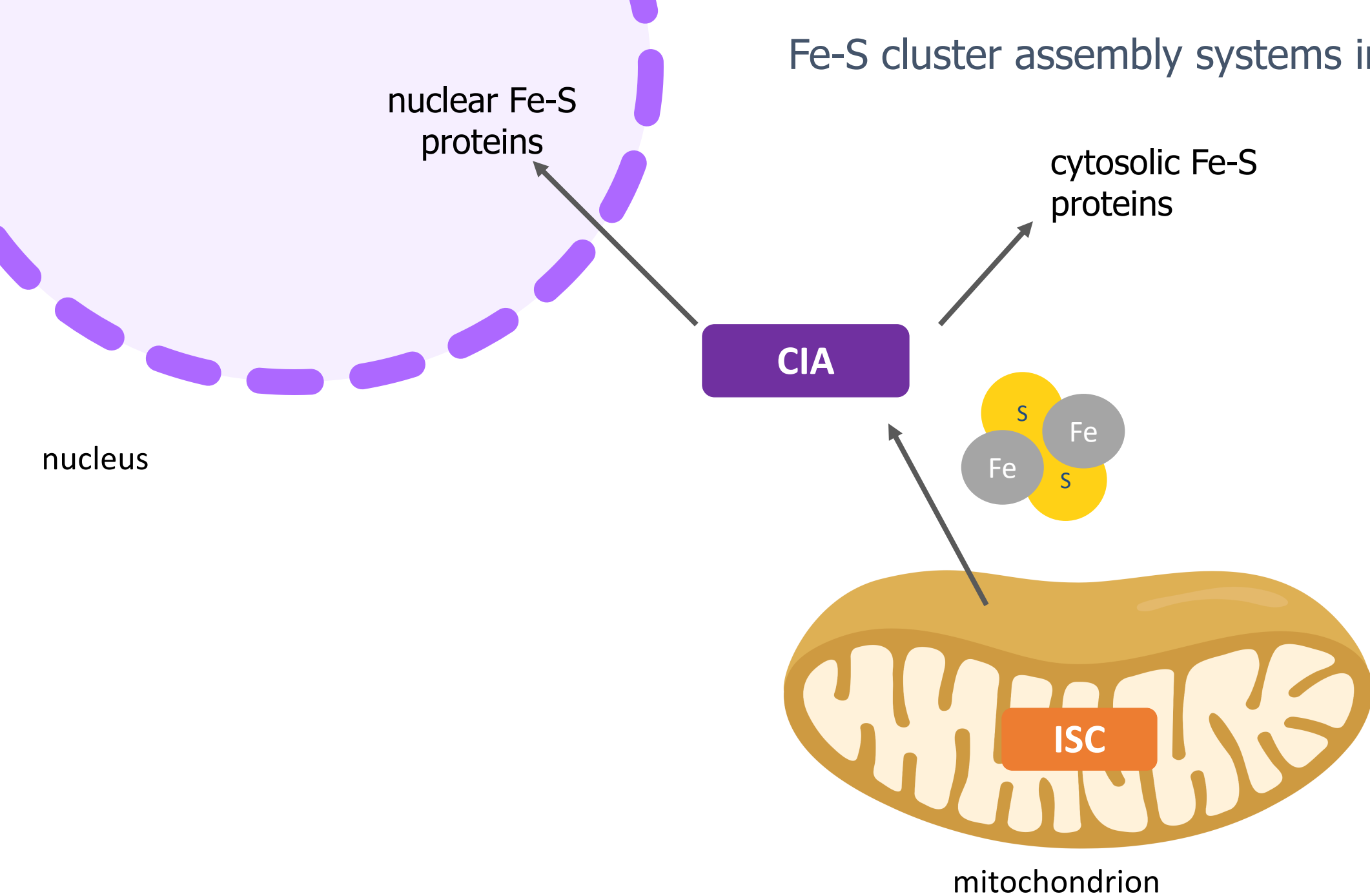


nucleotides
metabolism

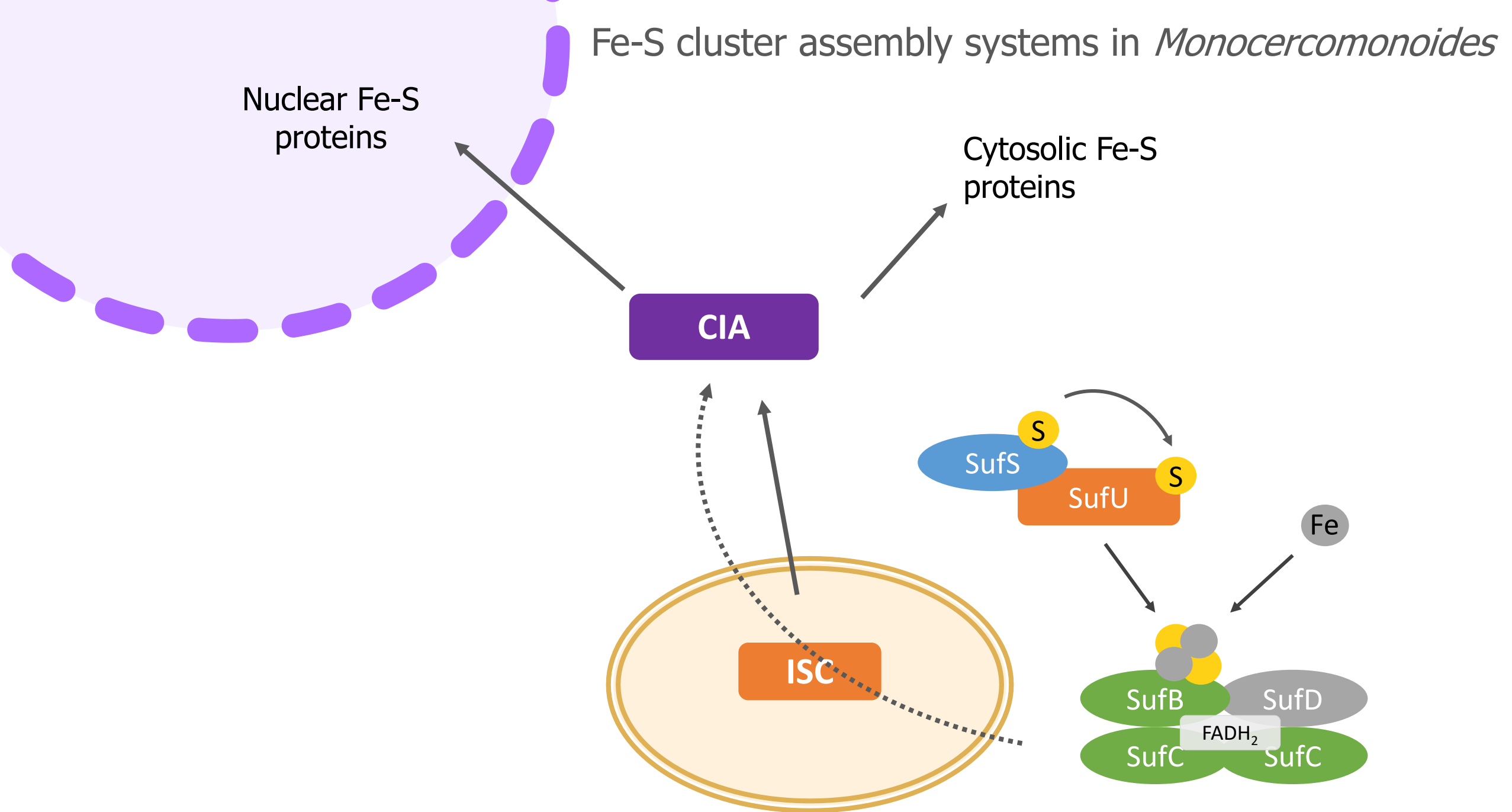
Fe-S
synthesis

Heme
synthesis

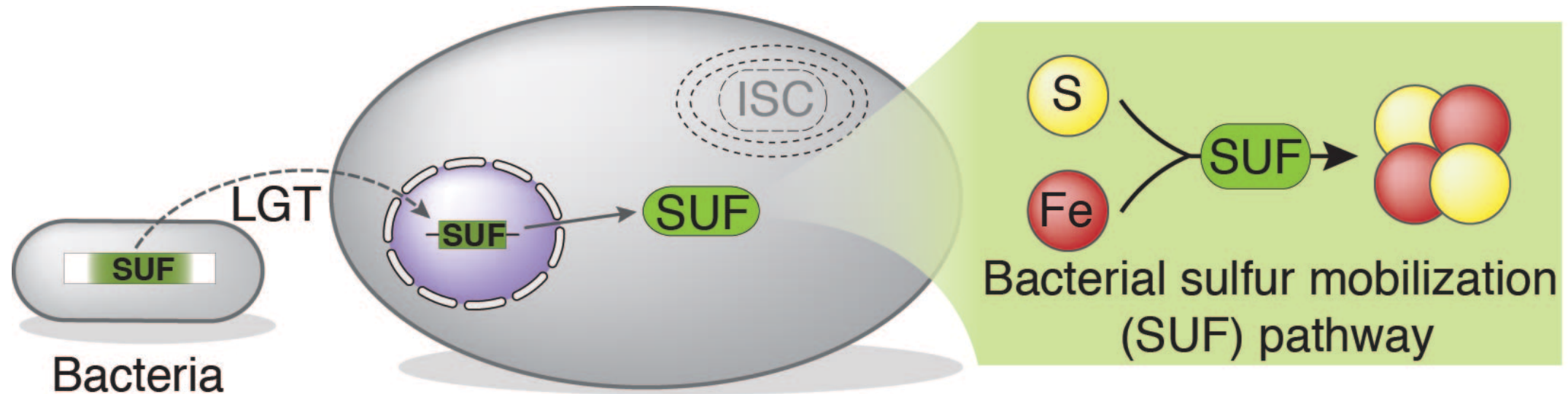
Fe-S cluster assembly systems in eukaryotes



Fe-S cluster assembly systems in *Monocercomonoides*



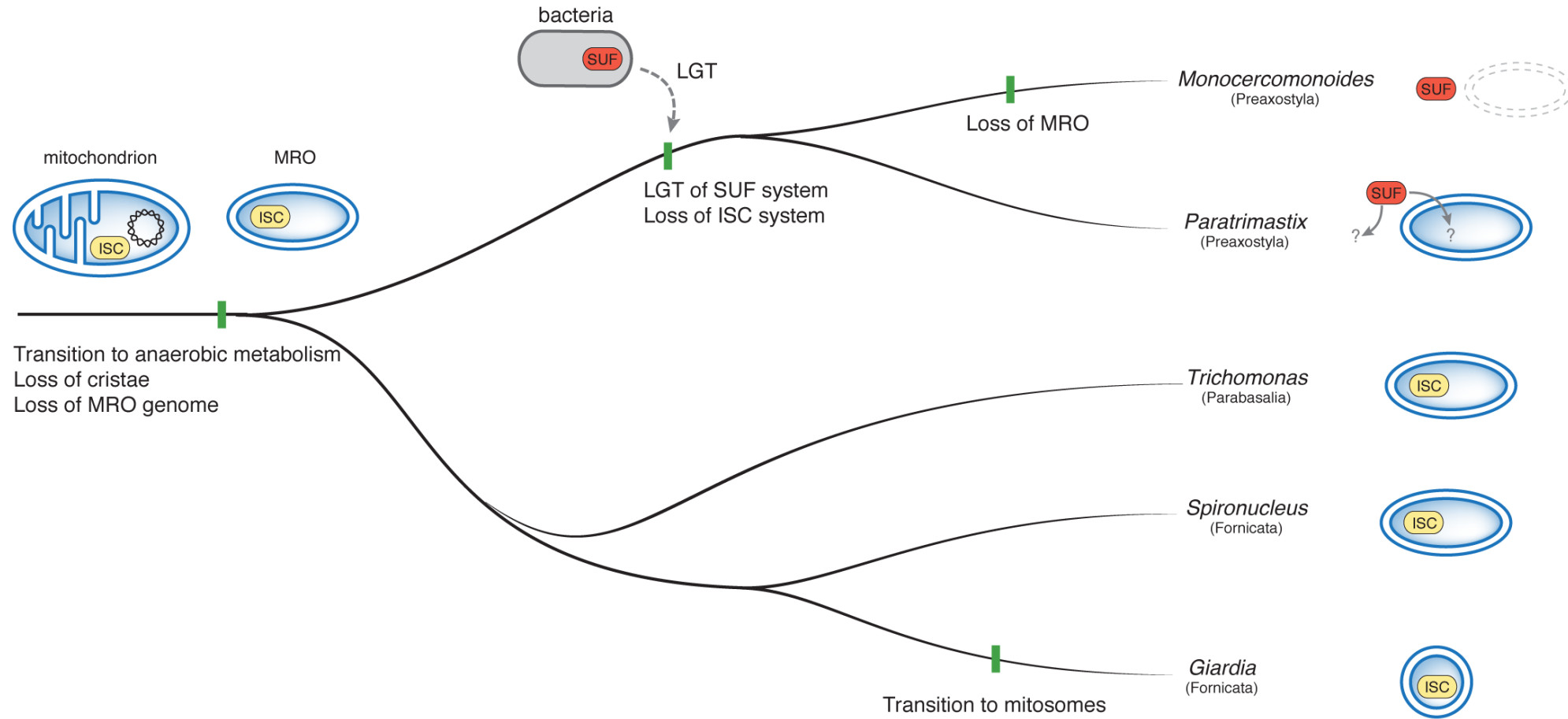
Monocercomonoides an amitochondriate eukaryote



Lateral gene transfer (LGT) of bacterial genes encoding sulfur mobilization pathway (SUF) and loss of reduced mitochondrion

Loss of a mitochondrial organelle

LGT of **SUF** system resulted in relocation of the pathway to the cytosol

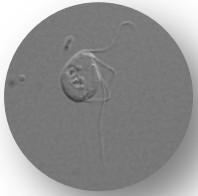


Endosymbiosis can be undone!

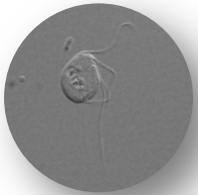
Take home message



(almost all) eukaryotic cells have mitochondria



complex eukaryotic cell can live without a mitochondrion



Monocercomonoides can serve as a model for cell biology studies



studies on eukaryotic microbial diversity help to understand evolution of eukaryotes

Acknowledgements

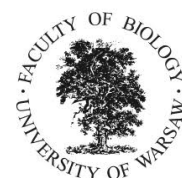
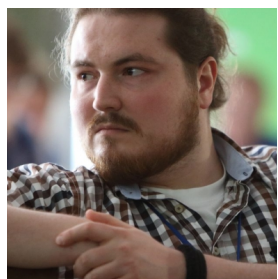
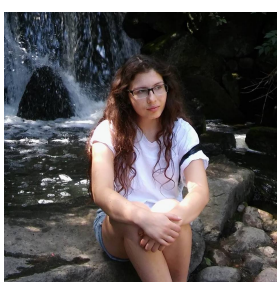
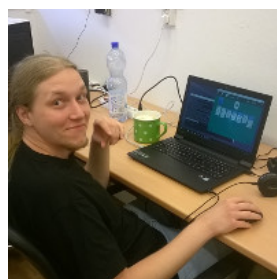


Hampl Lab



Keeling Lab





University of Warsaw
Biological and Chemical
Research Centre



Exploring microbial diversity to understand the evolution of eukaryotes

