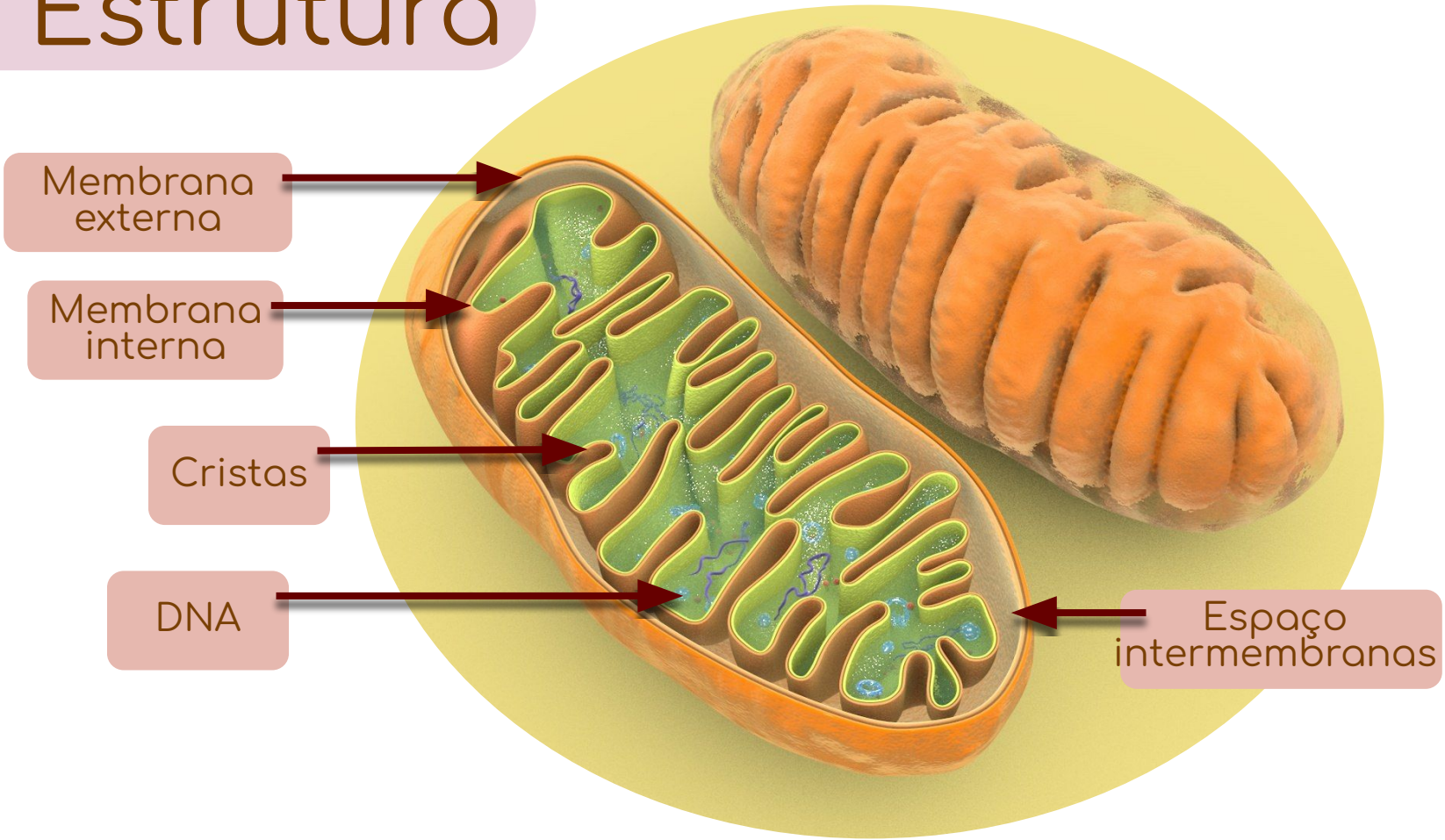
A mitocôndria

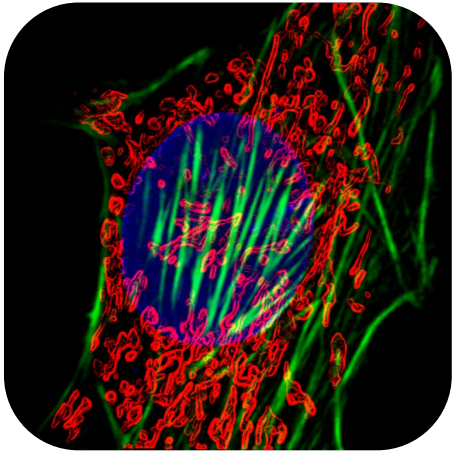
e o estudo da biodiversidade

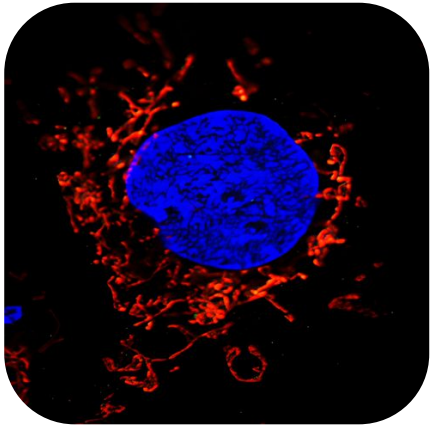
Heron O. Hilário

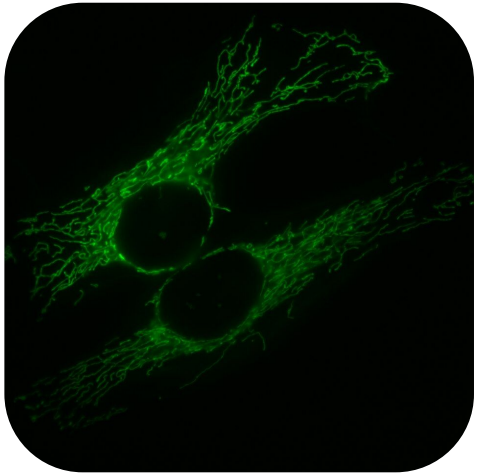
Estrutura

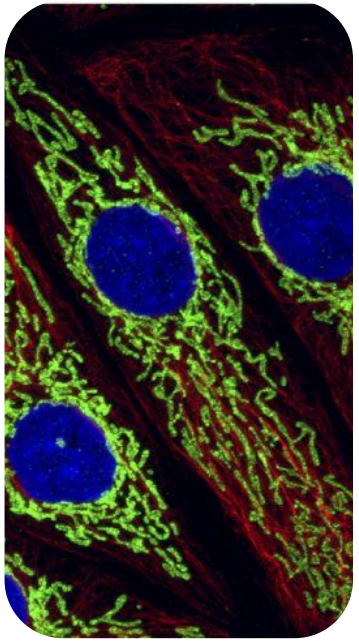

Membrana externa
Membrana interna
Cristas
DNA
Espaço intermembranas

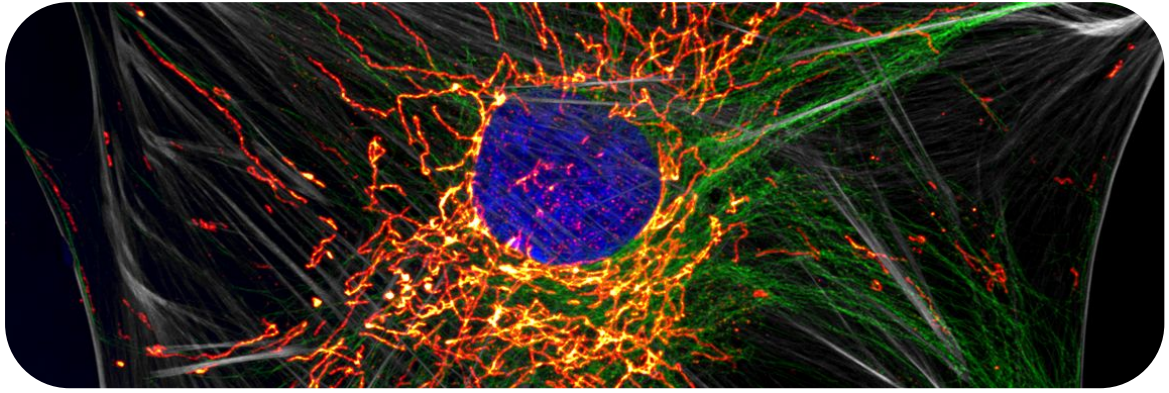
Estrutura

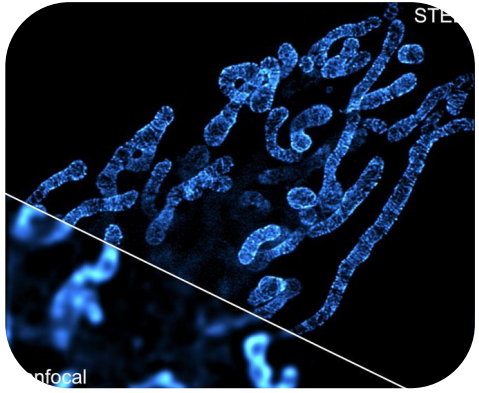








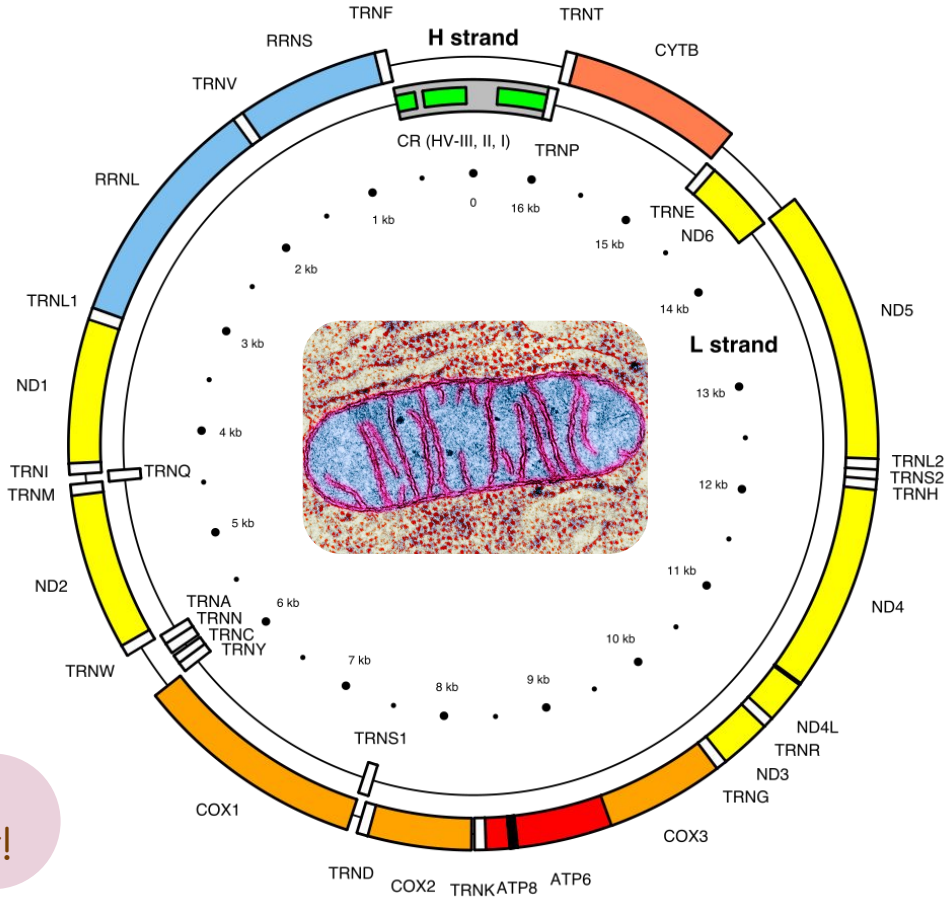




O genoma

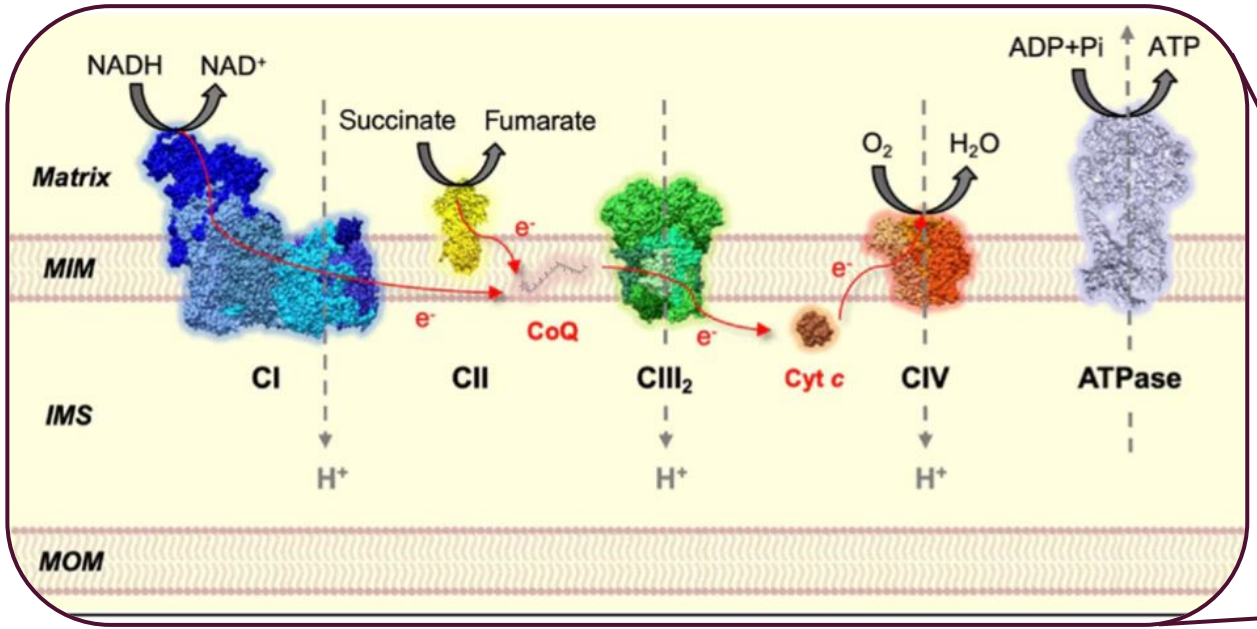
- genoma circular *
- +- 16500pb *
- 37 genes *
  - 13 proteínas
  - 22 tRNAs
  - 2 rRNAs
- +- 1500 proteínas *

-> A maior parte das proteínas é codificada no genoma nuclear!



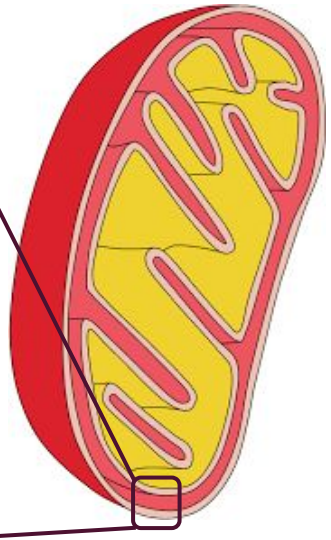
* nem sempre!

A central energética da célula



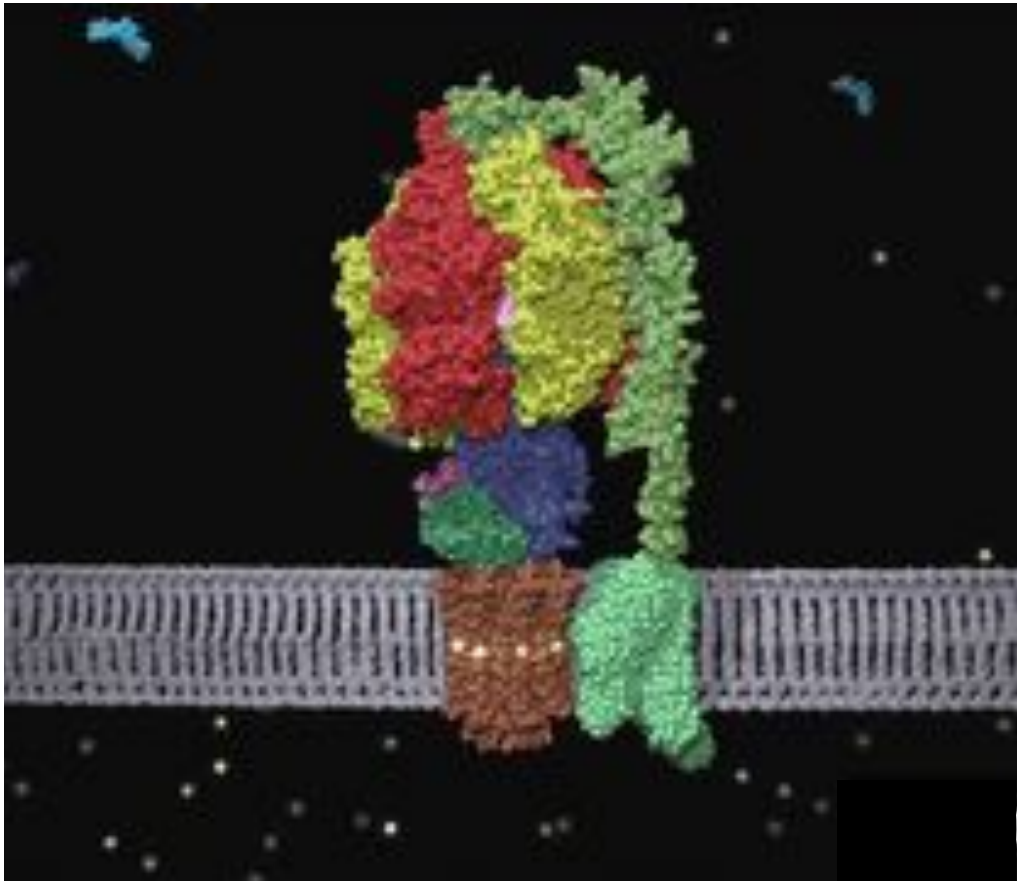
Membrana interna

Membrana externa



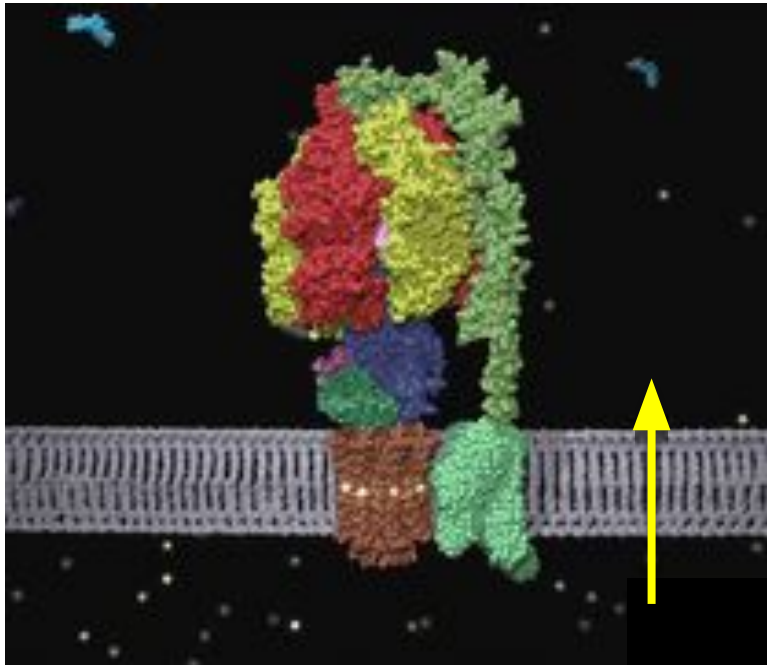
- respiração celular
- do piruvato ao ATP
- oxidação gera acúmulo de H^+ no espaço intermembranas

A central energética da célula

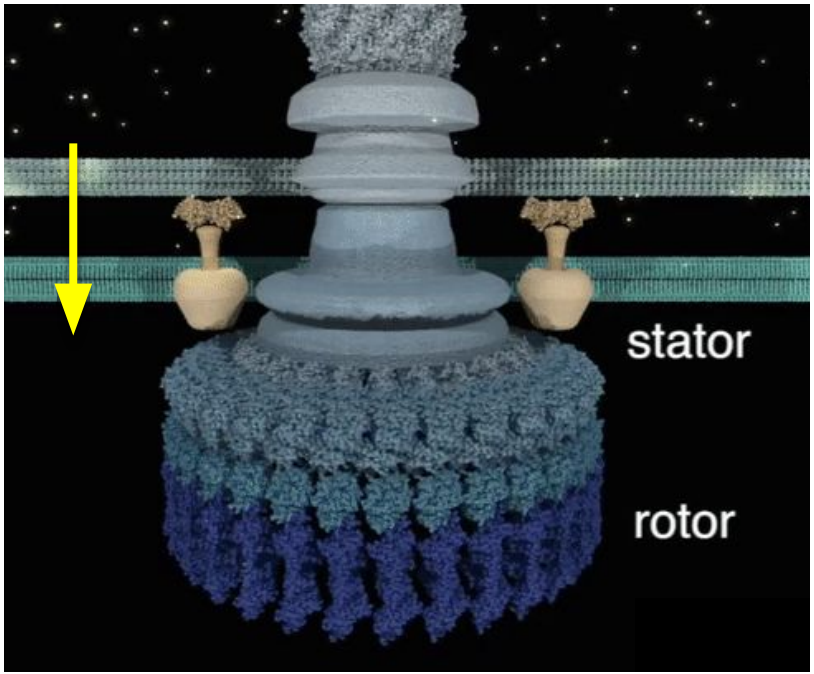


ATP sintase

A central energética da célula



ATP sintase



Flagelo bacteriano

A endosimbiose

Lynn Margulis Sagan

1966

- dupla membrana
- tamanho/forma semelhante a bactérias
- divisão por fissão binária
- DNA & ribossomos próprios
- sensibilidade a antibióticos

Uma célula dentro de outra célula

On the Origin of Mitosing Cells

LYNN SAGAN

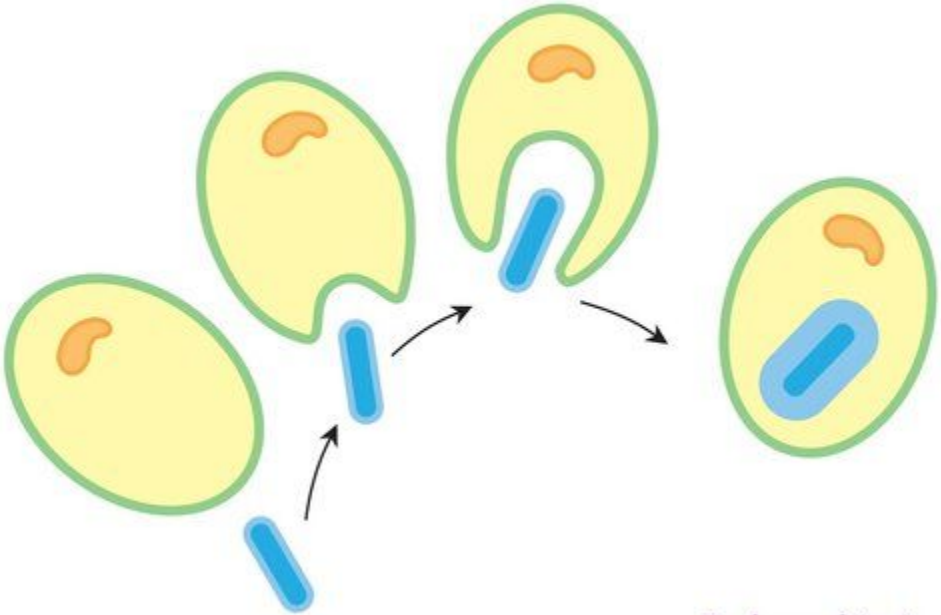
Department of Biology, Boston University
Boston, Massachusetts, U.S.A.

J. Theoret. Biol. (1967) **14**, 225–274

https://doi.org/10.1016/0022-5193(67)90079-3

A endosimbiose

Lynn Margulis Sagan



Uma célula dentro de outra célula

A endosimbiose

1978

Evidência molecular

- comparação de sequências de proteínas

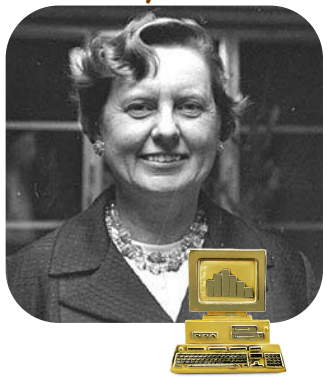
  proteínas mitocondriais

  -> semelhantes às de bactérias

  -> diferentes de eucarióticas

	115								120					125				
Sequence A	F	S	T	A	A	F	R	F	G	H	A	V	H	P	L	V	R	R	L
Sequence B	F	S	T	A	A	F	R	F	G	H	A	V	H	P	L	V	R	R	L
Sequence C	F	S	T	A	A	F	R	F	G	H	A	V	H	P	L	V	R	R	L
Sequence D	F	S	T	A	A	F	R	F	G	H	A	I	H	P	L	V	R	R	L
Sequence E	F	A	T	A	A	F	R	F	G	H	A	V	Q	P	I	V	R	R	L
Sequence F	F	T	T	A	A	F	R	F	G	H	A	I	P	P	M	V	H	R	L
Consensus	F	s	T	A	A	F	R	F	G	H	A	v	h	P	I	V	r	R	L

Margaret Dayhoff



Robert Schwartz

Origins of Prokaryotes, Eukaryotes, Mitochondria, and Chloroplasts

A perspective is derived from protein and nucleic acid sequence data.

Robert M. Schwartz and Margaret O. Dayhoff

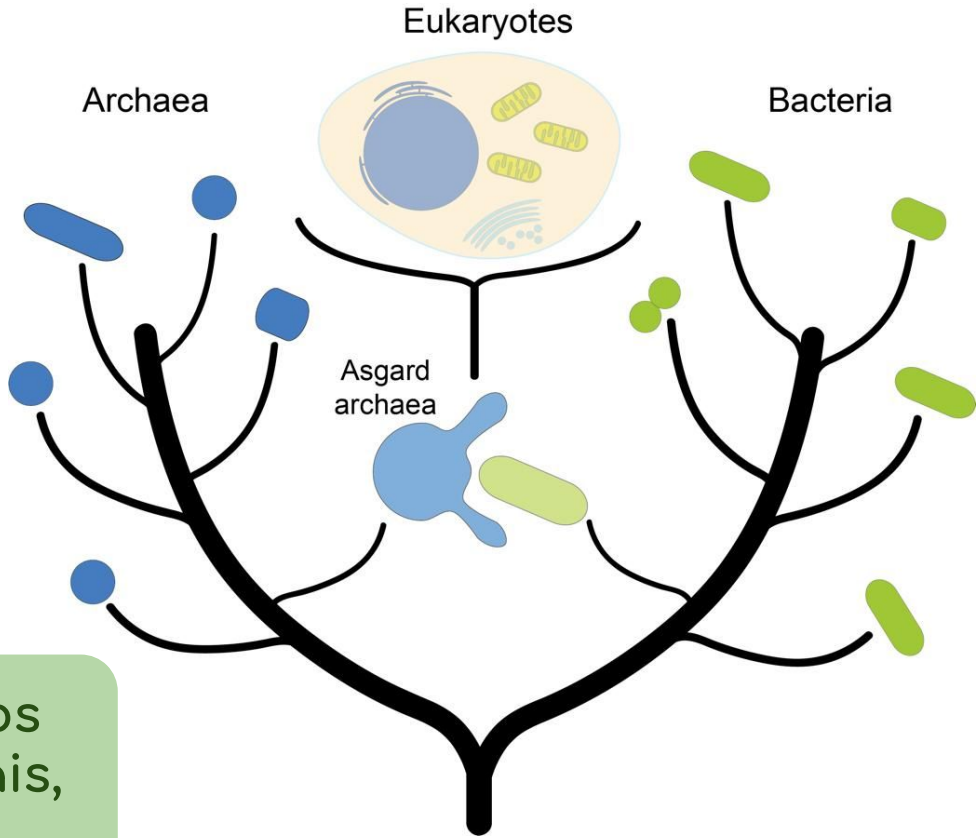
SCIENCE, VOL. 199, 27 JANUARY 1978
0036-8075/78/0127-0395$02.00/0

https://doi.org/10.1126/science.202030

A endosimbiose

Uma α-proteobactéria englobada por uma archaea

+- 1,5 bilhões de anos atrás



Tudo isso também se aplica aos cloroplastos das células vegetais, mas com uma cianobactéria

A endosimbiose

Todos eucariotos descendem de um único ancestral comum

echinodermos vegetais poríferos

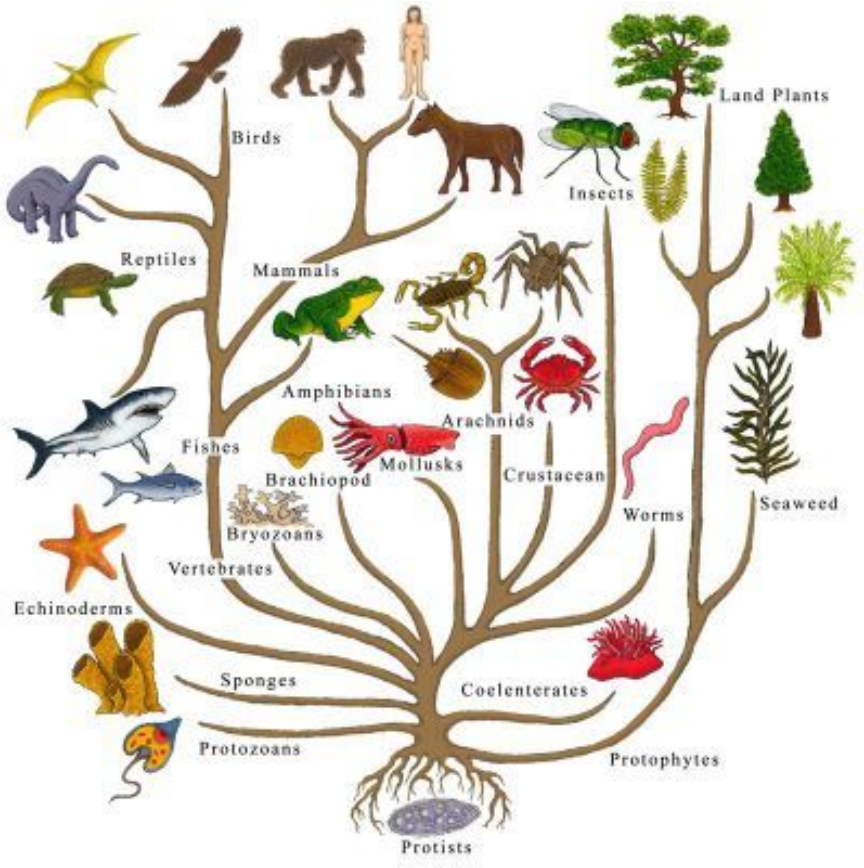
insetos plantas vermes

fungos animais leveduras crustáceos

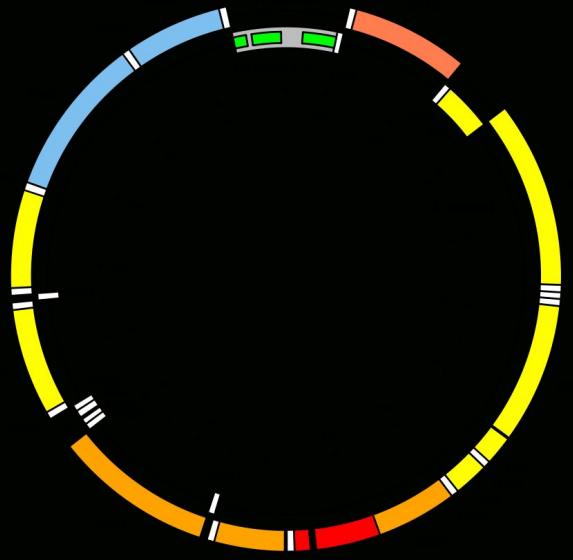
protozoários algas moluscos

e *todos** têm mitocôndrias

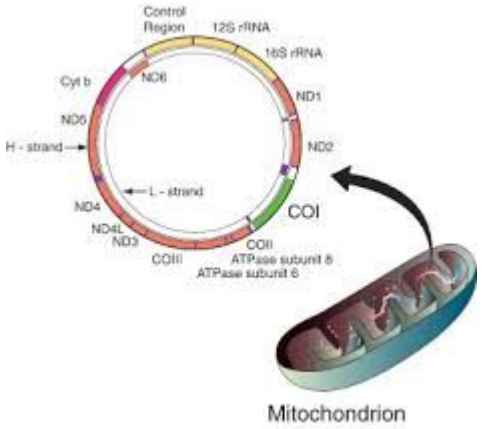
*quase todos



A mitocôndria e a biodiversidade



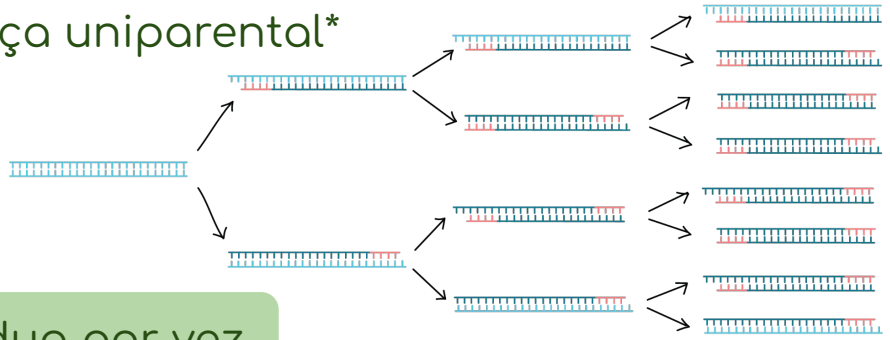
A mitocôndria e a biodiversidade



DNA *barcoding* (2003)

-> identificar uma espécie a partir de um pedacinho do seu DNA

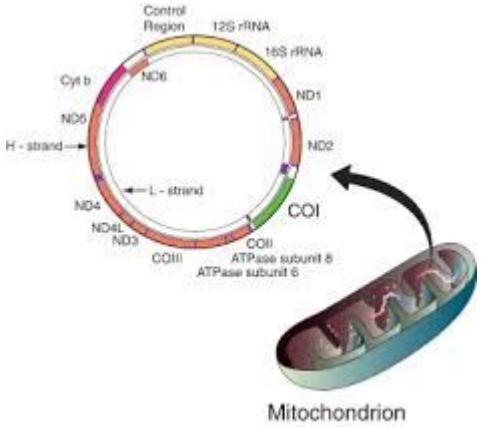
- mitocôndrias não recombinam, herança uniparental*
- amplificação por **PCR**, sequenciamento por **Sanger**



1 único DNA de 1 único indivíduo por vez

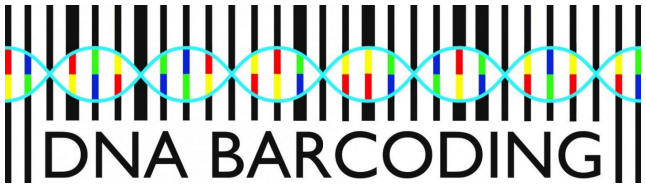
- genes conservados -> um mesmo *primer funciona pra todos*

DNA barcoding



- Um <u>código</u> = Um <u>produto</u>;
- Identificação rápida;
- Catálogo de <u>produtos</u> e <u>códigos</u>.

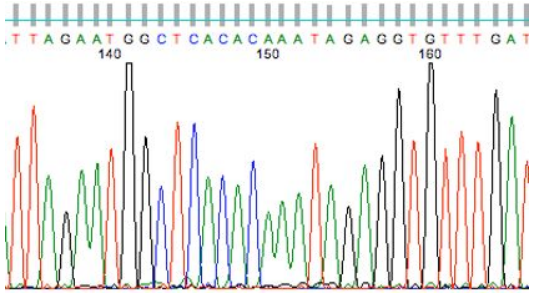
≈

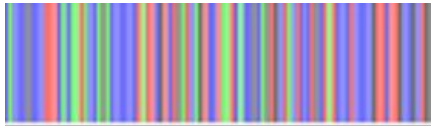


- Uma <u>sequência</u> = Uma <u>espécie</u>;
- Identificação rápida;
- Catálogo de <u>espécies</u> e <u>sequências</u>
- **Marcador molecular: COI**

DNA barcoding

Espécie A





barcode

Banco de referência

Espécie A

Espécie B

Espécie C

Espécie D

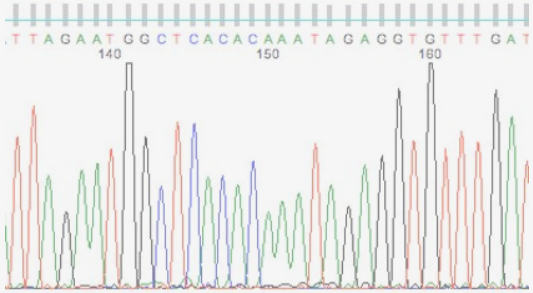
Espécie E

Espécie F

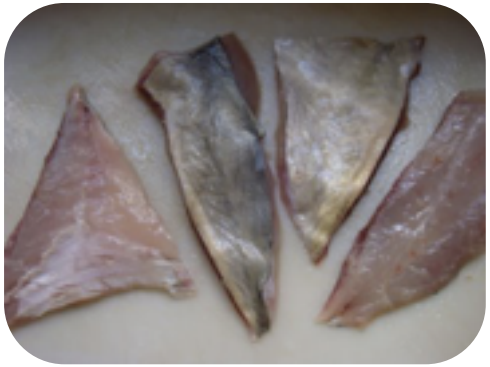
Espécie G

DNA barcoding

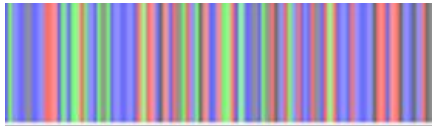
Espécie A



barcode



Espécie ????



Espécie A

DNA barcoding

Prof. Daniel Carvalho

Laboratório de Genética da Conservação

@lgc_pucminas

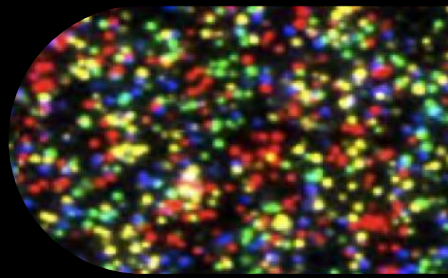
PUC Minas

Programa de Pós-graduação em biodiversidade e meio ambiente

site do PPG

NGS: sequenciamento de nova geração

NGS: sequenciamento de nova geração

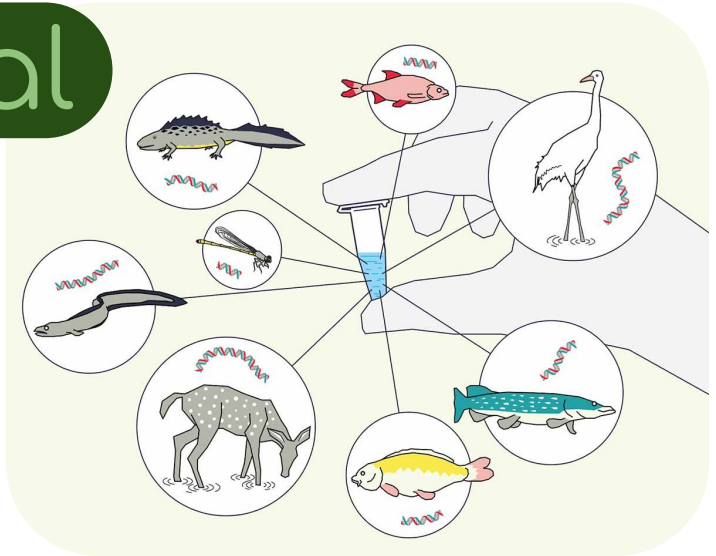


2005

- Antes, **1 DNA** por vez, agora, **milhões** ao mesmo tempo
- Genética -> Genômica
- 1 indivíduo -> amostras complexas
- DNA *barcoding* -> ***eDNA metabarcoding***

O DNA ambiental

O DNA ambiental



eDNA metabarcoding

- Amplificação do DNA de um grupo específico a partir de uma amostra ambiental complexa

- Sequenciamento de nova geração -> **toneladas de informação**

- Análise computacional -> bioinformática

→ Detectar organismos a partir de vestígios ambientais

O eDNA na PUC Minas

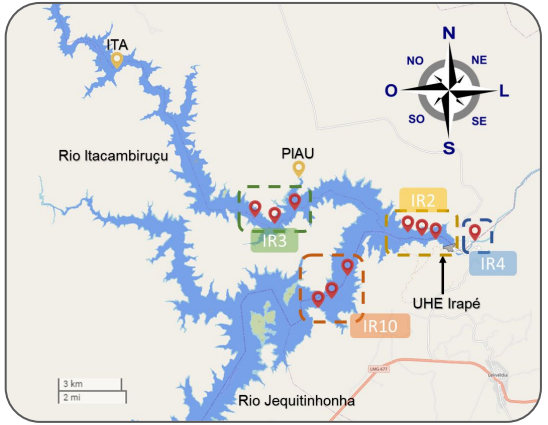
P&D CEMIG

2020

- Bacia do Rio Jequitinhonha;
- Reservatório mais profundo do BR 205m;
- Área inundada de 137,16 km²;

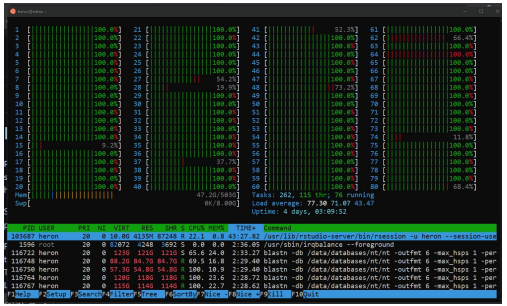
eDNA

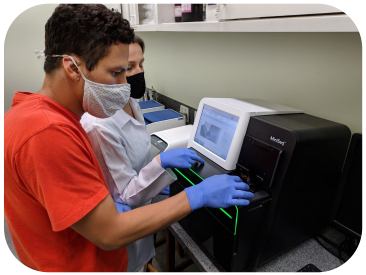
Redes de emalhar

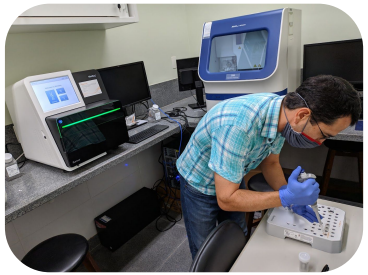


O eDNA na PUC Minas

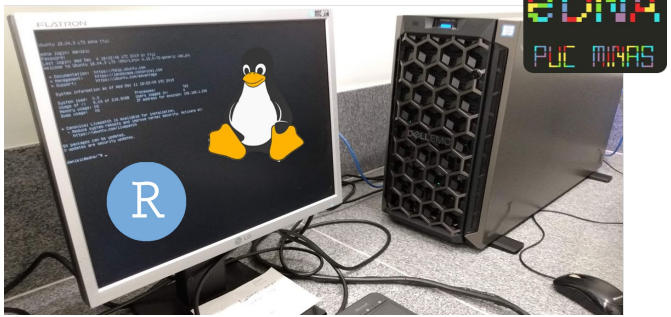
Sala limpa





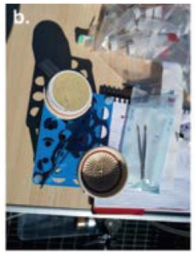


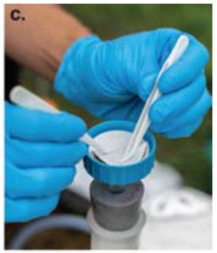
Sequenciador NGS



Servidor computacional

O eDNA na PUC Minas





O eDNA na PUC Minas

Environmental DNA
Open Access
Dedicated to the study and use of environmental DNA for basic and applied sciences

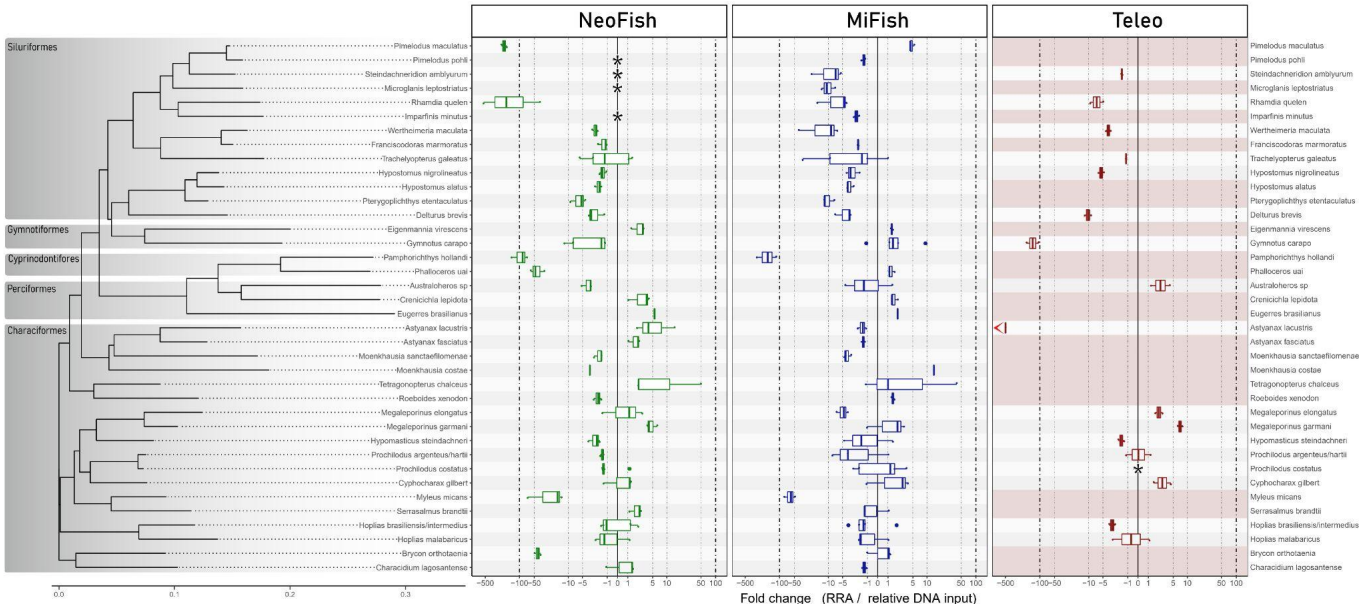
ORIGINAL ARTICLE | Open Access

DNA metabarcoding of mock communities highlights potential biases when assessing Neotropical fish diversity

Heron Oliveira Hilário, Izabela Santos Mendes, Naiara Guimarães Sales, Daniel Cardoso Carvalho

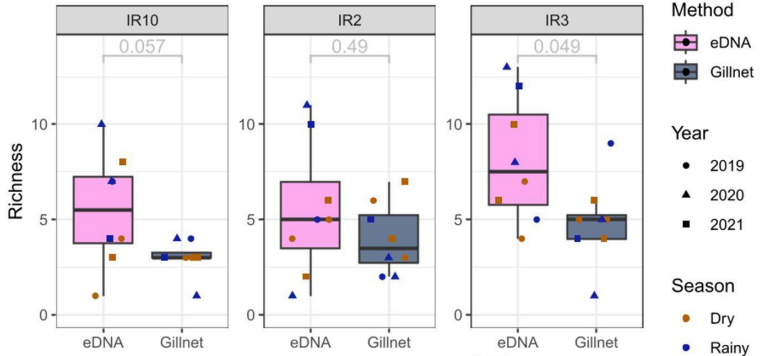
Dr. Eu

Dra. Izabela Mendes

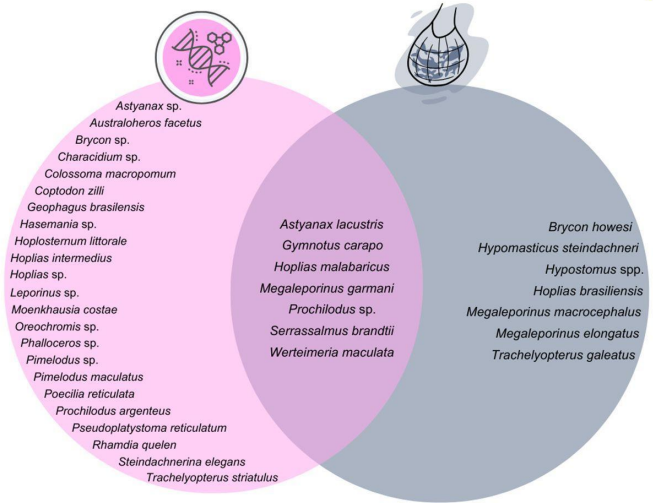


O eDNA na PUC Minas

a

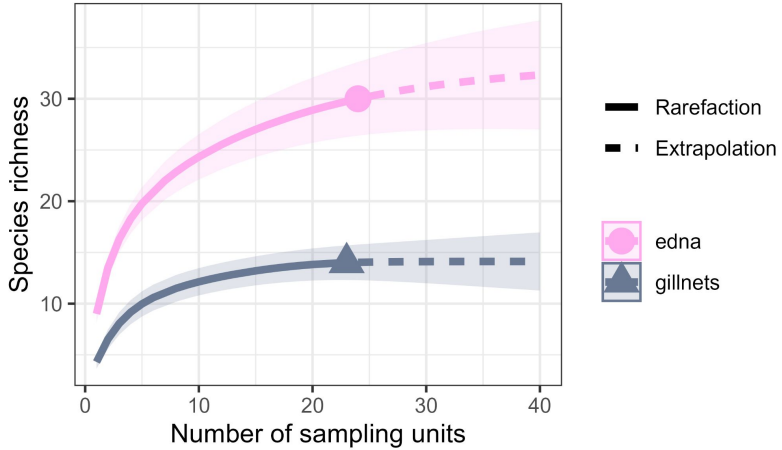


b

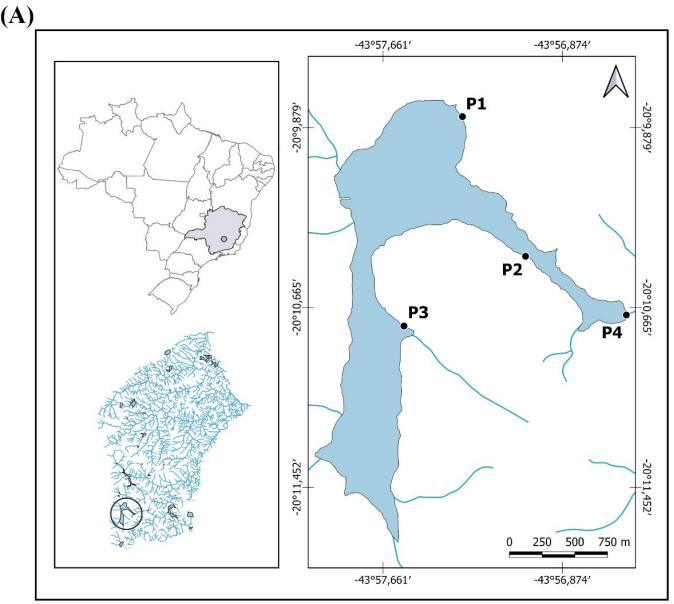


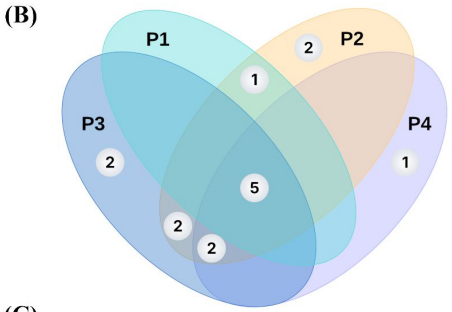
Dra. Izabela Mendes

ACCEPTED



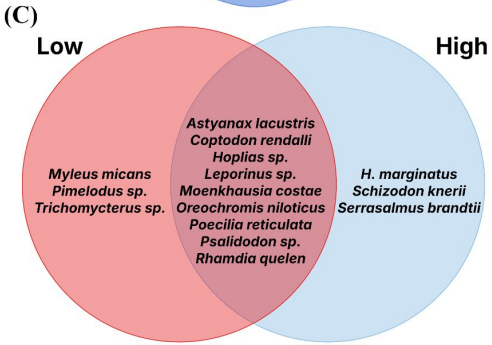
O eDNA na PUC Minas

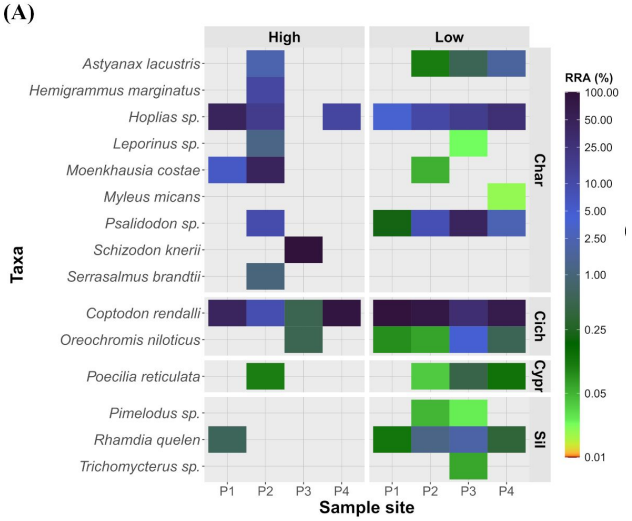




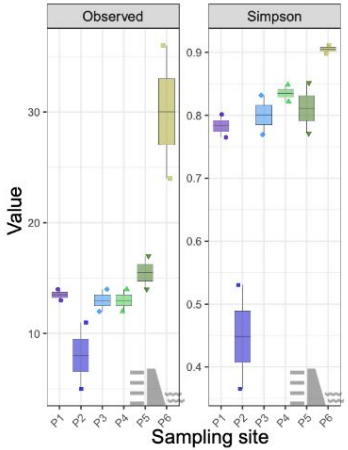
MSc. Gabriel Mendes

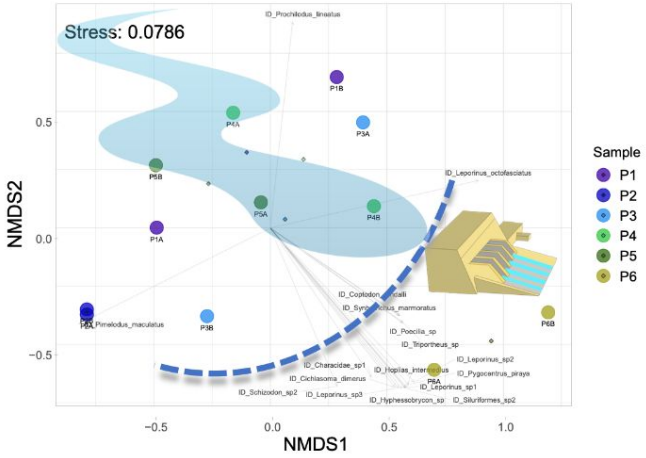
ACCEPTED





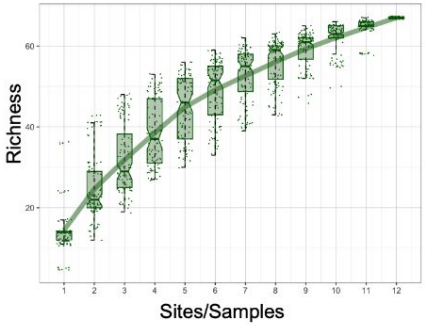
O eDNA na PUC Minas



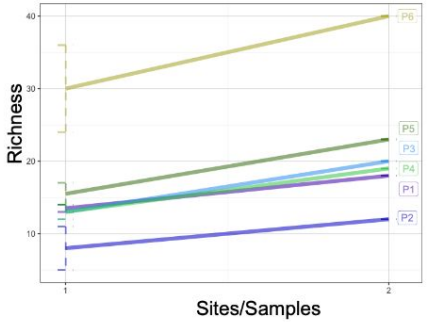


Prof. Daniel Carvalho

D



E



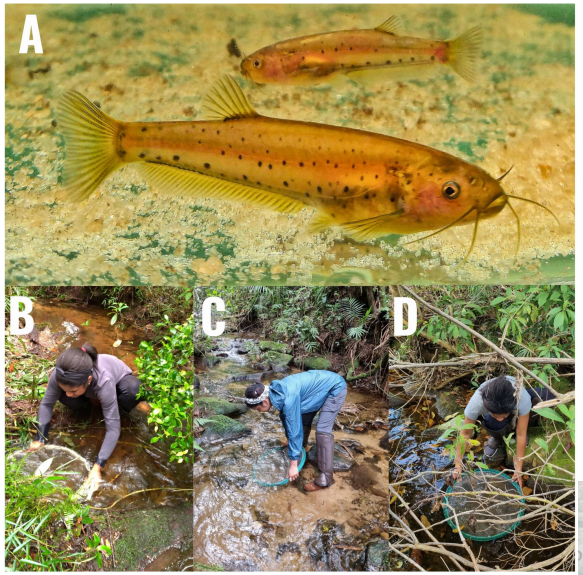
ORIGINAL ARTICLE | Open Access

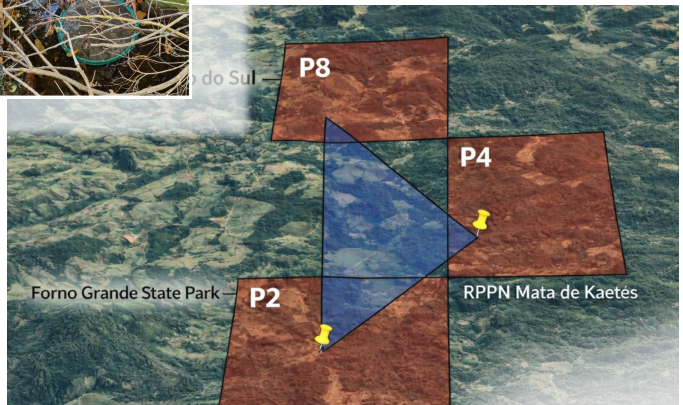
Low-Effort eDNA Sampling Reveals Fish Community Patterns in a Neotropical River Basin

Daniel Cardoso Carvalho, Heron Oliveira Hilário, Igor Henrique Nascimento, Guilherme Costa Berger, Paulo Santos Pompeu

First published: 06 August 2025 | https://doi.org/10.1002/edn3.70164 | VIEW METRICS

O eDNA na PUC Minas





Dr. Eu

MSc. Juliana Novelli

Neotropical Ichthyology

Original article

https://doi.org/10.1590/1982-0224-2026-0

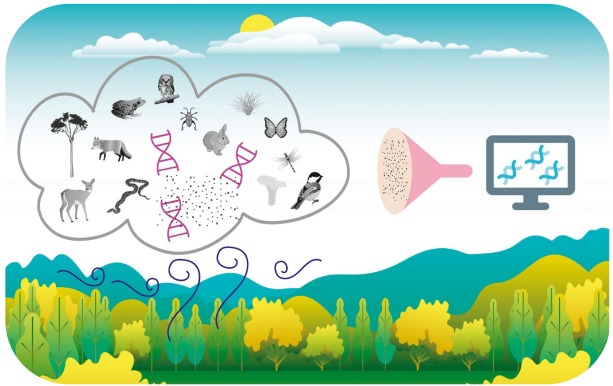
ACCEPTED

Detection of the critically endangered catfish *Trichogenes claviger* (Siluriformes: Trichomycteridae) using environmental DNA

Correspondence:
Luisa Maria Sarmento-Soares
sarmento.soares@gmail.com

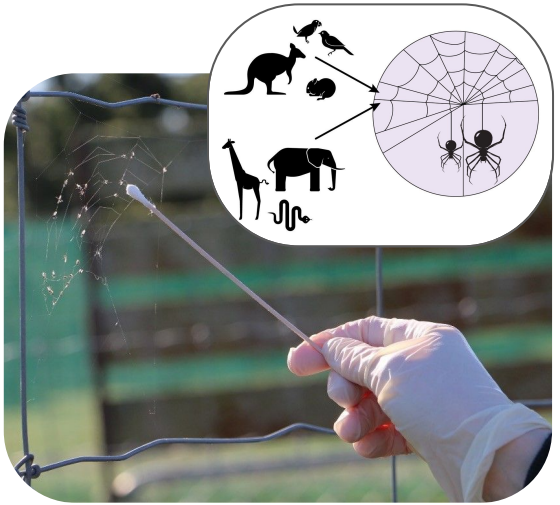
Juliana Paulo da Silva-Novelli[1,2], Heron Oliveira Hilário[3], Daniel Cardoso Carvalho[3], Ronaldo Fernando Martins-Pinheiro[4] and Luisa Maria Sarmento-Soares[1,4,5]

(e)DNA metabarcoding
infinitas possibilidades



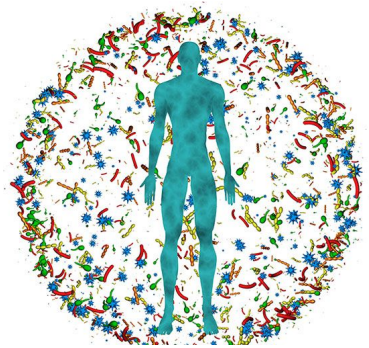
eDNA do ar

iDNA
DNA ingerido

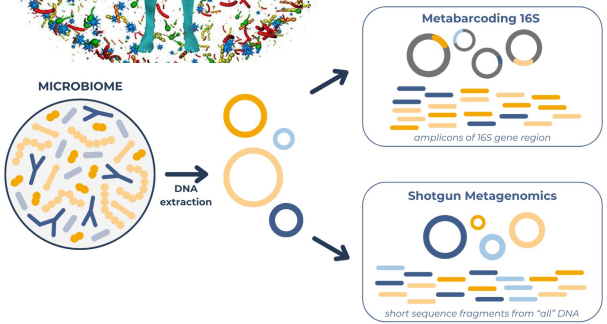


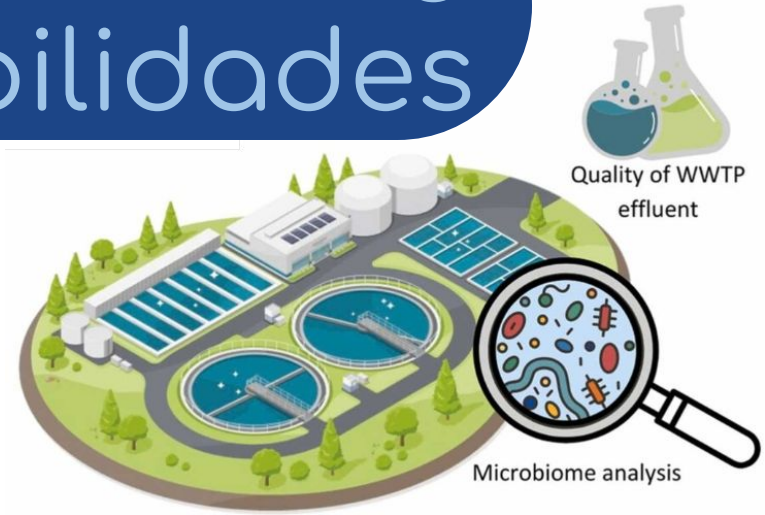
eDNA de teias
de aranha

(e)DNA metabarcoding
infinitas possibilidades



Microbioma:
microorganismos associados à nós, na saúde e na doença





Vigilância genômica:

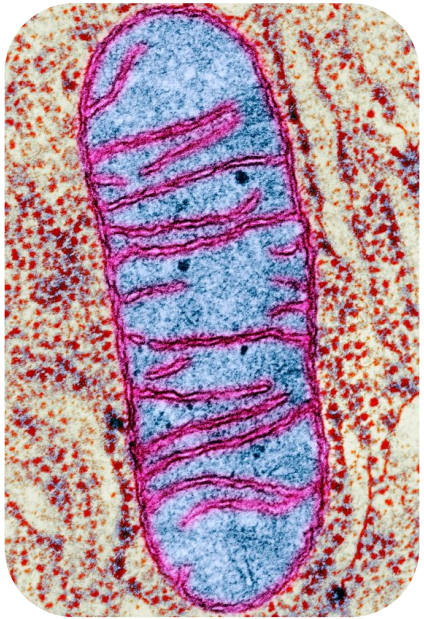
- detecção precoce de vírus, bactérias, protozoários
- genes de resistência em efluentes
- zoonoses

Obrigado!

Grupo de Estudos em Genética

GENETICANDO

@geneticandopucpl



Grupo de Estudos em Citologia e Histologia

GECIH

@gecih.pucmg


Obrigado!