

Previous course

Characteristics of living organisms

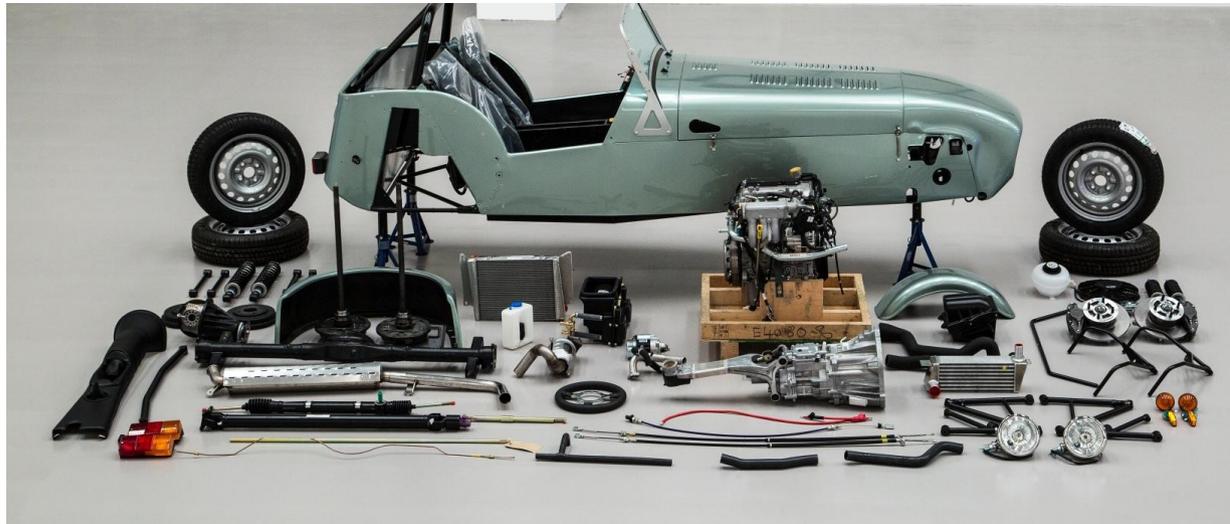
Main molecules in living organisms

Virus, Bacteria, Eucaryote, Archaea

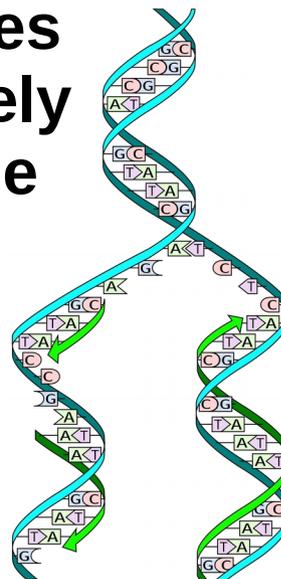
Cell division, Virus amplification

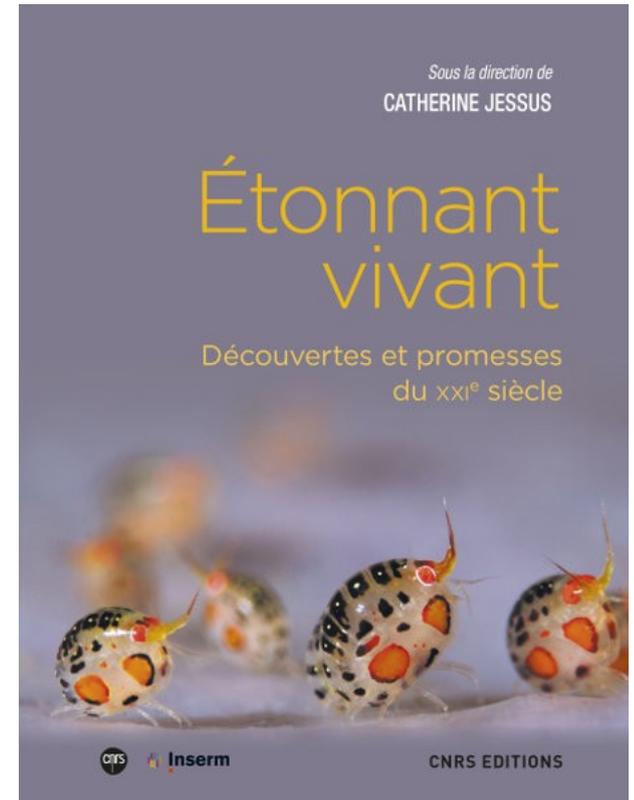
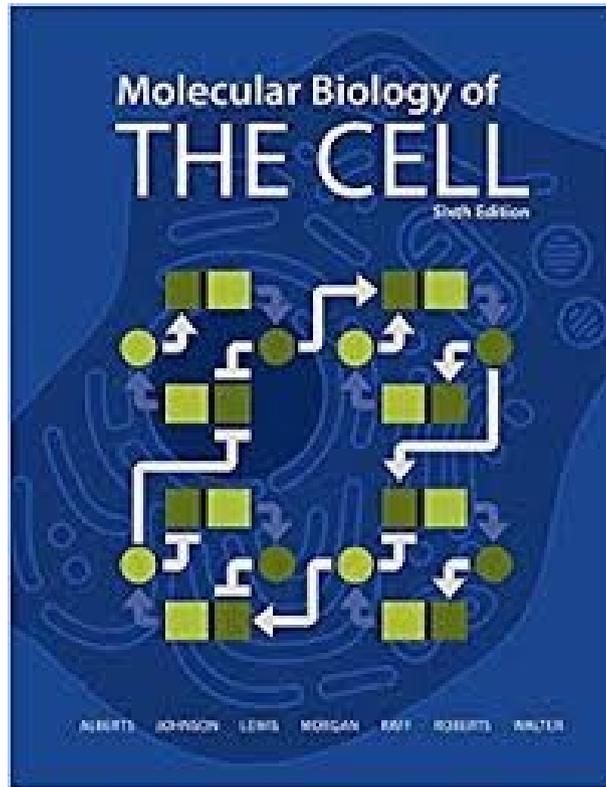
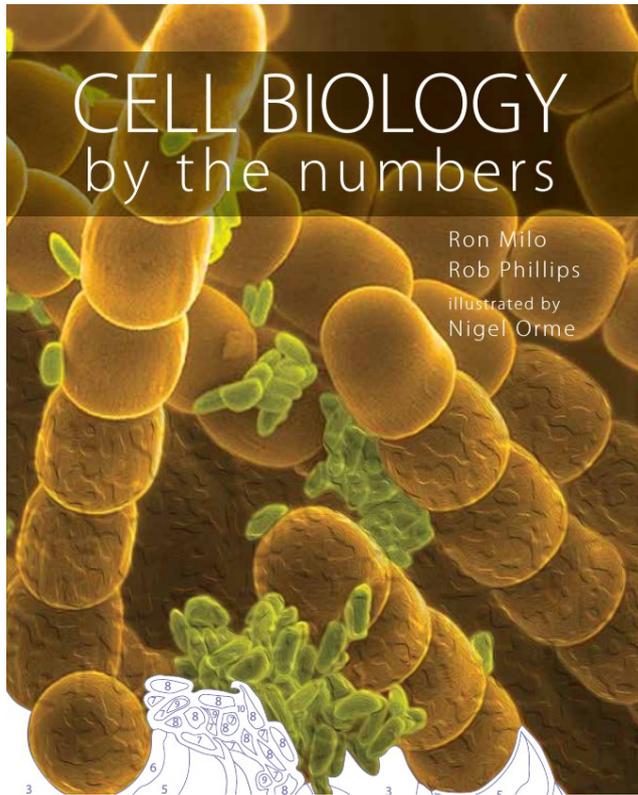
Ecological observations

A living organism is not made by assembling pieces together



..but results from changes that occurred successively across evolutionary time





Bionumbers.org

Anthropocene

Anthropocene

proposed geologic timescale dating from the commencement of significant human impact on Earth's geology and ecosystems, including anthropogenic climate change

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Plastic

Pollution

Transports

Humans move sediments at rates higher than all rivers together (mines, constructions)

Extensive Agriculture (deforestation)

Climate change

Biodiversity crisis

Anthropocene

proposed geologic timescale dating from the commencement of significant human impact on Earth's geology and ecosystems, including anthropogenic climate change

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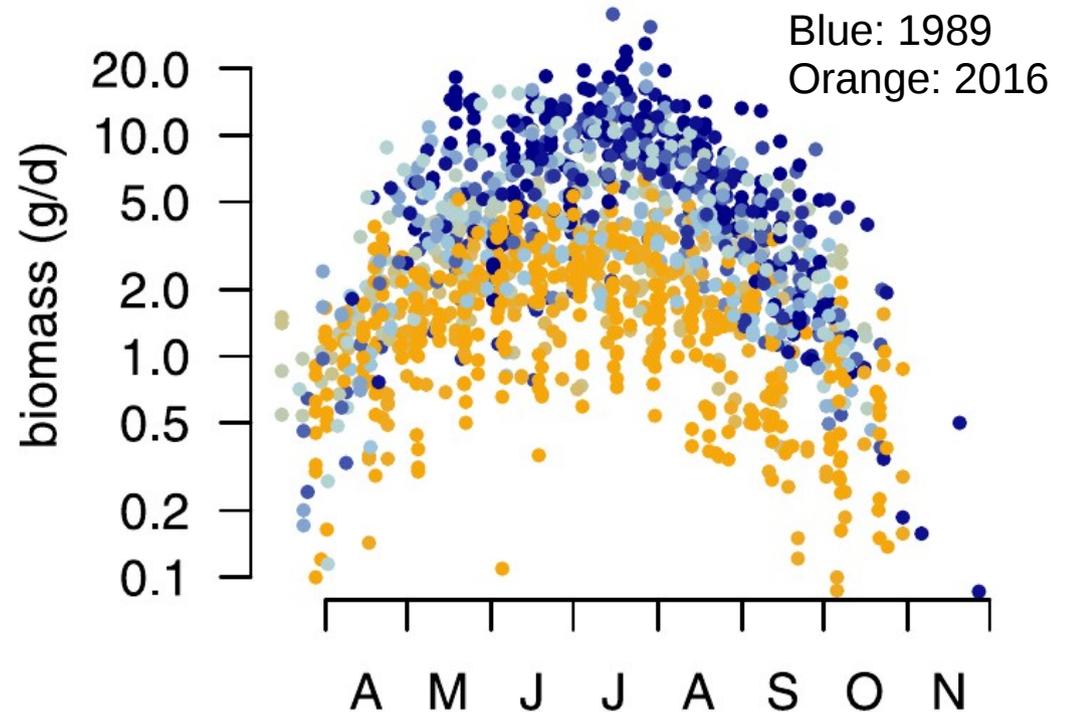
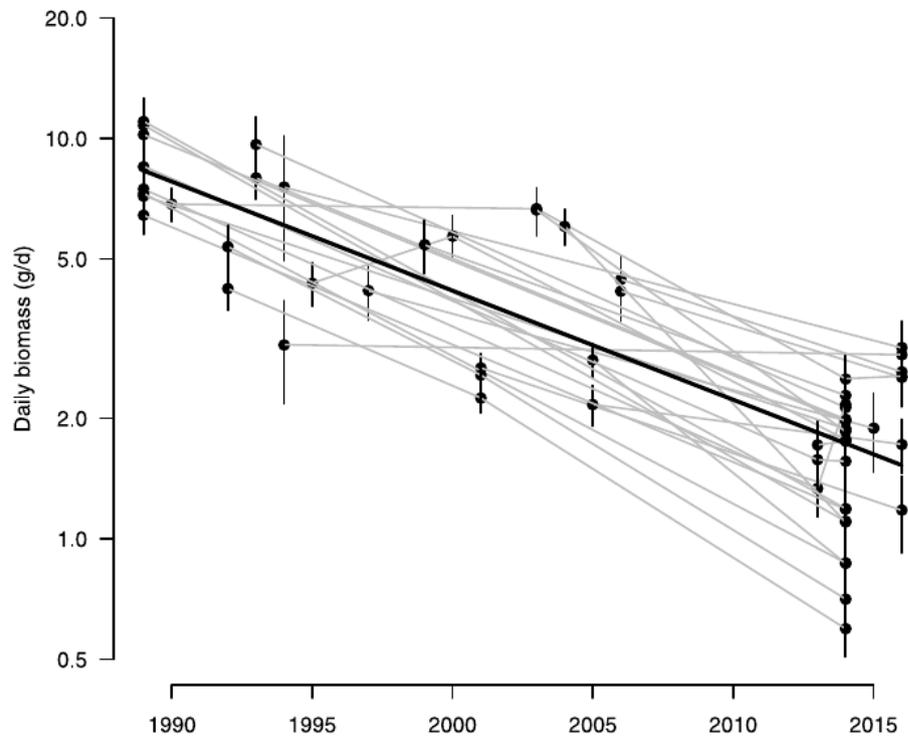
Biodiversity crisis

*Not all human, certain human activities - **Capitalocene** (D. Haraway, J. Moore)*

75% decline of flying insect biomass in 27 years



Malaise trap
96 unique location-year samplings
in Germany from 1989 to 2016 (27 years)
~50 kg of insects collected



Finding causes for the decline

Check various parameters: climate (T, precipitations, frost days, light...), habitat (plants, pH...), land use

Decline = evident throughout the growing season
irrespective of habitat type or landscape configuration

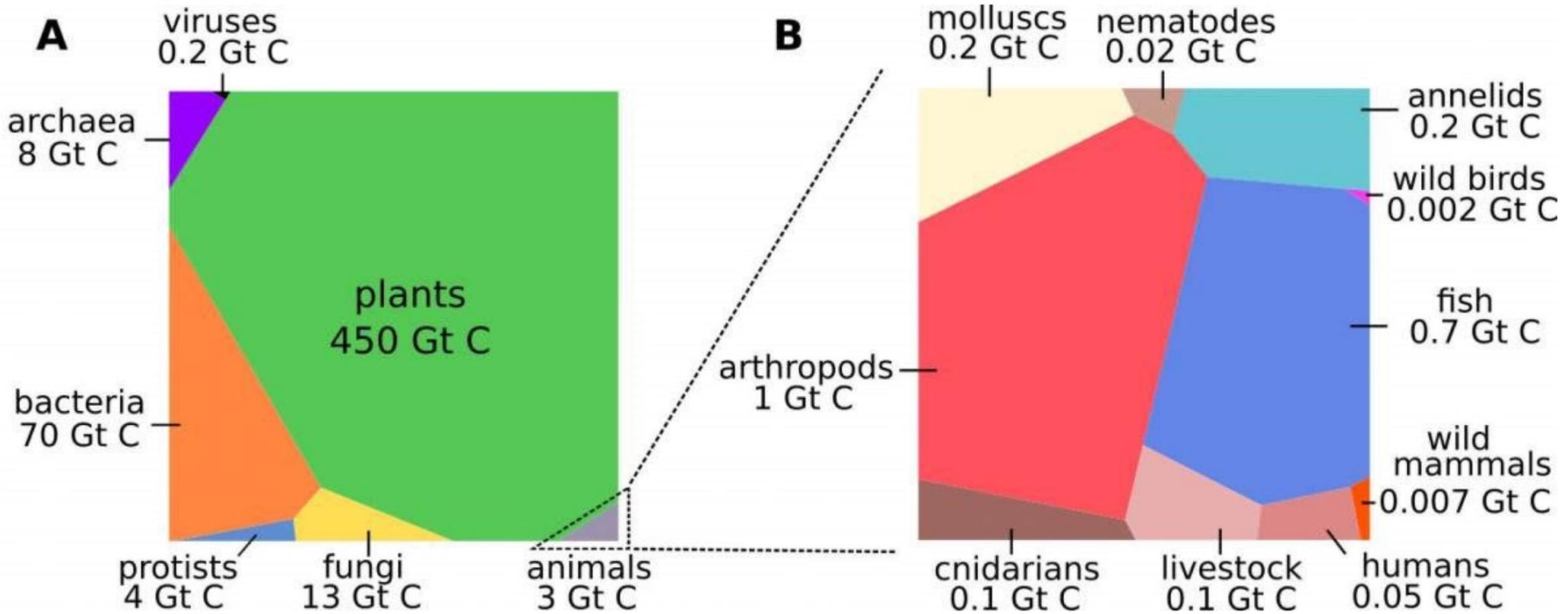
Temperature: increase in 0.5°C, should have increased insect biomass

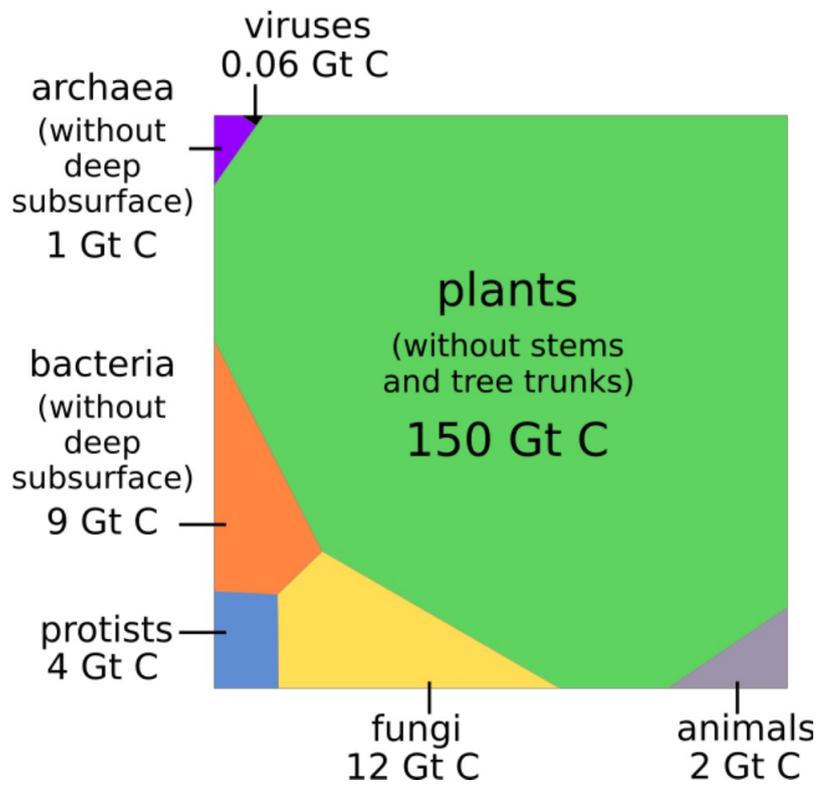
Pesticide usage not tested

What is the largest biomass on earth ?

- Insects**
- Viruses**
- Bacteria**
- Green plants**

Biomass distribution on earth

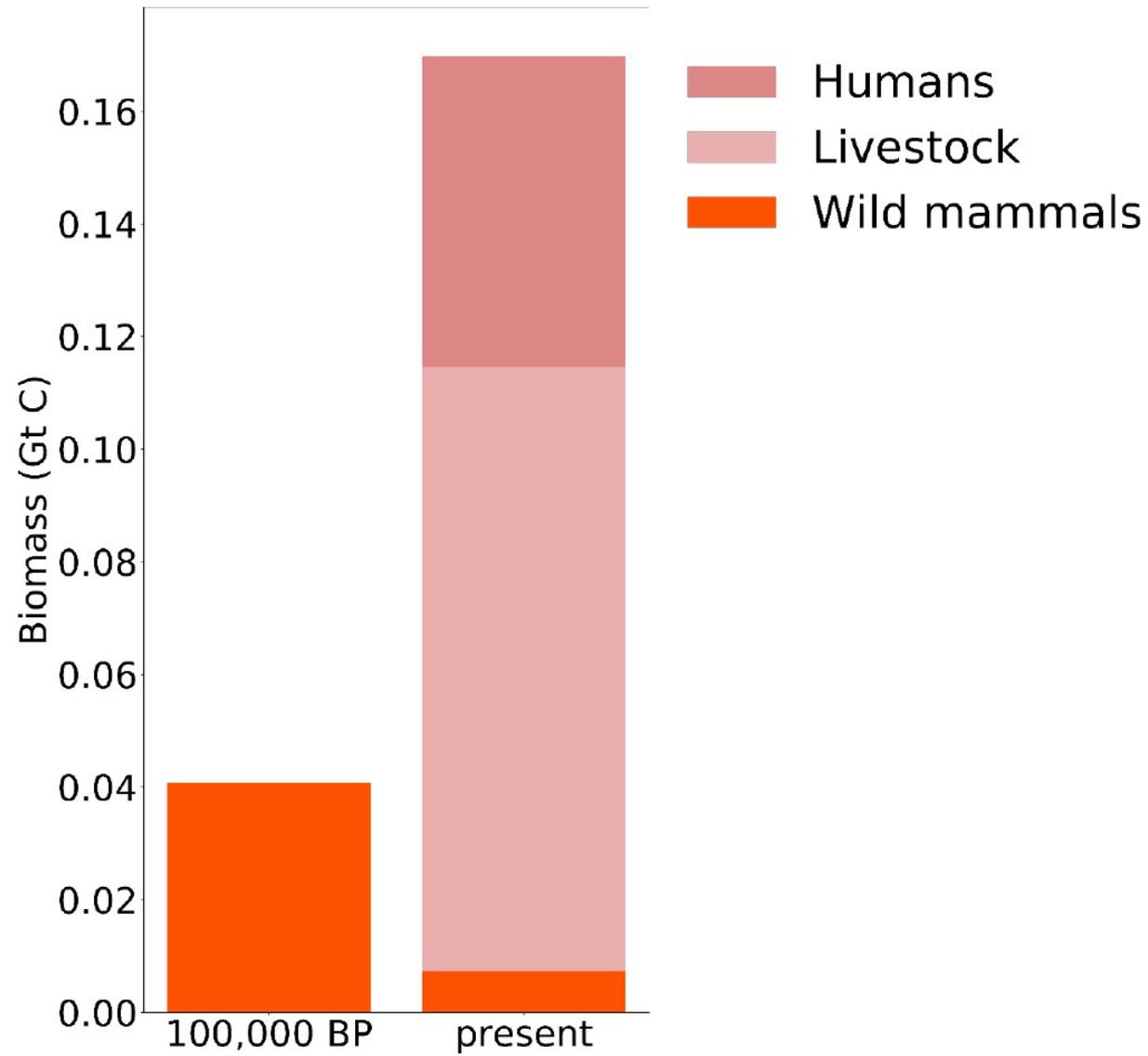


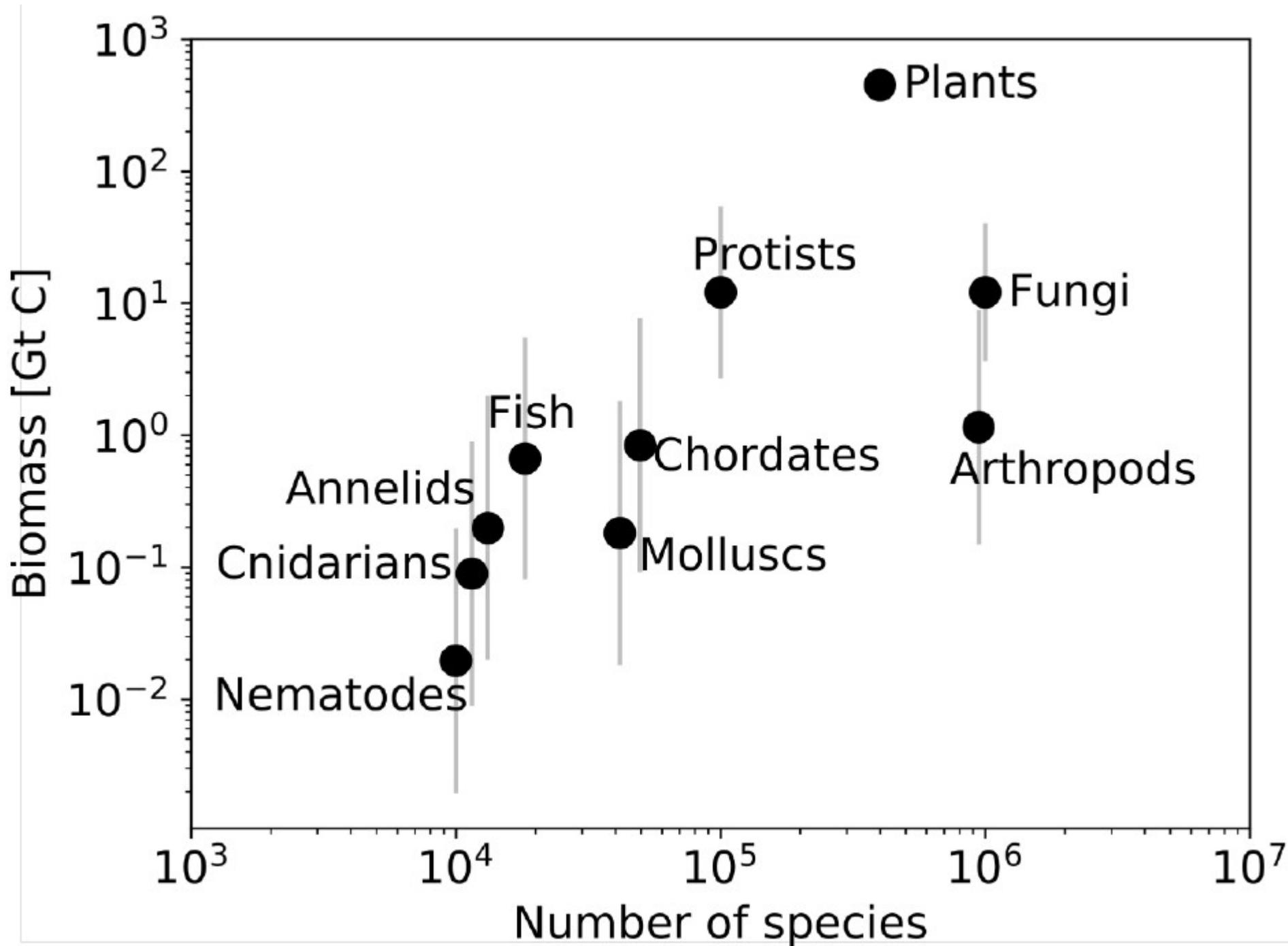


Which has the largest biomass ?

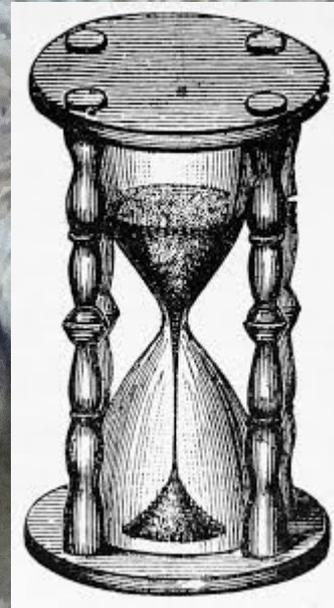
- all humans
- all cattles







Living entities through time

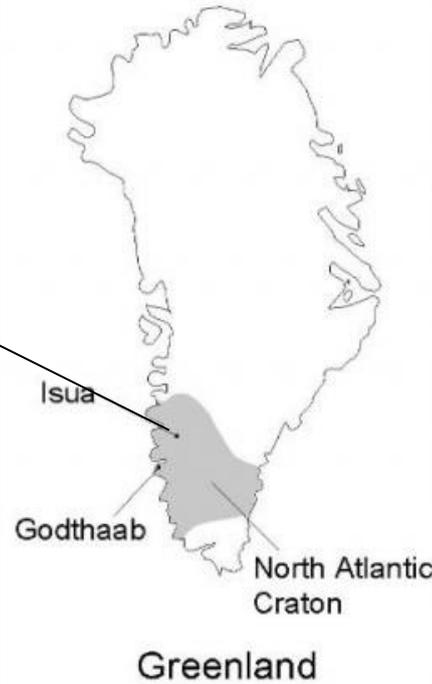


Past history of life

Les plus vieilles roches affleurant à la surface



3,80 MMA



4,03 MMA



3,60 MMA



4,5

milliards d'années

formation
de la terre

Les plus vieilles traces de vie

3,48MMA: Biofilm



(Noffke et al. 2013)

3,7MMA: Graphite biogénique



(Ohtomo et al. 2013)

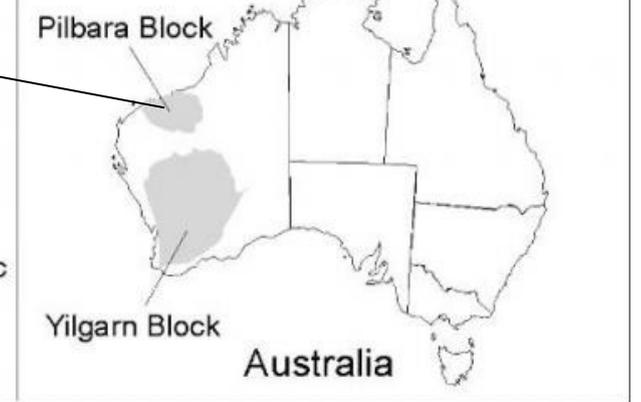
3,80 MMA



4,03 MMA

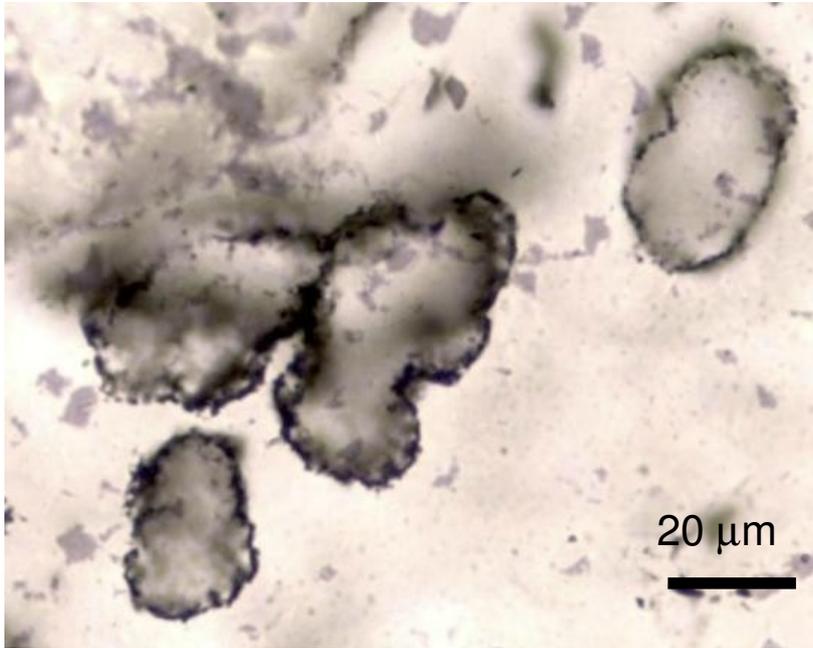


3,48 MMA



1ères traces (graphite)

Premières cellules fossilisées : 3,4 MMA



(Wacey et al. 2011)



Strelley Pool Formation, Australie



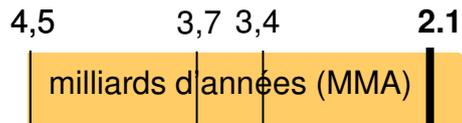
1ères traces (graphite)
1ères cellules fossiles

Multicellular organisms : 2 MMA



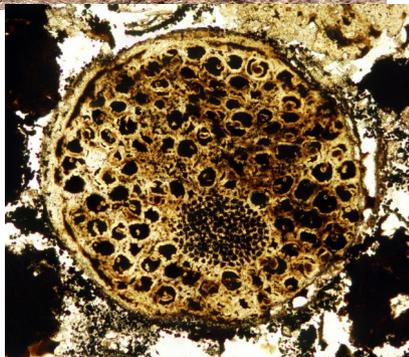
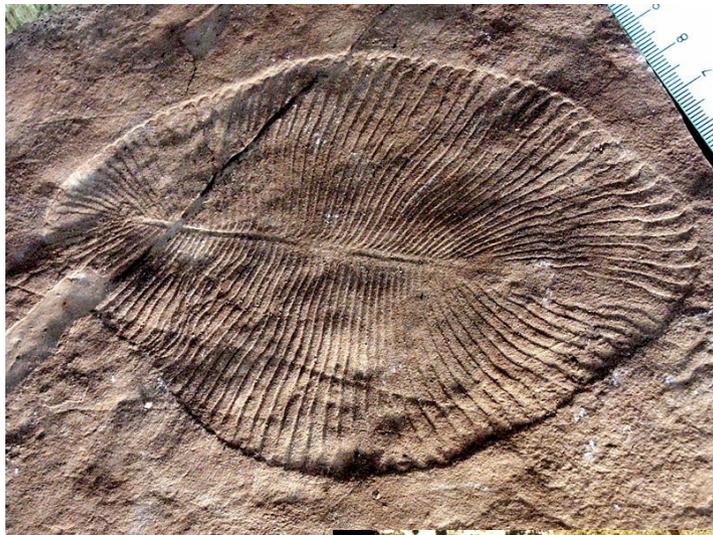
In Gabon

Concomittant with a peak in oxygen levels (from 0,1 % à 15 %)



1ères traces (graphite)
1ères cellules fossiles
1st multicellular organisms

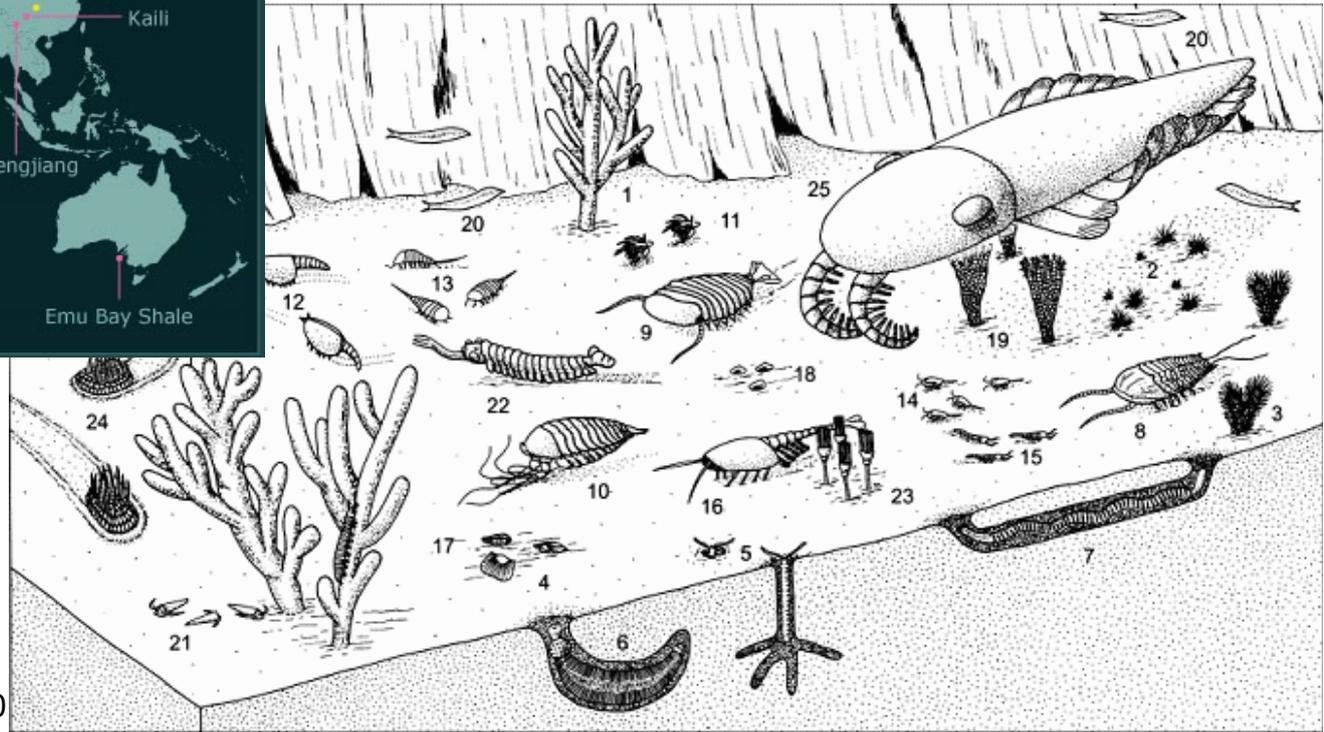
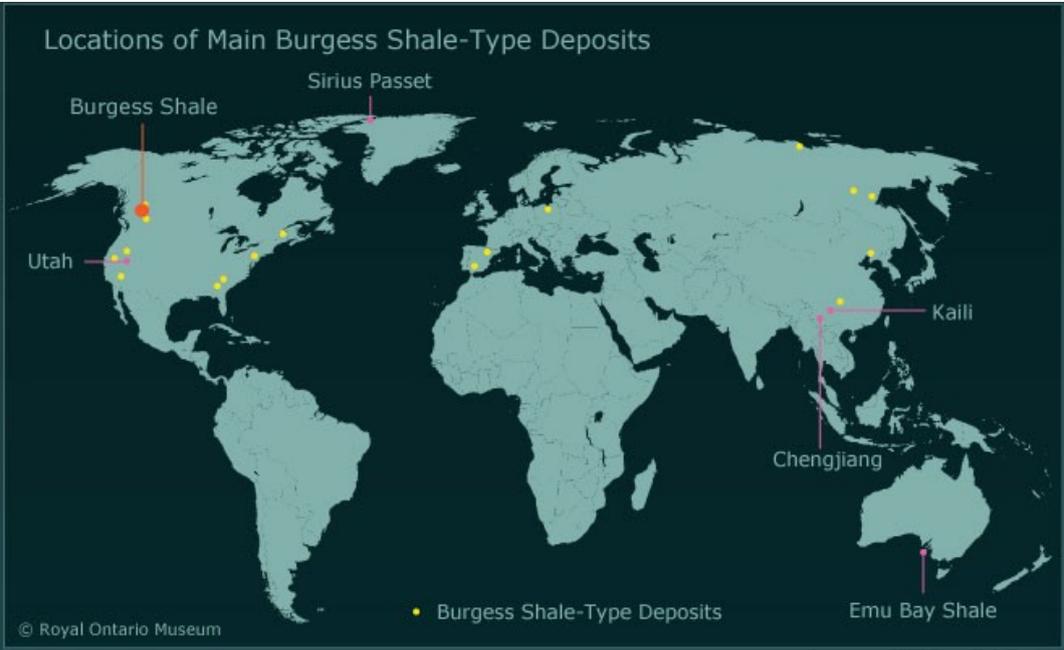
Fossiles d'Ediacara : 630-540MA



1ères traces (graphite)
1ères cellules fossiles

1ers fossiles complexes
faune d'Ediacara

Cambrian explosion : -540MA -480MA



4,5
milliards d'années

3,7 3,4

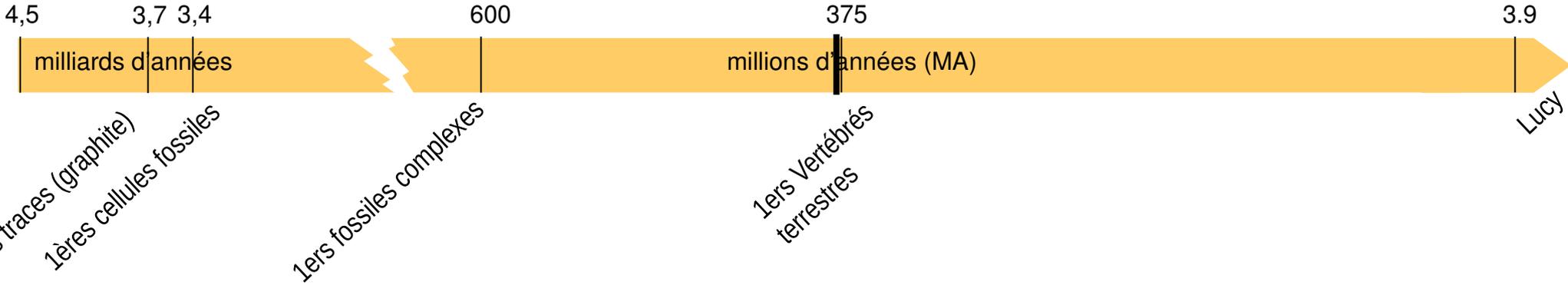
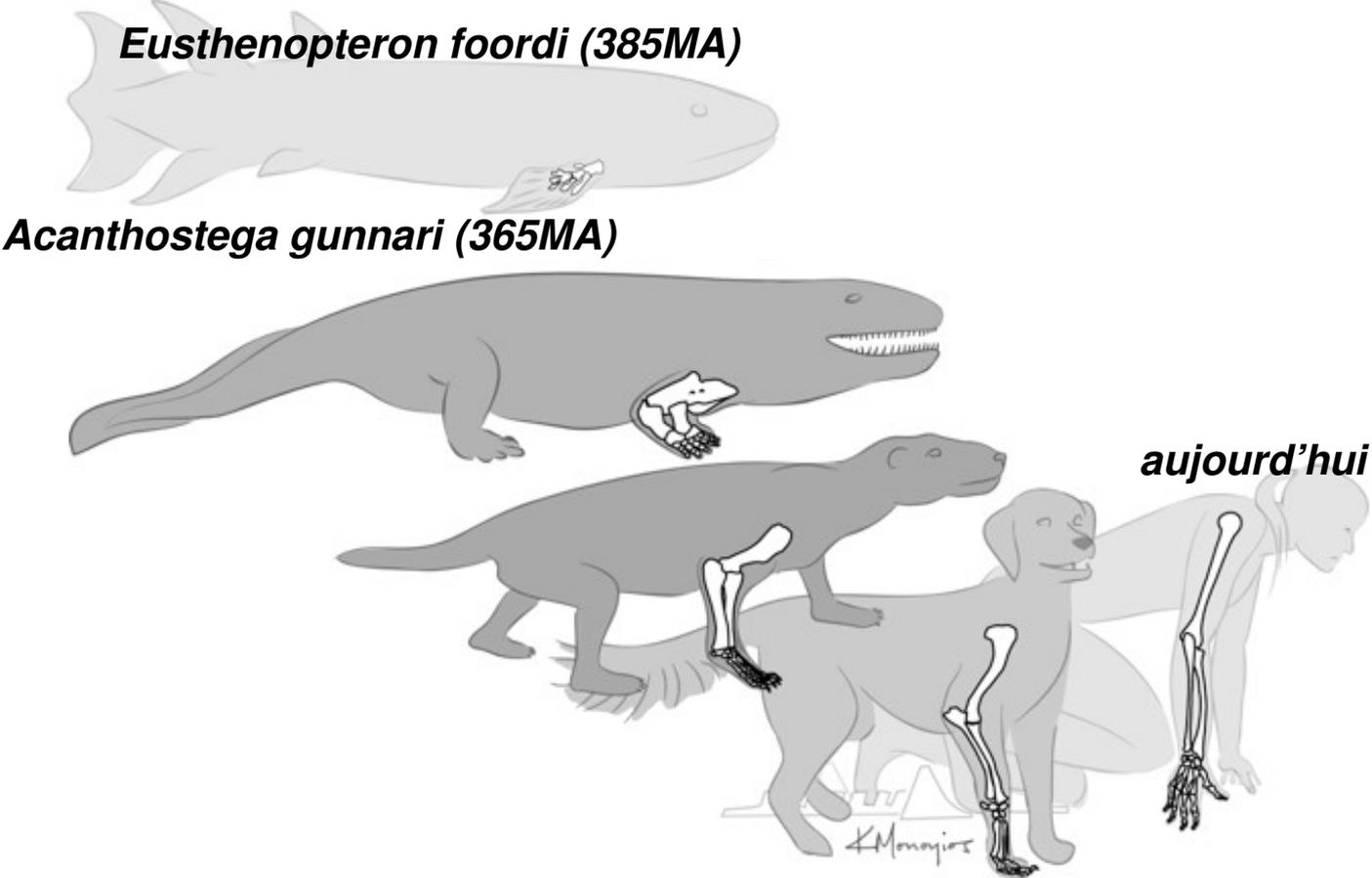
630-540

1ères traces (graphite)
1ères cellules fossiles

1ers fossiles complexes
faune d'Ediacara



Sortie de l'eau des Vertébrés

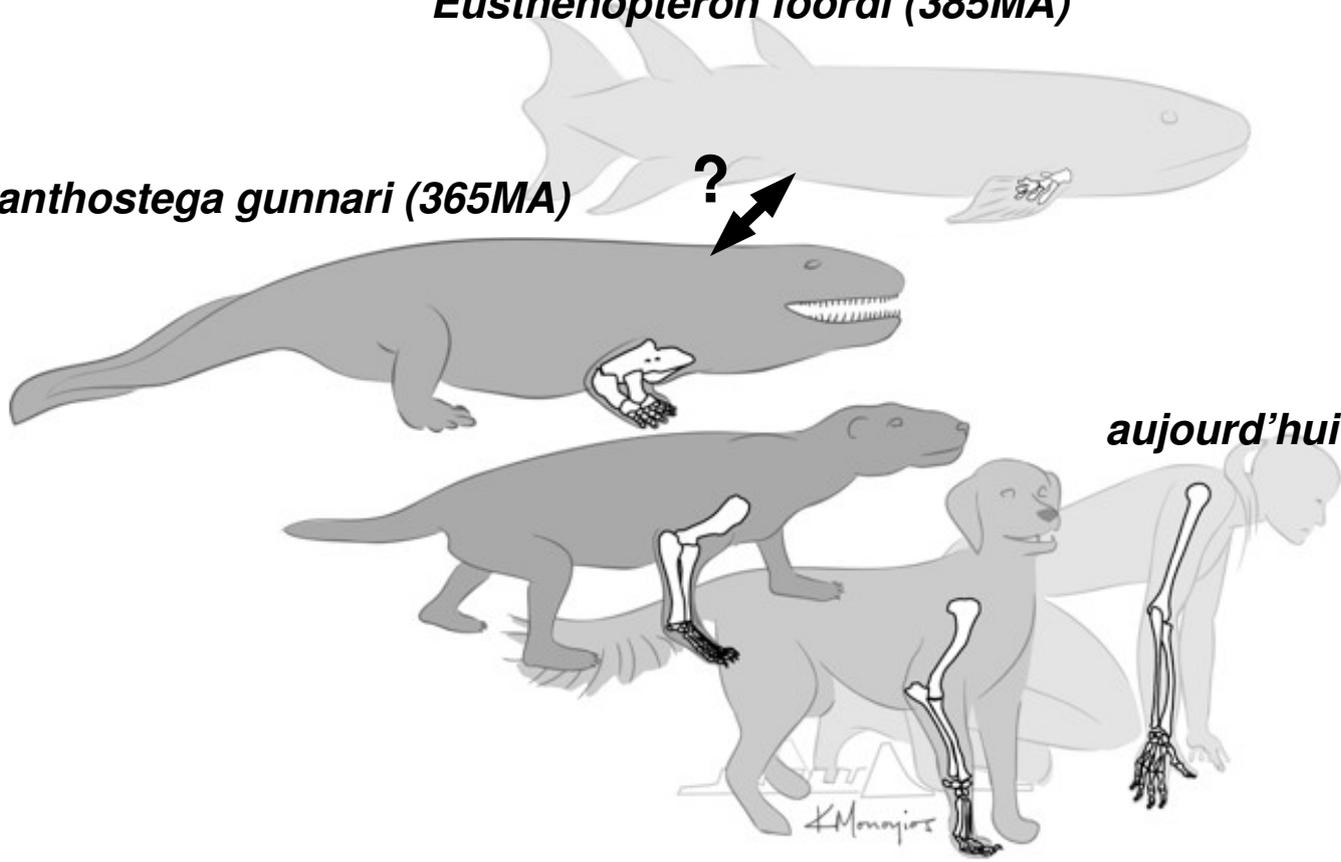


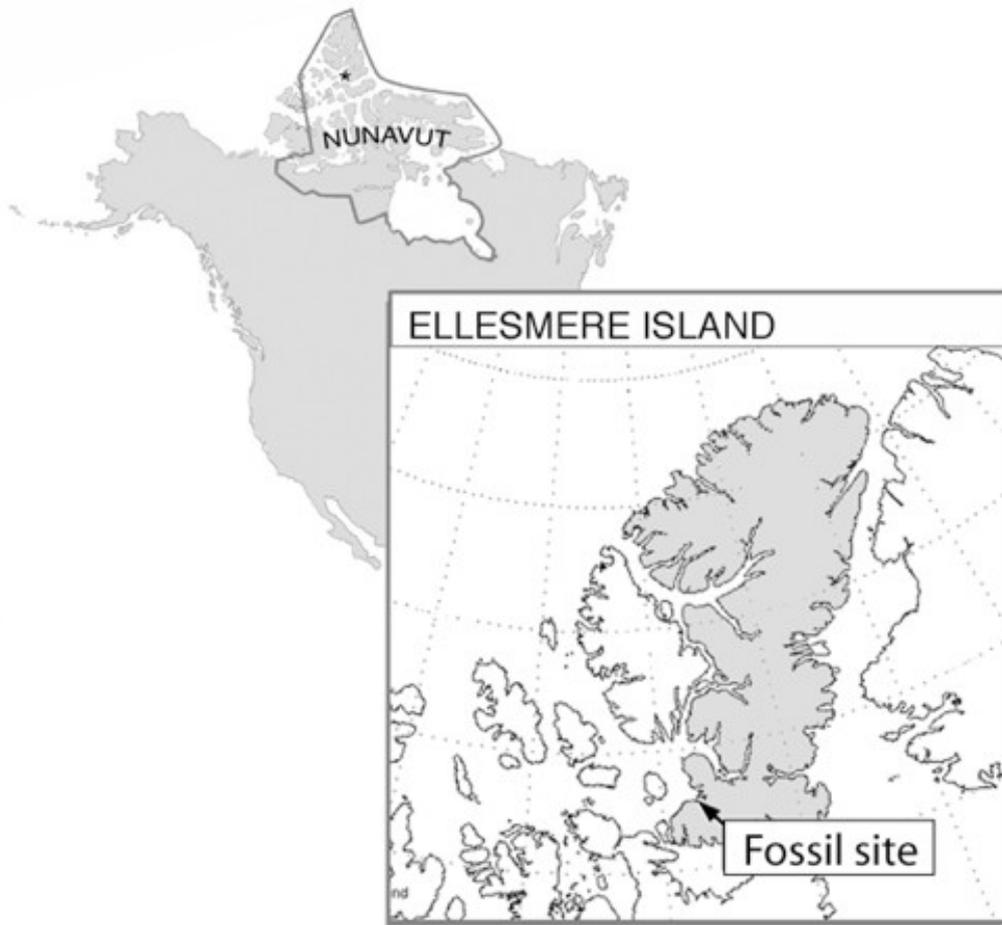
Eusthenopteron foordi (385MA)

Acanthostega gunnari (365MA)



aujourd'hui





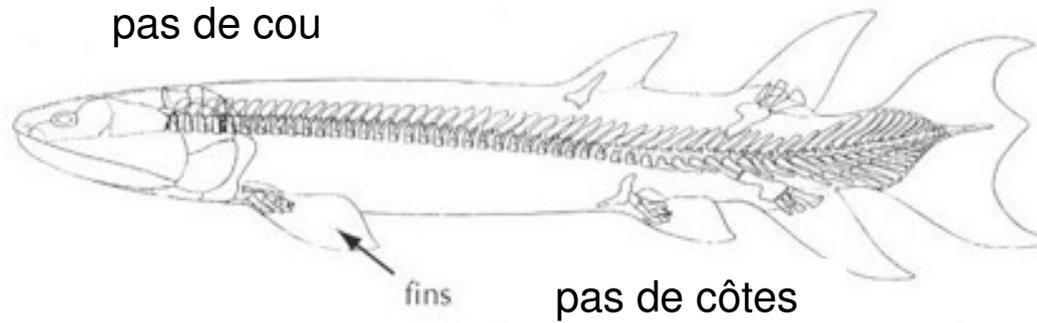
375MA





POISSON

385MA

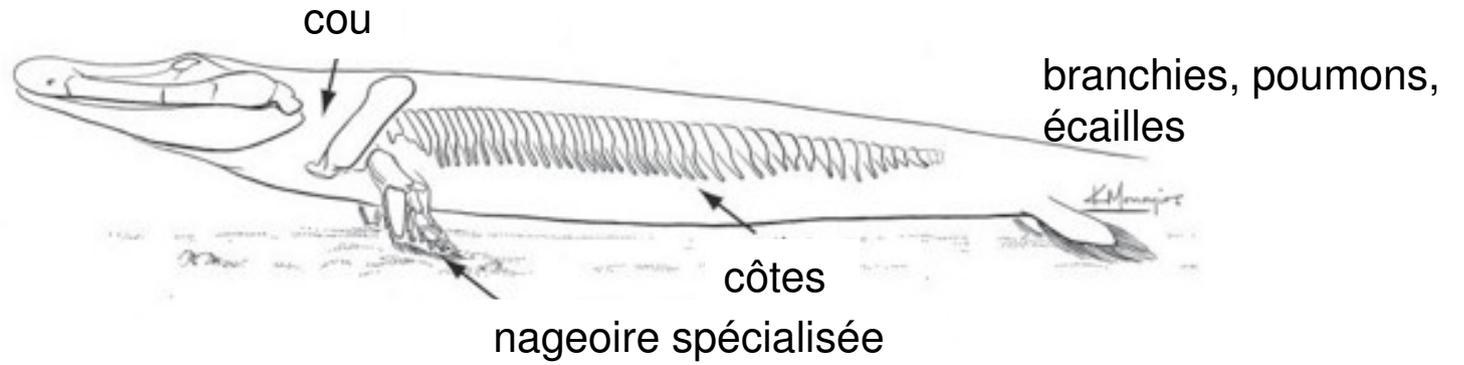


TIKTAALIK

375MA

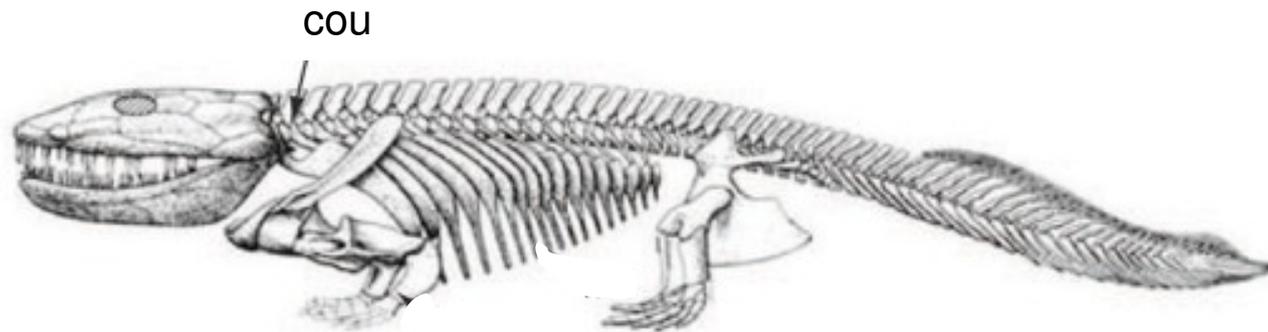


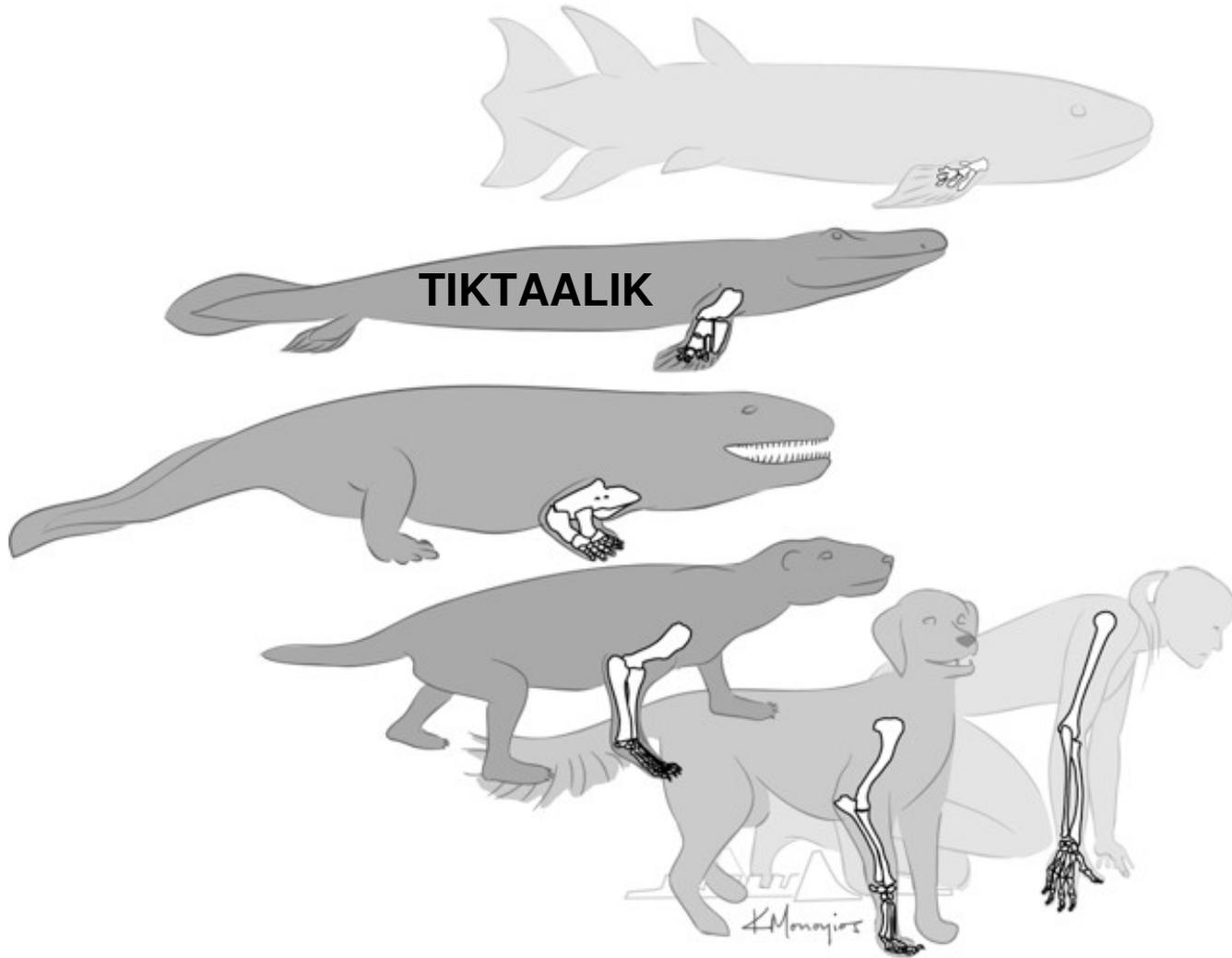
(Daeschler et al. 2006)



TÉTRAPODE

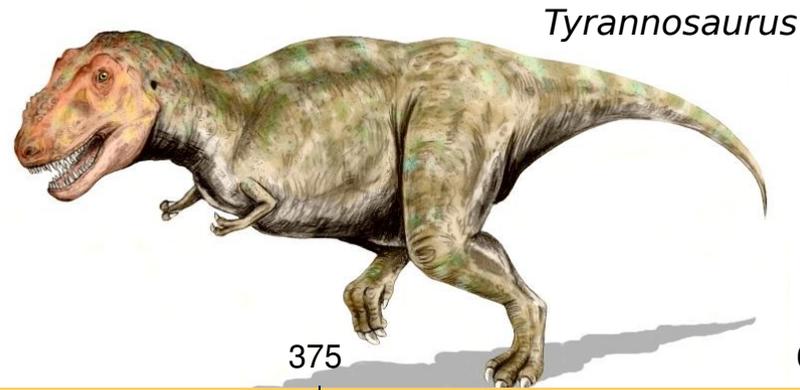
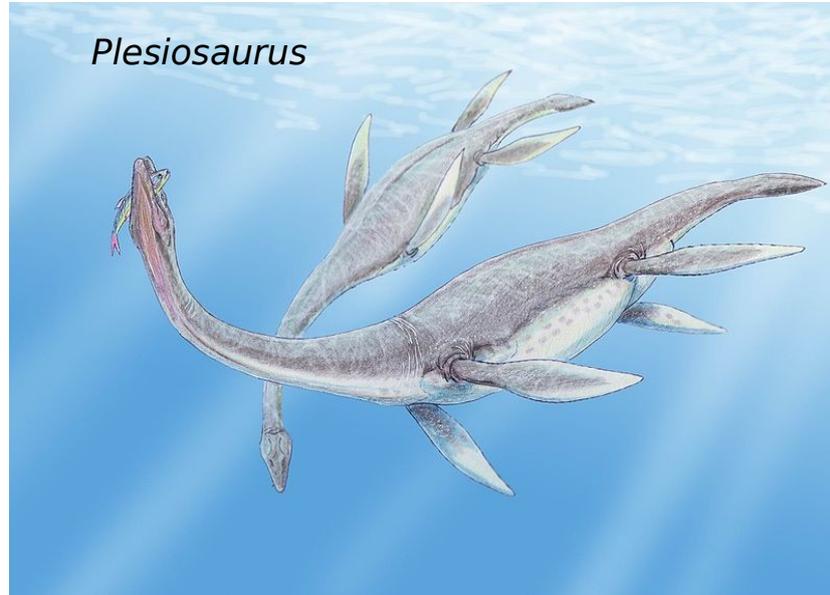
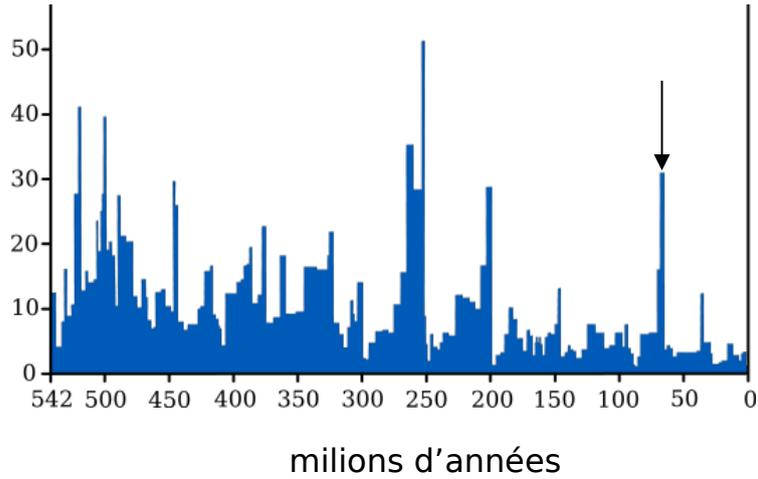
365MA





Extinction de masse : 65MA

% de genres de fossiles animaux marins disparus



1ères traces (graphite)
1ères cellules fossiles

1ers pluricellulaires fossiles

1ers Vertébrés terrestres

extinction des dinosaures

Liée à d'importants changements de l'environnement

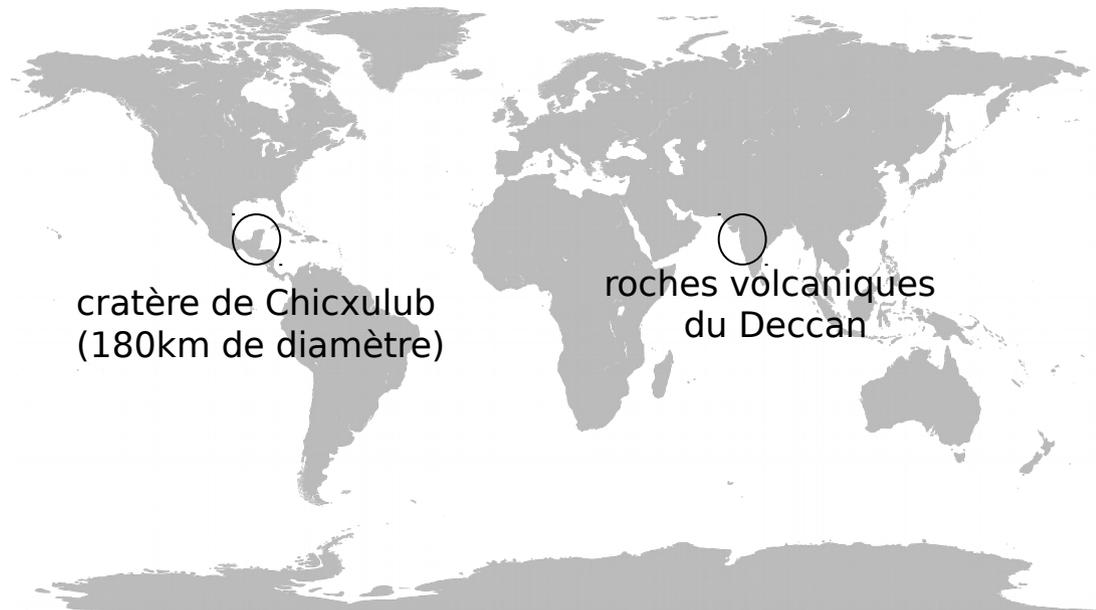


Roche du Wyoming (États-Unis)

après 65MA

couche 65MA : 1000 fois plus d'iridium

avant 65MA

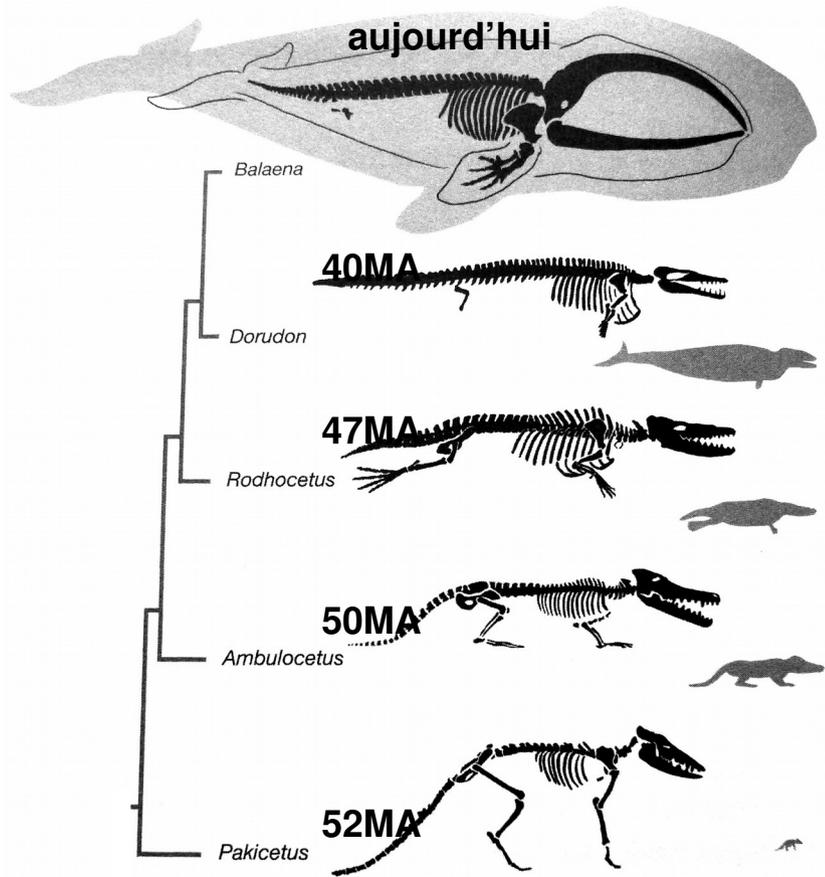


cratère de Chicxulub
(180km de diamètre)

roches volcaniques
du Deccan



Retour dans l'eau de certains Mammifères



4,5
milliards d'années

3,7 3,4
années

600

375
millions d'années (MA)

65

40

1ères traces (graphite)
1ères cellules fossiles

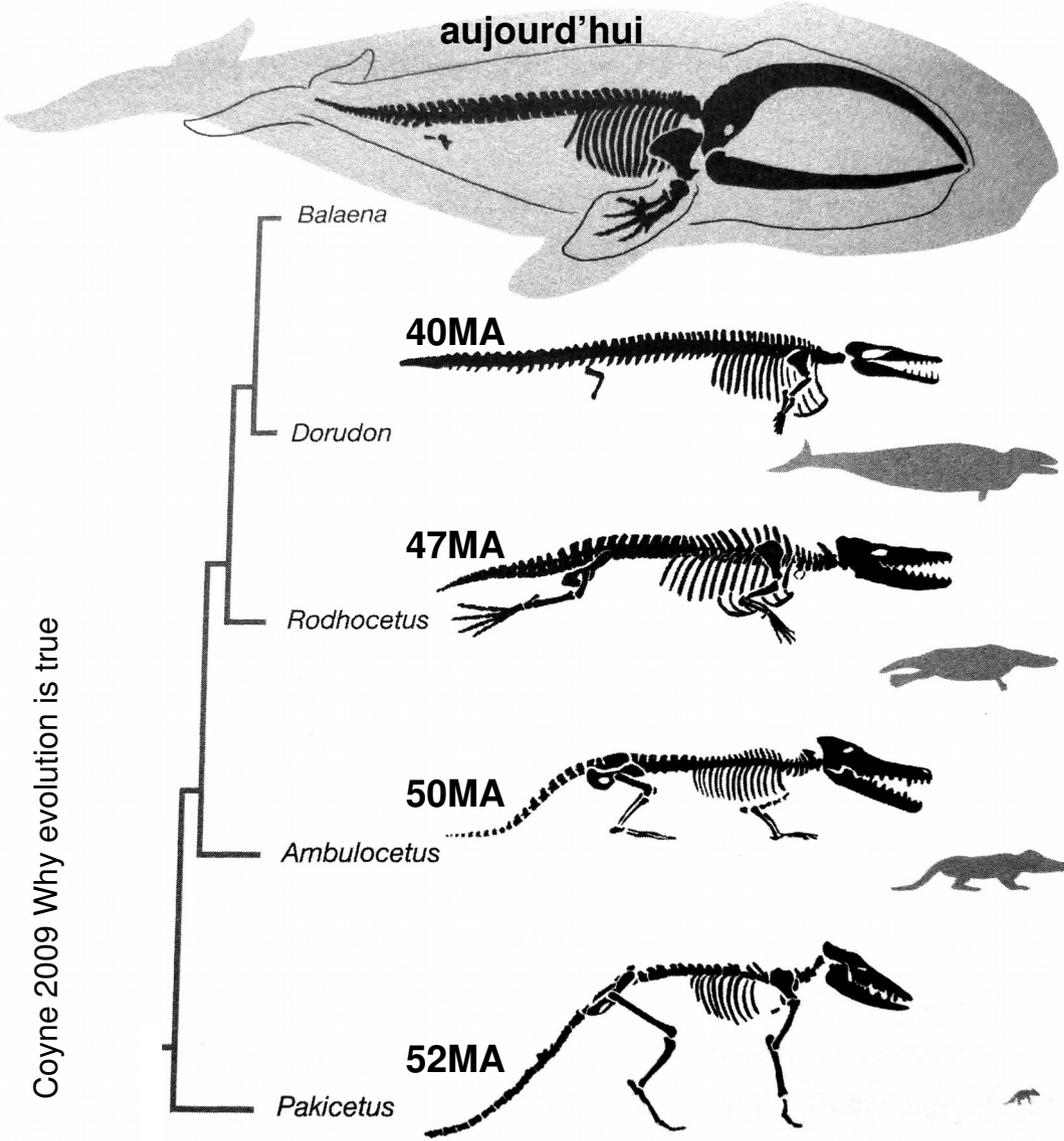
1ers fossiles complexes

1ers Vertébrés
terrestres

extinction
des dinosaures

1ères "baleines"

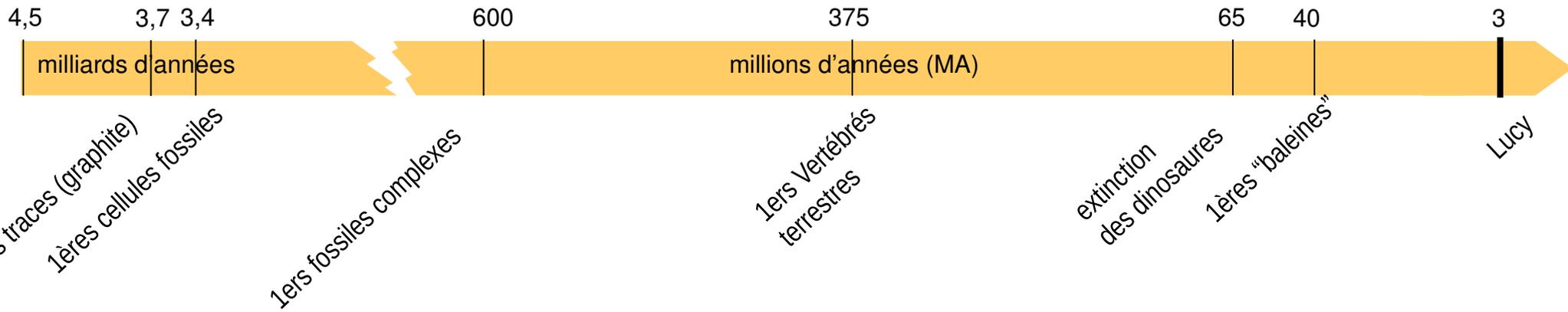
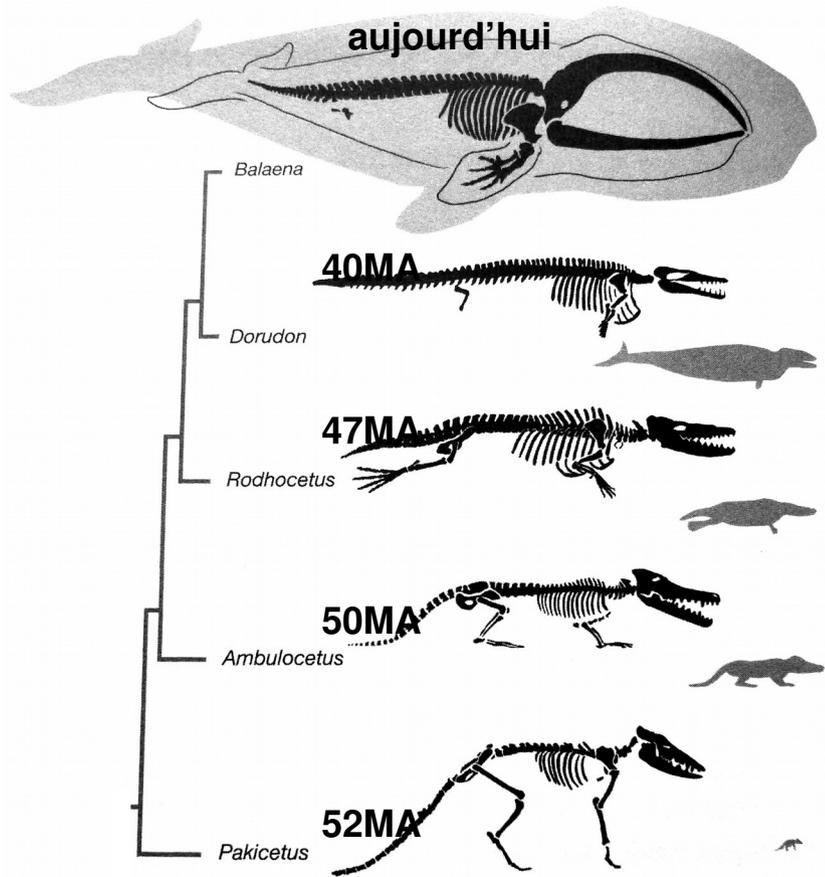
Retour dans l'eau de certains Mammifères



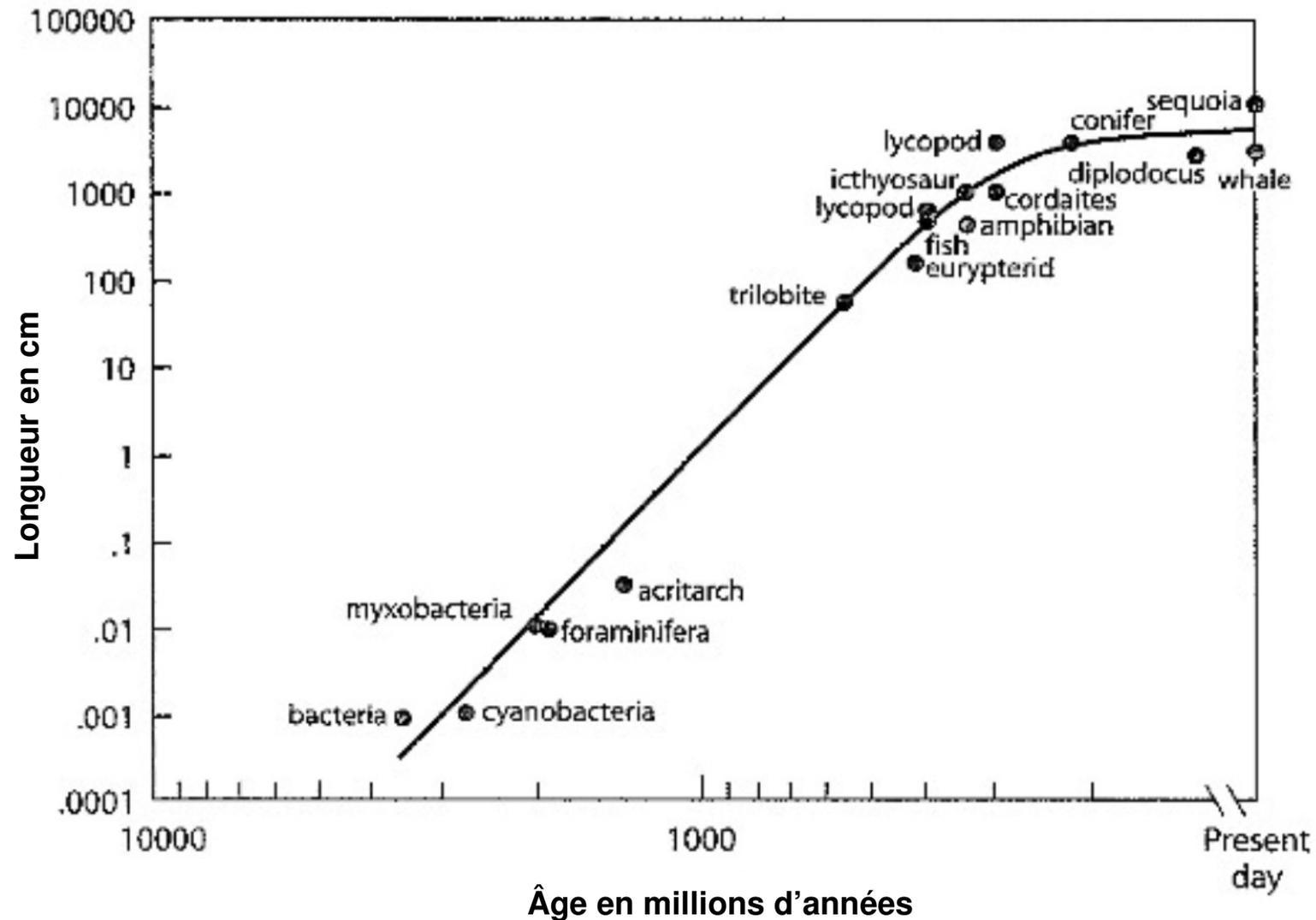
Coyne 2009 Why evolution is true



Retour dans l'eau de certains Mammifères



Augmentation générale de la taille des espèces



Evolution convergente

Sortie de l'eau

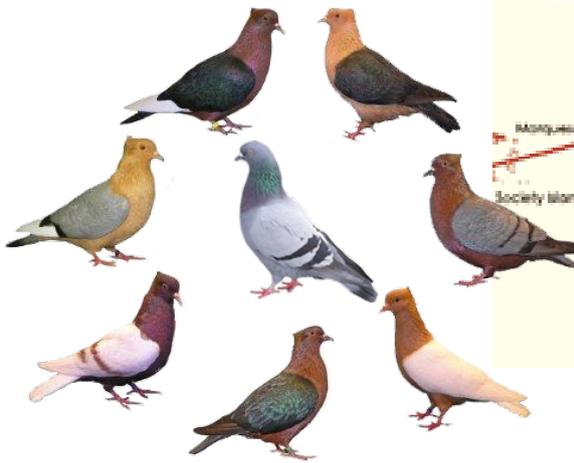
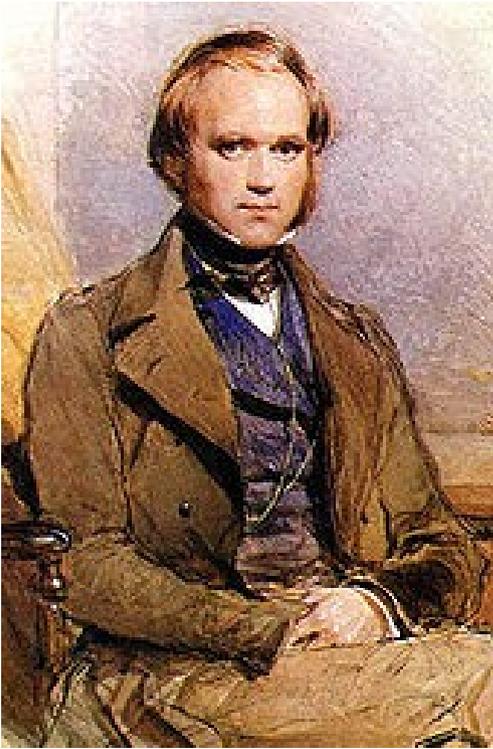
Retour dans l'eau

Thylacine/Loup

The theory of evolution

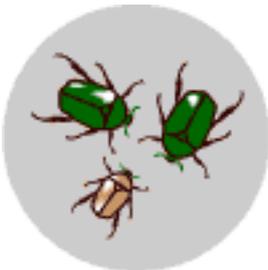
Charles Darwin énonce les mécanismes de base de l'évolution

L'origine des espèces (1859)



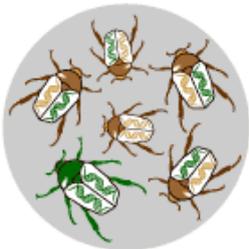
Classical Darwinian Evolution

1
Variation

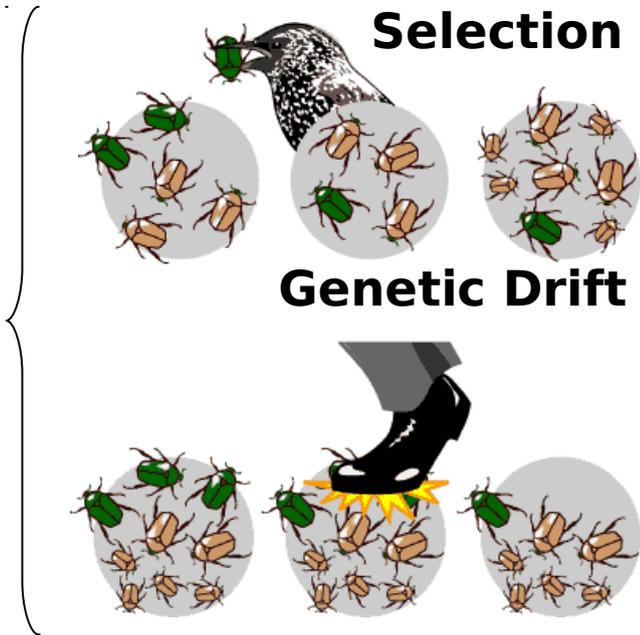
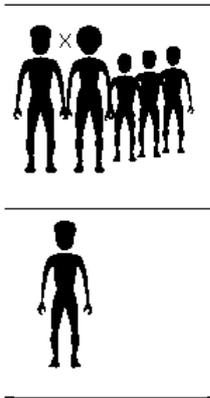


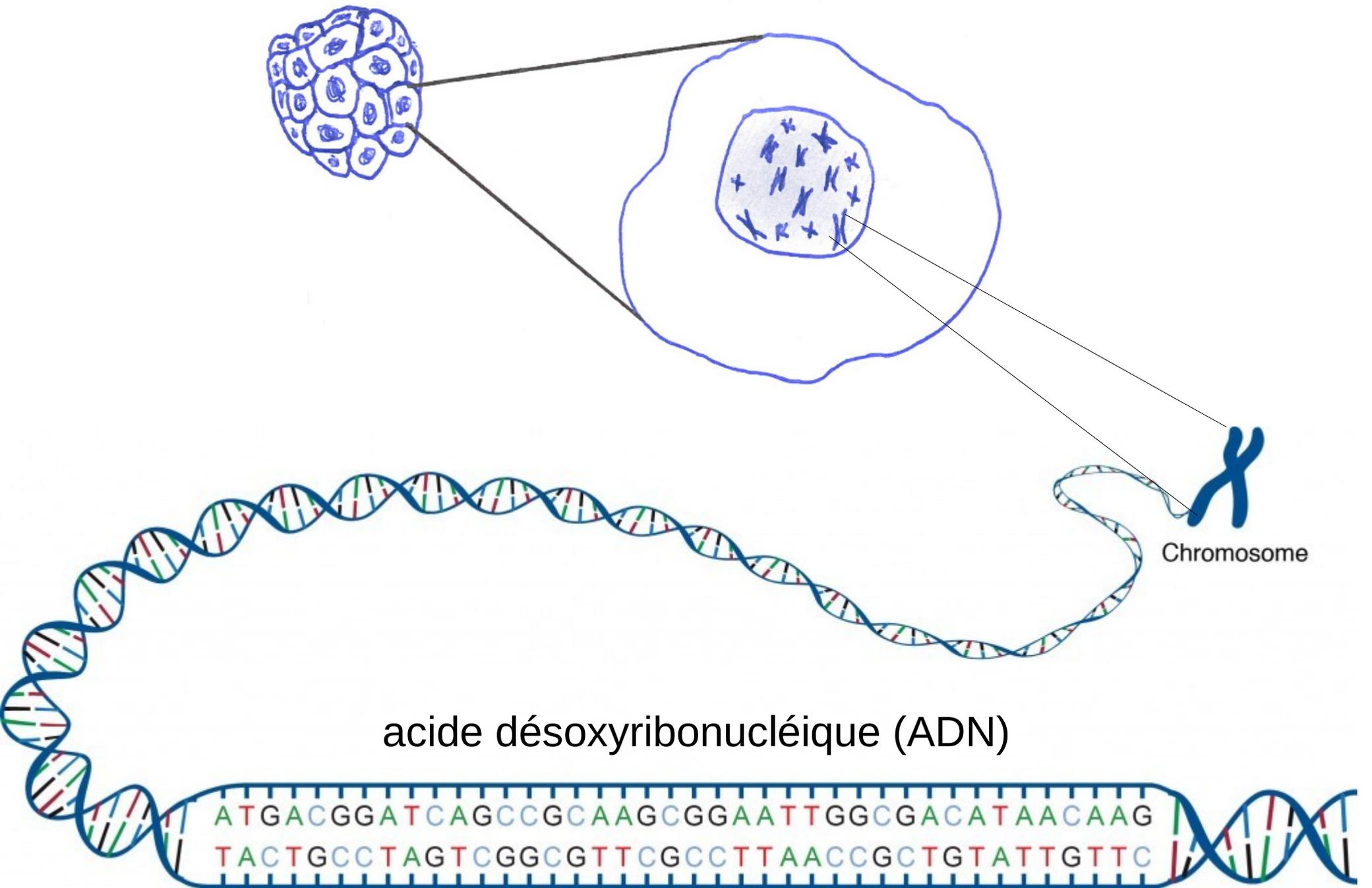
Mutations in DNA

2
Transmission to the next generation

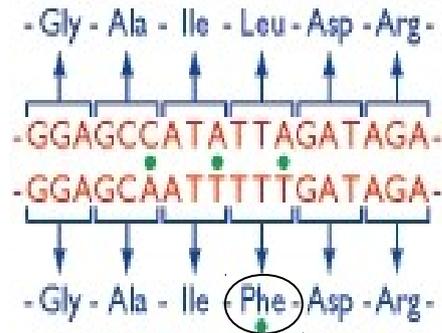
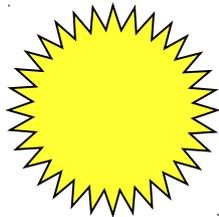
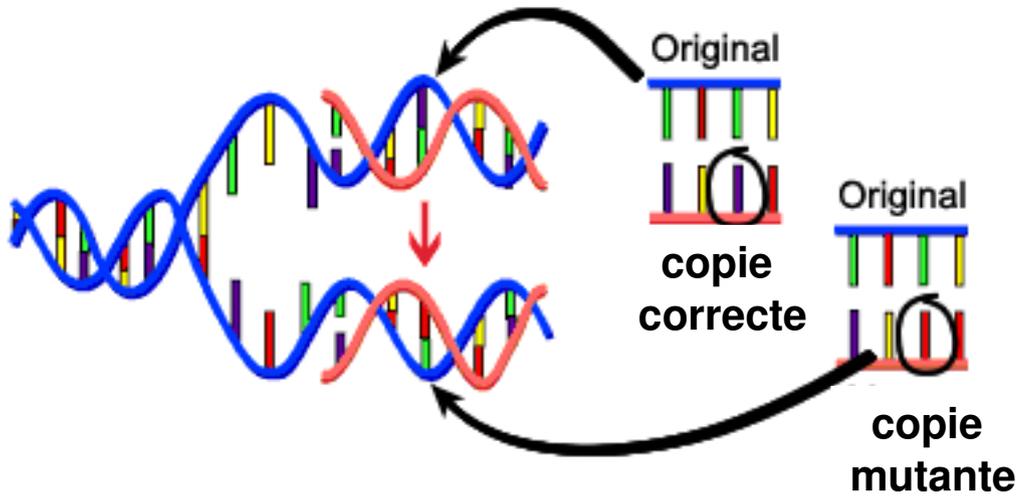


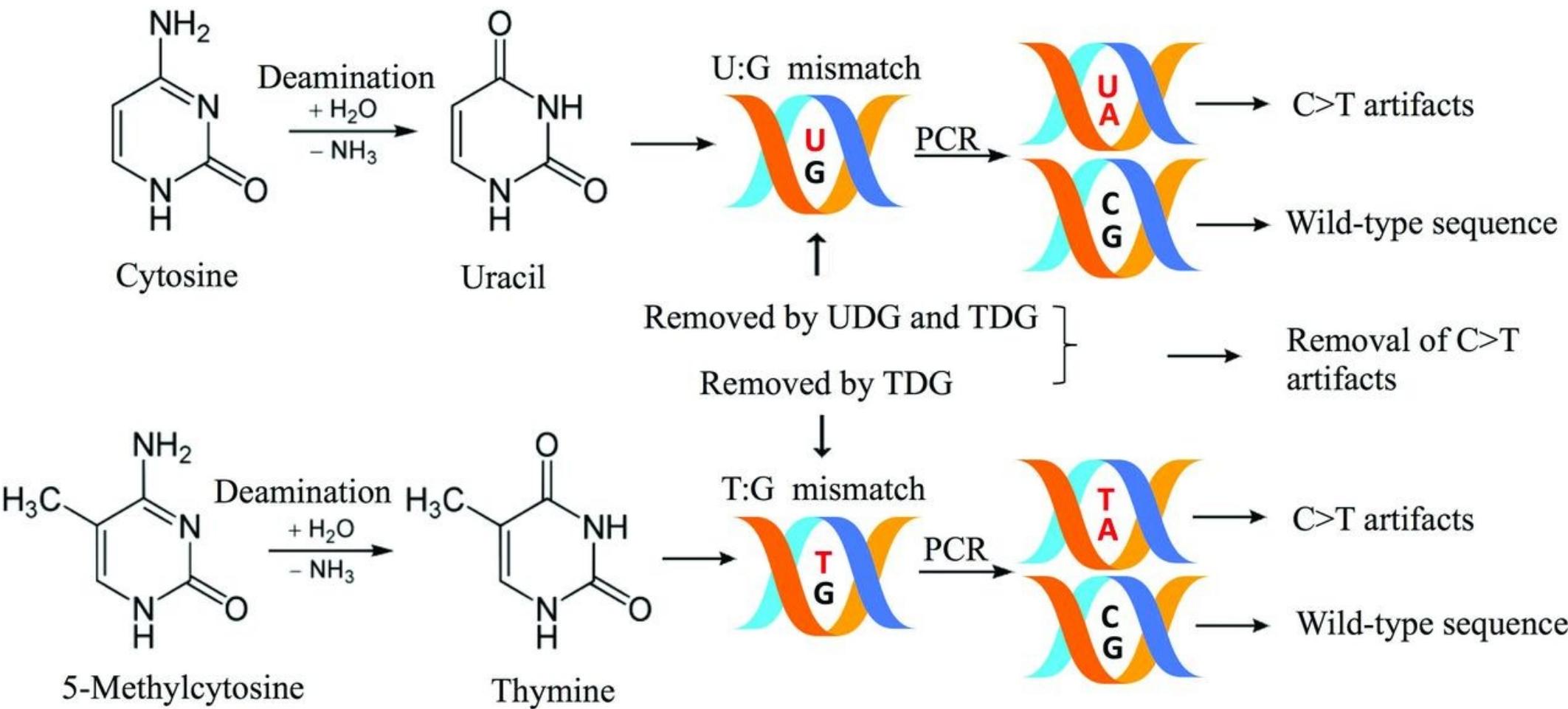
3
Reproduction Variability between individuals





Les mutations

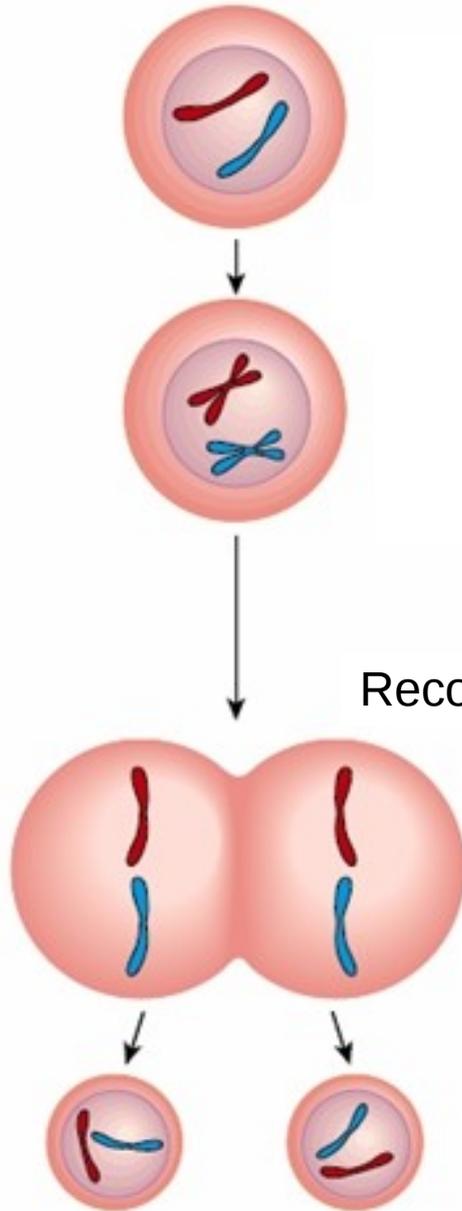




UDG (uracile-ADN glycosylase) removes the uracil from U:G mismatches.

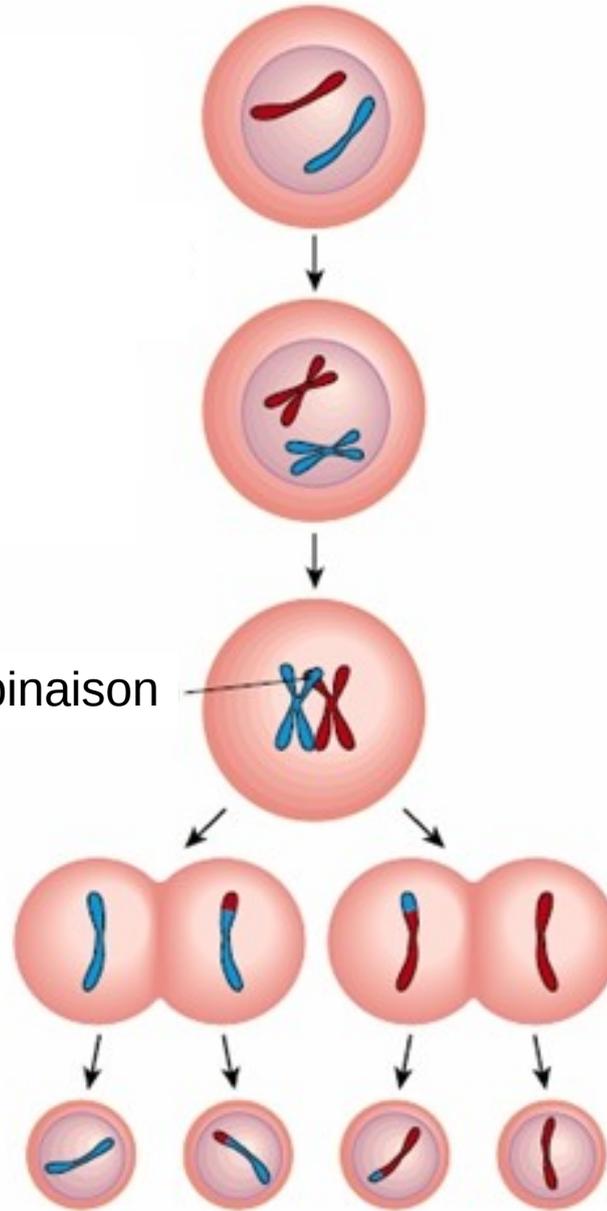
TDG (thymine ADN glycosylase) removes the uracil from U:G and thymine from T:G mismatches.

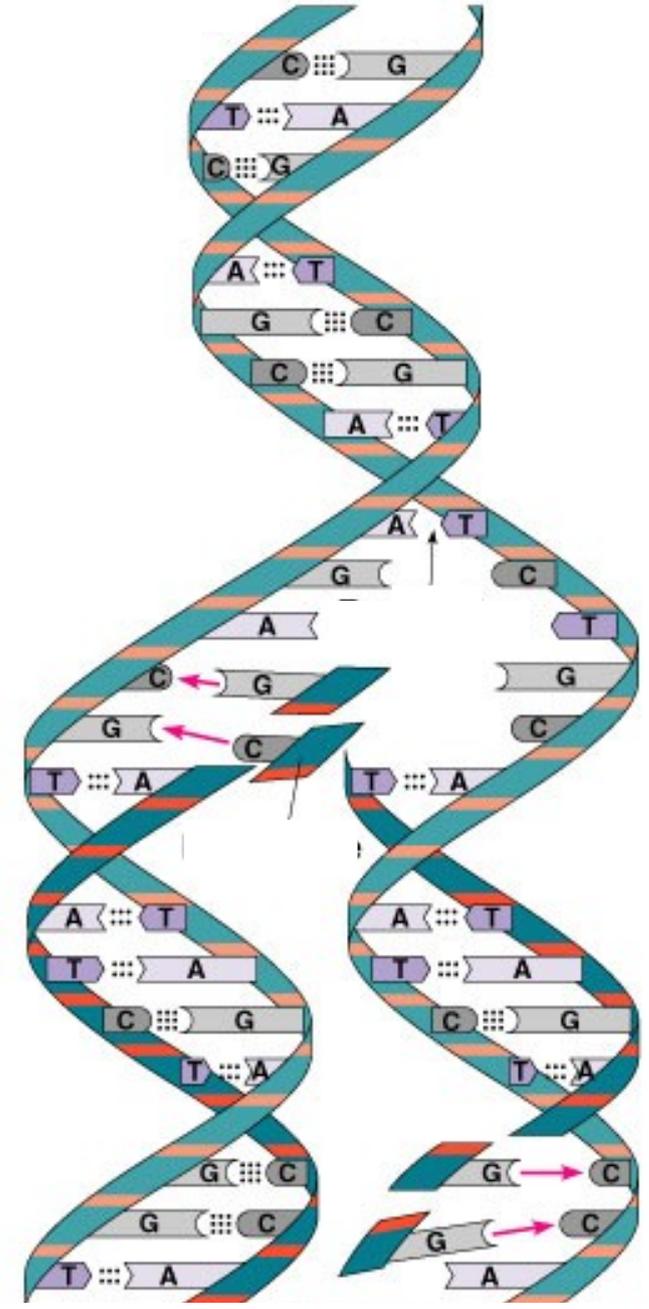
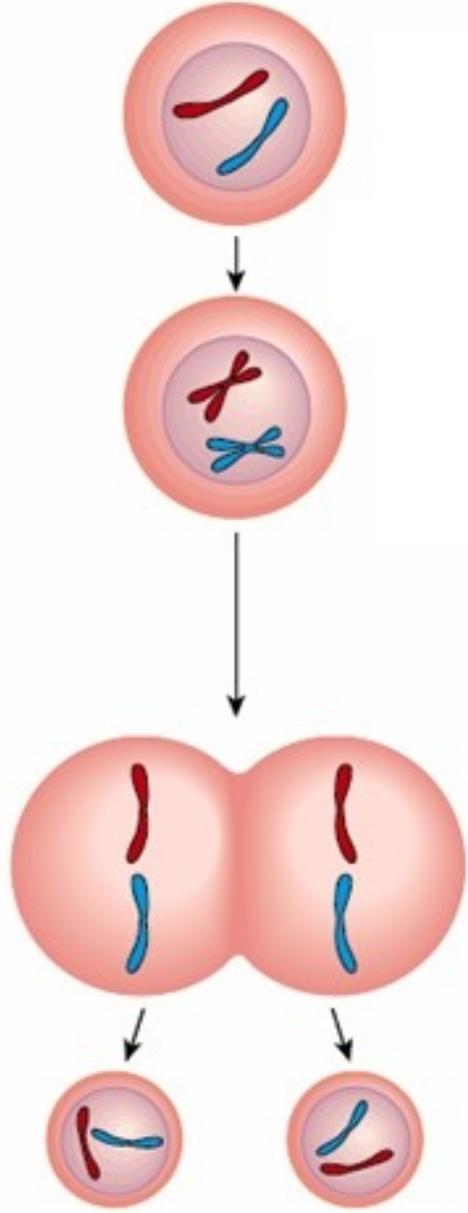
Mitose

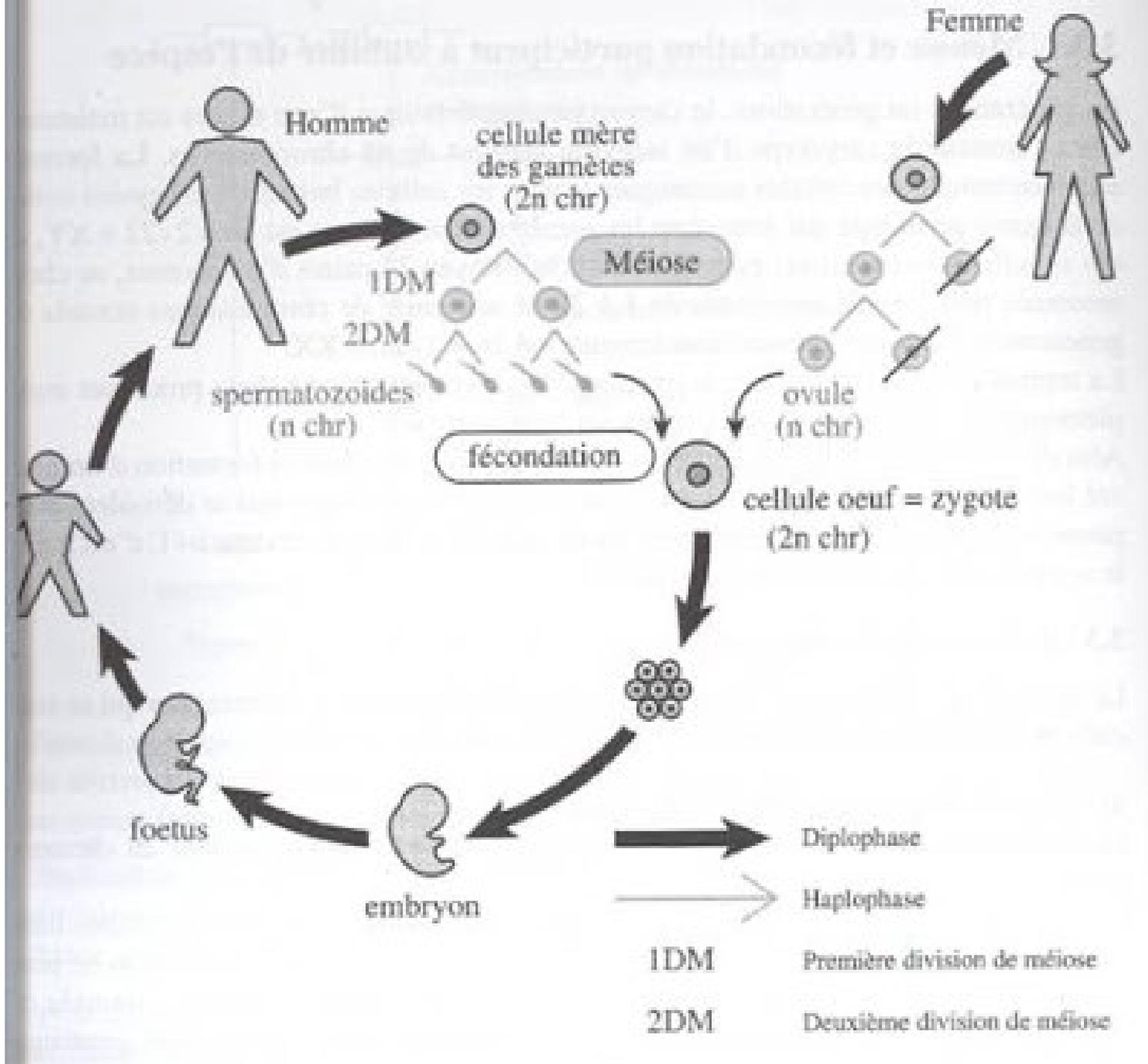


Méiose

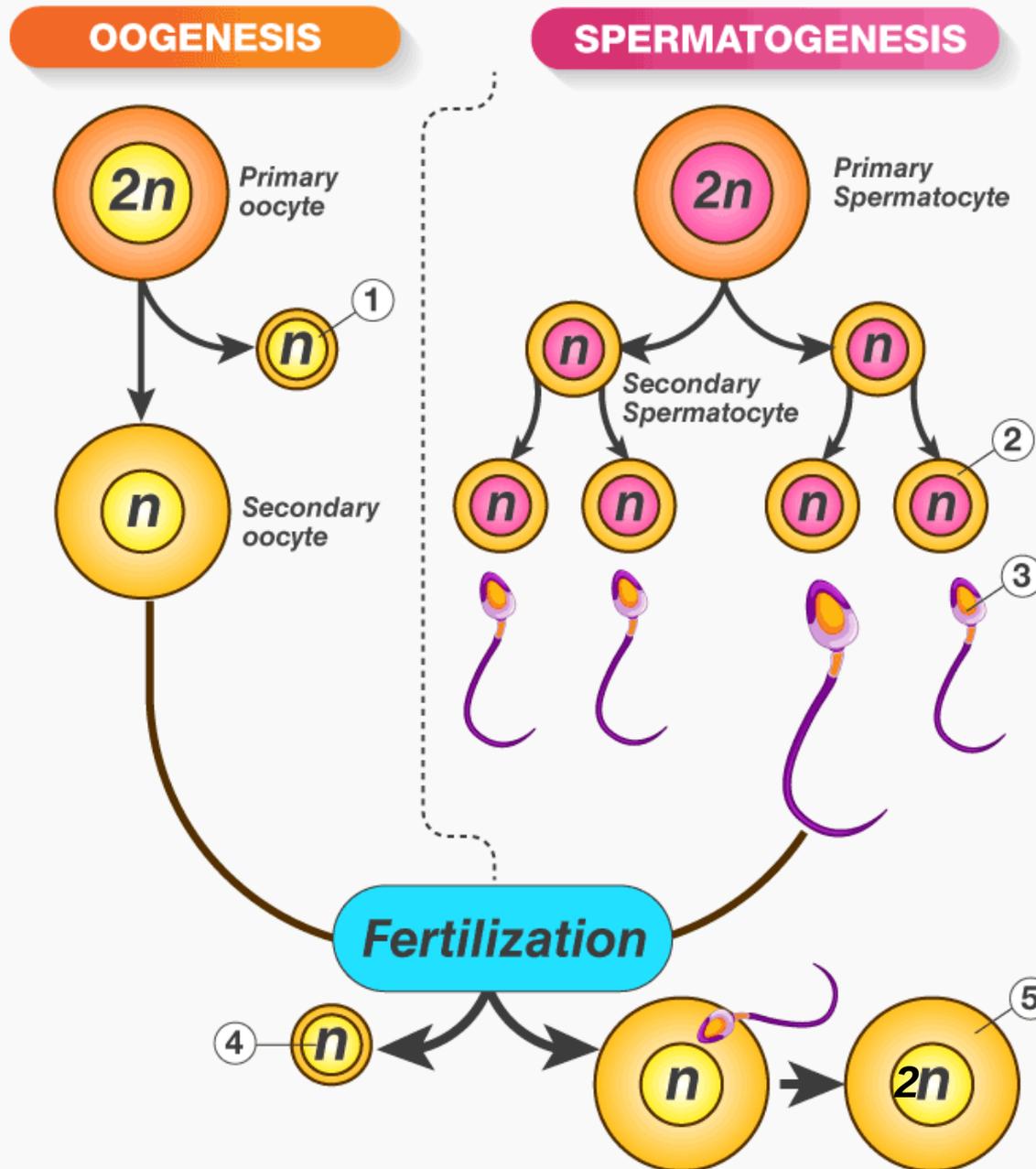
Recombinaison





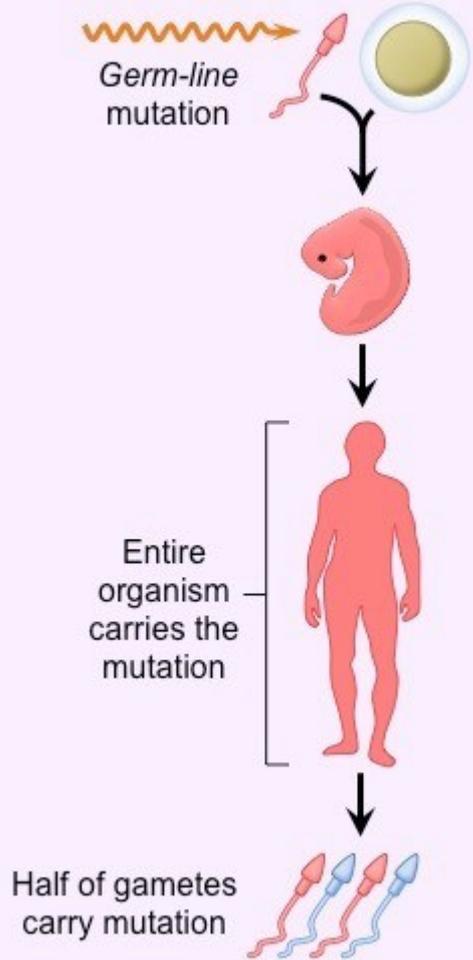


SPERMATOGENESIS Vs OOGENESIS



- 1 First polar body
- 2 Spermatid
- 3 Sperm
- 4 Second polar body
- 5 Zygote

GERM-LINE MUTATIONS



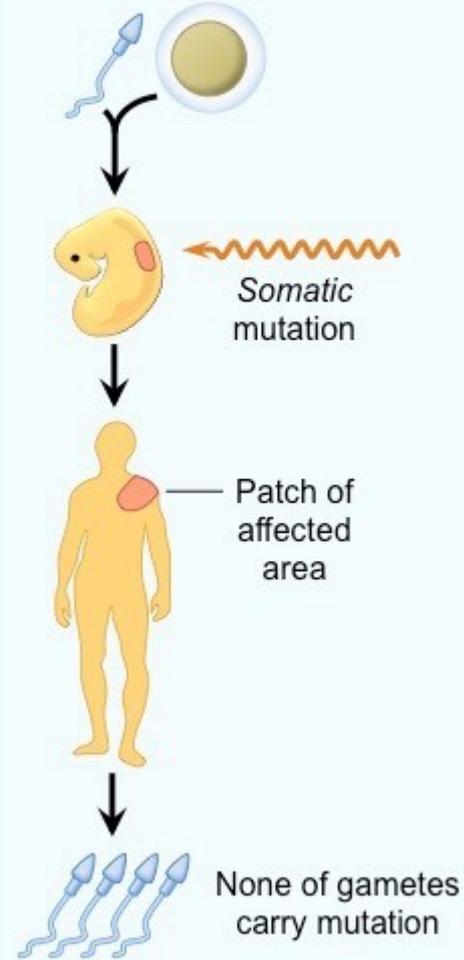
Parental Gametes

Embryo

Organism

Gametes of Offspring

SOMATIC MUTATIONS



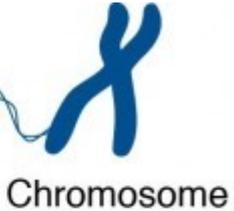
None of gametes carry mutation

La panthère noire



changement de
1 nucléotide





léopard

GCAAGCCGCCGGCGCCCGCCTGCTGCGACCCGTGCGCCTCC
CGTTCGGCGGCCGCGGGCGGACGACGCTGGGACACGCGGAGG

S C K P P A P A C C D P C A S ...

panthère noire

GCAAGCCGCCGGCGCCCGCCTG**A**TGCGACCCGTGCGCCTCC
CGTTCGGCGGCCGCGGGCGGACT**T**ACGCTGGGACACGCGGAGG

S C K P P A P A **STOP**

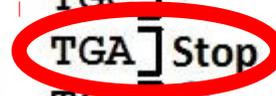
Le code génétique

deuxième lettre

première lettre

TTT	TCT	TAT	TGT
TTC	TCC	TAC	TGC
TTA	TCA	TAA	TGA
TTG	TCG	TAG	TGG
CTT	CCT	CAT	CGT
CTC	CCC	CAC	CGC
CTA	CCA	CAA	CGA
CTG	CCG	CAG	CGG
ATT	ACT	AAT	AGT
ATC	ACC	AAC	AGC
ATA	ACA	AAA	AGA
ATG	ACG	AAG	AGG
GTT	GCT	GAT	GGT
GTC	GCC	GAC	GGC
GTA	GCA	GAA	GGA
GTG	GCG	GAG	GGG

troisième lettre

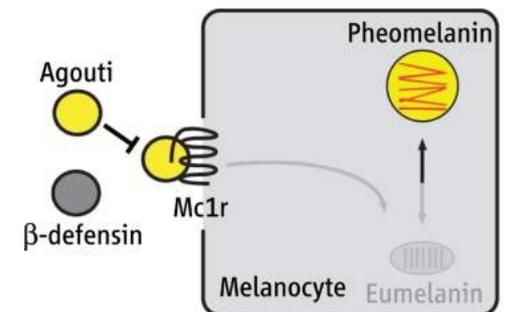
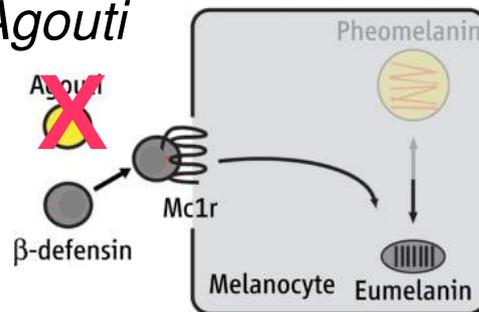


La panthère noire

Schneider 2012



changement de
1 nucléotide
dans le gène
Agouti



La panthère noire

Schneider 2012



Agouti



Couleur du
corps

Agouti normal



Agouti stop

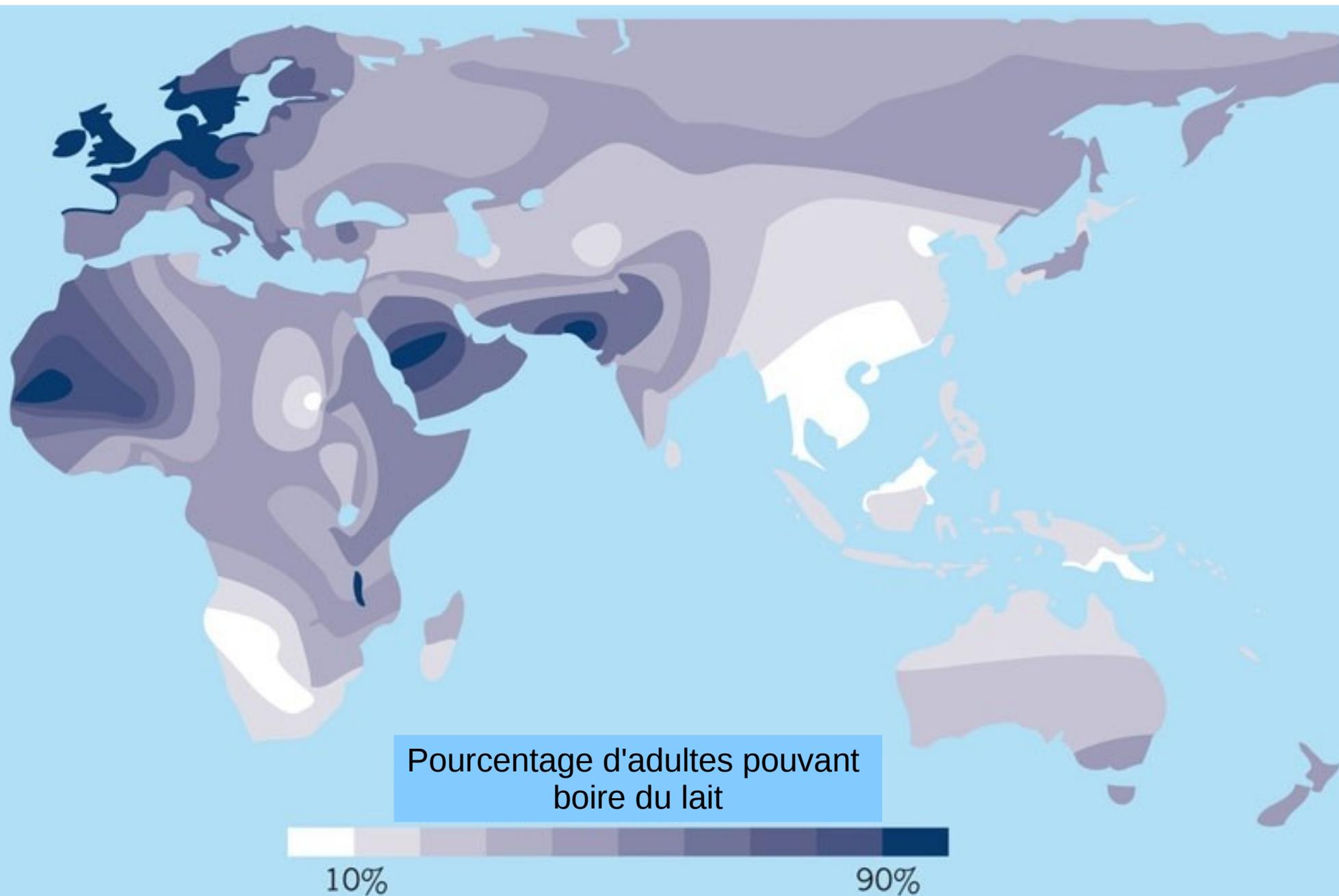


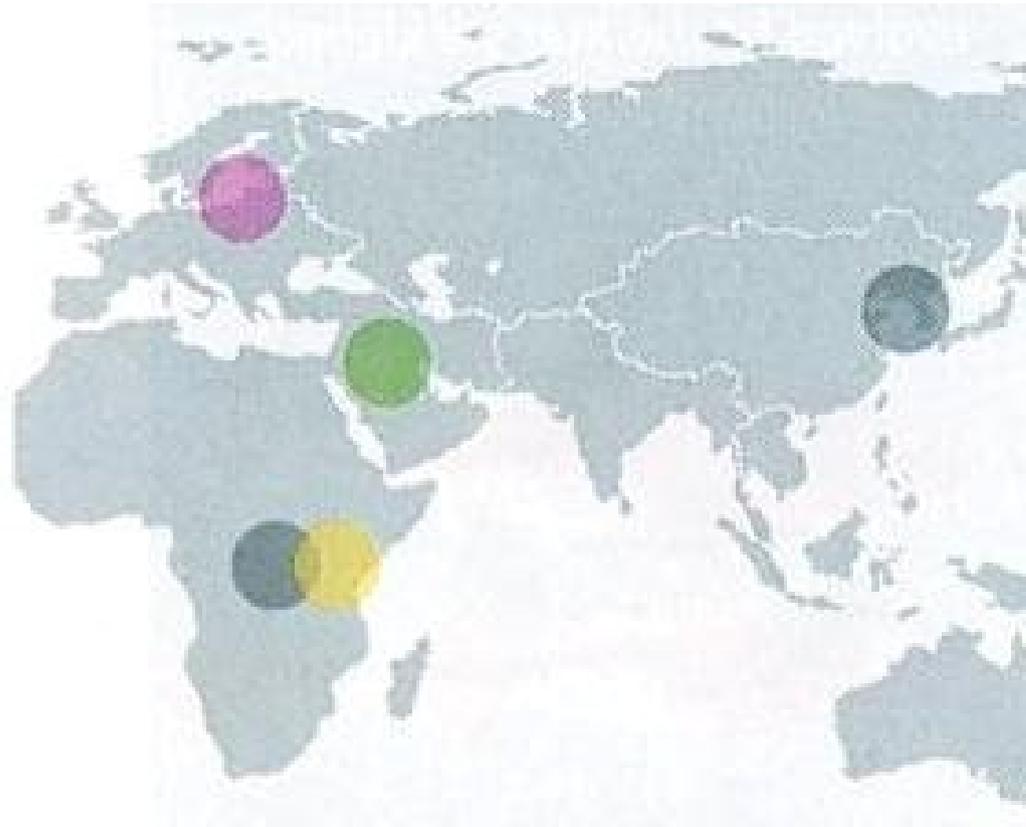
Panthère tâchetée



Panthère noire

Evolution récente chez l'homme



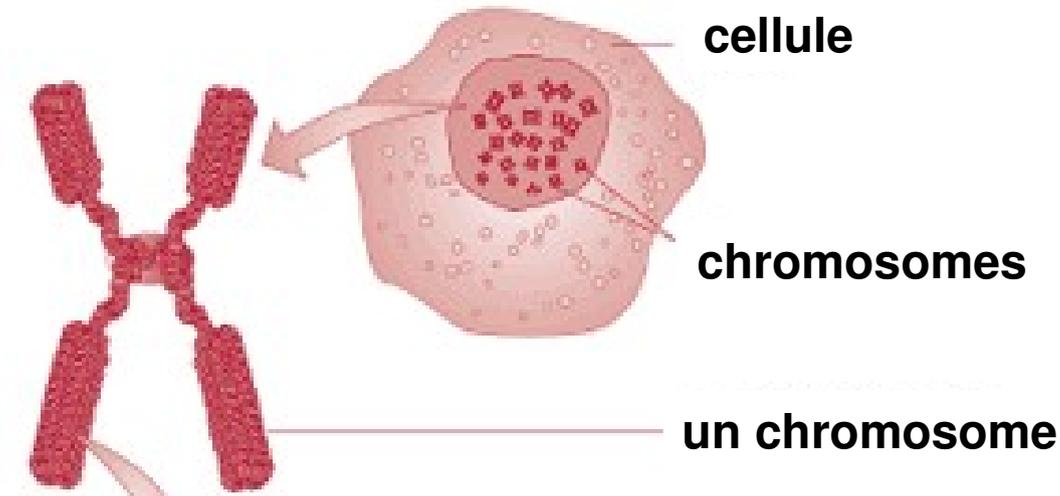


Séquence régulatrice du gène *lactase*

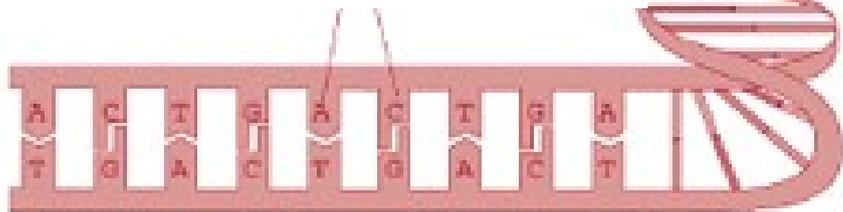
C G T } A A T G T A G C C C C T G



- ● ● Mutations distinctes
- Pas de mutation



L'ADN est constitué d'une suite de nucléotides



ADN

ADN codant



protéines

un acide aminé



3 lettres

ADN

ADN non codant

Le code génétique

première lettre

		première lettre				
		U	C	A	G	
deuxième lettre	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G

troisième lettre

ADN codant



protéines

un acide aminé



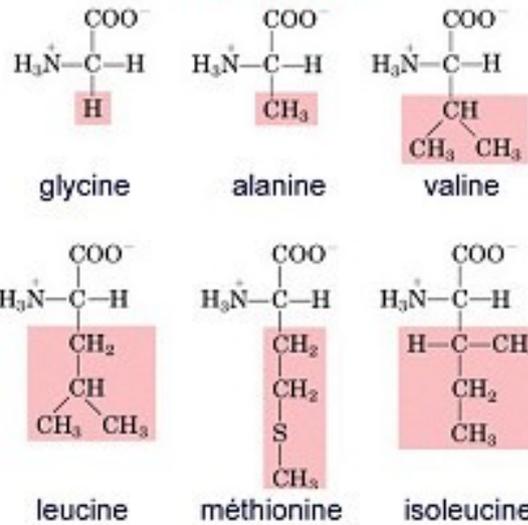
3 lettres

ADN

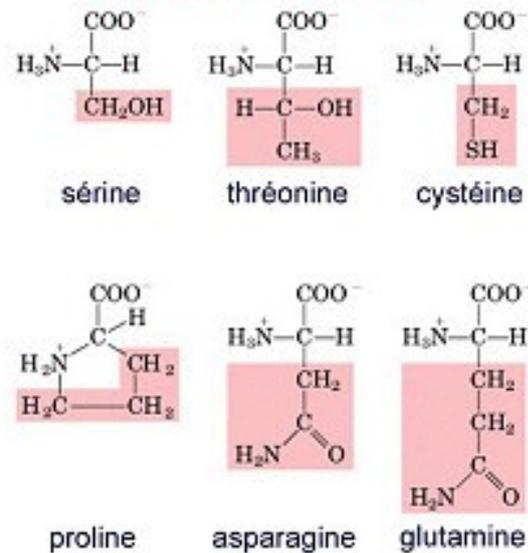
ADN non codant

Les vingt acides aminés

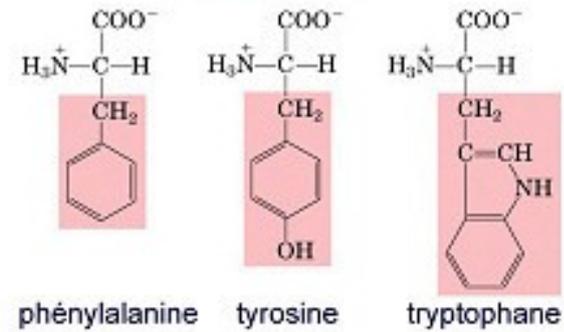
non polaires



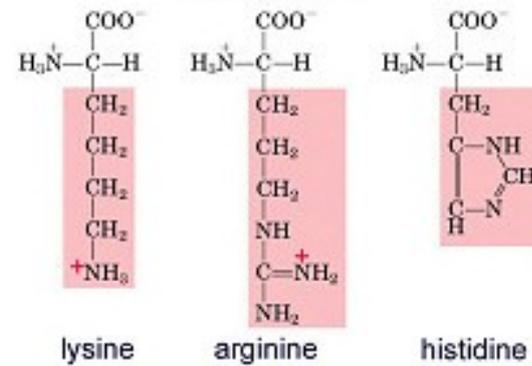
polaires mais non-charge



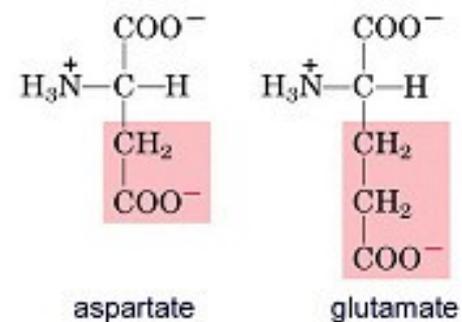
aromatiques

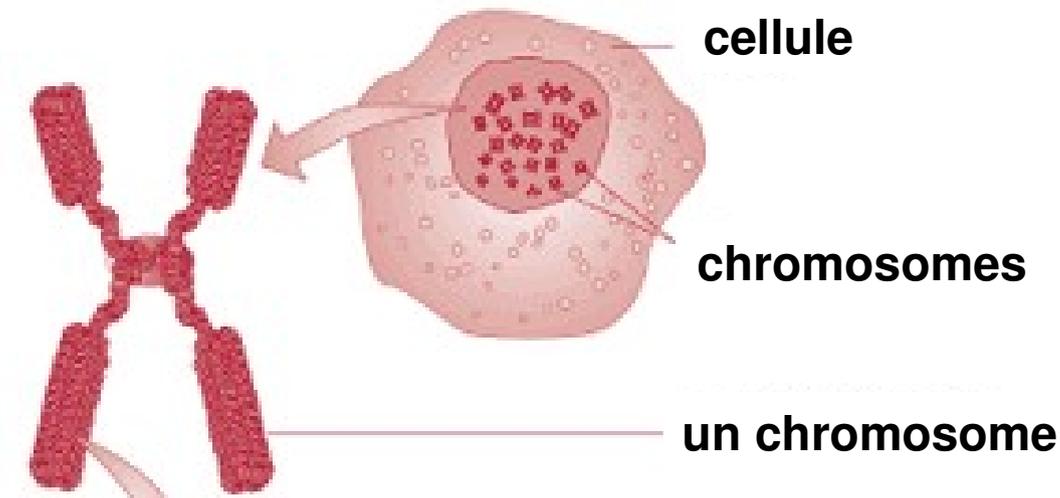


chargés positif

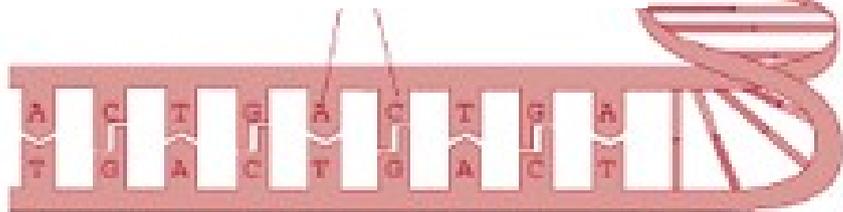


chargés négatif





L'ADN est constitué d'une suite de nucléotides



ADN

ADN codant



protéines

un acide aminé



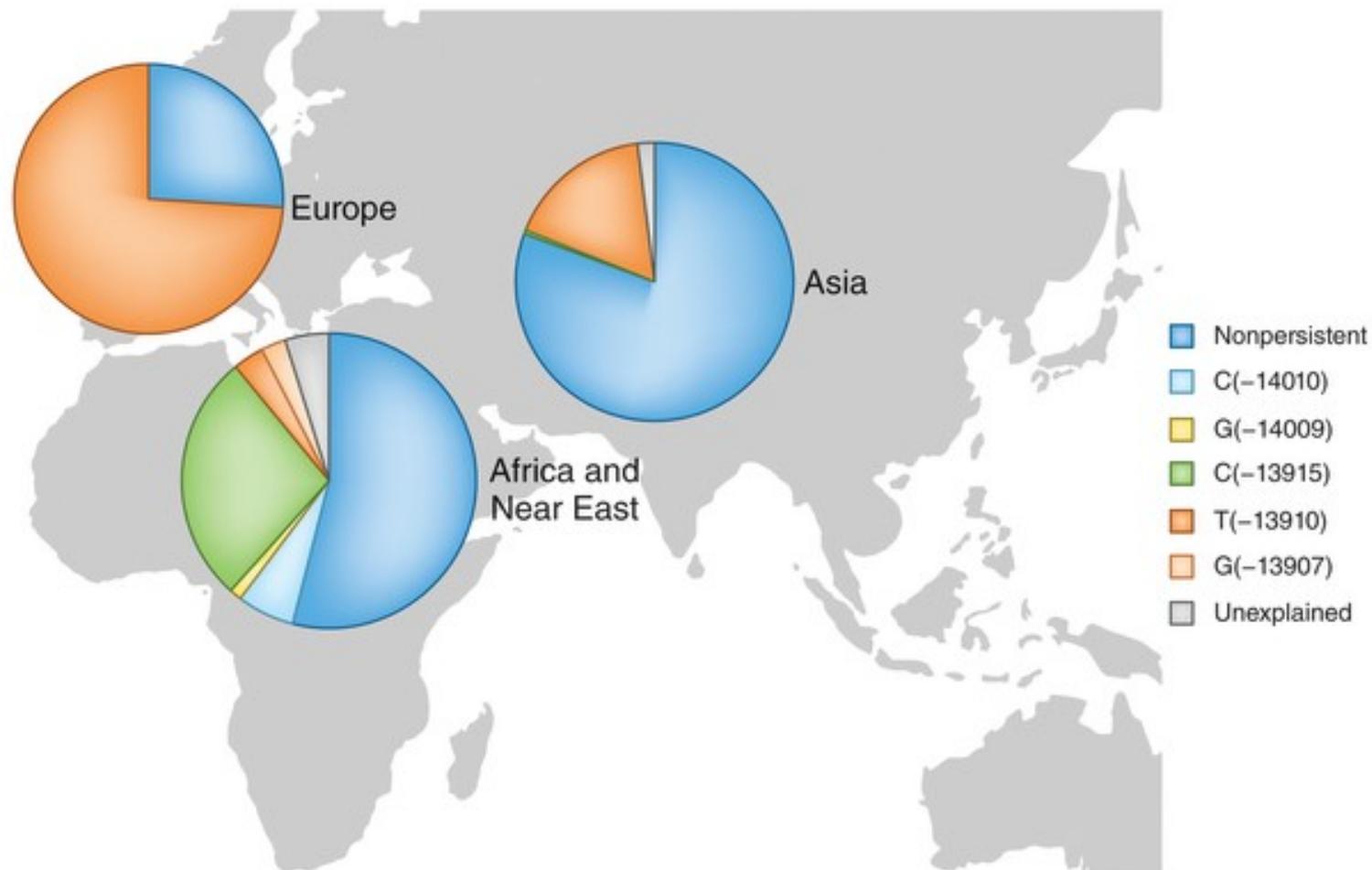
3 lettres

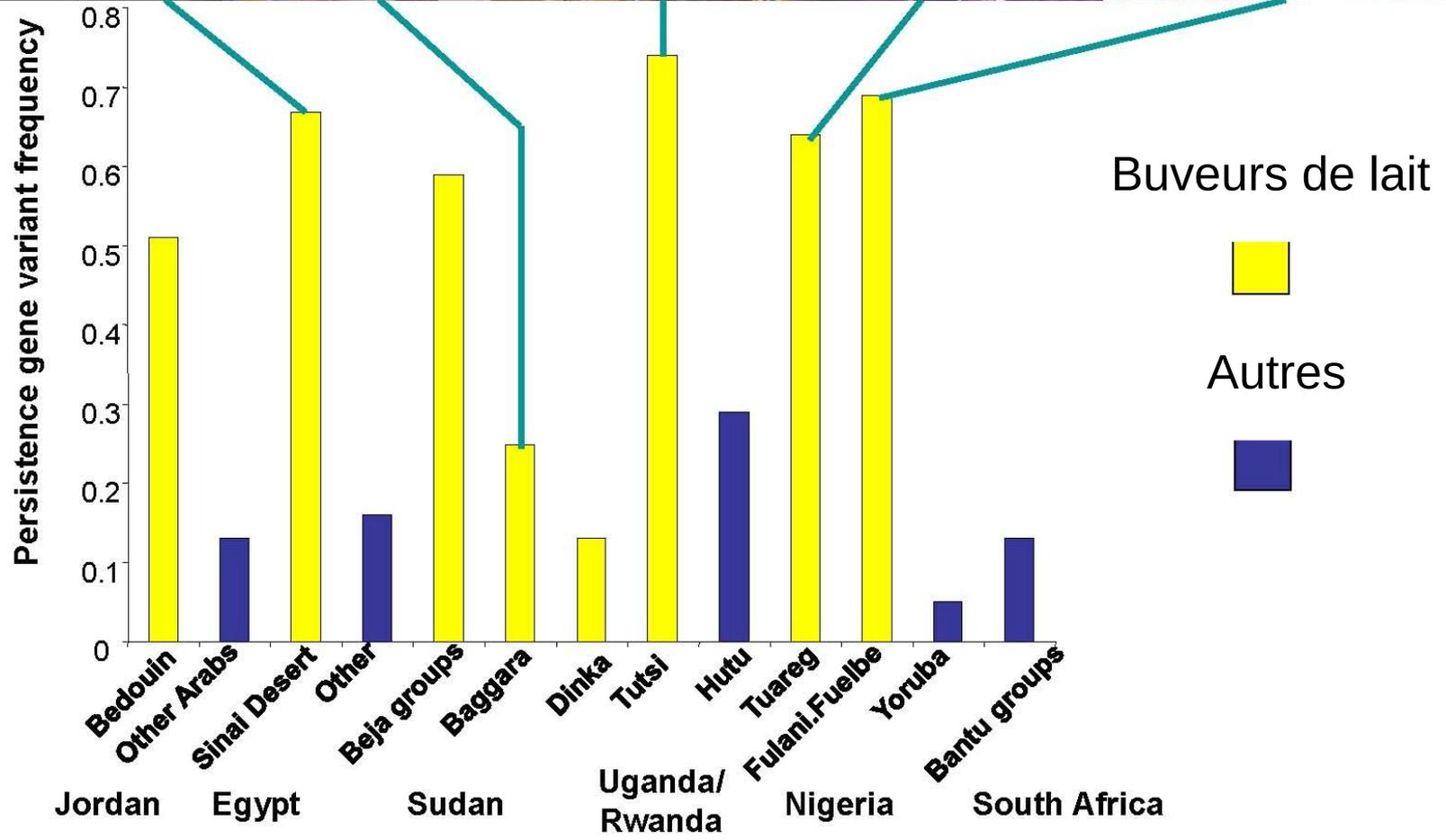
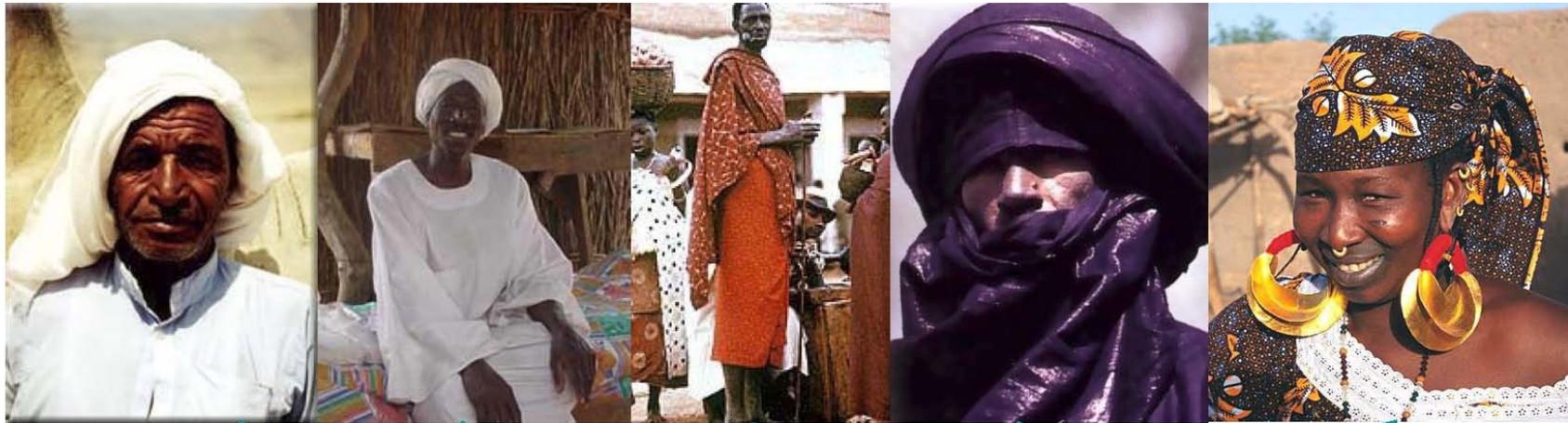
ADN

ADN non codant

contrôle de la formation des protéines
maintien de la structure de l'ADN
réplication de l'ADN

5 mutations différentes dans le même gène





L'évolution se répète

Intraspécifique

Persistence de la lactase



lactase

Interspécifique

Coloration noire



agouti

Coloration noire



pannier

Rétention des graines

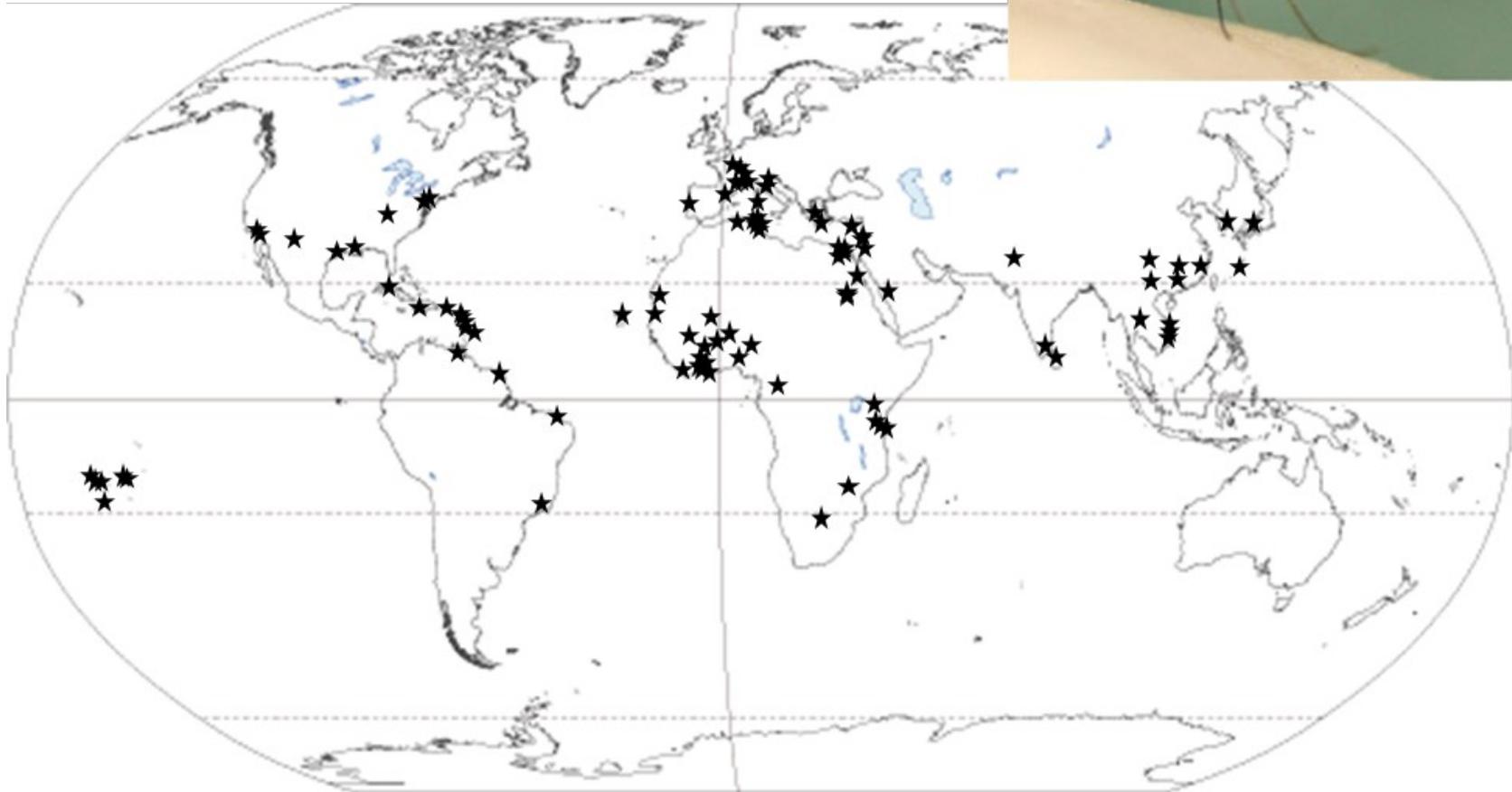


Sh1

Résistance à un insecticide chez *Culex pipiens*

Ester²

DéTECTÉ pour la 1^{ère} fois au Liberia et Nigeria en 1977
et en France en 1986



En Australie chez la mouche *Lucilia cuprina*

1952

Première utilisation
d'insecticides
organophosphorés
dans le monde

(1955 en Australie)

1965

Premières
observations
de résistance
en Australie

La mutation est apparue avant l'épandage d'insecticides

En Australie chez la mouche *Lucilia cuprina*

Avant 1950



Analyse de spécimens de musée
Mutation présente dans 4 individus sur 24

1952

Première utilisation
d'insecticides
organophosphorés
dans le monde

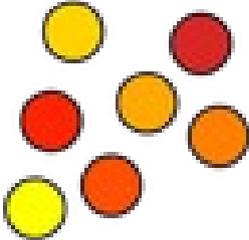
(1955 en Australie)

1965

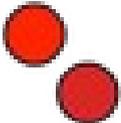
Premières
observations
de résistance
en Australie

Résistance aux antibiotiques

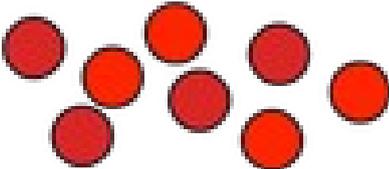
Avant la sélection



Après la sélection



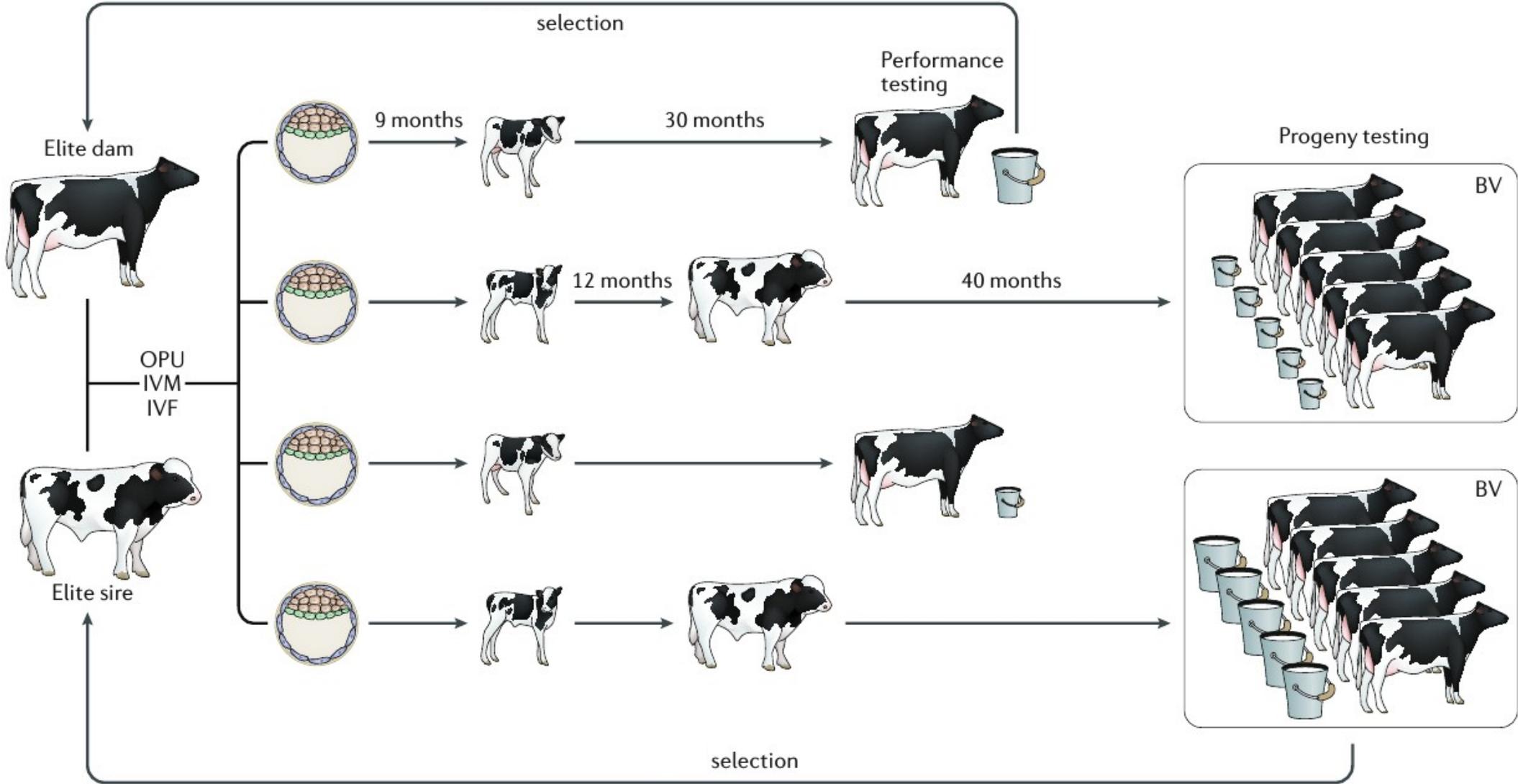
Population finale



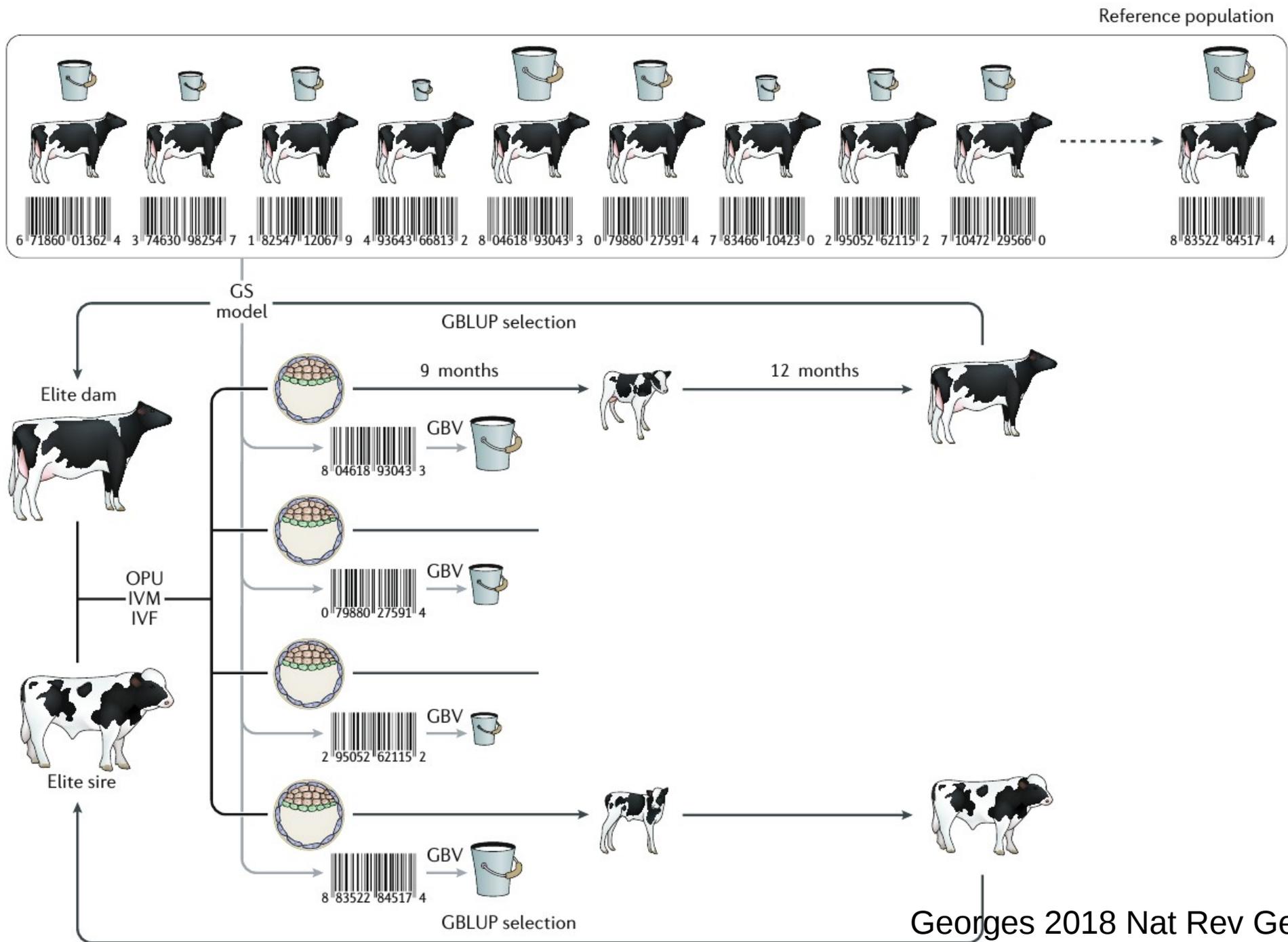
Niveau de résistance

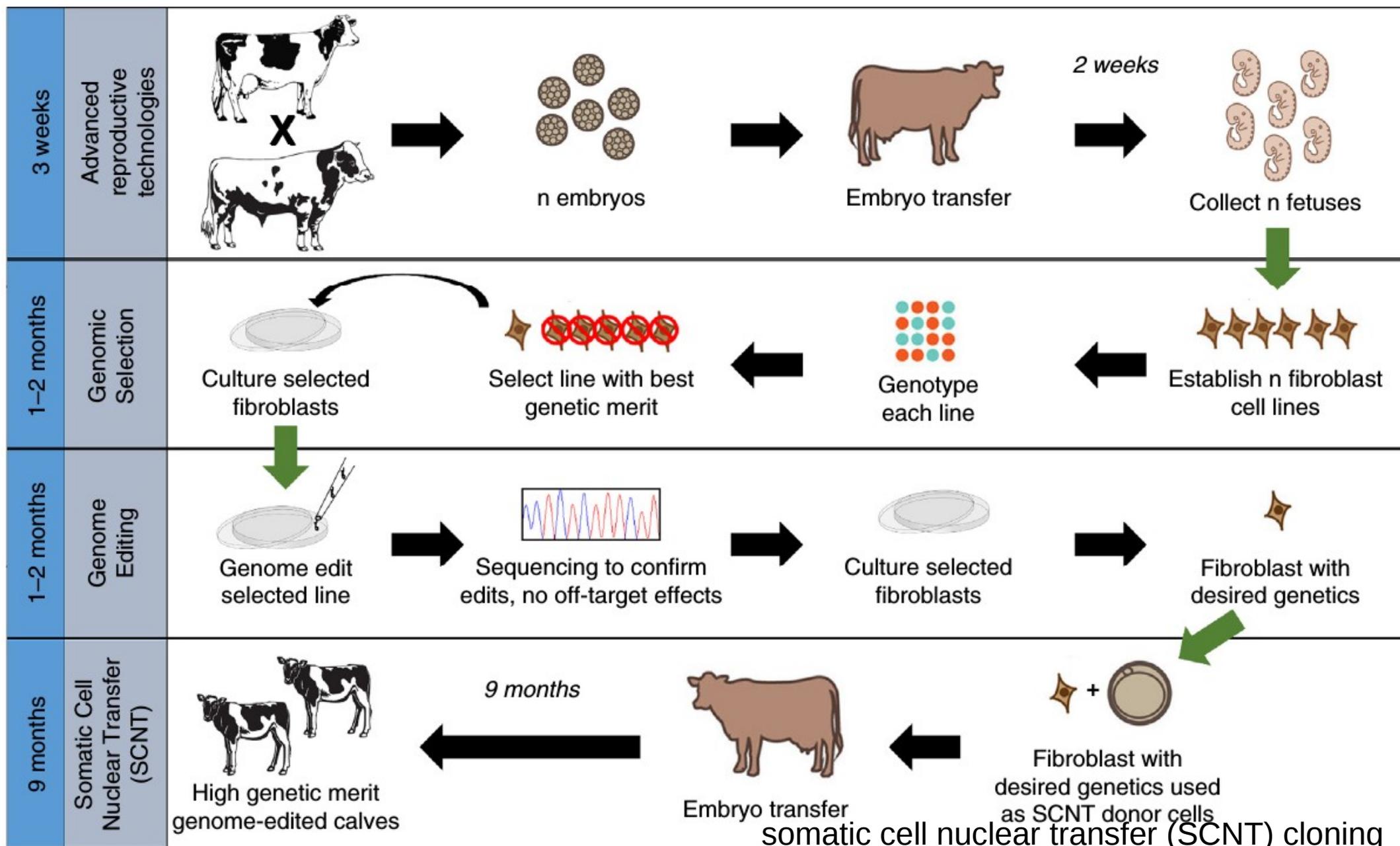


Classical selection



Faster selection based on genetic predictions





somatic cell nuclear transfer (SCNT) cloning

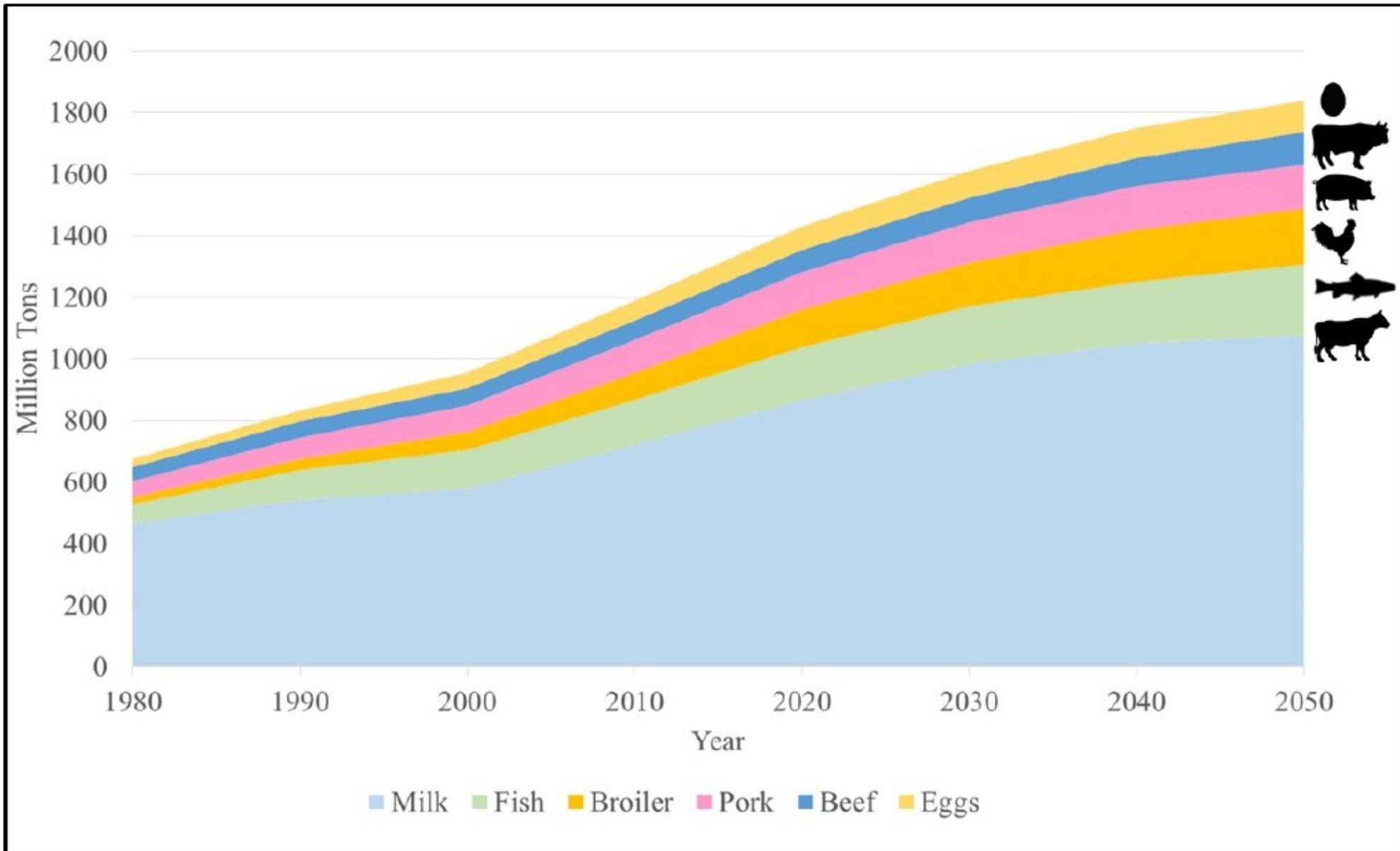


Figure 1. Egg, beef, pork, chicken, fish and milk production since 1980 and projected to 2050 (FAO 2018; Alexandratos and Bruinsma, 2012).

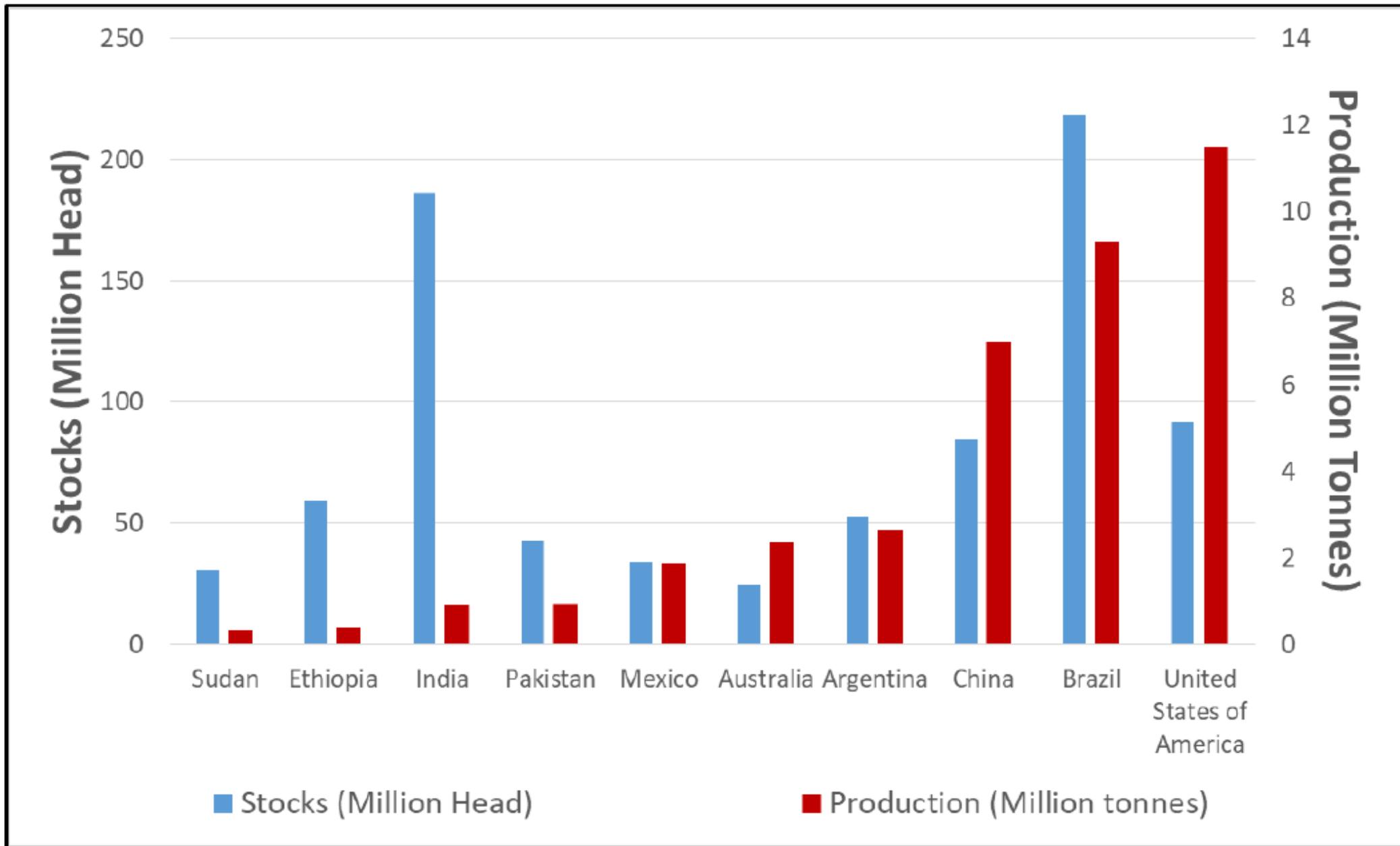


Figure 3. 2016 global beef production: cattle numbers (Million Head; blue, left) versus beef production (Million Tonnes; red, right). (FAO, 2018).

Anthropocene

Past history of Life

The Theory of Evolution

Mutations

Repeated Evolution

