Evolution of the living world

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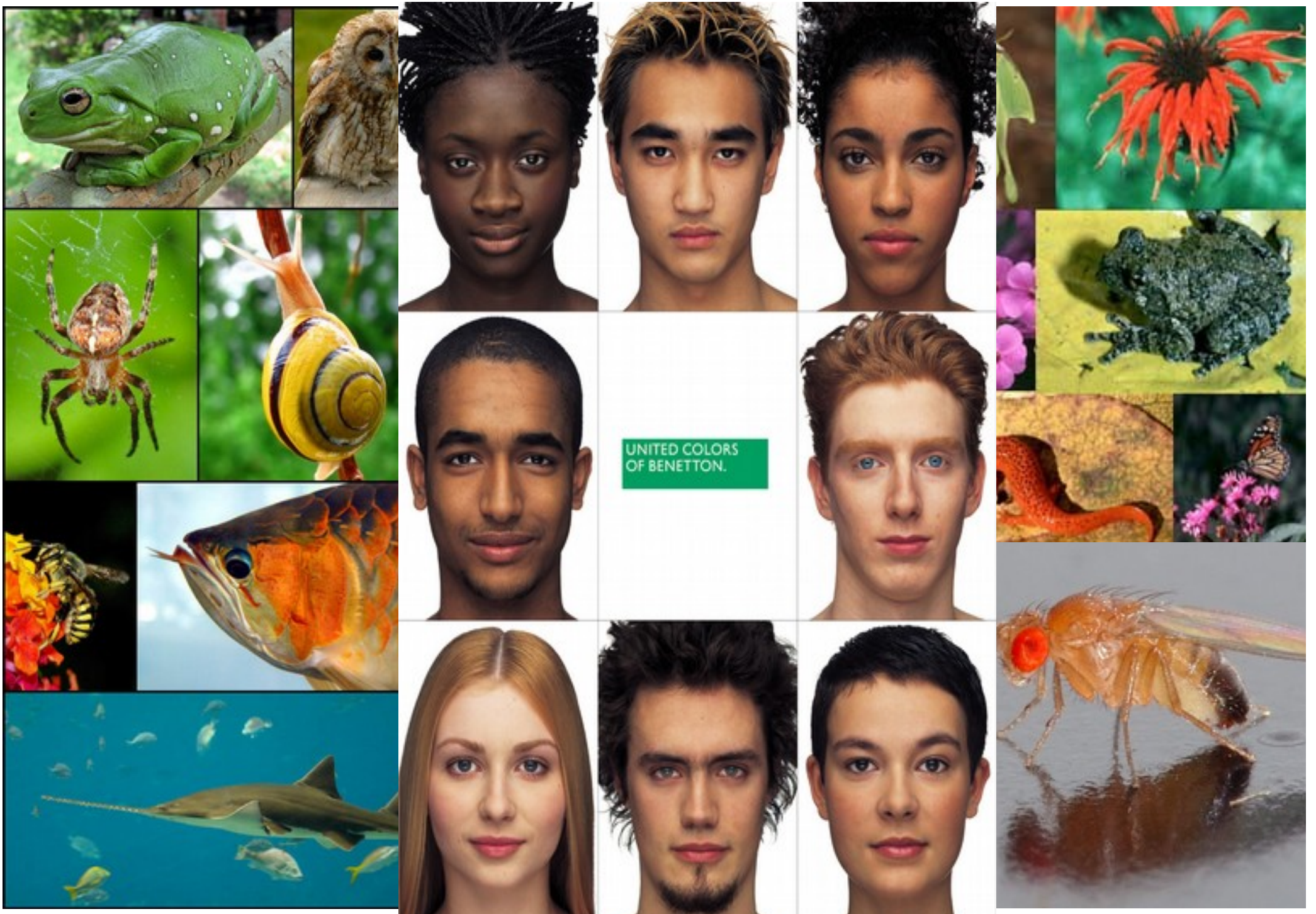
- **Can we explain the diversity in living forms?**
- **How do living beings evolve?**
- **What about other possible living forms?**


UNITED COLORS
OF BENETTON.

Observable characters (phenotype)

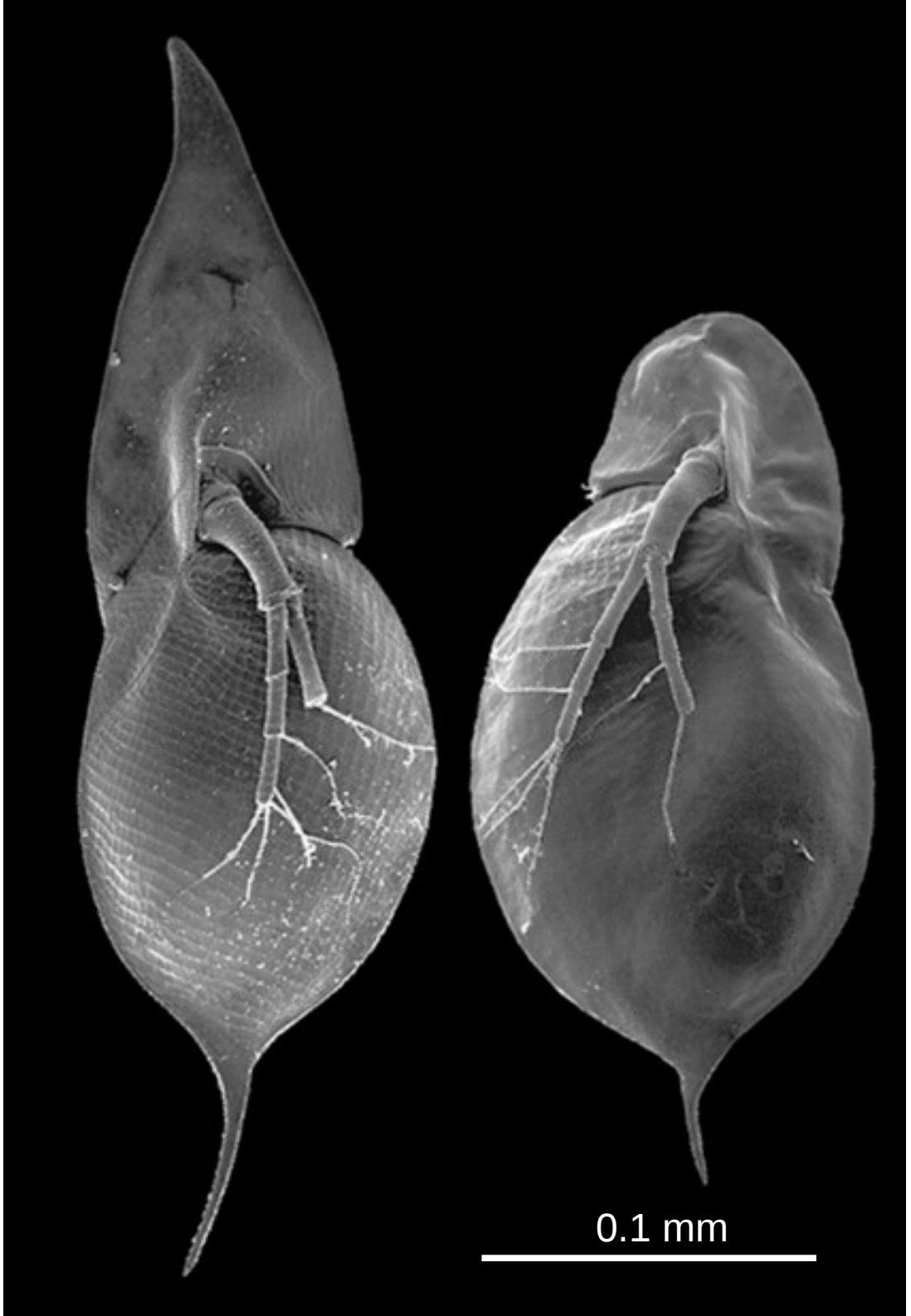
Morphology

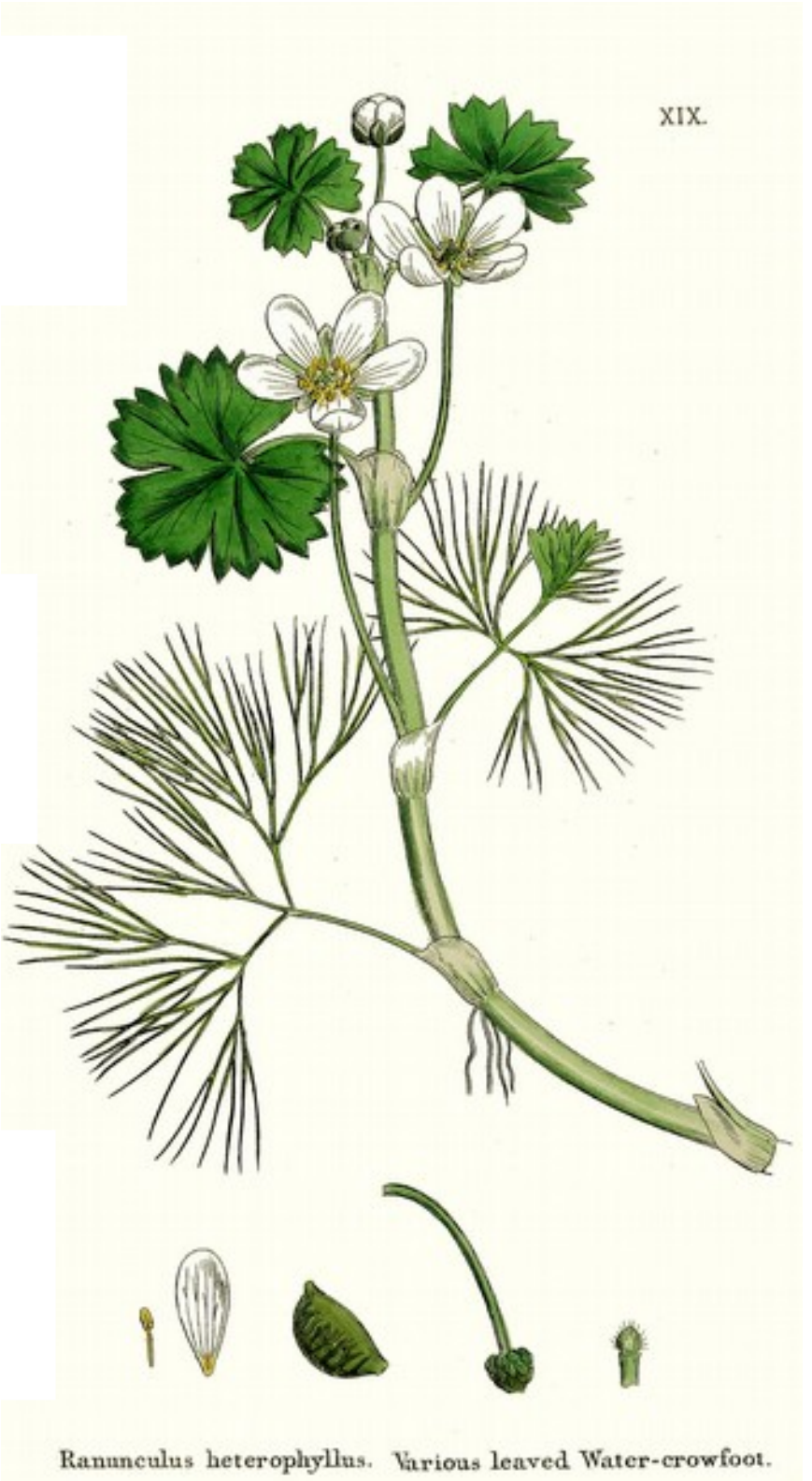
Color
Size and Shape
Presence/absence
Position

Aristote, Historia animalium, book I, 2, 300BC

Physiology

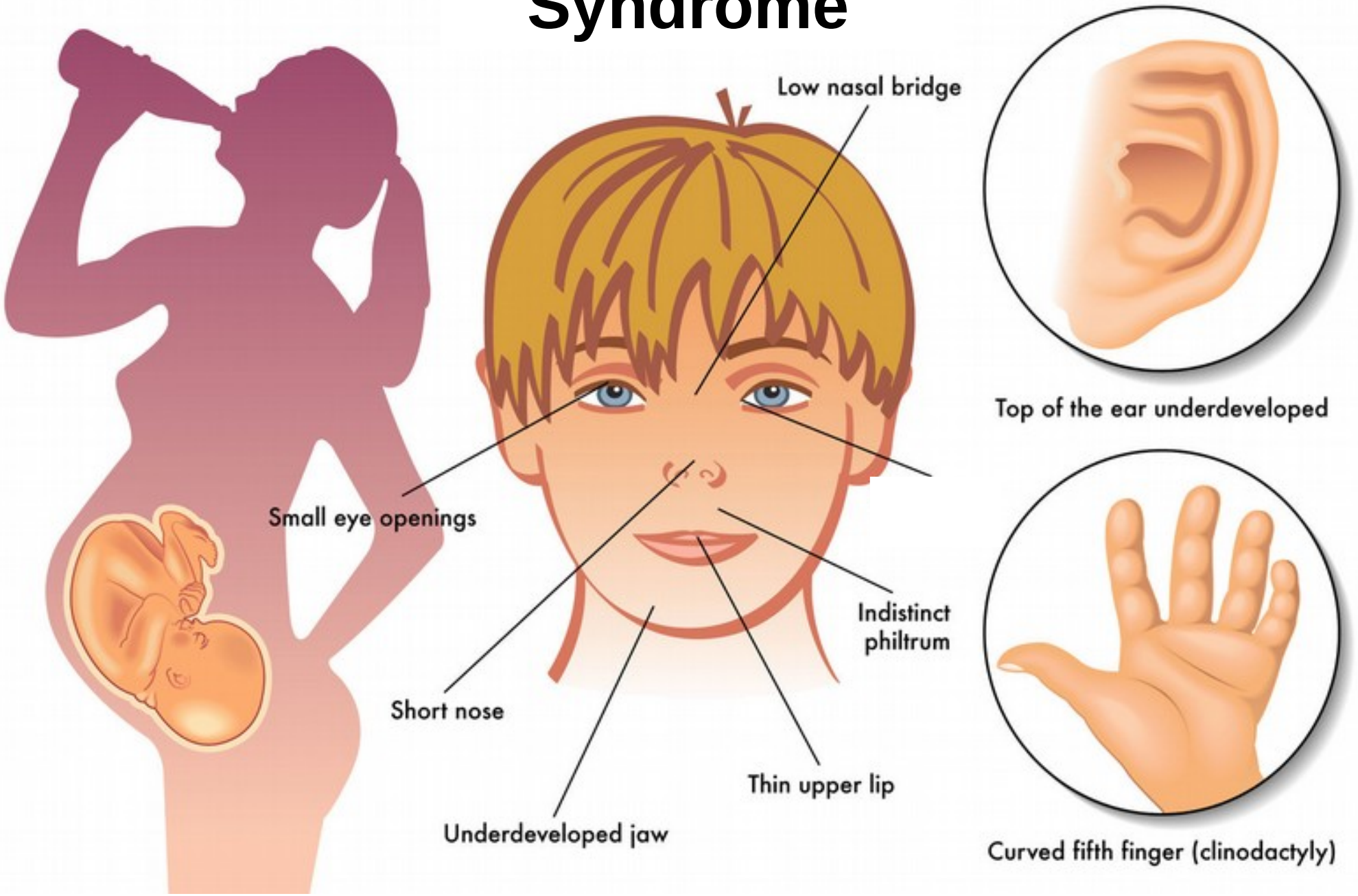
Behavior

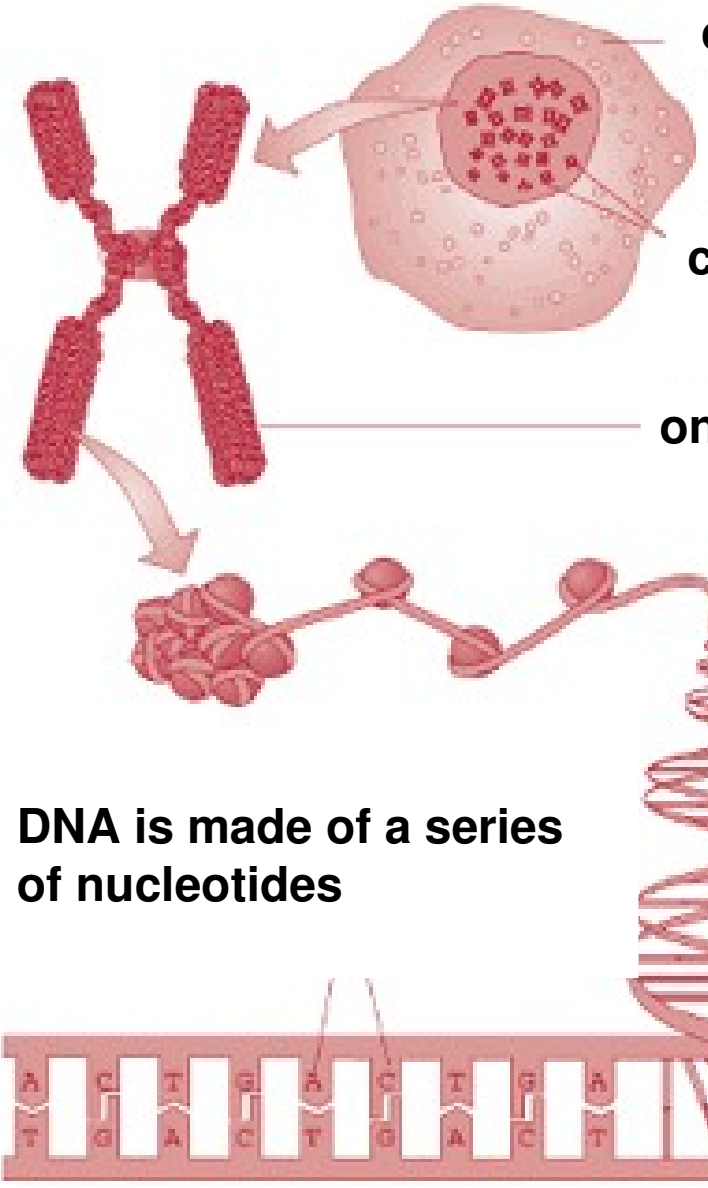

0.1 mm

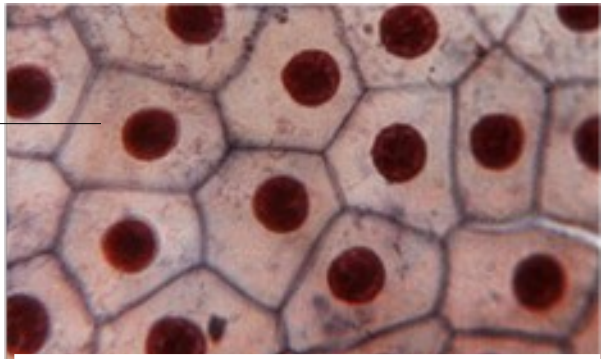


Ranunculus heterophyllus. Various leaved Water-crowfoot.

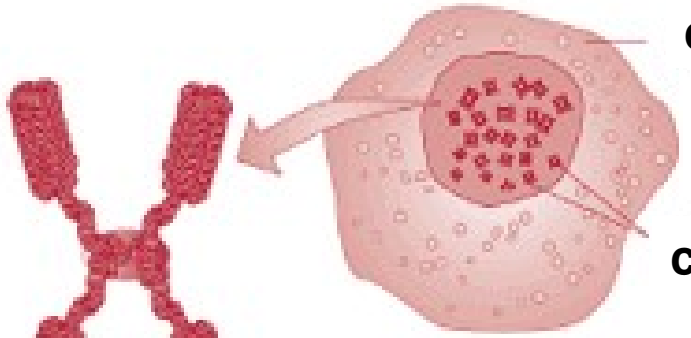
Foetal Alcohol Syndrome





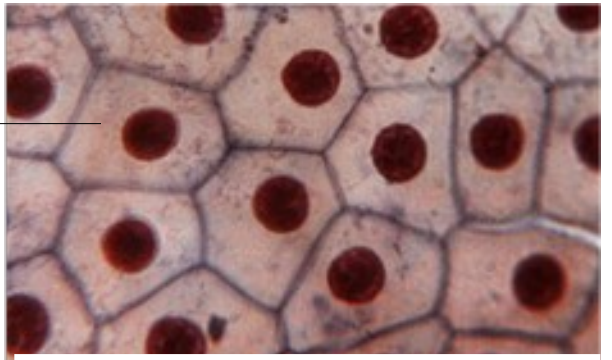


Frog skin (x400)



cell

chromosomes



Frog skin (x400)

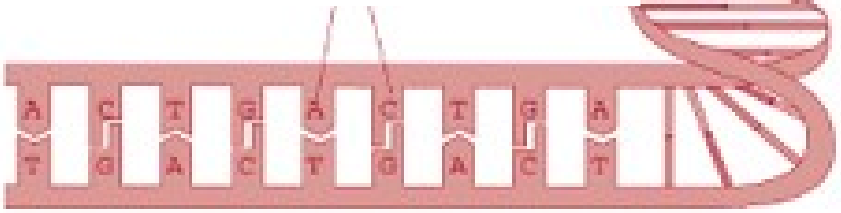
one chromosome

non coding DNA

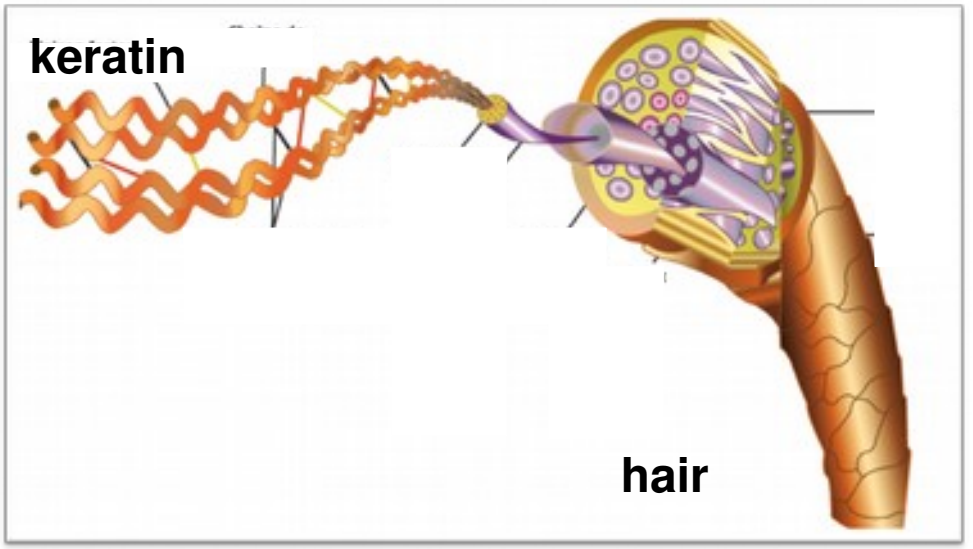
coding DNA

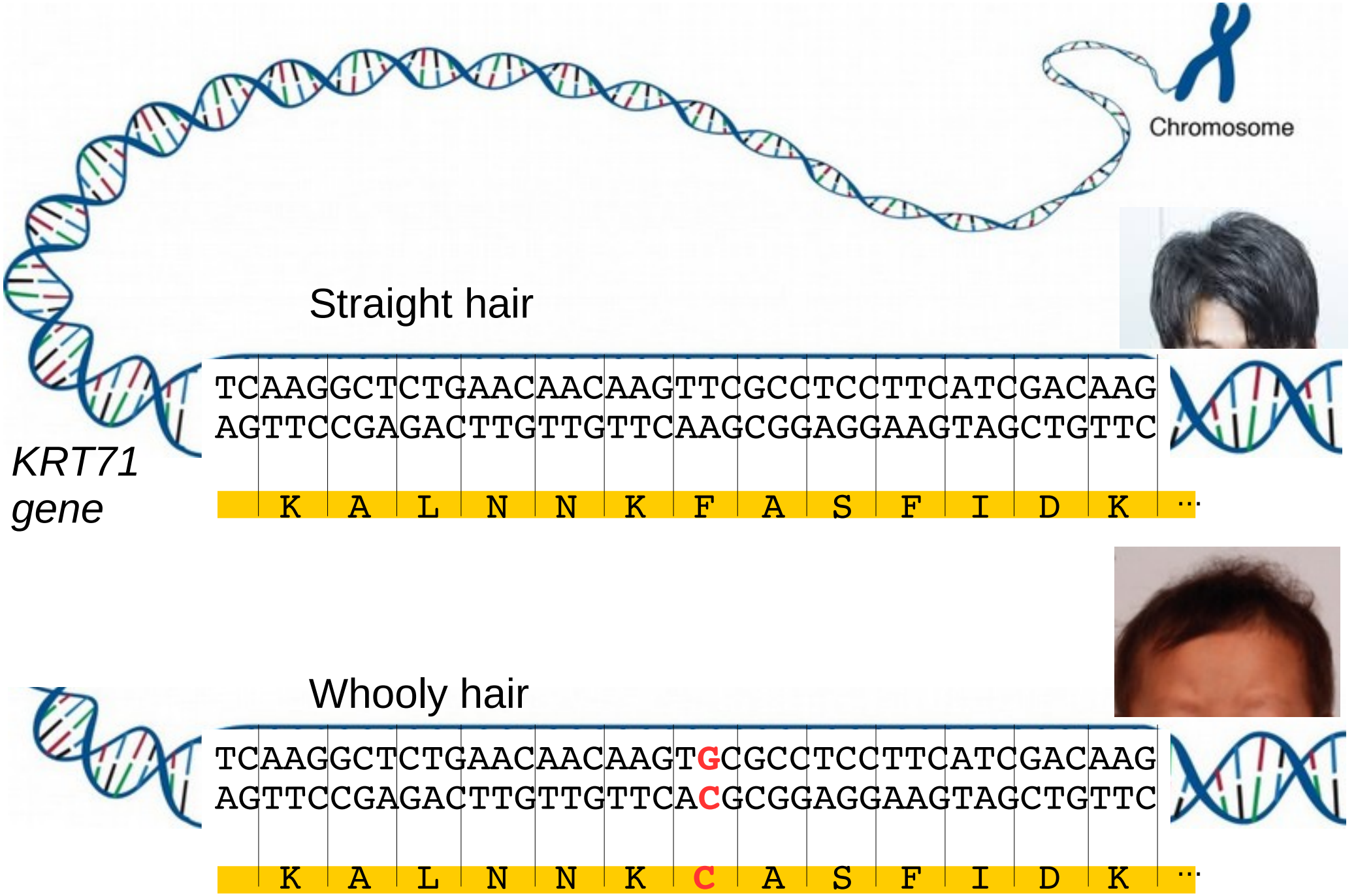
proteins

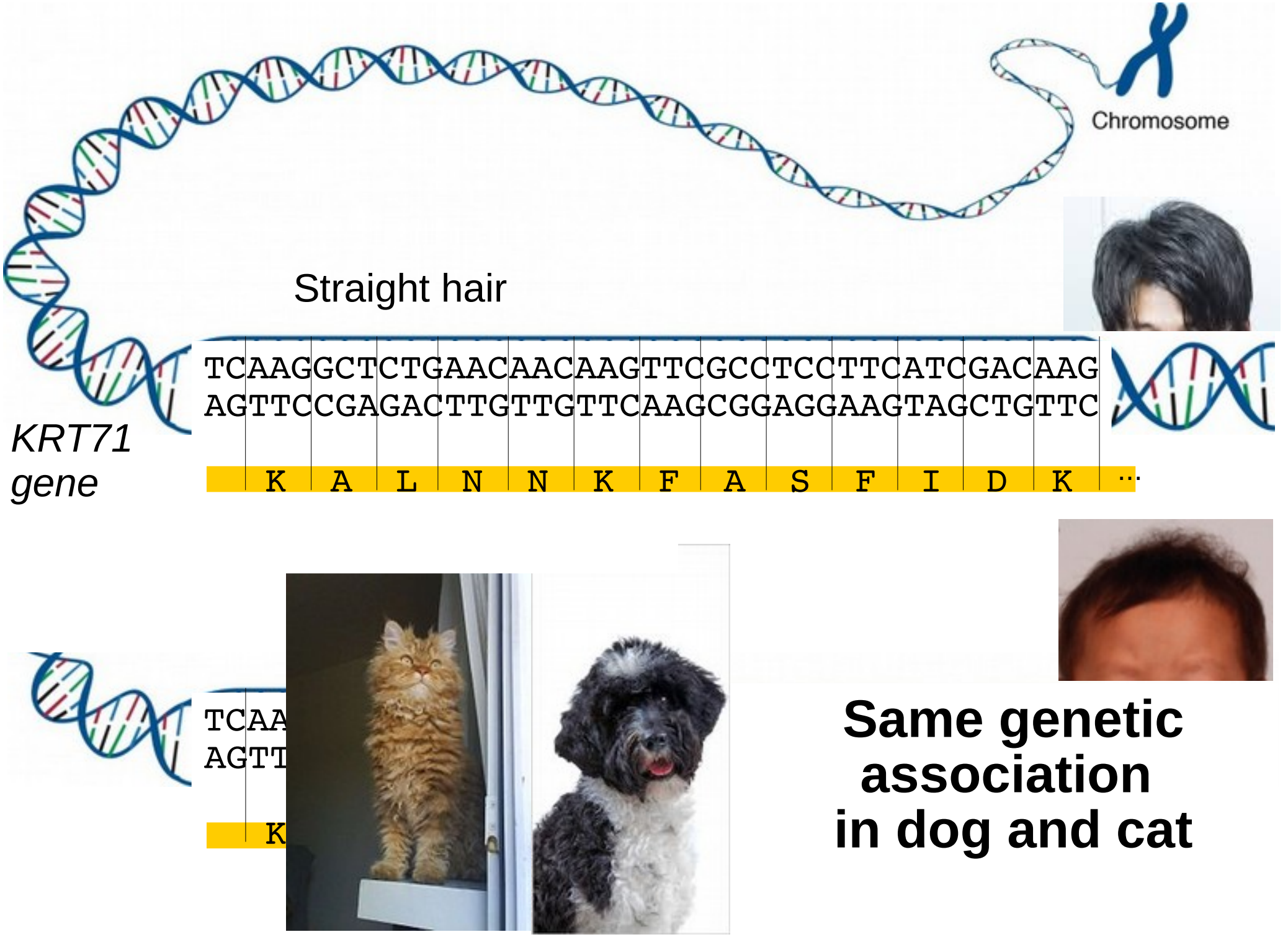
DNA is made of a series of nucleotides



DNA




Chromosome
Straight hair
TCAAGGCTCTGAACAACAAGTTCGCCTCCTTCATCGACAAG
AGTTCCGAGACTTGTTGTTCAAGCGGAGGAAGTAGCTGTTC
K A L N N K F A S F I D K ...
KRT71 gene
Whooly hair
TCAAGGCTCTGAACAACAAGTGCGCCTCCTTCATCGACAAG
AGTTCCGAGACTTGTTGTTCACGCGGAGGAAGTAGCTGTTC
K A L N N K C A S F I D K ...



Same genetic association in dog and cat

Genetics

Environment

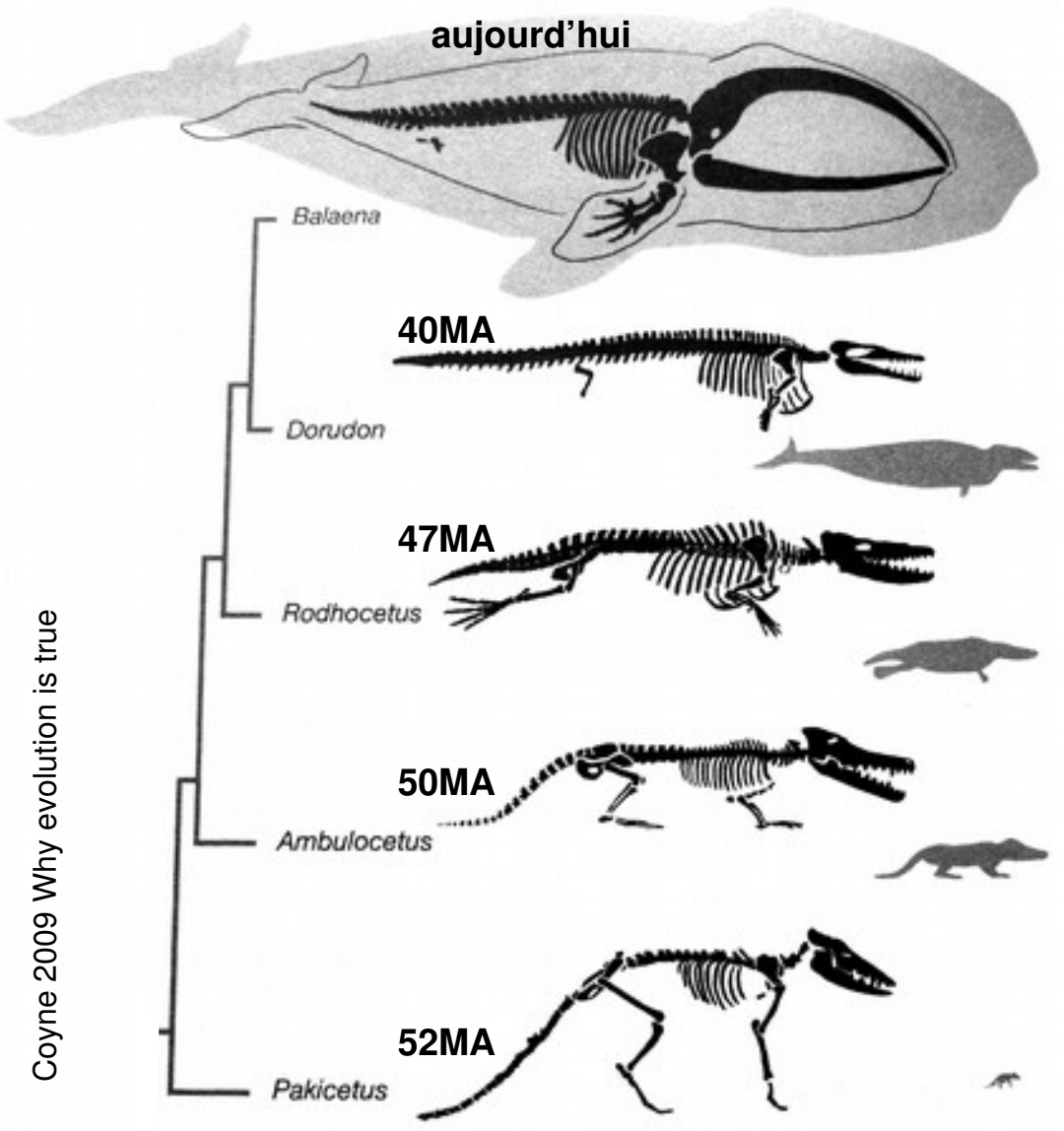
Genes
Amount of food
Alcohol
Mechanical forces
Presence of predators
Temperature
...

Shape

Stochasticity

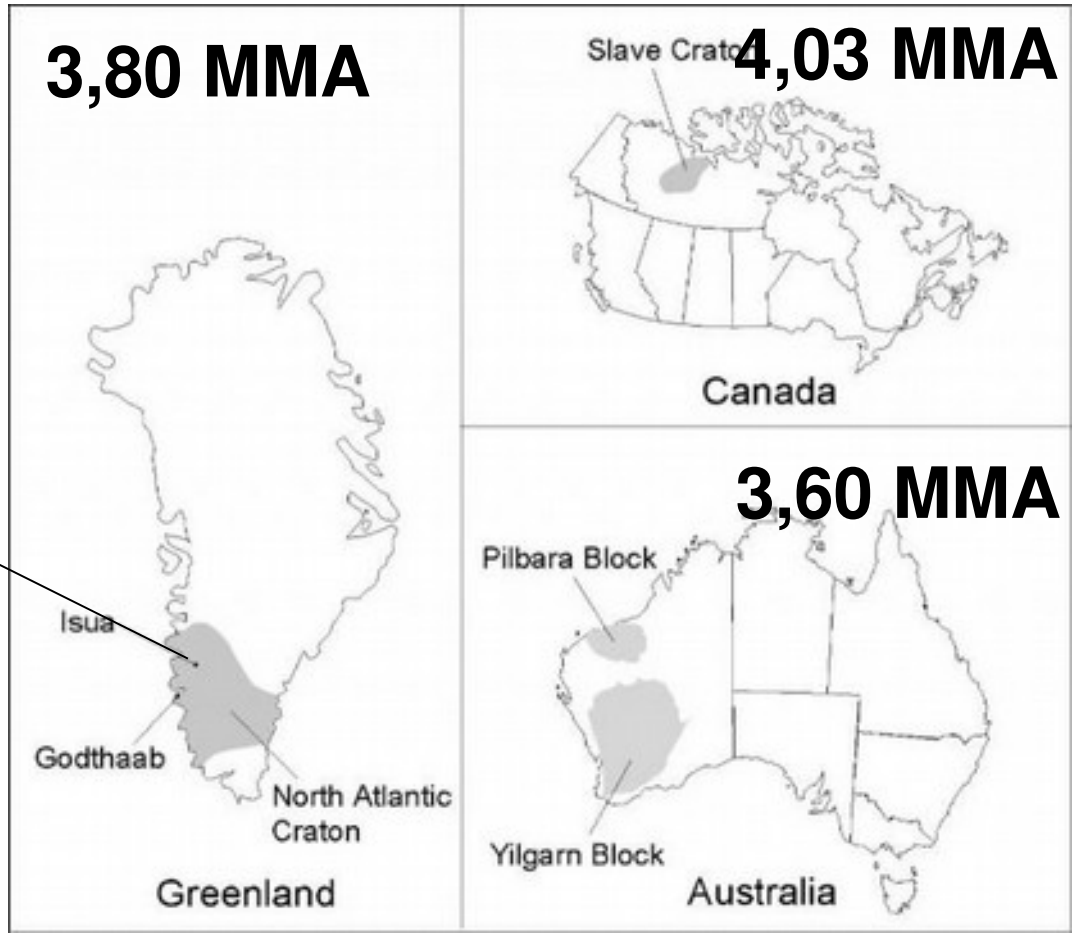
- Can we explain the diversity in living forms?
- **How do living beings evolve?**
- What about other possible living forms?

Evolution = modification of living beings over successive generations



Coyne 2009 Why evolution is true

The oldest rocks on earth



http://gustavus.edu

NCSE

4,5

Billion years

formation
of the earth

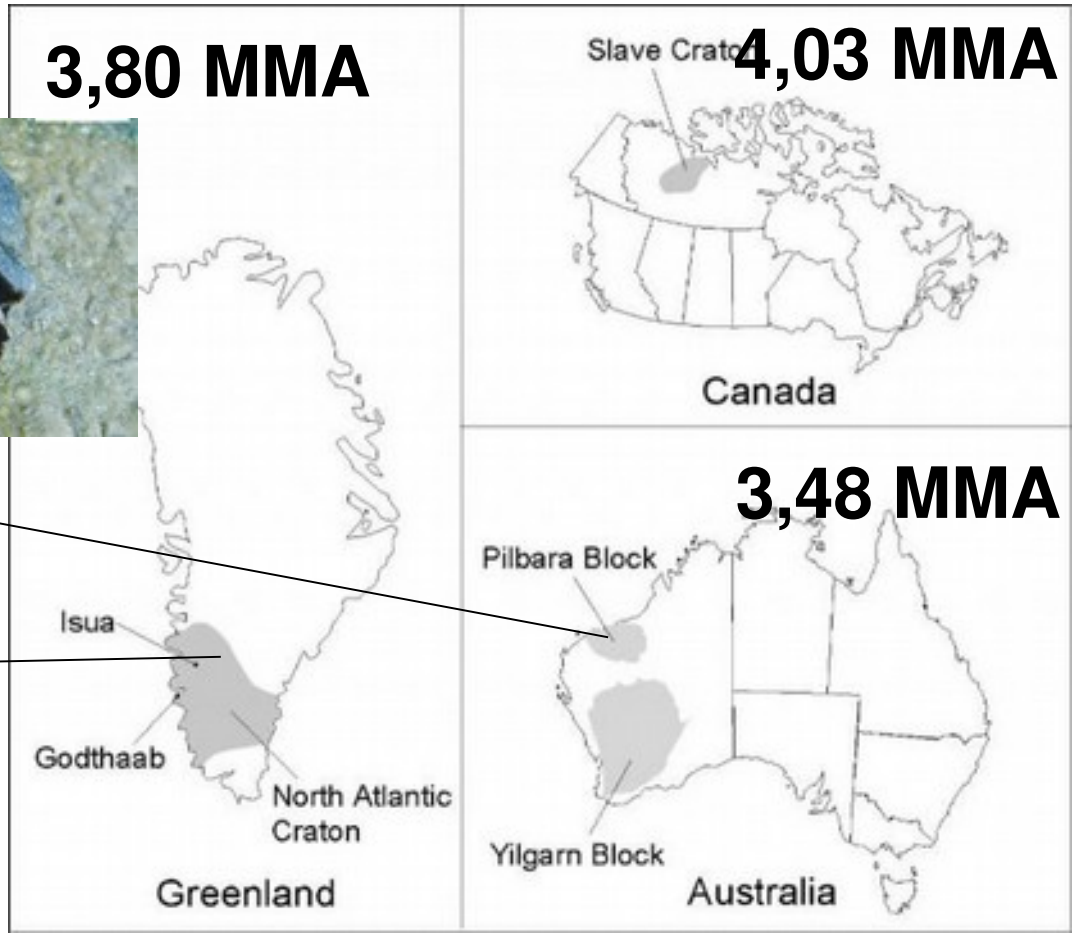
The oldest traces of life

3,48MMA: Biofilm

(Noffke et al. 2013)

3,7MMA: Graphite biogénique

(Ohtomo et al. 2013)

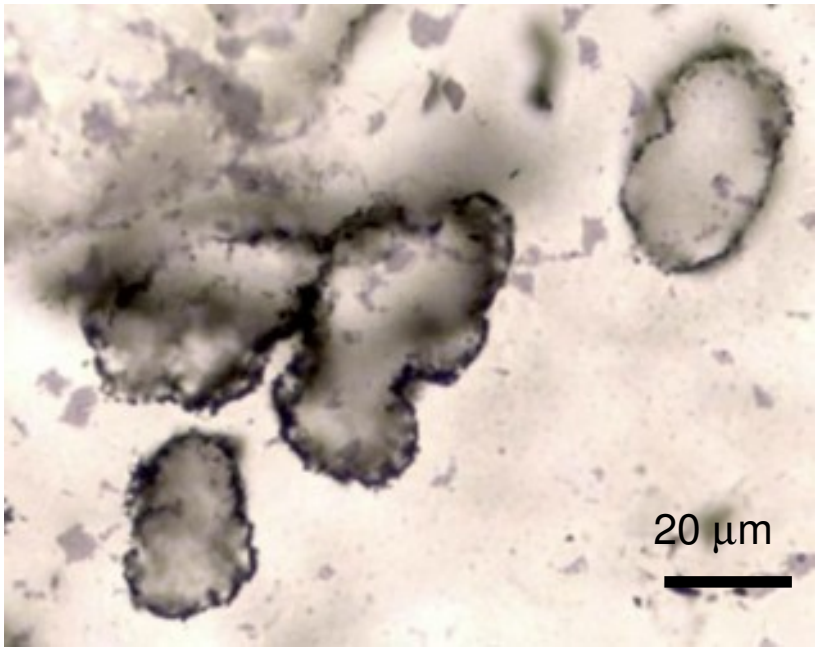


1rst traces (graphite)

http://gustavus.edu

NCSE

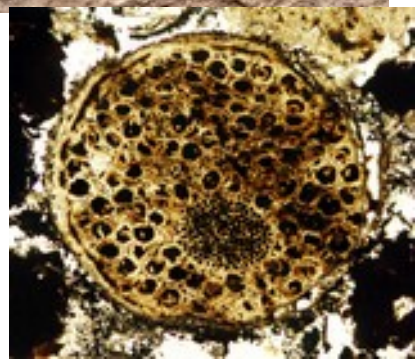
First fossilized cells : 3,4 MMA



(Wacey et al. 2011)

Strelley Pool Formation, Australie

Ediacara fossils: 630-540MA



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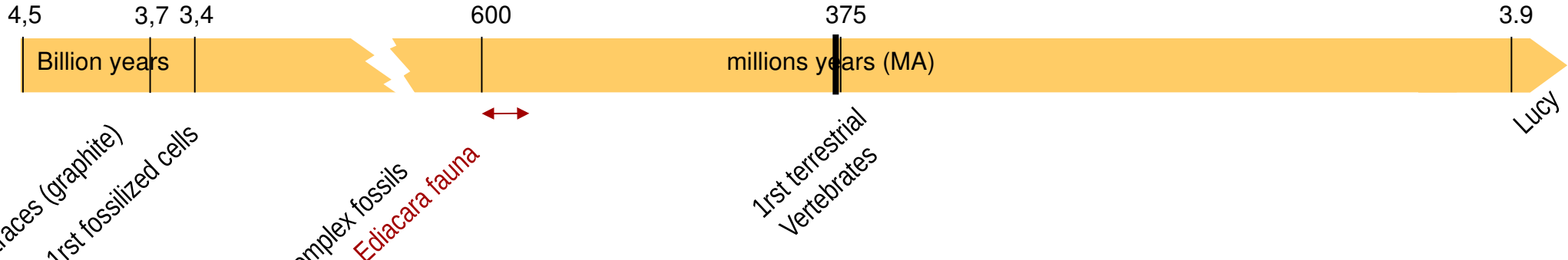
Vertebrates move out of water

Eusthenopteron foordi (385MA)

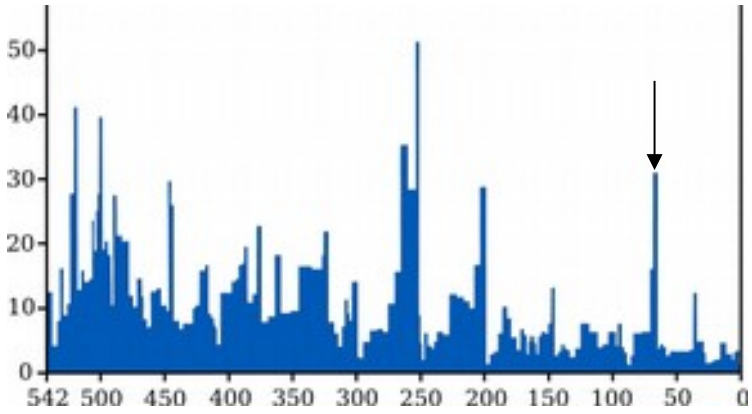
Acanthostega gunnari (365MA)

aujourd'hui

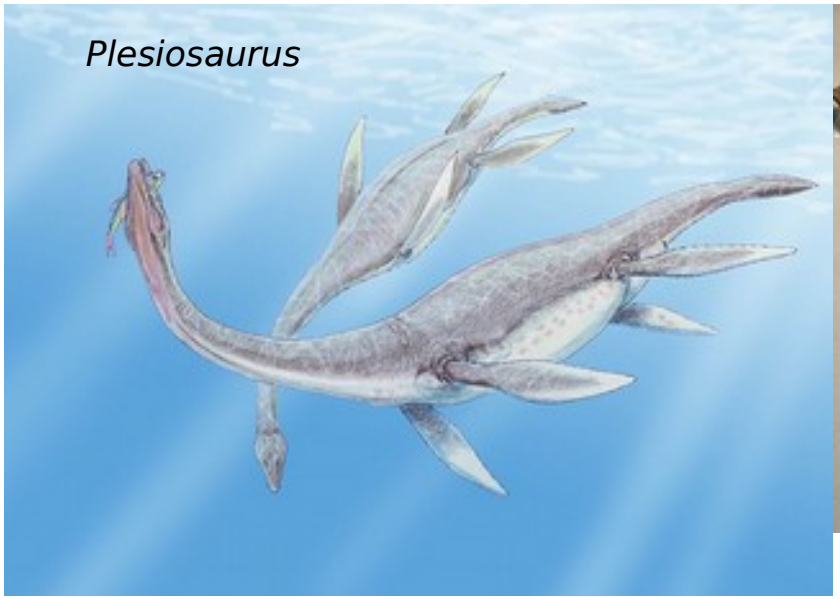


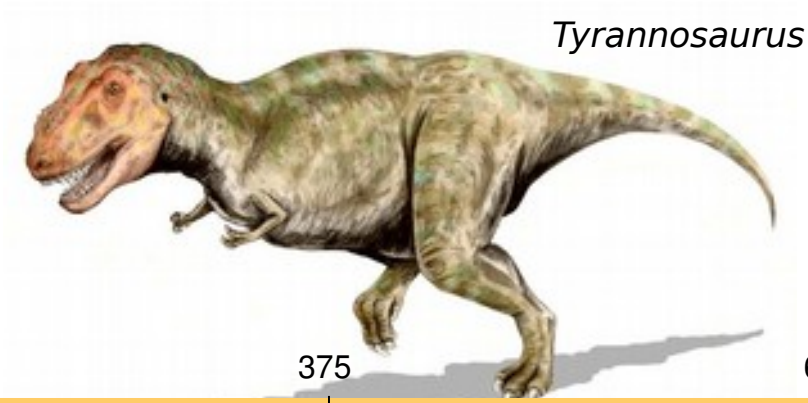
Mass Extinction: 65MA

% lost genera of marine animals



milions years





Luis Miguel Bugallo Sánchez http://commons.wikimedia.org/

4,5 | 3,7 | 3,4 | 600 | 375 | 65

Billion years | Million years

1rst traces (graphite)

1rst fossilized cells

1rst complex fossils

Ediacara fauna

1ers Vertébrés terrestres

extinction of dinosaurs

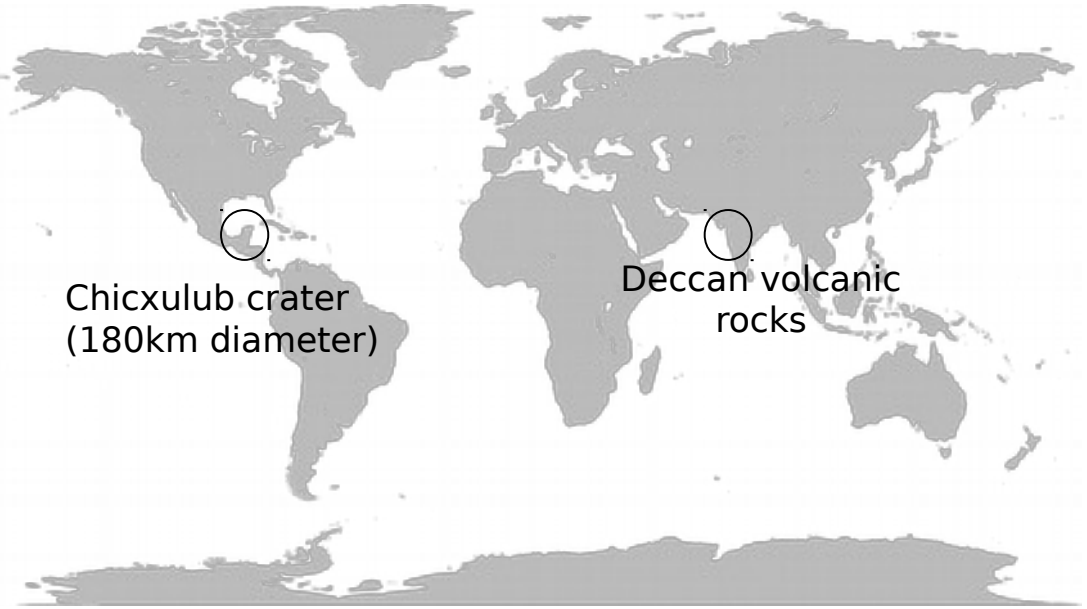
Linked to important changes in the environment

after 65MY

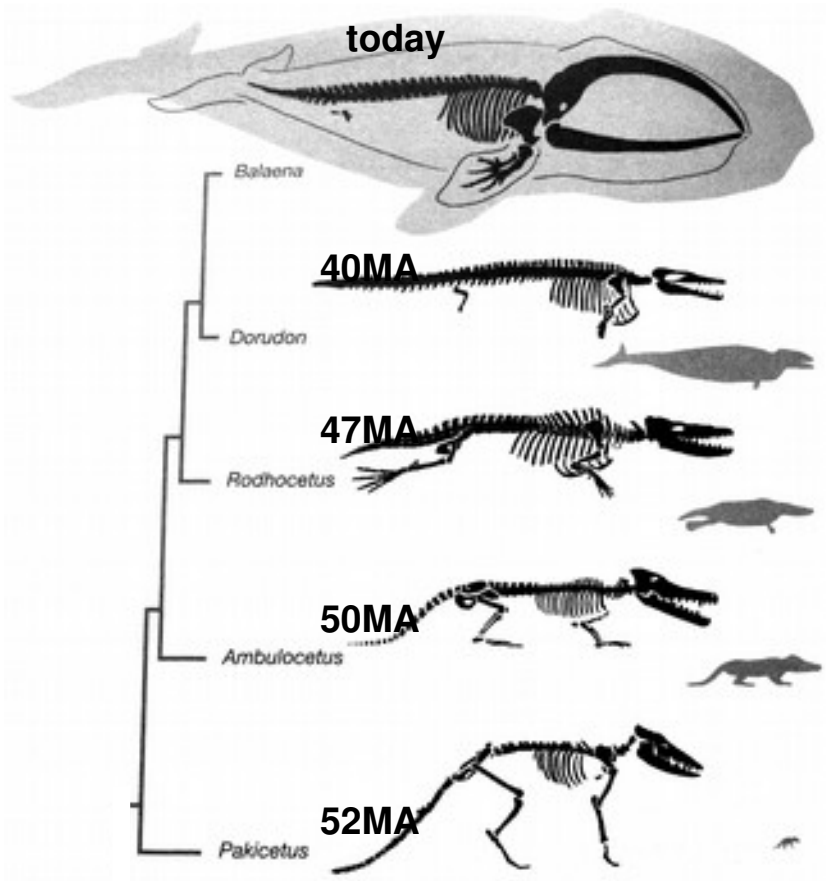
65MA : 1000 times more iridium

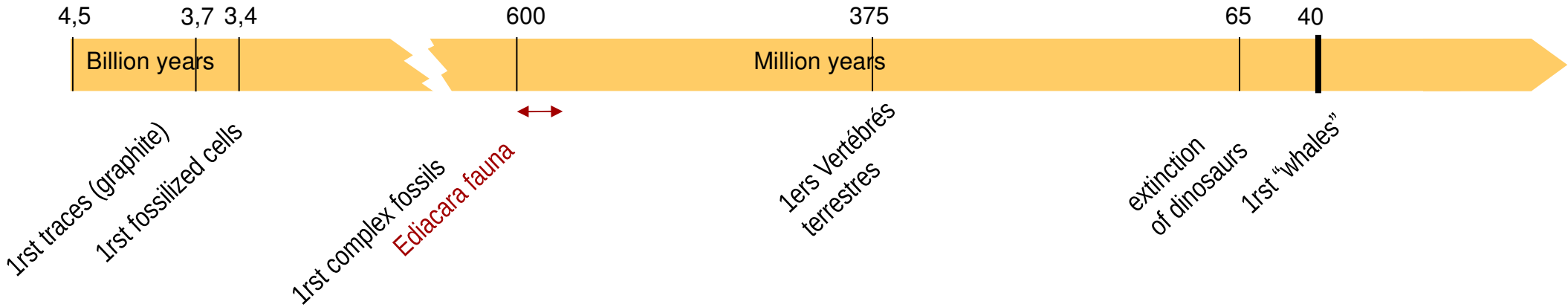
before 65MA

Wyoming Rocks



Back to water for some Mammals





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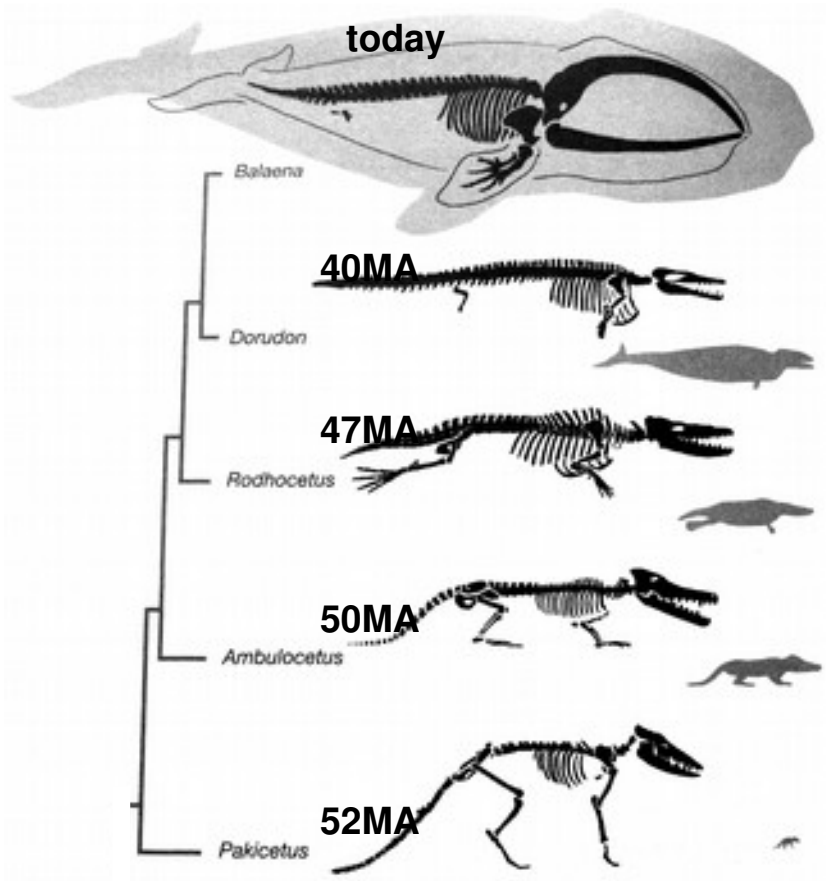


4,5 | 3,7 | 3,4 | 600 | 375 | 65 | 40 | 3

Billion years | Million years

1rst traces (graphite)

1rst fossilized cells

1rst complex fossils

Ediacara fauna

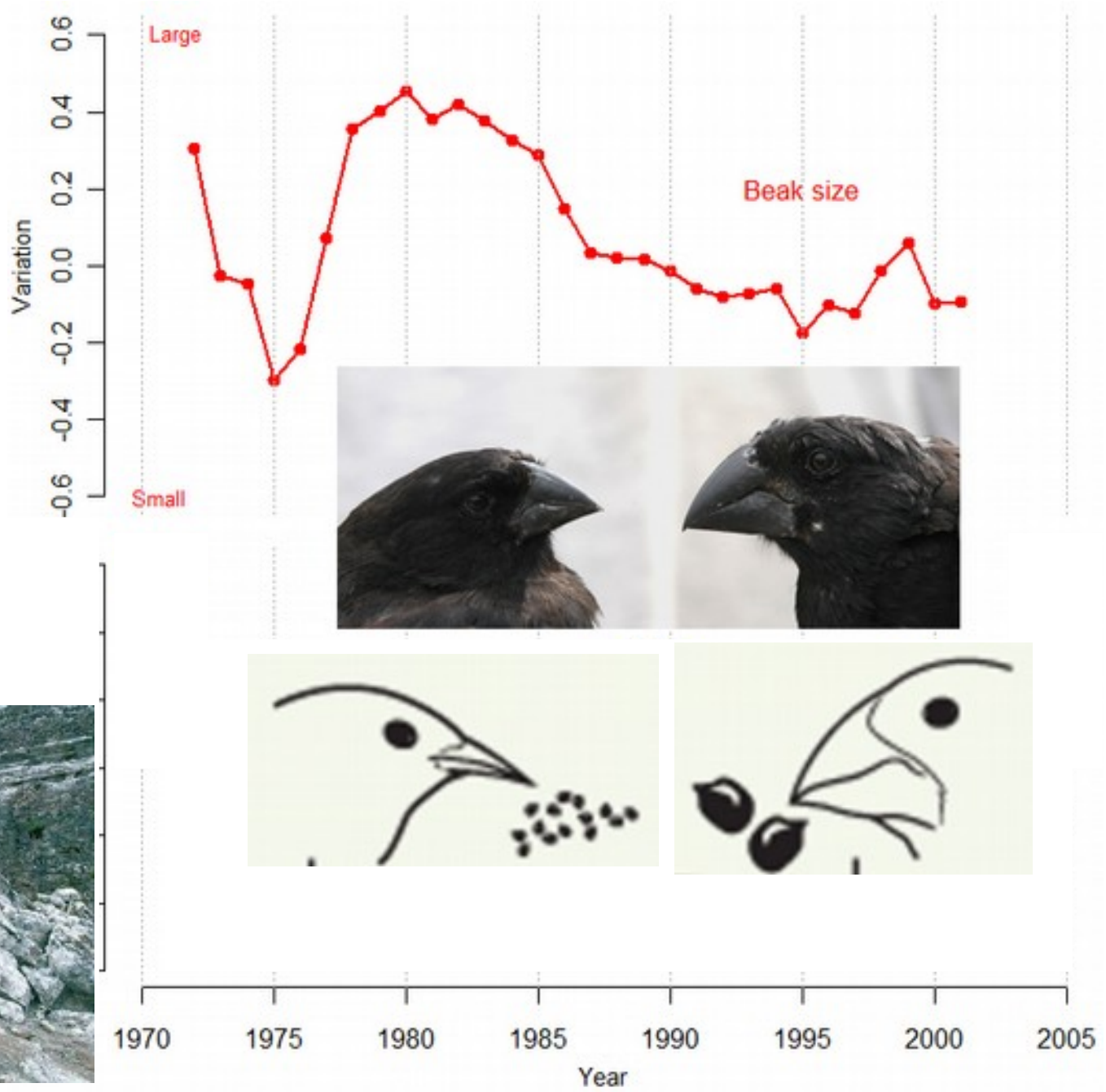
1ers Vertébrés terrestres

extinction of dinosaurs

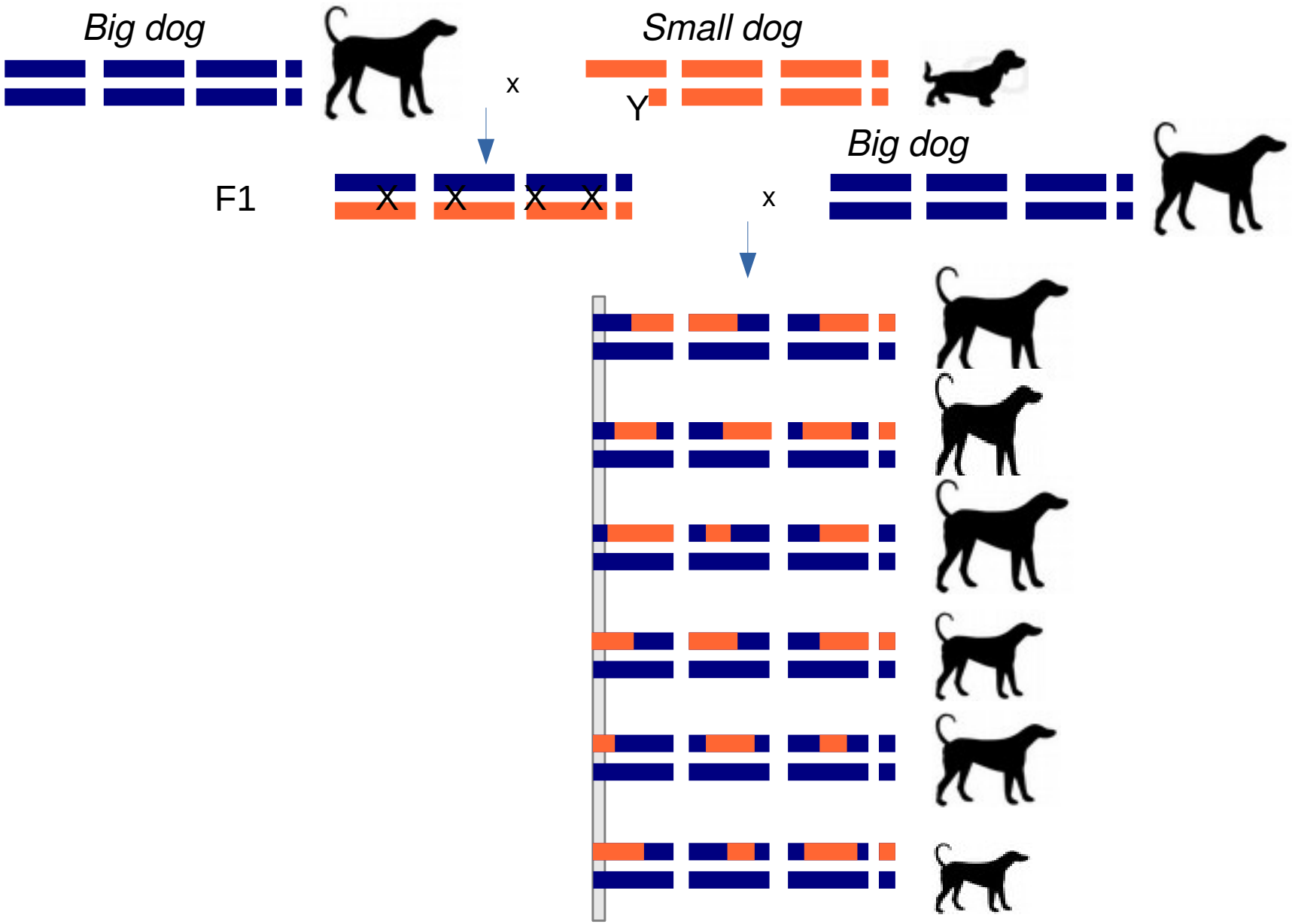
1rst "whales"

Lucy

Rapid Evolution in Galapagos islands



Crosses and genetics



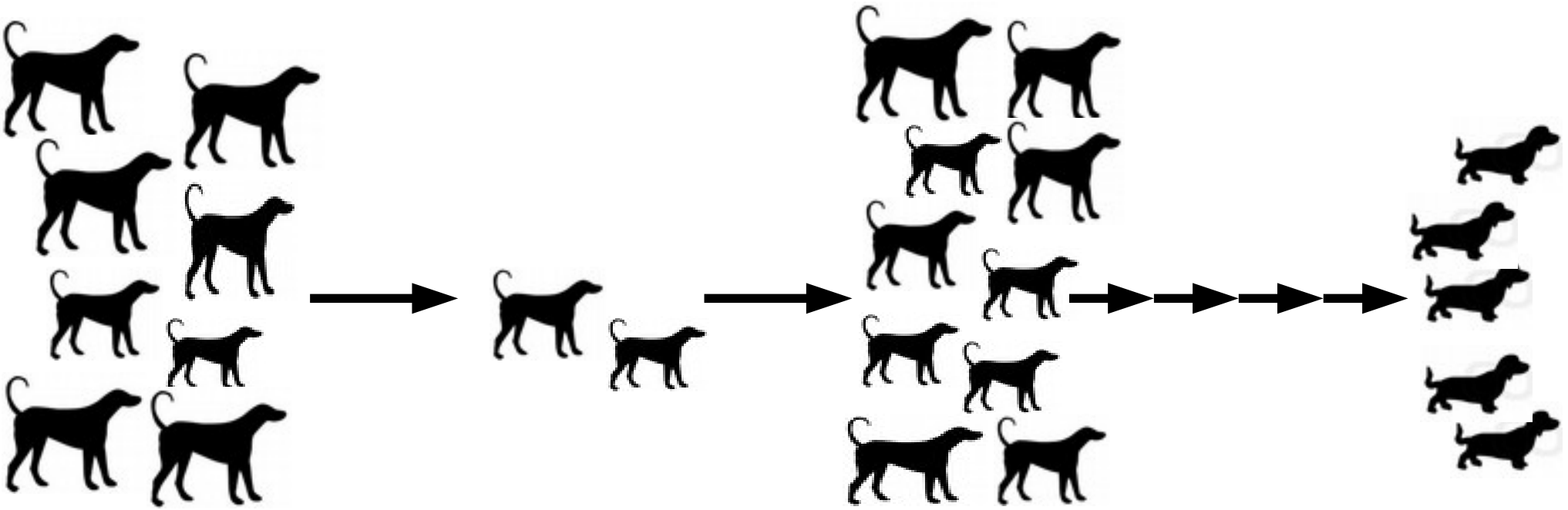
Association between DNA and phenotype

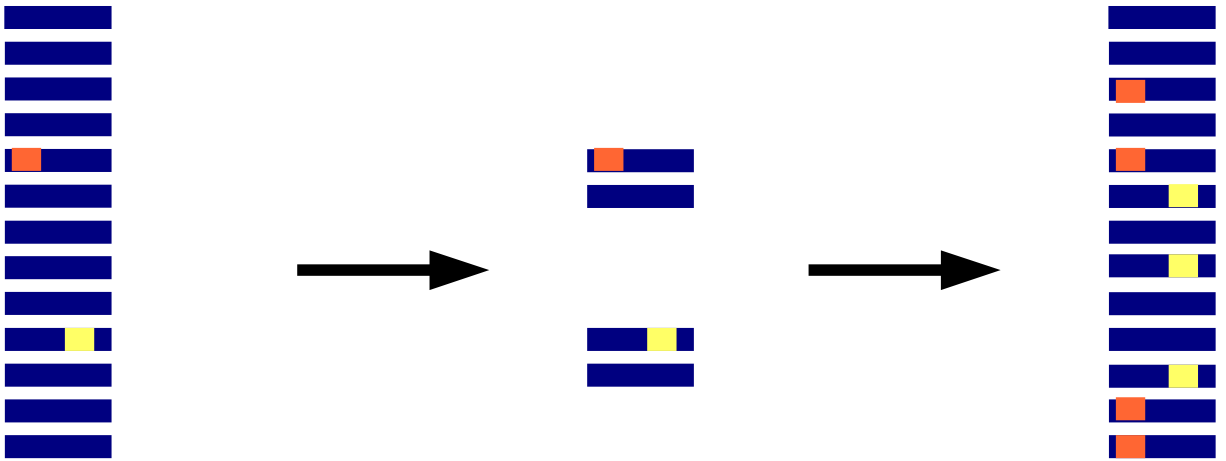
Small dogs carry a different *insuline IGF1* gene

Small dogs carry a different *insuline IGF1* gene

Same genetic association in humans and mouse

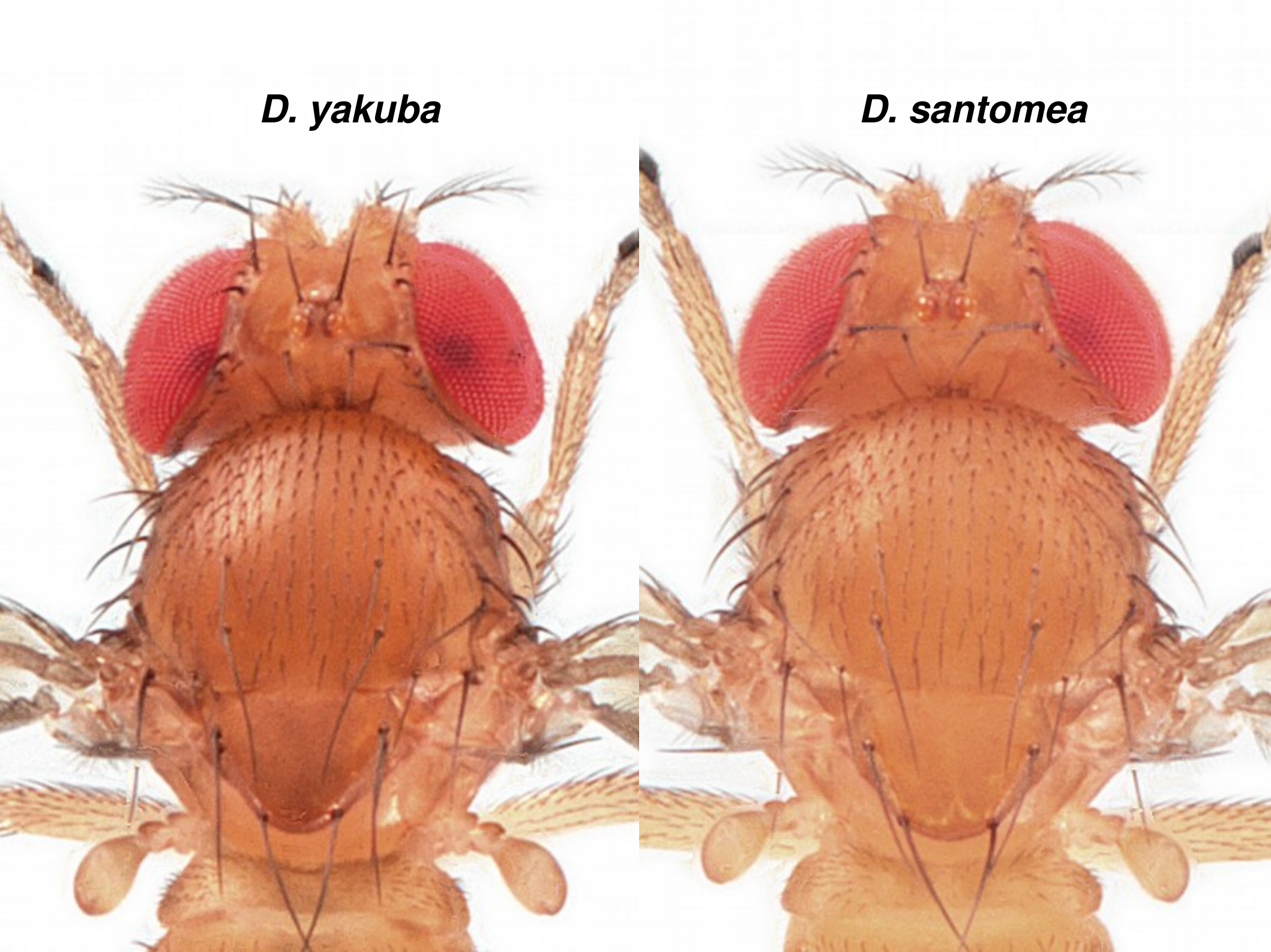
Evolution

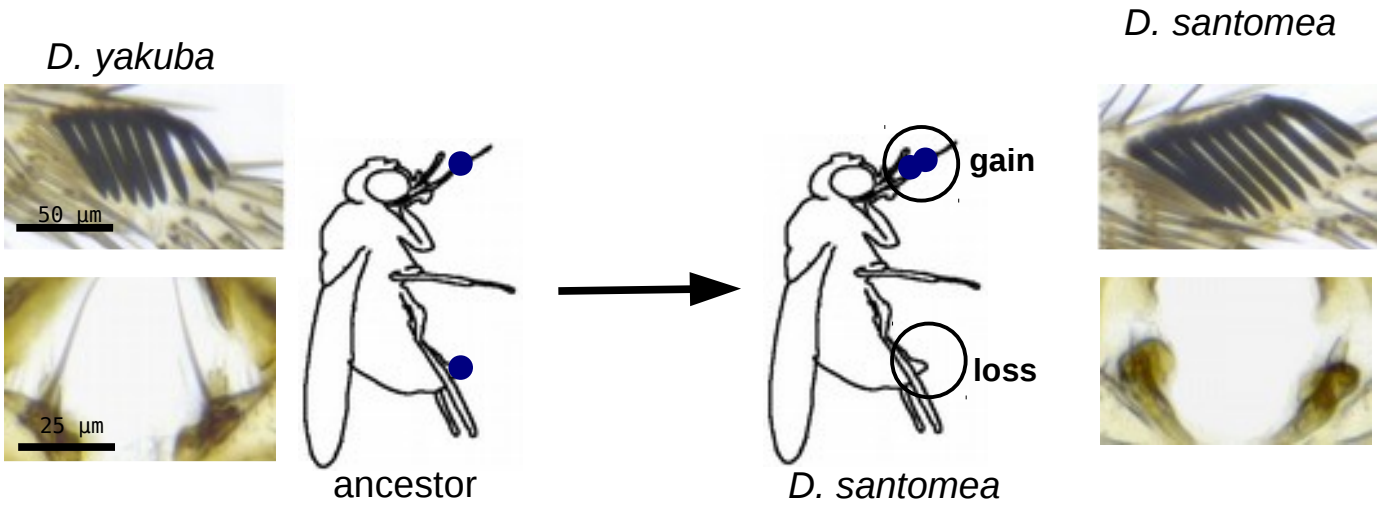




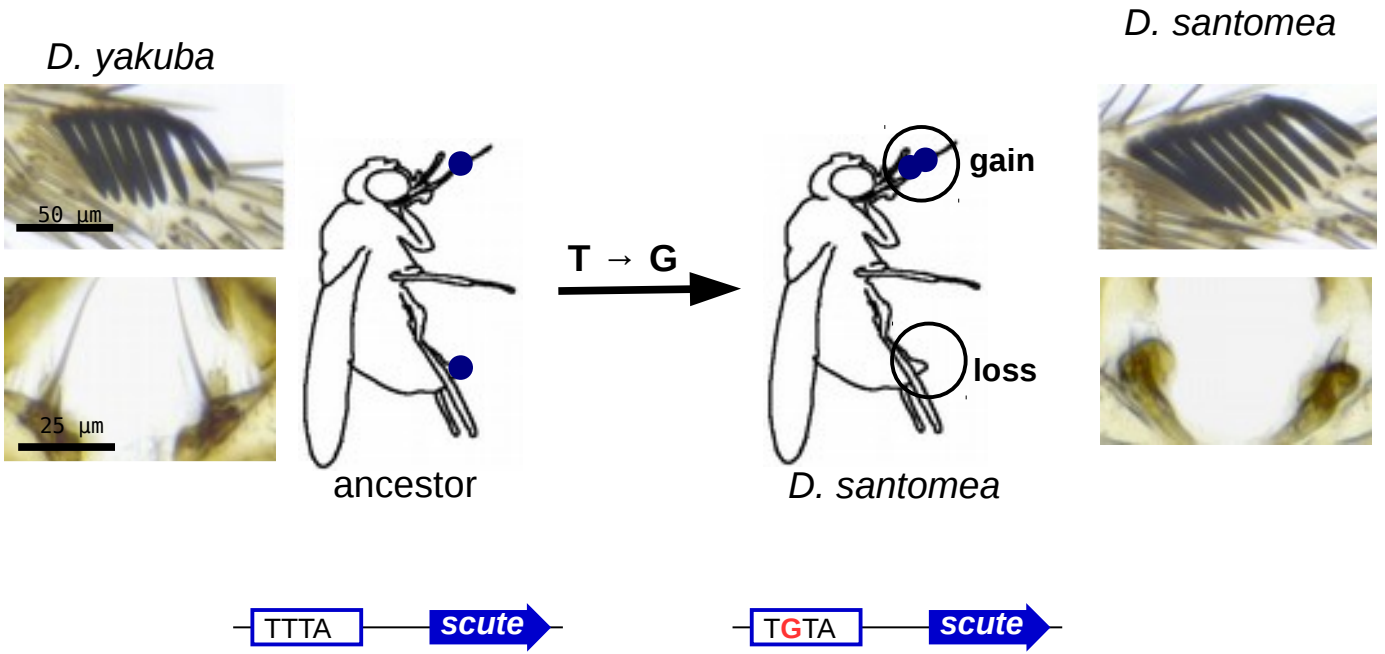
D. yakuba

D. santomea

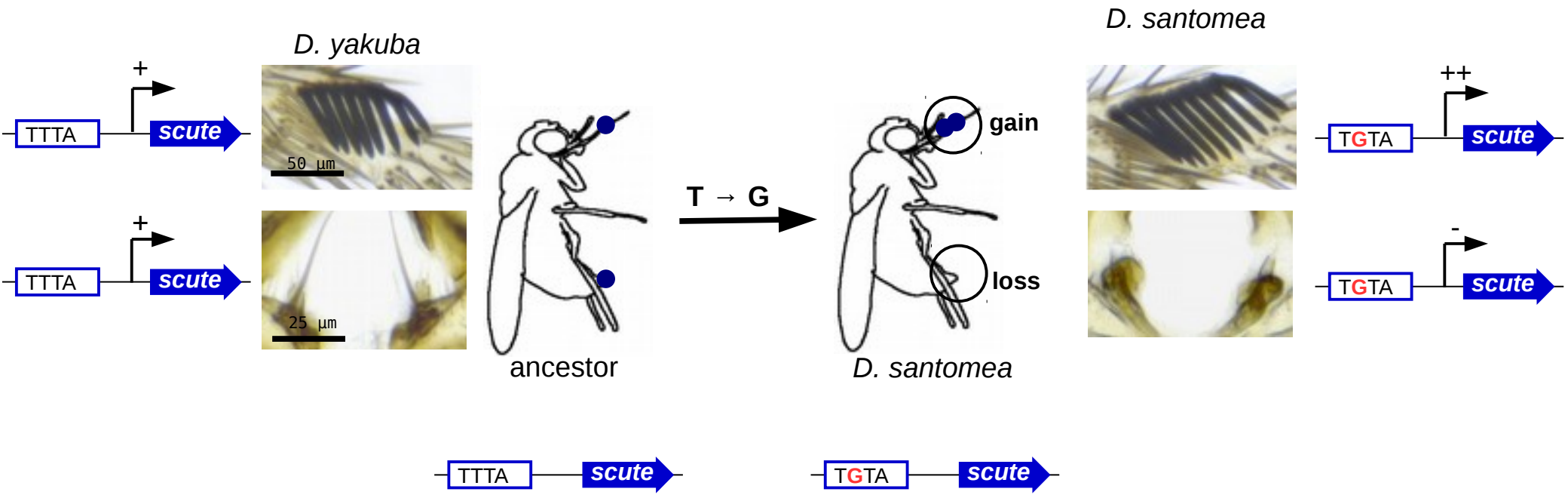



D. yakuba
50 µm
25 µm
ancestor
gain
loss
D. santomea
D. santomea

A single mutation decreases genital bristles and increases leg bristles



A single mutation decreases genital bristles and increases leg bristles



- Can we explain the diversity in living forms?
- How do living beings evolve?
- **What about other possible living forms?**

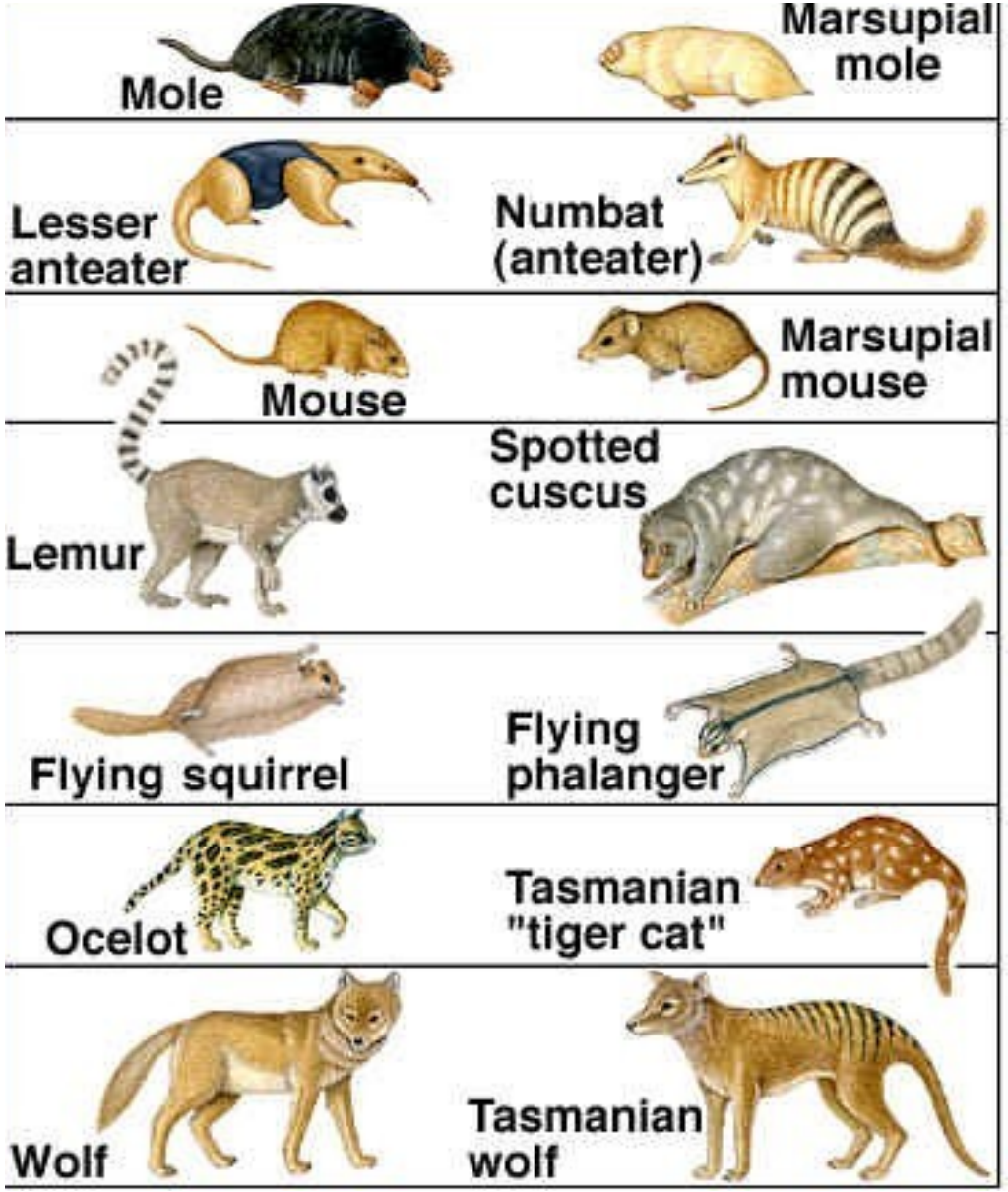
Same evolution in the same conditions

Placentals

North and South America

Marsupials

Australia



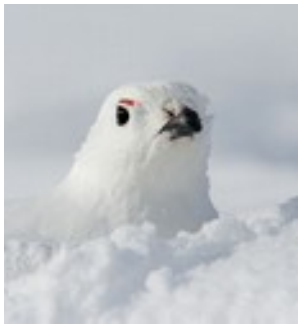
Euphorbs

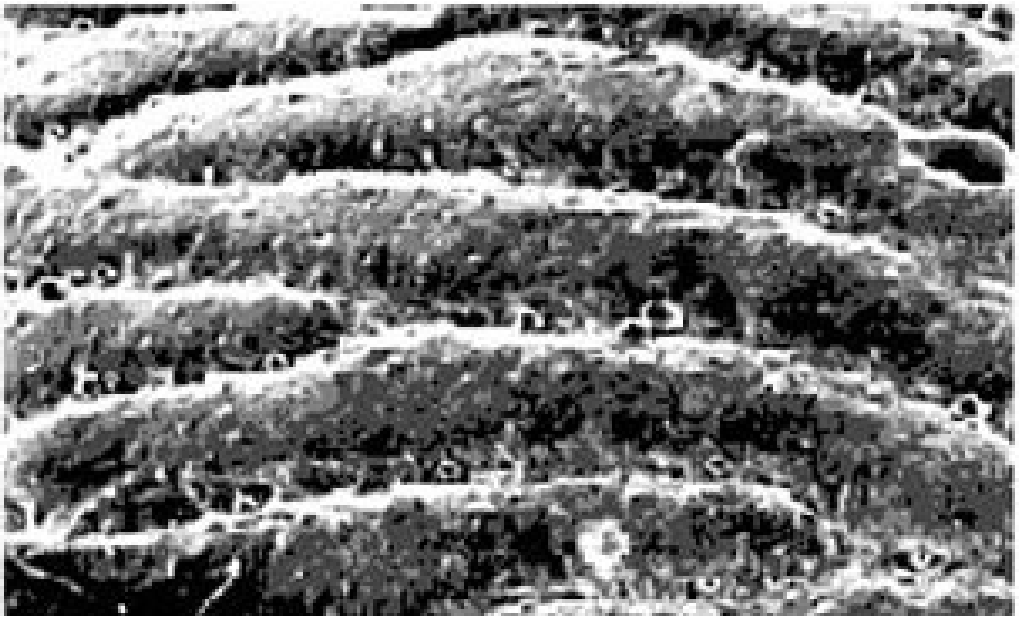
Asia, Australia, Africa

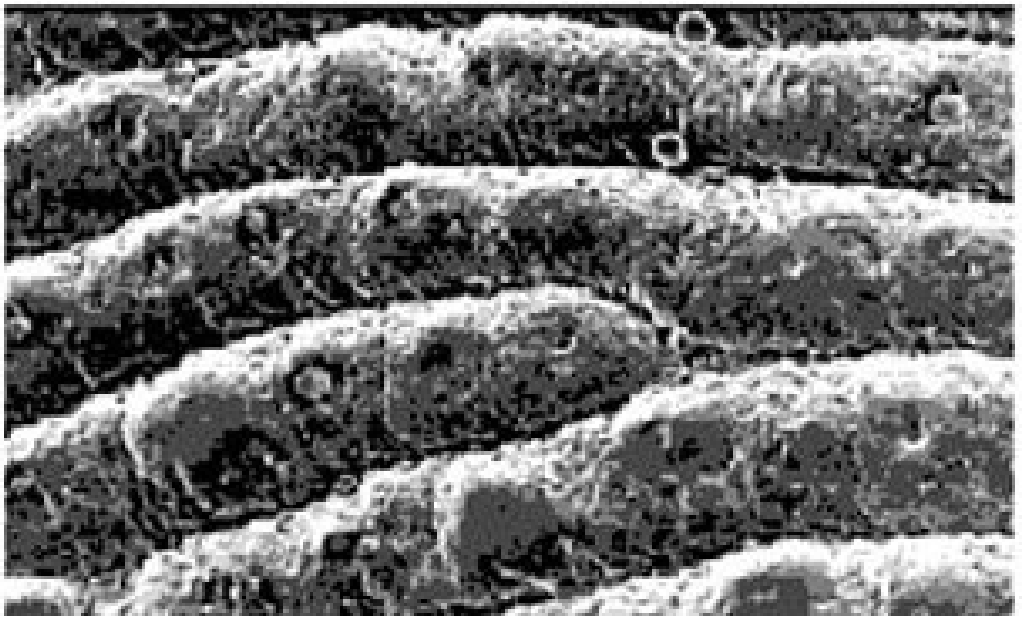
Cactae

North and South America

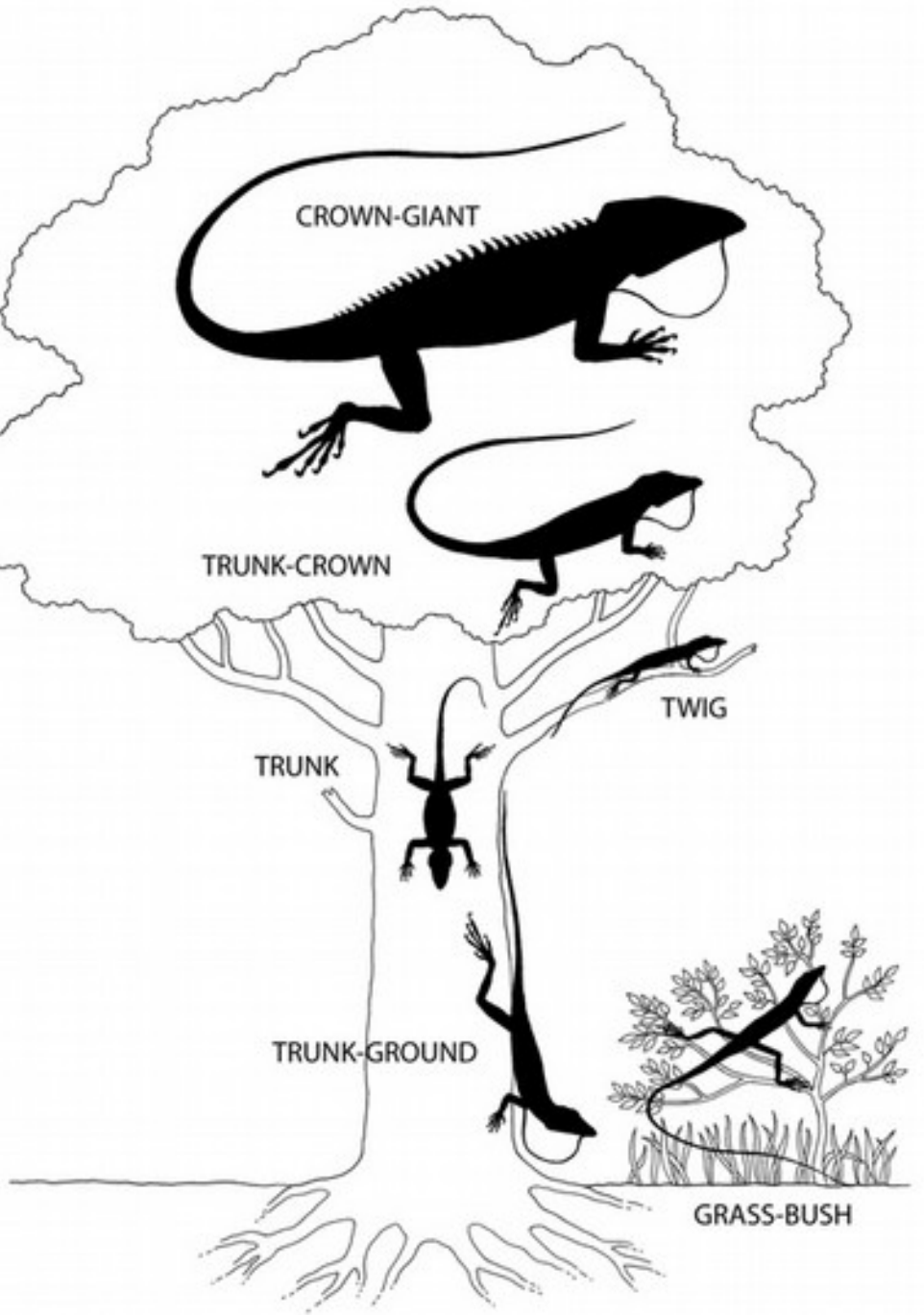
http://commons.wikimedia.org/



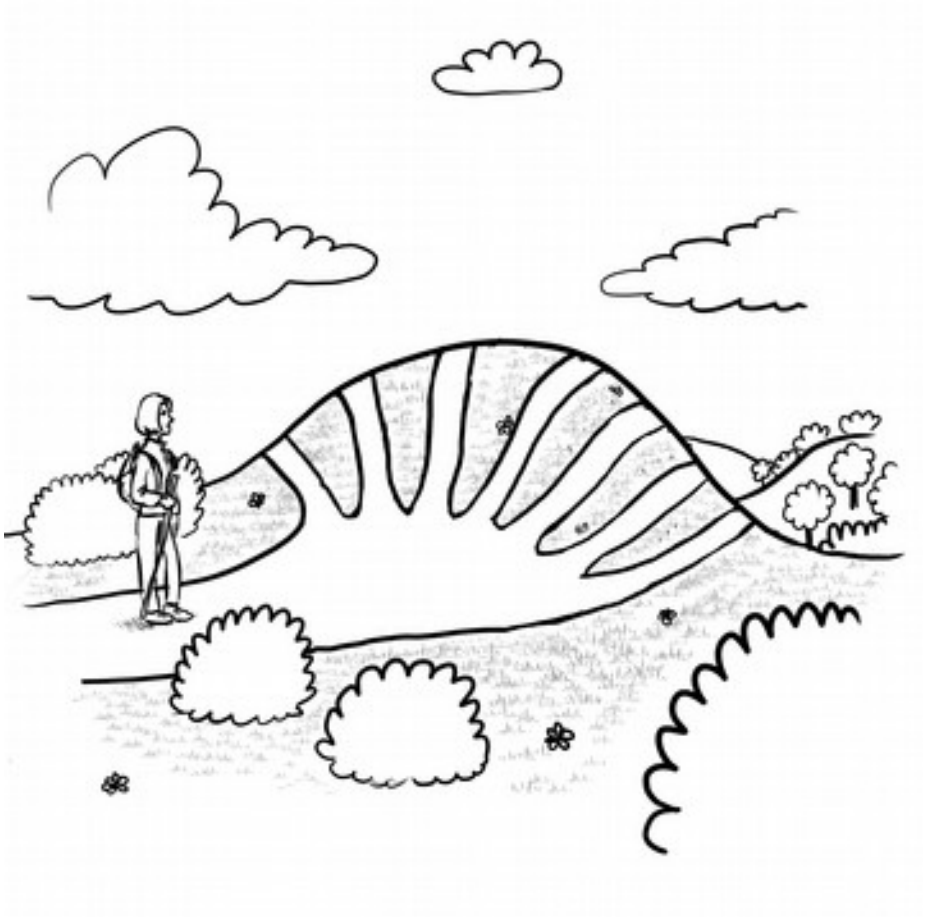




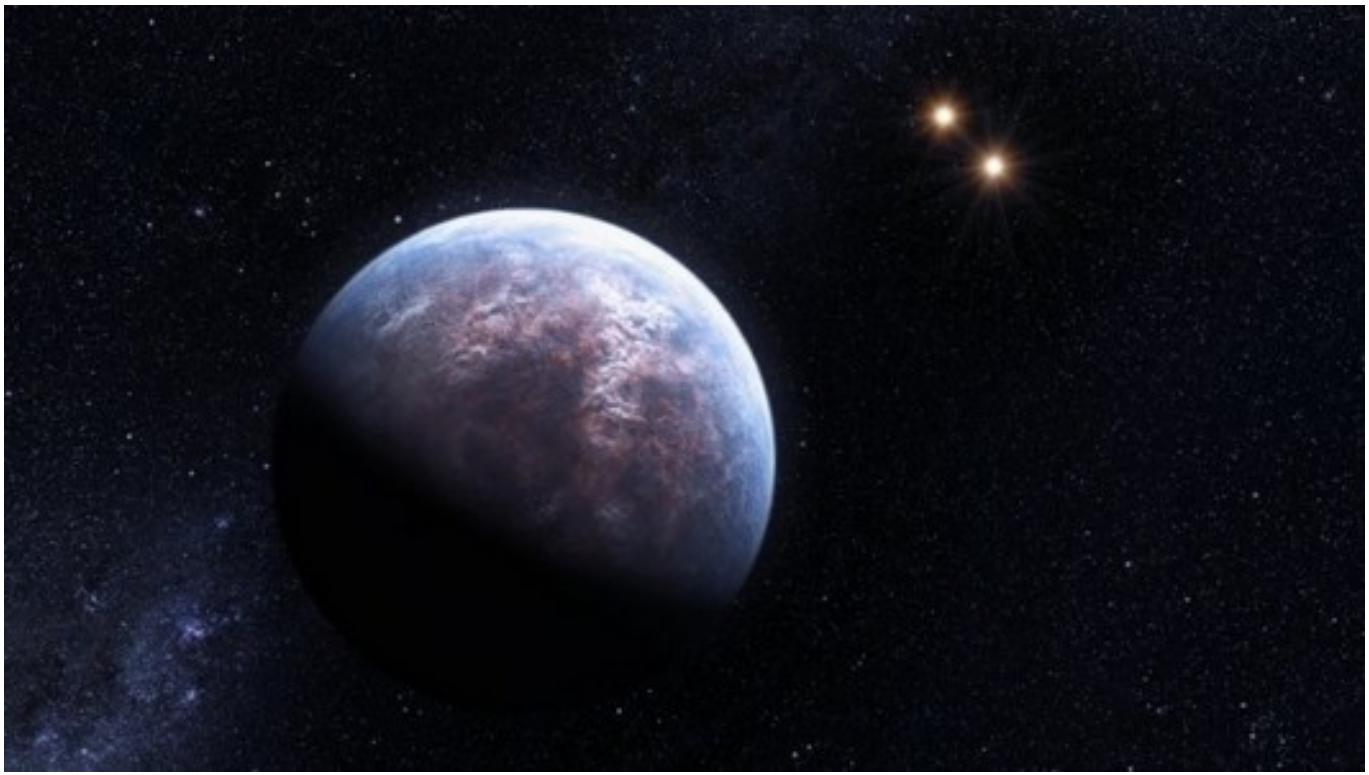
Same evolution in multiple Caribbean islands



The number of possible paths is smaller than previously thought



What kinds of other living forms?



evolution

How ?

Why ? (1) rather than nothing

Why ? (2) rather than something else

Imagining other living worlds

1. combining characters

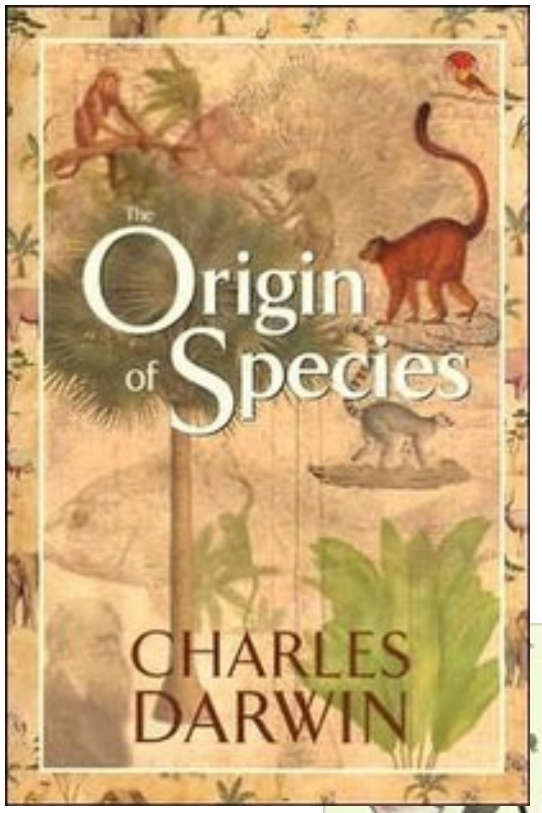
2. changing a variable
number of arms, gravity, etc.

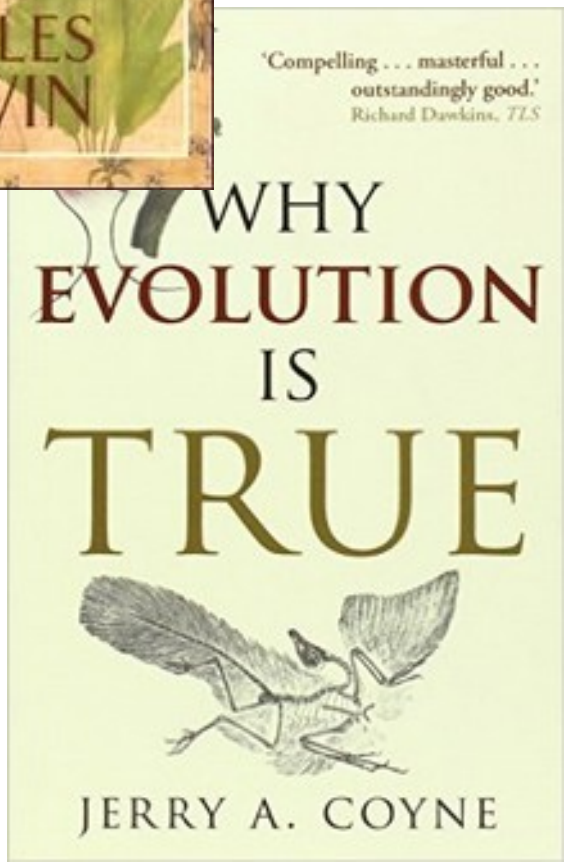
3. analogy with non-living objects

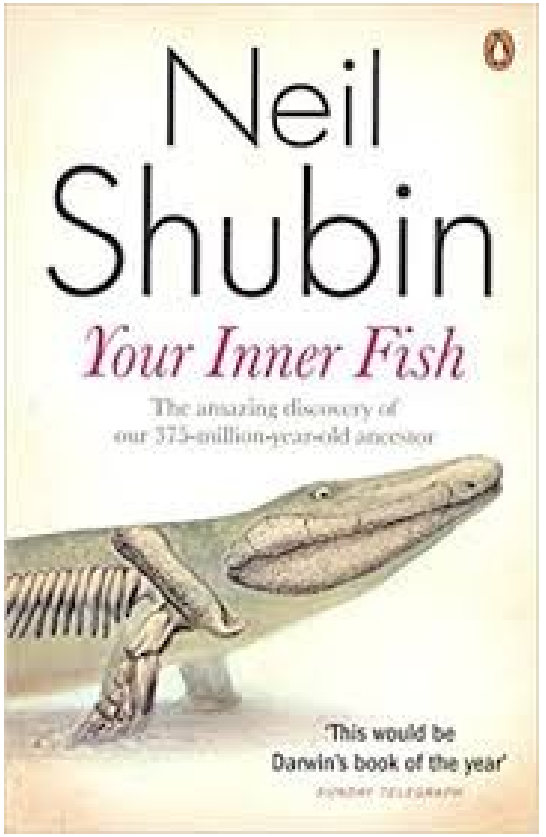
Always refers to our known world

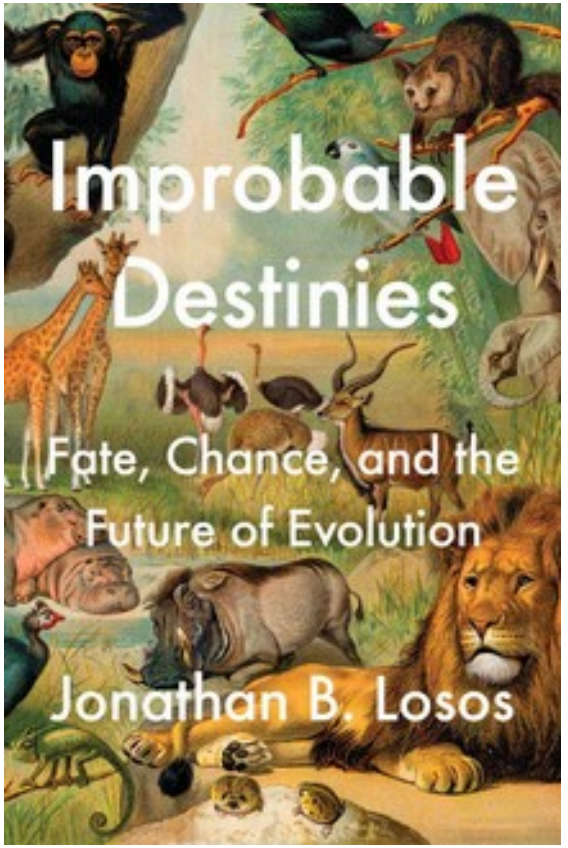
Conclusion

- **The diversity in the living world is caused by genetic, environmental and stochastic differences.**
- **Fossils allow us to reconstruct the history of life on earth.**
- **Maybe we should look for similar living forms in other planets.**


The
Origin
of Species
CHARLES
DARWIN


'Compelling . . . masterful . . .
outstandingly good.'
Richard Dawkins, TLS
WHY
EVOLUTION
IS
TRUE
JERRY A. COYNE


Neil
Shubin
Your Inner Fish
The amazing discovery of
our 375-million-year-old ancestor
'This would be
Darwin's book of the year'


Improbable
Destinies
Fate, Chance, and the
Future of Evolution
Jonathan B. Losos