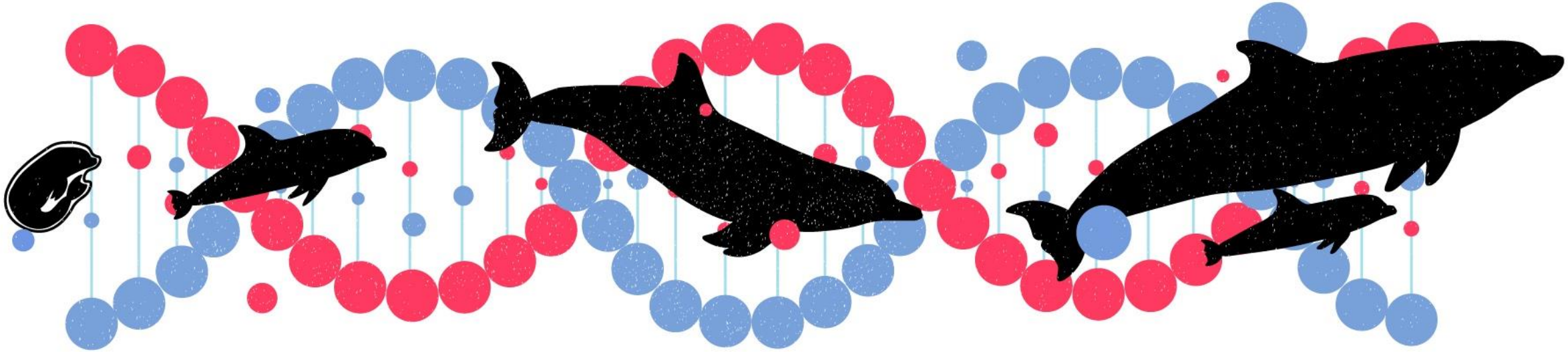


10th September 2025 Marine Mammal Commission Annual Meeting

What can epigenetics tell us about aging and health of marine mammals?

Dr. ASHLEY BARRATCLOUGH
BVetMed, MSc WAH, MS, PhD, MRCVS

Chicago Zoological Society
Inspiring Conservation Leadership

University of St Andrews

NATIONAL MARINE MAMMAL FOUNDATION

Why is age determination in marine mammals important?

- Aid interpretation of biological information
- Understand population reproductive capacity
- Improve understanding of population demographics

Photo credit Shawn Noren

How was age previously estimated?

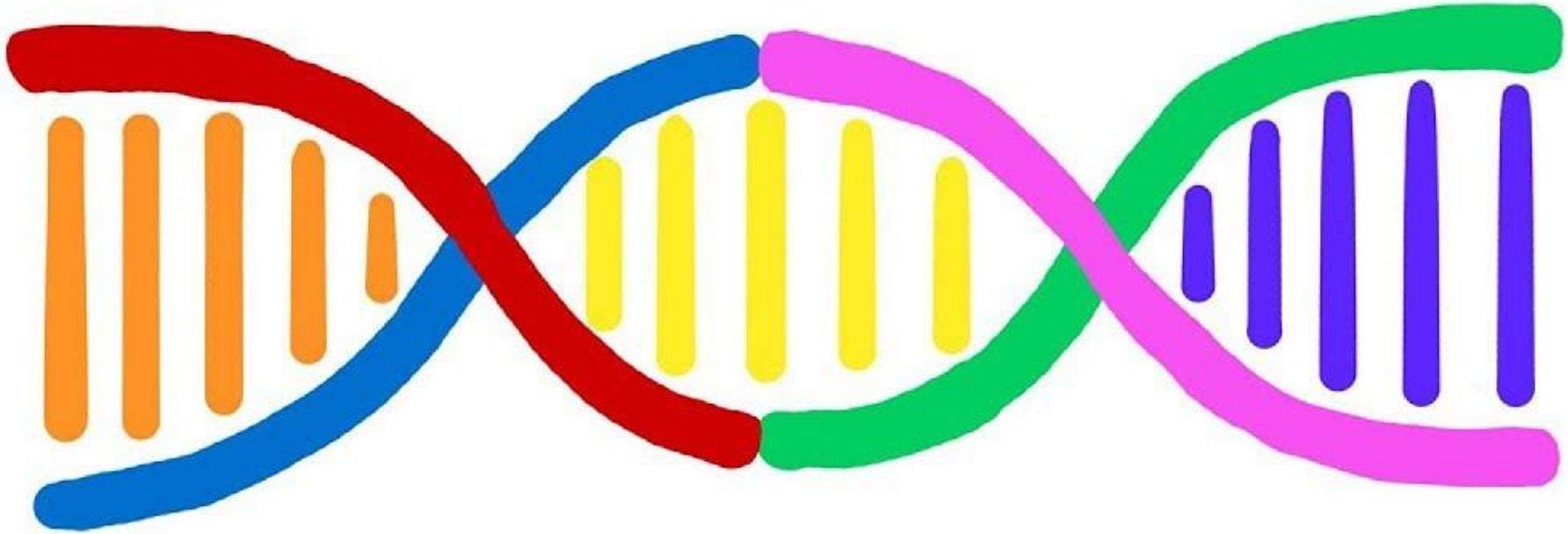
Tooth extraction and cross section

GLG – Growth layer groups

A. Hohn

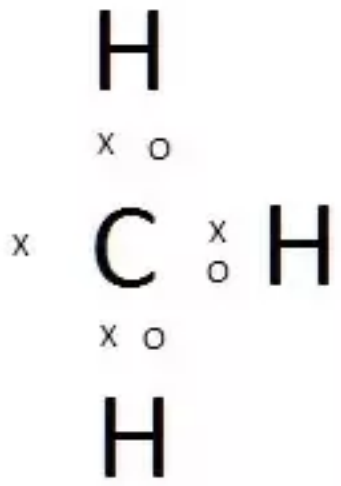
How can we estimate dolphin age remotely?

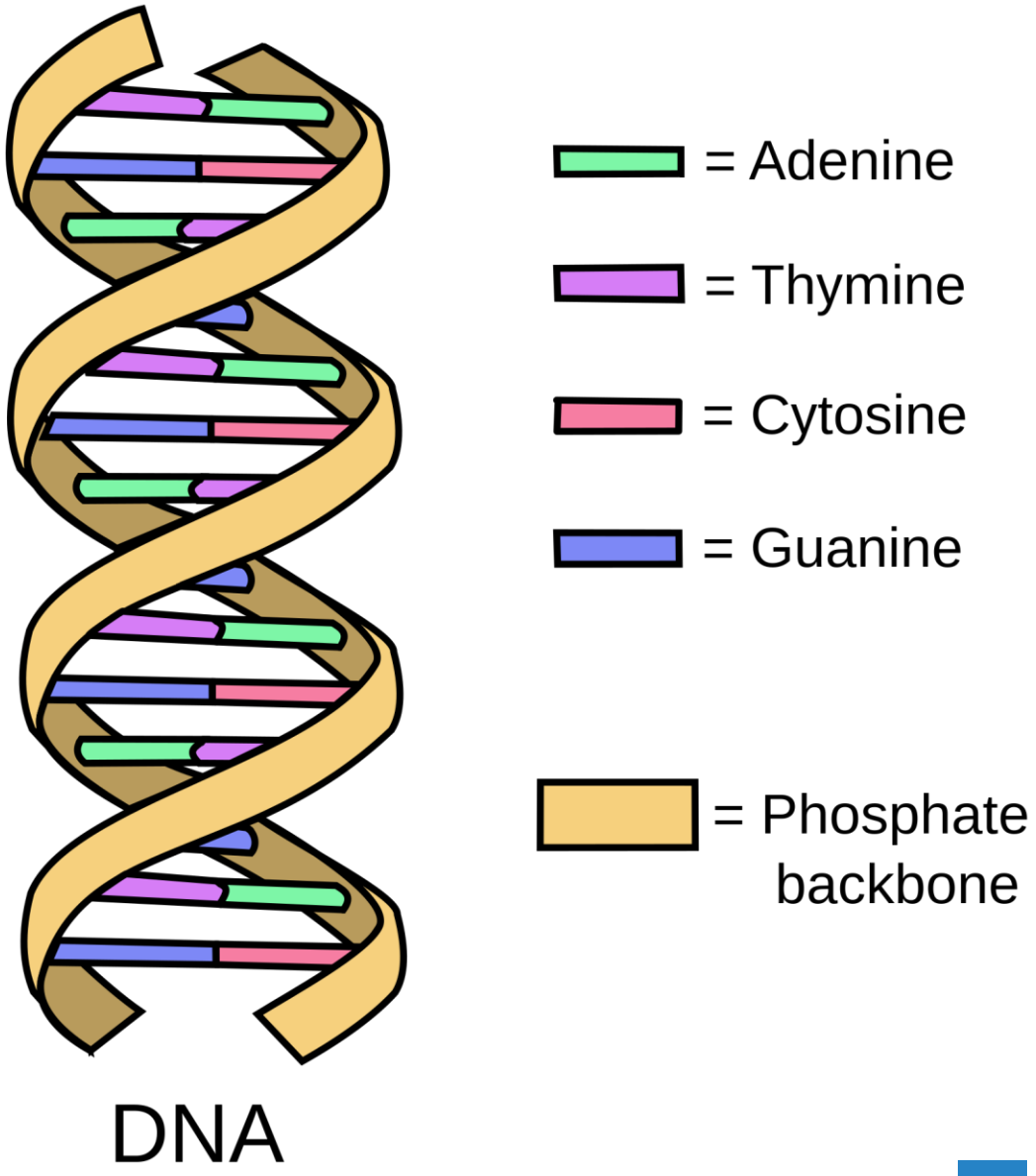
WHAT IS EPIGENETICS?



Back to Biochem 101…

- CpG site
- CH_3





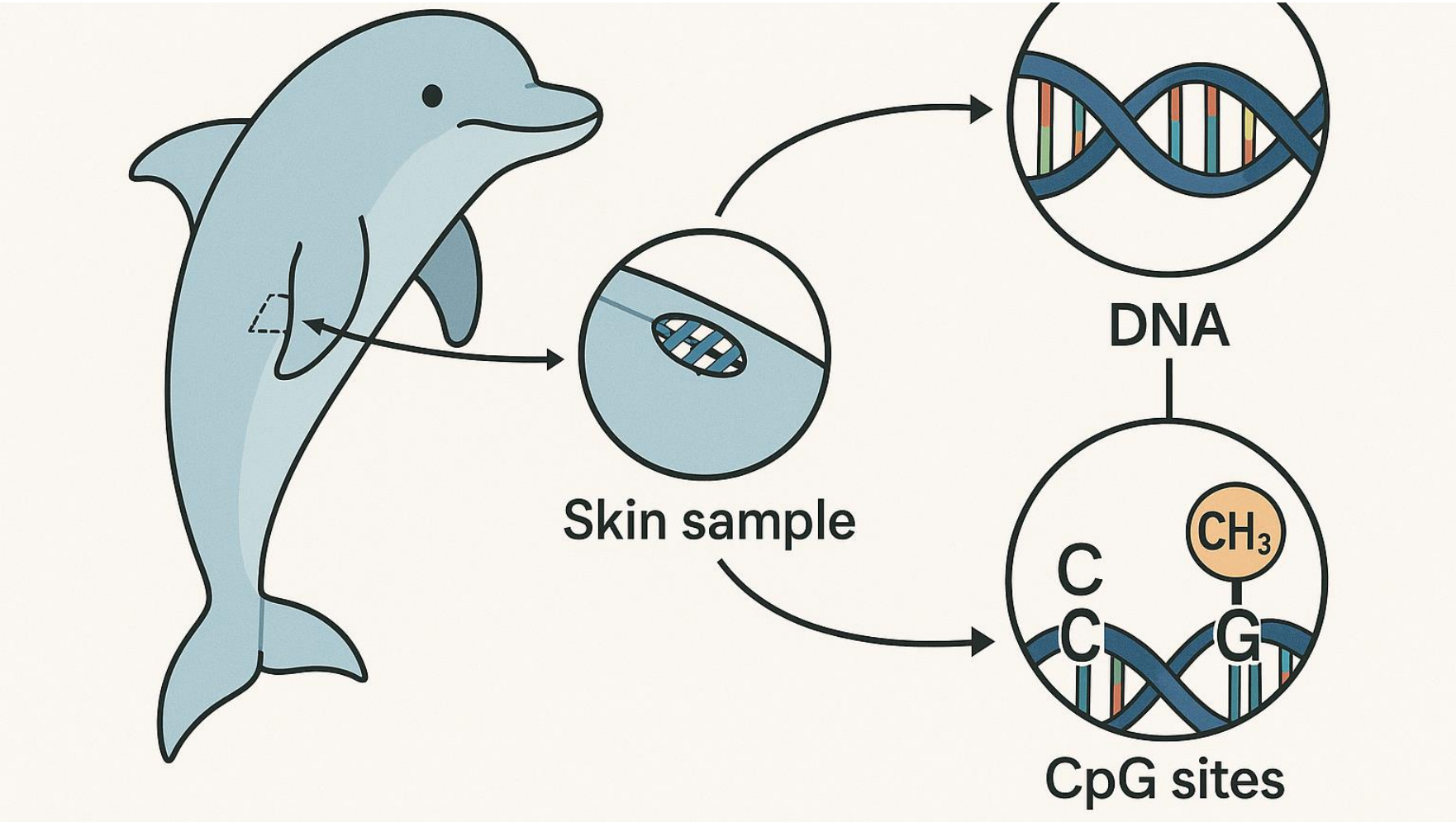
DNA

American society human genetics

Wikimedia

Epigenetic Age

Assessment of the degree of methylation of CpG sites to correlate changes with chronological age.



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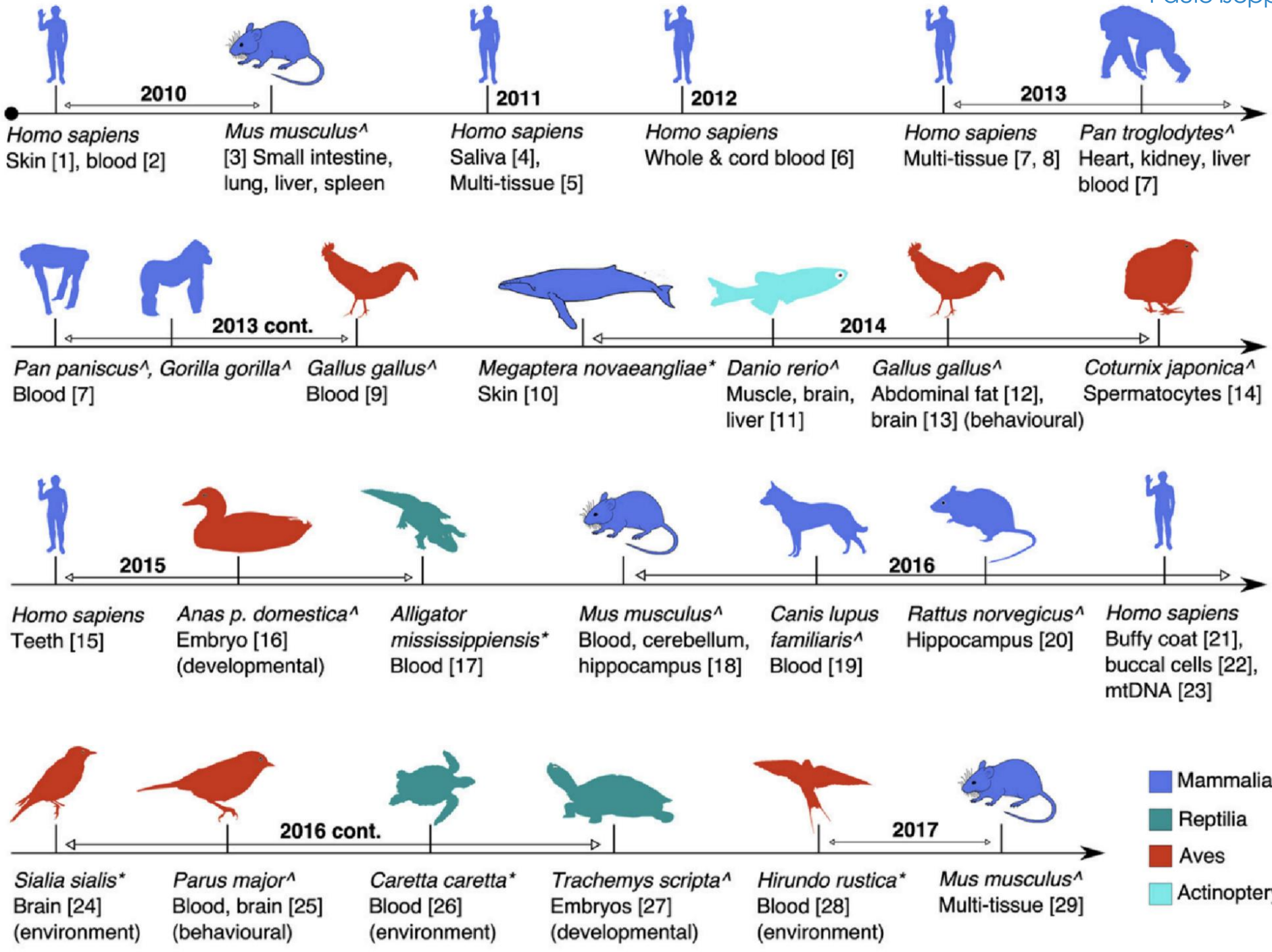
DNA extracted from blood or skin has been successfully used to create epigenetic clocks in marine mammals.


2010
2011
2012
2013
Homo sapiens
Skin [1], blood [2]
Mus musculus^
[3] Small intestine, lung, liver, spleen
Homo sapiens
Saliva [4], Multi-tissue [5]
Homo sapiens
Whole & cord blood [6]
Homo sapiens
Multi-tissue [7, 8]
Pan troglodytes^
Heart, kidney, liver blood [7]
2013 cont.
2014
Pan paniscus^, Gorilla gorilla^
Blood [7]
Gallus gallus^
Blood [9]
Megaptera novaeangliae*
Skin [10]
Danio rerio^
Muscle, brain, liver [11]
Gallus gallus^
Abdominal fat [12], brain [13] (behavioural)
Coturnix japonica^
Spermatocytes [14]
2015
2016
Homo sapiens
Teeth [15]
Anas p. domestica^
Embryo [16] (developmental)
Alligator mississippiensis*
Blood [17]
Mus musculus^
Blood, cerebellum, hippocampus [18]
Canis lupus familiaris^
Blood [19]
Rattus norvegicus^
Hippocampus [20]
Homo sapiens
Buffy coat [21], buccal cells [22], mtDNA [23]
2016 cont.
2017
Sialia sialis*
Brain [24] (environment)
Parus major^
Blood, brain [25] (behavioural)
Caretta caretta*
Blood [26] (environment)
Trachemys scripta^
Embryos [27] (developmental)
Hirundo rustica*
Blood [28] (environment)
Mus musculus^
Multi-tissue [29]
Mammalia
Reptilia
Aves
Actinopterygii

Marine mammal “epigenetic clocks”

Cetaceans

2021 - Beluga whale
- Bottlenose dolphin
- Odontocetes; multiple species

2022 - Humpback whale
- Indo-Pacific Bottlenose dolphin

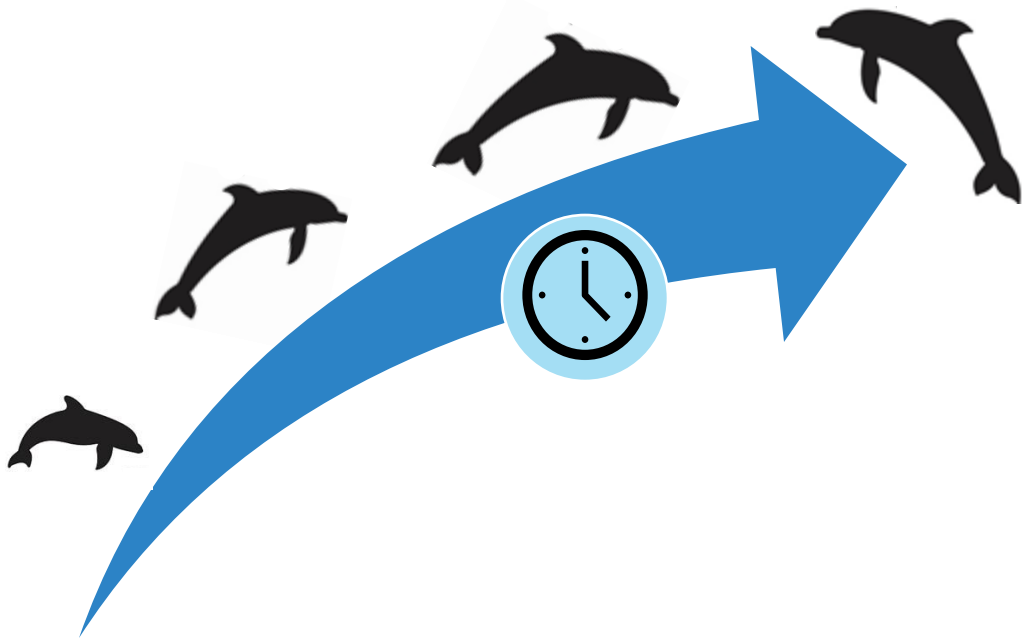
2023 - Killer Whale
- Bowhead Whale
- Maui and Hector’s dolphin

2024 - Bottlenose dolphin multiple stocks
- Cetaceans, multi-species
- Common dolphin

2025 - Lahille’s bottlenose dolphin
- North Atlantic right whale – coming soon!

Other marine mammals

- 2023 - Sea lions, walruses, seals
- 2025 - Polar bear
  - Elephant seal – coming soon!



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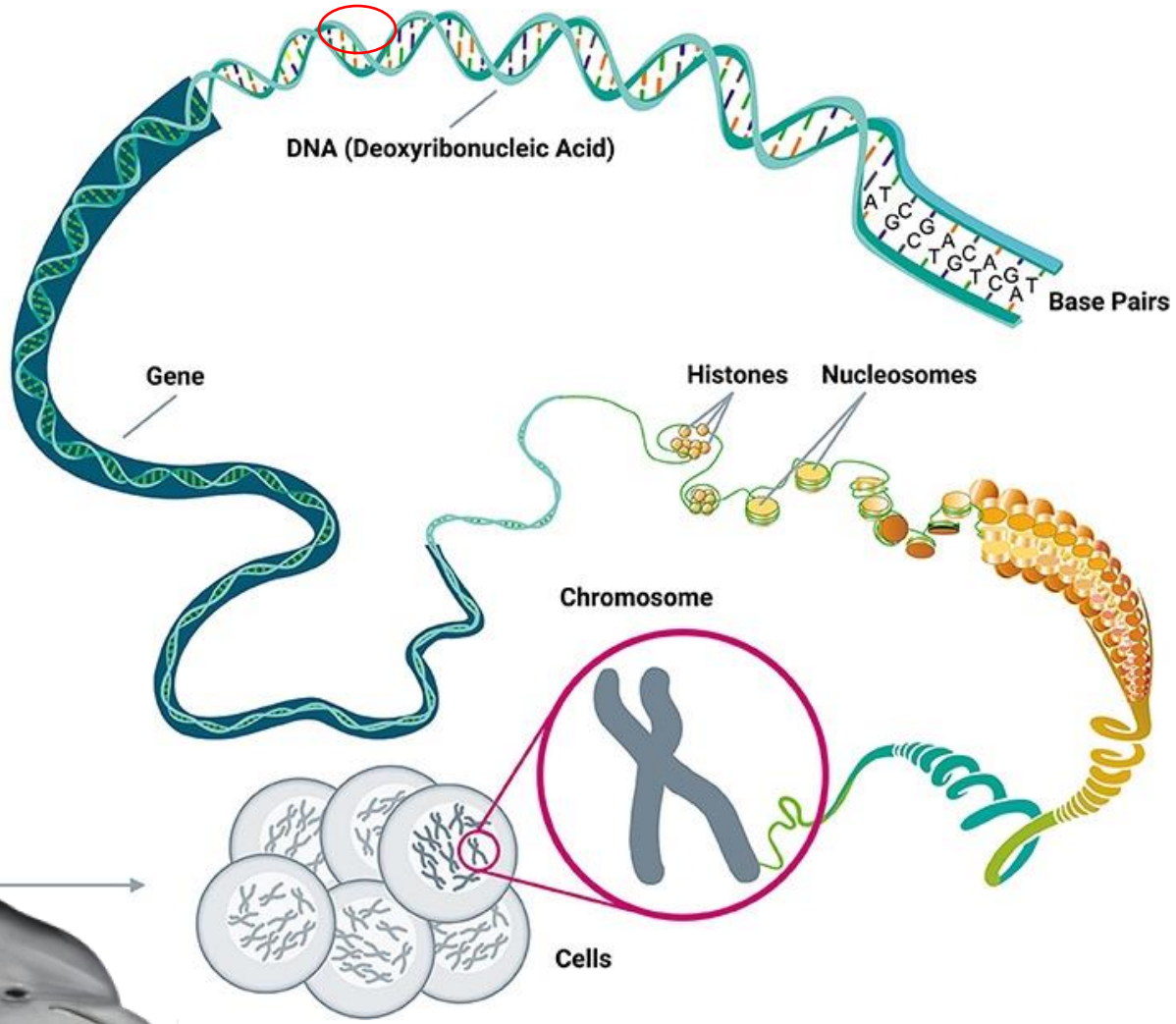
It's very accurate!

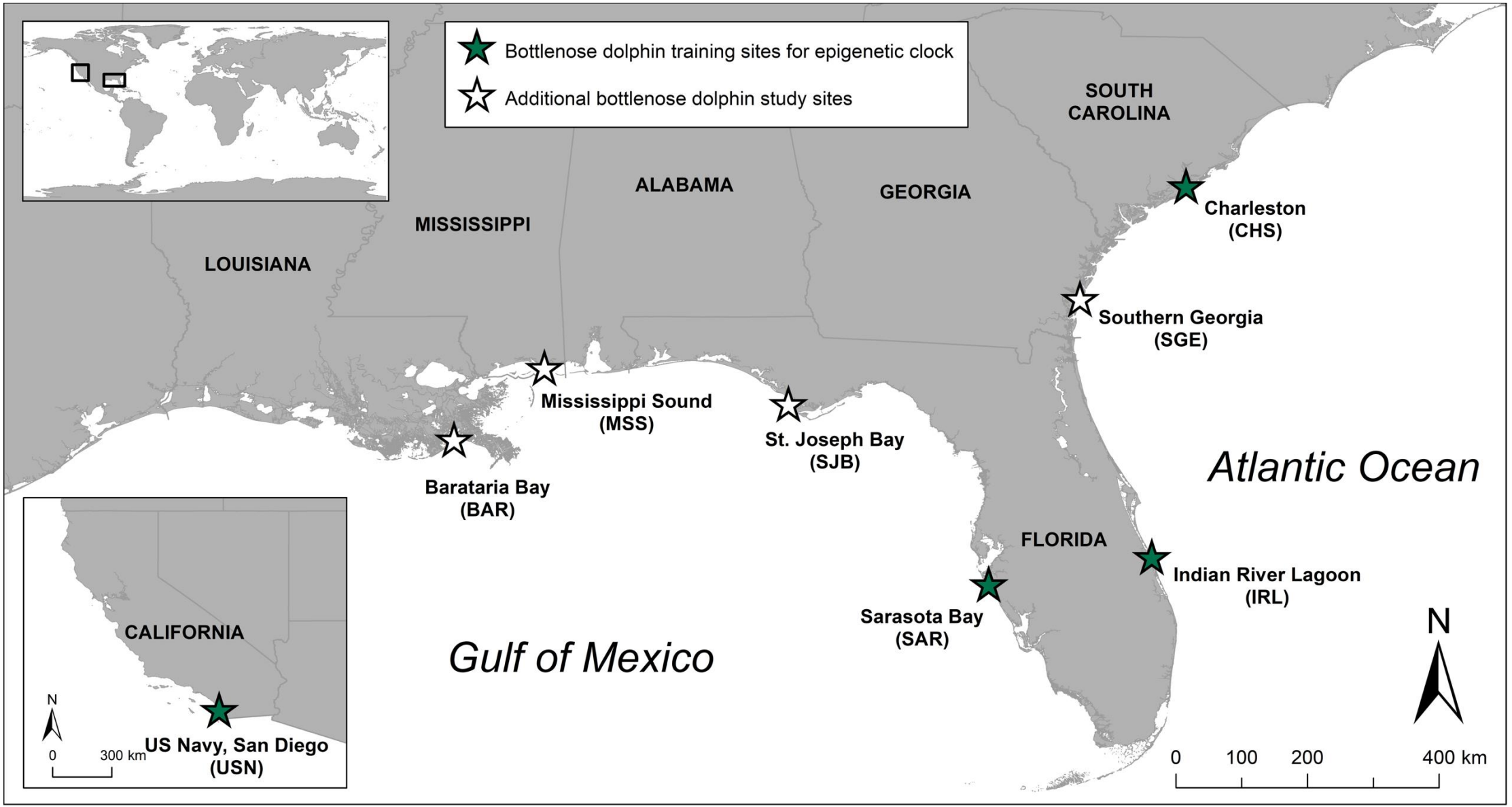
Can estimate age within 1.9 years!

Selected 211 CpG sites

Barratclough et al 2024. Biological Conservation



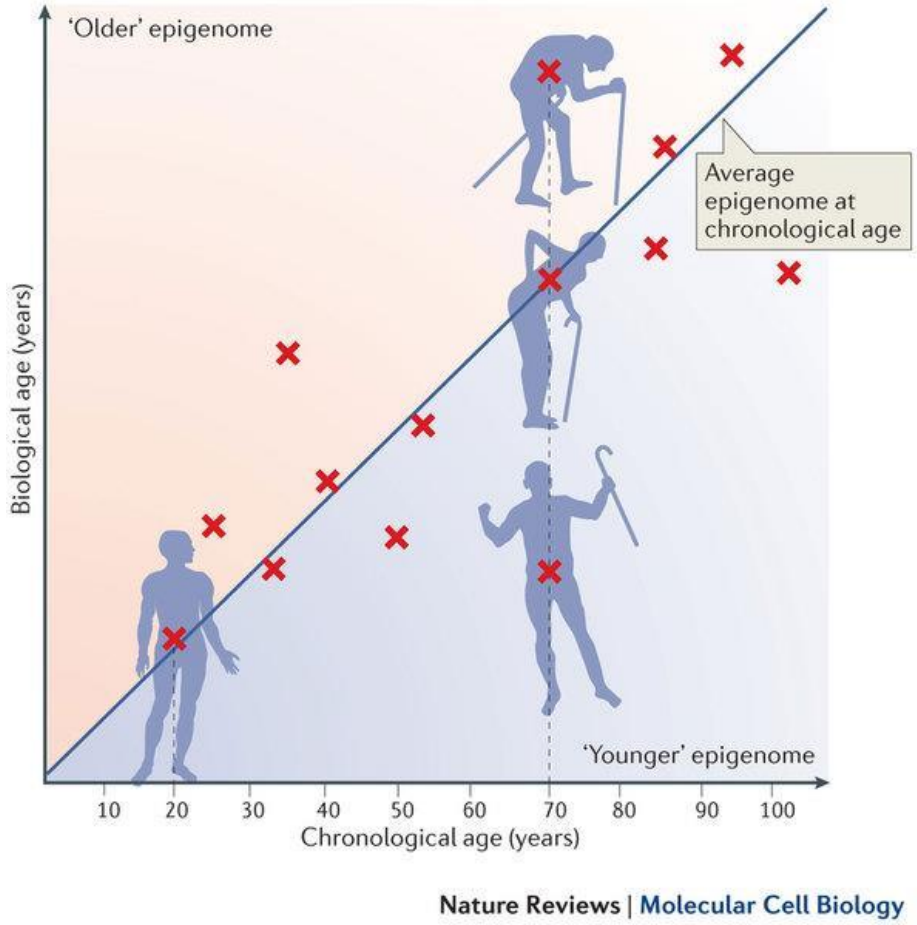
Wild dolphin health assessments



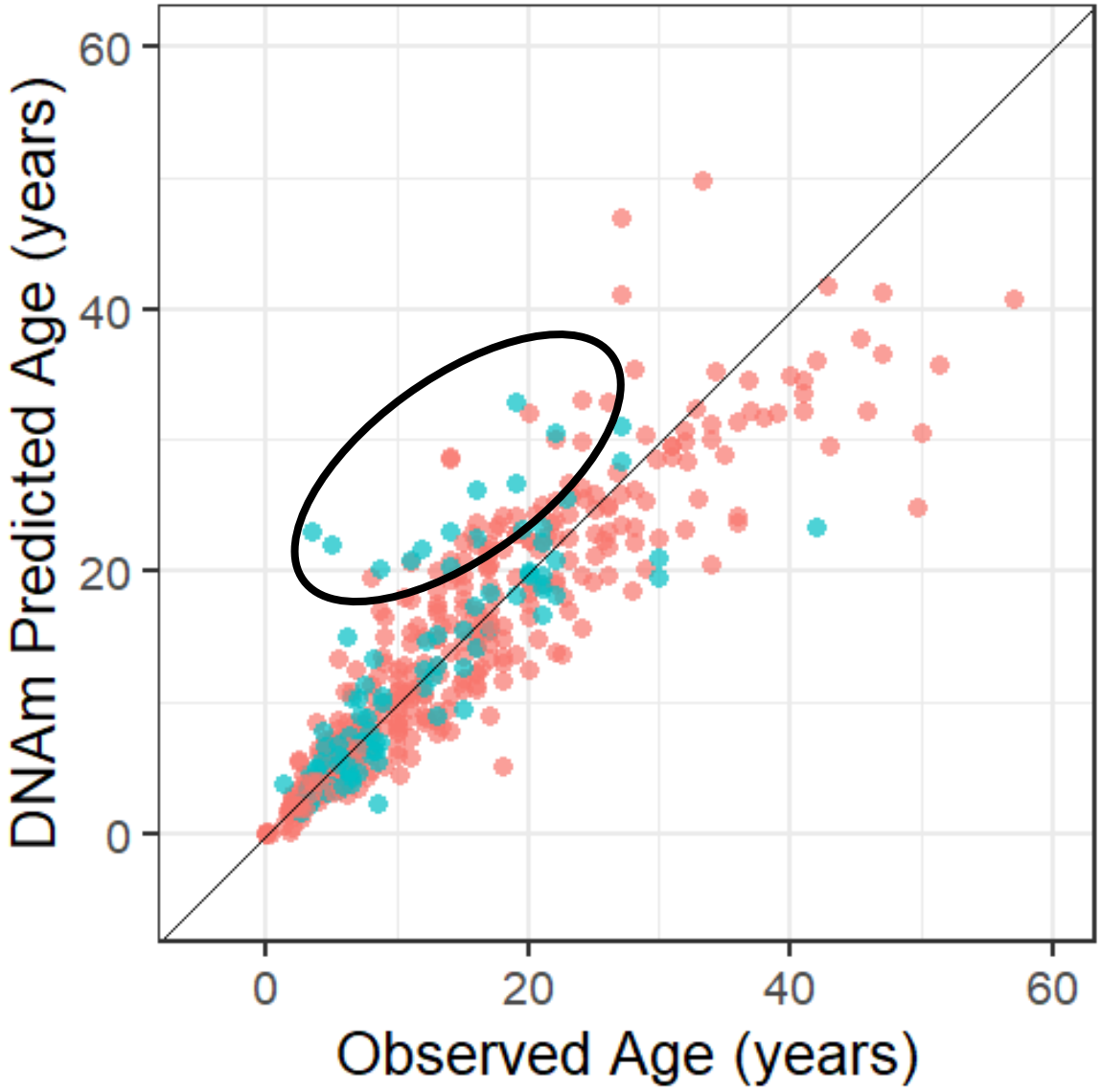
Epigenetic clock

Assessment of the degree of methylation of CpG sites correlating with chronological age.

Age acceleration occurs when a biological age is higher than a chronological age.



Age residuals were higher for the DWH cohort (p = 0.041)



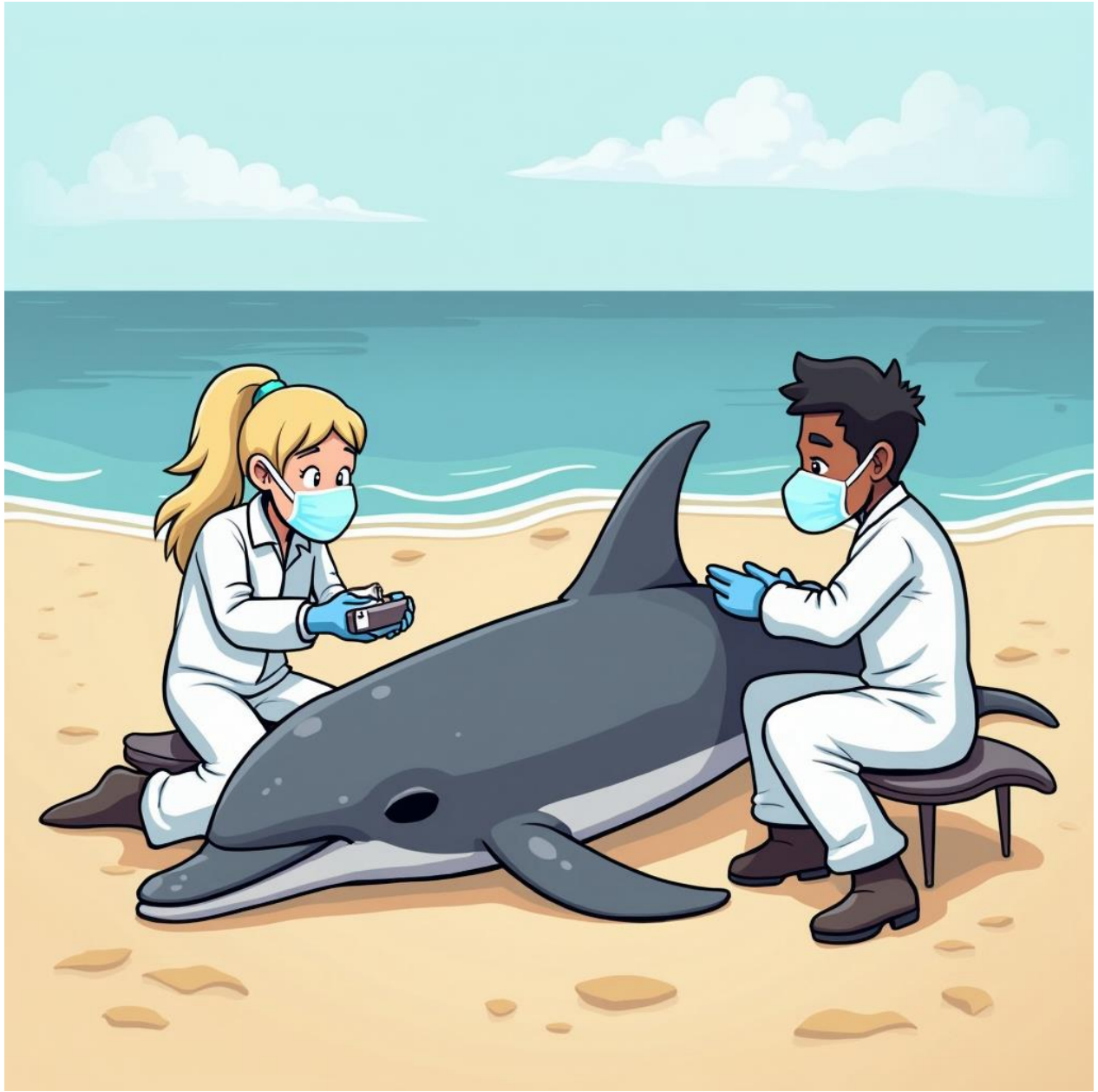
Age residuals from GAM fit to DNAm age from observed age versus health scores derived from VESOP model.

Dolphins with highest positive age residuals had lowest health scores;
p = 0.013

What samples can we use?

- Code 1
- Code 2
- Code 3

DNA quality in Code 4 samples likely too poor



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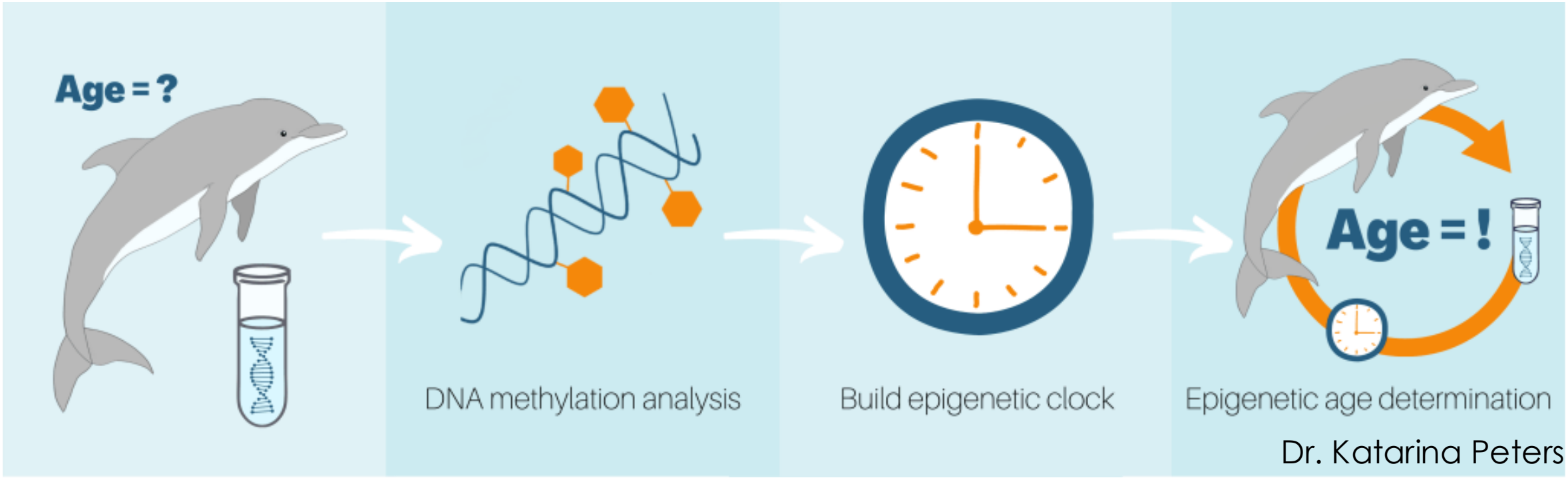

Epigenetics enables remote age assessment and can indicate health status

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Check for updates

Estimating age and investigating epigenetic changes related to health across multiple bottlenose dolphin populations

Ashley Barratclough [a,*], Ryan Takeshita [a], Len Thomas [b], Theoni Photopoulou [b], Enrico Pirotta [b], Patricia E. Rosel [c], Lynsey A. Wilcox Talbot [c], Nicole L. Vollmer [c,d], Randall Wells [e], Cynthia R. Smith [a], Teresa K. Rowles [f], Steve Horvath [g,h], Lori Schwacke [i]

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[g] Altos Labs, Cambridge, UK
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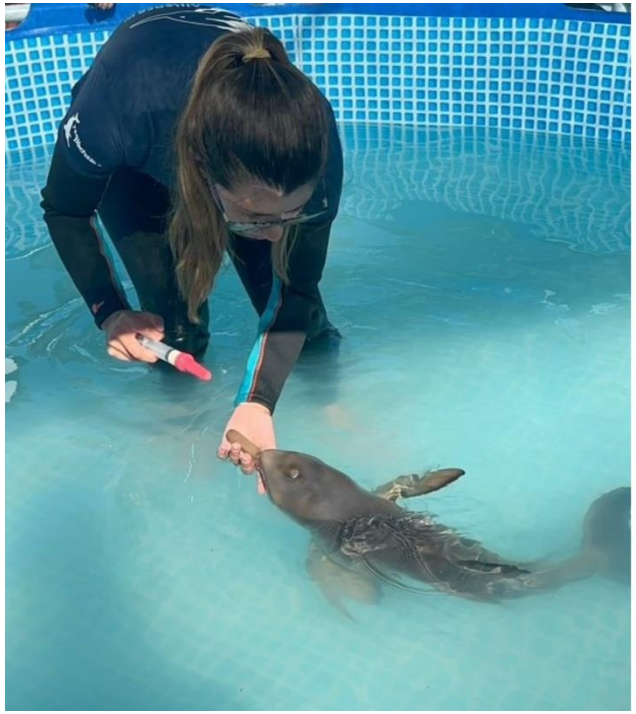
[i] Marine Mammal Commission, Bethesda, MD 20814, USA

Future Work:

- Expand epigenetics to other endangered species
- Expand Lahille's epigenetics sample size
- Apply to UME / stranding response
- Explore relationship between epigenetics and health / PCBs

Photo Credit NMMF Operation GRACE



NATIONAL MARINE MAMMAL FOUNDATION

Thank you to all funder, co-authors & collaborators who made this research possible!

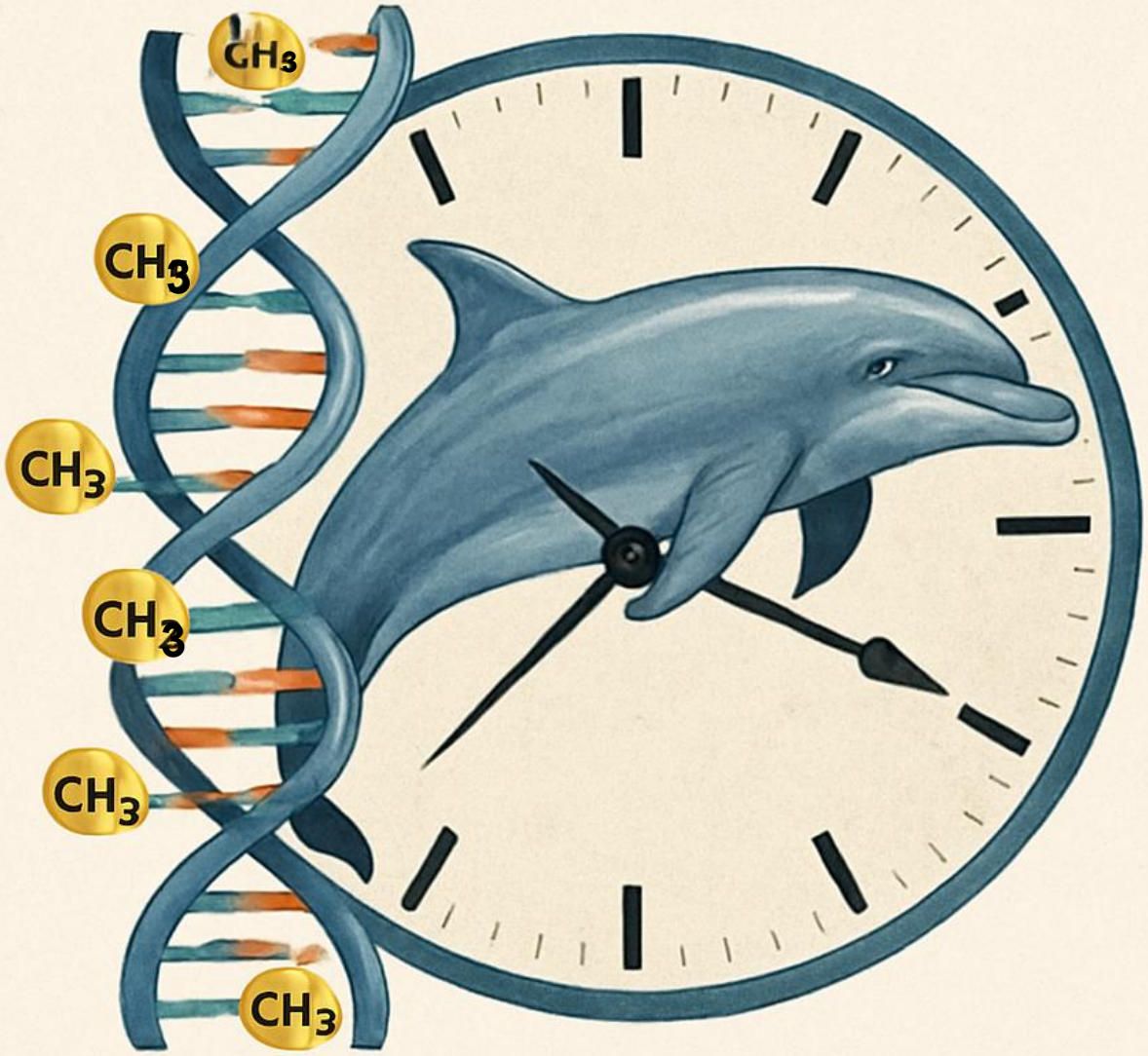
Any questions?

ashley.barratclough@nmmf.org

Thank you!

NATIONAL MARINE MAMMAL FOUNDATION

MARINE MAMMAL COMMISSION



BOTTLENOSE DOLPHIN EPIGENETIC CLOCK