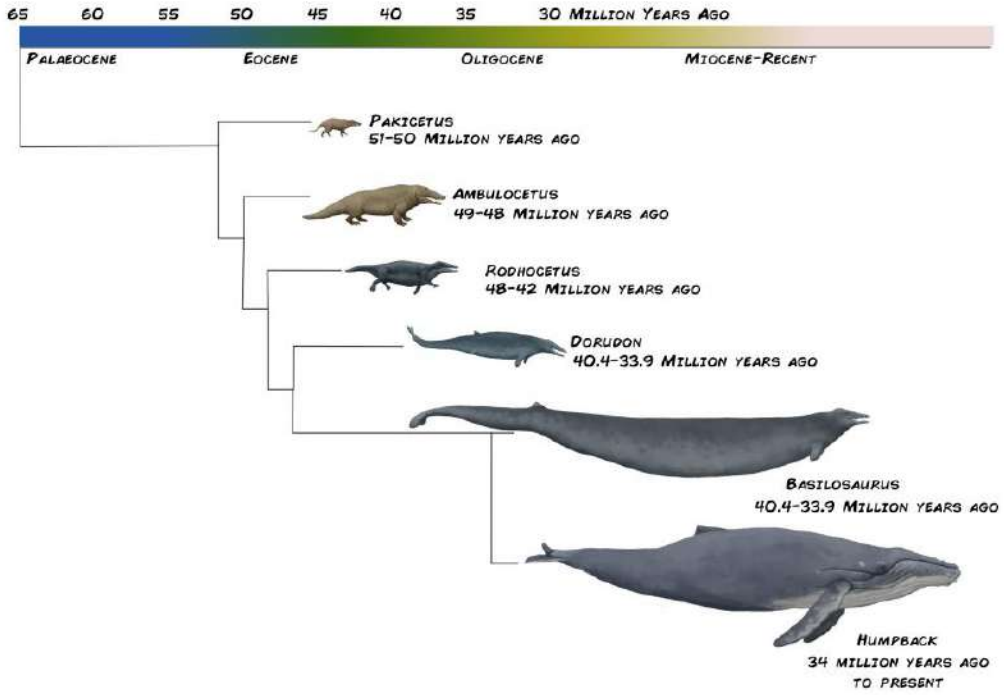
Evidence of Evolution: Whales



Biology

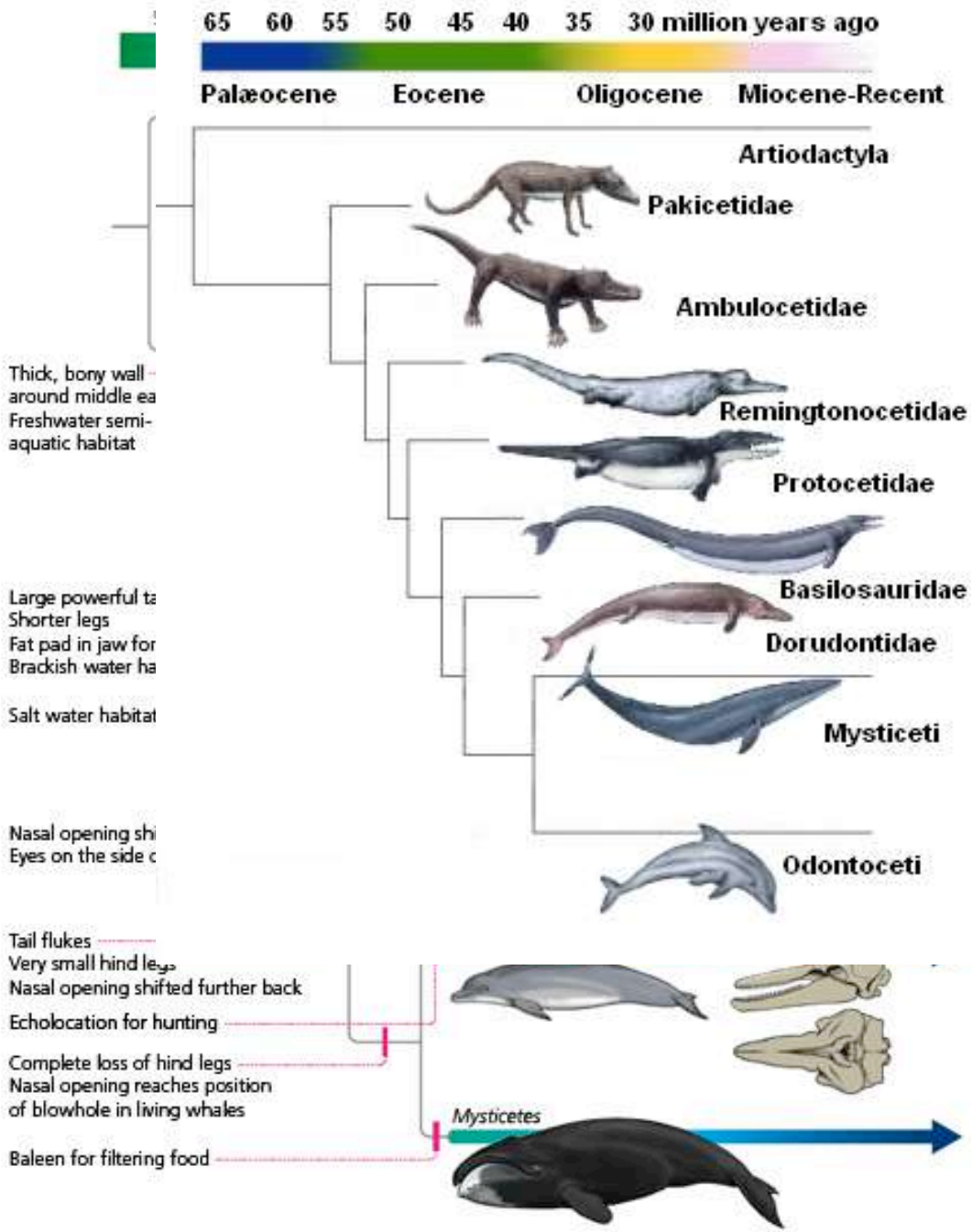
Chapter 15

Whale Evolution

- Whales evolved from land-dwelling mammals over millions of years.
- Their ancestors were small, four-legged animals that lived near water.

Whale Evolution

- Over time, some of these mammals adapted to aquatic life, developing stronger limbs for swimming.
- Cetaceans are a scientific term that refers to the order of marine mammals.
- Through millions of years of evolution, the cetaceans adapted to their watery environments.

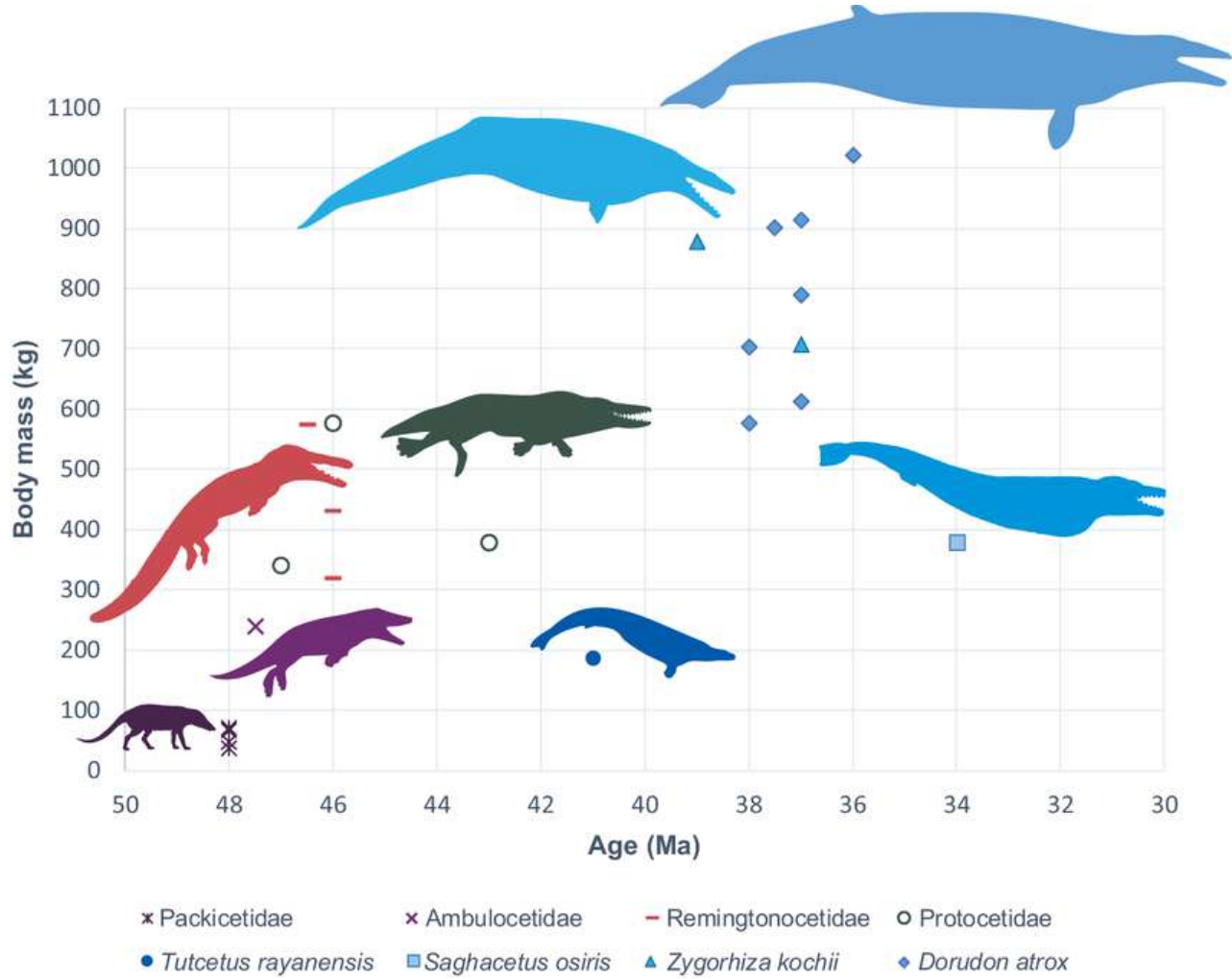


Question #1: Around what time period did modern whale's evolve?

A. 40 MYA
B. 45 MYA
C. 50 MYA
D. 55 MYA
E. 60 MYA

Whale Evolution

- As they spent more time in the water, their bodies became longer and larger.
- Their legs reduced in size and they developed tails for swimming.
- Eventually, modern whales evolved with streamlined bodies, flippers, and tail flukes, fully adapted to marine environments.

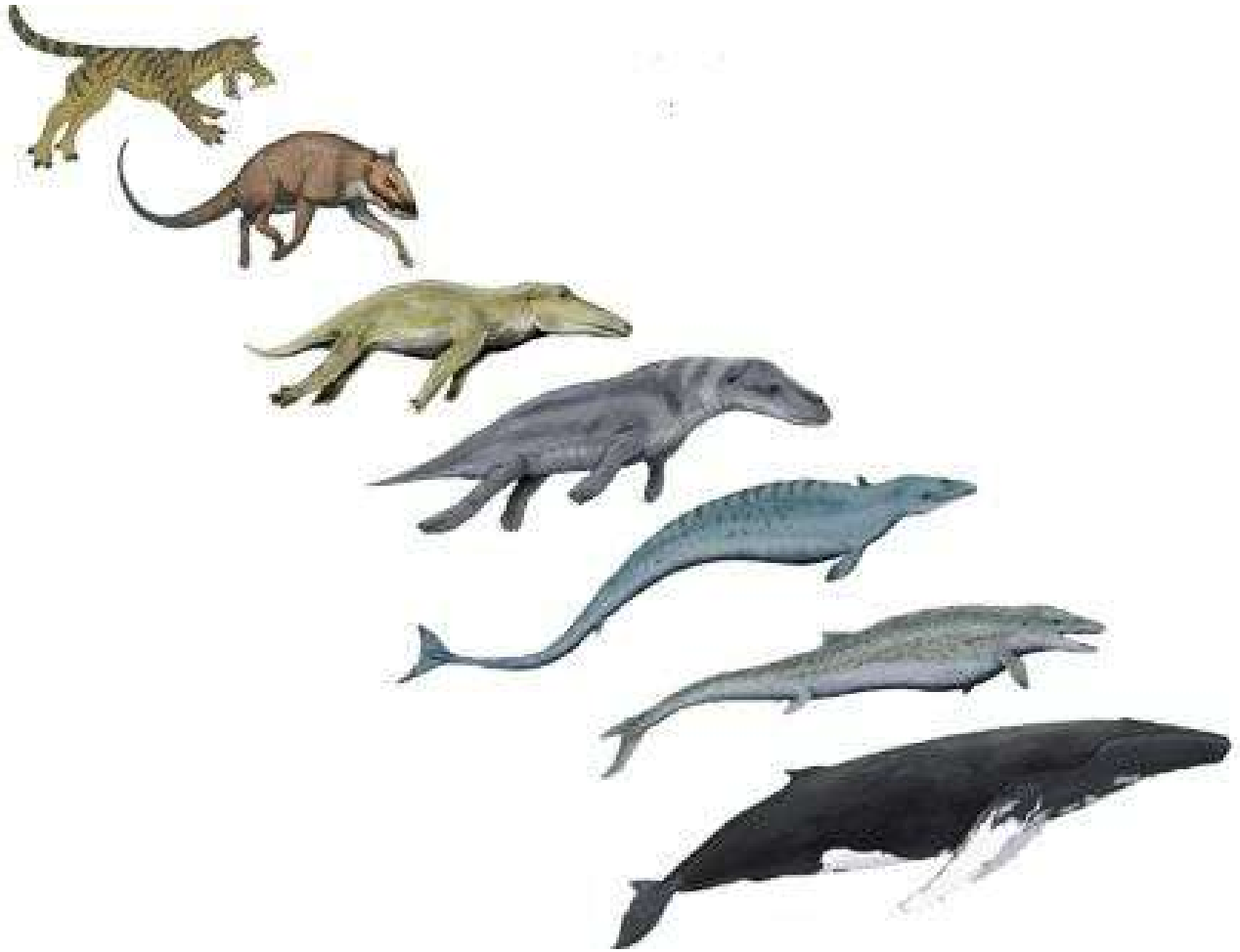


Question #2: Around how many years ago did the body mass of the early whale species reach over 600kg?

A. 48 MYA
B. 60 MYA
C. 38 MYA
D. 30 MYA
E. 42 MYA

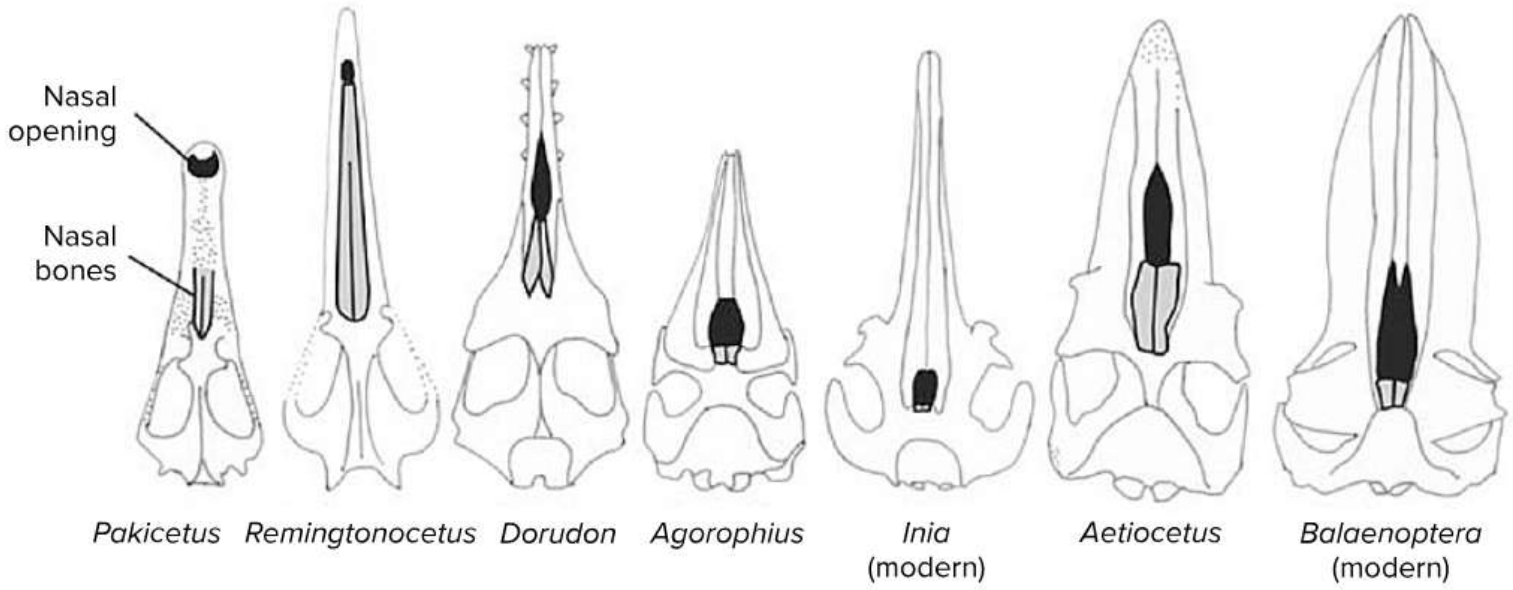
Part 1: Fossils

- As whales adapted from land to water, their nostrils moved.
- Early whales had nostrils near the front of their snouts, like land animals.



Part 1: Fossils

- Over time, their nostrils shifted to the top of their heads, becoming blowholes.
- This helped them breathe more easily while swimming.



Question #3: During the evolution of whales, how did the position of the blowhole change?

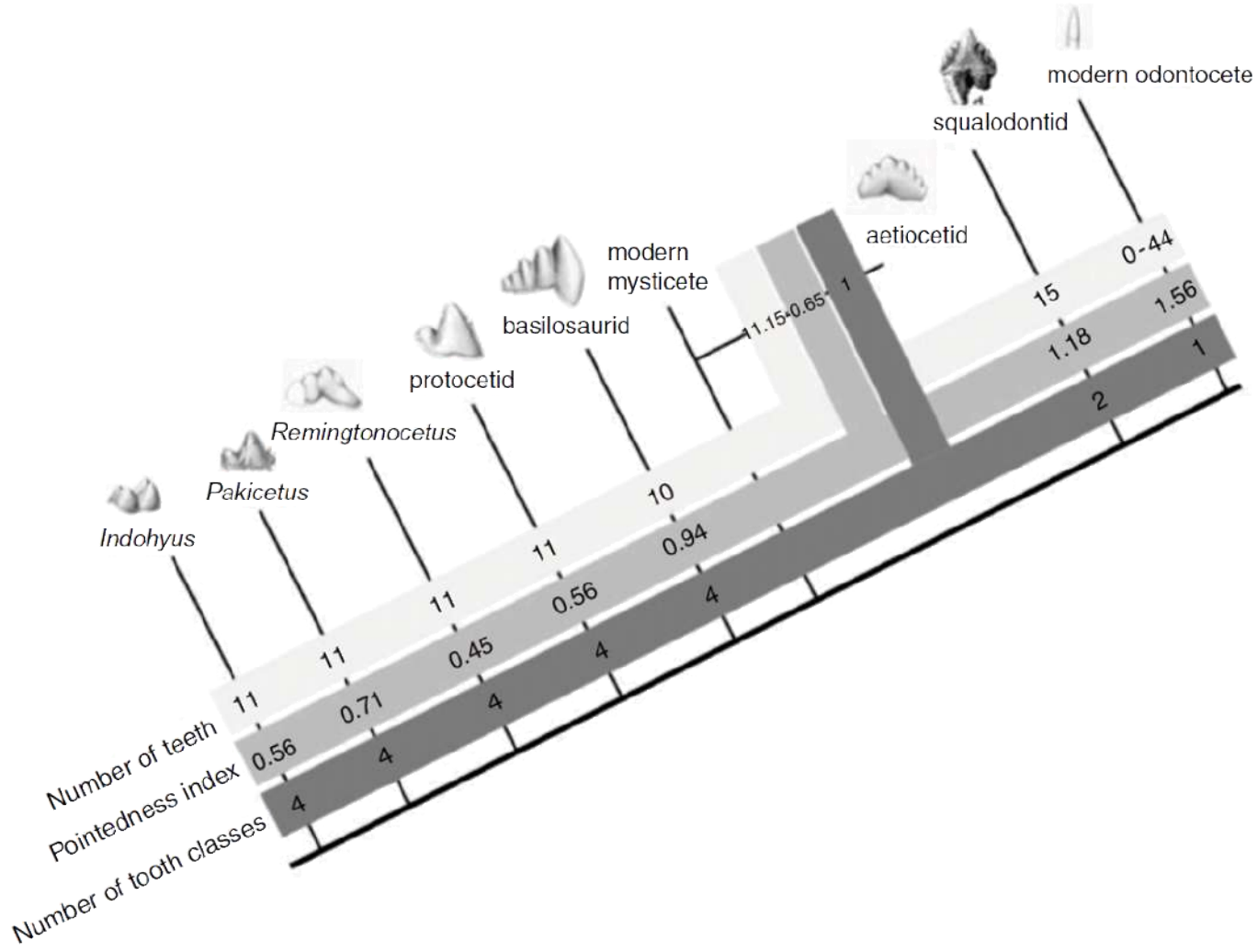
A. It moved from the side of the head to the tip of the snout.
B. It moved from the back of the head to the forehead.
C. It moved from the snout to the top of the head.
D. It moved from the snout to the back of the head.
E. It stayed in the same position but grew larger over time.

Question #4: Why was the movement of the blowhole to the top of the head beneficial for whales?

A. It helped them filter food more efficiently.
B. It improved their sense of smell in water.
C. It allowed them to stay submerged longer while swimming.
D. It made them faster swimmers by reducing drag.
E. It allowed them to breathe without lifting their heads above water.

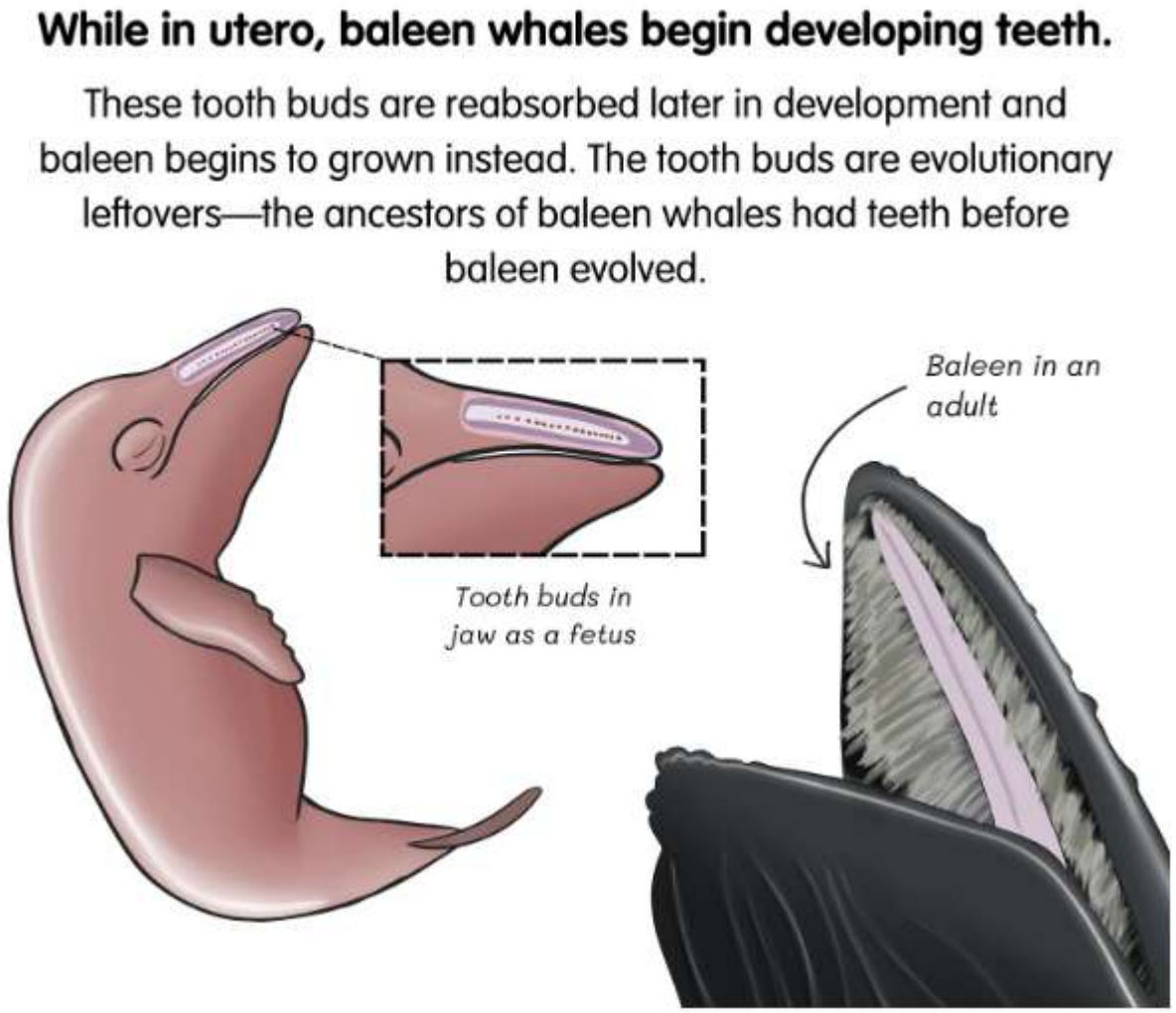
Part 1: Fossils

- Whale teeth evolved from those of ancient land mammals as whales adapted to life in the water.
- Early whale ancestors had teeth like those of land carnivores, used for gripping and tearing meat.



Part 1: Fossils

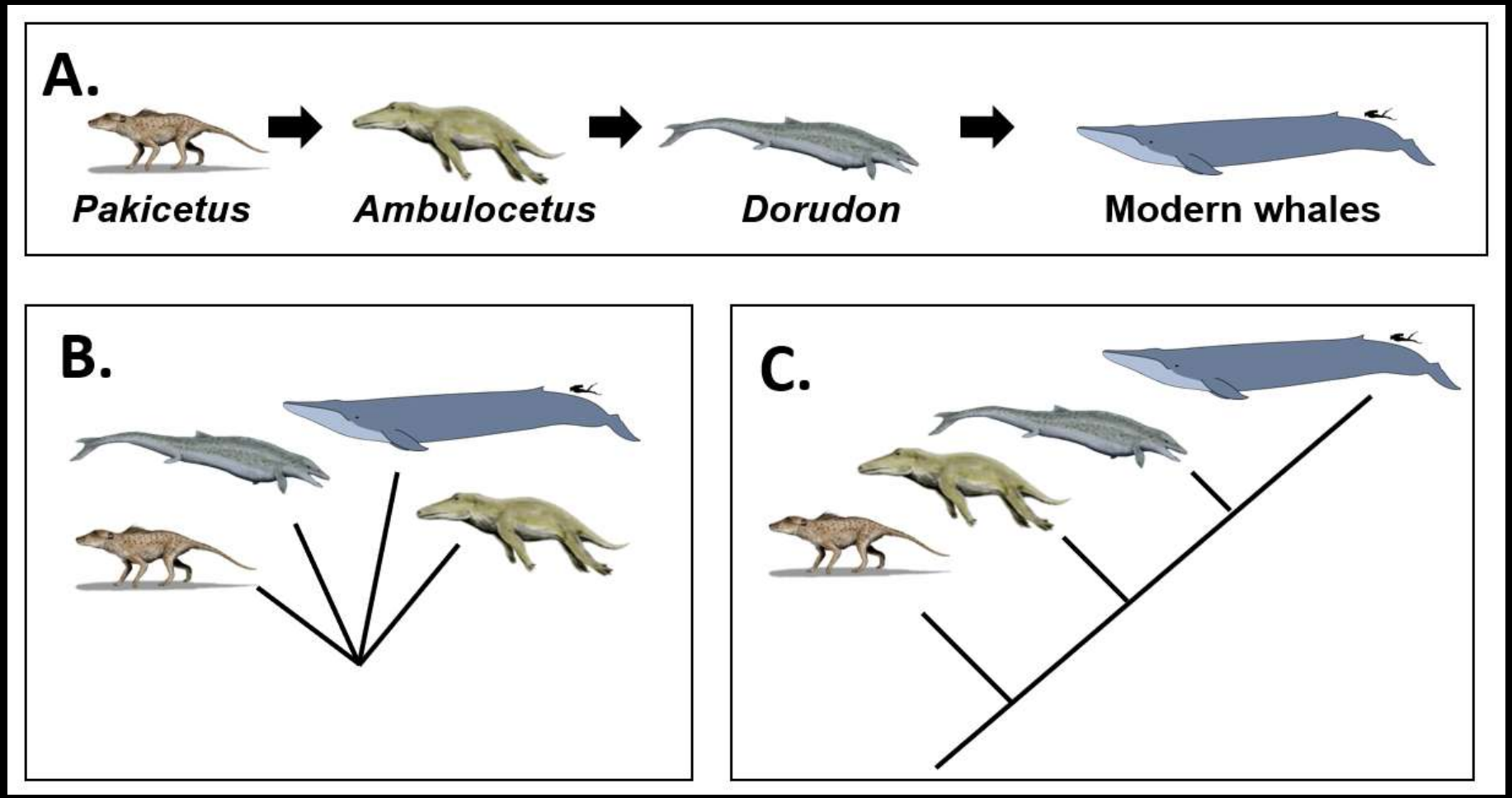
- Over time, as whales became more aquatic, their teeth changed.
- Today, whales have different types of teeth, from sharp ones for eating animals to baleen plates for filtering food, showing how their teeth evolved from their land-dwelling ancestors.



Question #5: Why did the teeth cetaceans change over time?

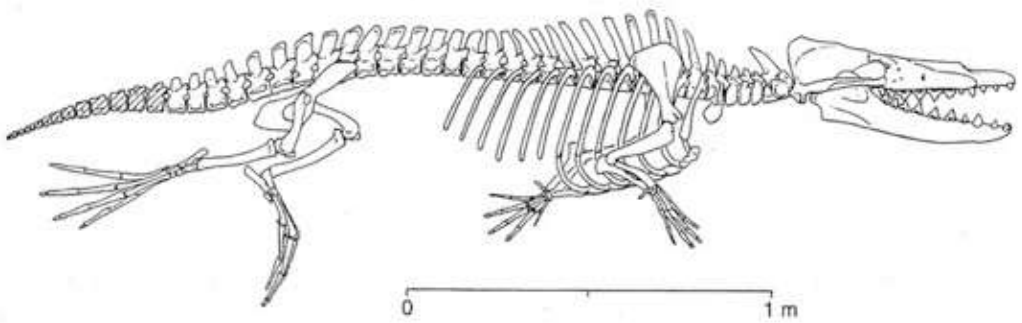
A. The ocean environment made their teeth dissolve over time.
B. Since larger teeth helped them camouflage from predators.
C. To reduce body weight for faster swimming.
D. To allow them to crack open large nuts and seeds.
E. The teeth evolved for specific diets and environments.

Question #6: Which diagram do you believe best represents the relationships among fossil whale species and modern whales?

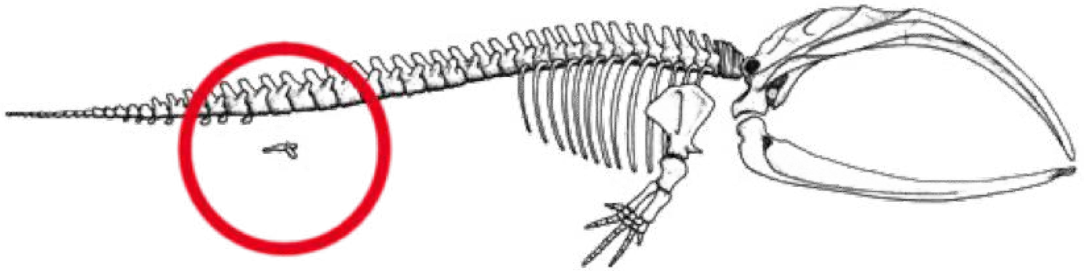


Part 2: Anatomical

- Fossil from the ancestors of whales found in Egypt and Pakistan had functional hind limbs.
- Modern whales possess in their pelvic region the remnants of these hind limbs.



Distant relative of the whale, *Ambluocetus* note the fully functional hind legs (46-48 million years before present).



A skeleton of a Baleen whale, with the pelvic bone and hind leg structure circled.

Question #7: What evidence from whale fossils supports the idea that whales are closely related to land mammals?

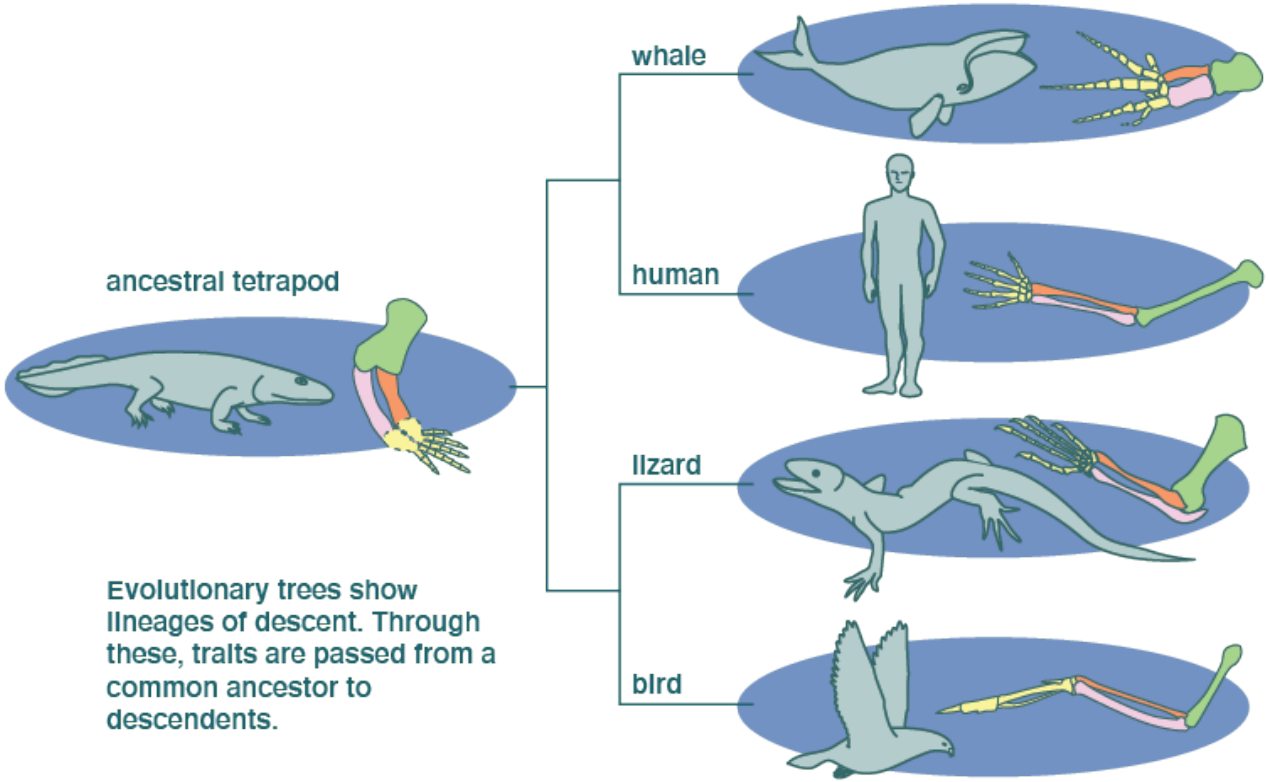
A. Fossils show that whale ancestors were already large in size before they moved into the oceans.
B. Fossils show limbs with bones similar to those of modern hooved mammals.
C. Fossils reveal the presence of baleen plates for filter-feeding.
D. Fossils indicate that whales once had scales like fish.
E. Fossils suggest early whales had gills instead of lungs.

Question #8: Modern whales show small, non-functional hind limbs. What are these structures an example of?

A. Homologous structures
B. Mutations
C. Vestigial Structures
D. Adaptations
E. Fitness Structures

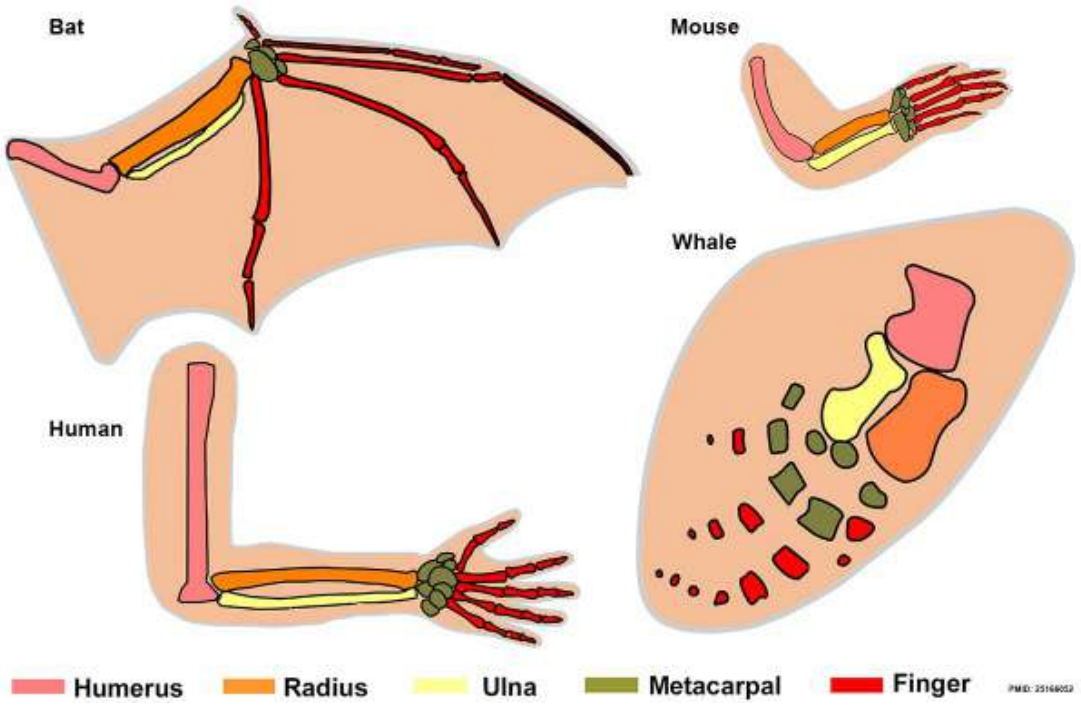
Part 2: Anatomical

- The arms of whales and other tetrapods (four-limbed animals) are homologous because they share a common ancestor and similar bone structures.
- All tetrapod's share a common bone structure in their forearms: One bond, two bonds, many bonds.



Part 2: Anatomical

- These similarities in bone structure show how different species evolved to do different jobs but kept the same basic structure from a common ancestor.
- Notice how the whale's bones are shorter which allows the flipper more strength for moving through the water.

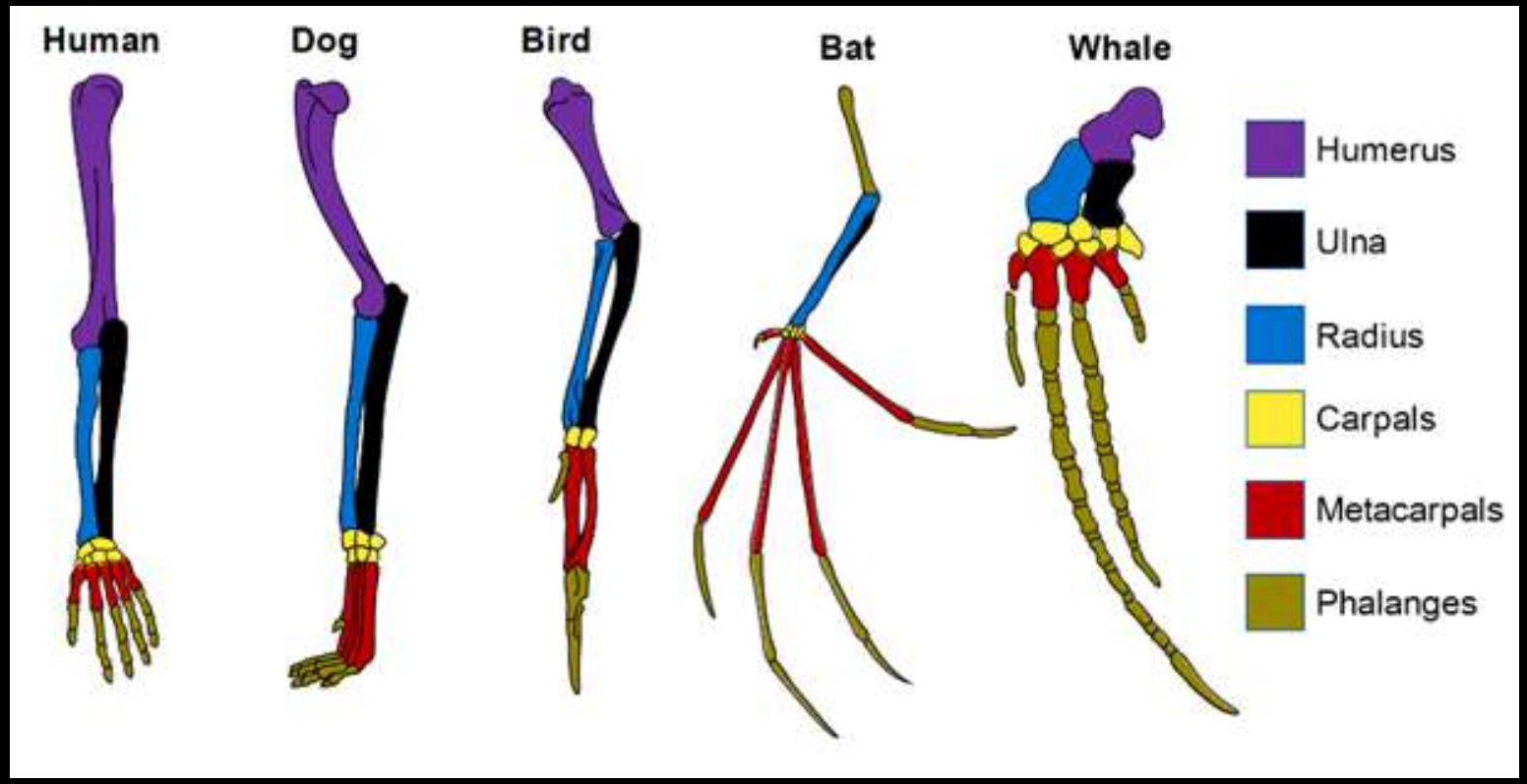


Question #9: What species would not share the bone structure found in tetrapods?

A. Monkeys
B. Rabbits
C. Lizards
D. Butterflies
E. Crows

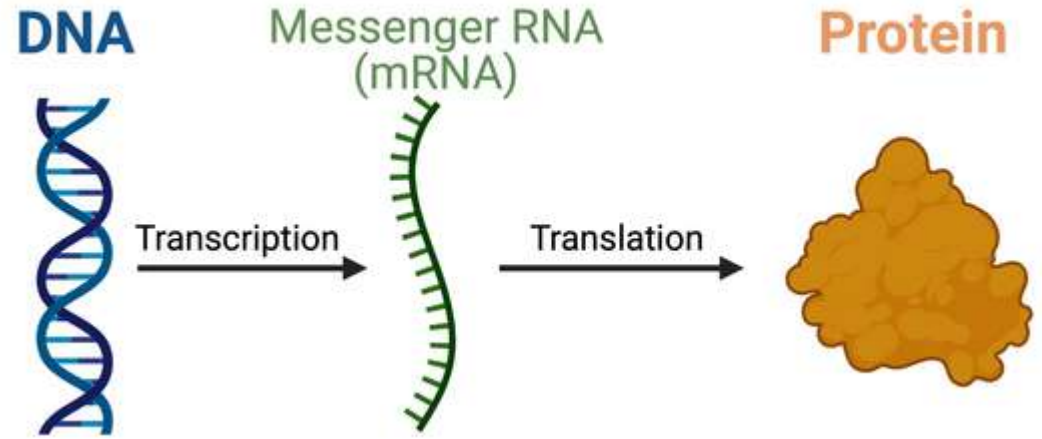
Question #10: Which part of the whale forearm is elongated compared with other tetrapods?

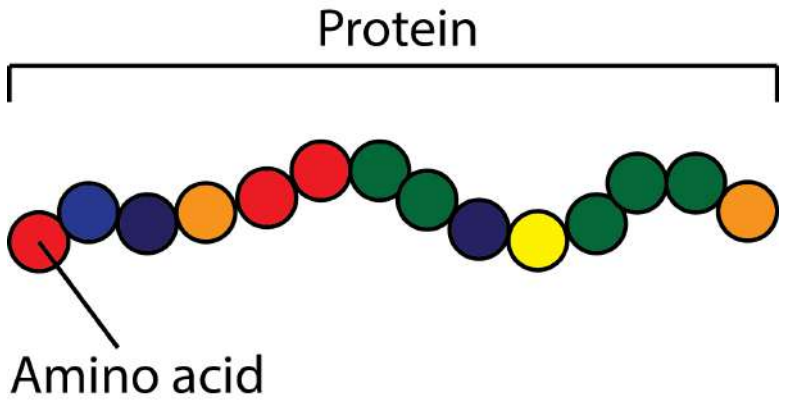
A. Humerus
B. Ulnda
C. Radius
D. Carpals
E. Phalanges



Part 3: Molecular Evidence

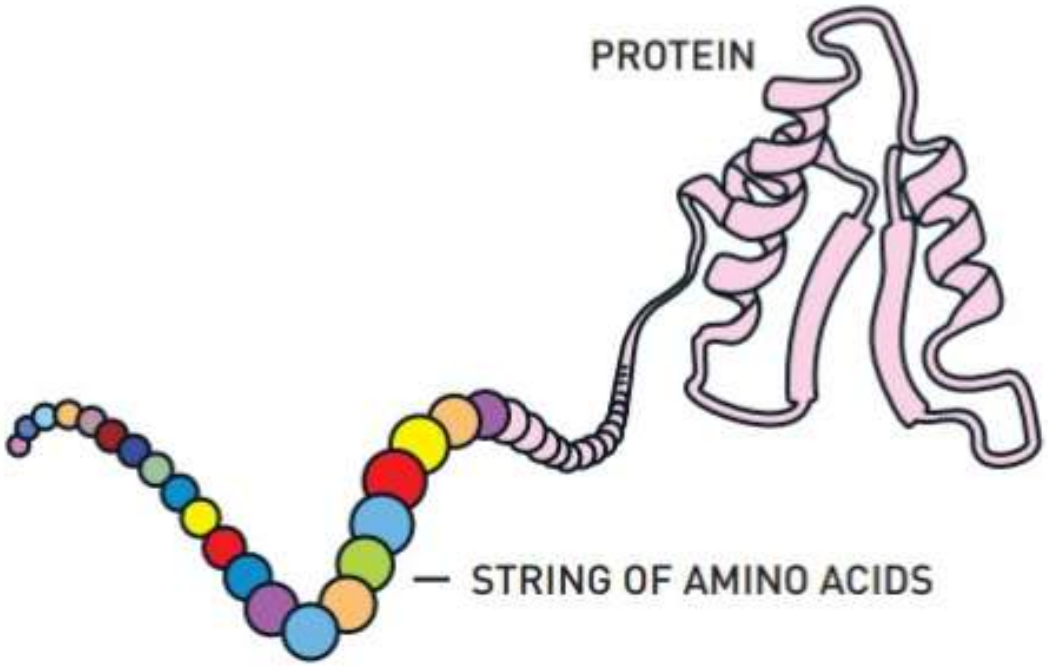
- Remember that the central dogma outlines how DNA codes for RNA which codes for our proteins.
- All life in Earth is related through this common shared genetic inheritance.





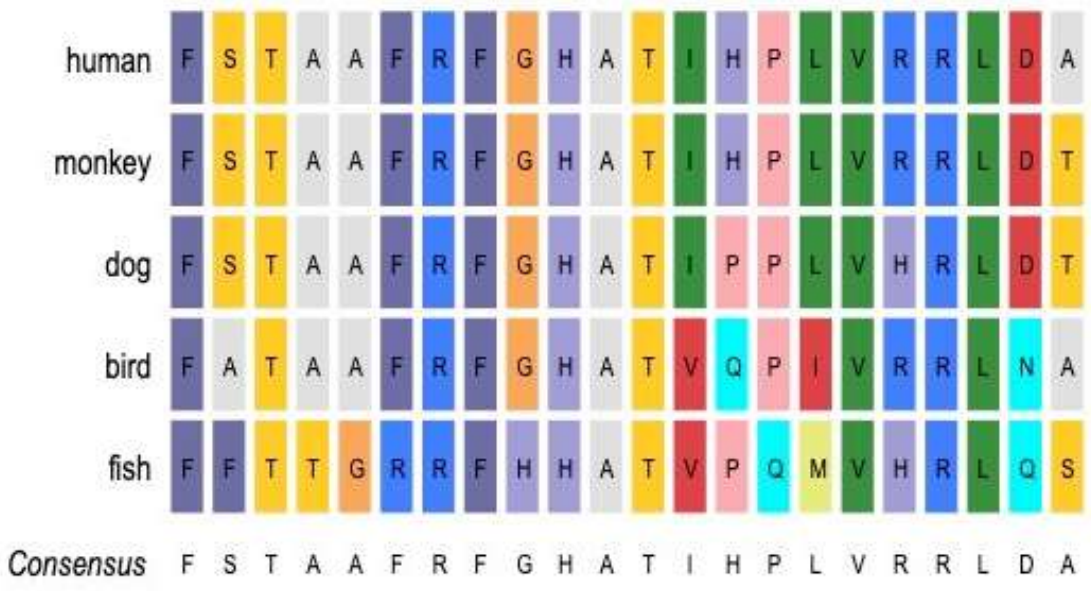
Part 3: Molecular Evidence

- Each protein is comprised of amino acids is a specific order.
- This order determines the shape of the protein. The shape of the protein determines its function.



Part 3: Molecular Evidence

- The more similar two amino acid sequences two species have, the more closely related they are.
- The more different two amino acid sequence are, the less related they are.



Each letter in the table represents an amino acid in the _____ protein. Each amino acid that is different from the whale is highlighted in yellow. The ____ protein consists of many more amin acids, but our table focuses on the first 15.

Species	Picture	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Whale		I	G	C	D	T	L	M	E	K	A	T	N	W	E	E
Dolphin		T	G	C	D	T	L	M	E	K	A	T	N	W	E	E
Basilosaurus		T	G	C	D	T	L	M	E	D	A	T	N	W	E	E
Protocetidae		T	K	C	E	T	L	M	E	K	A	T	N	W	E	E
Remingtonocetidae		T	G	C	D	T	L	M	E	D	A	T	S	W	E	K
Ambulocetus		T	G	C	E	T	L	M	E	D	A	T	S	W	E	K
Pakicetus		T	G	C	E	T	L	M	E	S	A	C	S	W	E	K
Indohyus		V	N	C	E	T	L	R	E	K	A	T	S	W	N	K
Hippo		T	Q	C	E	T	L	R	I	K	T	A	A	W	Q	E

Question #11: Which amino acid do all of the species have in common?

A.#1

B.#3

C.#9

D.#11

E.#15

Question #12: How many differences does a whale and Remingtonocetidae have?

A.4 differences

B.5 differences

C.1 difference

D.2 differences

E.7 differences

Question #13: Which species is the closest related to the whale?

A. Dolphin

B. Hippo

C. Basilosaurus

D. Ambulocetus

E. Indohyus

Question #14: Which species is the least related to the whale?

A. Basilosaurus

B. Dolphin

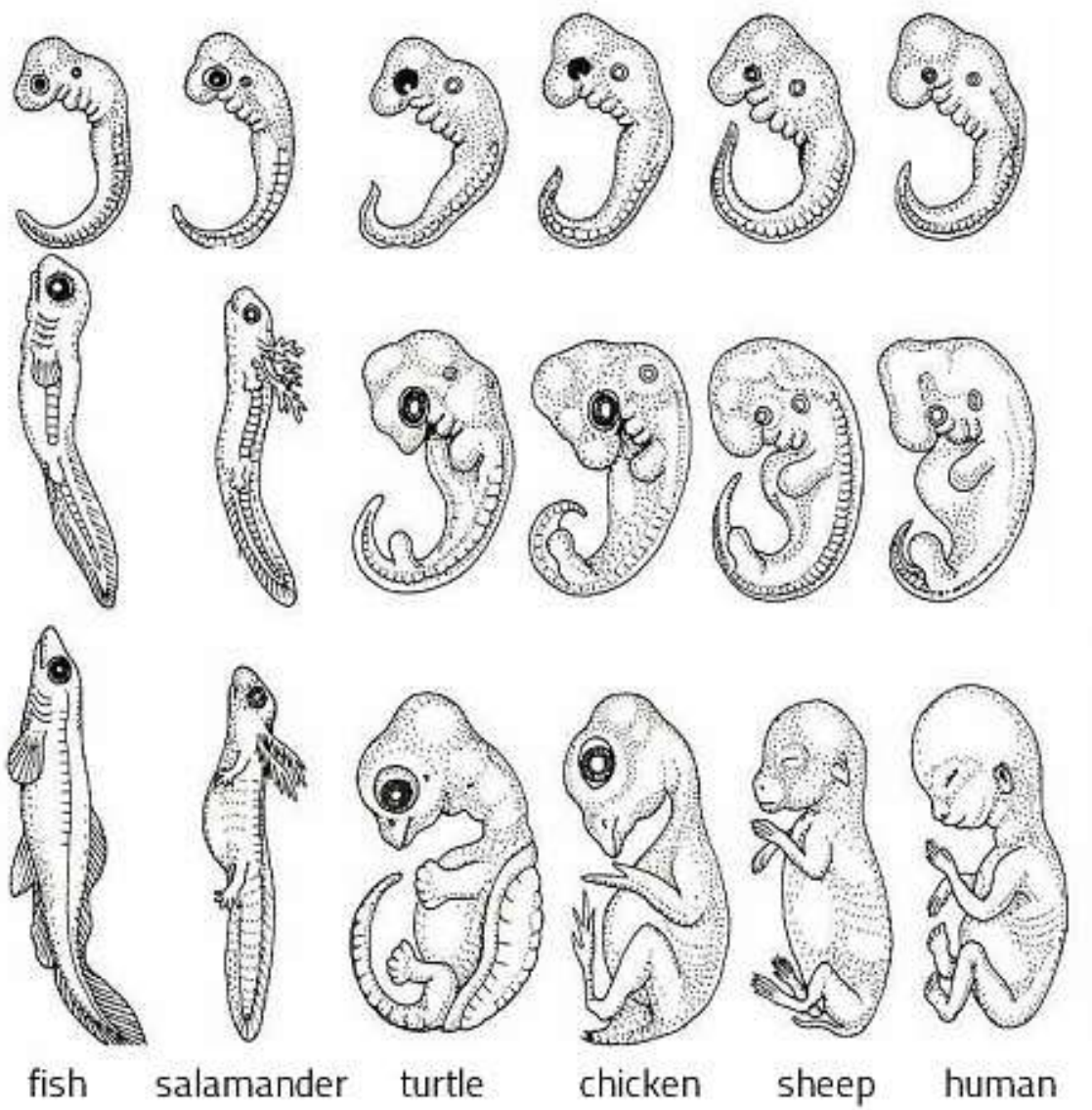
C. Ambulocetus

D. Indohyus

E. Hippo

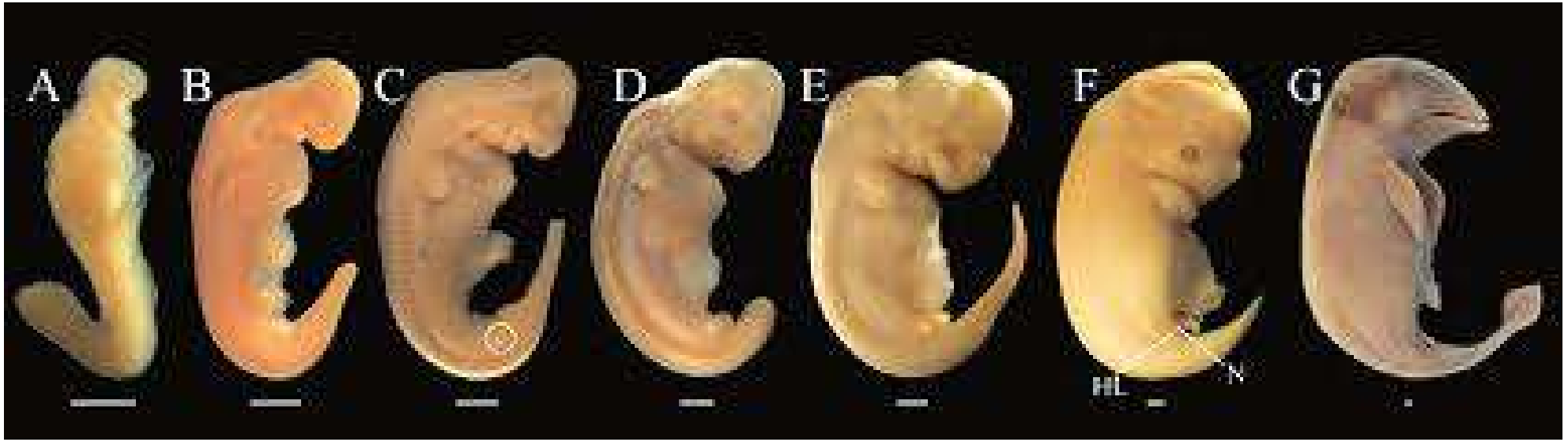
Part 4: Embryological

- Embryos of different species often show similar features during early development, revealing common ancestry.
- Early embryos of vertebrates, for example, often have features like gill slits, tails, and similar body shapes, which are seen in species as diverse as fish, birds, and mammals.
- Over time, as embryos continue to develop, these traits may disappear or transform into different structures.



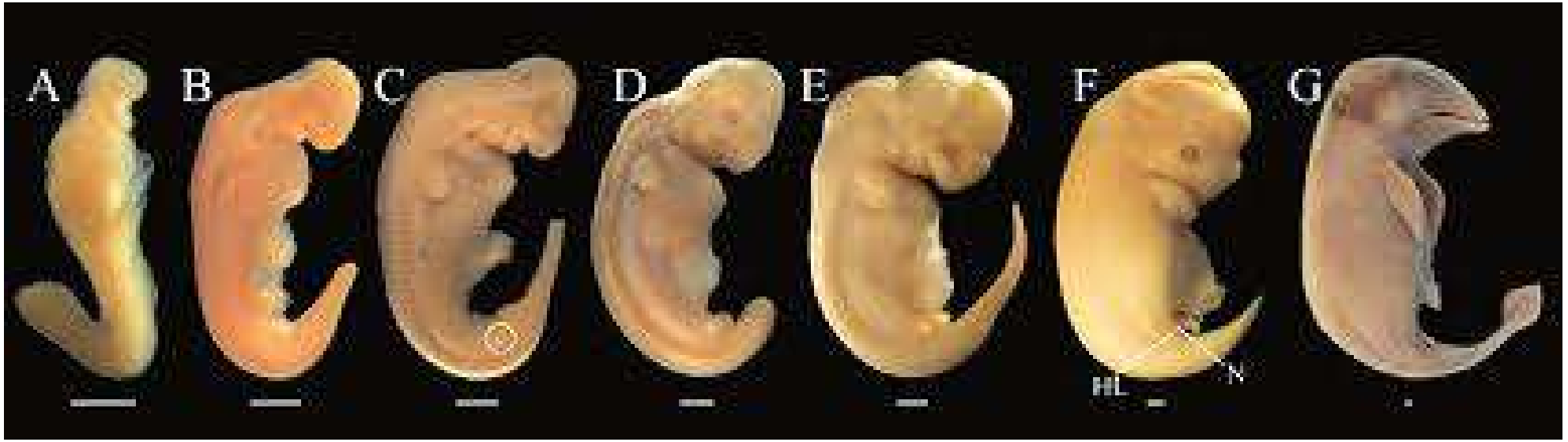
Part 4: Embryological

- Hind Limb Buds: Whale embryos form small hind limb buds, like legs, but these disappear before birth.
- Blowhole Movement: The blowhole starts near the nose and moves upward to the top of the head as the embryo grows.



Part 4: Embryological

- Hair Growth: Whale embryos grow a thin layer of hair (lanugo) that falls off before birth, a feature found in other mammals.
- Vestigial Teeth: Some whale embryos form tiny teeth that later disappear before birth, replaced by baleen plates.



Question #15: Which of the following is NOT true about the embryonical development of whales?

A. Whales start out with a tail.
B. The whale's tail remains through the entire development.
C. Whale embryos grow flippers, not front legs, during development.
D. Whale embryos develop legs that fuse together to make the tail.
E. Whale embryo development would be similar to other mammals since they are closely related.

Answers

Whale Evolution

1. A
2. B

Part 1: Fossils

3. C
4. E
5. E
6. C

Part 2: Anatomical

7. B
8. C
9. D
10. E

Part 3: Molecular

11. B
12. A
13. A
14. E

Part 4: Embryological

15. D