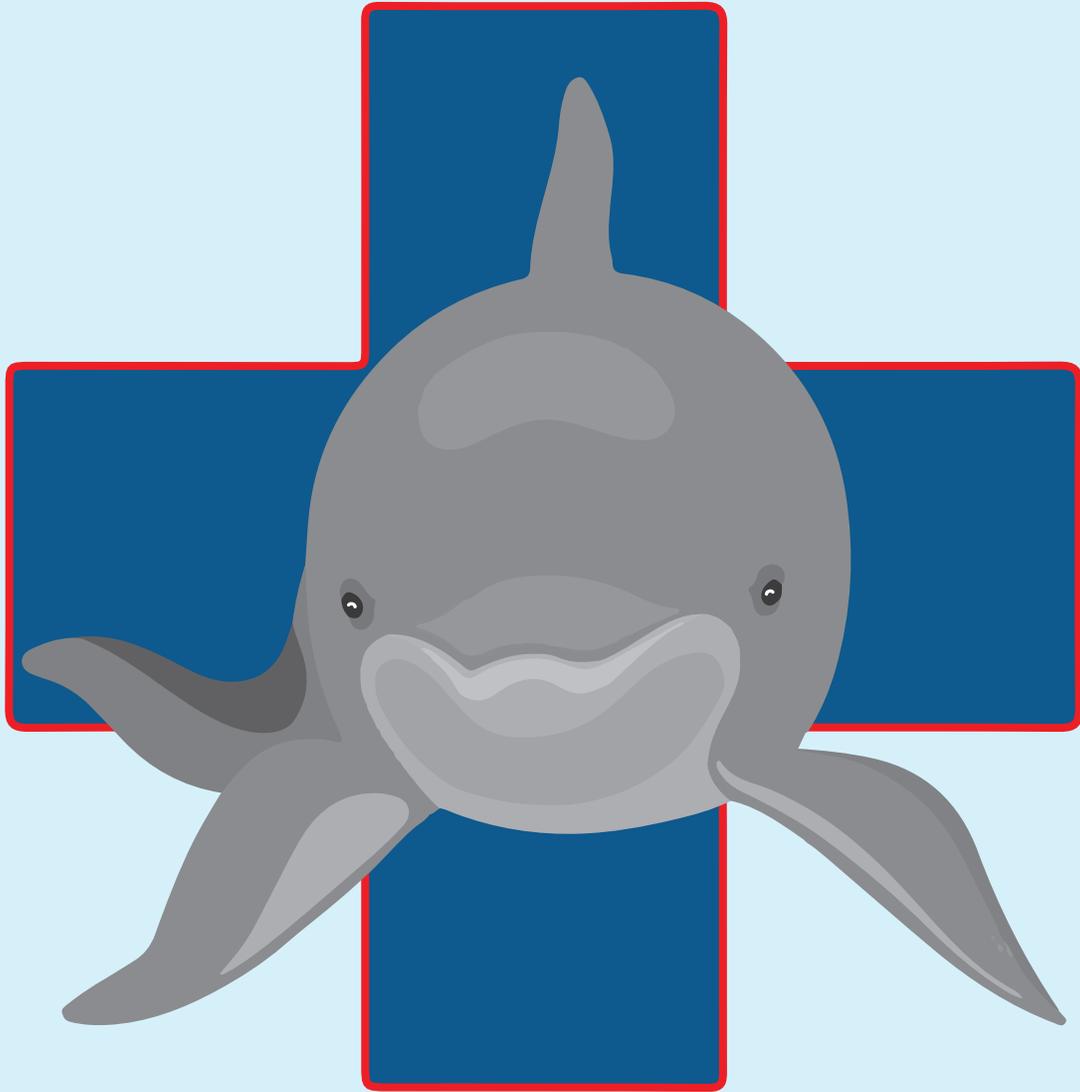


DOLPHIN DOCTOR



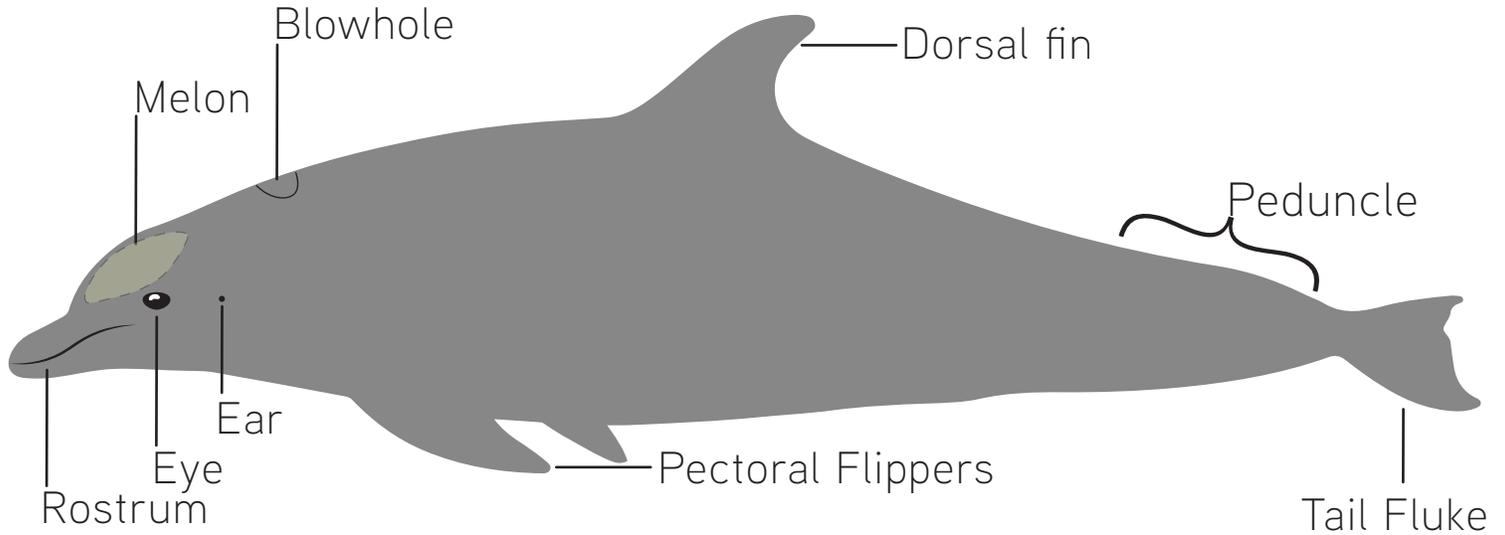
WORKBOOK



NATIONAL
MARINE MAMMAL
FOUNDATION



DOLPHIN ANATOMY



How do you tell a boy and girl dolphin apart?
Look at their bellies!

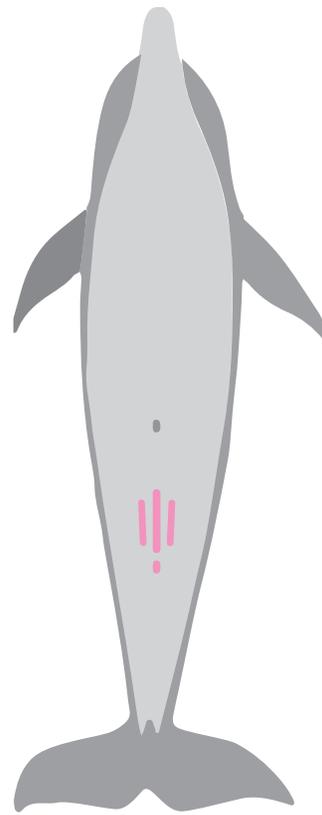
(Hint: look for a division sign or exclamation point!)



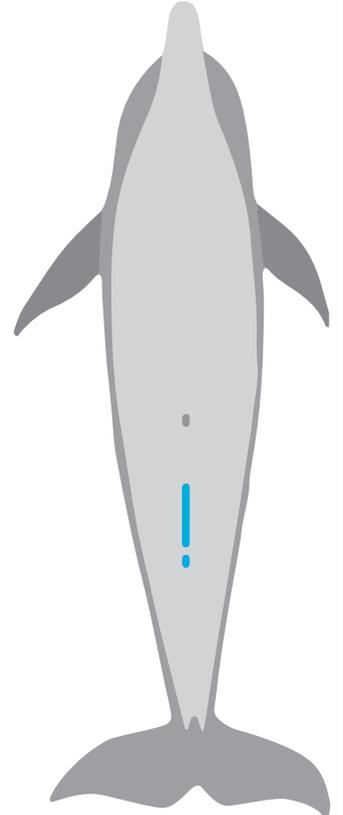
Female = \div



Male = $!$



Female = \div



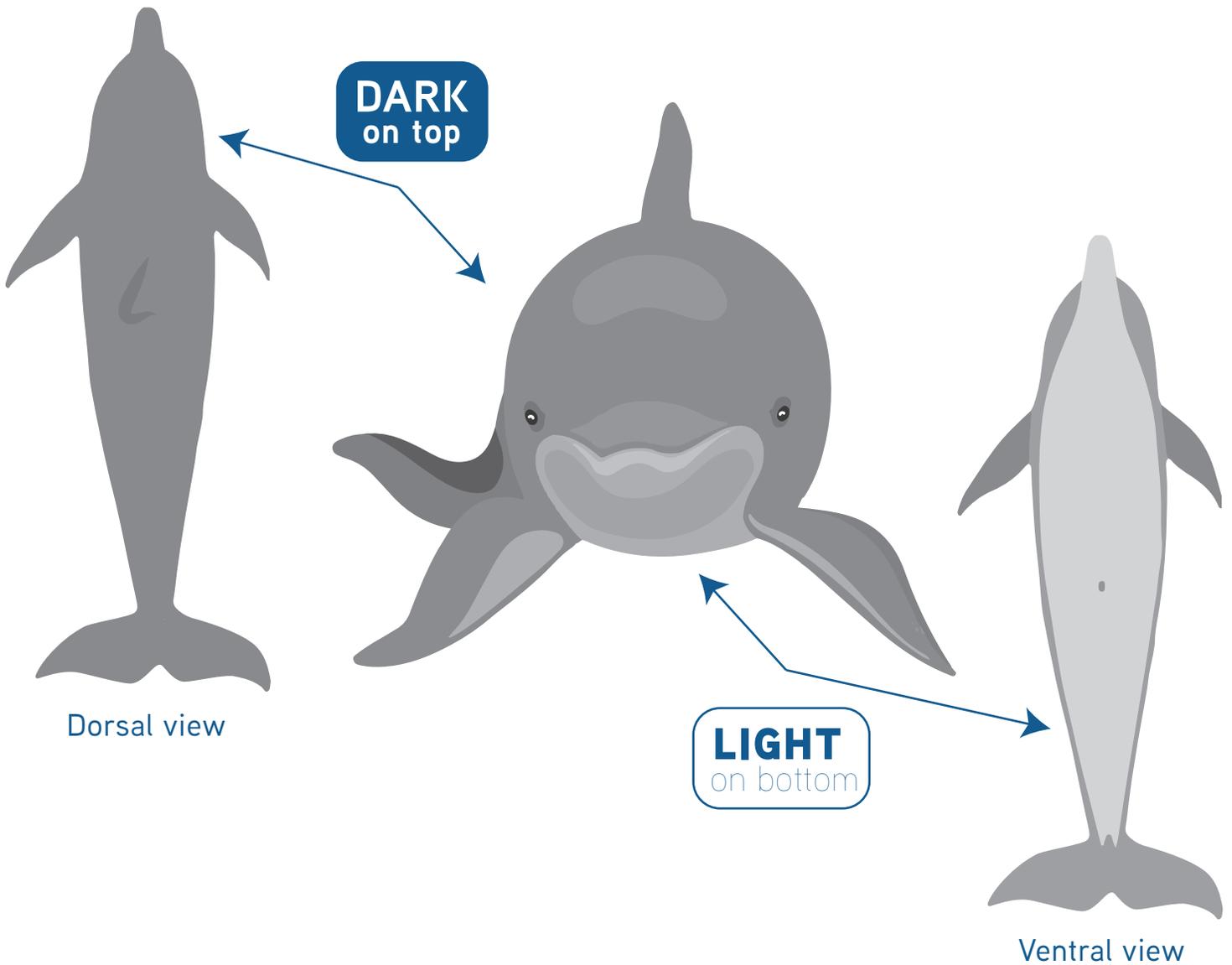
Male = $!$





COUNTERSHADING (THAYERS LAW)

Dolphins have adapted to light penetrating the water. They use countershading to blend in with their environment. Looking down on them, the dark colors blend in with the ocean. Looking up from underneath, the patches of light and dark skin blend in with the sunlight penetrating the water. By being darker colored on top and lighter underneath they help to conceal themselves from predators and prey.

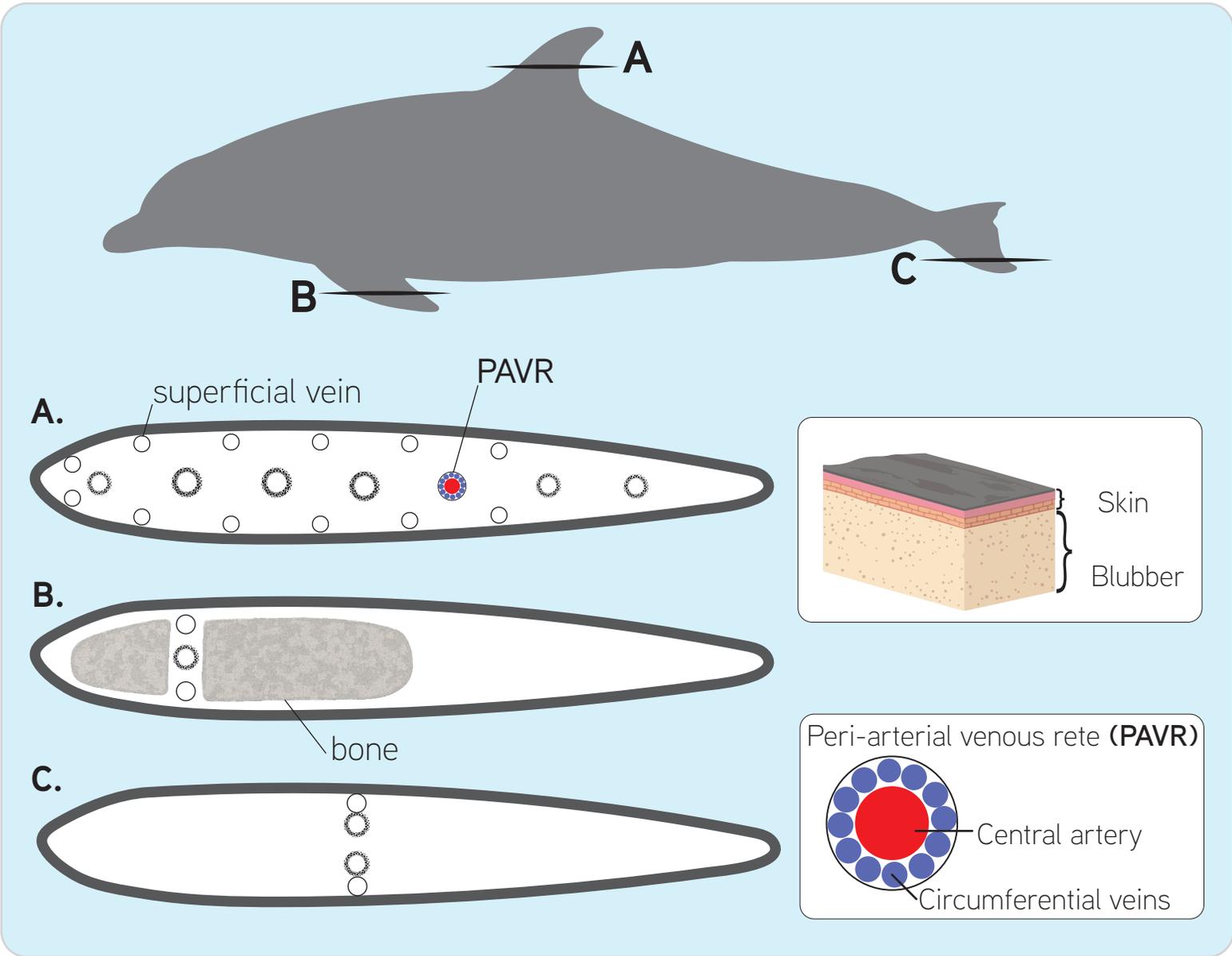




THERMOREGULATION

COUNTERCURRENT HEAT EXCHANGE

A bottlenose dolphin's circulatory system adjusts to conserve or dissipate body heat and maintain body temperature. Thus, some heat from the blood traveling through the arteries is transferred to the venous blood rather than the environment. This countercurrent heat exchange aids dolphins in conserving body heat.



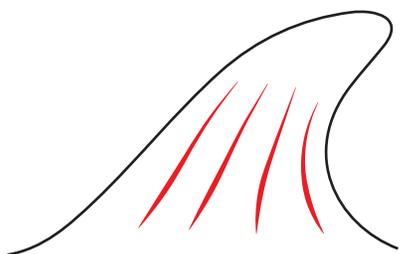
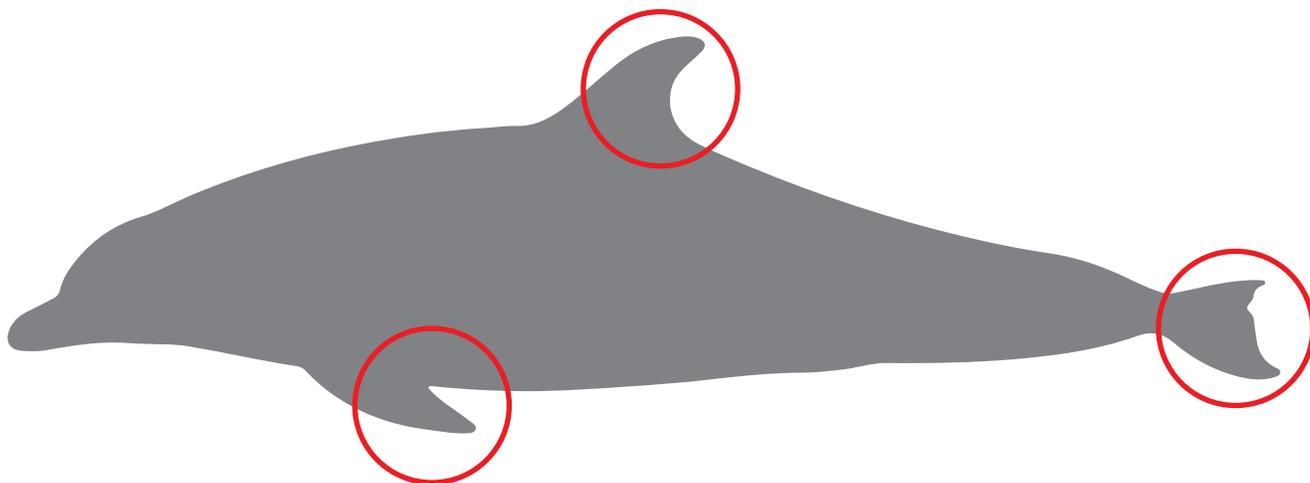
Schematic representations of countercurrent heat exchanges in bottlenose dolphin. Cross-sections through (A) the dorsal fin, (B) the pectoral flipper and (C) the flukes. (modified from Pabst et al., 1999).



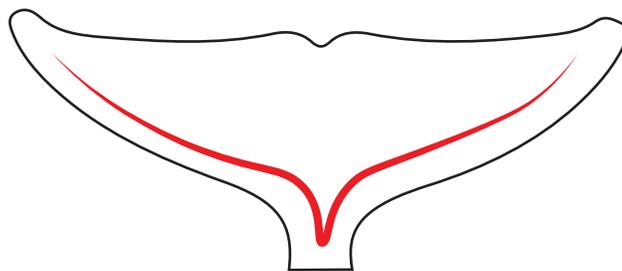
BLOOD SAMPLING CITES

Bottlenose dolphins share many ecological and life history traits with humans. Some of these include long lifespans; similar reproductive cycles, such as giving birth to one offspring at a time and length of birthing intervals; fat stores that can concentrate toxicants; and top-predators feeding on similar food sources, such as fish and squid. To understand dolphin health and how it relates to human health, blood samples can be taken from the three common sites below.

Additionally, one way to monitor an ecosystem is to study sentinel species, or organisms that are indicators of the environment. Bottlenose dolphins are considered sentinel species and are ideal for bio-monitoring because they can provide early warnings of ecosystem changes, and potential impacts to humans. Bottlenose dolphins also often inhabit coastal waters that are in close proximity to human activities.



lateral surface of **dorsal fin**



Ventral surface of **tail flukes**
and **caudal peduncle**

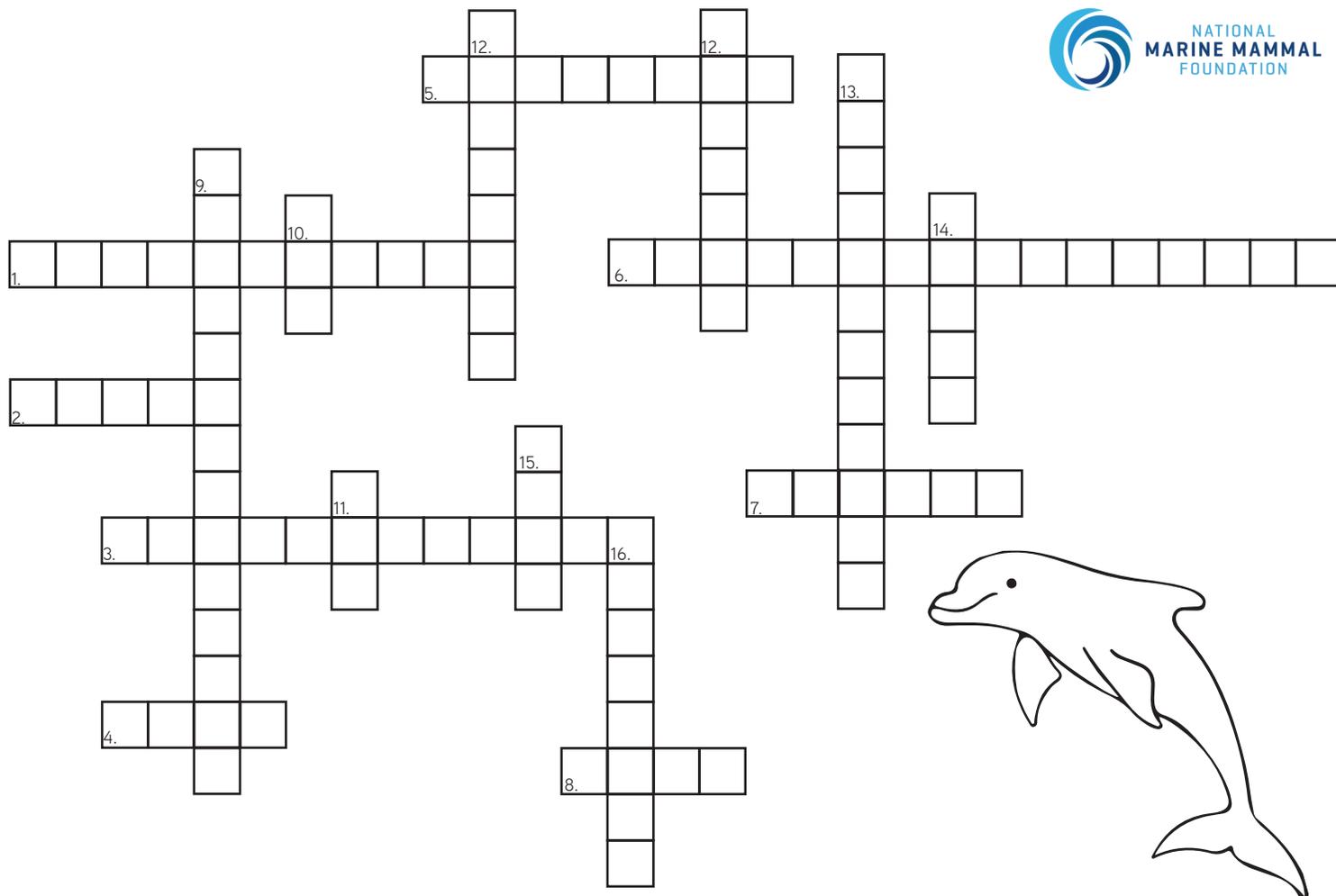


Dorsal surface of **pectoral flipper**





CROSSWORD PUZZLE



ACROSS

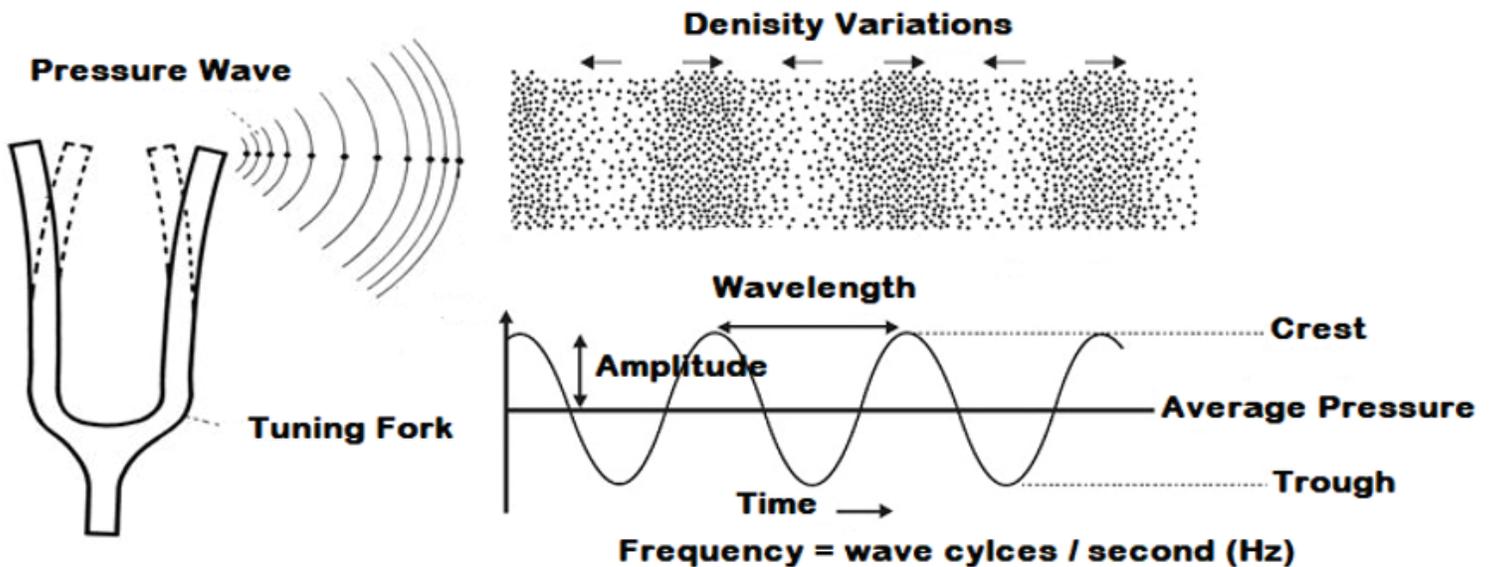
1. Dolphins use clicks and whistles to _____, or talk to one another!
2. A dolphin's tale is called a _____
3. Dolphins use sound and echoes to detect and locate objects. This is called _____, or bio sonar!
4. Dolphins use echolocation to _____ fish.
5. Dolphins breathe from their nose (or _____), located on top of their head.
6. Dolphins are warm blooded and have the ability to _____, or maintain their body temperature. Their dorsal fins and tail flukes release excess heat from the body!
7. Dolphins breathe air, have hair, give birth to live young, and are warm blooded. This means dolphins are a type of _____ - just like you!
8. A baby dolphin is called a _____.

DOWN

9. Dolphins are a darker color on their backs to blend in with dark ocean depths, and a lighter color on their bellies to blend in with the bright surface. This form of camouflage is called _____.
10. Dolphins breathe _____ and can hold their breath for over 10 minutes! Dolphins also have more red blood cells, so they are able to carry more oxygen throughout their bodies!
11. A group of dolphins is called a _____.
12. Dolphins have a thick layer of fatty tissue called _____. This helps keep the dolphin warm and makes up 20% of their body weight!
13. The dolphin's torpedo-like shape makes it more _____, or able to move more efficiently in water.
14. The "bump" on a dolphin's head used to focus the animal's sounds in one direction during echolocation is called the _____.
15. Did you know: Dolphin _____ regenerates (or restores itself) 10-20 times faster than a humans' does!
16. Dolphins also use echolocation to travel and _____ their environment.



LEARNING TO ANALYZE GRAPHS



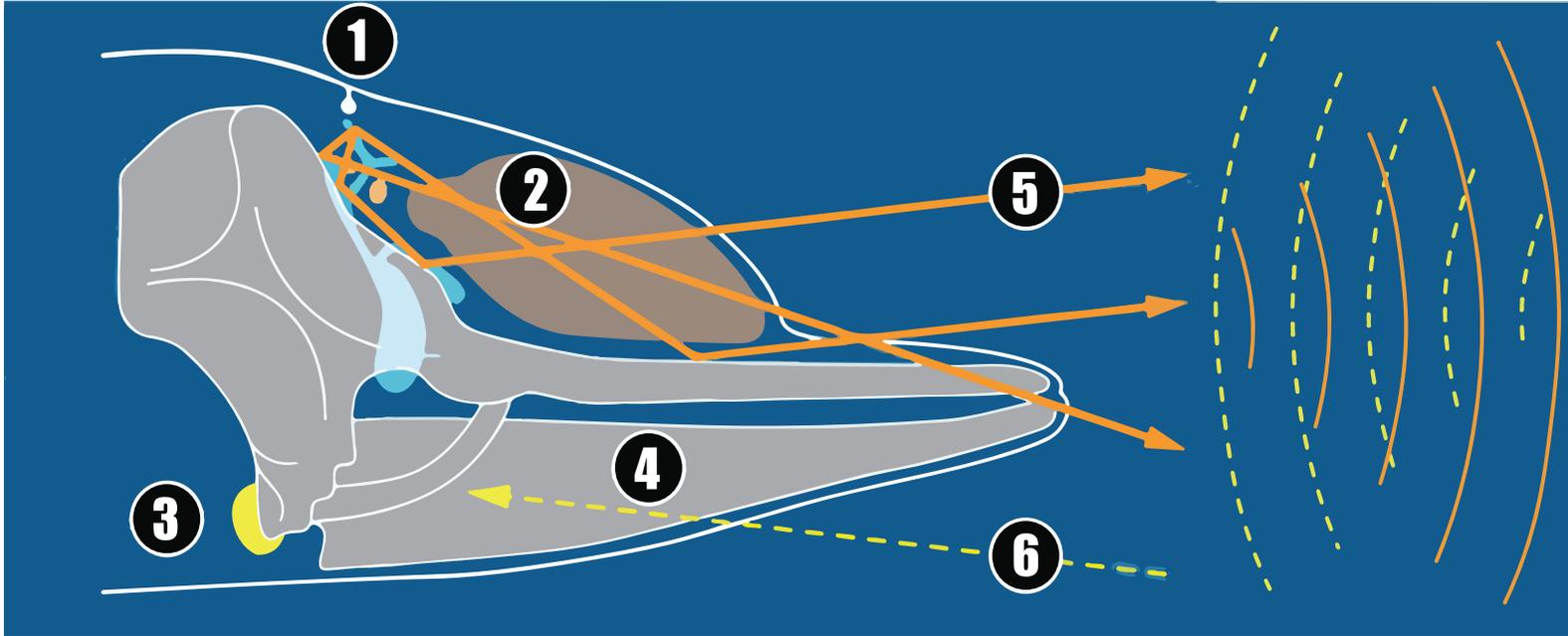
SOUND WAVE ANALYSIS

1. Sound is:
 - A. vibrations of a compressible medium
 - B. photons of sound
 - C. noise measured in bels
2. There is no sound in a:
 - A. solid
 - B. vacuum
 - C. liquid
3. Sound travels:
 - A. slower in warm air than cold air
 - B. faster in solids and liquids than in air
 - C. faster in air than in water
4. The height of a wave is the:
 - A. trough
 - B. amplitude
 - C. wavelength
5. The distance from one crest of a wave to the next crest of a wave is:
 - A. wavelength
 - B. frequency
 - C. amplitude
6. The height of a sound wave indicates:
 - A. frequency of the sound
 - B. pitch of the sound
 - C. the loudness of the sound
7. The number of cycles or waves passing a particular point every second is the:
 - A. frequency
 - B. wavelength
 - C. volume
8. Frequency is measured in:
 - A. hertz
 - B. cycles per second
 - C. both of the above
9. The pitch of a sound (high or low notes) is determined by the:
 - A. talent of the singer
 - B. amplitude
 - C. frequency
10. Human hearing is between about:
 - A. zero and 10,000 hertz
 - B. 15,000 and 20,000 Hz
 - C. 20,000 and 25,000 decibel

DOLPHIN SOUND PRODUCTION

Use the dolphin head schematic (A) to match each number to corresponding key word (C). Write the key word next to the correct number (B) and its function below.

A



B

1

2

3

4

5

6

C

KEY WORDS

Dolphin

Tursiops truncatus

Melon

Click

Echo

Mandible

Blowhole

Phonic Lips

Acoustic Window

Tooth

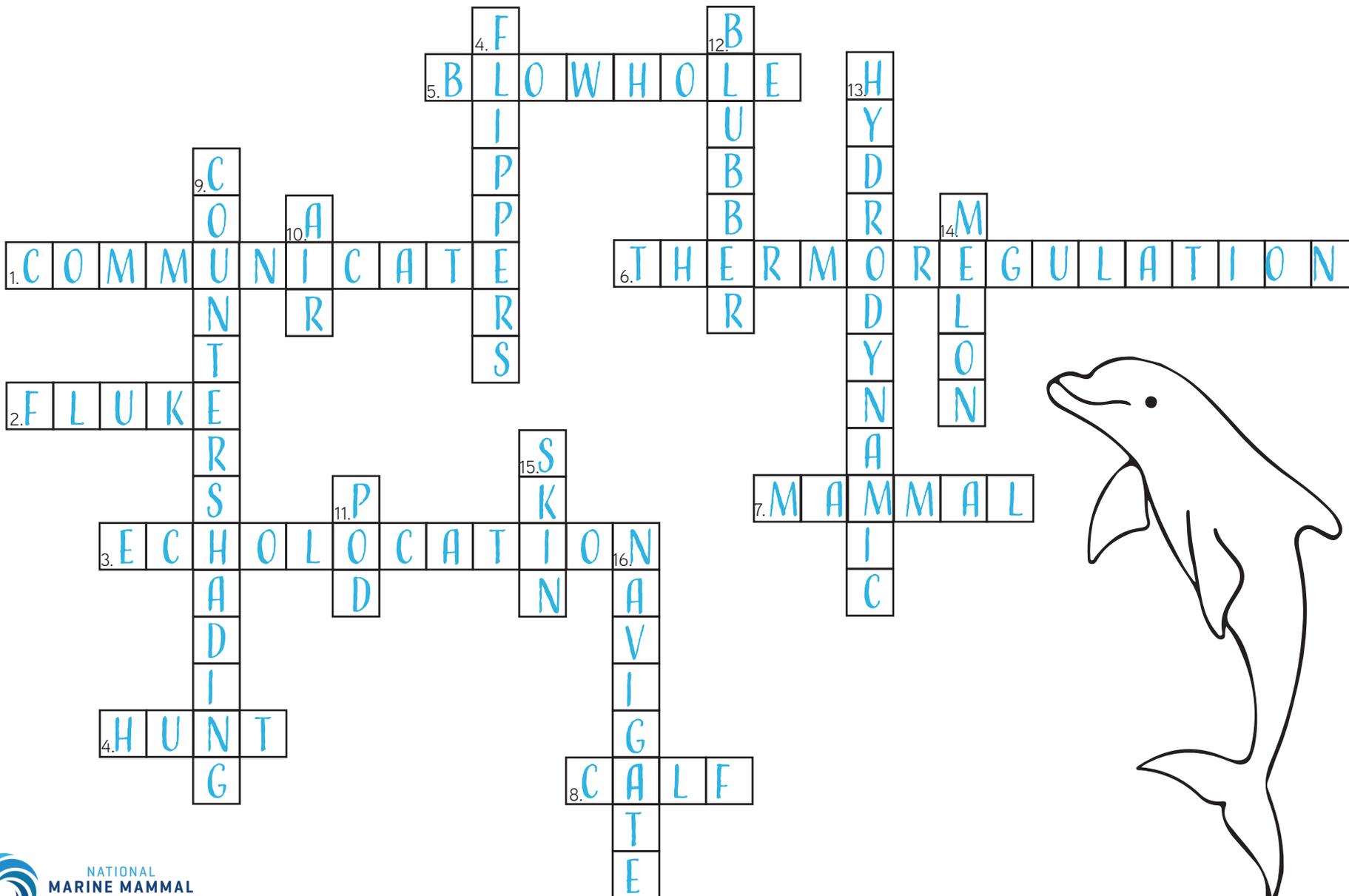
Blubber

Ear

Taste buds



ANSWER KEY





WHO'S YOUR DOLPHIN DAD?

Dolphin Doctor: On the Front Lines of Marine Mammal Medicine National Marine Mammal Foundation

Find the (Dolphin) Daddy: DNA Fingerprinting

Age Level: High School

NGSS Standards: HS-LS3-1 Heredity: Inheritance and Variation of Traits

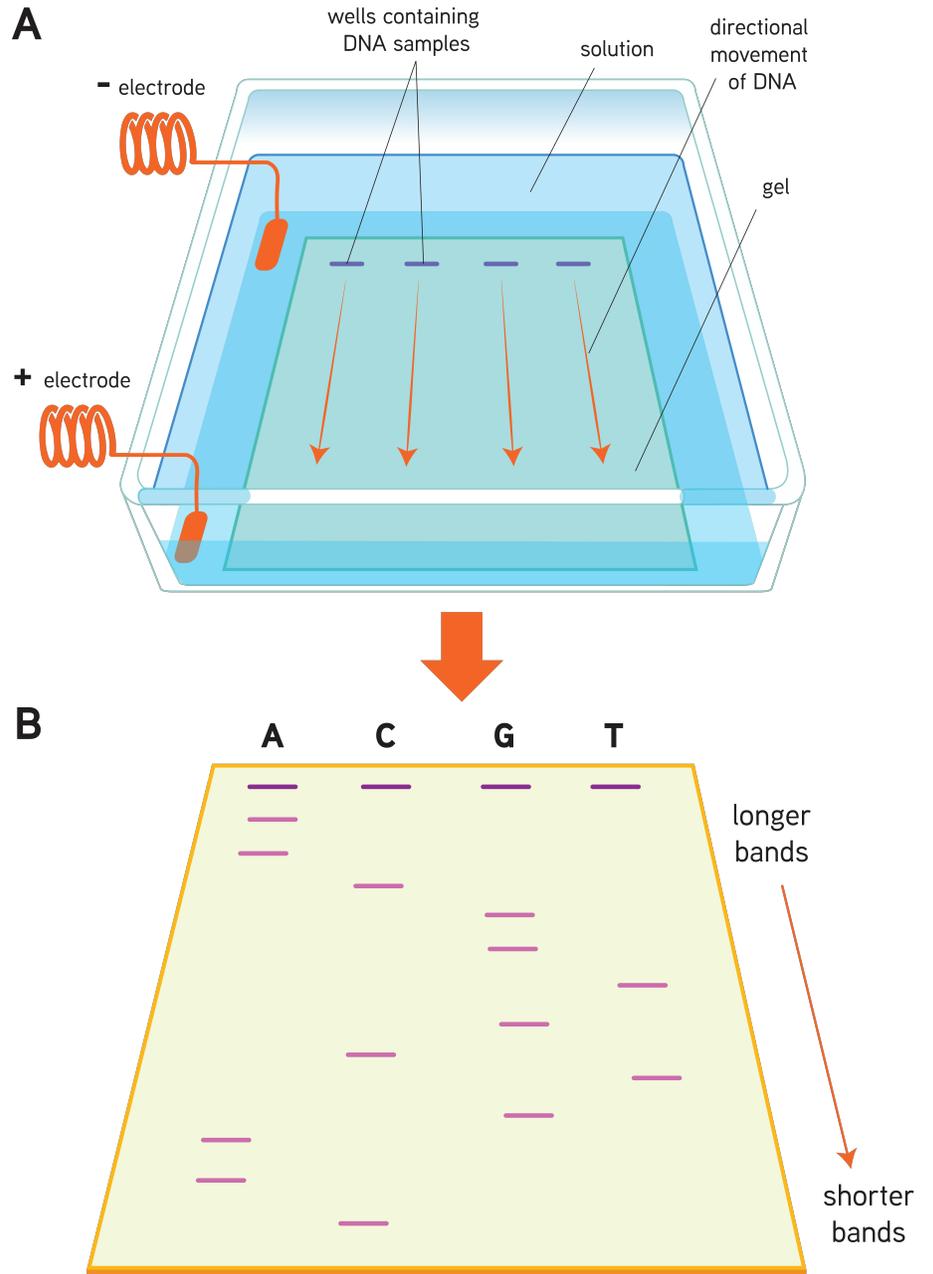
When a baby dolphin is born, it is often obvious who the mother is, but the father could be any of the males in the dolphin pod. Marine mammal veterinarians can use a DNA paternity test to determine which dolphin is the father. They use a method called DNA fingerprinting.

Any two animals, including humans, will have the vast majority of their DNA sequence in common, but within your DNA exist genetic clues to your heritage. Some of these clues are found in the non-coding regions of DNA where random mutations are relatively common. DNA fingerprinting is a technique used to distinguish between individuals of the same species using only samples of their DNA. DNA fingerprinting exploits highly variable repeating sequences called microsatellites. Since these minor changes do not usually affect genes essential to survival, the variations pass from parent to offspring. Over generations, these changes accumulate and the DNA regions develop distinct patterns. Two unrelated dolphins will likely have different numbers of microsatellites at a given locus. To analyze these DNA regions, scientists use a method of genetic profiling called DNA fingerprinting. DNA fingerprinting takes advantage of these inherited sequences, and uses them to identify the genetic similarities between certain individuals. Using this technology, family relationships can be identified on a genetic level and uncertainty about lineage can be resolved.

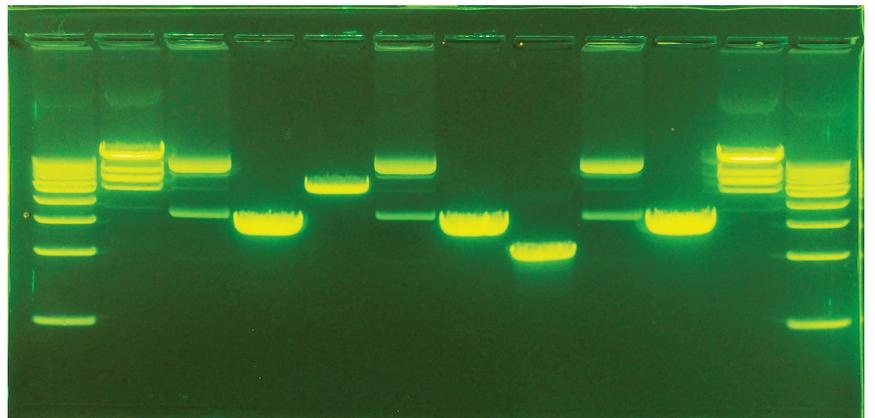
By using a technique called Polymerase Chain Reaction, commonly called "PCR", to detect the number of repeats at several loci, it is possible to establish a match that is extremely unlikely to have arisen by coincidence. The first step of PCR is to collect and isolate DNA from the animal. The DNA is then amplified, replicated billions of times, using PCR. The DNA is then cut with special enzymes and analyzed using a DNA separation technique called gel electrophoresis. When separated by gel electrophoresis, a banding pattern for each individual's DNA is created based on fragment size. This pattern can then be compared with the banding patterns of other individuals. The more similar banding patterns are, the higher the probability that individuals are related.

Microsatellites can also be used to understand the population structure of wild dolphin pods. DNA fingerprinting is the same method used in human paternity testing and forensic science, to match crime suspects to samples of blood, hair, saliva or semen.

Electrophoresis is a technique used in many areas of science to analyze and separate samples by applying a constant electric field. Biologists or forensic scientists can use this technology to separate mixtures of DNA or dyes into each component based on size and electrical charge. One of the most commonly used and effective reagents for DNA separation is agarose. Agarose gels are usually cast in a tray with molten (melted) agarose. A comb is placed while the agarose is molten and then removed after the gel solidifies to create wells in which to load samples. A DNA stain is used to enable visualization of the DNA. As an electric field is applied to the agarose gel, the particles in the wells will begin to move. The direction that particles migrate depends on their charge. DNA has a negative charge, so it will be attracted to a positive electrode.



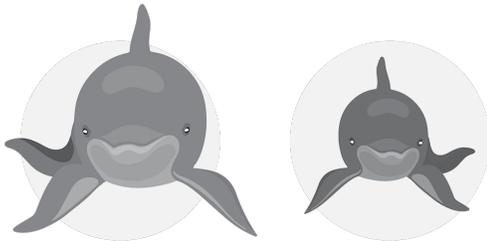
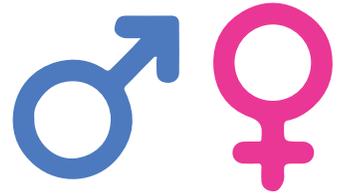
Picture of an actual agarose gel with bands of DNA



WORKSHEET: Your Turn!

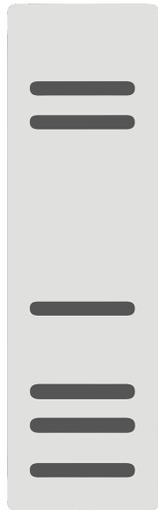
The recent birth of a female dolphin calf named Baby Blue has given the research team an opportunity to gather more data about the dolphins' mating behaviors.

By observing nursing behavior, they have already been able to match Blue with her mother. They have also narrowed down her father to one of three possible candidates based on observations made during the previous mating season, however they have yet to definitively link Blue to her father. Using a DNA fingerprinting technique, you are going to help them figure out which whale is Blue's father!



Mother

Baby Blue



'Dad' 1

'Dad' 2

'Dad' 3



Questions

1. What is DNA and what does it do?

2. How much DNA do you share with each of your parents? How much DNA do you share with your siblings?

Parents:

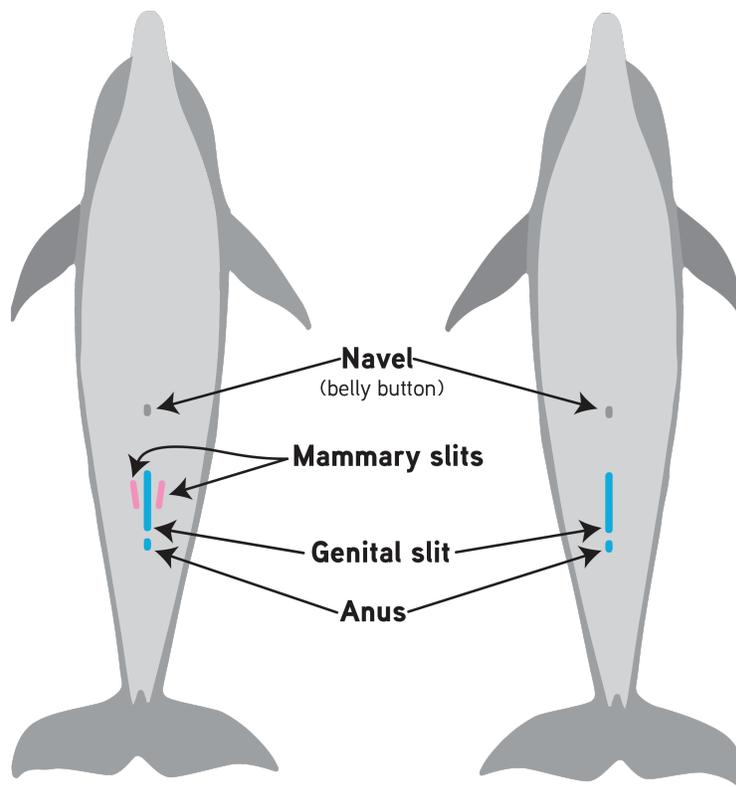
Siblings:

3. How many bands does Baby Blue have in her fingerprint? What about her mom? How many bands do they have in common?

4. Compare Baby Blue's fingerprint to each of the possible fathers. How many bands does Blue have in common with Male A? Male B? Male C? Who is most likely to be Blue's father? Justify your answer based on your data.

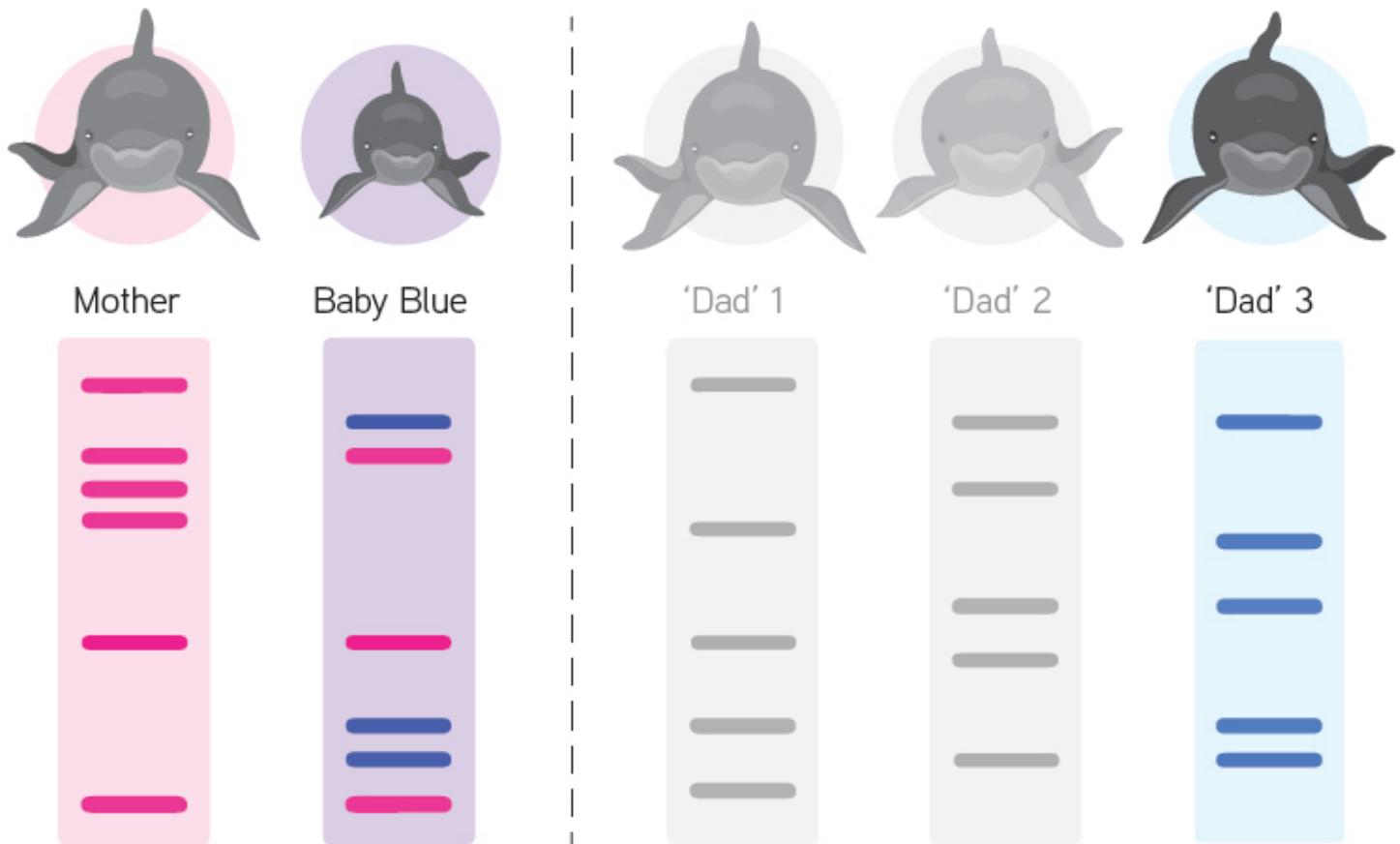
BONUS: How can you tell if a dolphin is male or female?

DNA analysis can also be used to tell if a dolphin is male or female. However, this is not often needed because it is possible to determine if a dolphin is male or female from the exterior of their body.



Circle one: **Male** / **Female** Circle one: **Male** / **Female**

Answer Key:



1. What is DNA and what does it do?

DNA stands for deoxyribonucleic acid. DNA is an extremely long macromolecule that is the main component of chromosomes. It is the material that transfers genetic characteristics from one organism to their offspring and exists in all life forms. The genetic information of DNA is encoded in the sequence of the bases and is transcribed as the two strands of the chromosome unwind and replicate.

2. How much DNA do you share with each of your parents? How much DNA do you share with your siblings?

You share $\frac{1}{2}$ of your DNA with each of your parents. How much you share with your siblings depends on which chromosomes are passed to each sibling from each of their parents and it is usually between 38% - 61% (average is 50%).

3. How many bands does Baby Blue have in her fingerprint? What about her mom? How many bands do they have in common?

Baby Blue has six (6) bands in her fingerprint, and of those she shares three (3) with her mother.

4. Compare Baby Blue's fingerprint to each of the possible fathers. How many bands does Blue have in common with Male 1? Male 2? Male 3? Who is most likely to be Blue's father? Justify your answer based on your data.

Bands in common with:

Male 1: 0-1

Male 2: 0-1

Male 3: 3

Male C is most likely to be Baby Blue's father because she shares three bands of DNA with him, which is approximately half of her bands.

BONUS:

