WHO'S YOUR DOLPHIN DAD?

DNA Fingerprinting for Marine Mammals

Age Level: High School
NGSS Standards: HS-LS3-1 Heredity: Inheritance and Variation of Traits

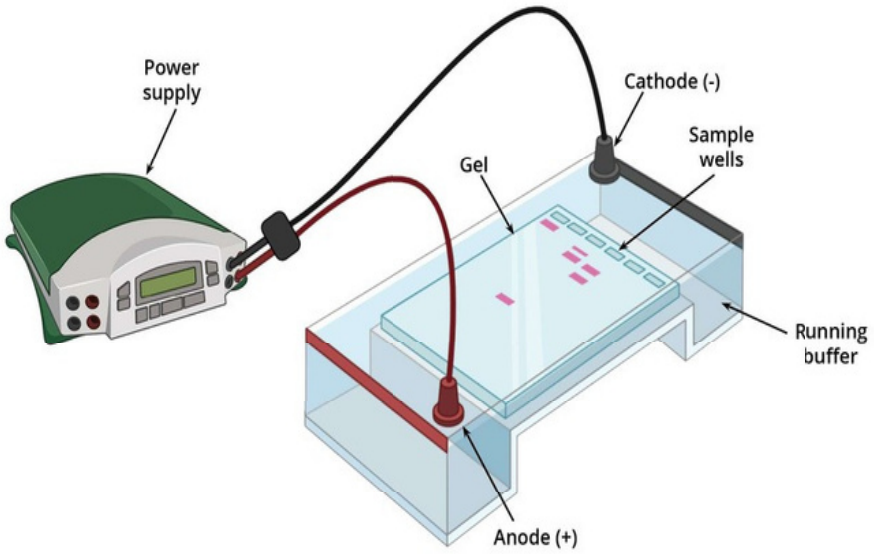
When a baby dolphin is born, it is often obvious who the mother is, but the father could be any of the males in the dolphin pod. Marine mammal veterinarians can use a DNA paternity test to determine which dolphin is the father. They use a method called DNA fingerprinting.

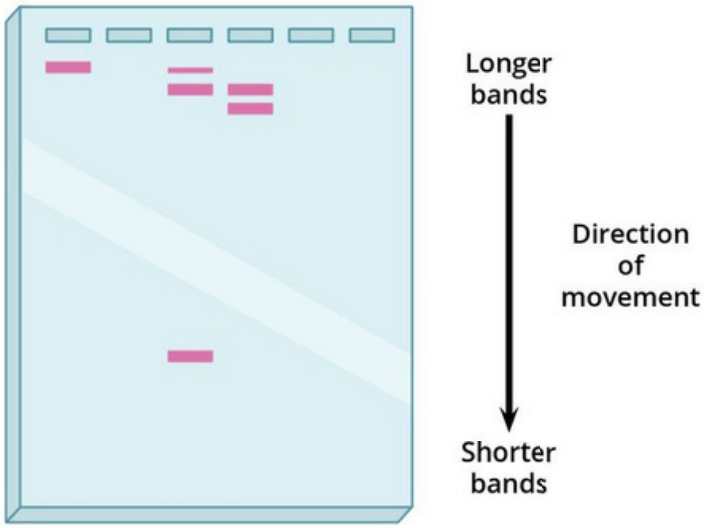
Any two animals, including humans, will have the vast majority of their DNA sequence in common, but within your DNA exist genetic clues to your heritage. Some of these clues are found in the non-coding regions of DNA where random mutations are relatively common. DNA fingerprinting is a technique used 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.

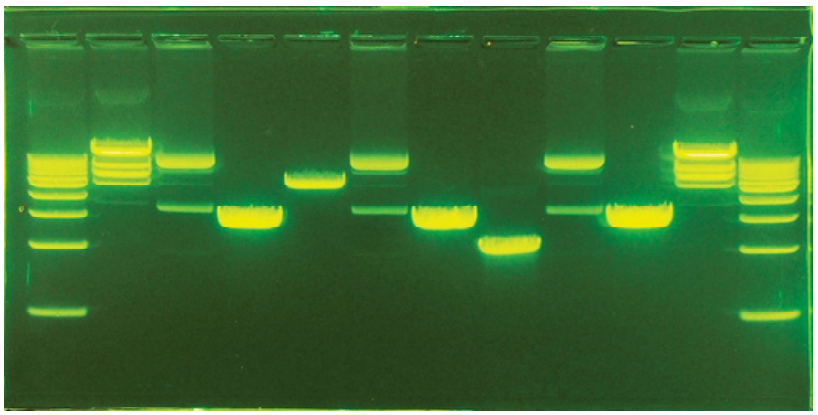
Electrophoresis is a technique used in many areas of science to analyze and separate samples by applying a constant electric field. Biologists or forensic scientists can use this technology to separate mixtures of DNA or dyes into each component based on size and electrical charge. One of the most commonly 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.





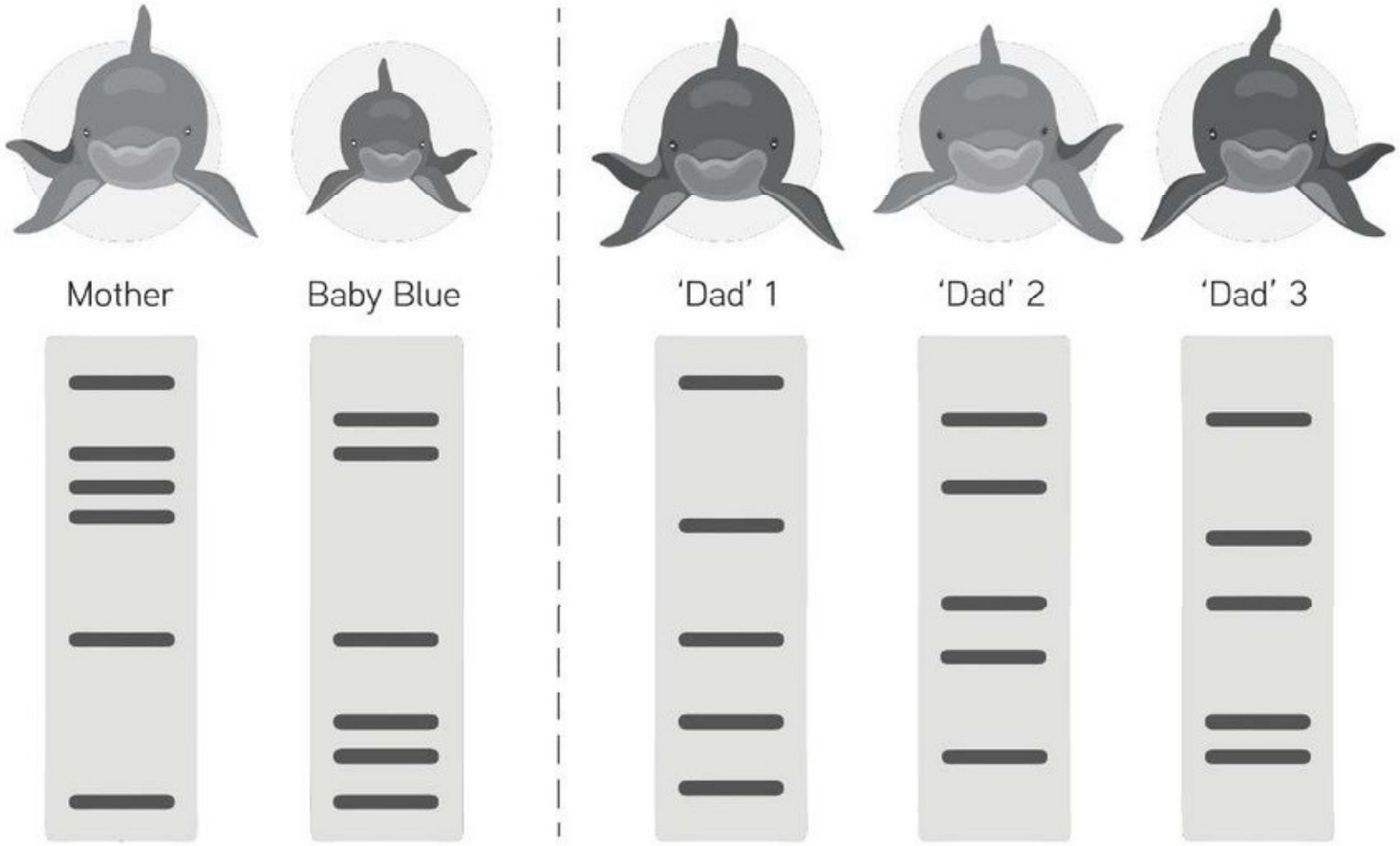
An illustration of gel electrophoresis workflow (figure made in BioRender, AnTiBiquest

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!



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?

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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.

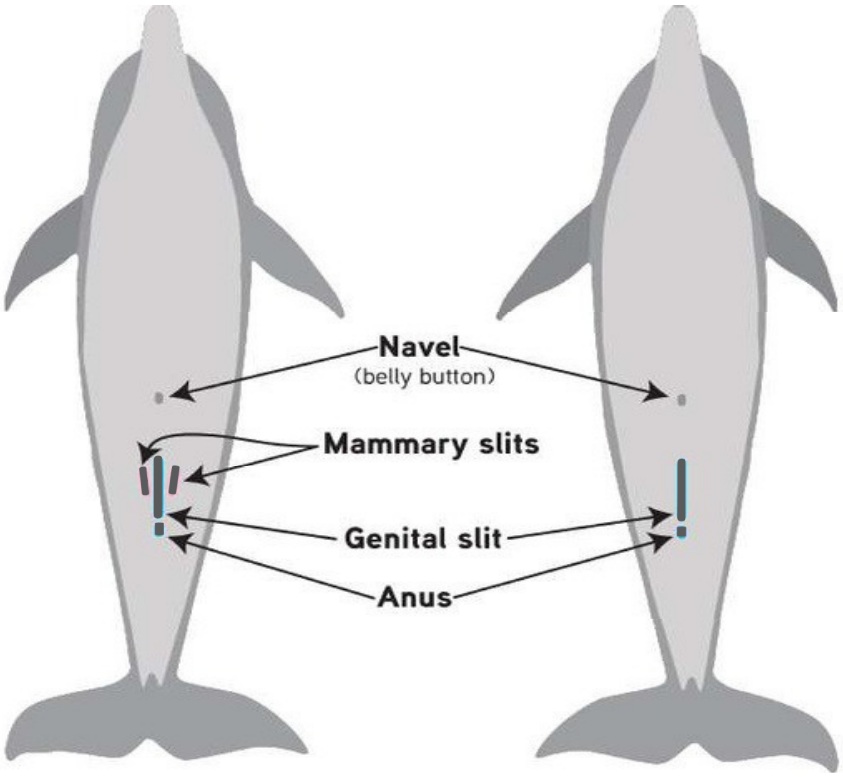
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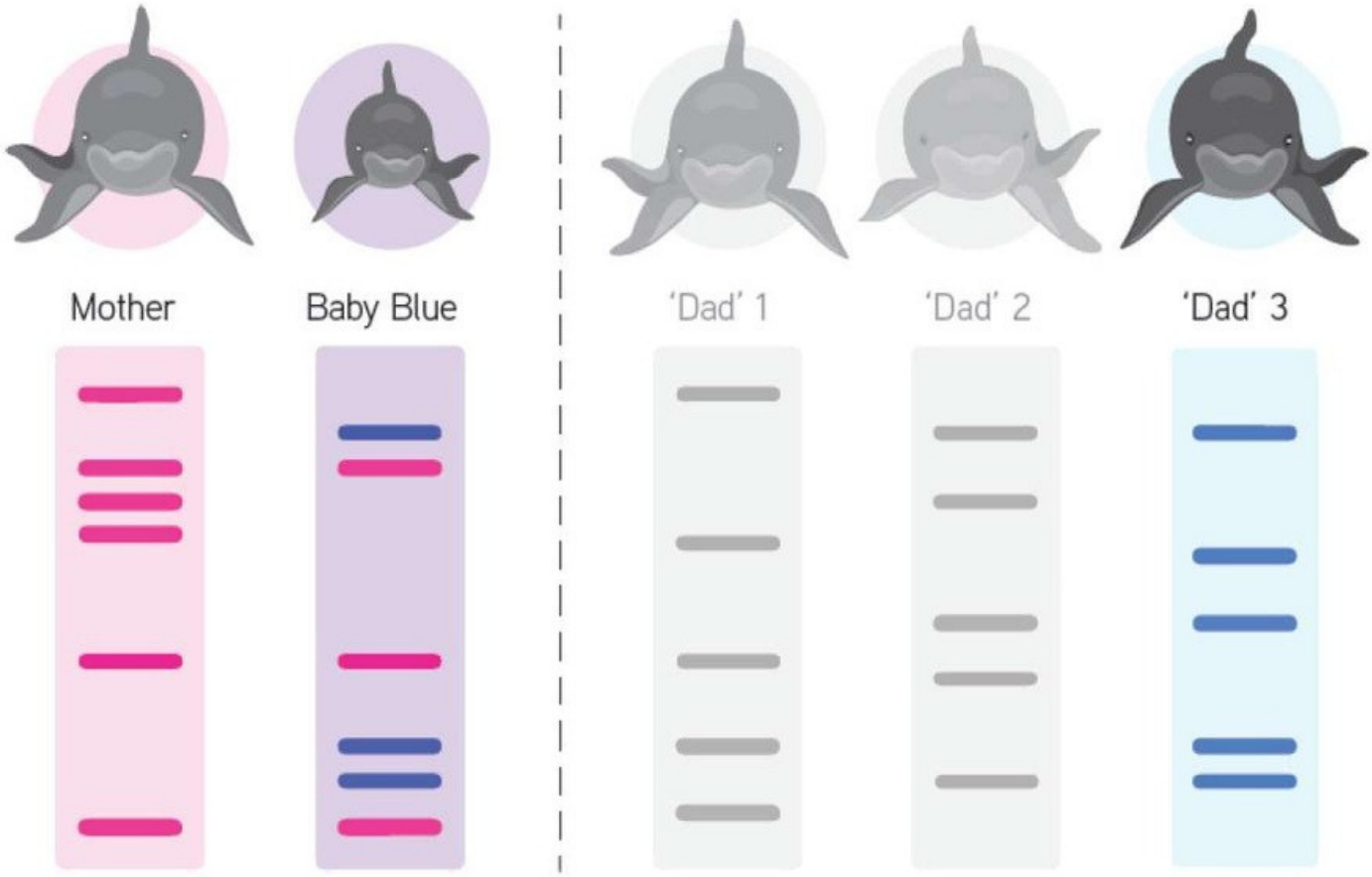
BONUS: How can you tell if a dolphin is male or female?

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

Page 10: Who's your dolphin dad?
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 ½ 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:

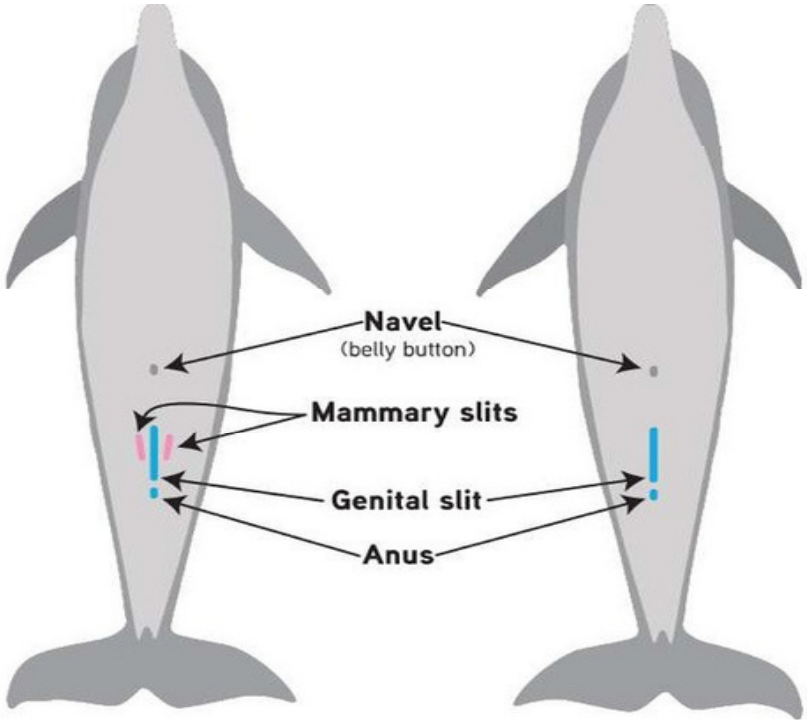
Male 1: 0-1

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:



Circle one: Male / Female

Circle one: Male / Female