Understanding Genetics

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Rustling up some DNA

Scientists use animal DNA to stop poaching

by Dr. Natalie Dye, Stanford University

You can tell where a cow has been rustled from by its brand. But what about an elephant? Or a shark?

These animals obviously aren't branded—they're wild. So how can you tell if someone has rustled them? By the brand in their DNA.

Like people, every animal's DNA is unique. As anyone who has watched CSI knows, we can catch criminals by the DNA they leave behind. But we can also catch poachers by looking at the DNA of the animals they poached.

How does this work? It is actually very similar to using human DNA to catch a criminal. What scientists do is look at an animal's DNA and compare it to animals of the same or different species. They look for differences that can tell them which animal has been taken.

In our first case, the police want to figure out from where in Africa elephants are being taken. By looking at the DNA inside tusks, they can tell where the elephant used to live. This gives them a clue for where the poachers are hiding.

In our second case, the police want to figure out which kind of shark has been killed. They do this by looking at the DNA of the shark meat and comparing it to DNA from different shark species. Who would have thought we'd want to save Jaws?

Tusk, tusk, tusk

African elephants have been hunted for a long time for their ivory tusks. So much so that now they are dying out. Between 1979 and 1987, their population was cut in half (from 1.3 million to 600,000).

In 1989, an international ban on the ivory trade was created to protect the elephants. But illegal trade continued. In 2002, the Singaporean government found 6.5 tons of illegal ivory! How is this still happening?

Scientists can use DNA to figure out from where in Africa elephants are being poached

Well, Africa is a big place, and elephants are all over it. Poachers can be anywhere, and the police can't watch the whole continent.

But what if the government was able to find out that all of the tusks were taken from the same area of Africa? Then they'd be able to focus their search on that one region. Hopefully then they would have a better chance of enforcing the law.

Well it turns out that there are now genetic tests to do just that.

Elephant tusks don't have a lot of DNA, since they are teeth after all. DNA is kept mostly in living cells. But there is a little DNA left on most elephant tusks.

And luckily, there is a method for turning a tiny amount of DNA into a whole bunch. That technique is called "Polymerase Chain Reaction" or PCR for short.

But with this technique, you don't make a copy of the entire set of DNA from an animal. You can only copy pieces of it. So you have to select the pieces to copy that are going to give you the most information.

Scientists at the University of Washington and the Fred Hutchinson Cancer Research Center have figured out which pieces of DNA to look at.

They did this by taking DNA samples from elephants all over Africa. Then they looked for regions in the DNA that varied between groups of elephants from different parts of Africa.

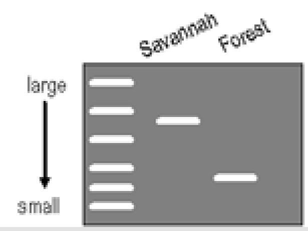
The pieces of DNA that they found to be the most different are called "microsatellites." These are short repeating units in the DNA code. The number of repeats can vary a lot between two different animals of the same species (including people*).

Remember, our DNA is made up of four letters, G, A, T, and C. Imagine the sequence ATCG.

A microsatellite is just a spot on the DNA where these 4 bases are repeated over and over. And the number of repeats varies between different individuals.

So one group of related elephants might have 2 repeats, ATGCATGC. And another might have 4 repeats, ATGCATGCATGCATGC.

Microsatellite DNA from elephants of different regions



Scientists can use PCR to quickly tell the difference between these two. When they run the reaction on these two samples, the two samples will make DNA pieces of slightly different size. This is because each sample has a different number of repeats.

We can either compare the samples by size or we can read their codes directly. By comparing the results to samples taken from known regions of Africa, we can figure out where the tusks came from.

These tests are just beginning to be used, so the jury's still out on whether they will really help law enforcement track down the elephant killers. In the mean time, scientists are trying to come up with similar tests for other threatened animals.

Another group of animals in danger is sharks. But shark fins are only illegal to trade if they came from a certain species. So instead of figuring out where the animal came from, like we did for the elephants, now we need to know what kind of animal it was. Let's find out how they do this.

* It turns out that these repeating DNA segments are also useful for determining where people have come from. Scientists use these to try to determine genetic ancestry (Click here to learn more).

More Information

- [Elephant poaching]
- [Animation about how PCR works]

Great White DNA

DNA can tell scientists which kind of shark was killed

Earlier this year, U.S. federal agents in Florida found a fishing boat that was carrying nearly a ton of shark fins.

Shark fins are a delicacy in Asia, where soup made from this meat can cost over $100 a bowl! So lots of people are trying to catch and trade sharks.

While sharks are thought to be vicious man-killers, they are actually the ones that need to be protected from man. Since there are so many people killing sharks all over the world, the population of sharks has been rapidly dwindling.

But not all shark species are in trouble. Some are more prized, so they are hunted more. Others are in trouble because they don't have babies as fast as other species. For example, some species of sharks have babies starting at the age 8, while others wait until the age 13.

Taken together, these two factors have led to many species of sharks becoming endangered. In order to protect these animals from extinction, the U.S. has made laws to protect certain species of shark, including the Great White.

If any of the shark fins found on that fishing boat in Florida were from a Great White, the owners would be in serious violation of U.S. laws.

But you can't really figure out the species of the shark just by looking at the fin. If they had the whole body, it would be possible. But many kinds of sharks have similar looking fins.

Here's where DNA comes in.

With DNA, you don't need the whole animal to figure out what species it is. In fact, you only need a small amount of flesh. We can use the same technique that I told you about in the elephant story—PCR—to make more DNA from a small sample.

So, the police in Florida gave samples of the shark fins taken from the boat to Professor Mahmood Shivji, Director of the Guy Harvey Research Institute. His task was to figure out if any of the fins were from a Great White.

Now, Dr. Shivji couldn't look at the same pieces of DNA that they used to analyze elephant tusks. He needed to pick DNA that would be different between the various shark species, not between animals of the same species.

One piece of DNA that Dr. Shivji used was called ribosomal DNA. It turns out that this piece of DNA tends to be the same between animals of the same species of shark, but different between animals of different species of shark.

Another piece of DNA he used is called the cytochrome b gene in the mitochondrial DNA.

Now that Dr. Shivji had these to sections of DNA to look at, he could read the DNA code in those pieces and see if it matched those from a Great White shark. This is just like what they did for elephants.

But Dr. Shivji wanted to find a faster, easier way. He wanted to make a test that would help the police catch more shark-hunters in the future. Something quicker than reading the code for every sample and comparing it to codes in a database.

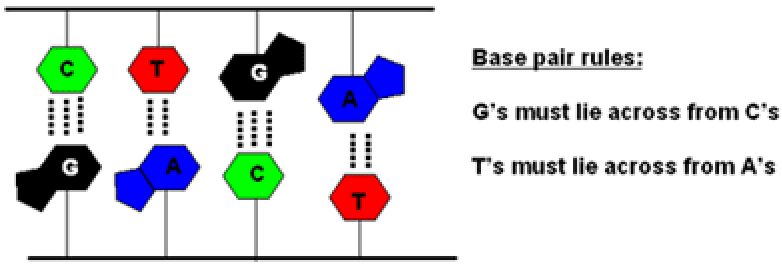
And he came up with one. To understand how this test works, we need to explain a little more about the PCR reaction.

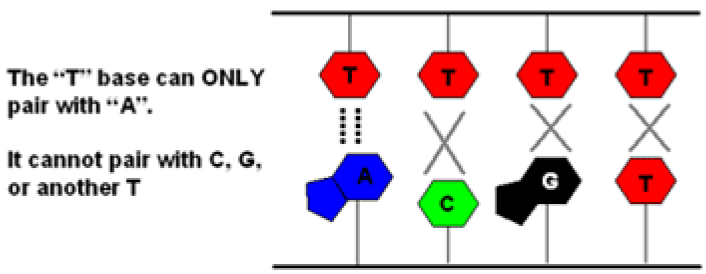
In PCR, you use a special protein called a "polymerase." It's job is to copy DNA over and over again. But first you have to tell the protein what DNA to copy by giving it starting and ending points, called "primers."

Primers are small segments of DNA that match the sample DNA. If there's a match, the polymerase is able to come in and copy the DNA that lies between the primers. If the primers don't match the target DNA, then the reaction won't work.

There is a rule for how DNA can be matched up. Remember that DNA has two strands wound up on one another in the famous "double helix." Each base within the strand has a specific partner that it must be across from.

A's must be across from T's and C's across from G's. This is because of the way the two molecules are able to fit together.

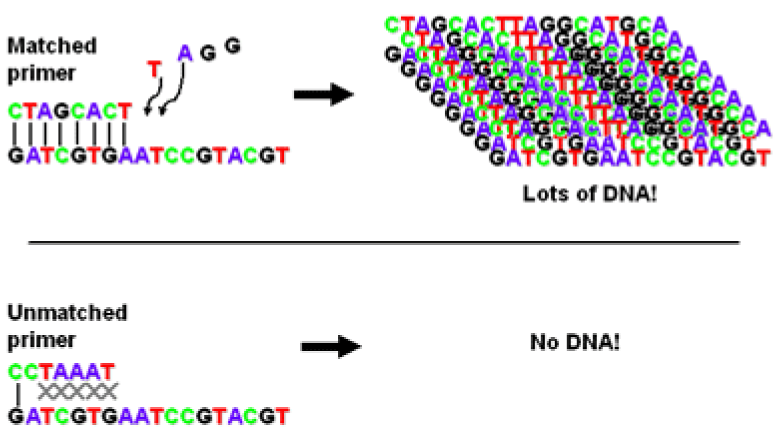




These are the only pairs that are allowed. For example, T's can ONLY pair with A's and NOT C's, G's, or other T's.

Now, during a PCR reaction, the primer has to match with one of the strands of the target DNA. Then the polymerase can come in and start copying the DNA.

Dr. Shivji took advantage of the fact that primers have to match their targets exactly. He made primers that would only match DNA from a Great White shark and not any other species of shark.



That way, when he ran the reaction on his mystery sample, he would only see DNA being made if there was Great White DNA there. If there was no DNA made at the end of the reaction, he would know that there wasn't any Great White DNA in the sample.

As any good scientist would do, he made sure the

PCR reactions from samples with or without Great White shark DNA protein was working by testing it with a set of primers that would copy any kind of shark DNA, not just Great White.

Using this technique, Dr. Shivji identified fins from a Great White shark on board the Florida vessel and federal agents were able to charge the fishermen with the crime.

More Information

- Shark poaching report from LA Times
- Shark poaching report from Science News

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The Tech Museum of Innovation 201 South Market Street San Jose, CA 95113
(408) 294-TECH info@thetech.org