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Dr. Arthur Eisenberg

University of North Texas Health Science Center at Fort Worth

Oral History Interviewee: Dr. Arthur Eisenberg

Oral History Interviewer: Jessie Milligan

we should start on your background a little bit. Tell us little bit about where you're from.

All righty. Well I'm an ex-New Yorker. I grew up in Bronx, New York, and I seemed to always have an aptitude for math and science. And in New York City, there are a couple of specialized high schools and one of them is referred to as the Bronx High School of Science. And they give tests in junior high school for those who seem to have aptitudes for math and science. I went to the Bronx High School of Science. I passed or whatever I had to do. I got into the Bronx High School of Science. I've always had a love of math and science.

And I went to college at the State University of New York at Albany. It used to be referred to as SUNY at Albany—one of the state university system in New York. My intent had always been to go to medical school to become a doctor. Seemed like that was what my parents wanted, and family wanted, and seemed to be what I wanted—at least at the time. I did fairly well in college: majored in biology, minored in chemistry.

I applied to lots of medical schools, had a number of interviews, but didn't get in my first try. (1:40) I decided that I would go back and get a master's degree in biology and then reapply. Well, that was the… I only applied once to medical school and never applied after that. I just really fell in love with doing research. I've always enjoyed, y'know, sort of mysteries and who done-its and to try and figure out who did it. And that was very much research is that you try to solve some problem, some mystery, some riddle. And I just was fascinated by doing research. What's interesting is, y'know, the field that I chose was molecular biology and my field of study was actually in plant molecular biology. So in 1984, the beginning of the year I'd completed my Ph.D. in molecular biology, plant molecular biology. And I actually sort of delayed it a little bit because I got involved in teaching at the undergraduate… I TA'd for a course, and then the professor got ill and I basically took over what was the undergraduate biology course for non-majors. It was a huge course, and I love to teach. And so I stayed probably a little longer. At Albany I got my undergraduate degree, my BS, and then I got a Masters of Science, and then I got my Ph.D. So I was sort of a lifer at Albany. It was kind of a nice little world—not the real world—being a student, being in graduate school. So I was in Albany for 11 years.

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I made lots of good friends and associates. So one of these individuals, who was a postdoc at the time when I was a graduate student at Albany… I was also a little bit of an entrepreneur. I developed some

techniques and technologies, and I'd made different things for different people at the school—sort of a side business.

What kind of things did you make?

Plasmids, and I purified plasmids, and I did constructs, inserted DNAs into these plasmids and grew it up. So it was a little business on the side for other people, and one of them was this particular postdoc. His name was Stuart Fisher. Stuart had left in 1983 and he went to a company that was originally in Westchester, New York. And I grew up the Bronx, and Westchester was very close. Sometime in the… oh it was probably the early part of 1984, when I had been finishing up my… defended my thesis and was pretty much getting done, I got a phone call from him. He was at a company originally called Optigen Corporation. And I had never heard of this corporation. It was very small. It was only about 19 people in the company at that time. And he said, "Do you want to come down and interview for a position." I said, "Sure." I mean, it was 20 minutes from where my parents lived, where I grew up, and it sounded good. And I went down. I gave a seminar, and they basically offered me a job right after the seminar was over.

And this company… there was three scientists, two MDs and a Ph.D., who had this idea. At that time in the early 1980s, there was really the first discoveries of what's called genetic polymorphisms. These are variations that exist within the human genome. Some of them were associated with disease. Really the first one was sickle cell anemia where a single base change could result in the alteration in the protein hemoglobin, which affect the shape of red cells and cause them to sickle. Well, there were these discoveries that there were other polymorphisms that existed throughout the human genome that weren't associated with any type of functional genes, and that there are lots of very different variations that could be detected at regions of DNA. So these three individuals had the idea of using these genetic variations for identity testing to distinguish individuals.

The company originally started sometime in mid-1982 and they were looking for people who could help them develop these concepts into practical tests, so to speak. So I went down there and they offered me a job and I started, I think it was, March 1st, 1984. So the rest is history.

I mean, I just… I fell in love with what I was doing. Didn't have much of a life. I mean I just threw myself into my work. In fact I had a cot in my office. I probably slept there [ha] three or four nights a week. And they wound up putting in a shower facility pretty much for me because, you know, I was living there and it would be nice to shower once in a while. So then we wound up hiring other friends from Albany.

So what I was essentially asked to do was take these sort of researchy type things and develop them into a test. In 1985, we opened up the very first DNA lab in the world for doing DNA paternity testing, and then about six months to a year later we opened up a lab to do DNA forensics testing. Actagen changed its name to Life Codes. We were really the first commercial… really the first functional entity in the world using DNA technology for human identification. And over the next, oh until 1989, when I ultimately I joined here at the University… I started November 1st, 1989, I was involved in developing a lot of the methodologies, technologies which this field started with. What's interesting is the testing that we developed the human identification. So, Lifecodes, along with a British scientist—now Sir Alec

Jeffries, really were the two entities that were sort of credited with beginning the field of application of DNA for human identification. (~8:37)

Back when you joined Optigen in 1984, it wasn't focused on solely human identification, was it?

Well, no. The idea was also using DNA technology for genetic disease, genetic diagnostics. In fact, we had a clinical diagnostics lab. I had developed some tests for doing identification of leukemia, lymphoma, other genetic diseases. We had a cytogenetic lab. So in addition… I mean, the original primary focus was for human identification, but the applications of molecular biology and DNA technology for genetic disease diagnostics. I mean, that's really when the main boom… y'know, people understood the significance of trying to identify genetic diseases and DNA technology. The technique back then was really referred to as southern blotting. It used radioactive DNA probes, and none of that exists anymore. Basically no one uses those techniques—certainly in the field of human identification, we've moved well beyond that in the last 25 years.

A year after you started at Actagen that Sir Allen Jeffries coined the term 'DNA fingerprinting' and the focus rapidly started to change.

Right. You know there were no operational labs in any states. The FBI didn't have a laboratory. In fact, y'know, the FBI sent, at the time, one of their lead scientists, Dr. Bruce Budowle. He and I just instantly bonded. I think we first met in 1986 or the end of '85, and it took me, y'know, more than 25 years to finally convince him to leave the FBI and come join here the University. He was the lead scientist and became their chief biological scientist who helped develop their DNA program at the FBI. So in the early years we worked very closely in helping the FBI develop their DNA program. And they're one of the largest, certainly in the world, in terms of DNA laboratories.

What was tremendous is that it's still a relatively small field. And even though there's been lots of younger, newer people, there's still a group of us who are sort of the old-timers, so to speak. Y'know, we see each other frequently at meetings. It's just become like a family. We all try to work together, support each other, and help advance the field, and try to make sure that what we're doing is the best possible science, the most reliable techniques, technologies, applied for the field of human identification.

What was it about Lifecodes?

Well you know, we were a young bunch of scientists who just fell in love with this idea of helping to develop a technology that could do good—help solve some the most heinous crimes in the world. And y'know, we were being paid certainly very well for the time. By now it's pretty miniscule, but it wasn't about the money. It was about this quest, this challenge to try and take a technology and mold it and develop these tests for forensics, for familial testing, parentage, and also could be used for looking at bone marrow engraftment studies—where people had to have their own marrow, their own stem cells

killed because of disease, then replaced, then you could monitor and see whose cells are actually growing: the donor or the recipient's own cells had they not been completely eradicated.

So the technology was applicable for a number of different arenas. So I think it was the thrill of being part of something, and helping to develop something that ultimately now is used throughout the world. I don't think we thought that far back in the '80s. It was just that we were just so excited about this opportunity to be part of something that now you can't turn on the TV, or you can't open up a newspaper, or any kind of talk show where it's not being applied for something.

Absolutely. What was it like back then? There was Cellmark and ICI…

Well Cellmark actually sprung up… The people who started Cellmark were originally supposed to come work at Lifecodes and then they didn't show up, and then Cellmark sprung up. They were sort of an offshoot from, to some extent from, Lifecodes.

Was there like a race, sense that kind of competition?

No, I don't think that… Y'know, we never. I certainly didn't sense any competition or a race to be the first, or this or that. It was just, what could we do to take this technology and develop the best that we could in terms sense of sensitivity, reliability. It was more personal challenges than any type of competitive… I mean we knew that the potential for this was so big that there couldn't simply be one organization, one group doing it. I think with some the original principal owners of the company thought that they could monopolize it, license it, and things like that. But it just became too big. Once we, y'know… places like the FBI and public sector laboratories began to do the testing, I mean we were selling… I was making reagents and materials, and I became a little manufacturer too. But we knew that once it caught on, and we certainly believed that it was going to catch on and just spread, that there couldn't be one group controlling it.

Let's talk a little bit about the impact on criminal justice and how science has helped change the whole of the criminal justice system. You've essentially replaced Sherlock Holmes, in so many ways.

Well, I haven't seen the second version of Sherlock Holmes. I'm trying to get to see the second version of Sherlock Holmes. I still love the idea of the who done-it, and the mystery, and the role that DNA technology can play and certainly trying to solve cases that previously could never be solved without the DNA technology.

Can you go over for us some the changes you've seen in the sciences?

Clearly one of the keystone developments was really the development and application of what's referred to as PCR, polymerase chain reaction, the idea of being able to amplify small regions of DNA. So you could start off with very small amounts of genetic material, DNA, amplify those regions of interest and now be able to develop a profile where previously… when we first started this technology, as you indicated, we needed considerably more amounts of genetic material. Back in those days for a reference sample, we take a venipuncture. We take a tube of blood. Now we wouldn't use that much of it, but it was still based upon a collection of a blood sample. Nowadays, the reference samples—you

simply do a buccal swab. You rub the inside of the cheek, and that's more than a sufficient amount of DNA to do hundreds and hundreds of tests. And that was all made possible by the development of this technology, PCR, polymerase chain reaction, which the inventor Kerry Mullis was actually… won a Nobel Prize for this technique.

So this… we first started doing the testing, really the first criminal case in the United States were '85, '86. Dr. Bob Shaler joined Lifecodes. Bob was a crime lab director, originally part of the Medical Examiner's Office in New York City, and he joined Life Technologies, I mean, Lifecodes. He had the real forensic background. We were all basically molecular biologists. So we learned about, really from him, the field of forensics. In fact, what happened was that towards 1988, '89, Bob was asked to come back to the Medical Examiner's Office in New York City and start the DNA lab for the City of New York. And he in fact asked me to essentially go with him and start the DNA section. I was going to do that until I met a woman who lived in Irving, Texas, and sort of fell in love, and came to visit her here, and where we were looking... We got engaged. She actually relocated to New York, and we started looking for places to live. And even back in the late 1980s, living in New York City was outrageously expensive. For a two-bedroom sort of small condo was, y'know, $150,000, where in this area back then you could buy huge home. It was a lot slower and nicer lifestyle than the hustle and the bustle of New York City. So, that's when I made a decision. I was getting offers here. The University, Texas College of Osteopathic Medicine, had been given a bunch of money by Gib Lewis, who was the Speaker of the House in Texas at the time. He had donated, well done legislature that provided money to the school to start a laboratory for the Attorney General's Office Office of Child Support Enforcement. So they had been looking around. Dr. Putthoff, whose the chairman of the Department of Pathology, and Dennis Shingleton who was sort of the business manager were looking for somebody to start this lab and my name had come up a couple of times. It just so happened that I'd been to Texas a number of times. And they wanted me to come here and I wanted to come here and the rest is history, so to speak. So, all for love of good woman, I relocated to Texas.

What were some of the major changes here over the past 20 years? Did it start with the Texas Missing Persons Database?

Well, actually that was later on. Really, I got here in November of, November 1st, 1989 and the first challenge was really… in the State of Texas at the time, there were probably a couple of dozen labs doing paternity testing for the Attorney General's Office of Child Support Enforcement Division—which is the largest component of the Attorney General's Office. And the cost of the test was all over the place. There was really no one laboratory standardized… and each area was doing their own thing within Texas. So, the first challenge was actually to get an operational laboratory here at the Health Science Center—well it wasn't a Health Science Center then, it was the Texas College of Osteopathic Medicine. So they had given me some space, and I had to go through and order all the equipment. And with state purchasing, it took a bunch of time in order to get everything in and operational. So during that interim period, my buddy Dr. Budowle said "come on down to the FBI." He was in charge of the R&D division. …And work there while things were getting delivered. And I'd come back-and-forth and get things set up. So that's how the lab became operational, and my work with the FBI. So the very first cases we did

for the AG's Office was in May of 1990. It was in San Antonio, and so we started doing the DNA paternity testing for the state. We did that for the state for more than 20 years.

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So that's where it began was paternity testing here. Now at the same time, part of what my challenge was, what I was asked to do since I had a hand in starting a number of, and training quite a few people in the DNA technology for forensics: I was asked to work with the DPS lab here in Tarrant County, with the Tarrant County Medical Examiner's Office, Fort Worth PD and other DNA, or other crime labs, forensic crime labs throughout the state to try and help them develop the forensic DNA technologies. So I did that for quite a few years, I was sort of the go to guy. And I helped all these different labs, the DPS become operational, and everyone realized that forensic testing would require a DNA laboratory. You know, all of the other disciplines certainly are very important, but when it came to biological material that serology, which was the state-of-the-art prior to DNA, was limited in terms of sensitivity, degradation and really individualization. You couldn't essentially individualize someone based upon a biological sample prior to the DNA technology. We started a consortium of DNA forensic labs within the state, we'd all get together and we'd exchange information and data and I'd review things for other laboratories, and I go and help testify to support them since at that time I had been in the field really since its inception. So we developed a very strong cohesive group of forensic labs throughout the State of Texas and even to this day. Here we're an adjunct lab for the DPS. We're a State Medical School now. By state law we're considered a criminal justice agency. We still do technologies that the DPS doesn't do and virtually no other labs in the State of Texas do. So we provide these services throughout the State of Texas again at no charge. So we are still sort of a hub. And even though the DPS is now huge system—they probably have at least maybe seven or eight operational labs throughout the state, we still work to support them and interact very closely with DPS.

We still interact with other crime labs throughout the state, whatever we can do. …Certainly law enforcement agencies. There's such a demand for DNA testing. There's backlogs that exist. We try and help reduce those backlogs and support agencies that may have rush cases, things that maybe we can get to a little quicker.

At the Health Science Center, but it was before it was the Health Science Center, you started of paternity testing.

Right. Back then it was the Department Pathology. So I was… And the Department of Pathology was part of the Medical School. So about for 20 years of my life here, I was part of the Medical School under the Texas College of Osteopathic Medicine. So there's been so many changes in names. The Department of Pathology merged with the Department of Anatomy, so then it was Pathology and Anatomy. And then it split back out and then it was Pathology. And then it became Pathology and Human Identification because we were very active. We were generating lot of funds. We had our, sort of our, own identity within the Department of Pathology, so it became, Pathology and Human Identification. Then Cell Biology and Anatomy became a separate department which was part of the graduate school. And then

the Department of Pathology started to…. There were very few faculty left. And ultimately we were sort of traded to the Graduate School and we became our own department of Forensics and Investigative Genetics. So there's been a very long history of name changes and changing schools. And today we're one of the departments, five departments, within the Graduate School of Biomedical Sciences. We're still the smallest department but we've been very successful in terms of obtaining federal grants and funds and generating revenue. So I think the graduate school, I think is pretty happy to have us.

What are some of the more significant cases that you've worked on that have either contributed most to science or have hit you emotionally?

Well, probably… Well there have been a number of different forensic cases over the years that have had a lot of significance. One of the ones that I will never forget is when… it was a case in the really early 1990s where an individual had killed a number of people and by some technicality he only served about less than 10 years of his sentence. He had gotten out and he moved in with a woman who had a young child, and he raped this child; She was an 11-year-old girl, and impregnated her. So here you have a baby pregnant with a baby. The mother found out and she was going go to the police and this individual tried to stop her. He came back with the shotgun and looking to kill the mother and the girl. And the mother wasn't there, but he killed this 11-year-old girl and her two aunts that were there at the time. And this was a case… The autopsy and the work was done by the Tarrant County Medical Examiner's Office and when they autopsied this 11-year-old girl, they saw her fetus. We showed, proved that this individual was the father of this fetus. The jury deliberated for, I think it was one the fastest murder convictions and death penalties on record. I mean, I think the jury was out long enough just so that they could finish their coffee and donuts. It was such a horrendous, horrific case that has always stuck in my mind.

But then one of the things we were involved with because of our expertise in doing relationship testing was when the World Trade Center occurred. Having grown up in New York and having been in those buildings many, many times.

So the Department of Justice convened a panel of experts to support the OCME's office and Medical Examiner's Office in New York City, and also the state police were involved. A number of us who were appointed to that panel actually now work here. I've been able to sort of bring my friends as part of this group. A number us back then were involved in working with them to try and apply technologies, apply statistical analysis to try and identify as many of the victims from the World Trade Center incident as possible. Sometime after the World Trade Center, we… In 2004, Congress had appropriated a very large amount of money for DNA forensic testing throughout the United States. That was really was one of the major jumps… Well, let me just go back little bit. In 1994, at that time, Congress passed this overhaul of what we call the crime bill—overall the federal laws related to crime. Part of what was in that crime bill was called, 'the DNA Identification Act.' And in this act, there was a lot of money, at the time, that became available for laboratories who were getting involved in DNA testing. Part of that was also, Congress gave the authority to the FBI to establish an advisory board to help develop national standards for using DNA technology. Towards the beginning of the 1990s, late 1980s, the FBI had put together a

group of scientists, a group of states that were getting involved, and formed what was called TWGDAM, which was Technical Working Group in DNA Analysis Methods. And I was asked to be part of that so we had helped. There was about 20 of us that had helped develop these guidelines. Well, when Congress passed this DNA Identification Act, they actually wanted national standards. A panel of individuals, this DNA advisory board, was put together try and establish or make recommendations to the director who had the authority from Congress to actually establish these national standards. So I was originally appointed to this committee as an expertise in molecular biology. What was really neat was my sister, who had sort of followed me in my career, she was also appointed to this committee, this DNA advisory board. The first chair was a Nobel Laureate, Dr. Joshua Lederberg, and after a couple years he elected to retire and I was appointed as the chair of the DNA advisory board. So that was certainly something in my past that I'm pretty proud of. In fact being on it with my sister made it that much more special. And again several of the people who were on that advisory board, Dr. Ranajit Chakraborty, Dr. Bruce Budowle—we're all here. So it doesn't get any better than when you get to you do good things, and do it with your friends. That was pretty amazing.

So jumping to the World Trade Center. Then in 2004, there was another large pot of money available. Also, the State of Texas decided to start this Texas Missing Persons DNA Database, and we were essentially appointed to do this by the Texas Legislature, and that occurred in 2001. We were tasked with being operational by the beginning of 2003—which we were. And we were really the first state laboratory dedicated to the missing and unidentified. It wasn't really a race, but California and Texas were really the two states that introduced this being the two largest states. California being the largest state in the country, and then Texas being the second-largest. So we became operational in using the DNA technology for identification of missing persons in human remains. So in 2004, there was a lot of money provided by Congress. That was sort of the beginning of the president's DNA initiative at the time to try and really fund DNA labs to start addressing these huge amounts of backlogged sexual assault cases and crimes where the DNA technology could be very useful. So there was a smaller pot of money—although for us very large—dedicated for missing persons and human, identification of human remains, and we were the only initial recipient of those funds, and have continued to get substantial funding for the identification of human remains and missing persons. We originally started off as the Texas Missing Persons DNA lab and we've now morphed into the, what we now call, the UNT Center for Human Identification. Along with the FBI, we're the two national entities performing this testing throughout the country. Not only do we do it for Texas, but we've done testing in probably 49 of the 50 states, and thousands of the law enforcement agencies, medical examiners, and coroners throughout the country.

Regarding the World Trade Center attack, was UNTHSC involved in identification of any remains?

We weren't involved at all in the identification or involved in any of the testing but we really served in an advisory capacity but we really helping standardized analyses and recommended the correct statistical methodologies and thresholds.

Really, our first sort of disasters, that we got involved in, you know, Katrina. We were operational as a missing persons laboratory funded through the federal government. When Katrina occurred, we had kits, and we reached out to Louisiana State police and the New Orleans to try to help them. There were several hundred bodies that because of the flooding they drowned and bodies began to decompose and bloated made visual identification difficult. We were not utilized as much as we would've hoped, but Louisiana and New Orleans wanted to try and control it and do everything themselves. So they had to start doing things from scratch, which delayed a lot of the investigations we did play a role in Mississippi where there were again some fatalities is a lot of a lot of because of some the flooding a lot of cemeteries bodies were essentially is separated from gravestones and we would help to try re-identify so the remains can be properly reburied but we did play a role in making a number of identifications and Katrina. That was really the first natural disaster.

Although, we did make some identifications in Oklahoma City bombing. There was sort of a day care center and there were a number babies that were killed and then we are heavily involved in helping to identify the remains so that so they could be properly buried.

So those were some, obviously, some the, I don't want to use the word memorable, terms of catastrophic types of things we were able to use the technology for. More recently a number of countries have reached out to help them. We've had a very large project with the Chilean government trying to help identify victims of their late dictator Pinochet. When he assumed power, there were thousands and thousands, of mostly men, who were murdered and bodies scattered in mass graves and things like that. So we've been involved and received a probably approaching about 200 different sets of remains. We have successfully helped work with them to identify, well over120, 130 at this point.

Some other events that throughout the country where the technology has been used but really our Forensic effort has been concentrated in the DFW area although we do a lot of cases with throughout the state of Texas. I think when you count it up, I think we've done cases within about 25% of the counties in Texas, is there's over 250 counties in Texas so we have had a hand in working with many different agencies throughout Texas and throughout the United States and got involved a lots of cases. Early on, one of the major cases was working with Seattle, King County in terms of trying to identify victims of the Green River Killer who was believed to be the largest serial killer in the United States history. Ultimately he was found. He'd murdered young women; many of them were prostitutes over 20-30 years' time frame until he was caught. I think he was tried and convicted of either 47 or 49 murders. Yet, when the FBI behavioral unit actually started talking with him, he had no idea how many women he killed; it could have been double, triple that amount over that period of time. It just became common for him to just murder these young women.

Even after he was caught, the King county sheriff Department still had files of missing women. We were working with them and they went back to these families and asked them have their loved one ever shown up and if they didn't they were given the opportunity to provide reference samples which we were processing with our federal grants at no charge and putting them in the national databases for

missing persons. Even today, we're probably the single largest contributor in the United States to the DNA databases specifically for the missing and unidentified.

We worked with the FBI in developing the next generation software. The overall database is called CODIS: the Combined DNA Indexing System. There are multiple databases within CoDIS and what most people are familiar with is the databases of individuals who have been convicted of crimes who are required to provide DNA sample by law through. Every state has enacted laws requiring this. There is probably about 10 million, we call them offender samples in the databases. Probably approaching 400,000 samples from different crime scenes so those are the two databases that most people probably know. Half the states have passed laws that allow the collection of a known DNA samples from people who are arrested, arrestee database; the same way when a person is arrested they take fingerprints now states are passing laws that allow the DNA samples from those who have been arrested and not yet convicted.

There are three other databases that we are the predominant contributors to. That's the databases made up from the DNA profiles from human remains. The family members of missing loved one biological family, the biological parents, biological children, brothers or sisters, siblings who set of samples are being used to compare to the remains. There's a third database as part of the missing which is a direct reference sample, which is a sample from the missing person. They may have saved …they may have a baby's tooth or a biopsy sample that could be located. All of us have, or at least since sometime in the 1970s, a heel stick done at birth a number of genetic tests are done, like a PKU test (Phenylketonuria) and people are more familiar with a PKU type biochemical test. Now every state has certain battery of tests, some biochemical, some DNA based, that try to identify certain diseases that if treated or dietary restrictions are applied, these babies can develop normal healthy lives where if not may be fatal and certainly very debilitating. So those kind of reference samples, if they're stored properly if they can be found, catalogued, they could be used as a direct reference sample our lab here UNT center for human identification is the single largest contributor to those three databases relative to remains and family reference samples.

Highlight some of the big things about the Center for Human Identification – the things that make it unique and are nowhere else.

We haven't talked about our DNA-ProKids program for human trafficking and there are a number of other activities like the center for forensic excellence our international training program. So there are a lot of events that within the last couple of years which I think have added value not only for the state of Texas but also nationally and internationally.

What's your current research and what are you trying to solve?

We're always trying to develop technologies. We do a lot of applied research and development. Applied meaning we want to move it into an operational case working labs to make us better that allow us to work with highly compromised, smaller types of samples.

46:00

One of the lessons learned from the World Trade Center was that the fires had been burning for such a long period of time. DNA can be degraded to a point, where using current technologies we can't get any results or is just too small an amount of sample. So those are the type of areas that certainly we do a lot of research and development, those two. So how can we work with more compromised, smaller, quantities of samples trying to obtain as much genetic information as humanly possible? That's always been a key focus of our R&D, is technologies and trying to develop the right conditions to obtain, you know, sufficient amounts of genetic information so that we can make these comparisons. That the main focal points. We're also looking at different genetic systems the types of DNA markers that we've looked at have evolved from what we've originally did in the 1980s and early 1990s to what now we call the short tandem repeats, these small repeating blocks of DNA. The analogy that we always use its court and it still holds true is that we are looking at the fragment lengths are different length per pieces of DNA in each length represents different particular variation. If you think of a railroad train, each train starts with an engine and ends in a caboose but the length of the train depends on the number railroad cars between the engine and the caboose. If you had five cars it would be an allele five or five car variation. Six cars and it's a six car variation.

48:00

Well, again, that technology has now existed relative to all our ability to get genetic results for more than 15 years, so we're looking at some of the other types of variations, we call single nucleotide polymorphisms. Where a Single base change... you know the alphabet for DNA is made of four letters, where the English alphabet is made up of 26, so those four letters, A, C, T, and G form all the words of the genetic information that makes us what we are. And now we've started to look at individual letters and were looking at the variation. Although, one would think that if you only had maybe four different of types of variation it's not that informative, but if you find enough of these regions we can literally distinguish any two people. So we're looking at other types of variations that again can simplify and hopefully provide increased sensitivity, increased power of discrimination. We're looking at one of the, Dr. Budowle is very interested in what we call pharmacogenomics, that is variations within certain key genes that may be involved in drug metabolism. There's so many these drugs are introduced. They're now doing large population studies because the effect of the drug may be great for me and help save me, but that same drug may potentially may kill you because a certain genetic variations were you over metabolize over metabolize a particular drug, it could become lethal. So that's also to some extent involved in cause and manner of death and still sort of the forensic mindset but also applying it to the idea of pharmacology, drugs. And which, again the school has one of the strongest and largest departments is pharmacology and neuroscience, Alzheimer's, aging. We're now getting the school pharmacy here so this idea of the pharmacogenetics and molecular biology applied to why and how drugs are metabolized is an area of research that our Department wants to get much more actively involved in.

Dr. Budowle, while he was at the FBI, also played a large hand in coordinating different three and four letter government entities in biodefense, biosecurity, the idea that microorganisms can be manipulated to become a weapon and so he's involved in things like that.

50:00

One area is that we are funded we get funded from the state is in the form tick-borne diseases. Texas being very outdoor population there's hunters and there are these ticks. These ticks can have any number of diseases where if they go undiagnosed they could be very debilitating and potentially lethal so are trying to develop technologies, we do a lot of work for the Texas State Department of Health Services using molecular techniques to identify some of these bacterial pathogens that can be transmitted through tick bite. So we been doing that for people within Texas any ticks that are found on people Texas health services sends to us on for molecular analysis so we continue to do a lot of research and testing in that regard.

Some the more futuristic things… we are now learning that there are DNA genes that that help to determine physical phenotypic features, what we can see. Genes for red hair, genes that determine eye color and skin color and distances between the nose and ear and whether you have attached or detached earlobes. In terms of human identification, we deal with a lot of skeletal remains. Sometimes we get skulls where we work with forensics artists to try doing facial reconstruction. Well now, we're trying to use genetic information to supplement some of the features of a skull to provide better quality facial reconstructions. Can we tell the color the hair was? Anything about the shape of the face? Well, we know just intuitively that there are genetic variations that affect physical facial features. Why? Identical twins look identical; it's not an accident. They have the same genetic makeup and so on. We're starting to learn and work and understand that so we can start applying some of those genetic tools to help better identify individuals. What happens if we don't get the skull we get a leg bone or arm bone or something? Can we provide any information? Did that person have blue eyes and brown hair? Things like that just from information that's stored within any DNA that we can recover. Anything about skin tone, skin color.

So those are some futuristic things technology is we're always trying to make the tests faster cheaper more reliable. So that's always going to be a very large component of our research and development is to try and provide, not only law enforcement, but families with a missing loved one, the very best tools to help them answer a question. That's still part of the being a scientist, and being a teacher. We try to convey information, in terms of missing identified it's usually the worst-case scenarios that their loved one is dead, but you know. Even with that, the hope is that the families that have gone 10-20-30-40 years have gone without knowing, at least now, they know, maybe that can help them move past the grief and things like that. So that's a lot of what we're doing today and certainly into the future.

What's your advice for students?

I think we have probably one of the best graduate programs in the country, in the world in terms of forensic genetics. We have a program, a Masters of professional, a professional master's program we've trained a lot of analysts have gone, we sort of keep the best-and we then send the rest out throughout the country, throughout the state and sort of incestial inbreeding, but it's worked so well to help us grow our laboratory. We know the quality of these students and they're hired throughout the state and throughout the country.

Unfortunately, joking around with friends and family, I always say that so I have pretty good job security because there's always going to be crime and there's always going to be a need for this type of testing. I think the job prospects are still very good and I don't think that the field has been saturated. There's going to have to be a lot of people who are going to replace us old dinosaurs and when we become extinct in our bones are dug up. I think it's a challenging field and people need to understand that you deal with the worst and the best a society.

We learn what the legal system is truly like; it's truly an adversarial type situation. When you go in and to testify, your past even, as a forensic analyst testifying, they could bring up anything about your education, "Well, he got a D in the course? How do we know that your work is reliable if you got a D in calculus 20 years ago?" You have to be meticulous; you have to be honest. Its challenging and you would hope, that it's just black and white, but there are lots of shades of gray in our legal system which is truly an adversarial type situation. Really most of us would hope that was that it was always the search for the truth, but that is often not the case when you have to testify. We try to prepare our students that for that.

We actually have a course in expert witness testimony and where we put them through moot courts. And we're tough on the students because we'd rather them learn what it is today than when they actually get on the stand for the first time. You know if you make mistakes or you testify improperly and that could come back to haunt you throughout your career. It's important to have that very strong educational training and that's what we provide here. We certainly train individuals who want to become more research scientists. We're pretty proud of our educational training program.

Now, because of interactions with companies and so forth we've been able to develop, with an award from Life Technologies, a Center for Forensic Excellence, which is now an international training program (we also use it for our students). Idea is that the expansion of these DNA databases worldwide is just exponentially growing and the real limitation is qualified trained people. And they've given us equipment, materials, reagents and money to hire people, to establish, you know, a state-of-the-art international training program so we can help other countries grow and expand their databases to keep up with the demand and the need. So that's been a tremendous boon. Our interaction with Life Technologies, which not only is the leading manufacturer of a reagents and materials, they are now helping sponsor this training program to help increase the utilization and demand that been unmet before with the international expansion.

One other application I really want to talk about is the program that we've been privileged to get involved in. It's a program actually started by a very close friend of mine at the University of Granada, Doctor Jose Lorente. He started the program a number years ago called DNA-ProKids. DNA-ProKids was started with the idea of using the same DNA technology we use to solve rapes, murders, burglaries, but now applying that technology to try to help reunite children who have been kidnapped, that have been victims of human trafficking throughout the world. Most people probably don't realize the impact of human trafficking, child trafficking. Human trafficking now recognized assist single largest crime throughout the world.

Literally millions of young women, children who are trafficked each year. And we think we're immune here in the United States, but there's probably hundreds of thousands of active human trafficking involved in prostitution and forced labor that exist here in the United States. You're either a country of where children and women are trafficked from or you're sort of an intermediary country are trafficked through or your destination country where women and children who were kidnapped are sold. Most of industrial countries are the destinations countries, in terms of Western Europe, United States, Japan, Australia; you know there's sort of this insatiable demand for these things.

Texas is probably the portal between into the United States, not probably, is the portal to the United States for women and children coming from South America, Central America through Mexico. You hear about drug trafficking into the United States but not human trafficking. It goes hand-in-hand: arms trafficking, human trafficking coming up through Mexico across the boarders into Texas. We're very actively involved in and helping these countries. Again through the Life Technologies foundation we received almost $1 million in money and reagents and materials to try and not only provide the services, if the countries don't have the ability to do their own testing, between the University of Granada and here providing analysis of samples and helping other countries to develop the capability to test their own samples. So we've been concentrating primarily here in terms of South America Central America and Mexico and the United States. In Southeast Asia, DNA-ProKids has MOU (Memorandum of Understanding) with Thailand, Philippines Indonesia, Sri Lanka, Nepal, Malaysia there sort of a crossroads country along with Indonesia, where once you go through these countries you can go anyplace in the world. It's an amazing program that we've been fortunate to partner with the University of Granada.

How does DNA help in human trafficking?

The idea is to the establish in these countries two databases: One for the parents whose had children disappeared, kidnapped and another database where the children who are found on the streets or rescued from these forced prostitution rings or slave labor type camps, these sweatshops, where children are working 15 hour days essentially for no money. They've either forgotten, or they don't know where they came from certainly babies have been kidnapped and sold for illegal adoptions. The idea is that we have these databases and we can make comparisons and hopefully reunite children with their parents. Now they're certainly cases where parents are just selling the children. We've been able to identify the mother who is becoming pregnant just to sell her children, where you get multiple

children associated with the same mother and things like that. According to the United Nations, human trafficking affects every country in the world. Every country has signed a declaration. The United Nations have a program called UN GIFT United Nations global Initiative to Fight Trafficking and it's under their office of Drug and Crimes. The U.S. State Department is one of the major players in trying to identify countries and try to put pressure on countries to try and do something about human trafficking. We're hoping that DNA-ProKids can be a tool that can be used to… you know it's never going to stop, the best one could ever hope to it is for is to slow down. and then to show that these traffickers using DNA technology there's always associate children with families and find the routes and hopefully identify the traffickers so maybe it can be slowed or deterred.

How are direct reference samples, like a baby tooth, stored properly?

Many years ago we actually started, in fact in Florida and in certain school districts. The DNA technology on the things we helped developed… In terms of direct reference samples you can take a little tiny finger stick and put it on a piece of paper, and allow it to dry, as long as it kept relatively low humidity and now with the technologies the samples can be available to test almost indefinitely. A buccal swab sample, part of the problem is that everyone's mouth has a certain amounts of bacteria so if you dry that sample properly, and keep the humidity, temperature under control even those kinds of samples can lasts very long. Teeth are good but not the best. Sometimes, certainly most baby teeth haven't had any dental work done but certainly, you wouldn't want a tooth that had a cavity and you drill out that's actually the pulp where the cells are. Hair: Shed hair has very little value but a plucked hair actually contain the follicle the cells that secrete the protein, the hair. So if you had a plucked hair.

We have an archivist who wants to know how to archive DNA.

We helped work with these specialized types of papers that have inhibitors of DNA degradation. So if you could put a finger stick or some cells you collect on a swab, touch them to this paper and you could store them indefinitely. You don't want to put them in freezers. I mean most home freezers there's one of promises is that they are frost free. They have a cycle. How do you get rid of the Frost? Well, you warm it up. That freezing and warming can break down DNA samples so you don't necessarily want store them and freezers. As long as they're stored relatively dry on low humidity and the temperature's fluctuating greatly will be available almost indefinitely.

You just want to keep away from basic atmospheric gases. Acidity is essentially in terms of the atmosphere and gas. Acid will depurinate, chop up DNA. This paper that this Australian scientist originally developed, and we had a hand in making a functional thing has bases that buffers, that neutralize and prevents oxidative damage and depurination and acid damage and inhibit nucleolus and DNases that could destroy DNA. It's the same cotton card where there's a series of chemicals that are impregnated in the in the paper so biological samples can be preserved.

In summary, what makes the UNT Health Science Center unique?

In terms of things that make us unique or specialized you probably have the strongest collection of forensics DNA experts certainly with Dr. Bruce Budowle, Dr. Ranjit Chakraborty, myself, Dr. Rhonda Roby. Rhonda had a hand in developing the armed forces DNA Identification laboratory AFTIL, which is the group that is responsible for trying to identify Military service men and women who lost their lives in conflict. For a long time the military had the largest repository of DNA samples every service man and woman was required to provide a sample and it was stored in the event of some sort of catastrophic event or military conflicts where they've lost their lives. She had a hand in developing that. So we have a lot of people who have been in the field for a long time.

I neglected to mention that it's not just UNT center for human identification is not just the health science center we have an incredible team of forensic anthropologists, osteologists(?) up in Denton on the Denton campus Dr. Harold Gill King and myself are the directors of the UNT center of human identification. I direct the sort of the molecular DNA here and he is one of the leading forensic anthropologists and he directs the lab for forensic anthropology up in Denton. The combination of makes us, I think, something very special. There are very few entities that bring together such expertise that works in synergy is the team to help answer these questions in terms of who an individual was and they certainly make us better. Remains go there and they'll try to determine cause, manner of death and make the identification and the skeletal structure and so forth. If they're not able to make a run of the mill identification, they'll sample the remains. We don't want 206 bones or so, they're just selected for us. They know what it's most appropriate and it has the best chance of getting DNA from the remains. So we work hand-in-hand and that's something that Department of justice and national institutes of justice realized and that's why I think we've been so successful in obtaining funding, because of this unique partnership. So that's something that that clearly makes this a unique and strong him programs individually how much stronger we are work together as a team, which we've been doing since early 2000.

You know some educational program to me that have been such an important tool that has helped our operational labs grow stronger. We're cultivating our own employees and training, providing them all the skill sets and then realizing that there are some that are better than others and those are the ones that we want to try and hire, bring into the fold to help us grow as more and more cases come here and we become people limited. I think that's what makes us unique is so now that we're training our own future employees, in training qualifying excellent people to go out help other laboratories and then just the breadth of knowledge the difference in different disciplines that can come together to help solve other types of disease states. Dr. Roby now is actively involved and she's an expert in mitochondrial DNA it's now known that mitochondrial DNA may play a key role in Alzheimer's, aging, different types of cancer so the same techniques and tools that we were applying for solving crimes can also be applied to help solve and identify disease.

So do you ever regret not becoming a doctor?

Never. You know I love what I do and I've been here 22 years and I jokingly say "well, maybe in another 18 I may consider retiring" but at that time all my current grandchildren will be out of college. But I love

what I do and we've been pretty fortunate myself, Dr. Budowle, Dr. Chakraborty, although we're academicians we do a lot of service work, we travel throughout the world. Our Department has more frequent flyer miles than probably most whole Departments or schools. It's not that we just want to accumulate miles, we're collaborating, and we're developing relationships. It's all part of an educational research that, you know, not only we do we do in house, but we also do throughout the world.