



WE INTERVIEW...

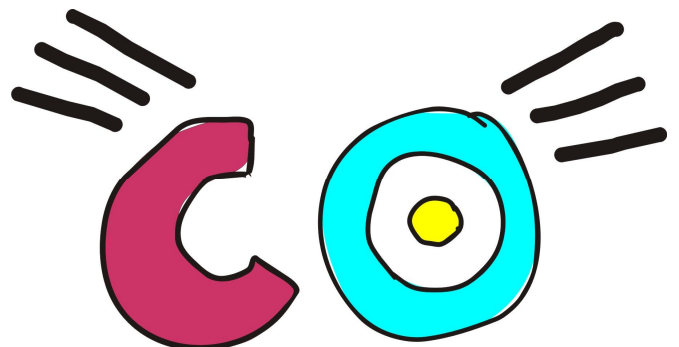
ÁNGEL CARRACEDO

- legal medicine scientist -

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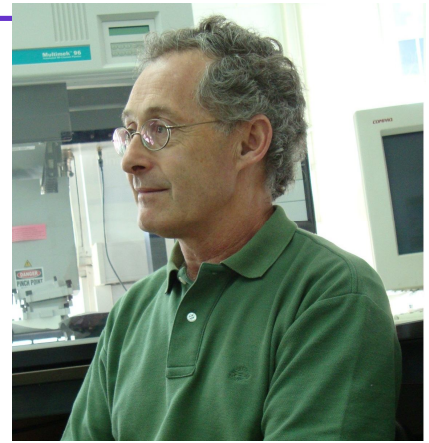
We interview Angel Carracedo

Galician scientist, **Ángel Carracedo Álvarez**, was born in Santa Comba, A Coruña, Spain, in 1955. He has worked as a professor at the USC (University Santiago de Compostela) since 1977. He is the Managing Director of the Legal Medicine Institute and also of the Galician Genomic Medicine Foundation.

In 2009 he was given King Jaime I Medical Research Award for his work which was pioneer on using new technologies on applied genetics, particularly on forensic identification and population genetics. He is participating in the Human Genome Project heading an interdisciplinary team formed by more than one hundred researchers: biologists, mathematicians, physicians...

He is also researching on psychiatric disorders, such as autism, obsessive-compulsive disorder and schizophrenia.

His works have been published in the most prestigious magazines, such as Nature. He has researched on Christopher Columbus' remains, on the fossils found in the paleolithic site in Atapuerca (Burgos), and on the 11-M case, among others.



ÁNGEL CARRACEDO: legal medicine scientist

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When you were a child, did you ever think that your own work would become so important and be valued so highly?

Well, I don't know how important and appraised my work is. I always try to do things well. When I was a child I had no idea that I would work on this. I never think, and I've never thought, if what we are doing is important. I just work and live with a will and that's all.

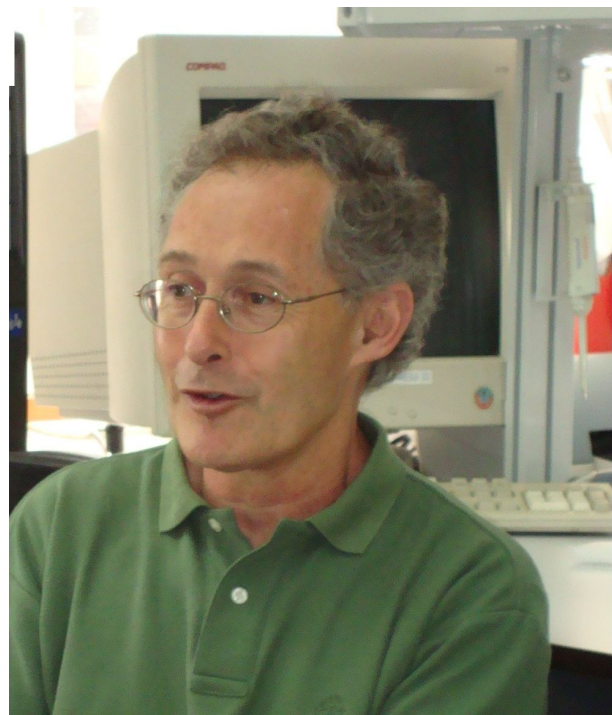
Have you ever had a clear idea about what you wanted to be when you were older? Or did anything happen which made you choose this career?

I never had a clear idea of what I wanted as a child. It was quite later. When I was a child I liked everything. I already liked genetics when I was your age because I thought it was something difficult to understand but I knew it was the key to very mysterious things. For example, that from a pine seed a tree could sprout, or from a pea a pea plant, or from a potato, a potato plant. This all was very mysterious for me. Understanding that was mysterious because nobody could understand it. That was the beginning of my interest in this. Then later I studied medicine, I don't know why, but I think it was in order to make my parents happy. I didn't like it very much but I had excellent qualifications and I was the best in the class and this was probably the reason. However I liked absolutely

everything, History, Literature, Biology... everything. I didn't have a vocation for one particular thing. Then when I finished my career I discovered that I preferred research because it was very hard for me to give a patient bad news. Imagine telling a parent, 'Your child has cancer and he'll die in two months'. For me that was impossible. I would start to cry, even more than the father himself and I wouldn't be able to sleep in twenty days. And that's why I had a professional crisis and I almost ended up working in a lighthouse. And I devoted myself to fishing for a whole year. But I eventually re-steered my life to research and my initial interest in genetics and it was, fortunately, in the good direction. By working on this I've learnt a lot, I've enjoyed myself a lot and, although I work hard, I have a good time.

It is said that you started showing interest in genetic research after reading one of your grandfather's books (interested in anthropology)?

You have worked hard on this interview! Not many people know that! My Galician grandparents were peasants, but my grandparents on my mother's side were from Valladolid and my grandfather was a Criminal Law professor. At that time, early 20th century, there was the theory that all the criminals had particular physical features. It was called the



Lombrosian idea. A lot of people were persecuted for having that physical shape. This is completely absurd! My grandfather fought hard against it. They even made instruments to measure people's face shape, nose shape... He published a book saying that all that was nonsense, that he had measured criminals and normal people and there was no difference at all. He was one of the first anti- Lombrosians and he fought really, really hard against this idea which later took the genetics problems to Nazi Germany and the fascist world. I was fascinated by all this, and on top of all it had



been done by my grandfather, well, in this case my great-grandfather. It had a great impact on me. I still have the boxes with all the instruments he asked to be made for all the measuring.

Did you have to sacrifice many things in order to be where you are today?

I don't know where you think I am. But I am just a normal person who does his job. But yes I did, I sacrificed many things because I've worked, and I still work hard. That's true. I'd like to have more time for fishing, cycling, sailing...and above all, more time to spend with my children. For me, they are a priority and I spend a lot of time with them. But I'd like to have even more time. It is true that I work a lot and I've missed some things, but it has been worth it. And still is, otherwise I probably wouldn't do it.

Do you find it gratifying to see that your work during all these years finally bears fruit?

There are two satisfying things at this life stage. Each life stage has its own

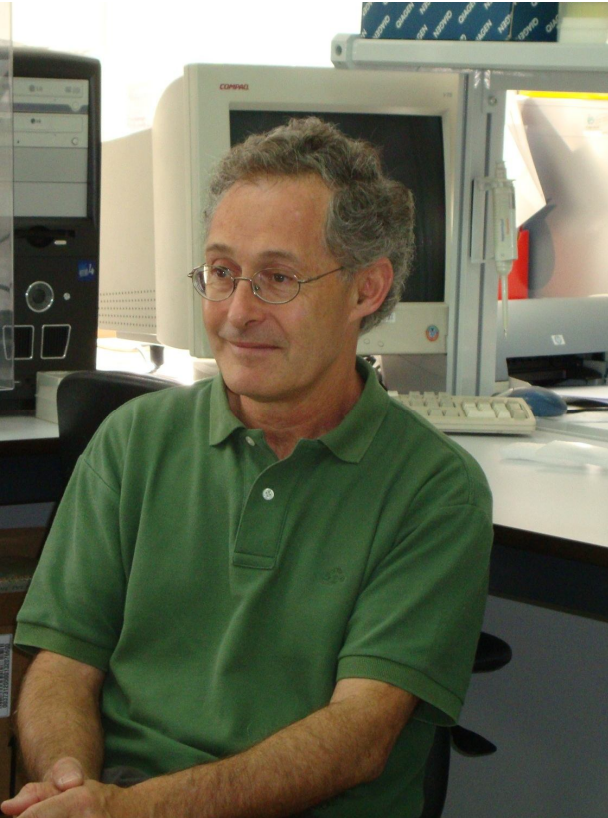


hopes, ambitions, feelings... For me one of the most gratifying things is to be surrounded by great young people to whom I convey, more than knowledge, interest for doing things. It's a way of understanding life, understanding research and understanding work. I am learning from them all the time. That's the most gratifying part. I work with a group of people who are really the best. And they are worth any effort I can make. I always tell them that I work more or, at least, as hard as they do. It's nice to see it. For me it is the greatest satisfaction. But also to see that our research work is published in the best magazines and that it has a practical application in order to solve people's problems in medicine and in justice. IT is really gratifying to see that you can offer a solution to someone's problem.

Why did you decide to take up research when you finished your medical studies?

I've partially answered that question earlier. I didn't like clinical medicine. I liked it theoretically, to understand why a person was ill, but I didn't like the rest. That's why I admire doctors. My wife is an intensive-care doctor, which is the most vocational thing in the world. But I didn't have that vocation and I didn't have the capacity for bearing the suffering of communicating pain. Psychologically it was hard for me and I've always liked research, I've always wondered about the reasons behind things. I really liked that. Fortunately I had the strength of mind at a certain time to fight for what I liked and not for what it was right for me. And that was a good decision in my life. Although this was more difficult and had an uncertain future, I decided to choose what I liked. And it was a very good decision.

How would you define your work as a researcher?



Research means asking about the reasons behind things. As I told you we work on everyday problems in order to solve medical problems and problems for justice. We know the questions, but sometimes we don't have the answers. Research means being able to give an answer to a question. If someone touches this, and that information is important to solve a crime, we have to develop methods to get DNA from here, to get information. Research must be done. We research on real life problems. If there is a group of patients who have an illness with a genetic cause, but quite unknown, what else can be better than research and be able to help them, to give them some genetic advice, to make some medicine which gives them hopes of future. This is what research means.

As an experienced researcher, especially in forensic genetics, you have worked on paternity testing, criminal investigation, biology research...), if you had to choose just one, which one would be your choice? Why?

This is very difficult to answer, because the same happens as when I was a child, I like everything. I have a very serious problem with this and I tend

to be dispersed. Fortunately now I work with so many people that some of them can work on one thing, some on another and some on something else. And I enjoy myself much more. What do I like the most? Everything. But if I had to choose, at this very moment what I feel like doing is to find out the reason for psychiatric illnesses. Do you know why? First because they are a mystery that nobody can understand. In the second place, because a lot of people are affected, many more than we imagine. We look the other way with stigmatized illnesses and we don't know exactly how many people are affected, but only in Galicia we are speaking of more than ten thousand. This is a lot. Thousands and thousands of people are suffering and it is very important to research so that they can be treated better and they can have more hopes. A lot of families are suffering. At this moment this is what I am most interested in. But I enjoy everything we do.

You receive a lot of samples at Santiago University in order to be genetically analyzed, where do they come from?

Look, here we have two small laboratories, this one, which is very small, where the forensic part is done, and a very big one which is at the Hospital. Here we work on forensic genetics and at the hospital we work on clinical genetics. The



samples we receive here come from Spain and a lot of places all over the world. We don't have a routine. We don't work on many cases. The police in Madrid have a hundred times more cases. What we do, apart from some cases we receive from many places nearby, is to work on cases which other labs all over the world can't solve. Some time ago Scotland Yard was here, last week it was the Norwegian Police, any country in the world. When other laboratories cannot find a solution for a case, they send it here because we are leaders in field research and we have the latest means which we are always improving, and we may find the answer, although not always, most of the times we do. So we receive samples from all over the world: the USA, Australia, Austria, United Kingdom, everywhere.

What can you find out about a person's profile through this analysis?

You mean the forensic part. If you have the DNA, everybody can be identified. You can get DNA from everywhere because when you touch something or hold a gun of a crime, even if you have washed your hands, you leave enough DNA to be identified. For the Police, when there is someone accused, it's easy. You compare the DNA you got from the object and the suspect's DNA. But if you don't know who did it? Well, forensic genetics today can be used to give some clues to the police such as the geographical origin of the person whom the DNA belongs to. For example, during the 11-M investigation they sent us some unidentified samples and we told them that it was a person from the north of Africa, probably an Algerian. We can also know the eye colour and the skin colour, the hair colour and texture. There are a lot of people working on physical features so that from the slightest trace of DNA they can tell more things which help the police



and judges to persecute crime better. It seems science-fiction, but it is the truth.

Do you know your genetic profile?

No, I have no idea. I've never done it and I am not in the least interested. I could have been tempted to find out which genes are behind some of the illnesses I've suffered, but not even that has been the case. It hasn't been a question of negligence, but it's just that I am

not interested. I remember the mad cows' case. Don't you remember? People who ate meat from a cow with bovine spongiform encephalopathy, commonly known as mad-cow disease, could be infected, but not everyone, only that person who had a particular mutation in his genome. Not all of us, even if we ate infected meat, can develop the Creutzfeldt-Jakob disease, as it was called. Well, all people in the lab started with analysis to see if they could eat meat with no problems. There was

a lot of hysteria at that time. I didn't do anything and I ate, with real pleasure, more meat than they did.

Are there more genetic diseases in Galicia than in other parts of Spain?

No, as a general rule. But it's true that we are people who have lived here for long and we haven't had much immigration, not much genetic contribution from other people. From a genetic point of view, this fact makes us more prone to have certain peculiarities. There are some genetic diseases which only we develop due to the so-called 'founder effect'. The first inhabitants here had a mutant gene and, as we didn't dilute our genes with other new ones, we suffer illnesses which are only here. For example, inherited breast cancer isn't much

more frequent here than in other parts of the world, but maybe just a bit more. But a great number of women and men who suffer from inherited breast cancer had a particular mutation which can only be found here. This is a genetic peculiarity which is a consequence of our history.

What inherited diseases are the most common?

Well, there are a lot of inherited diseases, but we must specify. Some are transmitted directly from parents to children and they are called Mendelian diseases. There are thousands of them and almost all are rare. There are some which are more frequent like 'Cystic fibrosis', but most of them are rare, but there are a lot. To a certain extent all of them are hereditary. Genetics is not important only for these rare diseases but also for common diseases such as asthma, hypertension, diabetes, schizophrenia,



cancer, which have an important hereditary component. It's more and more important in order to get a diagnostic and find out the risk of suffering it. Genetics changed from working on rare diseases to trying to find out which is the genetic component of the most common diseases. So this is the answer: the most



common hereditary diseases are almost all because we are genetically prone to suffering them. It's important to analyse that component in order, at least, to understand them better.

What do you think about human cloning?

Human cloning is strictly forbidden by Law. And I agree with that. Genetics must worry about derived ethic problems. I like to be very cautious. It's very difficult to stop progress. But sometimes you have to place restrictions when you see the possible consequences of things. Human cloning was invented by nature long ago, identical twin brothers or sisters, but doing this on purpose looking for I don't know what, I don't understand what they try to do, really. So, I think something which isn't useful and is potentially dangerous must be forbidden.

Do you think that stem cells can be the solution to many of the current diseases?

I think they have a great future for research, a very promising future. They have a huge potential. We don't research on stem cells because we have so many things already that I can't diversify the group more. But I really find a big potential in them. However I don't think it will be easy to control this potential. I hope it won't happen as with the gene therapy long ago.



Gene therapy was: if we have genetic diseases which have a mutant gene, why don't we correct it? Why don't we introduce harmless viruses which contain the defective gene so that we can correct the fault? This was a great hope in medicine in the eighties, but eventually it was really difficult to control all that and it hasn't been very useful, so far. After 30 years of work significant progress hasn't been made. I see more potential in stem cells. But it won't be that easy. It's very difficult to control how to carry a stem cell to correct a very particular fault. And they also have a bad outcome, cancer for example. They are cells that can produce different outcomes. So it's not that easy. It takes time.

Do you think that genetically modified food can affect our health and cause DNA mutations?

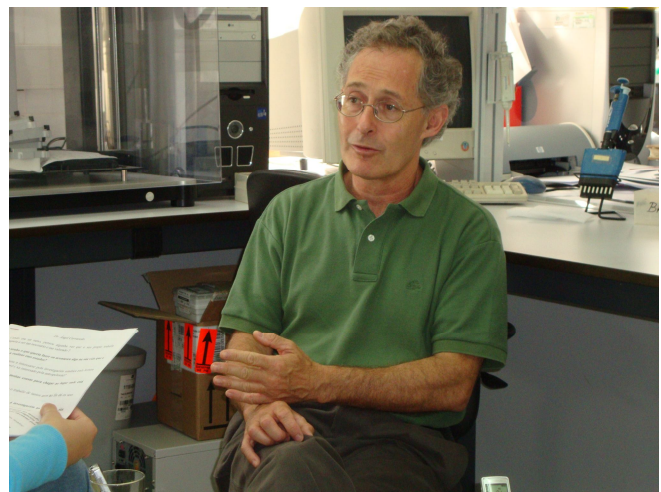
No. If you eat transgenic food, nothing will happen to your genes at all. I am completely sure about it. They are very unpopular. Luckily we don't work on this field. I wonder if this is fair. I don't know much about transgenic plants but I hear people talk about it. I have friends who work on transgenic food and others who are completely against it. I really enjoy listening to their discussions. If you eat some transgenic food it will be OK. As a matter of fact, it must be the most controlled food all over the world, from the point of view of public health.

Potential danger can come from other ways. If we create pesticide-proof transgenic plants and then we use pesticide with all the other plants so that only these can survive we are causing an ecological disaster. This is a potential danger. Or plants which have such adaptation advantages that they invade everywhere. In my opinion most of the things said about transgenic food don't have a scientific basis. I don't think they are bad *per se*. And I think they can be a solution to many things. I am not a radical anti-transgenic at all. It must be controlled, that's all.

How many people are there in your team? How many women?

Women are majority. I am the managing director of many big foundations with several working groups. Here at the Legal Medicine Institute is my team, the genetic team, but there are also toxicologists, forensic pathologists... In my closest team there are about a hundred people with different careers and from different countries. They are wonderful and women are 70%. What I wonder is where the men are. But that is a mystery I have to solve it in a future research, ha, ha, ha...

Which of all your achievements are the



most important for science?

It's very difficult to say because sometimes research has a more practical impact and in other cases it has a more theoretical impact. It's very complicated. I've been working for so many years and I could choose 15 or 20 of our research which I like. Some have direct

repercussions in the practical work and are the solution to things, others help to understand better the causes of diseases, and others help to understand our history better. Each one of them is interesting, fascinating... I wouldn't be able to choose just one. When one of our articles is published in a very important magazine such as Nature or Science it has a big impact. But I like some other articles published in other magazines which helped to solve a problem in an efficient way. I wouldn't choose just the articles published in the so-called 'top journals'.

**What are you working on at this moment?
What are your next targets?**

I've told you that I have a really big team but when I started it was just me, then it was me with one person, then me with four and now we are more than one hundred. We have a tendency to dispersion. I've learnt that we can build a tower upwards and be the best in the world in one field, but it's much more beautiful to build a city and leave other people in the future to build towers.



And that's my current ambition. We work on different things. We work on forensic genetics trying to find answers to difficult cases, cases which haven't been solved so far. We also want to give an answer to pathology cases because people die and we don't know why. And this is interesting, not only to find out why that person died, but also to prevent other deaths because of the same problem. We are researching quite a lot on sudden death. We work on many other diseases, too. My group is researching particularly

on cancer, colorectal cancer and breast cancer. Now we are also working on mental disorders, schizophrenia in particular, and on autism. We are



working in neurogenetics, genetic diseases with a neurological base, such as ataxias, and even common diseases which affect a lot of people, like migraines. We work on pharmacogenomics as well, to study drug response in patients. When a patient takes a drug, it doesn't always work and it has side effects. Nowadays we have means which allow us to study this and see the influence of genetic variation on drug response so that we can do DNA tests in order to give the right drug to the right patient. This is called pharmacogenomics and for us is an important line of research. These are the main fields we are working on. But we also do some basic research on population genetics, which is more fun, not as practical, but it is important to know where we come from, how populations emigrated... Galician people are here but, since when? How? Who are we? And this applies to all people all over the world. We are doing very beautiful research. Yesterday a member of our team, Antonio Salas, wrote an article in the newspaper about the Tuareg people. He discovered that they come from the north of the Iberian Peninsula. Things like that become very useful for historians in order to know what happened in the past.

Currently Santiago University is working on the development of DNA microarray (chip) for criminal investigation. Could you tell us what the research exactly involves?

Well, DNA microarray is just a tool which became famous some time ago. A chip is a small glass



where you put microscopic spots of [DNA](#) for quicker analysis. We don't use them now in forensic genetics because we have more efficient methods. But in clinical medicine they are very useful. We use DNA microarrays for many things, for screenings of genetic diseases and, above all, to see what the reasons for the most common diseases are. You can do millions and millions of analysis really fast.

Do you think that the kind of research you do is at a higher level in Spain than in other countries in Europe?

It depends on which one. On forensic genetics it is. We are the team with the largest scientific production in Europe and all over the world. In general Spain is at the top. In other fields, for example cancer genetics, other European countries such as United Kingdom, Germany, have much more production. And in psychiatric diseases genetics we are average, Iceland has more scientific production and United Kingdom much more. It depends on the field. My idea is, as I said before, to build a city, but not my generation, yours, I mean, to lay the foundations and in the future, as today we are proud of ourselves for being the best team in the world in forensic genetics, maybe in thirty years' time we'll be able to say that we are also the best team in psychiatrics. But that means laying the foundations, researching, getting into partnerships... You can't become the best in the world without history, without tradition, without interdisciplinary, without...many things. It's a question of years and years and years. The success of forensic genetics didn't start in my generation. It comes from long ago. It started with Dr Concheiro, who is retiring this year and, by the way, he is from Ordes. What we do can't be understood without taking him into account.

At this moment there are several TV series related to forensic medicine. How much is true? What are the differences with real life?

Can you believe that I've never seen CSI? I don't have much free time and, besides, I am not interested at all. My wife is an intensive-care doctor and she likes TV series about medicine. I don't understand it because she spends all day in hospital, but she likes them. But that's not my case. I have very little free time and I hardly watch television. I prefer reading to watching television. I've never ever seen CSI. But according to what I've been told it's not very different from real life. However in real life problems are not solved in just one hour. Maybe getting information from an object takes our team a week or three months. And there are many people working on it. It's not just someone saying, 'The DNA matches Mr X and he's got blue eyes'. No, it's a tough job, tough job of interpretation, tough job of training. But the strategy in general in the series is not very different from real life, according to what people say.

Are English or other foreign languages needed to carry out your work?

Absolutely! Ninety-eight per cent of what I write is in English, over fifty per cent of my daily speaking is also in English, all my talks in conferences are in English, within my working



team the first language spoken is English because some are English and they can't speak

Spanish. It's funny because for them learning Spanish is as difficult as English for us. But today English is the language of Science. For our team, speaking English is basic. I learnt French at school, in Santa Comba, not English. And I learnt good French, I must say. But when I started researching I had to learn English very fast because when I went to Sweden they didn't speak French, Spanish, Galician, or any languages I could speak. And the exams were in English so I had to learn English fast. Now you have many more facilities and you must take advantage of them. You must learn good English. It's something very important, especially if you want to work in the world of Science.

Do you think that people who can speak languages (at least English) have more chances in their future?

Definitely! Definitely! Nowadays mobility is essential. You have to travel from one place to another and the opportunity of getting a job increases if you can travel. There is a lot of unemployment here and in some countries the unemployment rate is very low. The most important things are your professional capacity and languages. That's something I insist on with my own children. They are lucky because they can perceive it in their everyday life because when most of my friends come home we have to speak English, and their children speak English, too. They have to learn, the only important thing is to learn new things all the time. So languages are really important, especially English, in spite of the difficulties. My older son, he is sixteen, says that it's a pity we are not living in the 16th century because the important language then was Spanish. Yes, it's a pity for us, but not for the English. They are very lucky. But that's the world we live in and there is nothing we can do about it. So, learn English, because it is basic.



What job opportunities are there in this career?

I think quite a lot, especially if we think of internationalization. All the people who used to work in our team are working either here or somewhere else. Nobody is unemployed. If there isn't enough work in Spain, whenever they want to work in any lab in any country, they just have to go there and apply for the job, because they are welcome everywhere. So in our group opportunities are clear. However, there is a moment of crisis in Spain. Of course, it's not easy. You have to work really, really hard. Those who have expectations and work hard won't have any problems in their professional future. But you have to work hard from the beginning to the end. That's the key. If you do it, you won't have any problems.

Our school is taking part in a European Union "Comenius" project together with Poland and Lithuania. Do you think that these school projects can improve students' level of English? Can it help in some other ways?

I think it helps in more aspects than the language. I've already told you that language is basic, but in the world of science, at this moment, the most important things are internationalization and mobility. To understand

other peoples, other cultures, to travel, to speak to people from other places, that's basic, basic, basic for progress and for your personal education. So speaking with Lithuanian people, with Polish people, working in



geneticists in population genetics are within the best in the world and forensic medicine is very well organised. I had the pleasure of travelling there to give talks in conferences two or three times and I found a

common projects with them, is enriching for everyone. And for you it has a tremendous educational value. It's very important to travel and get to know other cultures, other problems. You can understand the world much better and it makes you more competitive, in terms of work. It's not only for English, in this case English is the least important thing. The real important thing is the fact of collaborating in the project, which has an inestimable value.

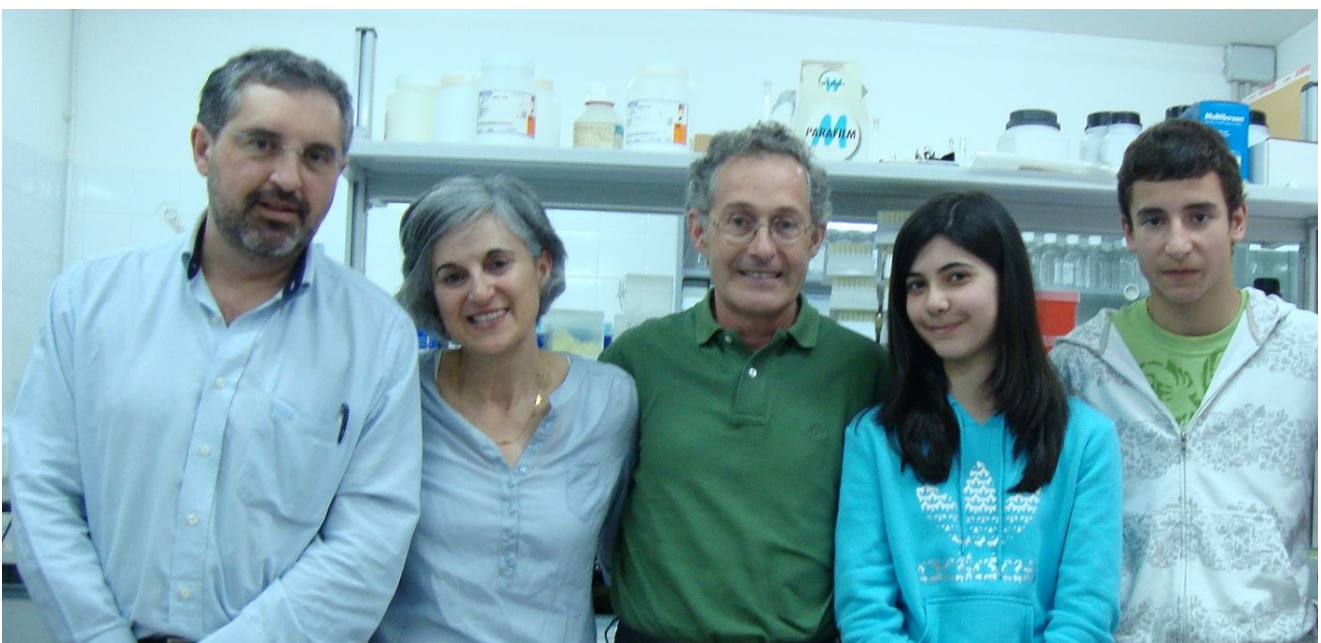
We know that your research on genetics extends to a worldwide level (USA, Sweden, America, Japan...), but in Europe, have you ever worked in Lithuania or Poland?

Yes, in both countries. I think there is not a single country in Europe we haven't collaborated with. Poland has worked very well in the science world for many years. And Lithuania, too. Lithuanian

country of wonderful people, a much richer country that I thought. The Baltic region has a great future. It is very similar to the south of Finland. I was pleasantly surprised and, as a matter of fact, I intend to go there with my family very soon. I have to give some talks and my family will take advantage of my trip. They'll get to know this incredible country with such rich culture and kind people. People there are really charming and welcoming. That's why we are travelling there. And we collaborate with both the two countries, a lot.

Where would you recommend us to study, in a Spanish university or somewhere else with a higher level of education?

That's a very good and complicated question. First, it depends on what you want to do. If you could choose the best place in the world





according to your choice, that would be ideal. But two things are essential, one is means - and life is quite unfair- and then talent, which doesn't depend on you. But what really depends on you is the possibility of working on your own education. I met a girl a bit older than you who asked me if she should go to Oxford University. I think she had means, and she certainly had intellectual possibilities. She could speak English as good or even better than Spanish and Galician because she had spent two years in the USA studying, and her student record was remarkable. As a matter of fact, she is at Oxford now. But, of course, this depends on many factors. And there is another thing, which is the best place? It depends on what you want to do. And life is a question of being balanced. It's not just going to the best place what matters. You may value to have your family and friends near more than anything else. Making decisions is difficult and you must bear in mind different things. It's a personal decision. And you must make that decision when you are too young and not ready for it. It's a bit easier for women because you mature sooner, but boys... at sixteen or seventeen... I think it's a bit too soon. I'd like to live in a world, at least in Europe, where if you are talented and hardworking you can choose what and where to study, no matter how rich you are. Means shouldn't be what prevents you from studying where you want. If you think that you are good enough to go to Oxford University you should be able to go. We must fight for that.

How do you combine your work with your family life?

It's very difficult to do. It's a crucial question at this particular moment in my life. It's really

difficult. I sacrifice my hobbies in order to spend as much time as possible with my family. I usually travel every week, but when I am here I always take my children to school, I have lunch with them, and when they arrive home from school I'm already there, I work with them. While they do their homework, I do mine. In our free time we play basketball, we go for a walk, we chat, we go for a bike ride, and at the weekend we go fishing to Louro. The worst of my life are trips. I have an urgent need of controlling, diminishing the number of trips. Although I usually go on one trip a week, sometimes it's more. All this year's and next year's trips are already arranged. My life is very complicated in that sense. I have to find another way. I need to find a balance, because life like work is a long distance race. I like running. By the way, I usually run in the Ordes race and I've won in my age-group several times. Life is nothing but this so you need balance. Perseverance and constant work are really important, not just a big effort and then stopping. And family balance for me is the most important thing. It must be a Galician feature, but for me my family is a priority, really a priority, not only my closest family, but the whole family.

If you were not a scientist, what would you do?





me, 'You are lucky!' I almost strangle them. It's very tiring and you don't enjoy the trip.

If you could make a wish knowing that it would come true, how far would you wish your career to go?

I'd like to find the genetic causes of some psychiatric disorders such as autism, obsessive-compulsive disorder, above all, those suffered by children.

Let us ask you the last question, as inexperienced interviewers, is there a question you would like to answer but nobody has asked you?

That's a beautiful question. I must congratulate you for this fantastic interview, with such interesting questions. You know, once I organized a scientists' meeting in my brothers' lighthouse, with scientists from all over the world, and the title of that meeting was exactly like your question, 'Is there something you want to talk about, but nobody has asked you?' Well, I'd like to talk about a lot of things. I'd need another interview just for that. So we can leave it for a more intimate occasion, do you agree?

Like my brothers, because it was my idea, I would be a lighthouse keeper on the Coast of Death, completely sure about it. Before that I thought about marine biology, which I liked very much. But if I weren't a scientist I would be working in a lighthouse, writing and enjoying our sea, our nature, our people.

Which aspects of your work do you like the most and the least?

What I like the most is researching, looking for the reasons for things. Well, sorry, I'm wrong. Although I love that, I also like teaching. I also like the practical part and seeing how we can solve problems in real life. As I told you from the beginning, I like almost everything. What I like the least is travelling so much because once I'm there I just have time for my talks and then I come back. When someone tells

