



## DR ANDREA HOLMES

Professor of Chemistry  
Doane University, Nebraska, USA  
Field of research: Nanotechnology

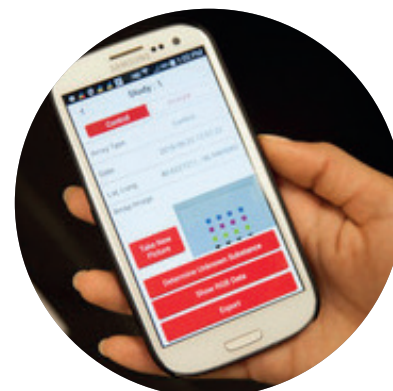
### CURRICULUM VITAE

Postdoctorate degree,  
Columbia University  
Doctorate degree in organic chemistry,  
New York University  
Undergraduate degree in biology and  
chemistry, University of North Florida

### RESEARCH PROJECT

DETECHIP®, a small, portable  
detection chip that can be used by the  
police, doctors, the military and the  
general public, even, to identify drugs,  
pesticides, explosives, microbes that  
cause bacterial infections, and much,  
much more.

The next step, then, is to supply people working  
in the emergency services, such as police officers,  
with DETECHIP and the smartphone app so that  
they can detect potentially dangerous substances  
like explosives. All they would need to do is place  
a sample on the DETECHIP, take a photo of the  
colour change, and let the app tell them exactly  
what the substance is.



The smartphone app analyses colour changes from a photo

# FIND. IDENTIFY. ACT.

SCIENTISTS AT DOANE UNIVERSITY HAVE DEVELOPED  
NANOPRINTED SENSORS THAT CAN IDENTIFY  
UNKNOWN SUBSTANCES, BUT WHY IS THIS IMPORTANT?

Imagine these two scenarios:



1) Soldiers come across an unknown  
substance whilst on patrol. This  
substance could be an explosive or  
nerve gas, but they have no way of  
knowing just by looking at it.



2) Environmental scientists are told  
that fish are dying in a stream,  
miles away from their workplace,  
but they can't tell which pollutant  
or microbe is causing this without  
taking samples of the water back to  
their lab.

Being able to identify unknown substances on the  
spot and outside of the lab is incredibly important,  
but, currently, it isn't easy to do this without  
sending samples to a laboratory for testing. Dr  
Andrea Holmes and her team have developed  
a nanoprinted sensor called DETECHIP, which  
she hopes can be used in all sorts of situations  
and environments to immediately detect  
unknown substances.

### WHAT IS A NANOPRINTED SENSOR?

Short for 'detection chip', the DETECHIP is  
made up of coloured inks printed onto a paper-like  
surface. These coloured inks are called nanoprinted  
sensors, which work in a similar way to the urine  
test strips doctors or nurses use to test for

infections. When the inks come into contact with  
a drug or other substance, they change colour.  
And, by analysing the colour changes, it is possible  
to identify the substance.

The paper-like surface is almost like a sponge,  
in that it has tiny pores that soak up the inks or  
sensors. The inks are called nanoprinted sensors  
because the miniscule pores are only 1 nanometre  
in size, and a special printer known as a Dip Pen  
Nanolithography or DPN printer can place minute  
or nanosized amounts of ink onto the surface.

Incredibly, larger nanoprinted sensors can also be  
printed using a standard ink jet printer available  
in any office supply retailer. Police officers,  
for example, might want to use these bigger  
sensors so that they can test for substances such  
as cocaine. A larger sensor would enable the  
policeman or woman to see the colour changes  
immediately. Nanosized sensors can only been  
seen under a microscope, but this is very useful  
when thousands of experiments need to be  
performed, or if there is only a small amount of  
the substance to identify.

### CAN THE DETECHIP BE USED NOW?

At the moment, DETECHIP can identify  
over 100 substances, from drugs of abuse to  
pharmaceutical drugs, pesticides, warfare agents  
such as nerve gas, and many more, but it isn't  
being used outside of Andrea's lab – yet! The  
researchers are developing a smartphone app that  
can analyse colour changes from a photo.





# WHAT IS NANOTECHNOLOGY?

Nanotechnology is the use or control of tiny matter known as nanoparticles or nanostructures. A nanometre is one billionth of a metre (0.000 000 001m) and scientists work with nanoparticles that are between 1-100 nanometres in size to create new materials and devices. Did you know that the diameter of a human hair is, on average, 80,000 nanometres?

## WHY DO WE NEED SPECIALISTS IN NANOTECHNOLOGY?

Nanotechnology has so many applications, from making smartphones and computers faster, lighter and more powerful to developing nano-cosmetics such as long-lasting lipsticks and natural looking makeup. In nano-medicine, researchers are investigating the use of nano-sized molecules to deliver anticancer drugs directly to the tumour, thereby avoiding damage to nearby healthy cells and tissues.

On the flip side, it is suggested that nanotechnology can be harmful to human health and the environment. For example, sunscreens use silicon-based nanoparticles, and many environmentalists claim that these nanoparticles are toxic to aquatic life. For this very reason, tourists in Mexico have to have a shower to remove sunscreen if they want to swim with giant turtles or in natural water springs.

All in all, nanotechnology has many unanswered questions that need to be addressed by specialists.

## WHAT PASSIONS AND PERSONAL QUALITIES DO YOU NEED TO WORK IN THIS FIELD?

To work in this field, you need to be passionate about working with other people who have different areas of expertise. You have to be open-minded and willing to go into uncharted territory. You also have to embrace failure and not despair. Research is often full of failed experiments; but we learn from failed experiments just as much as from successful ones.

## HOW DO YOU BECOME A NANOTECHNOLOGIST?

Studying for a doctorate degree is one route into nanotechnology. But not everyone working in nanotechnology will require a doctorate degree. For example, the International Association of Nanotechnology, in partnership with the California Institute of Nanotechnology and Clean Tech Institute, offer training programmes and apprenticeships.

The Los Alamos National Laboratory, which houses the Center for Integrated Nanotechnologies, is one of the most famous and highly respected labs in the world. Los Alamos offers undergraduate internship programmes and open positions for post-baccalaureates. The salary depends on the scientist's level of expertise. For example, the average salary for a Level 5 scientist is \$159,000 per year.



## OPPORTUNITIES In nanOTECHNOLOGY

- THE INTERNATIONAL ASSOCIATION OF NANOTECHNOLOGY OFFERS TRAINING PROGRAMMES AND APPRENTICESHIPS
- LOS ALAMOS NATIONAL LABORATORY, USA, OFFERS INTERNSHIPS AND OTHER CAREER OPTIONS
- LEVEL 5 NANOTECHNOLOGISTS CAN EXPECT TO EARN AROUND \$150,000 A YEAR



# ASK DR ANDREA HOLMES

## WHAT DID YOU WANT TO BE WHEN YOU WERE YOUNGER?

I always wanted to be a teacher. As a kid, when I role-played with my little sister, I insisted on being the teacher, and she had to be the student! After a while, she didn't like that anymore because I kept reprimanding her for not doing her homework! I realised then that I had to change my teaching style and explore new ways of getting her excited about "my class". From an early age, I had this innate feeling that I would be a great teacher and mentor.

As I grew older, and during adulthood, I connected best with students between 18-25 years of age, which is why I decided to pursue an academic career at a university.

## WHO OR WHAT INSPIRED YOU TO STUDY CHEMISTRY?

I was definitely not inspired by my high school grades. In fact, I hardly passed high school; I was almost kicked out for disorderly conduct and received mostly C or D grades in my courses. I was a rebel teenager with little desire to do anything in STEM.

At one point, however, I realised that I needed to take care of myself and make a living. So, I decided to become an X-ray technician. After a while, I got bored with that, and I didn't have enough patience to work with sick patients. I decided to attend college to get a Bachelor of Science degree. It was during my undergraduate education, that I became hooked on chemistry and nanotechnology.

During my undergraduate degree, I struggled in chemistry, and even though I studied and studied, I

still wasn't very good at it. But I wanted to conquer this incredible mountain, and that kept me on top of my game. Since then, I have never been bored again. I still find nanotechnology fascinating even though it can be hard to understand. Sometimes, I'm surprised by significant contributions I have made to nanotechnology.

## YOU STUDIED BIOLOGY, CHEMISTRY AND MATHS AT UNIVERSITY. IS THIS A 'STANDARD' ROUTE TO WORKING IN NANOTECHNOLOGY?

To be a professor at a university you have to have a doctorate. A doctoral degree involves completing independent research and a thesis, a long essay or dissertation that supports the research. During my doctoral education, I took organic chemistry courses but mostly conducted organic chemistry research for my thesis. There is no standard route for working in the field of nanotechnology. This field is so interdisciplinary [involving many subjects and areas of knowledge], that nanotechnology researchers might have backgrounds in physics, engineering, biology, materials science or computation, for example.

## IF YOU COULD GO BACK IN TIME WHAT ADVICE WOULD YOU GIVE YOURSELF WHEN YOU WERE STARTING OUT ON YOUR CAREER PATH?

I would tell myself not to be intimidated and ask questions. When I started in graduate school, I was very insecure about my qualifications and abilities, and I was really shy when I went to conferences or symposia where scientific research was presented. I felt that all these famous professors and researchers would think my questions were stupid. Now, having been in this field for so long, I realise

***"I was definitely not inspired by my high school grades. I hardly passed high school, and received mostly C or D grades in my courses."***

this was a big mistake. I should have told myself back then that the only stupid question is the one not asked!

## DO YOU HAVE A TOP TIP FOR YOUNG PEOPLE HOPING TO FOLLOW IN YOUR FOOTSTEPS?

Many young people don't know about careers that exist in chemistry or nanotechnology. My students usually want to become physicians [doctors] or to work in other, similar healthcare professions. I like telling my students that they have enough years in their lifetime to pursue at least three professions. They don't have to decide on a career for life. In fact, they have enough time to explore and work in several professions until they find the right fit.



Dr Andrea Holmes also teaches at Doane University

## ANDREA'S FIVE TOP TIPS FOR STUDENTS

1. NO BARRIERS! EXPLORE, EXPLORE, EXPLORE!
2. OPEN YOUR MIND! THERE IS SO MUCH OUT THERE
3. TRY IT ALL UNTIL YOU FIND WHAT'S RIGHT FOR YOU
4. DO NOT BE AFRAID AND ASK QUESTIONS
5. DO NOT BE DISCOURAGED BY BAD GRADES. GRADES DO NOT REFLECT YOUR CAPABILITIES

To ask Andrea a question, visit  
[www.futurumcareers.com](http://www.futurumcareers.com)