THE DNA HUNTER

A revolutionary new technique for DNA extraction promises to make it easier to find the needle in the proverbial haystack.

Physics Prof. Lorne Whitehead was aiming to improve electronic display technology, but what he discovered may very well revolutionize everything from molecular biology to crime scene investigation – thanks to some "casual" conversations and open-minded fellow scientists.

In 2003, Whitehead was searching for ways to manipulate pigment particles in his quest to develop an "electronic paper" when he looked closely at a phenomenon called electrophoresis.

"When you apply electric fields to particles suspended in liquid, the particles move according to their own characteristics as well as the intensity of the field," explains Whitehead. "And it occurred to me that if we apply alternating fields to particles – which normally would not cause a net motion – and then apply a synchronized variation of the particle's mobility, net motion will occur. In other words an AC force can produce a DC motion."

Whitehead named the new concept Synchronous Coefficient of Drag Alteration, or SCODA, and in a casual conversation, described it to UBC materials science researcher George Sawatzky. "George thought the concept might be useful in DNA extraction and suggested I speak to Andre Marziali, a fellow UBC engineering physicist with expertise in genomics. "Andre provided a key piece of information about DNA electrophoresis, and using this I was able to extend the mathematics to cause two-dimensional concentration in free space, which apparently was unheard of in the DNA field."

Fast forward through six years of sustained creativity and focused research on the part of Marziali and his team, composed largely of UBC Engineering Physics alumni, and the SCODA concept has spun-off Boreal Genomics. It is a burgeoning high-tech company where Marziali directs the development of Aurora, a device capable of extracting DNA and RNA from samples that until now were too small or too contaminated to work.

While other molecules spiral in a closed circuit when interacting with alternating electric fields, DNA's "imperfect" traits – high electrical charge and extremely "long and stringy" shape – literally create a drag effect that cause it to eventually spiral towards the centre. The resulting isolated concentration is 100 to 1,000 times better at isolating DNA than conventional methods.

Working with Hirin Poon of the RCMP, Marziali has been able to separate DNA from indigo dye in challenging mock forensic samples, including blood-stained jeans. His team, in collaboration with Rob Holt at the Michael Smith Genome Sciences Center has also successfully extracted microbial DNA from a highly contaminated sample from the Athabasca oil sands.

Marziali says the new technique addresses an enormous bottleneck in the field of DNA extraction and could have many applications "anywhere you have a needle-in-a-haystack situation."

"The implications for forensic science are obvious because DNA extraction has received so much attention in popular culture," says Marziali. "But we're also excited about potentials in clinical diagnostics – detection of biomarkers related to cancer and HIV research, and isolation of pathogens in bio-warfare or food safety."

Prototypes of Aurora are being used by the BC Cancer Agency, the University of Waterloo and McGill University, and a US defense contractor.

Whitehead's research in electronic display is supported through his NSERC-3M Industrial Chair in Structured Surface Physics. Marziali's work on SCODA is supported by Genome BC, the Government of Canada, the US National Institutes of Health and the US Defense Threat Reduction Agency. He has received past support from the Canada Foundation for Innovation.