Improving DNA analysis

September 9 2010

DNA analysis is poised to experience a significant advancement thanks to the work of a Texas A&M University chemical engineer, who has discovered a way to achieve more effective separation of DNA fragments.

Working with a widely used gelatin substance known as a hydrogel, Victor M. Ugaz, associate professor in the university's Artie McFerrin Department of Chemical Engineering, and graduate student Nan Shi have been able to determine the specific type of conditions that result in the optimum gel pore structure for separation of a wide range of DNA fragment sizes. Their findings appear in the Sept. 3 edition of the journal Physical Review Letters.

"It changes the way you think about the entire process because these findings demonstrate a rational way to connect the pore structure of the gel quantitatively to the mechanism by which the DNA moves through the gel," Ugaz explains. "Researchers can now actually design gels to specifically harness certain effects, and they will need this information we have found to do that."

The enhanced separation technique, Ugaz notes, could benefit a wide array of fields that utilize DNA analysis, including biomedical research, forensics and genetic engineering.

Key to Ugaz's findings is the manner in which DNA fragments move through a hydrogel. Employing a process called "electrophoresis," researchers who study DNA typically embed negatively charged DNA

into a porous hydrogel. They then apply an electric field which causes the DNA fragments to move through the pores of the hydrogel. Naturally, smaller DNA chains move faster through the maze of pores than longer strands of DNA.

However, when DNA chains are roughly the same size as the pores through which they are attempting to pass, a process called "entropic trapping" takes place, Ugaz notes. During this process, the naturally coiled DNA fragment, in a sense, has to unthread a bit to pass through a pore, he says. Because the fragment wants to return to its coiled shape, it quickly squeezes through the smaller pore so that it can enter a larger pore where there is enough room for it to return to its natural shape.

Harnessing this entropic trapping effect for separation through a hydrogel marks a significant advancement in DNA studies, Ugaz says.

Although it has long been predicted that entropic trapping effects can potentially benefit a wide variety of applications including separation technologies, actually figuring out how to use this phenomenon previously has been difficult in hydrogels because it has not been clear how this transport mechanism is linked to the gel's porous structure, Ugaz explains.

In other words, hydrogels need to have very specific properties such as pore size distribution, and prior to these findings, there has been no way to know how to choose the right hydrogel that has the right properties, Ugaz notes.

"You want to be able to detect the smallest possible difference in size between DNA fragments," Ugaz explains. "The size of the fragments may be very close, and you may need to detect a difference of one unit in size. To do this, you would want to be able to specifically construct a hydrogel with the necessary pore structure to achieve this."

Ugaz's research provided the "instructions on how to do just that.

"We have a better picture of how to do this than what has existed," Ugaz says. "We know what the gel needs to look like and how it needs to be prepared.

"We're able to understand how to construct a gel that would allow DNA to move via an entropic trapping method that enhances separation performance and in turn leads to more effective analysis. This finding could have enormous implications by helping remove current barriers to separation efficiency"

Provided by Texas A&M University

Citation: Improving DNA analysis (2010, September 9) retrieved 18 May 2024 from https://phys.org/news/2010-09-dna-analysis.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.