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Einstein's Tea Leaves Inspire New Blood Separation Technique

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Scientists at Monash University in Australia have developed a process for rapidly and efficiently separating blood plasma at the microscopic level without any moving parts, potentially allowing doctors to do blood tests without sending samples to a laboratory.

The new method uses the same principle that causes tea leaves to accumulate at the center of the bottom in a stirred teacup, a phenomenon first explained by Einstein in the 1920s.

The research was done by Drs. Dian R. Arifin, Leslie Y. Yeo and James R. Friend, of the Monash University's Micro/Nanophysics Research Laboratory. Their findings were published in the current issue of the new open-access journal *Biomicrofluidics*.

Separating blood plasma from red blood cells, proteins and other microscopic particles is an essential step in many common medical tests, including those for cholesterol levels, drugs in athletes, blood types in donors and glucose levels in diabetics. Current testing requires samples to be taken in a doctor's office and sent off to a laboratory and analyzed with a large centrifuge, a process that can take several days.

In the new method, a tiny amount of blood enters a fluid chamber, and a needle tip is placed close to the surface of the blood at an angle. A voltage is applied to the needle, generating ions around its tip that repel the oppositely charged ions close to it. This creates an airflow known as "ionic wind" that sweeps across the surface of the blood, causing it to

circulate. The microscopic particles in the blood travel in a downward spiral because of the needle's angle relative to the surface.

When the fluid begins to circulate, one might intuitively expect the microscopic particles such as red blood cells would be pulled to the outside wall of the chamber owing to centrifugal force. But because of a phenomenon called the "tea leaf paradox," the particles are instead pulled inward near the bottom of the chamber. Einstein proposed an explanation to this phenomenon in 1926 when he noticed that tea leaves collected at the center of the bottom of a stirred teacup instead of being expelled outward.

The tiny chamber of blood, like the teacup, is a cylinder of liquid that is rotated at the top while the base remains stationary. To satisfy a zero-velocity condition at the base, an inward force near the bottom of the liquid is generated, suppressing the centrifugal force there. Thus the microscopic particles spiral inward toward the bottom of the chamber like a miniature tornado, leaving a clear layer of plasma above.

Yeo anticipates the technology could be incorporated into a chip roughly the size of a credit card. He said the devices could be produced cheaply with current manufacturing techniques -- about 50 cents per chip -- but could still be five to 10 years away from mass production.

Article: Microfluidic blood plasma separation via bulk electrohydrodynamic flows, *Biomicrofluidics* 1, 014103 (January-March 2007), accessible at link.aip.org/link/?bmf/1/014103

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