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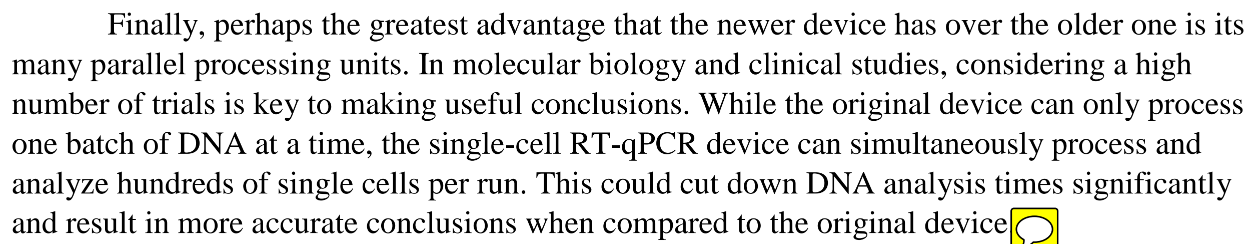
MCEN 4228-006
HW #2

DNA Analysis Device Comparison

The devices described in the papers “An Integrated Nanoliter DNA Analysis Device” [1] and “High-throughput microfluidic single-cell RT-qPCR” [2] both have the same goal in mind: to create an integrated DNA analysis system at the microscale in order to conveniently and accurately analyze DNA. Both papers also cite the high cost of traditional DNA analysis as a motivating factor. However, due to over a decade of advancement between the publishing of these two groups’ work, the single-cell RT-qPCR system has several noteworthy capabilities that the original device lacked. Overall, it is clear that while many design and fabrication principles have not changed in that time, numerous remarkable innovations have appeared.

An impressive aspect of both these DNA analysis devices is the integration of DNA amplification into each system. As indicated in the first paper, polymerase assisted amplification requires several linked steps that traditionally involve costly equipment and labor. The fact that both devices were able to minimize the volume of expensive reagents used as well as the number of user mediated steps gives both a major cost and convenience advantage over traditional PCR. Additionally, both devices integrate fluorescence detectors that allow for real time monitoring and DNA analysis. This allows for very rapid results in real time.

However, one major difference between the two devices is the integration of pre-analysis DNA processing such as cell capture and lysis, as well as the reverse transcription of RNA. The original device was loaded with a solution containing template DNA for amplification. This implies that entire cells were processed externally without the help of the analysis device. A major advantage of the single-cell RT-qPCR device is its integration of single cell capture and lysis within the system. In addition, DNA is acquired using reverse transcription of cell products in the newer device, whereas the source of DNA in the older device is uncertain. This allows the single-cell RT-qPCR device the benefits of single-cell analysis (as opposed to cell population analysis) and greater automation of pre-analysis DNA processing.



Finally, perhaps the greatest advantage that the newer device has over the older one is its many parallel processing units. In molecular biology and clinical studies, considering a high number of trials is key to making useful conclusions. While the original device can only process one batch of DNA at a time, the single-cell RT-qPCR device can simultaneously process and analyze hundreds of single cells per run. This could cut down DNA analysis times significantly and result in more accurate conclusions when compared to the original device

A similarity between the two devices that I found interesting was the way they were manufactured. Although a mold rather than an actual device was made in the newer paper, both utilized photolithography and other similar methods. It is clear that while the scientists and engineers of 15 years ago understood and the enormous power of microfabrication in DNA analysis, significant progresses have been made. In the next 15 years, it is very possible that DNA analysis accuracy and throughput will increase exponentially with further innovations in microfabriation technology.

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Citations

[1] Burns M. A., Johnson B. N., Brahmasandra S. N., Handique K., Webster J. R., Krishnan M., Sammarco T. S., Man P. M., Jones D., Heldsinger D., Mastrangelo C. H., and Burke D. T., 1998, “An Integrated Nanoliter DNA Analysis Device,” Science, **282**(5388), pp. 484–487.

[2] White A. K., VanInsberghe M., Petriv O. I., Hamidi M., Sikorski D., Marra M. A., Piret J., Aparicio S., and Hansen C. L., 2011, “High-throughput microfluidic single-cell RT-qPCR,” Proc. Natl. Acad. Sci. U. S. A., **108**(34), pp. 13999–14004.