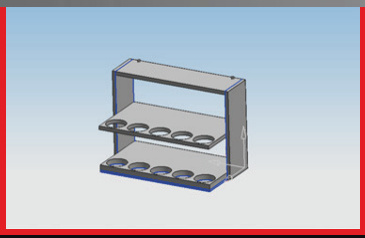
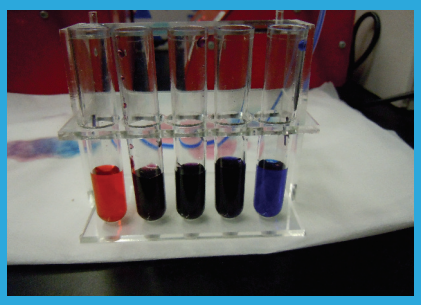
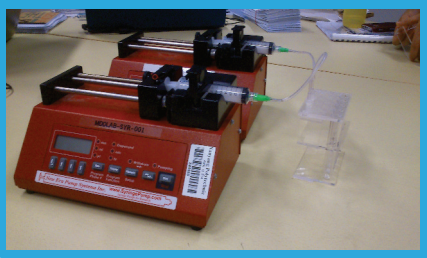


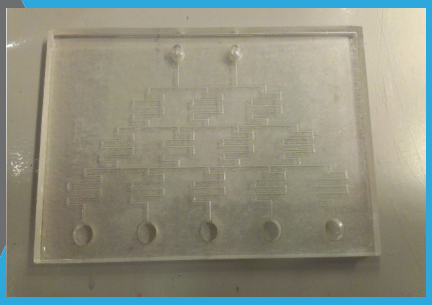
Design and Fabrication of a Microfluidic Gradient Generator

Abstract

Conventional serial dilution requires large volumes of buffer solution to achieve a very low concentration of a certain substance and only a bit of the mixture is going to be used. With the microfluidic gradient generator, we can reduce the volume of buffer solution used in order to save resources yet produce enough of the specific concentration of the substance we want. The method is to design a chip and then laser the design onto a piece of PMMA [Poly(methyl methacrylate)] with double sided tape, then attach the top piece to it. The result is a disposable chip capable of serial dilution of substances at a micro-level. This is aimed at reducing the costs of the resources, especially when the chip itself is inexpensive.







Introduction

The serial dilution of various cell media by Micro-fluidic Co-culture systems is important in microbiology as it enables convenient and accurate observations of cell interactions by physically separating them into wells. By producing concentration gradients of different cell media and controlling flow rate of these cell media into the system's various wells, the system proves to be a high throughput assay platform for cell-cell analysis. The entire process of cell gradient generation is a tedious and lengthy process, involving many procedures and steps. In our experiment, however, we manufactured our own gradient generator chip by use of carbon dioxide lasers and separated concentrations of red and blue dyes. The chip's integrity consists of a PMMA (polymethyl methacrylate) base, and two upstream wells lasered into it, leading out in a series of channels which eventually end in five downstream wells.

Methodology

The first step is to design the microfluidic gradient generator chip, which was made of a PMMA base with downstream wells, upstream wells and channels covered by another PMMA sheet to prevent leakage of fluids. In designing it, we used the designing software, AutoCad to map out the dimensions of the surface of the base. The second step was to design the top PMMA base with only upstream wells. The two would then be binded together.

Results

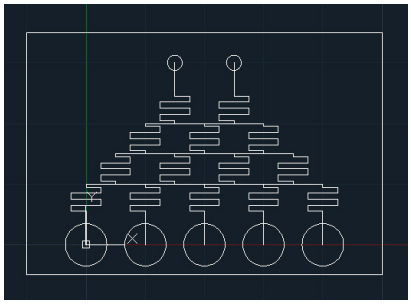
Theoretically, the concentration we should achieve according to the chip is 0%, 25%, 50%, 75% and 100%. However, there is no doubt that the concentration in reality differs by a certain percentage (±1%). This is due to imperfect mixing in the serpentine channels. We can further minimize this problem though, by simply extending the serpentine length to allow for more uniform mixing.

Conclusion

The chip proved to be a success as it had achieved what we intended it to do, which is to serial dilute. The chip design can be changed to suit different applications. For example, requiring more varying concentrations, we can increase the number of downstream wells. Cost wise, the chip is cheap. Lastly, it can also reduce the wastage of materials used in the conventional serial dilution methods.

Future improvements

Though the uses of our chip are potentially many, possible research in the future should concern blood typing, as this could save many lives. After refining the chip to be capable of blood typing, further improvements should be put in to make it cost effective such that it can be used to test blood types in hospitals. Blood typing by such chips will be fast and efficient, which is important in emergency situations common in hospitals. Also, manufacturing such small chips will be cheap, enabling mass-production of chips to be sold to hospitals and to countries where disease is rife, such as those in Africa where medical treatment is hard to come by due to the high medical expenses. The aim of making this chip is in the hopes of raising awareness among pharmaceutical manufacturing companies of the uses of the chip. If our aim is met, these companies will invest funds for research in refining the chip for more practical use in blood typing and mass produce the chip. We are confident that companies will realise the possible applications of the micro-fluidic gradient generator chip and seize the opportunity to aid us.



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