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Short Communication

Microfluidic Petri Dish: Leading Microfluidic Technology to the Future?

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DESCRIPTION

Electronic chips (microchips) have solved many problems from 1958 to the present (Figure 1a), and microchip products have been widely used in almost all products. The microchip has rigorous theory and technology. It has good durability, low cost, easy use, high reliability, low power consumption, and almost no need for peripheral equipment. The microfluidic chip is similar to the electronic chip, but the application range is far less than that of the microchip. Because all chemistry and life processes are based on fluids, life sciences and chemistry require microfluidic technology. For example, it is significant to use body-on-a-chip technology to simulate life systems [1]. The electron flow is easy to control because the electrons flow around the solid atomic lattice (solid) (Figure 1a). The micro flow of atoms or molecules is difficult to control because the atoms or molecules can only flow in the hollow (Figure 1b).

Before being widely used in life sciences and human health, the microfluidic chip still needs to solve many problems, especially the problem concerning micro pumps [2] (Figure 1b). For example, gravity [3] vacuum pumps [4,5] lose precise flow control, and diaphragm pumps [6,7] rely on deformable materials with poor biocompatibility. Cost, portability, simplicity, and ease of use also limit the application of microfluidic technology. Complex interfaces and designs bring reliability and life issues. Thurgood et al., tried to use simple balloons to drive instant diagnostic equipment [8]. Behrens et al., used 3D printing to manufacture microfluidic chips [9]. In addition, micro pump technology faces the problem of niche biology [10]. For example, cell-cell interactions and the molecular signals in the niche determine the fate of stem cells [11]. The hematopoietic stem cell niche promotes metastasis [12], and the stem cells niche accelerates tumor progression [13]. Cells form a microenvironment in traditional Petri dishes, and we must continue to use them. However, we do not have proper microfluidic technology to control the microenvironments in the Petri dishes, and we are reluctant to use a syringe [10] to transform the Petri dishes into microfluidic devices [14]. We hope to simplify the micro pumps and combine the pumps with Petri dish technology.

Molecules need microfluidics to transport to construct chemical microenvironment for cells. If we can put the micro pump in the Petri dish, we can build a complete microfluidic system. This kind of microfluidic Petri dish can be produced through injection molding and demolding processes. This solves the cost problem as well as the problem of operation obstacles. If a technology that allows for the precise control of cell microenvironments is developed, the microfluidic technology can be widely used.

The simplest localized motion is a one-dimensional vibrator with a stable flow field and with a flow rate that is proportional to the frequency (SMath pump) (Figure 1c) [15]. Following this theory, we designed the scanning magnetic field to control the 1mm magnetic beads and lead them to roll back and forth and drive the fluid (O-pump) (Figure 1d) [15]. The O-pump can be put directly into the Petri dish (Figure 1e) and becomes highly reliable. Thus, the micro pump has ultra-low power consumption and an ultra-long life span in the Petri dish. The microstructure forms a microfluidic system (Figure 1e). The microfluidic Petri dish can be operated as a traditional Petri dish, and the micro flow can be programmed by editing and playing a playlist on the mobile phone (Figure 1f) [16]. We designed a stem cell nest in the center of this microfluidic Petri dish—with ultra-slow microcirculation (<40 microns/s) and controllable exchange rate of molecules and nanoparticles. Embryonic stem cells, pluripotent induced stem cells, and mesenchymal stem cells can all proliferate in programmed microfluidic systems [16]. In the future, this microfluidic Petri dish can be further developed into a lab-on-a-chip that can be used as a mobile phone accessory for a wide range of applications in live simulations, human health, and organ reconstruction (Figure 1b).

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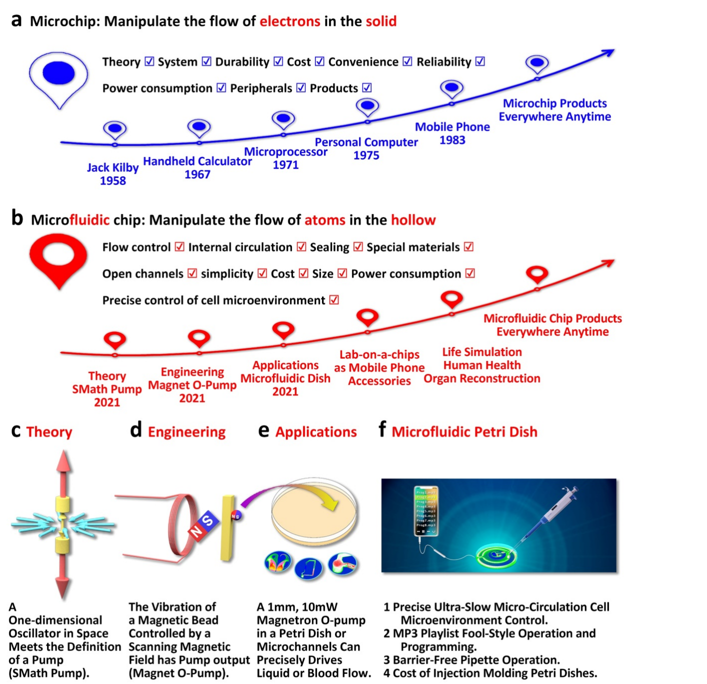

Figure 1: Technologies used in microfluidic petri dishes and their future application prospects.

CONCLUSION

Given a microfluidic Petri dish employs a technology that puts the most simplified micro pump into the Petri dish and establishes a microfluidic system. This technology is similar to the lithography technology mentioned in the history of integrated electronic circuit development. It solves many problems that hinder the widespread application of microfluidic technology in life sciences.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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