



A COMPREHENSIVE REVIEW ON ADVANCEMENT IN MICROFLUIDICS TARGETTED DRUG DELIVERY AND GENE THERAPY

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Abstract: Drug delivery system plays an important role in improving the treatment of various disease and cancer as well. The formulation procedure of drug delivery system in nanoscale is very difficult. So, several efforts been made towards developing and improving the drug delivery system. Microfluidics devices have unique advantage for development. It helps in developing effective drug carrier particles, cell free protein synthesis, fast techniques for direct drug screening. They put forward in improving quality of drug, gene and cell delivery system. They also help in the production of many viral and non-viral vector system. Microfluidics have the ability for correct handling of small liquid. This review discusses about the advancement in microfluidic strategies of targeted drug delivery and gene therapy. Moreover, this review discusses about the understanding of microfluidics, types of microfluidic devices and mechanism of microfluidics and recent application in drug and gene delivery.

Keywords: microfluidics, drug delivery system, drug and gene delivery

INTRODUCTION

Frequent development is done to improve novel drug and create new strategies for efficient delivery, to enhance treatment outcomes by enhancing bioavailability and targeting, while decreasing the side effects. There are many conventional method and strategies to synthesize drug or gene delivery system, they have numerous amounts of drawbacks as well such as drugs or chemicals to be used in large amount, some of the polydisperse particle affect the release profile and the difficulty relating with the localized drug delivery.

Many diseases are caused due to mutate or missing genes, that leads to abnormal proteins synthesis, that affect cellular function. Gene therapy is a medical intervention that treats disease by rectifying the genetic issue. Gene therapy works by altering a person's gene to heal a disease by restoring it with new or altered gene into the body. It requires the delivery of foreign genetic materials through the cell membrane without causing cell lysis. Innovative delivery of genetic material through the cell membrane is the important challenge in the gene therapy. So, there are lots and lots of method available in the market.

Microfluidics was developed in the 1950s, mainly used in inkjet printers. The process behind these printers is derived from microfluidics and it utilizes a very small tubes transporting the ink for printing. In 1970s, a mini gas chromatograph was built on a silicon wafer. Microfluidics is the science which examine the flow, fluidity, or flowability through miniturized channels. The technology of manufacturing of microminiaturized devices containing chambers and tunnels through which fluid flow.

UNDERSTANDING OF MICROFLUIDIC PARTS

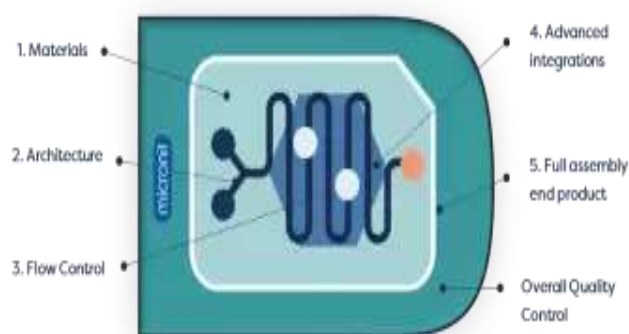


Fig: Microfluidic parts

- **Materials:** There are several materials used in microfluidic products but glass, silicon are commonly used. The material is selected because of its biocompatibility, optical transparency, chemical resistance, mechanical properties.
- **Architecture:** The architecture of this device can differ from simple single layer designs to complex multilayer systems. It is made up of diverse characteristics like micro channels, chambers and well-designed microminiatures to handle fluid.
- **Flow control:** It has the ability to operate and handle the fluids. This is achieved by active and passive method using external forces like pressure, electric fields and magnetic fields.
- **Integration:** The integration is composed of diverse elements in a single system. This can differ from integrating a single device to introducing real time monitoring.

TYPES

1. **Microfluidic Flow Cell:** The cells are uniquely curated to allow continuous flow of samples through a path of beam. It is used in various laboratory and industrial application. Through glass microfluidics we have the ability to assess the real time process.
2. **Microfluidic Droplet Generator:** This setup allows you to prepare highly reproducible micro sized droplets.
3. **Microfluidic Cell Sorting:** This helps in sorting or refining the samples. It can also cleanse the cell samples to form a well characterized group. This device sorts the sample according to their specific properties and helps in the area of stem cell research.
4. **Microfluidic Micro Mixers:** This mixes the small quantity of liquid swiftly and efficiently. They provide a very stable and controlled environment. These are a very important aspect in biochemical assay and chemical synthesis.
5. **Organ-on-a-chip:** This chip is an alternative for human organs. This device is used as more real and more relevant model for drug testing and disease modelling.

METHOD FOR PREPARING THE DRUG DELIVERY SYSTEM

1. T Junction:

- A small crossroad where two fluid streams meet – that is t junction. It is a point where continuous phase intersects with the dispersed phase at a right angle, forming T shape.
- This junction allows the formation of droplet depending on the properties of liquids used. The T junction is very important in many of the application and for chemical synthesis to biological assay.

2. Coflowing Junction:

- This refers to a specific design where two liquid flow parallel to each other mainly dispersed phase and continuous phase. Meeting at a junction where droplets of the dispersed phase is formed by interfacial tension it can be broken down by passively breaking the dispersed phase into small droplet.

3. Flow Focusing Technique:

- In this technique fluid is injected in different velocities creating bubbles side by side. It uses hydrodynamics as its principle. It does not require any additional driving force.

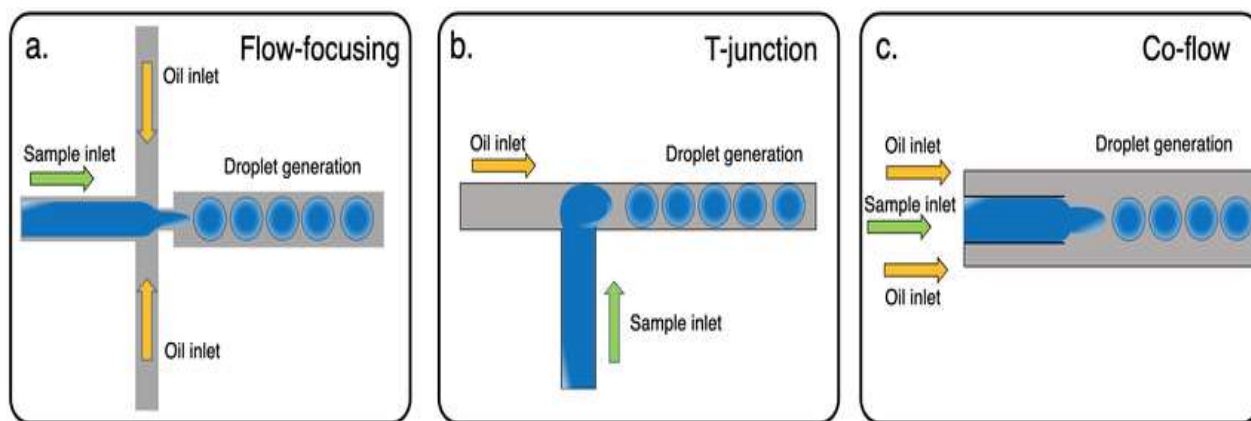


Fig: method of preparation of drug delivery system through microfluidics

APPLICATION

- Multiple emulsion created with the help of microfluidic have precise control over drug encapsulation and release.
- Researchers use microfluidics to process natural biomaterials like silk fibroin, collagen, gelatin for drug delivery systems.
- They are helpful in preparation of lipid nanoparticle production with much stability and homogeneity compared to conventional method.
- They enable precise fabrication of polymeric nanoparticle for drug delivery and gene therapy.
- Innovation like Nano Assembler GMP system showing a promise future.

FUTURE PERSPECTIVE

- Microfluidic provides cost effectiveness, high output while manufacturing drug delivery system and gene therapies.
- This allows precise customization and provides personalized treatments.
- It enhances gene delivery with targeted, efficient and lower toxicity.
- Formulation quality and consistency is optimized through real time monitoring.

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