Role of microfluidics in blood-brain barrier permeability cell culture modeling: Relevance to CNS disorders

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In vitro modeling of the human blood-brain barrier (BBB) is critical for pre-clinical evaluation and predicting the permeability of newly developed potentially neurotoxic and neurotrophic drugs. Here we summarize the specific structural and functional features of endothelial cells as a key component of the BBB and compare analysis of different cell culture models in reflecting these features. Particular attention is paid to cellular models of the BBB in microfluidic devices capable of circulating nutrient media to simulate the blood flow of the brain. In these conditions, it is possible to reproduce a number of factors affecting endothelial cells under physiological conditions, including shear stress. In comparison with static cell models, concentration gradients, which determine the velocity of transport of substances, reproduce more accurately conditions of nutrient medium flow, since they eliminate the accumulation of substances near the basal membrane of cells, not typical for the situation in vivo. Co-cultivation of different types of cells forming the BBB, in separate cell chambers connected by microchannels, allows to evaluate the mutual influences of cells under normal conditions and when exposed to the test substance. New experimental possibilities that can be achieved through modeling of BBB in microfluidic devices determine the feasibility of their use in the practice for pre-clinical studies of novel drugs against neurodegenerative diseases. © 2016 Bentham Science Publishers.

Blood-brain barrier

Drug development

Endothelial cells

In vitro cell models

Microfluidics

Permeability

Shear stress

Transport

aquaporin 4

excitatory amino acid transporter 1

excitatory amino acid transporter 2

excitatory amino acid transporter 4

fibroblast growth factor 2

gelatinase A

gelatinase B

glial cell line derived neurotrophic factor

multidrug resistance protein

multidrug resistance protein 1

platelet derived growth factor

thrombospondin 2

vasculotropin

Alzheimer disease

amyotrophic lateral sclerosis

Article

astrocyte

blood brain barrier

brain blood flow

brain capillary endothelial cell

brain development

CACO 2 cell line

cell culture

cell interaction

cell membrane permeability

cell transport

central nervous system disease

endocytosis

homeostasis

human

MDCK cell line

microfluidics

neuroprotection

Parkinson disease

protein expression

shear stress

tight junction

animal

blood brain barrier

cell culture

central nervous system disease

microfluidic analysis

pathology

pathophysiology

permeability

Animals

Blood-Brain Barrier

Cells, Cultured

Central Nervous System Diseases

Humans

Microfluidic Analytical Techniques

Permeability