Review Article

Future Journal of Pharmaceuticals and Health Sciences

Published by Pharma Springs Publication Journal Home Page: https://pharmasprings.com/fjphs

A Review on Brain Chip Technology

Gayathri DGNV*[1], Kavya K[1], Dusanapudi Swathi[2], Aminabee SK[3], Lakshmana Rao A[4]

[1]V. V. Institute of Pharmaceutical Sciences, Gudlavalleru – 521356, Krishna District, Andhra Pradesh, India
[2]Sri Vasavi Institute of Pharmaceutical Sciences, Pedatadepalli, Tadepalligudem-534101, West Godavari (Dist), Andhra Pradesh, India
[3]Department of Pharmacology, V.V. Institute of Pharmaceutical Sciences, Gudlavalleru – 521356, Krishna District, Andhra Pradesh, India
[4]Department of Pharmaceutical Analysis, V.V. Institute of Pharmaceutical Sciences, Gudlavalleru – 521356, Krishna District, Andhra Pradesh, India

Article History:

Received on: 20 July 2022
Revised on: 11 Aug 2022
Accepted on: 12 Aug 2022

Keywords:

Brain Chip,
Technology,
Paralysis,
Electrodes,
Woven Tissue

Abstract

In present days persons with severe developmental disorders overcome adversity able to perform realistic everyday tasks. Today researchers are developing a technology that could conceivably alleviate many difficulties associated with physical handicaps. They are, to be sure, highly specialized cells, but they function according to the laws that govern any other cells. About their electrical and chemical signals in the brain could be observed, documented as well as inferred as well as about there chemical compounds could be defined. Connection's that a brain's woven felt task could be modelled. In brief, a mind could be did study, whilst the kidney does. This technology is mainly used for paralysis. This is mainly used to monitor our body without usage of body parts. In this mainly the control of the brain with computers to control our body is done. In this mainly the level of dopamine will be controlled by electrodes of these technologies. The brain seems to be a tissue. It is just a difficult, tightly woven tissue, like no other we all know of from the multiverse, through it is made of cells.

*Corresponding Author

Name: Gayathri DGNV
Phone: +91 8333975845
Email: gayathrideevi2004@gmail.com

eISSN: 2583-116X pISSN:

DOI: https://doi.org/10.26452/fjphs.v2i4.306

Production and Hosted by

Pharmasprings.com
© 2022 | All rights reserved.

INTRODUCTION

Neurological dysfunction starts taking an enormous sociological fare, asserting a few 9 million lives annually, but also imposing an overall economic financial strain outpacing $700 billion as in the U.S. on its own. Recent predictions recommend a certain, within us, further than 7 million adults struggle from neurological conditions (E.g., Alzheimer's disease-5 million; Parkinson's disease-1 million; multiple sclerosis 400k) [1], and even at least 15% of youngsters under the age of 17 were diagnosed with neurocognitive illnesses. Neurodegenerative diseases seem to be expected to account for 6.3% of such disease burden internationally. But nevertheless, pharmaceutical research regarding central nervous system abnormalities persists extremely failure-prone, as well as the stenosis drugs trying to take 38% prolonged also to be accepted comparison as for non-CNS opioids [2]. As a result of all such problems, between the years 2005 as well as 2014, numerous largest pharmaceutical industries severely reduced with their CNS rug development projects or even excluded each other all together and one such trend seems to be of substantial issue

of about policy makers, who seem to be response as for campaigns to encourage invention through CNS study, forward into conquering the acute difficulties associated with all this domain [3].

The main path of between invention through study would be neuronal study would be through the design of in vitro central nervous system designs. Generally, in vitro techniques have made tremendous progress in recent years and becoming as such developed that they could probably replace animal studies in several applications [4]. Influential progressed in vitro operating systems are included, among many others, 3d-printed designs, or ganoids, as well as organ-on-a-chip (OOCS). They are further known as micro physiological system design, have been predicated through microfluidic chips usually contains mini engineered connective tissue and it represents distinct organ systems but also, preferably [5], recapitulates their important functions. This is predicted a certain acceptance like OOC processes through academic but also commercial laboratories could probably reduce research and development costs for every new medicine by such 10%–26%, within a time scale like 5 years [6]. Correspondingly, organs-on-a-chip retains evident approach such as central nervous study, as well as several microfluidic based neuronal model-based processes (i.e., "brains-on-a-chip") were already established. Through beam of a promise engrained through Nano fluidic Cooperating systems, an utterance "brain-on-a-chip" (BOC) is becoming widely popular as just a word to describe diversified in vitro model-based processes trying to target CNS systems which does not totally depend through micro-fluidics. This attitude aims of optimize about +improving a meaning of the term brain-on-a-chip as a destiny in vitro technology solutions, of about ensure that it needs to continue to indicate invention as well as impactful value added over conventional cultured cells system design [7].

Multiple Cell Types

The brain contains about 100 billion neural cells as well as up to 10 times greater glial cells. Along with neural cells as well as astrocytes, a brain contains endothelial cells, prices, microglia, oligodendrocytes, immune cells, and much more. Each one of these courses like cellular may consist subtypes like cells—for examples, neural cells lonely also include just as 500 subtypes, as well as the full extent still is unknowable. The truth that there's so many types of cells, with everyone having contact with its own fascinating way manner for each of the anyone else types of cells, makes it nearly impossible to collect all kinds like cell–cell conversations in vitro. Instances like important interactions also include following: astrocytes offer metabolic by-products such as neural cells; oligo-dendrocytes myelination neural cells; pericytes impact a permeation of an endothelial surface (blood–brain barrier) as well as microglia stimulate astrocytes interactions [Figure 1] [8].

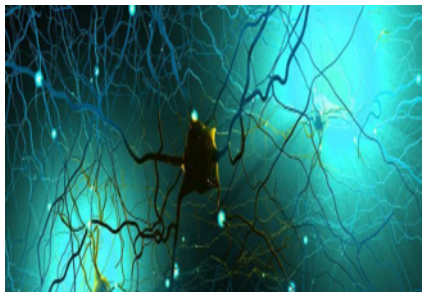

Figure 1: Neuron Cells

Electroencephalography (EEG)

Electroencephalography is indeed the machine where it records keeping each working of the brain through into the electrical pulses sent out by nerve fibres like the central nervous system. Those that capture one per structure as well as picture like connections in the brain send it but also data to a computer either through chip. There seem to be distinct electrical impulses such as neural network models of a brain create various methods for every action a human mind can. If patient stated "yeah" for such research, then there should be a distinct configuration, when a patient stated neither throughout its consideration once again device receives a special unique pattern [9]. Ever since going to record also every action this gets converted neural signals of about digital information as well as decides to send this to the device. Electroencephalography [Figure 2] has been held for converting to account electrical impulses of central nervous system nerve fibres of about digital information but also vies-versa. Previous researcher has created an electroencephalographic headband that either documents human mind fully functioning impulses.

Figure 2: Electroencephalography

A minimum of 3 main stages like brain-chip interconnecting were also identified because of a dimensional spectrum of biological entities associated: neural cells, tissue as well as brain. Now, neural cells are also most commonly linked up of about iron microelectrodes but rather oxide-insulated electrical micro transducers (e.g. misfits or electrolyte -oxide -semiconductor-capacitors) to record or enhance about their electrical events through disconnected traditions. All these first-level like interconnecting signifies a certain single cell have been going to contact as well as trying to signal of about cell-sized microdevices [10]. The current as well as initial exemplar of just such a chi has been suggested inside this brainstorm construction in which a tight electronic coupling among neural cells as well as chip has been obtained through the gold micronail formed micro-electrodes that had been engulfed through neural cells throughout a phagocytosis-like method. Large-scale high-resolution recordings through the individual neurons in such a network can indeed be acquired, rather than, attributable to a chip adorned with brass multi-transistor-array (MTA), just like illustrated with neural mechanisms in vitro [11]. The level 2 like interconnects implement a theory of creating a kind connection with both the brain tissue. This is attained, typically, through trying to place a tissue snip of many 100 nanometres durable in touch also with chip. We document, as an instance, a mat capturing slices out from rodent hippocampus. In such case scenarios, different micro devices sample an action of such a citizenry like cellular rather than that of single neural cells. The impulses will be in the type of local-field-potentials (LFPS), multi-unit but rather single-unit action. Through general, though if single-units could be discovered as well as identified, those that originally come as from action of many neural cells divided up within proximity of a sensor and it can be lowered, therefore, to such a population capturing scheme. Finally, a third stage like interconnecting has been symbolized through implantable chip devices within brain or even other portions of a nervous system, such as the spinal cord, peripheral nervous system but rather sense organs. Towards this honour, latest results from of the cyber art project display a certain high-resolution going to record from of the rat brain somatic sensory cortices could be conducted utilising MTAs [12].

Levels of Brain Chip Interfacing

A pedestal as for chip: A pedestal has been 2 cm, wherein a 4mm micro electrolytic array (brain chip) has been attached to it. This records all of the electric signals like brain nerve fibres as well as transmits them to such a signal amplifier [Figure 3].

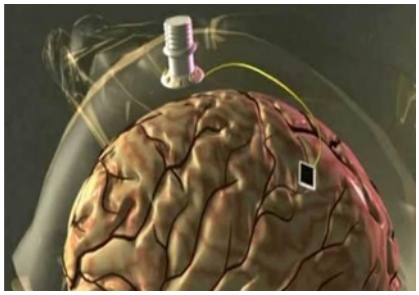

Figure 3: The Pedestal with Chip

Figure 4: Fibre Optic Cable

Fibre Optic Cable

It receives the signals sent by chip and sends it to a neural signal interpreter neural signal interpreter [Figure 4]: It converts the brain signals to digital signals and sends them to the computer, it can also convert digital signals into brain signals [Figure 5] [13].

Figure 5: Brain Connections

Development of Brain on Chip (BOC)

Functionally, a brain contains numerous layer upon layer wherein innumerable nerve cell, goal but also immunological cellular connect and thus are operationally secured even by skull through the mechanical stress although by the firmly BBB from of the toxicants. Now, a recapitulation of full structure and performance of a brain inside an engineered process seems to be disabled due to a restricted technic but also, thereby, recent research have decided to focus on it recapitulation of specific parts like brain tissue, such like unit-directional neural network, functionally tight BBB, myelination process, as well as structure of the spinal cord [14].

Ever since advancement of an in vitro cell-culture

technique. In 1907 neuronal cells were cultured in an open environment, such as glass substrates or petri dishes. The introduction of soft lithography by white sides allowed cultured cells in such physiologically constrained micro-environmental such like microchannels [15]. Later, microchannels as well as the various heights but also widths for such a single BOC could be fabricated utilising multi-step lithography technic, making it feasible of about conduct compartmentalized traditions, physiologically dividing a soma as well as axon.

Through fabricating ultra-high- but also low-height microchannels within such a single BOC, a axon as well as soma of such a nerve cell could be kept separate, allowing only axon of about go through a shallow channel. Such a "compartmentalization" technique that allows neurobiologists to review characteristic features of an axon themselves, cure except in the axonal continent, but rather research a renewal of an axon ever since axotomy. Moreover, geometric features like shallow streams where only axon could go through could be reconfigured, letting uni-directional axon development (i.e., axon diode) also be influenced. Moreover, through trying to construct 3 or even more channels inside bloc, an interconnected transmission f varied neural cells thru axons could be illustrated. Such BOCs as well permitted research like axon myelination through "real – time" by trying to visualize this under a magnifying glass.

Myelination is just a procedure wherein oligo dendrocyte feet sheath an axon. Myelination plays an important role within propagation like action potential through electromechanical shield to protect an axon from of the environmental. Whether the demyelination occurs mainly due of about immune disorders reactions or even a serious brain injury, neuron pathological brain illnesses, like multiple sclerosis, could be established. If indeed the myelination procedures could be recapitulated through BOC, one such console could function like an electro-optic window again for foundational research like myelination.

For instance, recent research has envisioned a phase like myelination utilising compartmentalized BOC process. Further to that, efficiency like electrical but also optical stimulations through myelination has been assessed just using compartmentalized brain-on chip process, displaying improved oligodendrocyte differences as well as packaging within existence like electrical and optical sensory stimuli. However, such micro channel-mediated brain-on chips pose numerous restrictions, such like 2d cell adherence and much firmer mechanical characteristics like silicon substrate. Moreover such a monolayer process cannot be used of about shape a transmit barrier, such like BBB [16].

Neural Ink-Latest Brain Chip

Neural ink is brain-machine [Figure 6] interface organisation co-founded through space as well as tesla founding member elongation musk including a group of specialists such as regions like neuroscientific, biochemistry but also robotics [17]. The brain chip developed by this company is called neural ink [Figure 7].

Figure 6: Neural Ink Logo

Figure 7: Neural Ink Brain Chip

It has passed all the trails on animals and now it is on human trails.

Future of Brain Chip

Although many brain-on chip models are developed, subsequent numerous factors must be regarded to exactly mimic the configuration as well as physiology of brain tissue: (1) cell sources, (2) cell–cell interactions and (3) cell–extracellular matrix (ECM) interactions.

First, human cell source materials have been compelled as recapitulating human mind physiology as well as working to develop precision medicine. Just like previously described, animal-originated cellular varies through the normal cell when it comes to about their genetic factors, but also cells in culture regularly lose important functions. Moreover, human-originated primary cells have been difficult to obtain. Therefore in regard, induced pluripotent stem cell (IPSC) advancements, presented such as 2006, is an effective applicant as providing human

cells. IPSCS could be acquired through going to deliver key factors of about stromal cells, which also whereupon influenced to distinguish into another cell, especially neural cells which are hard to isolate from of the human mind. Moreover, it allows the construction like precision medicine, which include patient-specific cocktail opioid design features, so because genetic data has been retained during in the induction of a pluripotent state and also the differentiation process [18]. The BBB designs have been manufactured utilising IPSCS-derived cellular but also highlighted the potential like engineered BBB designs such as precision medicine applications.

2nd, cell-cell relations must be carefully evaluated to know central nervous system illnesses greater. An on-chip reach is beneficial such as study and research cell-cell interactions which can summarize numerous complex relations among both cellular as well as recognize how illness begins as well as advancements thru cell communication. In the case of advertisement, microglia has been enabled through amyloid-beta, even as representative indicator, where it amplified nerve cells death thru interplay as for neural cells either through secretory neurotoxic inflammation variables as well as microglial activators. As a further exemplar, a synaptic, which would generally be a function such as trying to pass electronic as well as chemical signals among both neural cells, could be a route again for reproduction like neurological disorders. A valid representation indicator has been supplied thru inter-cellular interplay. Moreover, an on-chip study simpler a cell population as well as enables one to supervise a reaction of the each type of cell to produced opioids as well as, thus, will permit commercialization through choosing an effective opioids as well as trying to minimize unpleasant side-effects.

Finally, it's indeed needed to ascertain whom the extracellular matrix element should be used for in vitro culture, because of extracellular matrix not just features through simplistic physiological adherence but it also actions as just an indicating activating agent of about cellular. As seen in the decellularized brain extracellular matrix should be used in the civilization like neural cells obtained through direct reconditioning [19]. A neural cells cultivated within decellularized brain extracellular matrix have been distinguishable best than all those cultivated within typically utilised 2d culture and others in a collagen-based 3d civilization, helping to ensure not just structural stability but it also fully functioning puberty. Including calcium signals such variations were being shown thru trying to yes-associated protein (yap) signal, which would be implicated in such a centre stem cell fate regulating pathway influenced through mechanical cues. Such findings suggest a certain cell–extracellular matrix interactions significantly contribute to development as well as features like nerve cells. As yet another exemplar, astrocytes which have different functions within brain, such like glutamate recycling, modulation like inflammation, as well as circulation like cerebrospinal fluid are typically inside an inactive state. While exposed to physical harm, those who are becoming stimulated, trying to form a glial scar to guard an intact brain. However, even if astrocytes are still not exposed to physical harm, those who are becoming stimulated, trying to form a glial scar to guard an intact brain. However, even if astrocytes are still not exposed to physiological illustrations, particularly while cultivation in vitro in stiff substances and a less stress relaxing hydrogel, astrocytes gain entry into a kind activate state. So an unintended initiation like astrocytes also isn't desirable for such modelling of healthy brain tissue [Figure 8]. Starting to consider such variables, a preparedness of an acceptable matrix such as cultivation cells in the brain is just a pre-requisite for mimicking through vivo-like cellular functions on such an engineered platform [20].

Figure 8: Brain

CONCLUSION

From this entire outlook we've got capsulated the trail of brain on chip progress in terms of difficulty as well as high-throughput/high-content testing capacity. Diverse range brain on chips was always popularly used mostly for specific research purposes, such like axon-specific responses, cell–cell interactions, and high throughput screening. In spite of the progress along brain on chip innovation, the selection of cell sources, cell–cell interactions, and cell–matrix interactions must be pursued to precisely mimic brain physiology on an engineered platform.

ACKNOWLEDGMENT

We would like to thank our Principal sir, Dr. A. Lakshmana Rao, and Dr. Sk. Aminabee for supporting

and guiding us in writing the review article.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

Funding Support

The authors declare that they have no funding for this study.

REFERENCES

[1] J R Wolpaw, N Birbaumer, W J Heetderks, D J Mcfarland, P H Peckham, G Schalk, and T M Vaughan. Brain-computer interface technology: a review of the first international meeting. *IEEE transactions on rehabilitation engineering*, 8(2):164–173, 2000.

[2] Nidhi Behl, Vikrant Manocha, and Keshvi Chauhan. Implementation Of Brain Computer Interface. *International Journal of Engineering Research and Applications*, 1(3):807–812, 2000.

[3] O Tonet, M Marinelli, L Citi, P M Rossini, L Rossini, G Megali, and P Dario. Defining brain-machine interface applications by matching interface performance with device requirements. *Journal of neuroscience methods*, 167(1):91–104, 2008.

[4] M Hutzler, A Lambacher, B Eversmann, M Jenkner, R Thewes, and P Fromherz. High-resolution multitransistor array recording of electrical field potentials in cultured brain slices. *Journal of neurophysiology*, 96(3):1638–1645, 2006.

[5] C L Gooch, E Pracht, and A R Borenstein. The burden of neurological disease in the United States: A summary report and call to action. *Annals of neurology*, 81(4):479–484, 2017.

[6] A Akhtar, A Andleeb, T S Waris, M Bazzar, A R Moradi, N R Awan, and M Yar. Neurodegenerative diseases and effective drug delivery: A review of challenges and novel therapeutics. *Journal of Controlled Release*, 330:1152–1167, 2021.

[7] D W Choi, R Armitage, L S Brady, T Coetzee, W Fisher, S Hyman, and T Sherer. Medicines for the mind: policy-based "pull" incentives for creating breakthrough CNS drugs. *Neuron*, 84(3):554–563, 2014.

[8] A M Hopkins, E Desimone, K Chwalek, and D L Kaplan. 3D in vitro modeling of the central nervous system. *Progress in neurobiology*, 125:1–25, 2015.

[9] P Nikolakopoulou, R Rauti, D Voulgaris, I Shlomy, B M Maoz, and A Herland. Recent progress in translational engineered in vitro models of the central nervous system. *Brain*, 143(11):3181–3213, 2020.

[10] L Yildirimer, Q Zhang, S Kuang, C W J Cheung, K A Chu, Y He, and X Zhao. Engineering three-dimensional microenvironments towards in vitro disease models of the central nervous system. *Biofabrication*, 11(3):32003, 2019.

[11] P M Holloway, S Willaime-Morawek, R Siow, M Barber, R M Owens, A D Sharma, and M Zagnoni. Advances in microfluidic in vitro systems for neurological disease modeling. *Journal of Neuroscience Research*, 99(5):1276–1307, 2021.

[12] J Vanderburgh, J A Sterling, and S A Guelcher. 3D printing of tissue engineered constructs for in vitro modeling of disease progression and drug screening. *Annals of biomedical engineering*, 45(1):164–179, 2017.

[13] S C Zhang, M Wernig, I D Duncan, O Brüstle, and J A Thomson. In vitro differentiation of transplantable neural precursors from human embryonic stem cells. *Nature biotechnology*, 19(12):1129–1133, 2001.

[14] R Vargas, A Egurbide-Sifre, and L Medina. Organ-on-a-Chip systems for new drugs development. *ADMET and DMPK*, 9(2):111–141, 2021.

[15] N Franzen, W H Van Harten, V P Retèl, P Loskill, J Van Den Eijnden-Van Raaij, and M Ijzerman. Impact of organ-on-a-chip technology on pharmaceutical R&D costs. *Drug discovery today*, 24(9):1720–1724, 2019.

[16] M A Mofazzal Jahromi, A Abdoli, M Rahmanian, H Bardania, M Bayandori, S M Moosavi Basri, and M R Hamblin. Microfluidic brain-on-a-chip: perspectives for mimicking neural system disorders. *Molecular neurobiology*, 56(12):8489–8512, 2019.

[17] L J Millet and M U Gillette. New perspectives on neuronal development via microfluidic environments. *Trends in neurosciences*, 35(12):752–761, 2012.

[18] S Bang, S Jeong, N Choi, and H N Kim. Brain-on-a-chip: A history of development and future perspective. *Biomicrofluidics*, 13(5):51301, 2019.

[19] K Ndyabawe and W S Kisaalita. Engineering microsystems to recapitulate brain physiology on a chip. *Drug discovery today*, 24(9):1725–1730, 2019.

[20] B Miccoli, D Braeken, and Y C E Li. Brain-on-a-chip devices for drug screening and disease modeling applications. *Current pharmaceutical design*, 24(45):5419–5436, 2018.

Copyright: This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

Cite this article: Gayathri DGNV, Kavya K, Dusanapudi Swathi, Aminabee SK, Lakshmana Rao A. **A Review on Brain Chip Technology**. Future J. Pharm. Health. Sci. 2022; 2(4): 229-235.

© 2022 Pharma Springs Publication.