International Research Journal of Biotechnology Vol. 14(2) pp. 1-3, April, 2023
Available online http://www.interesjournals.org/IRJOB

Mini Review

The Uses of Pluripotent Stem Cells as a New Model for Embryology Gastrulation

Samuel Engida*

Department of Biotechnology, University of Ethiopia, Ethiopia

*Corresponding Author's E-mail: samuelengida18@gmail.com

Received: 29-Mar-2022, Manuscript No. irjob-23-94663; **Editor assigned:** 31-Mar-2022, PreQC No. irjob-23-94663(PQ); **Reviewed:** 14-Apr-2022, QC No. irjob-23-94663; **Revised:** 19-Apr-2022, Manuscript No. irjob-23-94663(R); **Published:** 26-Apr-2023, DOI: 10.14303/2141-5153.2023.43

Abstract

Embryonic Stem Cells (ESCs) are pluripotent stem cells that can differentiate into all three germ layers of the embryo, giving rise to each of the somatic cell types in the body. Pluripotent stem cells have been widely used to study and understand the developmental processes that take place during gastrulation, a key stage in embryonic development. During gastrulation, the embryo transforms from a simple ball of cells into a complex structure with multiple cell layers and distinct regions. Stem cells have the potential to differentiate into several cell types and thus are of great importance in the fields of medicine, biology and tissue engineering. Pluripotent stem cells, in particular, are cells that can differentiate into any cell type, making them highly valuable and versatile. These cells are derived from embryos, and their ability to differentiate into any cell type makes them a highly popular tool to study early embryonic development. In this review, we will explore the uses of pluripotent stem cells as a new model for embryology gastrulation and how they can be used to recapitulate the complex cellular movements and molecular events that occur during this developmental stage.

Keywords: Embryonic stem cells, Somatic cell, Gastrulation, Embryology; Cellular movements

INTRODUCTION

Embryonic Gastrulation

Gastrulation is the process by which the embryo transforms from a single layer of cells into a three-layered structure, consisting of the ectoderm, mesoderm, and endoderm. This is accomplished through a combination of cellular movements, cell differentiation and specification, and signaling cascades. In vertebrates, gastrulation begins with the formation of the primitive streak, a transient structure on the dorsal side of the embryo that marks the site of future germ layer formation. Cells at the posterior end of the primitive streak migrate and ingress between the ectoderm and endoderm to form the mesoderm. Concurrently, cells within the ectoderm migrate and ingress to form the endoderm. Finally, cells that remain on the surface of the embryo become the ectoderm. Signaling molecules such as bone morphogenetic protein (BMP), fibroblast growth factor (FGF), and Wnt are key regulators of gastrulation, controlling cell fate and differentiation **(Gebreyohannes EA et al., 2019).**

DISCUSSION

Modelling Gastrulation with Pluripotent Stem Cells

Pluripotent stem cells, both embryonic and induced Pluripotent Stem Cells (iPSCs), have the capability to differentiate into all three germ layers and can, therefore, provide a valuable tool for studying embryonic gastrulation. One approach to modelling gastrulation in pluripotent stem cells is through the use of 3D Embryoid Bodies (EBs), aggregates of cells that mimic the complex cellular structure of the early embryo. The formation of EBs can recapitulate early embryonic development, allowing for the generation of cells representative of all three germ layers. Studies have shown that cells within EBs undergo cellular movements similar to those observed during gastrulation, such as invagination and migration, thus providing a system for studying the mechanisms of gastrulation in vitro **(Oluma A et al., 2021).**

Another method for studying gastrulation is through the use of gastruloids, structures formed from pluripotent

stem cells that resemble the in vivo organization and gene expression patterns of the early embryo. Gastruloids can be generated from ESCs or iPSCs through the use of specific growth factors and signaling molecules that mimic the in vivo environment. Through this approach, it is possible to observe the morphological changes and cellular movements associated with gastrulation, as well as the molecular events that drive these processes **(Nyanzi R et al., 2014).**

Pluripotent stem cells can also be directed to differentiate into specific germ layers, allowing for the study of specific cellular behaviours and molecular events. For example, differentiation of ESCs into ectoderm, mesoderm, and endoderm has been used to investigate the signaling pathways and transcription factors that regulate germ layer formation. Additionally, iPSCs generated from patients with specific developmental disorders or diseases can be used to study the effects of genetic mutations on gastrulation and embryonic development **(Mutebi E et al., 2012).**

APPLICATIONS OF PLURIPOTENT STEM CELLS IN GASTRULATION RESEARCH

Pluripotent stem cells have not only been used to study normal embryonic development but can also be used to study diseases that occur during embryonic development. One such disease is spina bifida, which is a birth defect that occurs due to incomplete closure of the neural tube during gastrulation. Researchers have used mouse ESCs to study the effects of folate, a nutrient that is important for neural tube closure and has been identified as a preventative measure for spina bifida. The researchers found that folate deficiency leads to neural tube defects, but that administration of folate can prevent these defects **(Asiimwe D et al., 2020).**

Another disease that can be studied using pluripotent stem cells is Down syndrome. Pluripotent stem cells, which have the ability to differentiate into any type of cell in the body, can be used to create models of Down syndrome. Down syndrome is caused by the presence of an extra copy of chromosome 21, which can affect a variety of body systems and functions. By creating pluripotent stem cells from individuals with Down syndrome, researchers can study how chromosome 21 affects the development and function of different cell types, such as neurons or heart muscle cells. These models can also be used to test potential therapies for Down syndrome, such as gene editing approaches to correct the genetic abnormality that causes the disease **(Ketema EB et al., 2015).** Overall, using pluripotent stem cells to study Down syndrome has the potential to improve our understanding of this complex disorder and develop new treatments to improve the lives of those affected.

Investigating Signaling Pathways

Signaling pathways, such as BMP and FGF, play a critical role in regulating cell fate and differentiation during gastrulation. Using pluripotent stem cells, researchers can investigate the precise roles of these signaling pathways in controlling the specification of specific cell populations. For example, differentiation of ESCs into mesoderm can be used to study how BMP signaling regulates the formation of specific mesodermal cell types, such as hematopoietic or cardiovascular cells. Similarly, differentiation of ESCs into endoderm can be used to study how FGF signaling controls the formation of specific endodermal cell types, such as pancreatic or hepatic cells **(Mamo Y et al., 2019).**

Studying Cellular Behaviours

Cellular movements, such as invagination and migration, are key events in gastrulation that contribute to the formation and organization of the embryonic germ layers. Pluripotent stem cells can be used to study these cellular behaviours in vitro by directing their differentiation into specific germ layers and observing their movements in real-time. For example, endodermal differentiation of ESCs can be used to study the process of Epithelial-to-Mesenchymal Transition (EMT) and Mesenchymal-to-Epithelial Transition (MET) that occur during endodermal migration and organogenesis **(Patrick NB et al., 2021).**

Modelling Developmental Disorders

Pluripotent stem cells are a type of stem cell that has the capacity to differentiate into any cell type in the body. They have the potential to be used in the study and treatment of developmental disorders. Modelling developmental disorders with pluripotent stem cells involves creating and studying stem cell-derived models that mimic the development and function of specific cell types or tissues affected by the disorder **(Nduati NJ et al., 2016).**

For example, researchers can use pluripotent stem cells to create models of brain development disorders such as autism and schizophrenia. This allows them to study the genetic and environmental factors that contribute to the disorder and test potential treatments in a controlled environment. Pluripotent stem cells can also be used to model developmental disorders that affect other organs and tissues, such as the heart and pancreas. Stem cell-derived models can be used to study the disease mechanisms, test drugs, and develop new therapies. Overall, the use of pluripotent stem cells to model developmental disorders holds significant potential for advancing our understanding of these complex conditions and developing effective treatments for them **(Omar SM et al., 2018).**

CONCLUSION

In conclusion, pluripotent stem cells have been instrumental in providing a new model for studying embryology gastrulation. This approach has allowed researchers to simulate and study early developmental processes in a controlled environment that is not possible with traditional methods. Furthermore, it has provided valuable insights

into the development of various organs and tissues in the early stages of embryonic development, which has potential implications for regenerative medicine. However, there are still numerous challenges that need to be addressed for this technology to be fully utilized, including controlling differentiation and managing ethical concerns. Nonetheless, it is clear that pluripotent stem cells have revolutionized our understanding of embryonic development and have the potential to drive significant advancements in biomedical research.

CONFLICT OF INTEREST

None

REFERENCES

1. Gebreyohannes EA, Netere AK, Belachew SA (2019). Glycemic control among diabetic patients in Ethiopia: A systematic review and meta-analysis. PloS one. 14: e0221790.
2. Oluma A, Abadiga M, Mosisa G, Etafa W (2021). Magnitude and predictors of poor glycemic control among patients with diabetes attending public hospitals of Western Ethiopia. PloS one. 16: e0247634.
3. Nyanzi R, Wamala R, Atuhaire LK (2014). Diabetes and quality of life: a Ugandan perspective. J Diabetes Res. 2014: 402012.
4. Mutebi E, Nakwagala F, Nambuya A, Otim M (2012). Undiagnosed diabetes mellitus and impaired glucose tolerance among hypertensive patients in Mulago Hospital, Kampala, Uganda. Afr J Diabetes Med. 20.
5. Asiimwe D, Mauti GO, Kiconco R (2020). Prevalence and risk factors associated with type 2 diabetes in elderly patients aged 45-80 years at Kanungu District. J Diab Res. 2020.
6. Ketema EB, Kibret KT (2015). Correlation of fasting and postprandial plasma glucose with HbA1c in assessing glycemic control; systematic review and meta-analysis. Arch Public Health. 73: 1-9.
7. Mamo Y, Bekele F, Nigussie T, Zewudie A (2019). Determinants of poor glycemic control among adult patients with type 2 diabetes mellitus in Jimma University Medical Center, Jimma zone, south west Ethiopia: a case control study. BMC Endocr Disord. 19: 1-11.
8. Patrick NB, Yadesa TM, Muhindo R, Lutoti S (2021). Poor Glycemic Control and the Contributing Factors Among Type 2 Diabetes Mellitus Patients Attending Outpatient Diabetes Clinic at Mbarara Regional Referral Hospital, Uganda. Diabetes Metab Syndr Obes. 14: 3123.
9. Nduati NJ, Simon K, Eva N, Lawrence M (2016). Factors associated with glycemic control among type 2 diabetes patients attending Mathari National Teaching Hospital, Nairobi Kenya. J Endo Diab. 3: 1-11.
10. Omar SM, Musa IR, Osman OE, Adam I (2018). Assessment of glycemic control in type 2 diabetes in the Eastern Sudan. BMC Res Notes. 11: 1-5.