Mains Practice Question

Q. One of the most profound advances in the last decade of biomedical research has been the development of human induced pluripotent stem cell (hiPSC). Discuss the advantages and challenges of using stem cells in biomedical field. (250 words)

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Approach

- Introduce the topic by defining stem cells and research associated.
- Discuss the advantages and concerns related to it.

Introduction:

- **Induced pluripotent stem cells (iPSCs)** are derived from skin or blood cells that have been reprogrammed back into an embryonic-like pluripotent state that enables the development of an unlimited source of any type of human cell needed for therapeutic purposes.
- Reprogramming of human cells to iPSCs was reported in November 2007 by two independent research groups: Shinya Yamanaka of Kyoto University, Japan, who pioneered the original iPSC method, and James Thomson of University of Wisconsin-Madison who was the first to derive human embryonic stem cells.

Body:

Applications of technology

- **Disease modeling and drug development:** An attractive feature of human iPS cells is the ability to derive them from adult patients to study the cellular basis of human disease. Since iPS cells are self-renewing and pluripotent, they represent a theoretically unlimited source of patient-derived cells which can be turned into any type of cell in the body. These cells have been generated for a wide variety of human genetic diseases, including common disorders such as Down syndrome and polycystic kidney disease.
- One of the main uses of HiPSC has been in **genetic disease** modeling in organs and tissues, such as the brain (Alzheimer's, Autism Spectrum Disorders), heart , and skeletal muscle (Amyotrophic Lateral Sclerosis, Spinal Muscle Atrophy).
- **Other uses**- In Organ synthesis, in generation of Red blood cell, In Clinical trials, as a Anti-aging properties.

Concerns

- For putative regenerative medicine applications, patient safety is the foremost consideration. Standardized methods must be developed to characterize iPSCs and their derivatives. Furthermore, reprogramming has demonstrated a proof of-principle, yet the process is currently too inefficient for routine clinical application.
- Despite numerous technical advances in the derivation of human iPSCs, relatively little is known about their molecular and functional equivalence to Embryonic Stem Cells (ESCs), which could affect their potential therapeutic utility.

- There are also ethical concerns related to stem cells, such as designer babies, intervention in human genetic pool etc.
- There are also concerns regarding risks and experimental interventions which may be irreversible.

Conclusion:

Addressing this question will require a careful analysis of the genomic integrity of human iPSCs, as well as the development of optimized differentiation protocols and reliable assays to evaluate the functionality of iPSC-derived specialized cells.