Embryonic stem cells

History

- James Thomson (1998) isolated cells from the inner cell mass of the early embryo and developed the first human embryonic stem cell lines

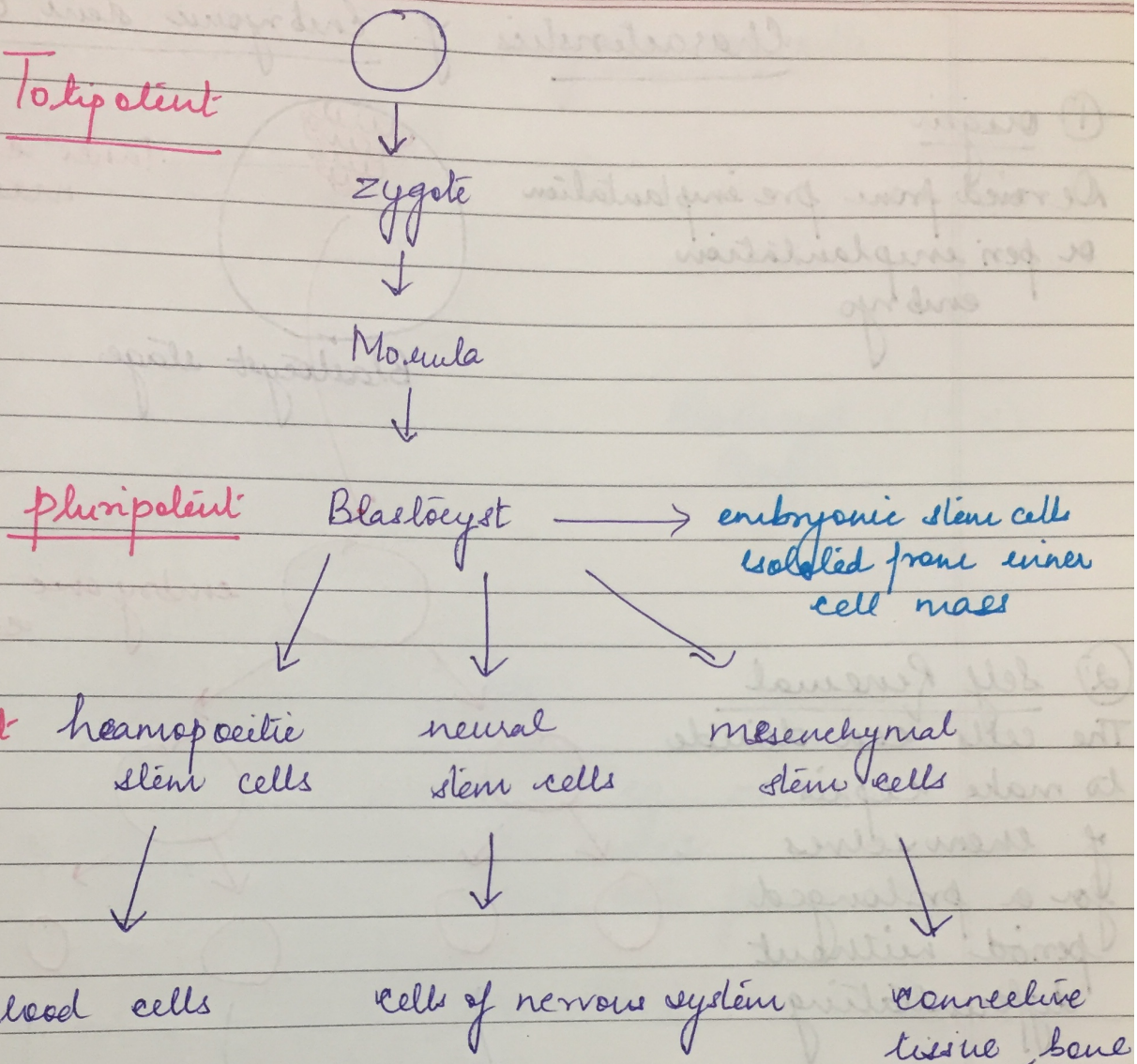
- John Gearhart (1998) derived human embryonic germ cells from fetal gonadal tissue (primordial germ cells)

Introduction

- A stem cell has the ability to continuously divide and differentiate into various other kinds of cells and tissues
- These cells have long term self renewal
- These are unspecialized but can become specialized cells in response to external and internal chemical signals

Stem cell Types

(1) **Totipotent** - ability to differentiate into all types including placental cells
(2) **Pluripotent** - ability to differentiate into all types except placental cells eg (embryonic stem cells)
(3) **Multipotent** - differentiate into specific cells eg haemopoetic stem cells
(4) **Unipotent** - differentiate into one type of common progenitor cell eg spermatogonial stem cells



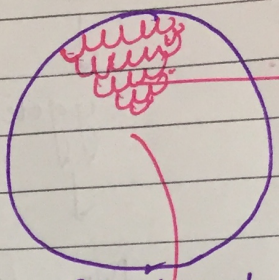
Embryonic stem cells

- These are derived from embryos at a developmental stage before the time that implamandation normally occur in the uterus.
- The inder cell mass have the potential to generate any cell type before implantation
- These cells are removed and cultured under appropriate conditions to form embryonic stem cells.

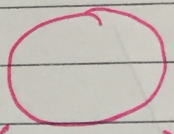
Characteristics of Embryonic stem cells

① Origin

Derived from pre implantation or peri implantation embryo

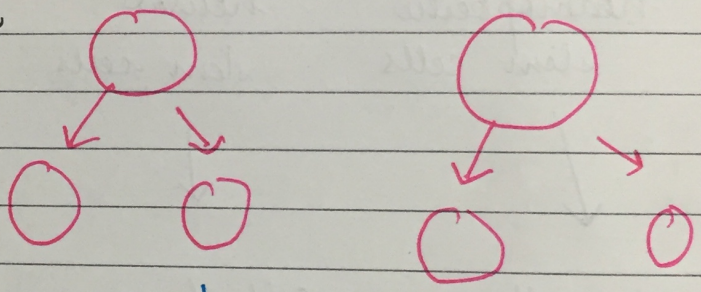


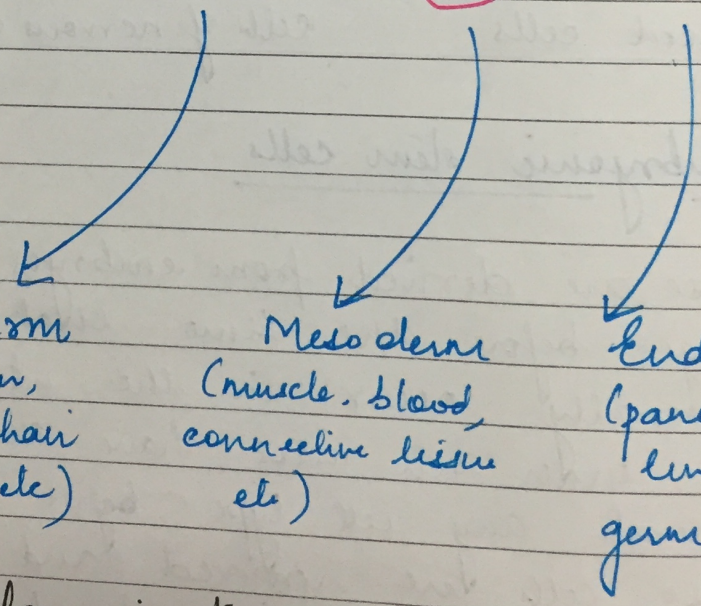
Blastocyst stage



② Self Renewal

The cells can divide to make copies of themselves for a prolonged period without differentiating





Ectoderm (cells of brain, spinal cord, hair skin teeth etc)

Mesoderm (muscle, blood, connective tissue etc)

Endoderm (pancreas, stomach, liver, lungs germ cells)

③ Pluripotency - Embryonic stem cells can give rise to cells from all three germ layers even after being cultured for a long time

Isolation of Embryonic stem cells

Invitro fertilization (Day 0) → Totipotent cells (Day 3)

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Blastocyst (ICM) (Day 5) → Culture the cells in culture medium (embryonic stem cells)

Applications of stem cells

1. Cell replacement therapy - eg neurons for Alzheimer or parkinson disease, pancreatic cells for diabetes, heart cells for myocardial infarction patients
2. Tissue repair and regeneration - skin replacement therapy
3. Understanding human development and diseases
4. Drug testing and gene therapy

Stem cells and cloning

- cloning by somatic cell nuclear transfer
- first successful nuclear transfer to the enucleated oocytes was done by J. Gurdon in Xenopus
- first mammal to be cloned was sheep named Dolly by Ian wilmut