SUBJECT: sc-RNA sequencing LECTURE: cell development DATE: Feb/26. 2025

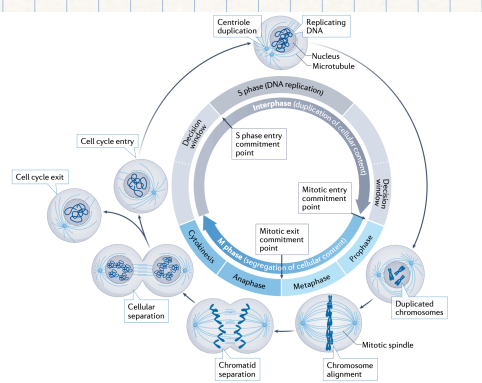
IMPORTANT (EQUATIONS, LAWS, ETC.)

cell fate, cell division (proliferation), cell differentiation, decision window, mitosis, interphase hematopoiesis, B cell, T cell.

NOTES

cell fate: Cell fate refers to the developmental trajectory and final functional identity that a cell adopts, determined by intrinsic genetic programs and extrinsic signals.

cell division: Cell division is the process by which a cell splits into two daughter cells.



1.Interphase: The cell grows, replicates its DNA, and prepares for division.

2.Mitosis (or Meiosis):

Prophase: Chromosomes condense and become visible.

Metaphase: Chromosomes align at the cell's equatorial plane.

Anaphase: Sister chromatids separate and move to opposite poles.

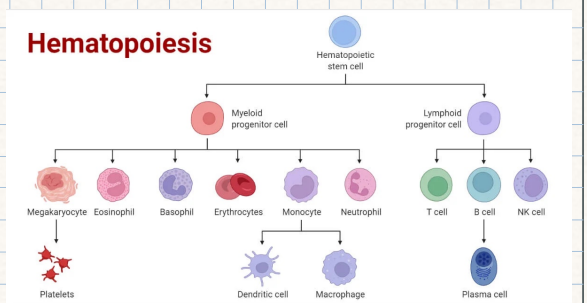
Telophase: Chromosomes de-condense, and nuclear membranes reform.

3.Cytokinesis: The cytoplasm divides, resulting in two (or more) distinct daughter cells.

decision window refers to a critical phase during the cell cycle where the cell assesses internal and external signals to determine whether to proceed with division, pause, or enter a resting state.

cell differentiation: Cell differentiation is the process by which a less specialized cell, such as a stem cell, develops into a more specialized cell type with a distinct structure and function, driven by specific gene expression patterns and environmental cues.

an example of cell differentiaion : **Hematopoiesis**



Hematopoietic Stem Cell (HSC): The origin of all blood cells.

Myeloid Progenitor: Produces red blood cells, platelets, and most white blood cells.

Lymphoid Progenitor: Generates T cells, B cells, and NK cells.

Megakaryocyte: Forms platelets for clotting.

Eosinophil, Basophil, Neutrophil: White blood cells fighting infections and parasites.

Erythrocytes: Red blood cells carrying oxygen.

Monocyte: Differentiates into macrophages and dendritic cells.

T cell, B cell, NK cell: Lymphocytes for immune defense.

Platelets: Essential for blood clotting.

Dendritic Cell, Macrophage, Plasma Cell: Key players in immune response and antibody production.

SUBJECT: sc-RNA sequencing LECTURE: cell development DATE: Feb 26. 2025

IMPORTANT (EQUATIONS, LAWS, ETC.)

stem cells, somatic (adult) stem cells, embryonic stem cells, inner cell mass(ICM),

NOTES

stem cells: Stem cells are undifferentiated cells with the unique ability to self-renew and differentiate into specialized cell types.
They are broadly categorized into **embryonic stem cells**, which are pluripotent and can give rise to all cell types, and **adult(somatic) stem cells**, which are multipotent and generate specific lineages within a particular tissue.
Induced pluripotent stem cells (iPSCs) are adult cells that have been genetically reprogrammed to an embryonic stem cell-like state, gaining the ability to differentiate into virtually any cell type in the body.

Feature	Somatic Stem Cells (Adult Stem Cells)	Embryonic Stem Cells
Origin	Found in specific tissues (e.g., bone marrow, brain, skin)	Derived from the inner cell mass of a blastocyst (early embryo)
Potency	**Multipotent** – can become only a limited range of cell types related to their tissue of origin	**Pluripotent** – can differentiate into any cell type in the body
Function	Tissue maintenance and repair	Formation of all body tissues during development
Availability	Harder to isolate, limited in number	Easier to grow in large quantities in the lab
Proliferation	Limited self-renewal, may lose potency with age	Can divide indefinitely under proper conditions
Therapeutic Use	Used in regenerative medicine, but with limited applications	High potential for regenerative medicine, but ethical issues limit use

Somatic stem cells are located in specific areas in body:
Bone marrow: Hematopoietic stem cells (blood cells) and mesenchymal stem cells (bone, cartilage, fat).
Skin (epidermis): Epidermal stem cells for skin renewal.
Intestinal lining: Intestinal stem cells in crypts for gut tissue maintenance.
Brain: Neural stem cells in regions like the hippocampus and subventricular zone.
Muscle: Satellite cells for muscle repair and regeneration.
Liver: Hepatic stem cells for liver tissue maintenance.

embryonic stem cells
Zygote: This is the initial cell which contains all the genetic information necessary to form a new individual.
Two cells: After the zygote undergoes its first division, it splits into two cells. This is the beginning of the process of cleavage, where the zygote divides repeatedly.
Four cells: The two cells further divide to form four cells. This rapid division continues without significant growth in the overall size of the embryo.
Morula: After several more divisions, the embryo forms a solid ball of cells called a morula. This typically occurs when there are around 16-32 cells.
Blastocyst: The morula continues to divide and eventually forms a blastocyst, which is a hollow structure filled with fluid. The blastocyst has an **inner cell mass (embryonic stem cells)** that will develop into the embryo and an outer layer of cells called the trophoblast, which will form part.