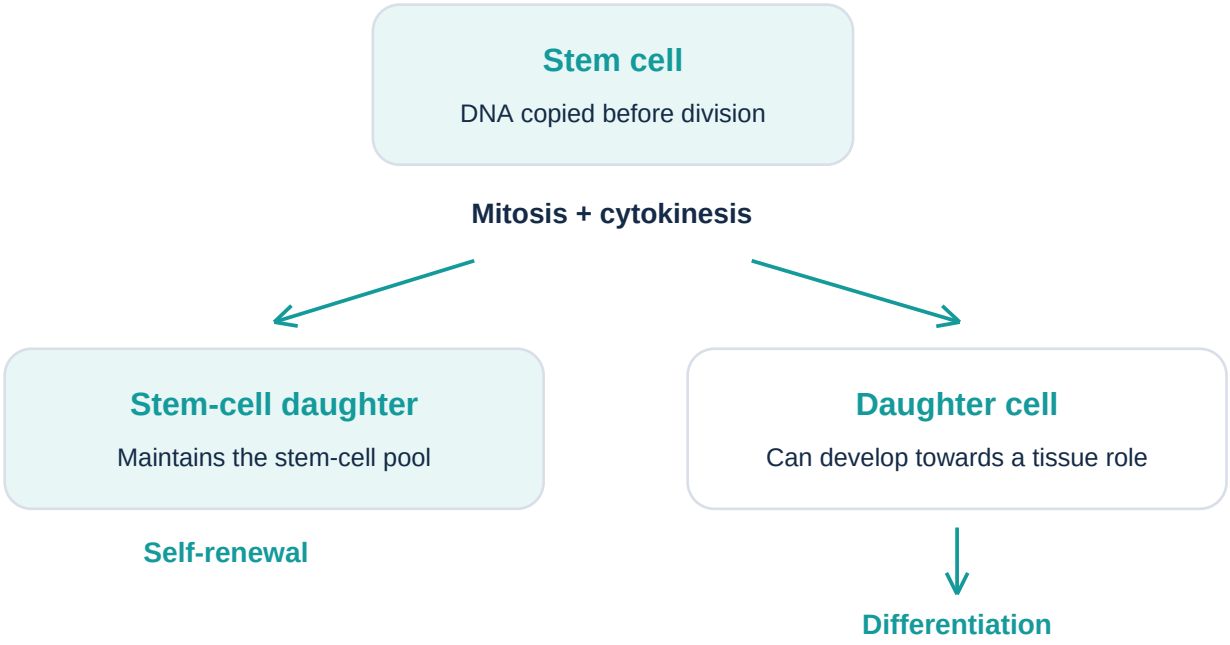
Renew the supply; replace the cells

A stem cell is an unspecialised cell with the capacity to self-renew and to give rise to specialised descendants.

1. TWO OUTCOMES SUPPORT THE TISSUE



One possible lineage is shown, not a fixed rule for every division. Stem-cell divisions can also produce two stem cells or two cells committed to differentiation.

2. SELF-RENEWAL PRESERVES THE SOURCE

Some descendants retain stem-cell properties, so the tissue keeps a supply for future replacement. If every descendant specialised, the stem-cell pool could be depleted.

3. DIFFERENTIATION PROVIDES THE RIGHT FUNCTION

Descendants develop the structures and activities needed for their tissue role. Producing more cells and making those cells specialised are related, but distinct, processes.

Stem-cell properties and possible division outcomes: NIH, Stem Cell Basics.

Scope: Cambridge Biology 9700 syllabus, section 5.1, outcome 5, p. 23.

From new cells to working tissue

Stem cells contribute to routine cell replacement and to tissue repair after injury. Their descendants supply the specialised cells that are needed.

1. ROUTINE REPLACEMENT

Cells are lost during normal tissue turnover. In the intestinal lining, resident stem cells maintain their own population while generating descendants that mature into epithelial cells.

2. TISSUE REPAIR: CONNECT THE STEPS

1 **Cell loss or injury**

The tissue needs replacement cells.

↓

2 **Cell production**

Stem cells and progenitors divide by mitosis.

↓

3 **Specialisation and integration**

Descendants help restore tissue structure and function.

3. BLOOD: A CONTINUOUS SUPPLY

Blood-forming stem cells in bone marrow give rise to blood-cell lineages, including red blood cells and immune cells. Progenitors are intermediate descendants that multiply before maturing. This is a sequence of stages, not a single step.

4. SKIN: MAINTENANCE AND REPAIR

Stem cells help replenish the epidermis and contribute to healing cuts and scrapes. Repair also involves other cells and tissue signals; stem cells are not the only participants.

Intestinal renewal: NIDDK, research update, 2018.
Blood-cell formation: Alberts et al., Molecular Biology of the Cell.

Scope: Cambridge Biology 9700 syllabus, section 5.1, outcome 5, p. 23.

Keep the processes distinct

Use each biological term for its own job. A complete explanation connects cell production with specialisation and the needs of the tissue.

1. THREE TERMS, THREE MEANINGS

MITOSIS	Divides the nucleus, normally preserving the chromosome complement in each daughter nucleus.
SELF-RENEWAL	Produces descendants that retain stem-cell identity, maintaining or increasing the stem-cell pool.
DIFFERENTIATION	Changes cell properties so that a descendant becomes suited to a specialised function.

2. NOT EVERY STEM CELL MAKES EVERY CELL TYPE

Adult tissue stem cells usually produce a restricted range of descendants appropriate to their tissue. A blood-forming stem cell normally gives rise to blood lineages, not any cell in the body.

3. REPAIR CAPACITY IS NOT UNLIMITED

Stem cells are not always actively dividing. Their activity depends on tissue needs and local signals. The presence of stem cells does not mean that every injury can heal completely or that all tissues regenerate equally well.

Core connection: mitotic cell division supplies new cells; self-renewal retains a source; differentiation provides cells suited to replacement and repair.

Self-renewal and blood lineages: Alberts et al., Molecular Biology of the Cell.
Tissue-specific potential and activity: NIH, Stem Cell Basics.
Skin repair and regeneration: NIGMS, What Are Stem Cells?, 2024.

Scope: Cambridge Biology 9700 syllabus, section 5.1, outcome 5, p. 23.