

Cell Cycle Game Key: Blood-forming Stem Cell in the Bone Marrow

If you are in G_1 or G_0 and roll: **Then. . .**

- 2, 3, 4, 5, 6, 7 The body needs more blood cells:
- Grow some by adding enough extra clay to your cell that it increases to about 1.5 times its size at the beginning of G_1 .
 - Move to the S phase.
- 8 The body needs more blood cells, but your cell is growing slowly right now. Stay in G_1 for this round. On your next turn, grow by adding some clay to enlarge your cell to 1.5 times its size, and move to the S phase.
- 9, 10 No new blood cells are needed right now. Stay in G_1 , and roll again next turn.
- 11, 12 The body has plenty of blood cells, but your cell has lost its normal controls and is getting ready to divide anyway. Roll the number cubes again. If you roll 2–8, the immune system has recognized and destroyed the developing cancer cell, and so start over in G_1 as a new blood-forming stem cell. If you roll 9–12, move your cell to S, and continue through the cell cycle as a cancer cell. Ask your teacher for a copy of the cancer cell cycle key, and follow that on your next turn.

If you are in S and roll. . . **Then. . .**

- 2, 3, 4, 5, 6, 7, 8 Your cell's DNA replicates perfectly. Advance to G_2 phase.
- 9, 10 There was a DNA replication error. Wait until your next turn while repairs are made. Then advance to G_2 .
- 11, 12 There was a DNA replication error. It cannot be repaired. Your cell awaits destruction. Begin again next round with a new blood-forming stem cell in G_1 .

Continue to the next side for G_2 and M phases of the cell cycle.

**If you are in G₂
and roll. . .**

2, 3, 4, 5, 6, 7, 8

Then. . .

All is well. Cyclin, a protein that regulates progress through the cell cycle, has accumulated.

- Grow a little more by adding another bit of clay to enlarge your cell to about twice its size at the beginning of G₁.
- Enter M right away, and roll again as part of the same round.

9, 10, 11

Cyclin accumulates slowly. Stay in G₂ for this round. In the next round:

- Grow a little more by adding another bit of clay, to enlarge your cell to about twice its size at the beginning of G₁.
- Enter M right away, and roll again as part of the same round.

12

Something has gone wrong with the factors that regulate your cell's cycle. Your cell is stuck in G₂ and will be destroyed. Begin again next round with a new blood-forming stem cell in G₁.

**If you are in M
and roll. . .**

2, 3, 4, 5, 6, 7, 8,
9

Then. . .

All is well. Your cell's chromosomes line up and progress through mitosis and cytokinesis. Separate your cell into two daughter cells by pinching it in half. Set one cell aside in your plastic cup, where it will differentiate into an adult blood cell. Move the other cell forward to continue to G₁ as a blood-forming stem cell.

10,11

There was a mitotic error. Your cell's chromosomes did not separate properly. Await destruction. Next round, start over as a new blood-forming stem cell in G₁.

12

Mitosis was complete, but cytokinesis did not work properly. Await destruction. Begin again next round as a new blood-forming stem cell in G₁.

Cell Cycle Game Key: Liver Cell

If you are in G₁ or G₀ and roll: 2, 3, 4, 5, 6	Then. . . The liver does not need new cells right now. Move to G ₀ , or stay there if you are already there.
7, 8, 9	The liver needs new cells! <ul style="list-style-type: none">• Grow by adding enough extra clay to your cell to enlarge it to about 1.5 times its size at the beginning of G₁.• Move to the S phase.
10, 11	The liver needs new cells, but your cell is growing slowly right now. Skip one turn. On your next turn, do not roll the number cubes. Instead: <ul style="list-style-type: none">• Grow by adding enough extra clay to your cell to enlarge it to about 1.5 times its size at the beginning of G₁.• Move to the S phase.
12	The liver does not need new cells right now, but your cell has lost its normal controls. Roll the number cubes. <ul style="list-style-type: none">• If you roll 2–8, the immune system has recognized and destroyed the cancer cell. On your next turn start over in G₁ as a new liver cell. or <ul style="list-style-type: none">• If you roll 9–12, move your cell to S. You will continue through the cell cycle simulation as a cancer cell. Ask your teacher for a copy of Student Sheet 13.1e, and follow that on your next turn.
If you are in S and roll. . . 2, 3, 4, 5, 6, 7, 8 9, 10	Then. . . Your cell's DNA replicates perfectly. Advance to G ₂ phase. There was a DNA replication error. Skip one turn while repairs are made. On your next turn do not roll the number cubes, but advance to G ₂ .
11, 12	There was a DNA replication error. It cannot be repaired. Your cell awaits destruction. In the next round start over as a new liver cell in G ₁ .

Turn over for G₂ and M phases of the cell cycle.

**If you are in G₂
and roll. . .**

2, 3, 4, 5, 6, 7, 8,
9

Then. . .

All is well. Cyclin, a protein that regulates progress through the cell cycle, has accumulated.

- Grow a little more by adding another bit of clay to enlarge your cell to about twice its size at the beginning of G₁.
- Enter M right away, and roll again as part of the same round.

10, 11

Cyclin accumulates slowly. Stay in G₂ for this round. In the next round,

- Grow a little more by adding another bit of clay to enlarge your cell to about twice its size at the beginning of G₁.
- Enter M right away, and roll again as part of the same round.

12

Something has gone wrong with the factors that regulate your cell's cycle. Your cell is stuck in G₂ and will be destroyed. In the next round start over as a new liver cell in G₁.

**If you are in M
and roll. . .**

2, 3, 4, 5, 6, 7, 8,
9

Then. . .

All is well. Your cell's chromosomes line up and progress through mitosis and cytokinesis. Separate your cell into two daughter cells by pinching it in half. Set one cell aside in your plastic cup, where it will remain in G₀. Move the other cell forward to G₁ where you will start a new round of the cell cycle.

10,11

There was a mitotic error. Your cell's chromosomes did not separate properly. Await destruction. In the next round start over as a new liver cell in G₁.

12

Mitosis was complete, but cytokinesis did not work properly. Await destruction. In the next round start over as a new liver cell in G₁.

Cell Cycle Game Key: Nerve Cell

**You are in G₁
and roll. . .**

2, 3, 4, 5, 6

Then. . .

You are a mature nerve cell. You enter G₀ permanently. So that you won't be bored, start over as a skin stem cell in the next round of the game. Share the skin cell key with the other skin stem cell in your group.

7, 8

You are a nerve cell. You cannot divide. You enter G₀ permanently. So that you won't be bored, start over as a liver cell in the next round of the game. Share the liver cell key with the other liver cell in your group.

9, 10, 11, 12

You are a nerve cell. You cannot divide. You enter G₀ permanently. So that you won't be bored, start over as a blood-forming stem cell in the next round of the game. Share the blood-forming stem cell key with the other blood stem cell in your group.

Cell Cycle Game Key: Skin Stem Cell

You are a skin stem cell. Skin stem cells divide to give two skin stem cells, or one or both of the daughter cells begin(s) differentiation to become a skin cell.

If you are in G_1 or G_0 and roll. . .

2, 3, 4, 5, 6, 7

The skin needs new cells.

- Grow by adding enough extra clay to your cell to enlarge it to about 1.5 times its size at the beginning of G_1 .
- Move to the S phase.

8

The skin needs new cells. Your cell is growing slowly at this time. Skip one turn. On your next turn, do not roll the number cubes. Instead:

- Grow by adding enough extra clay to your cell to enlarge it to about 1.5 times its size at the beginning of G_1 .
- Move to the S phase.

9

No new skin cells are needed now. Stay in G_1 , and roll again next turn.

10, 11, 12

New skin cells are not needed now, but your cell has lost its normal controls. Roll the number cubes again.

- If you rolled 2–8, the immune system has recognized and destroyed the cancer cell. Start over next turn in G_1 as a new skin stem cell.

or

- If you rolled 9–12, move your cell to S, and continue through the cell cycle as a cancer cell. Ask your teacher for a copy of Student Sheet 13.1e, and follow that on your next turn.

If you are in S and roll. . .

Then. . .

2, 3, 4, 5, 6, 7, 8

Your cell's DNA replicates perfectly. Advance to G_2 phase.

9, 10

There was a DNA replication error. Skip one turn while repairs are made. Then advance to G_2 .

11,12

There was a DNA replication error. It cannot be repaired. Your cell awaits destruction. In the next round start over as a new skin stem cell in G_1 .

Continue to the next side for G_2 and M phases of the cell cycle.

**If you are in G₂
and roll. . .**

2, 3, 4, 5, 6, 7, 8

Then. . .

All is well. Cyclin, a protein that regulates progress through the cell cycle, has accumulated.

- Grow a little more by adding another bit of clay to your cell to enlarge it to about twice its size at the beginning of G₁.
- Enter M now, and roll again as part of the same round.

9, 10, 11

Cyclin accumulates slowly. Stay in G₂ for this round. In the next round:

- Grow a little more by adding another bit of clay to your cell to enlarge it to about twice its size at the beginning of G₁.
- Enter M right now, and roll again as part of the same round.

12

Something has gone wrong with the factors that regulate your cell's cycle. Your cell is stuck in G₂ and will be destroyed. In the next round start over as a new skin stem cell in G₁.

**If you are in M
and roll. . .**

2, 3, 4, 5, 6, 7, 8, 9

Then. . .

All is well. Your cell's chromosomes line up and progress through mitosis and cytokinesis. Separate your cell into two daughter cells by pinching it in half. Set one cell aside in your plastic cup, where it will differentiate into an adult skin cell. Move the other cell forward to continue to G₁ as a skin stem cell.

10, 11

There was a mitotic error. Your cell's chromosomes did not separate properly. Await destruction. In the next round start over as a new skin stem cell.

12

Mitosis was completed, but cytokinesis did not work properly. Await destruction. In the next round start over as a new skin stem cell in G₁.

Cell Cycle Game Key: Cancer Cell

If you are in G₁ or G₀ and roll. . .

2, 3, 4, 5, 6, 7, 8, 9,
10, 11, or 12

Then. . .

- Grow by adding enough extra clay to your cell to enlarge it to about 1.5 times its size at the beginning of G₁.
- Move to the S phase.

If you are in S and roll. . .

2, 3, 4, 5, 6, 7, 8, 9

10, 11

12

Then. . .

Your cell's DNA replicates perfectly. Advance all of your cancer cells to G₂ phase.

There was a DNA replication error. Skip one turn while repairs are made. Then advance all of your cancer cells to the G₂ phase.

There was a DNA replication error, but all of your cancer cells continue into G₂ without repairing it.

If you are in G₂ and roll. . .

2, 3, 4, 5, 6, 7, 8, 9,
10

11, 12

Then. . .

- Grow a little more by adding another bit of clay to your cell(s) to enlarge it (them) to about twice its (their) size at the beginning of G₁.
- Enter M right away, and roll again as part of the same round.

Cyclin accumulates slowly. Stay in G₂ for this round. In the next round:

- Grow a little more by adding another bit of clay to your cell(s) to enlarge it (them) to about twice its (their) size at the beginning of G₁.
- Enter M right away, and roll again as part of the same round.

If you are in M and roll. . .

2, 3, 4, 5, 6, 7, 8, 9,
10

11

12

Then. . .

Your cell's chromosomes line up and progress through mitosis and cytokinesis. Separate each of your cells into two daughter cells. Move them both ahead into G₁, where they will continue through the cell cycle.

There was a mitotic error. Your cancer cells' chromosomes did not separate properly. Destroy one cancer cell. If you have cancer cells left, separate each one into two daughter cells and move them all ahead to G₁. If you have no cancer cells left, start over next round in G₁ as the same kind of cell as you began with in Round 1.

Mitosis was completed, but cytokinesis did not work properly in one of your cancer cells. Await destruction. Destroy one cancer cell. If you have cancer cells left, separate each one into two daughter cells, and move them all ahead to G₁. If you have no cancer cells left, start over next round in G₁ as the same kind of cell as you began with in Round 1.

