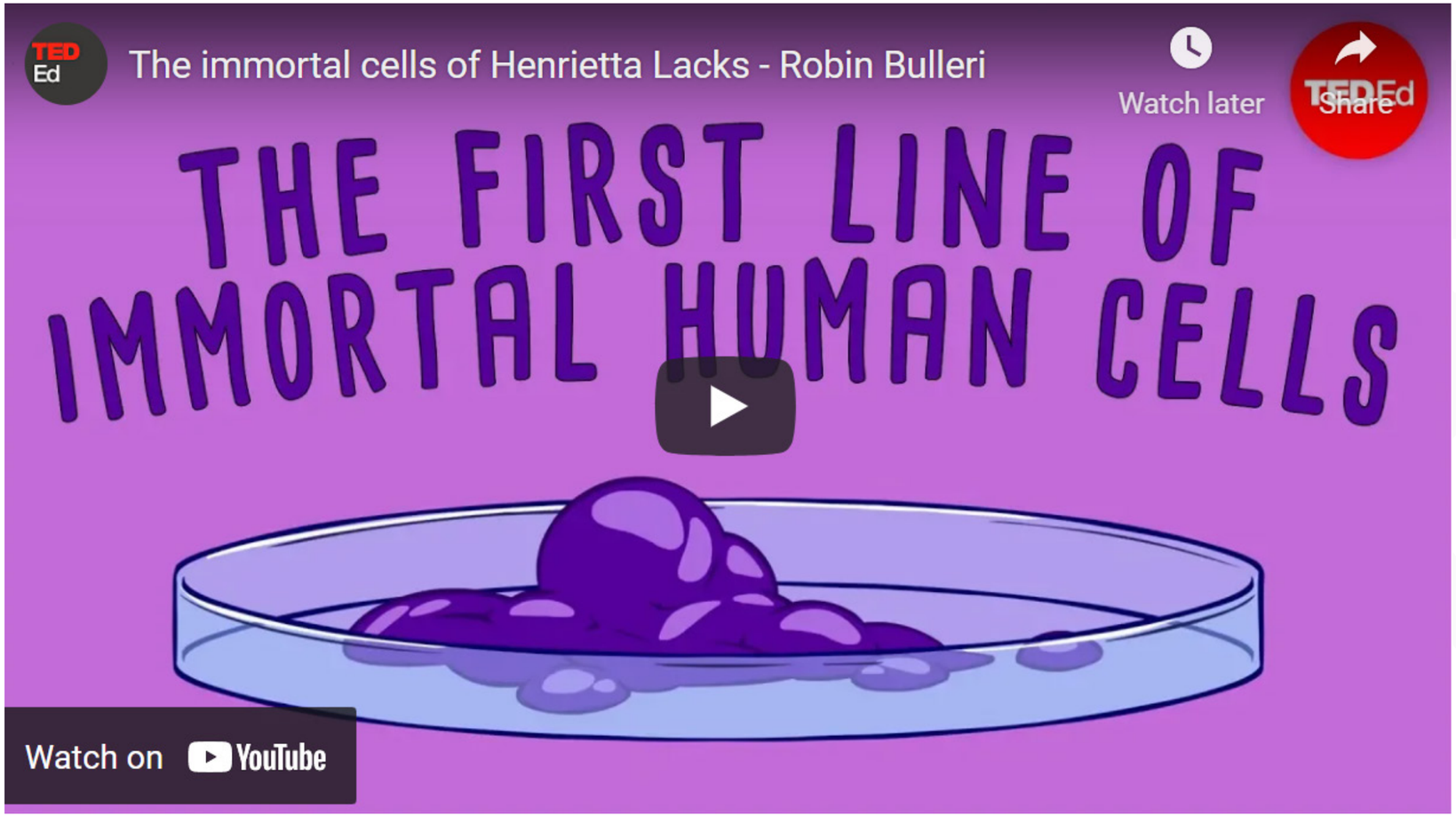
IMMORTAL CELLS

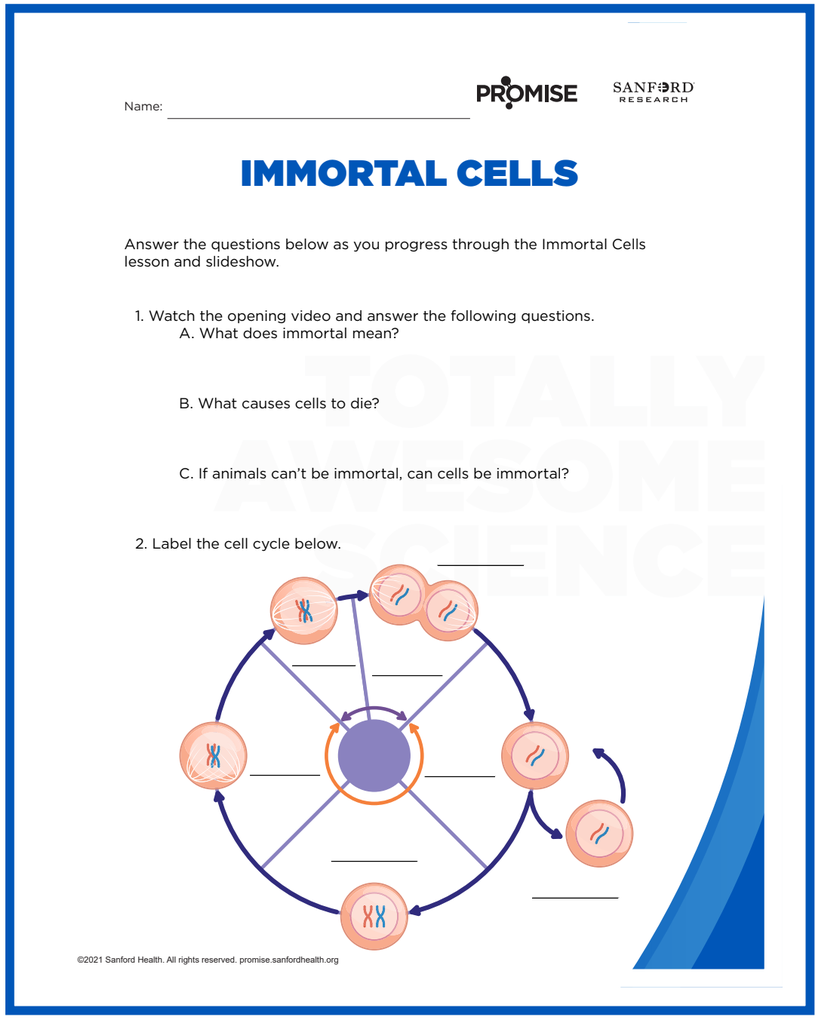
PROMISE

SANFORD RESEARCH

WATCH THIS!


TED Ed
The immortal cells of Henrietta Lacks - Robin Bulleri
Watch later
Share
TED Ed
THE FIRST LINE OF IMMORTAL HUMAN CELLS
Watch on YouTube

WHAT DO YOU THINK?



Name: _____

PROMISE SANFORD RESEARCH

IMMORTAL CELLS

Answer the questions below as you progress through the Immortal Cells lesson and slideshow.

1. Watch the opening video and answer the following questions.
   A. What does immortal mean?

   B. What causes cells to die?

   C. If animals can't be immortal, can cells be immortal?

2. Label the cell cycle below.

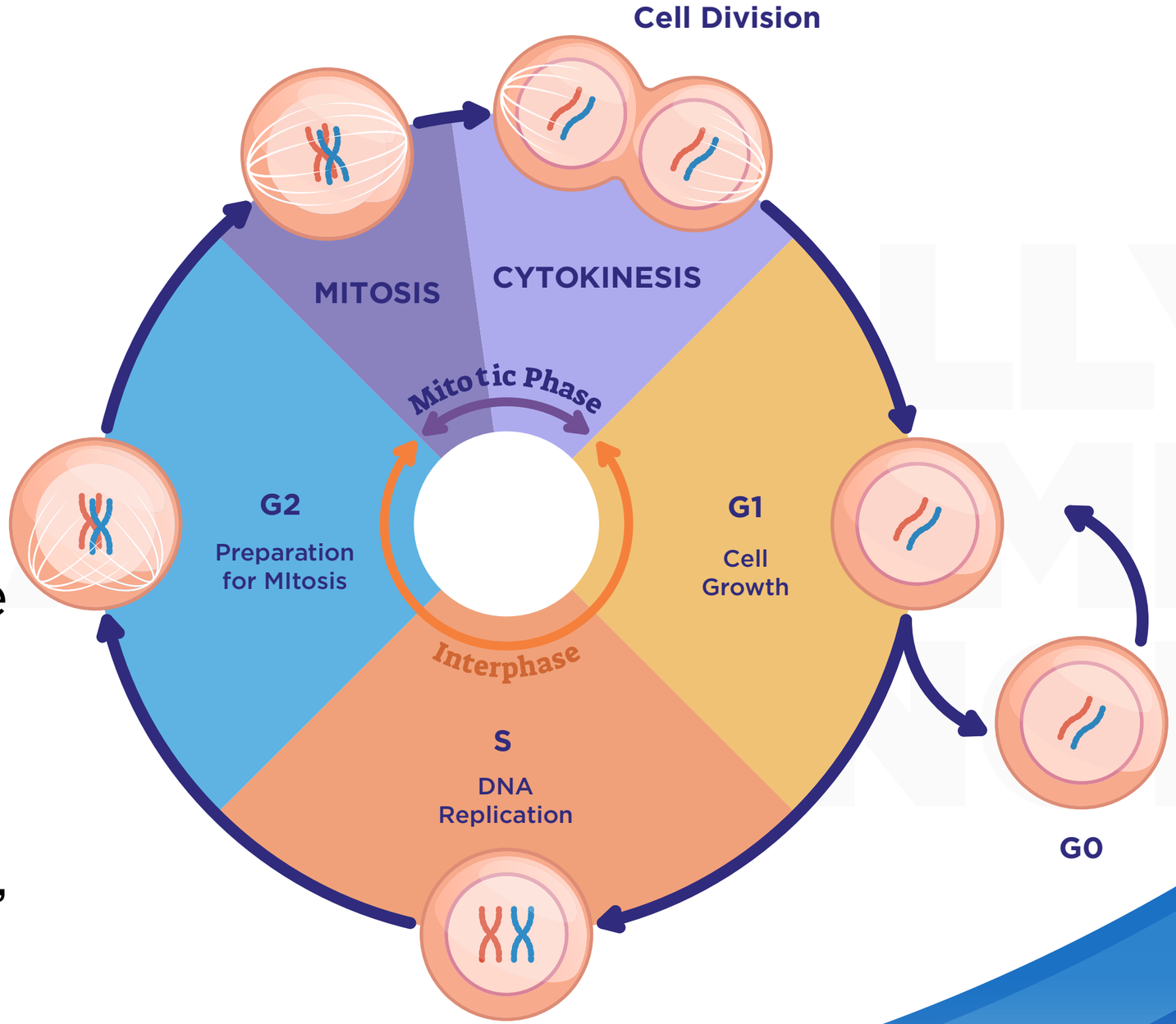
- What does immortal mean?
- What causes cells to die?
- If animals can’t be immortal, can cells be immortal?

WHAT WE'LL EXPLORE

- How cells grow and replicate
- The limits of cell replication
- How one cell can become many different types of cells
- The use of stem cells and immortal stem lines in research

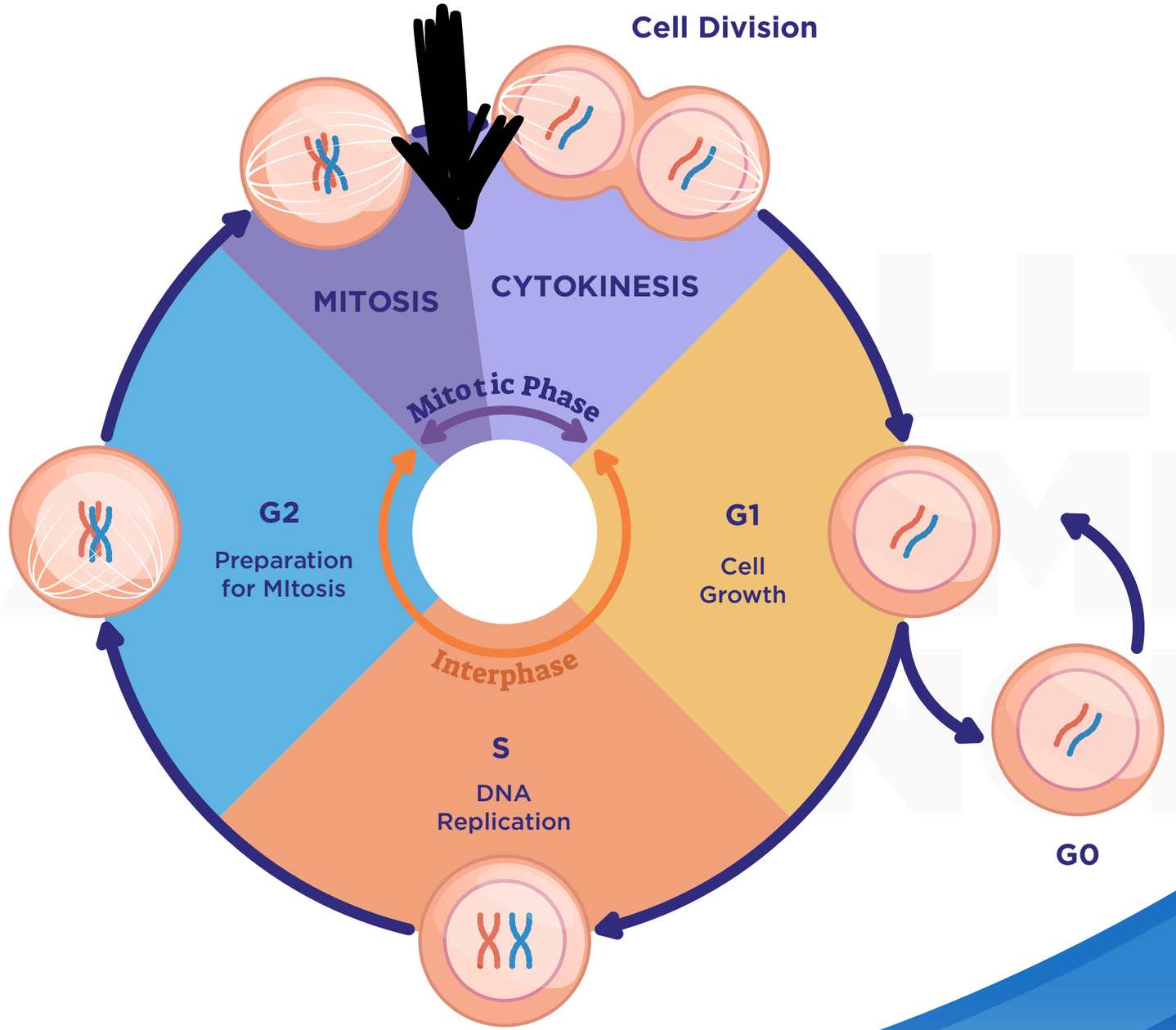
THE CELL CYCLE

- Once an egg is fertilized, the cell cycle begins.
- Cells grow, duplicate chromosomes, and grow again. Once they have gone through these phases, the cell divides through mitosis.



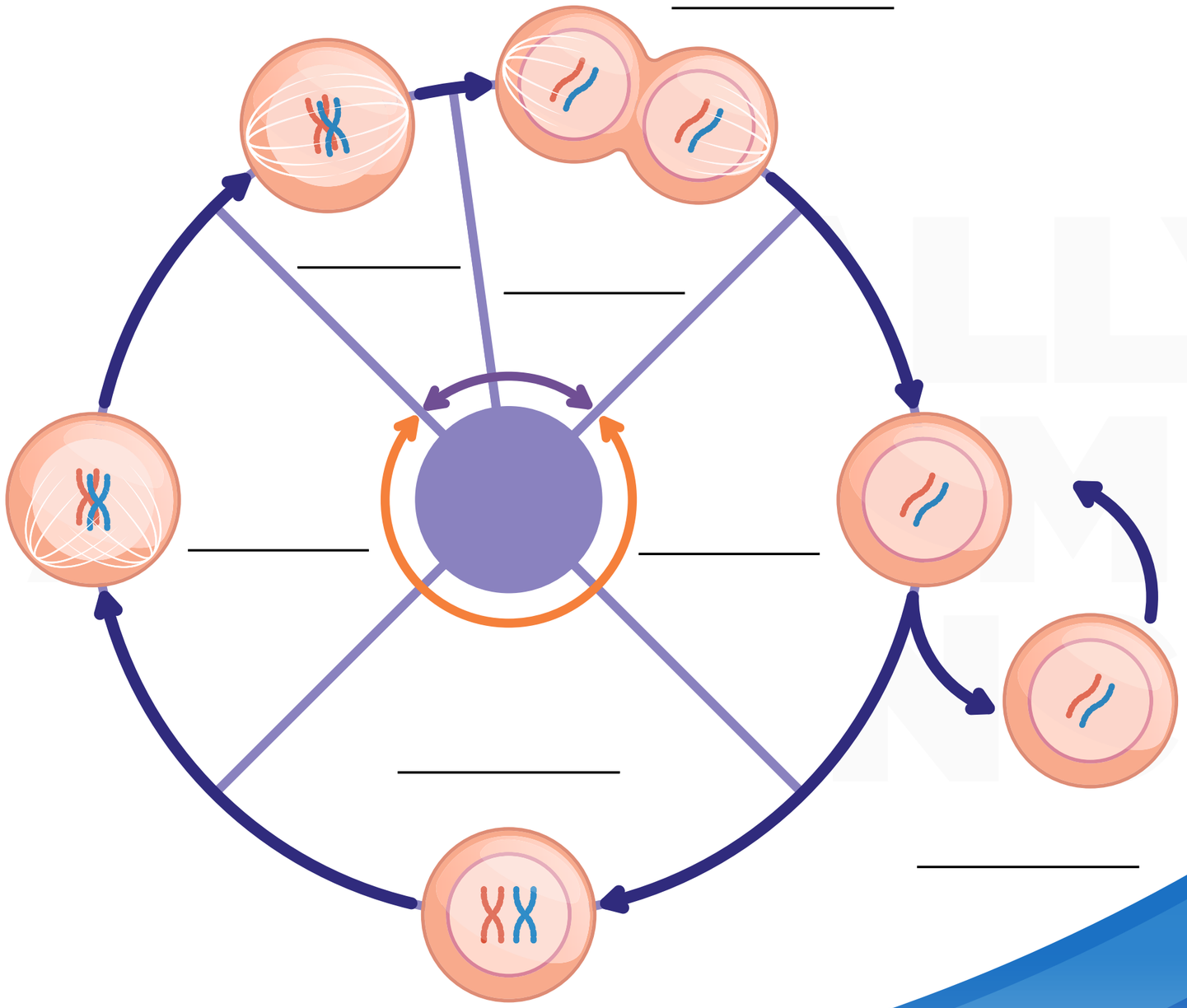
THE CELL CYCLE

At this point, these cells are called stem cells because they can turn into any type of cell.



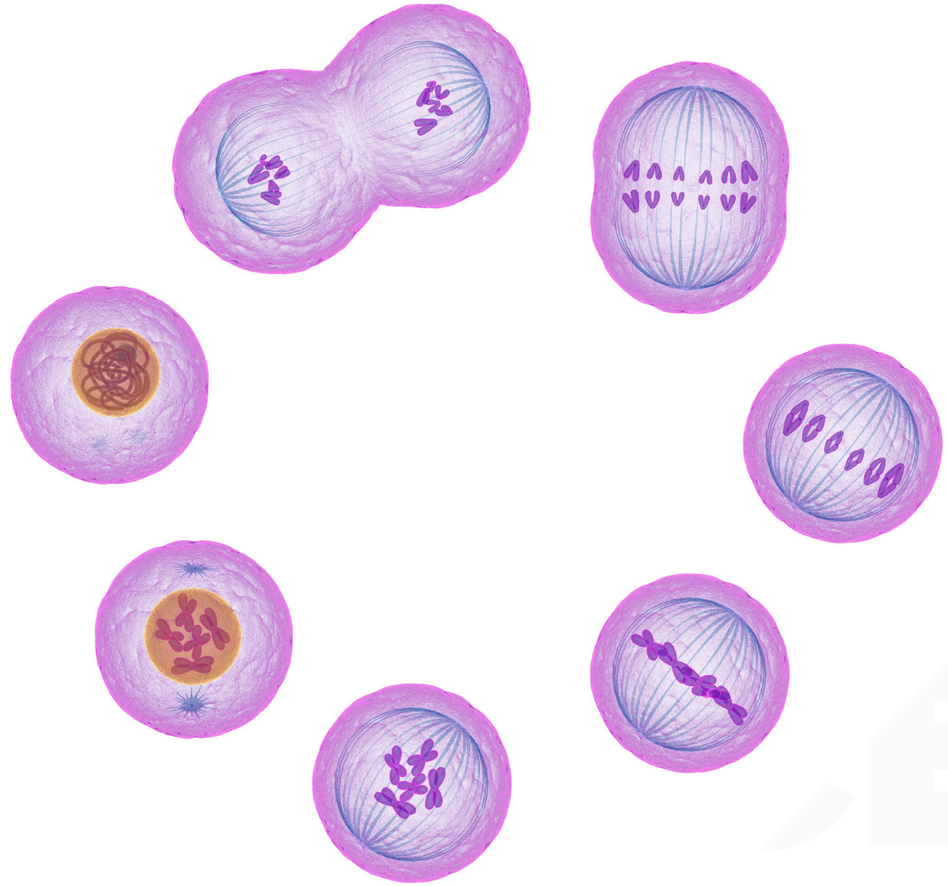
THE CELL CYCLE

Label the cell cycle diagram in the student notebook.

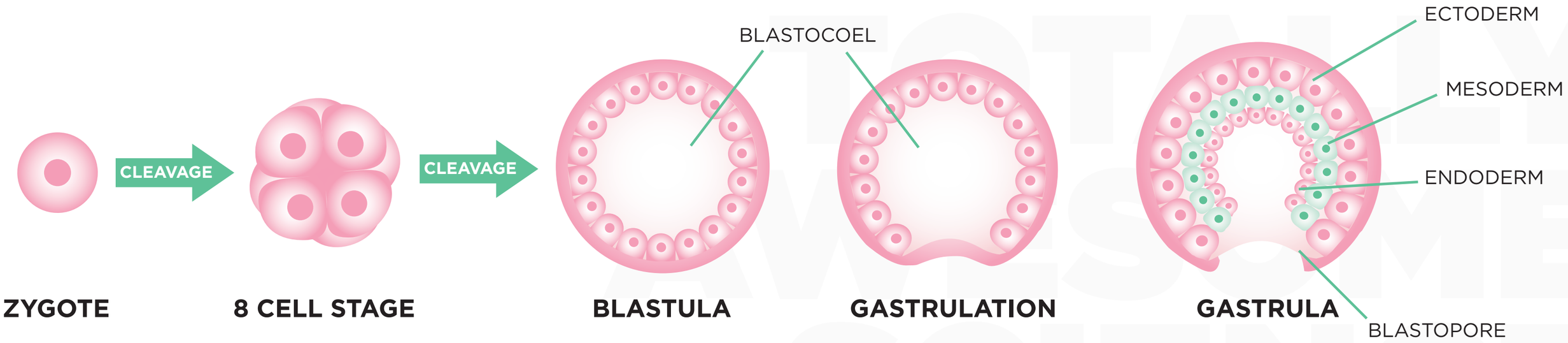


MITOSIS

- Cells make copies of their DNA before they divide.
- The process of mitosis ensures that each daughter cell has the same chromosomes as the parent cell.
- Each cell made should therefore have the same DNA.

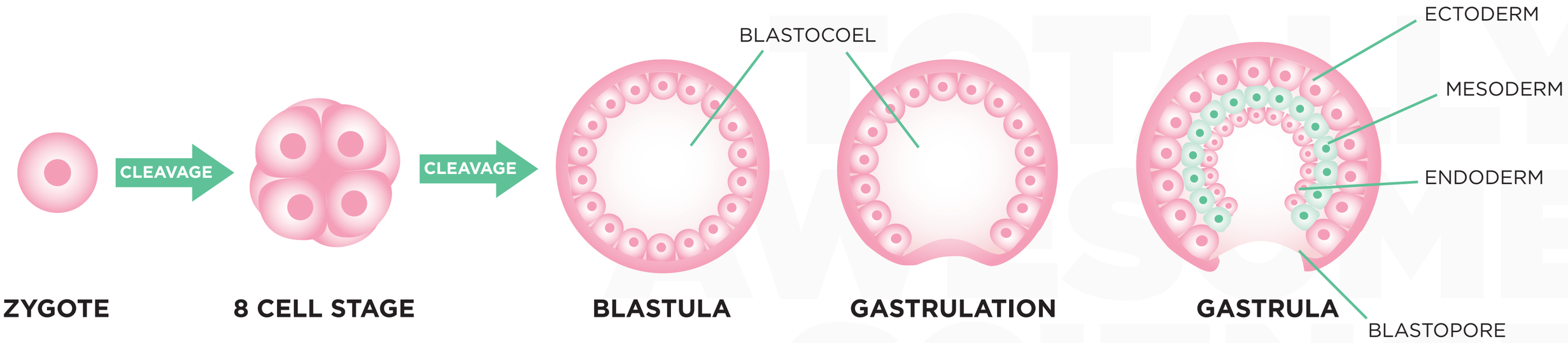


DIFFERENTIATION



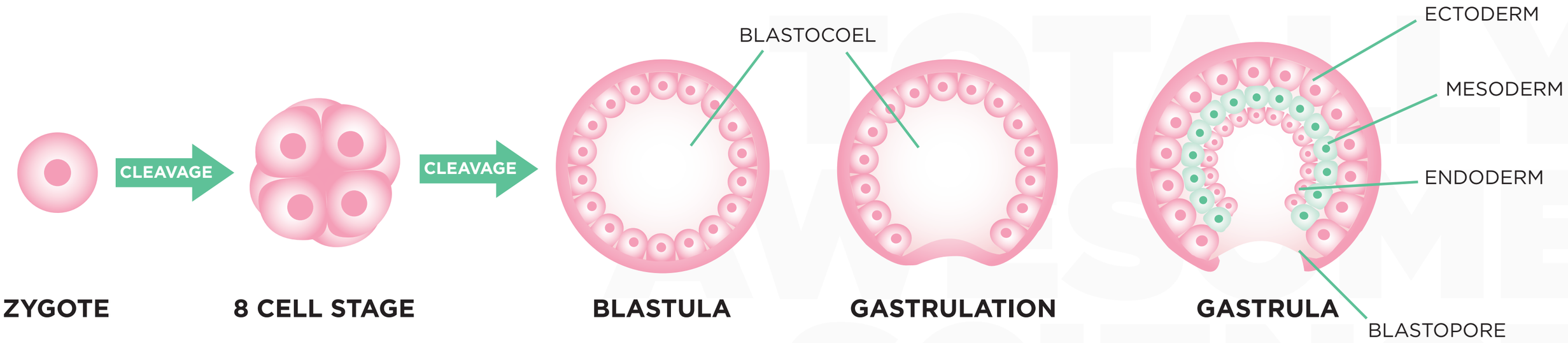
Once embryonic cells have divided multiple times, they form a cell ball called a blastula.

DIFFERENTIATION



The cells fold in to make a gastrula- which is a an embryo with three layers of cells.

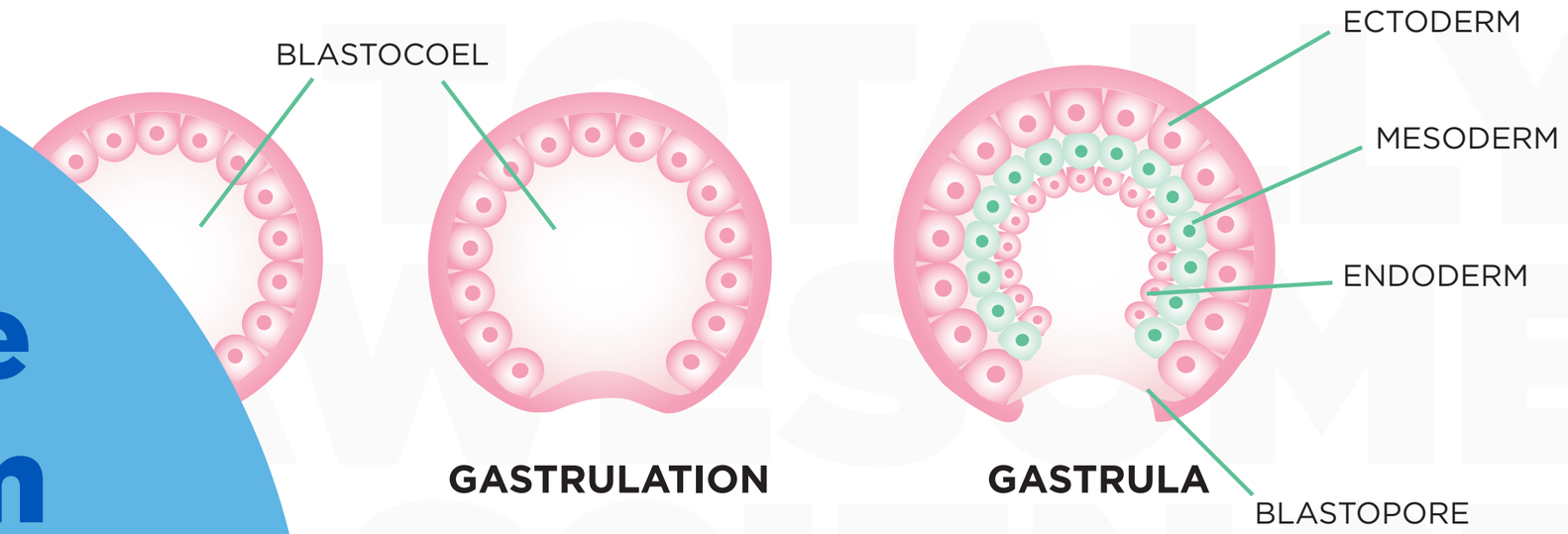
DIFFERENTIATION



These cells give rise to different cell types around the body. But as cells differentiate, they lose potency.

DIFFERENTIATION

Potency is the ability of stem cells to become different cell types



ise to different cell
body. But as cells
y lose potency.

POTENT CELLS

- **Pluripotent cells:** Can become any cell type found in the body.

  Example: Embryonic Stem Cells

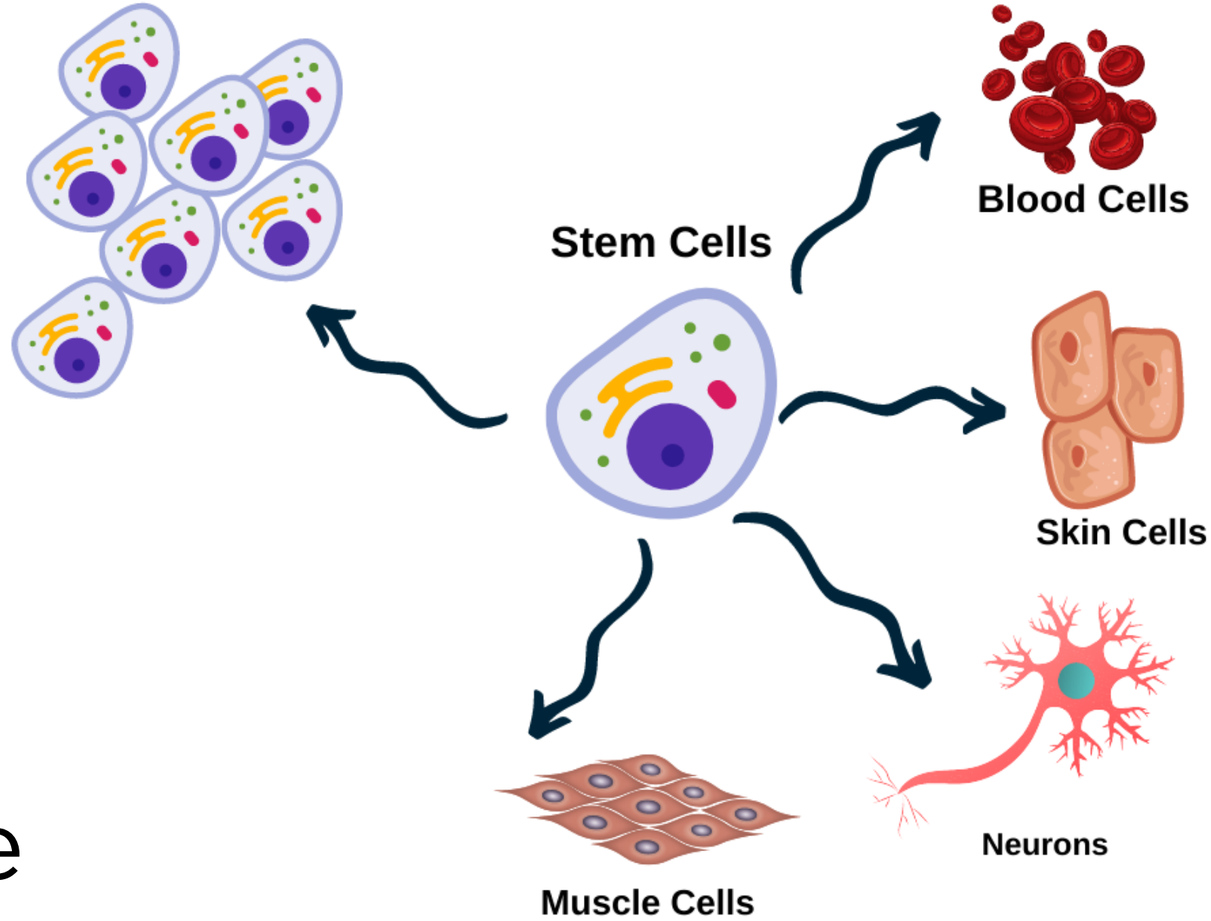
- **Multipotent cells:** Can develop into more than one cell type but not all cell types.

MULTIPOTENT CELLS

- Once embryonic stem cells are differentiated into the 3 tissue types, the cells can only become certain cell types.
    - **Endoderm** cells become cells in the intestinal lining, liver cells, kidney cells
    - **Mesoderm** cells become smooth muscle cells, skeletal cells, cardio myocytes (heart cells).
    - **Ectoderm** cells become skin cells, nerve cells, retina cells.

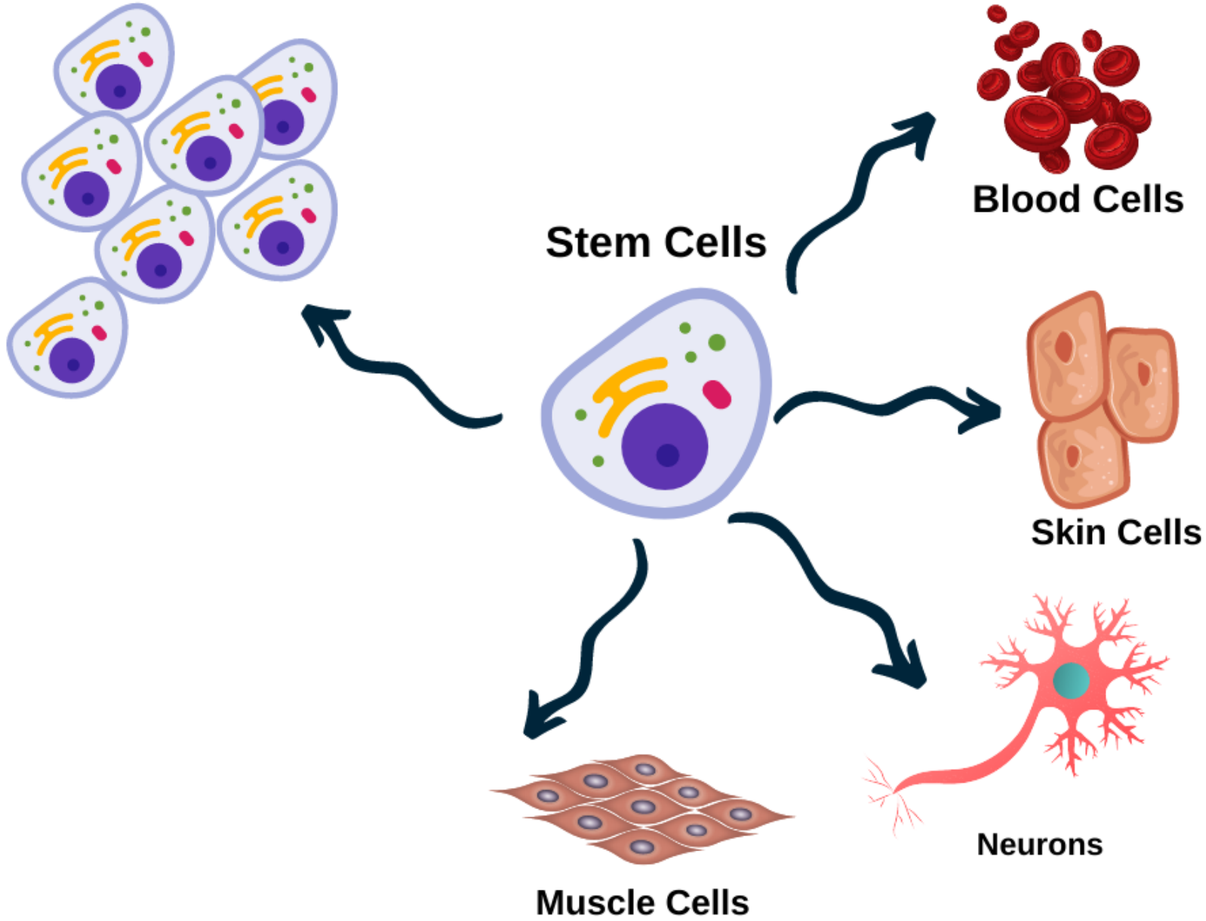
STEM CELLS

- Your body still has stem cells that are available to replenish tissues.
- Stem cells also make more stem cells.



STEM CELLS

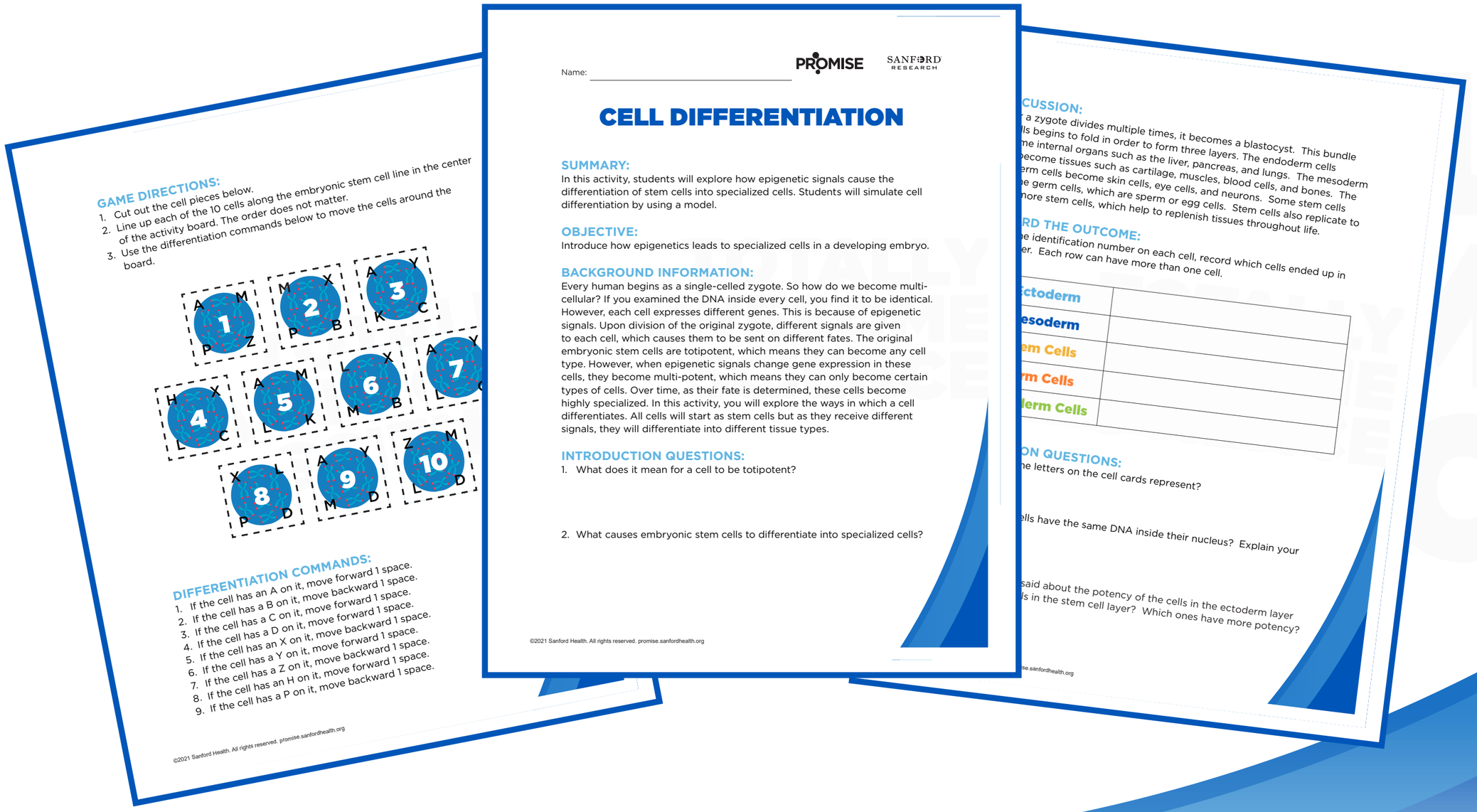
- Some places you can find stem cells are:
  - Bone marrow
  - Tissue under intestinal lining
  - Skin



HOW DO CELLS BECOME DIFFERENT IF THEY ALL HAVE THE SAME DNA?

- Genes code for proteins.
- Not all proteins need to be made in every cell.
- Genes can be turned “on” and “off”.
- After gastrulation, a cell’s fate is determined. A process of gene expression occurs which turns genes on or off depending on what is needed.

CELL DIFFERENTIATION ACTIVITY



GAME DIRECTIONS:
1. Cut out the cell pieces below.
2. Line up each of the 10 cells along the embryonic stem cell line in the center of the activity board. The order does not matter.
3. Use the differentiation commands below to move the cells around the board.

DIFFERENTIATION COMMANDS:
1. If the cell has an A on it, move forward 1 space.
2. If the cell has a B on it, move backward 1 space.
3. If the cell has a C on it, move forward 1 space.
4. If the cell has a D on it, move forward 1 space.
5. If the cell has an X on it, move backward 1 space.
6. If the cell has a Y on it, move forward 1 space.
7. If the cell has a Z on it, move backward 1 space.
8. If the cell has an H on it, move forward 1 space.
9. If the cell has a P on it, move backward 1 space.

Name: _____

PROMISE SANFORD RESEARCH

CELL DIFFERENTIATION

SUMMARY:
In this activity, students will explore how epigenetic signals cause the differentiation of stem cells into specialized cells. Students will simulate cell differentiation by using a model.

OBJECTIVE:
Introduce how epigenetics leads to specialized cells in a developing embryo.

BACKGROUND INFORMATION:
Every human begins as a single-celled zygote. So how do we become multi-cellular? If you examined the DNA inside every cell, you find it to be identical. However, each cell expresses different genes. This is because of epigenetic signals. Upon division of the original zygote, different signals are given to each cell, which causes them to be sent on different fates. The original embryonic stem cells are totipotent, which means they can become any cell type. However, when epigenetic signals change gene expression in these cells, they become multi-potent, which means they can only become certain types of cells. Over time, as their fate is determined, these cells become highly specialized. In this activity, you will explore the ways in which a cell differentiates. All cells will start as stem cells but as they receive different signals, they will differentiate into different tissue types.

INTRODUCTION QUESTIONS:
1. What does it mean for a cell to be totipotent?

2. What causes embryonic stem cells to differentiate into specialized cells?

CUSSION:
a zygote divides multiple times, it becomes a blastocyst. This bundle
lls begins to fold in order to form three layers. The endoderm cells
me internal organs such as the liver, pancreas, and lungs. The mesoderm
become tissues such as cartilage, muscles, blood cells, and bones. The
erm cells become skin cells, eye cells, and neurons. Some stem cells
e germ cells, which are sperm or egg cells. Stem cells also replicate to
more stem cells, which help to replenish tissues throughout life.

RD THE OUTCOME:
e identification number on each cell, record which cells ended up in
er. Each row can have more than one cell.

ctoderm	
esoderm	
em Cells	
rm Cells	
lerm Cells	

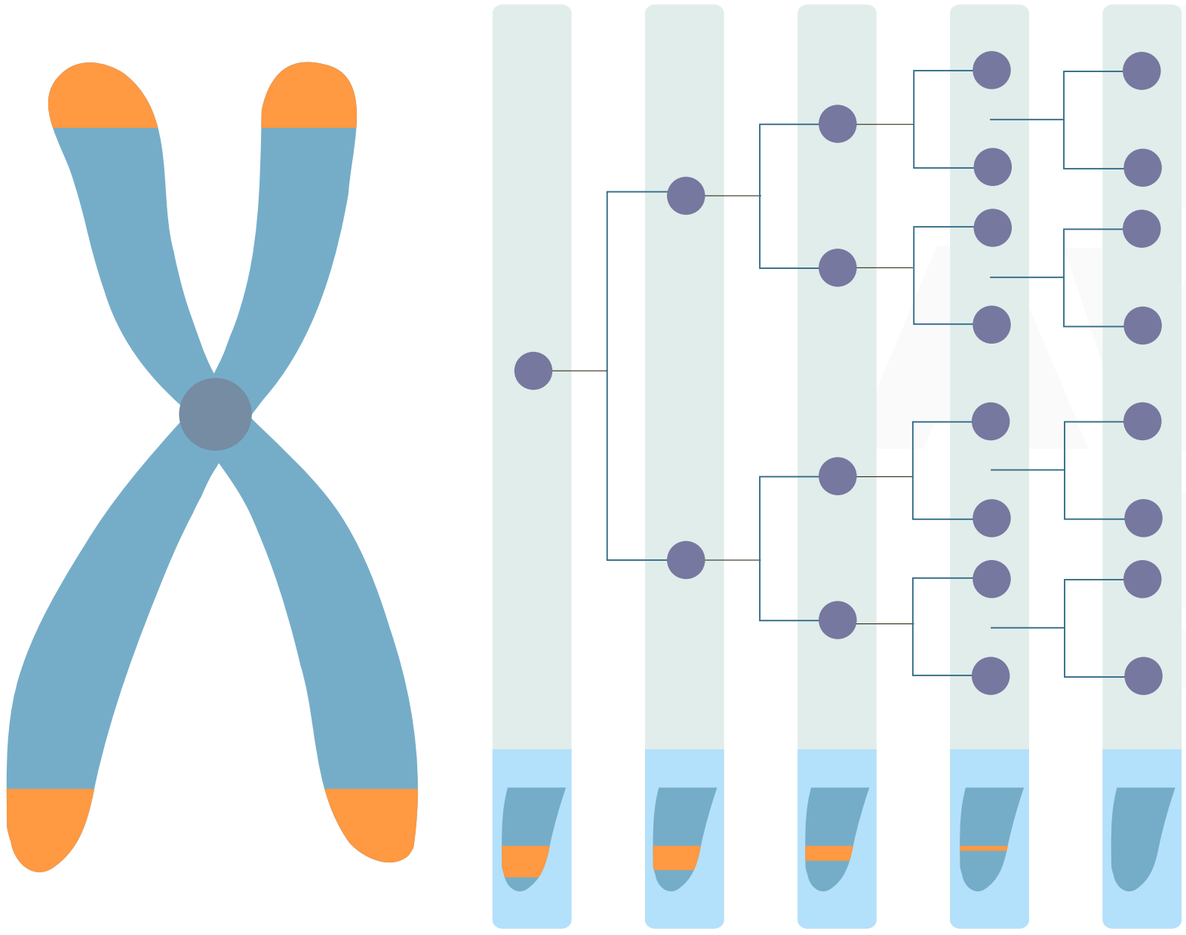
ON QUESTIONS:
he letters on the cell cards represent?

lls have the same DNA inside their nucleus? Explain your

said about the potency of the cells in the ectoderm layer
ls in the stem cell layer? Which ones have more potency?

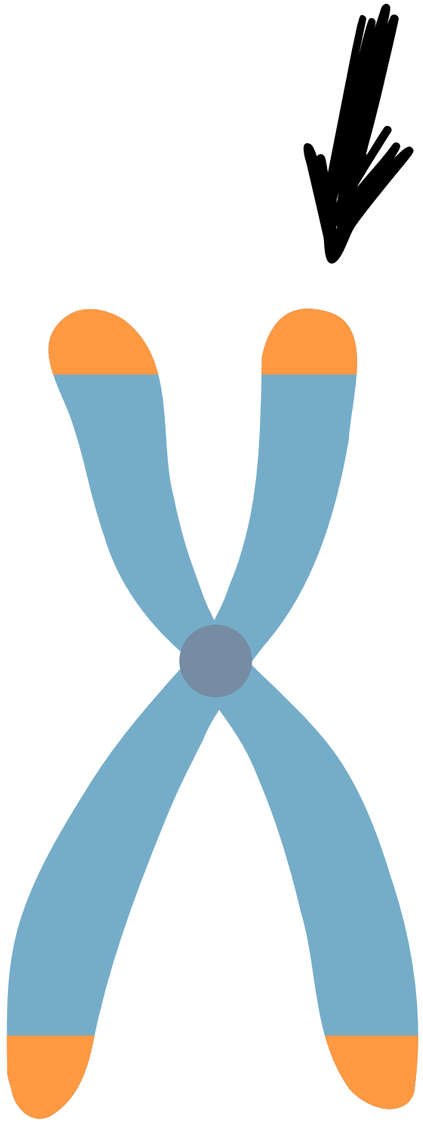
se.sanfordhealth.org

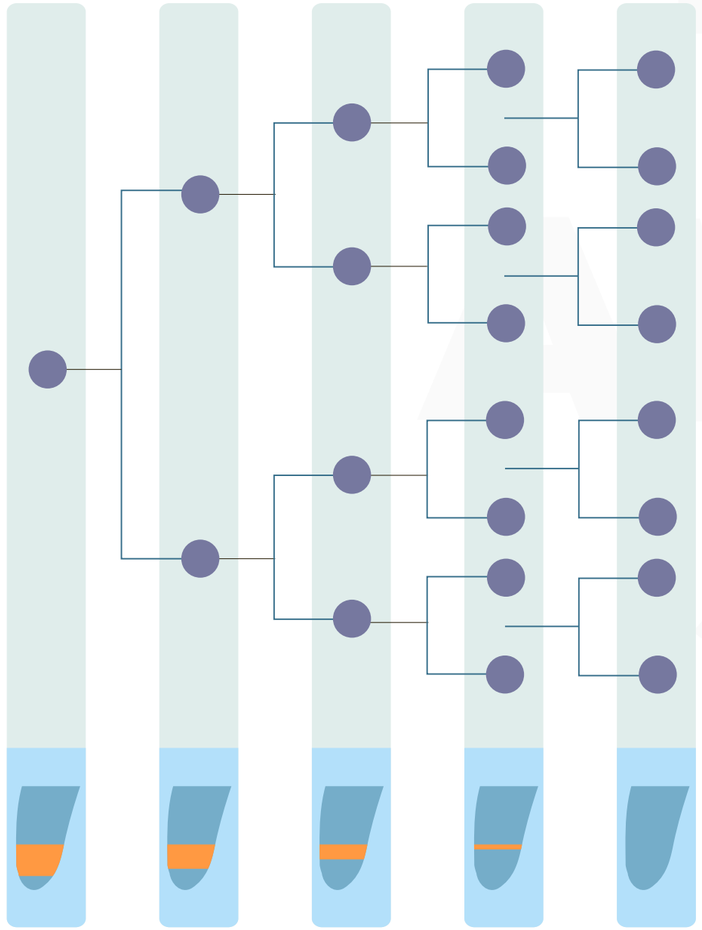
LIMITS OF MITOSIS



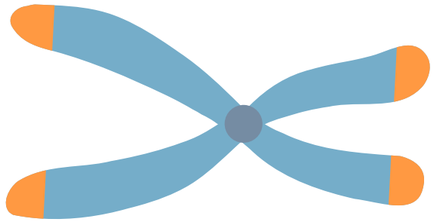
- Mitosis cannot happen indefinitely.
- Once a cell is differentiated, they experience telomere shortening.

TELOMERES

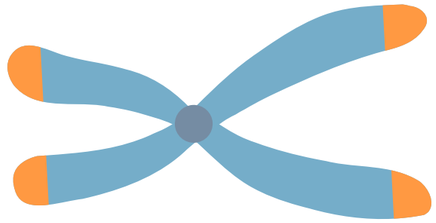




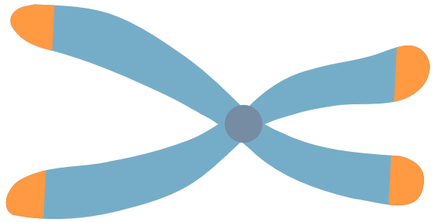
- DNA has caps at each end of a chromosome meant to protect the DNA from damage during DNA replication.
- These caps are called telomeres.



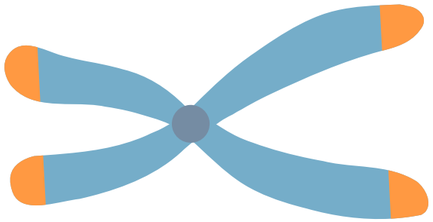
TELOMERES



- Telomeres are extra DNA that do not code for anything.
- Every time DNA is copied before mitosis a little bit of the telomere is lost.
- After about 60 replications, the telomere is too short and the cell stops dividing.



TELOMERES



Cellular Senescence is the point when the cell stops dividing.

are extra DNA that do not

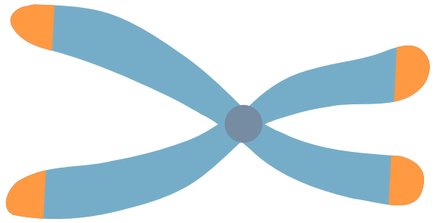
ing.

is copied before

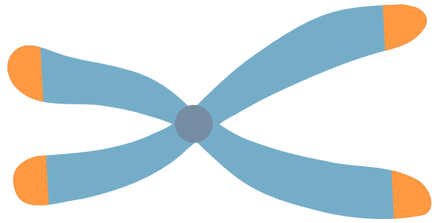
of the telomere is lost.

plications, the

ort and the cell stops



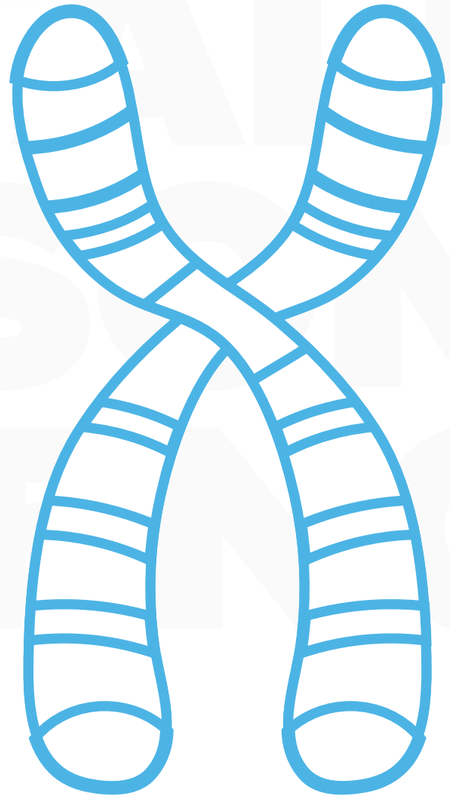
TELOMERES



- There are few cell types that have shown to be immortal given the right conditions.
- These cells have a telomere repair process that prevents cell death.

IMMORTAL CELLS

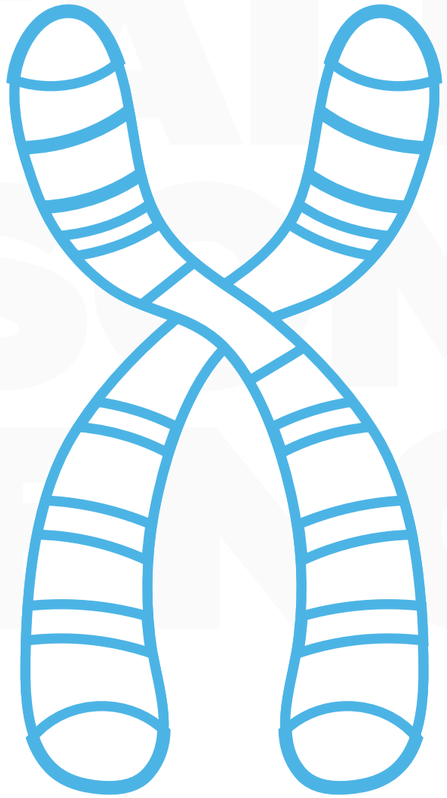
- Telomerase is an enzyme that adds telomere repeats to the end of a chromosome.
- Cells that have this ability include:
    1. Embryonic stem cells
    2. Cancer cells



IMMORTAL CELLS

- T is an enzyme that
  peats to the
  e.
  ability
  cells

Definition of immortal: Not subject to death, able to survive indefinitely



IMMORTAL CELLS

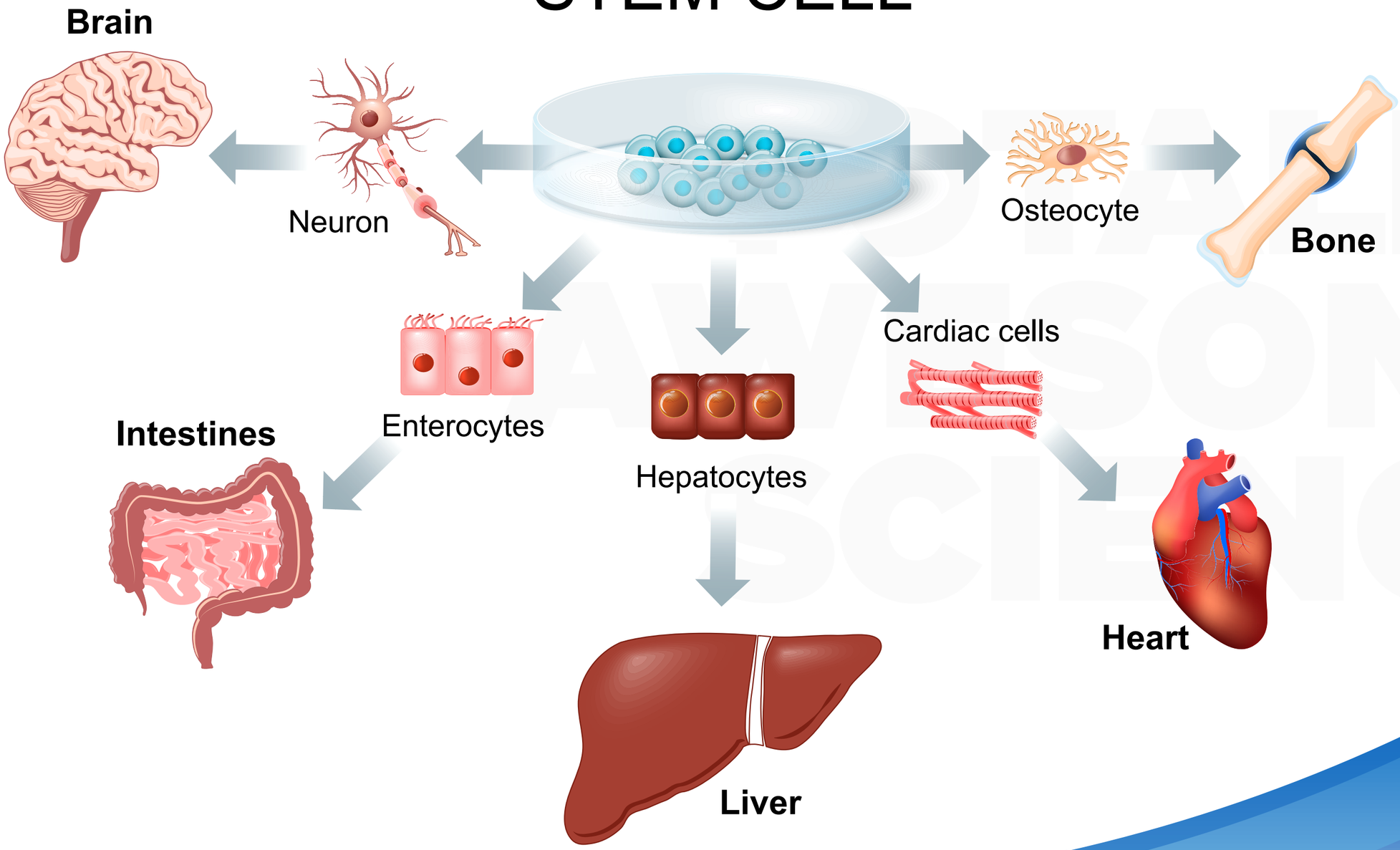
Discuss these questions with a partner.

- If all cells within a person die when the person dies, are they really immortal?
- If the cells are taken from the person before they die and grown indefinitely in a dish, are they immortal?
- Can cells be immortal, even if the host cannot be?

STEM CELLS IN RESEARCH

- Scientists at Sanford Research use a technology that can turn skin cells (fibroblasts) into a pluripotent stem cell.
- Called induced pluripotent stem cell (IPSC)
- These cells go through telomere reprogramming to make them immortal.

STEM CELL


Brain
Neuron
Osteocyte
Bone
Enterocytes
Intestines
Hepatocytes
Cardiac cells
Heart
Liver

WATCH THIS!

- As the stem cells age, they beat at different rates.
- Record the beats per minute of each age group in your lab notebook.

CREATING IMMORTAL CELLS

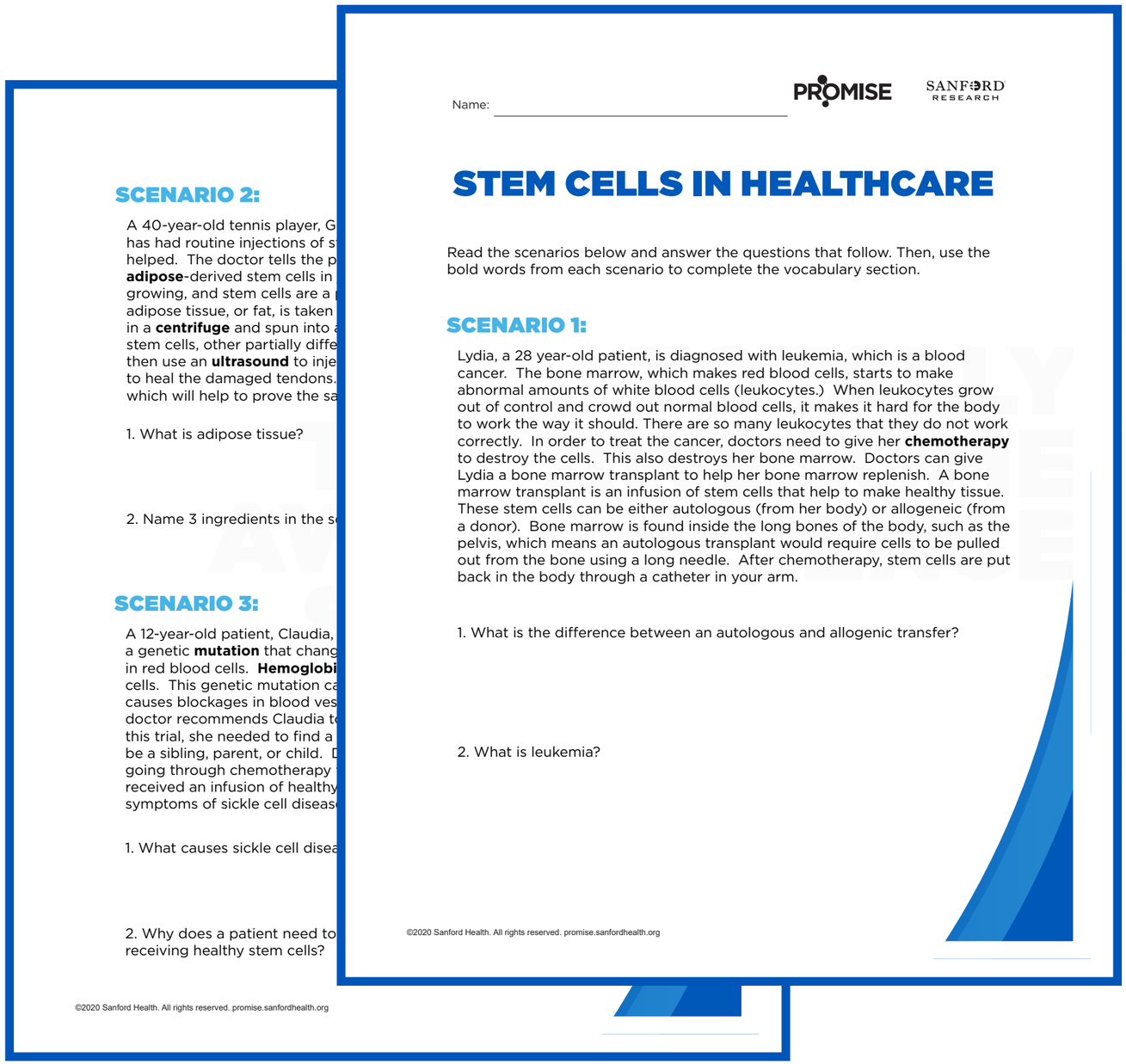
The first immortal cell line was discovered in a tumor that was taken from a patient named Henrietta Lacks. These cells (HeLa) are used in research all over the world.

CREATING IMMORTAL CELLS

- Cells from patients and animals can be immortalized so they can be used for research studies.
- Typical cells that are grown in a dish experience a point when they cannot replicate anymore- known as the Hayflick Limit. Cancer cells and immortal cell lines can overcome this limit.

STEM CELLS IN HEALTHCARE

- Stem cells have been used for many years to replenish blood cells.
- Stem cells are regenerative. This means they can heal and repair damaged tissue.
- There are several clinical trials at Sanford Health that are using stromal vascular fraction to relieve pain in joints. SVF is a collection of cells gathered from fat tissue that includes stem cells and white blood cells.



Name: _____

PROMISE SANFORD RESEARCH

STEM CELLS IN HEALTHCARE

Read the scenarios below and answer the questions that follow. Then, use the bold words from each scenario to complete the vocabulary section.

SCENARIO 1:

Lydia, a 28 year-old patient, is diagnosed with leukemia, which is a blood cancer. The bone marrow, which makes red blood cells, starts to make abnormal amounts of white blood cells (leukocytes.) When leukocytes grow out of control and crowd out normal blood cells, it makes it hard for the body to work the way it should. There are so many leukocytes that they do not work correctly. In order to treat the cancer, doctors need to give her **chemotherapy** to destroy the cells. This also destroys her bone marrow. Doctors can give Lydia a bone marrow transplant to help her bone marrow replenish. A bone marrow transplant is an infusion of stem cells that help to make healthy tissue. These stem cells can be either autologous (from her body) or allogeneic (from a donor). Bone marrow is found inside the long bones of the body, such as the pelvis, which means an autologous transplant would require cells to be pulled out from the bone using a long needle. After chemotherapy, stem cells are put back in the body through a catheter in your arm.

1. What is the difference between an autologous and allogenic transfer?

2. What is leukemia?

SCENARIO 2:

A 40-year-old tennis player, G
has had routine injections of s
helped. The doctor tells the p
adipose-derived stem cells in
growing, and stem cells are a
adipose tissue, or fat, is taken
in a **centrifuge** and spun into
stem cells, other partially diffe
then use an **ultrasound** to inje
to heal the damaged tendons.
which will help to prove the sa

1. What is adipose tissue?

2. Name 3 ingredients in the s

SCENARIO 3:

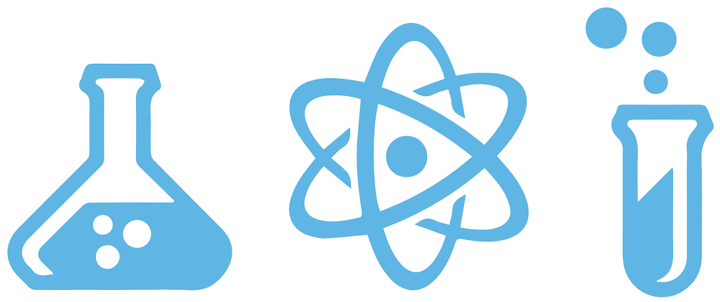
A 12-year-old patient, Claudia,
a genetic **mutation** that chang
in red blood cells. **Hemoglobi**
cells. This genetic mutation ca
causes blockages in blood ves
doctor recommends Claudia t
this trial, she needed to find a
be a sibling, parent, or child. D
going through chemotherapy
received an infusion of healthy
symptoms of sickle cell disease

1. What causes sickle cell disea

2. Why does a patient need to
receiving healthy stem cells?

COMPLETE THE STEM CELLS IN HEALTHCARE PRINTABLE!

ANSWER THE REMAINING QUESTIONS IN YOUR LAB NOTEBOOK!



7. Watch the video and count the heart beats for each stage of cell development. Record the count for 20 seconds and multiply by 3 to get beats per minute.

Cell Age	Beats per 20 seconds	Beats per minute
9 Days		
12 Days		
40 Days		
53 Days		
68 Days		

What do you notice about the rate as the cells age?

8. Using what you have learned, defend the following claim using evidence.
Claim: Cells have the potential to be immortal.