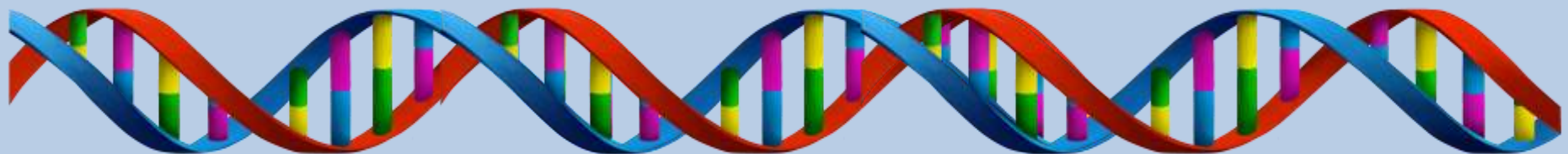




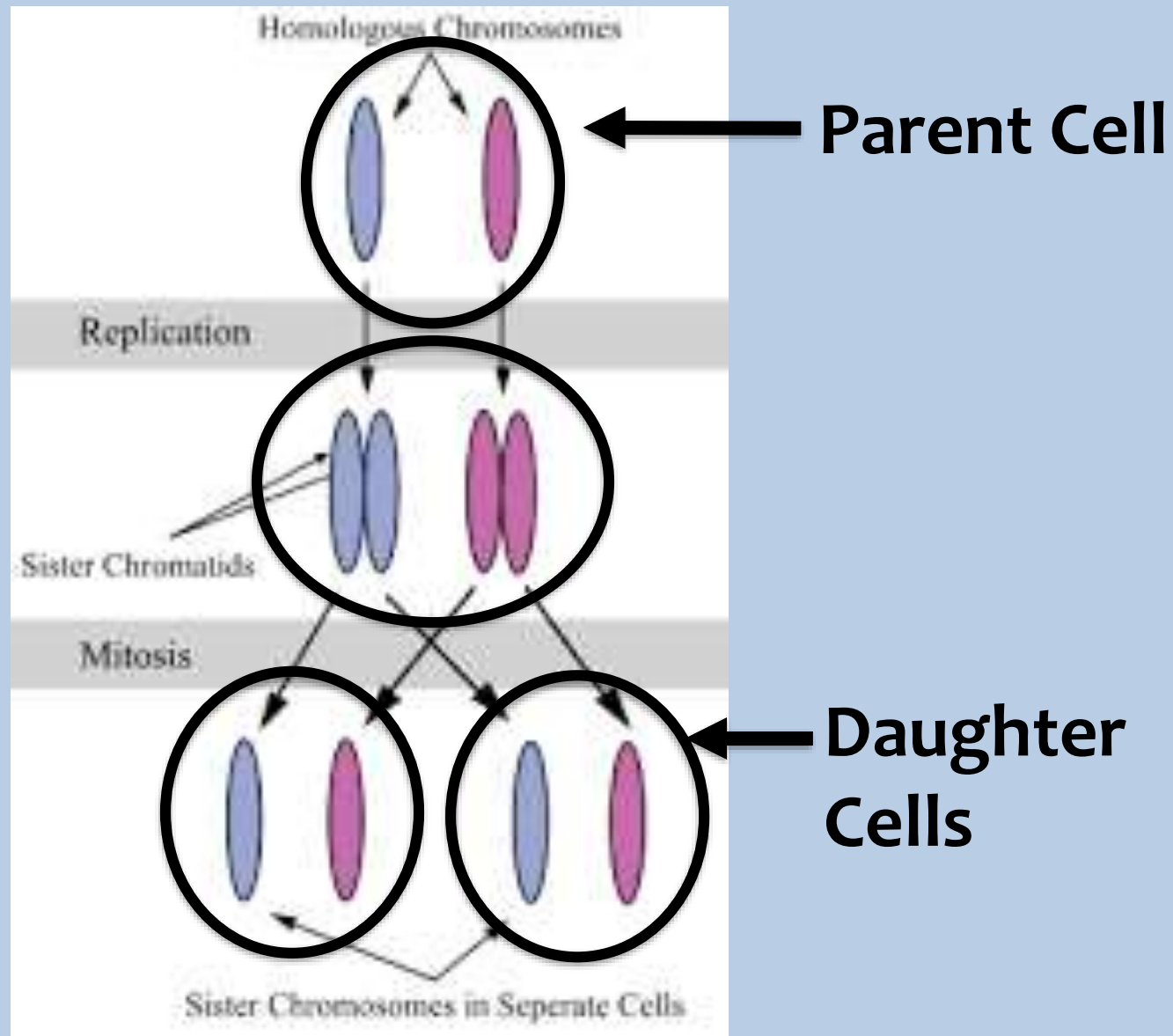
**\*Tape 11.2 Interactivity on to page 51\***

- 1. Why are chromosomes an important part of the cell cycle?**
- 2. Why do plant cells make a cell plate during cell division?**
- 3. What kind of molecule does DNA code for?**
- 4. Which organelle performs apoptosis/programmed cell death?**



# Chromosomes During Mitosis

Chromosomes have to replicate, so that each daughter cell has the **SAME** DNA



**Organelle: "I'm feeling really tired and worn out."**

**Lysosome:**



@APBiology\_Mem

# Logistics

- **Unit 5 Assessment**
  - **Friday, February 7<sup>th</sup>**
  - **So far we have covered objectives 1-7**
  - **Today: 8-12**

# Course Registration

- Which science class should you take next year?

# General Registration

- **The class recommended for most sophomores who would like to eventually take chemistry is chem/phys lab methods**

# General Registration

- The following are trends regarding registering for chemistry:

# General Registration

- **B or better in Biology**

- **69% of students with a B or better in S1 of Biology got a B or better in Chemistry the next year.**

- **C+ or below in Biology**

- **18% of students with a C+ in S1 of Biology got a B- or higher in Chemistry the next year.**



# General Registration

- **B or better in Semester 2 of Geometry**

- **58% of students with a B or better in S2 of Geometry during biology year got a B or better in Chemistry the next year.**

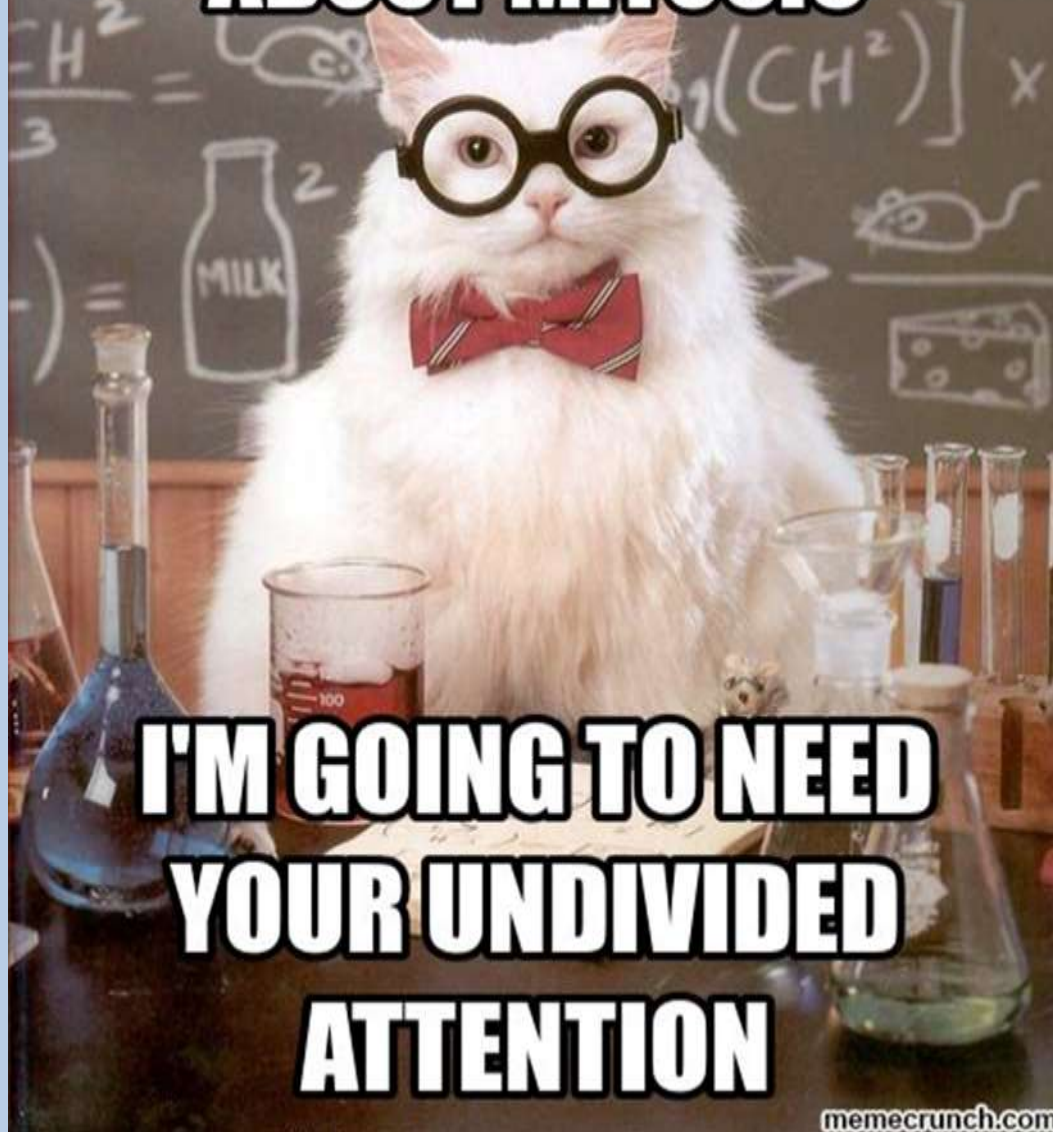
- **C+ or below in Semester 2 Geometry**

- **3% of students with a C+ in S2 of Geometry got a B- or higher in Chemistry the next year.**

# General Registration

- **B or better in Semester 2 of Algebra 2**
  - **90% of students with a B or better in S2 of Algebra 2 during biology year got a B or better in Chemistry the next year**
- **C+ or below in Semester 2 of Algebra 2**
  - **44% of students with a C+ in S2 of Algebra 2 got a B- or higher in Chemistry the next year**

**TODAY WE'RE LEARNING  
ABOUT MITOSIS**



**I'M GOING TO NEED  
YOUR UNDIVIDED  
ATTENTION**

# Brain Warm-up

- **What do HISTONE hands look like?**

# Brain Warm-up

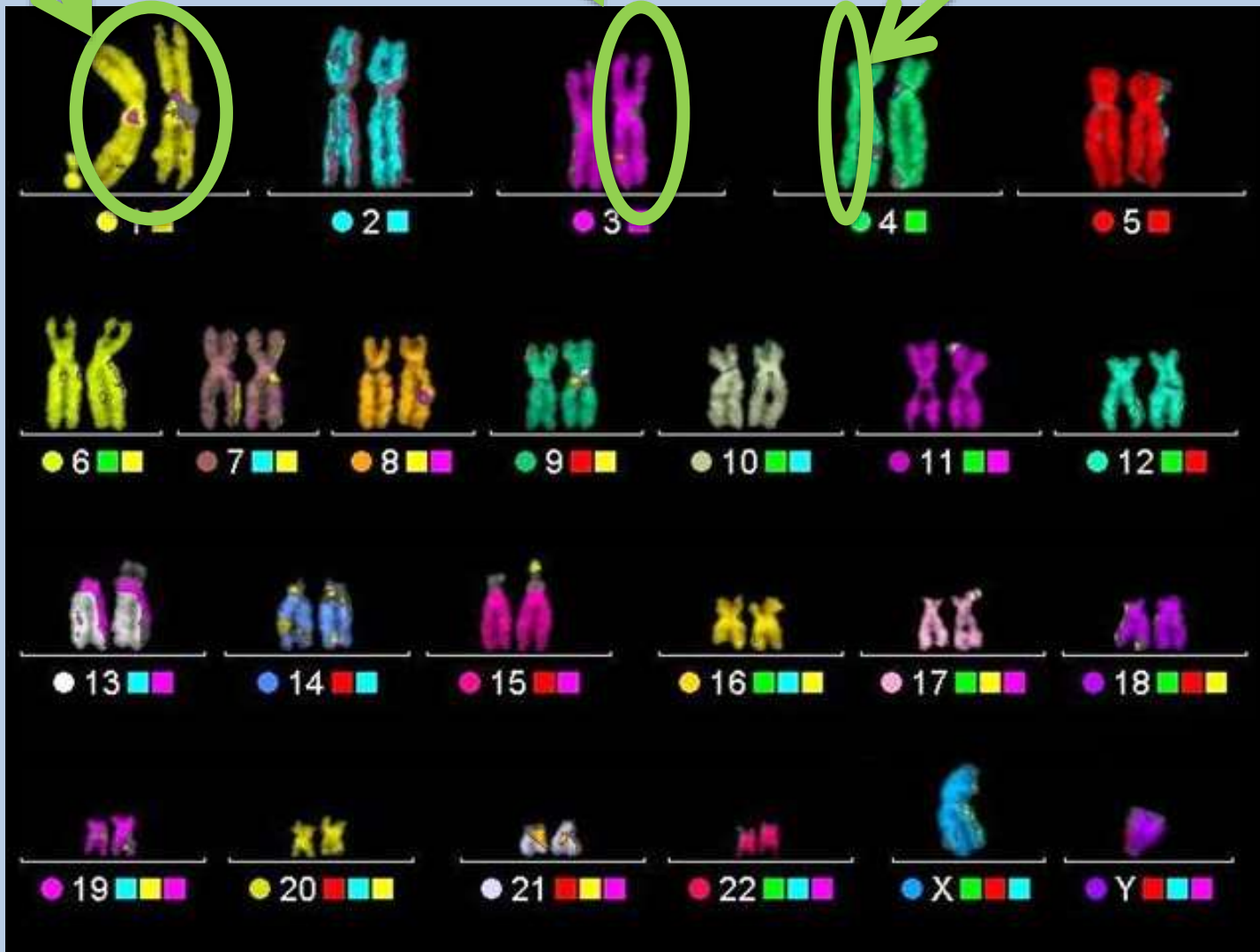
- **What is the difference between chromosomes, sister chromatids, and homologous chromosomes?**

# DNA - Humans

HOMOLOGOUS  
CHROMOSOMES

SISTER CHROMATIDS

1 CHROMATID



# Brain Warm-up

- **Why do cells need to replicate?**

# Cells Need to Replicate...

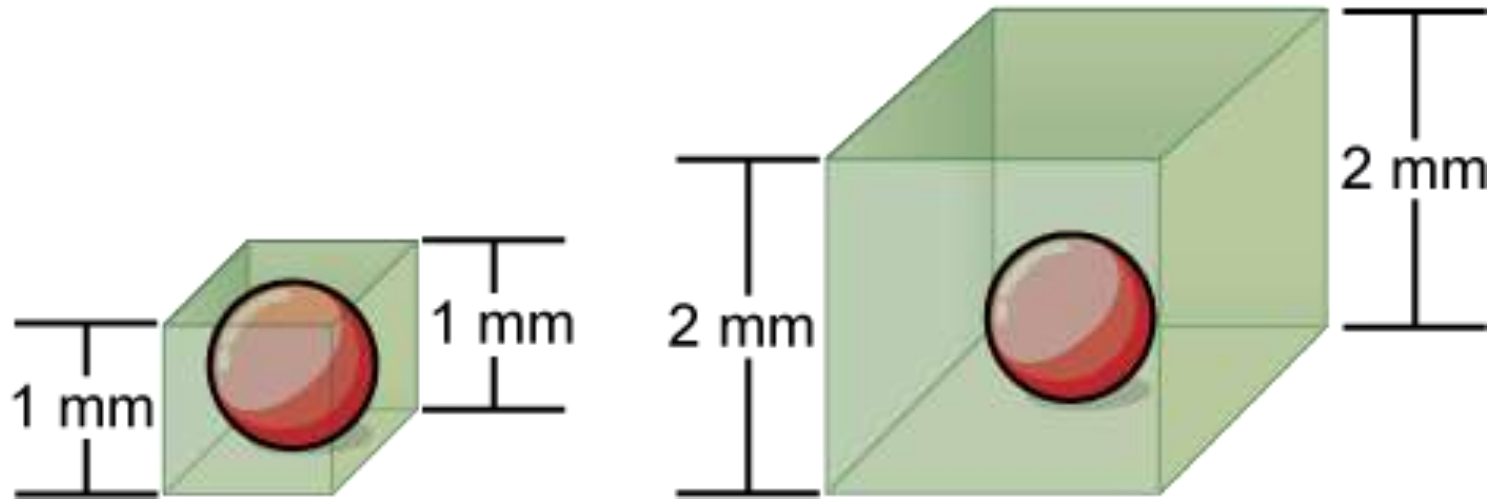




# Cells Need to Replicate...

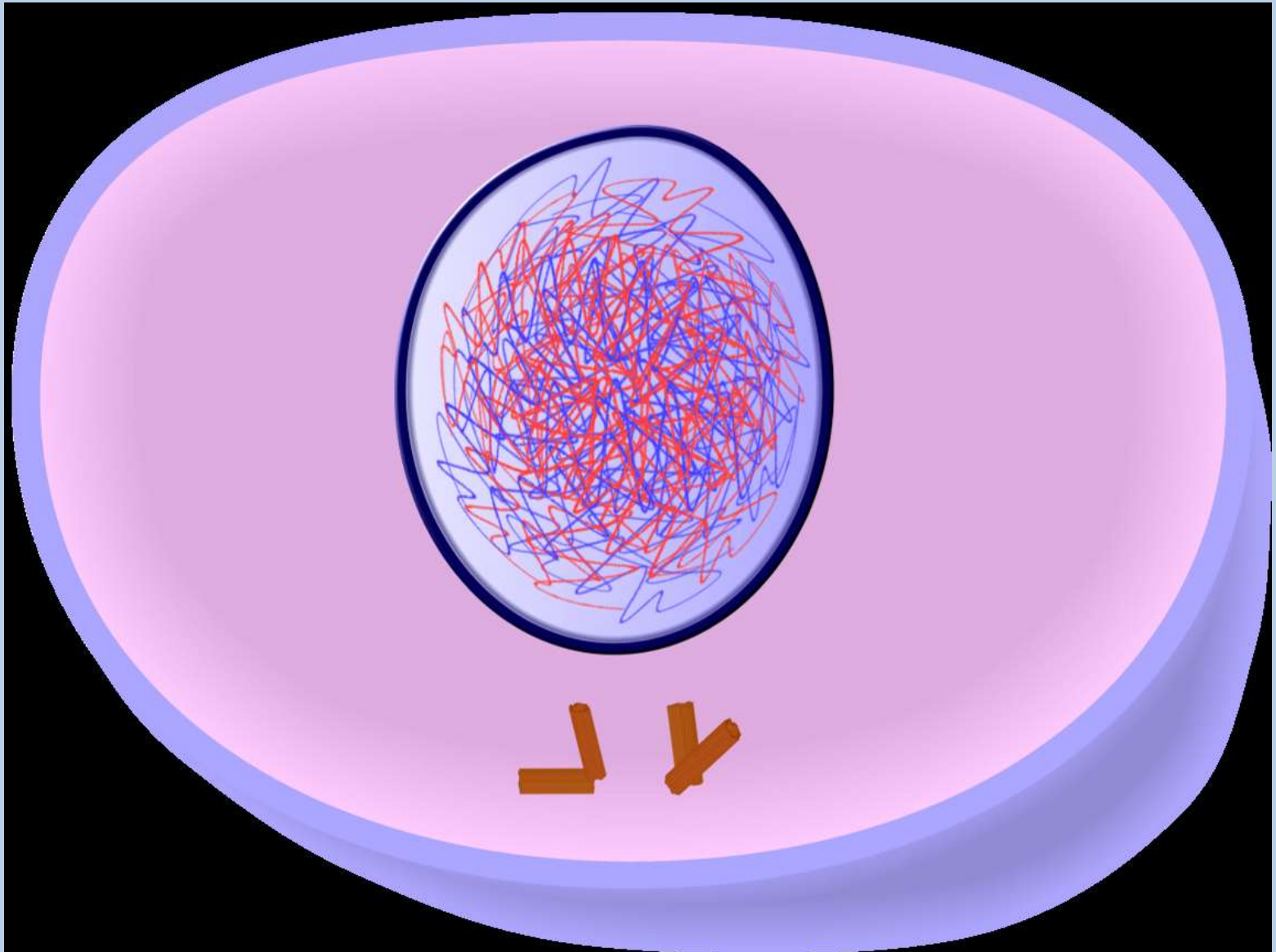


# Cells Need to Replicate...

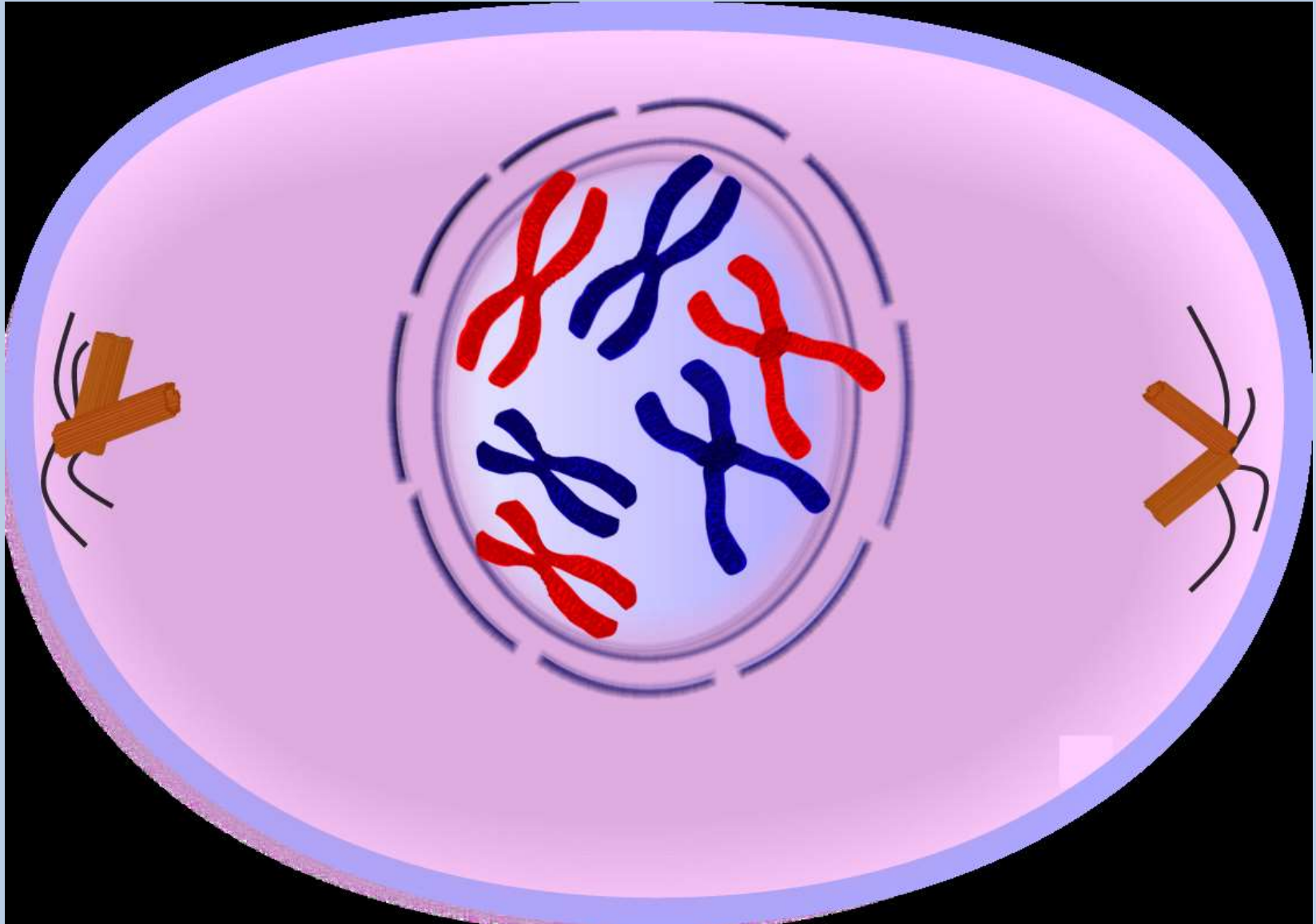


# What is IPMATC?

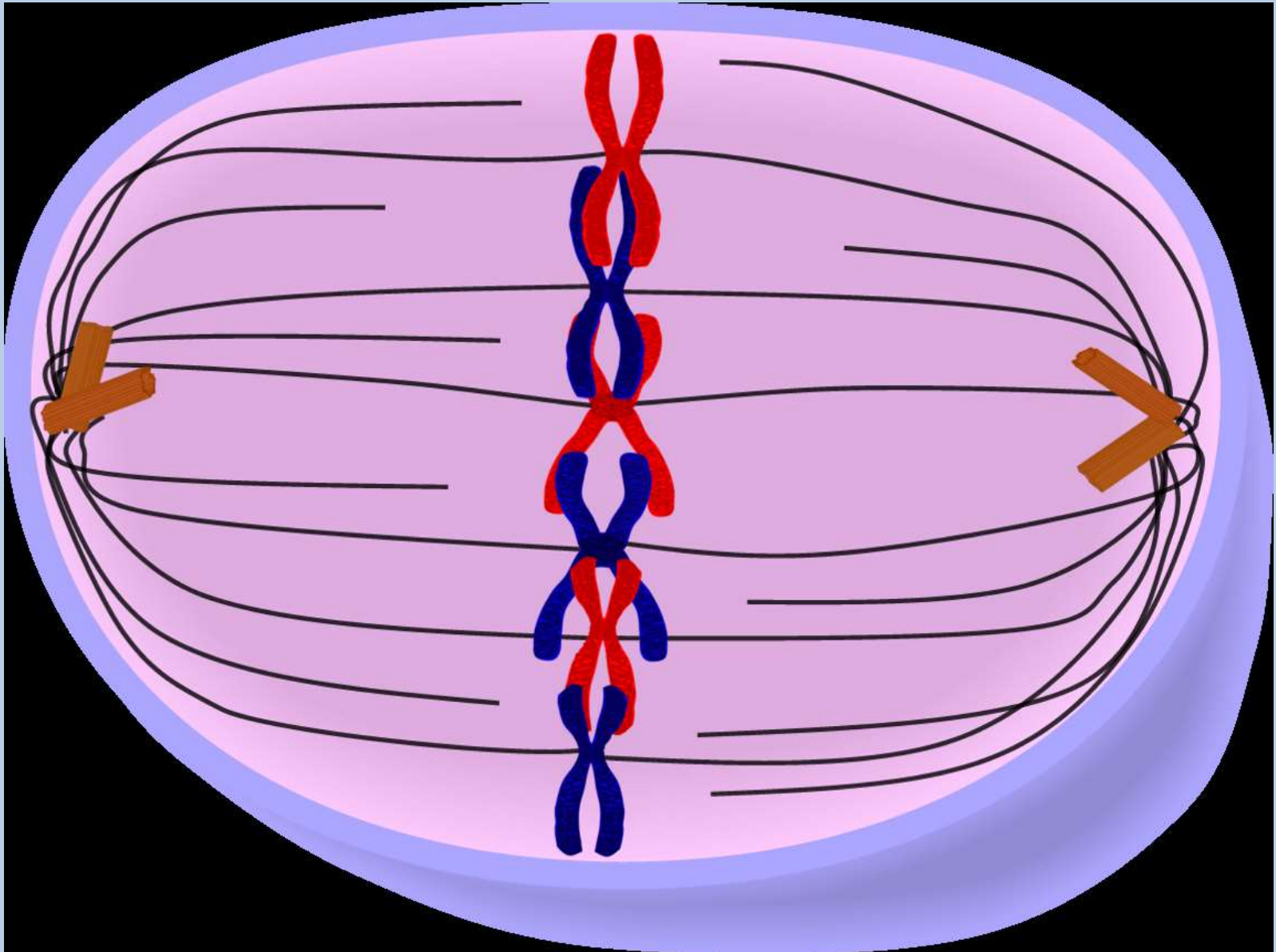
# Interphase



# Mitosis - PROPHASE

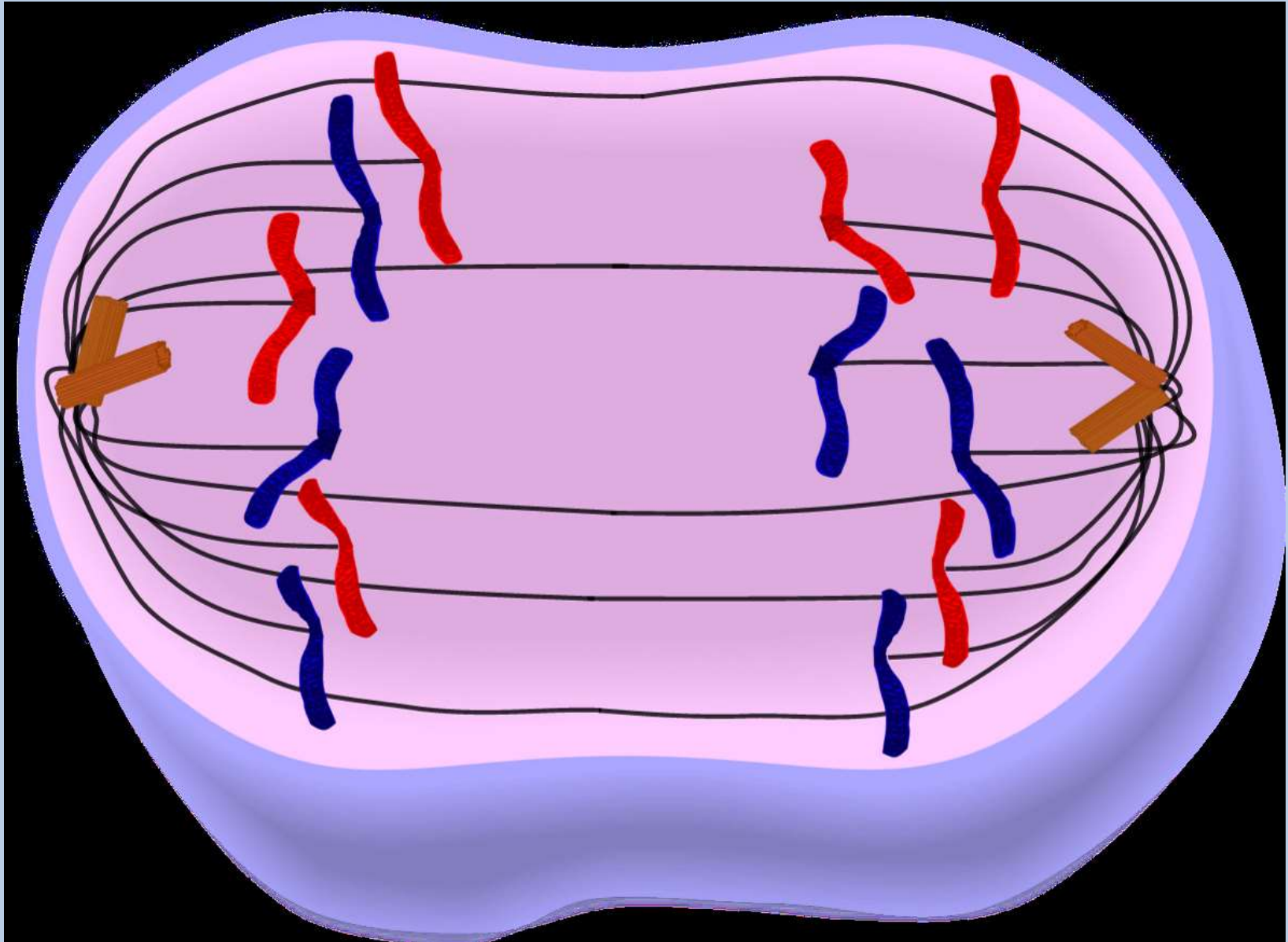


# Mitosis - METAPHASE

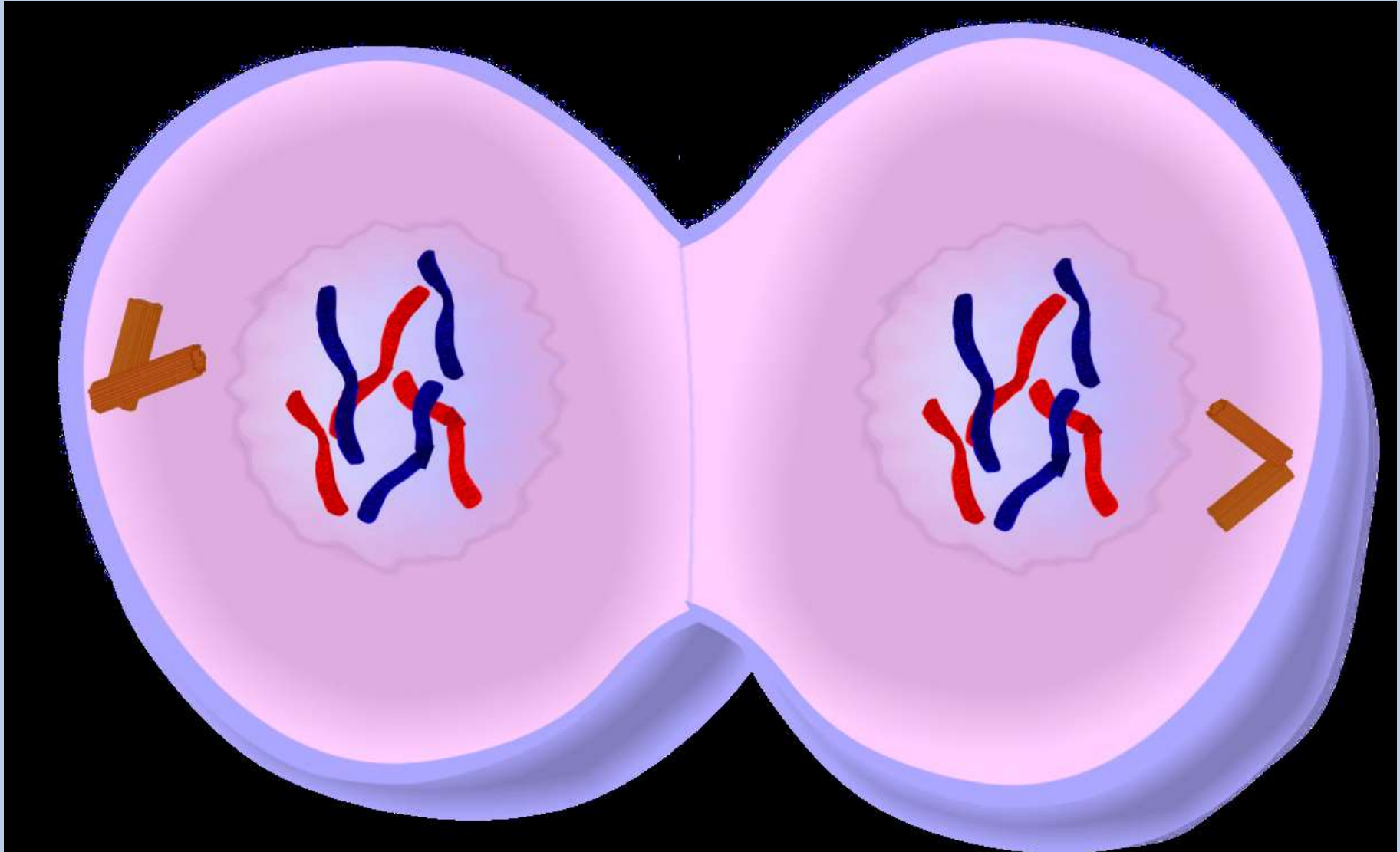




# Mitosis - ANAPHASE

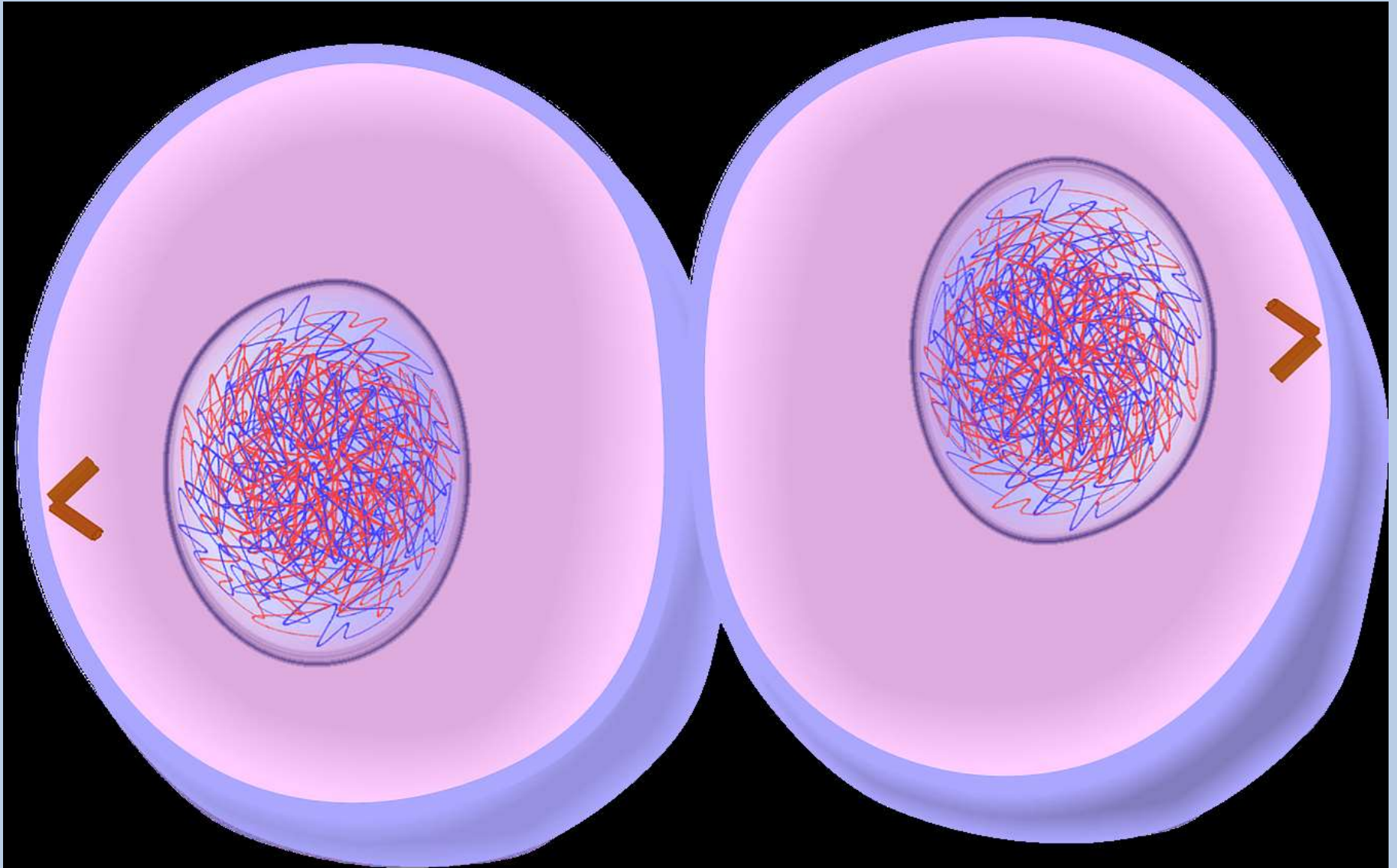


# Mitosis - TELOPHASE





# Cytokinesis



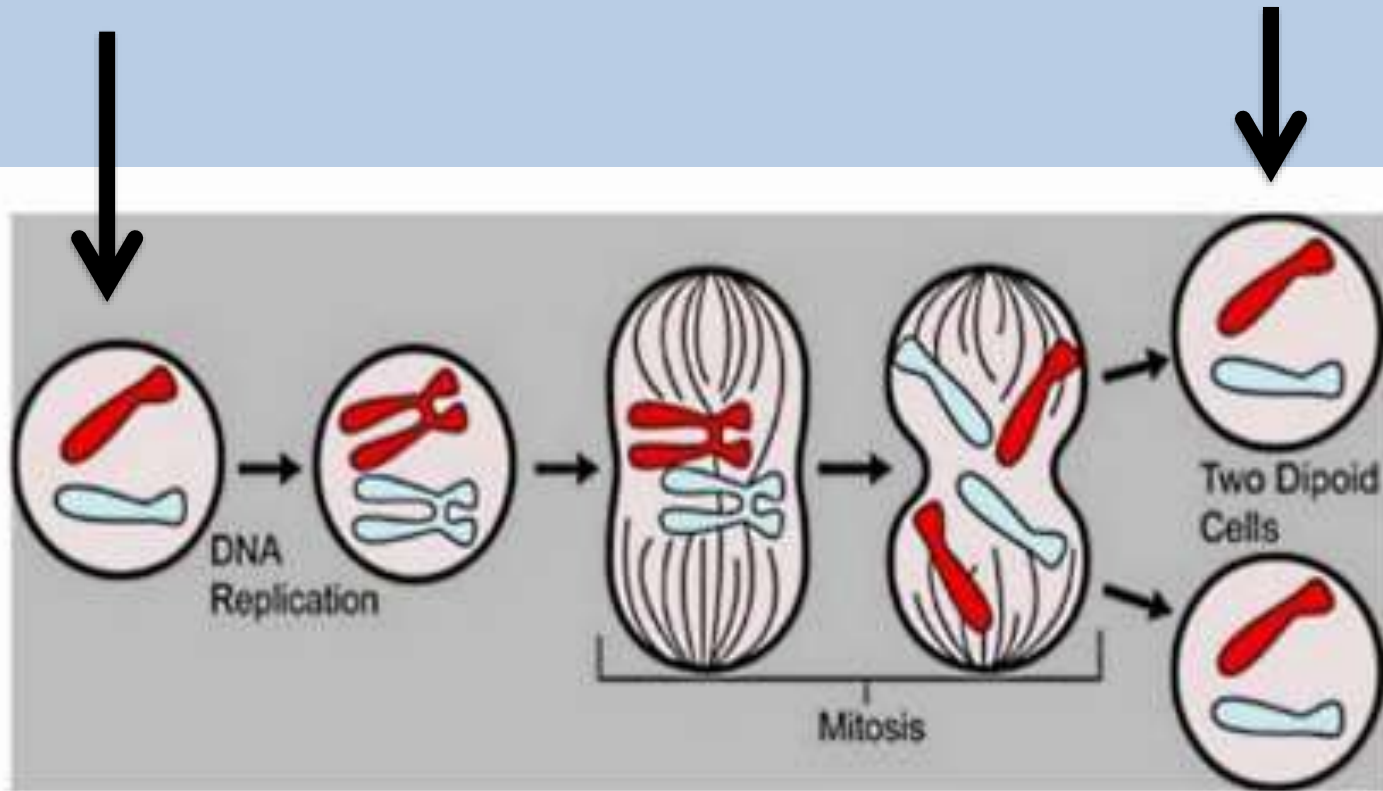
# Brain Warm-up

- **Mitosis hand motion**

# Product of Mitosis

Parent Cell

Daughter Cells



# Cell Differentiation

- **Every multicelled organism starts as 1 cell which differentiates into many cell types:**

# Cell Differentiation

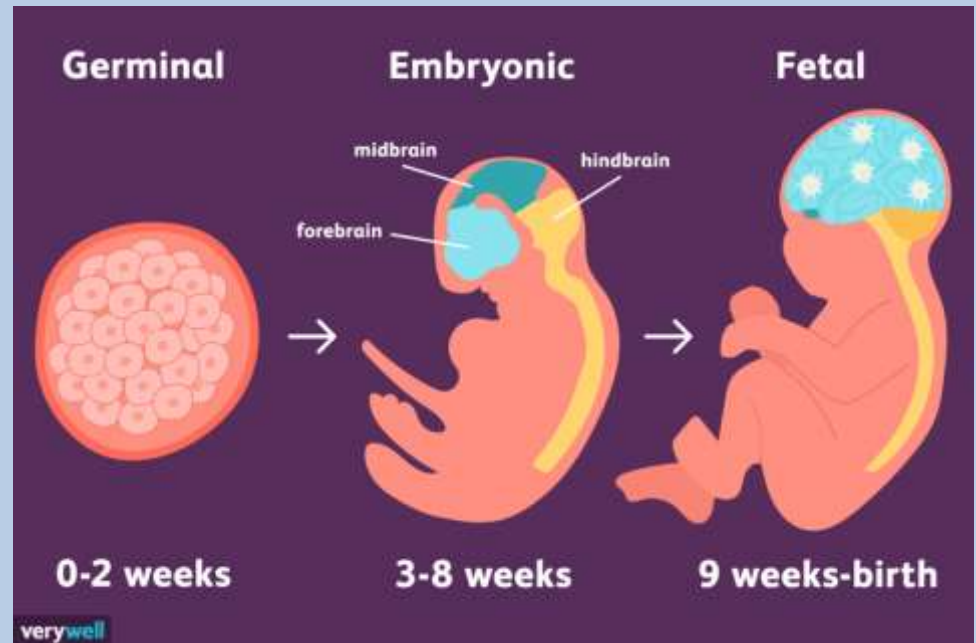
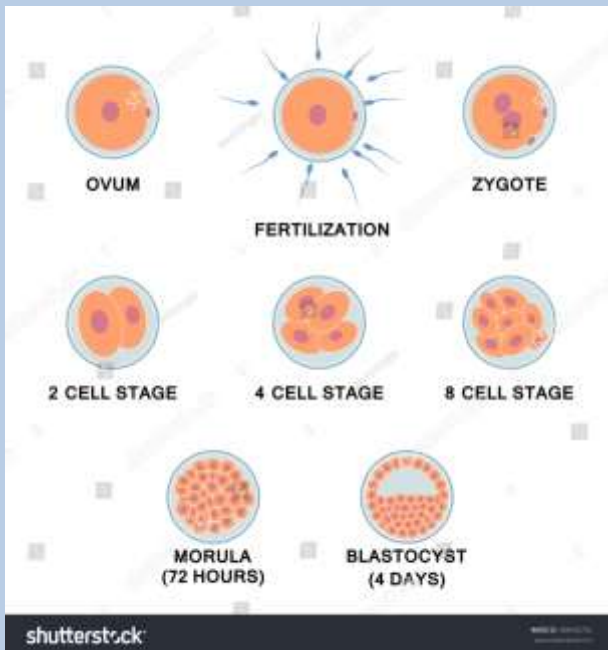
- **Differentiation: process by which cells become specialized to perform certain functions**

# Cell Differentiation

- The most incredible part of differentiation is that 1 cell leads to all of the cell types that your body will need, what do we call cells that can turn into specialized cells?
- **STEM CELLS** are unspecialized cells that can differentiate into specialized cells

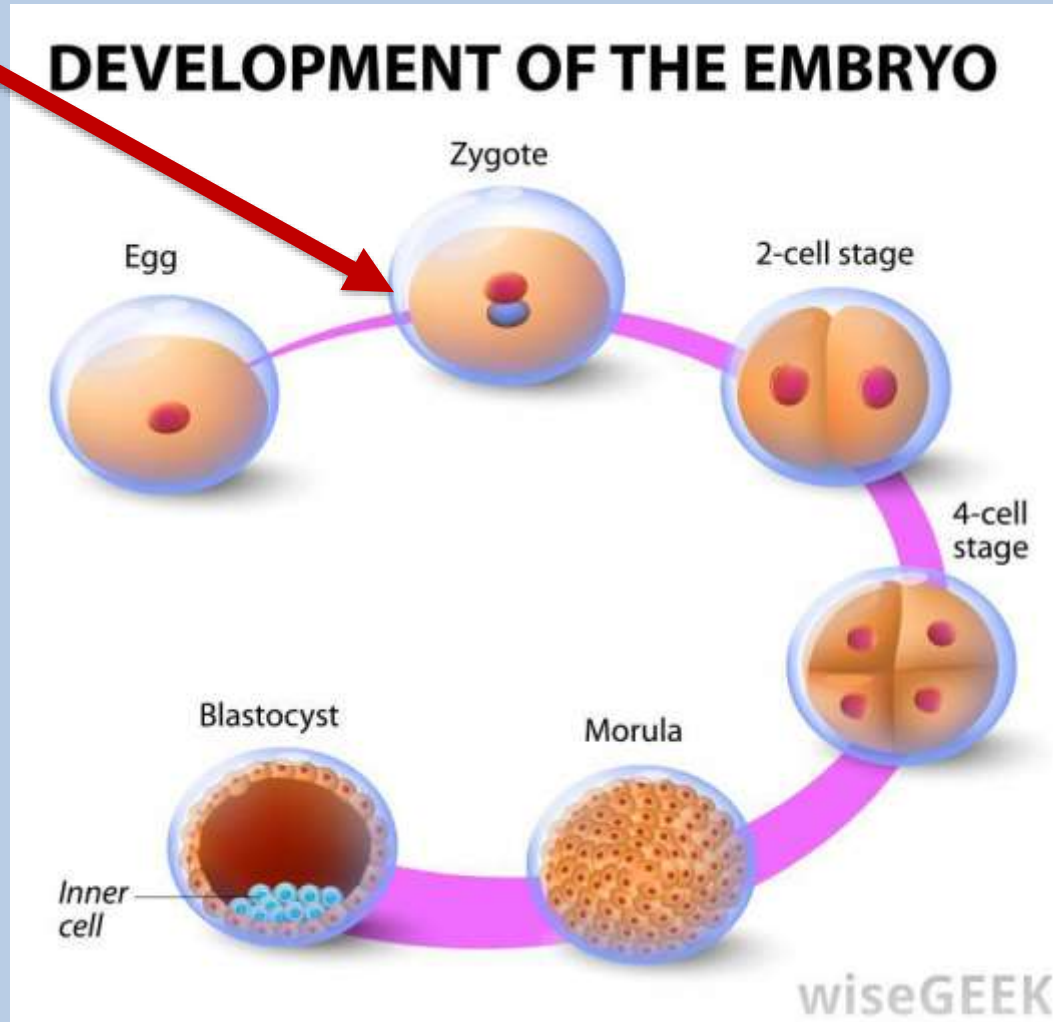
# Cell Differentiation

- Differentiation happens throughout the life of an organism, but the majority happens during development



# Cell Differentiation

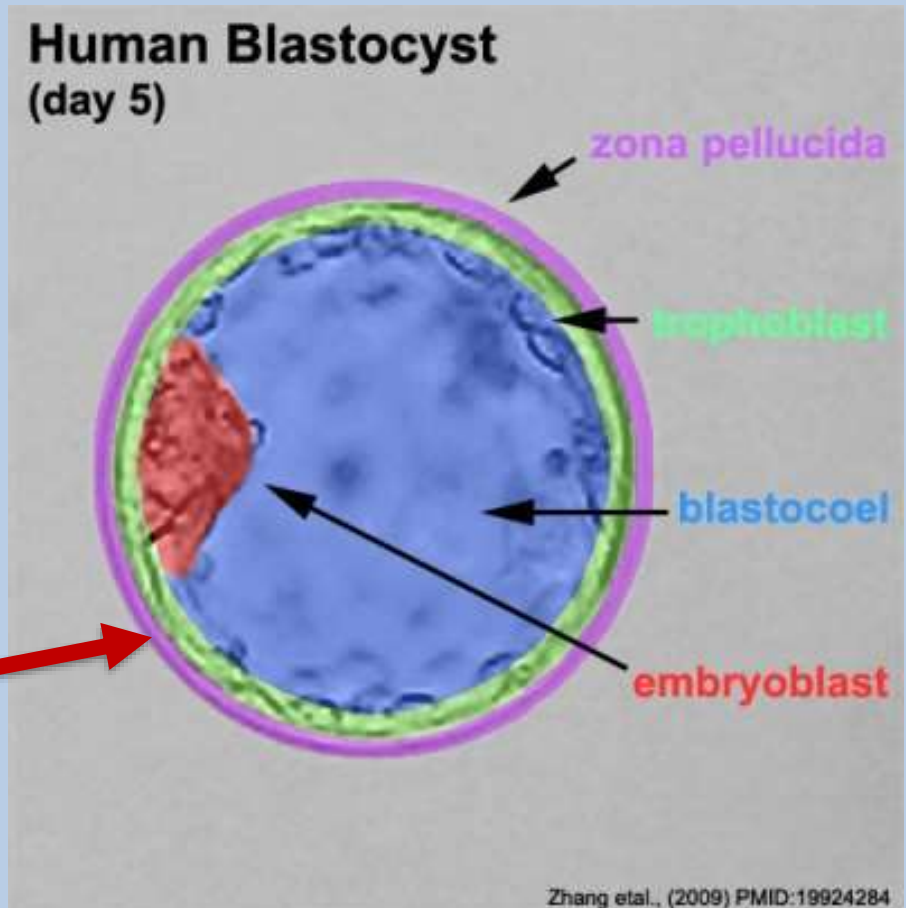
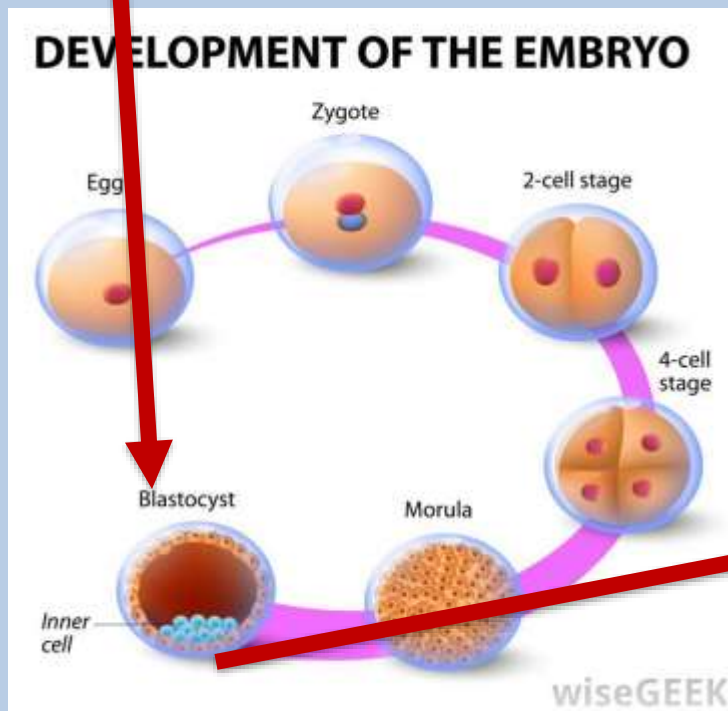
- Zygote: 1 cell, the fertilized egg





# Cell Differentiation

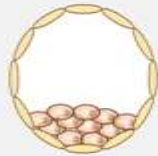
- **Blastocyst: a hollow ball of cells, with a cell cluster inside (~12 days)**



# Cell Differentiation

- Embryo: early developmental stage, after blastocyst, before fetus (~11 weeks)

## Human development overview



ZYGOTE

BLASTOCYST

EMBRYO

FETUS

# Cell Differentiation

- **Fetus: late developmental stage before birth (~40 weeks)**

## Human development overview



**ZYGOTE**

**BLASTOCYST**

**EMBRYO**

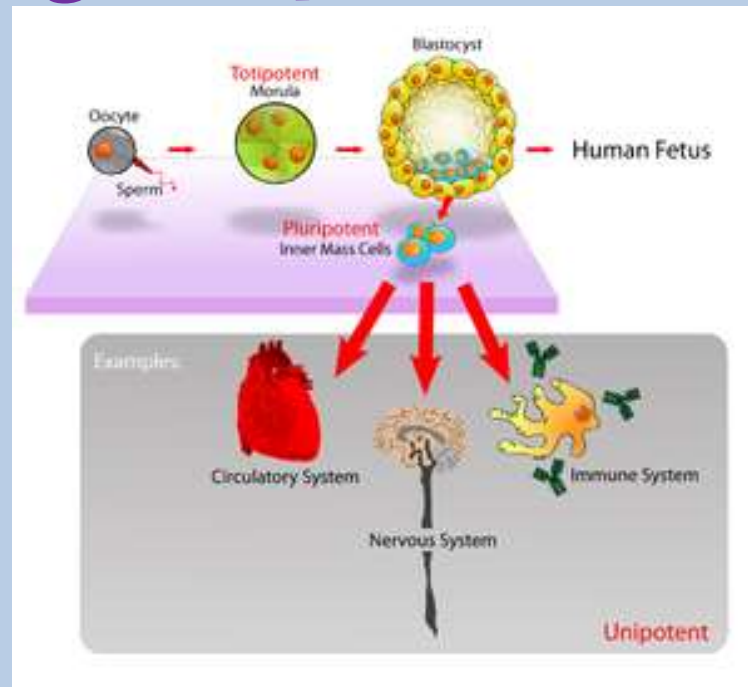
**FETUS**

# Cell Differentiation

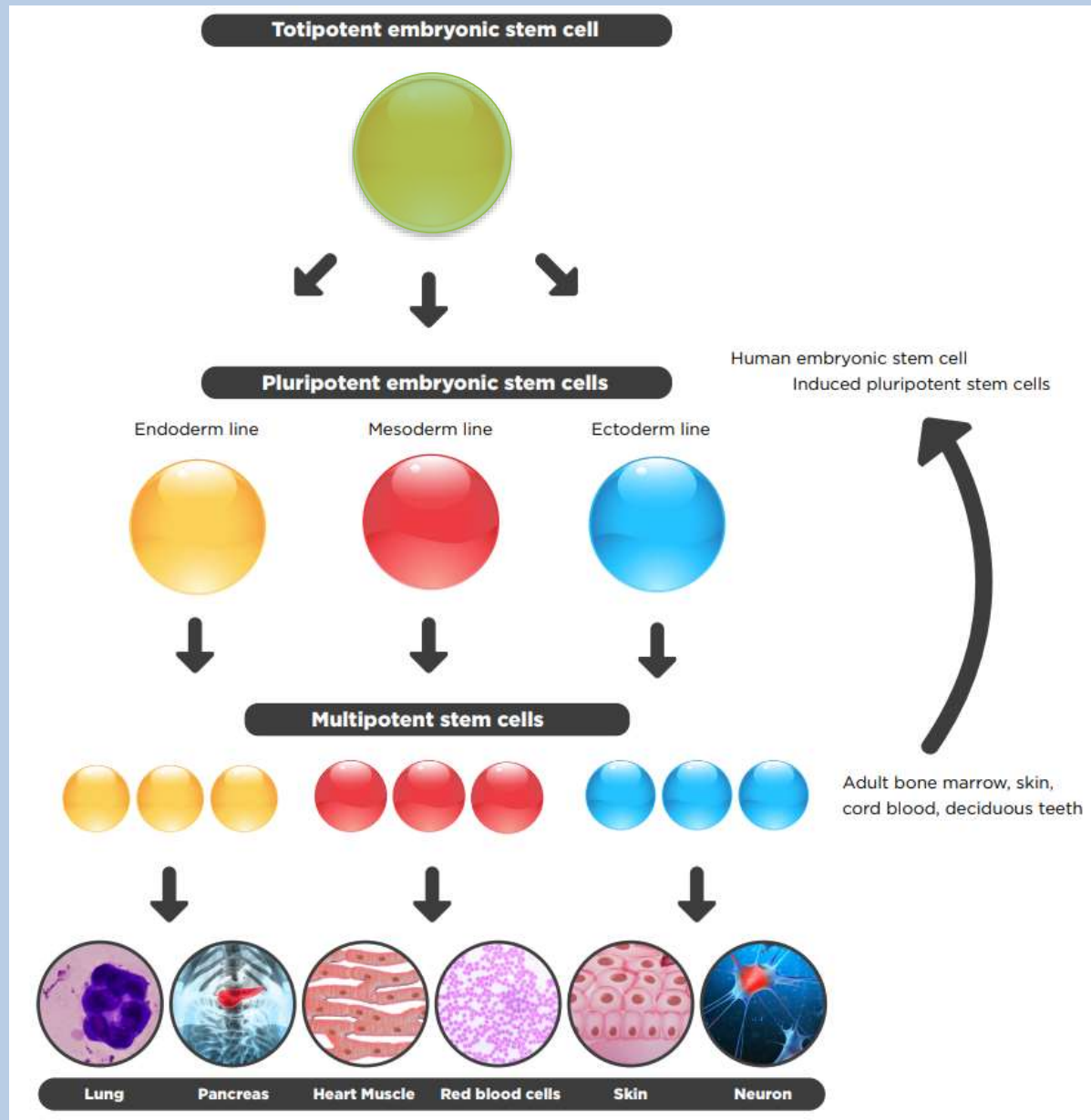
- **The types of stem cells at various stages of development, and life, change**
- **To understand this you will be completing a brief reading activity**

# Cell Differentiation

- During the zygote stage the stem cells are said to **totipotent**; capable of becoming any cell type, including the placenta



# Cell Differentiation



# Cell Differentiation

- Why might stem cell therapy be controversial?
- <https://www.youtube.com/watch?v=dly-zCaFaWw>



**INTERMISSION**





# Cell Division

- **Mitosis is part of cell division**
- **Should the body be in control of cell division?**
- **WHY?**

# Cell Division

- The body **MUST** be in control of cell division, and the entire cell cycle
- What kind of molecule does the body use to control this *function*?

# Cell Division

- **Regulatory proteins keep the cell cycle normal**
- **Inhibitory proteins; stop the cell cycle**
- **Stimulating proteins; progress the cell cycle:**
  - **Growth factors: signals from outside the cell that stimulate cell division**
  - **Cyclins: control the timing of the cell cycle (cyclins build up and cause mitosis to happen)**

---

# Cell Division and Repair

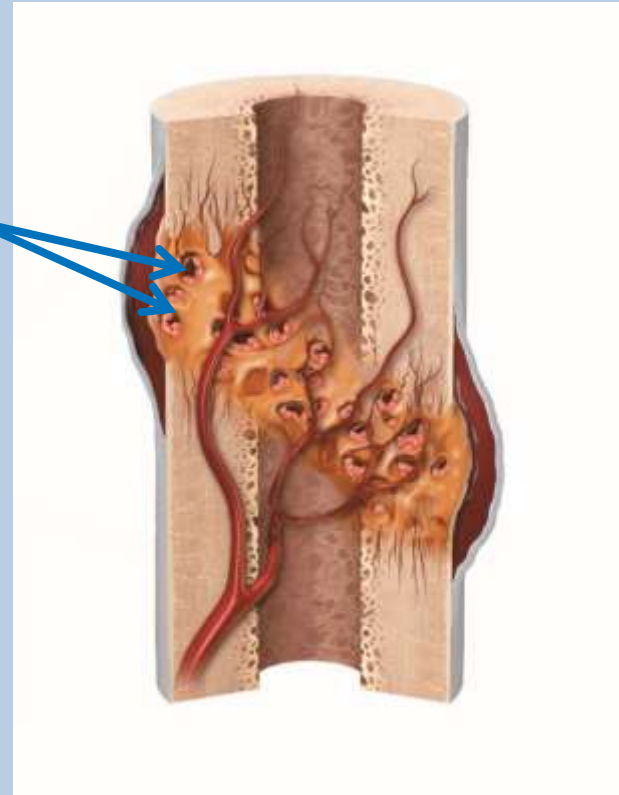
- This is part of how an injury is signaled to do a lot of cell division



# Cell Division and Repair



new bone cells



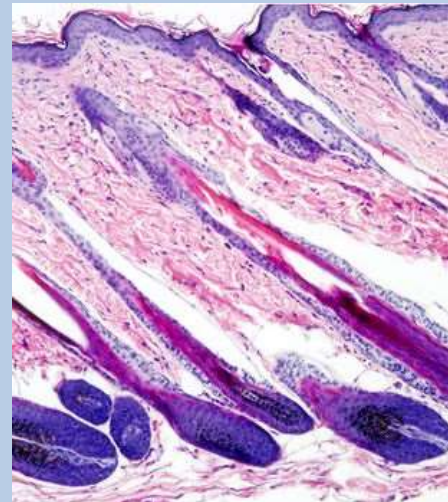
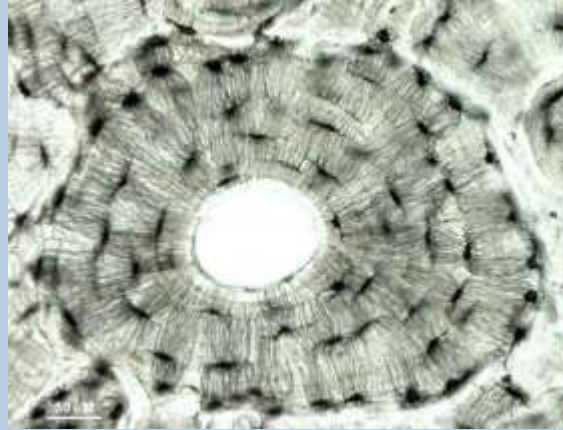
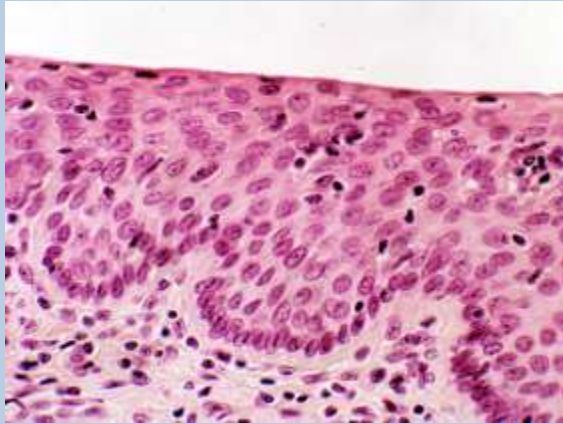
- Cells at the edge of an injury, and cells in certain organs, are stimulated to divide rapidly by proteins

# Cell Division

- **What kinds of cells might need to divide more often than others?**

# Cell Division

- Skin, bones, intestinal, blood, hair, etc.



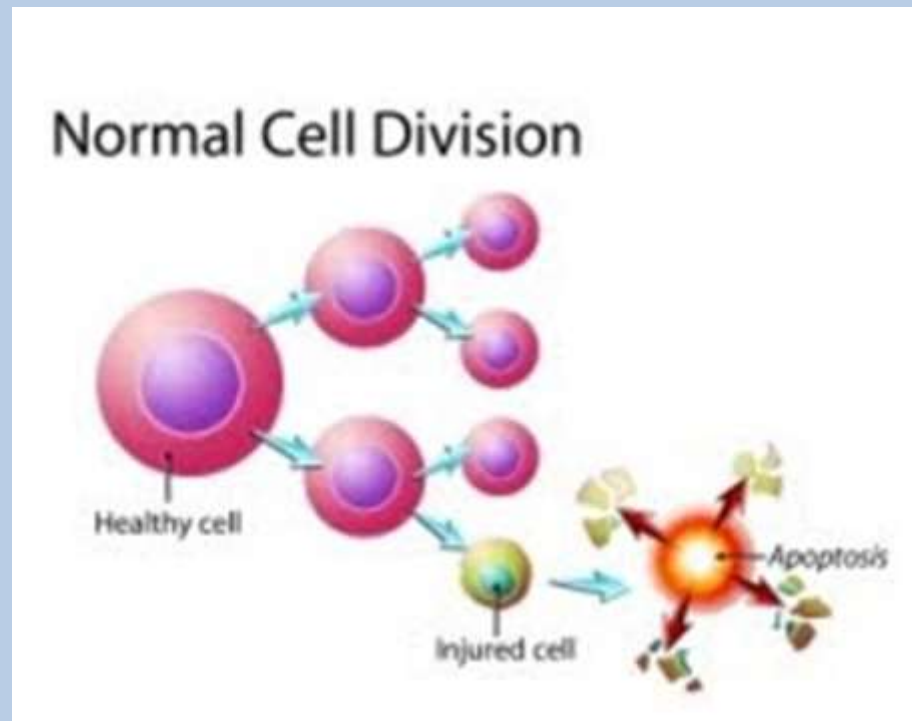
# Cell Division

- What *SHOULD* happen to a cell that stops responding to regulatory proteins?



# Cell Division

- Apoptosis: programmed cell death



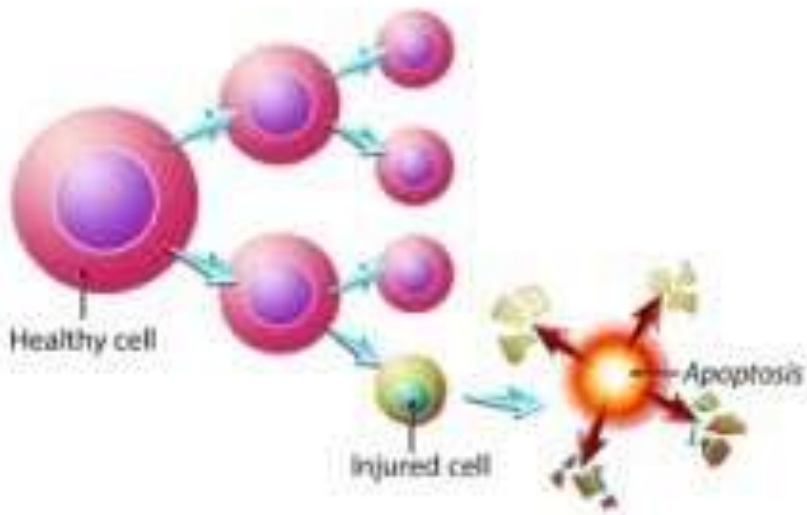
# Cell Division

- **WHAT WOULD HAPPEN IF CELLS DIVIDED UNCONTROLLABLY?**

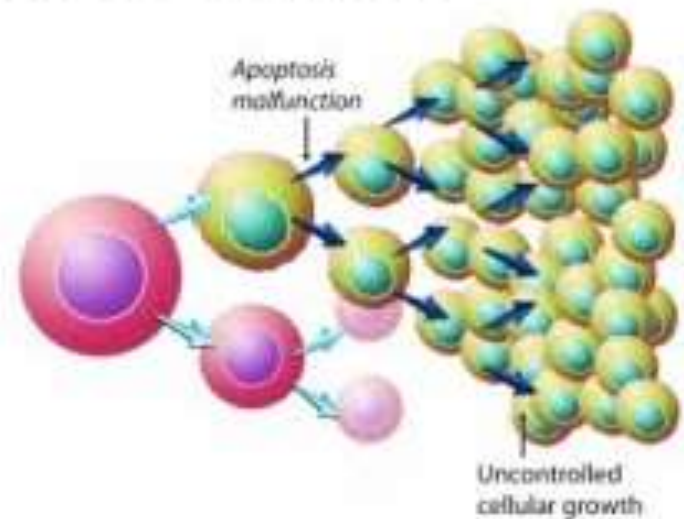
# Cancer

- **Uncontrolled cell division** can cause a tumor, a mass of abnormally dividing cells

Normal Cell Division

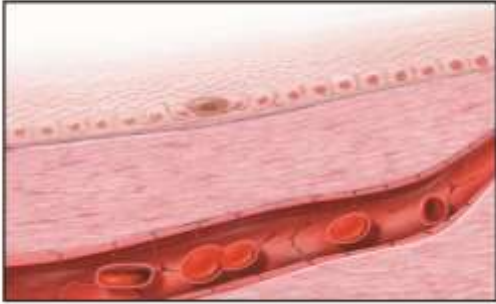


Cancer Cell Division



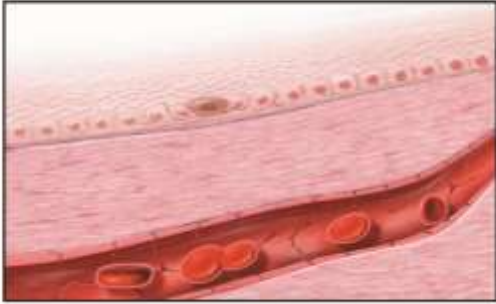
---

# Cancer Formation: A Closer Look

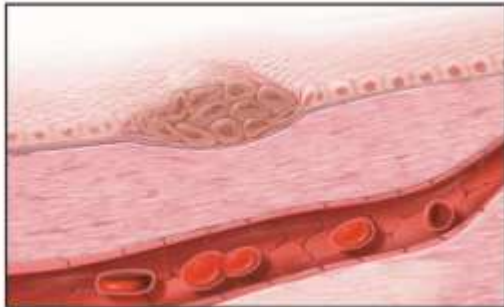


1. A cell begins to divide abnormally.

# Cancer Formation: A Closer Look

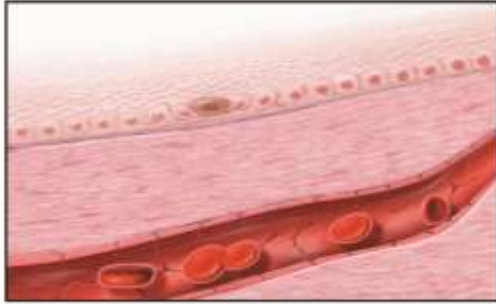


1. A cell begins to divide abnormally.

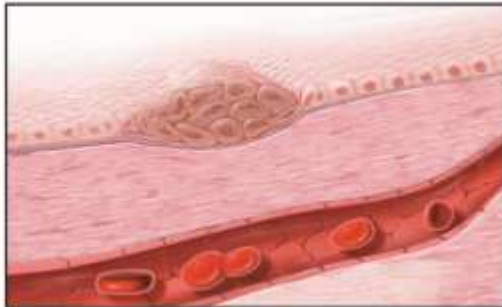


2. Cells produce a tumor and start to displace normal cells and tissues.

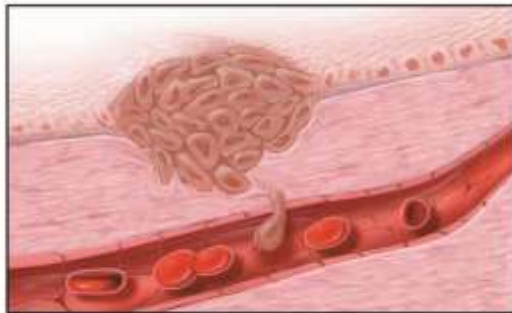
# Cancer Formation: A Closer Look



1. A cell begins to divide abnormally.



2. Cells produce a tumor and start to displace normal cells and tissues.



3. Cancer cells move to other parts of the body.

# Cancer

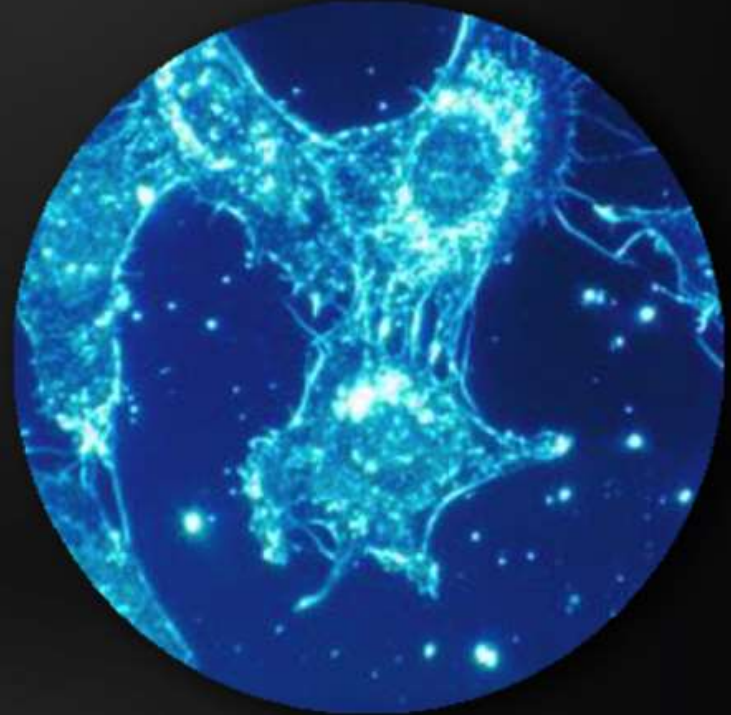
- <https://www.youtube.com/watch?v=leUANxFVXKc>

# Cancer

- Cells that have gone rogue, cancer cells, have different structures than healthy cells



Healthy

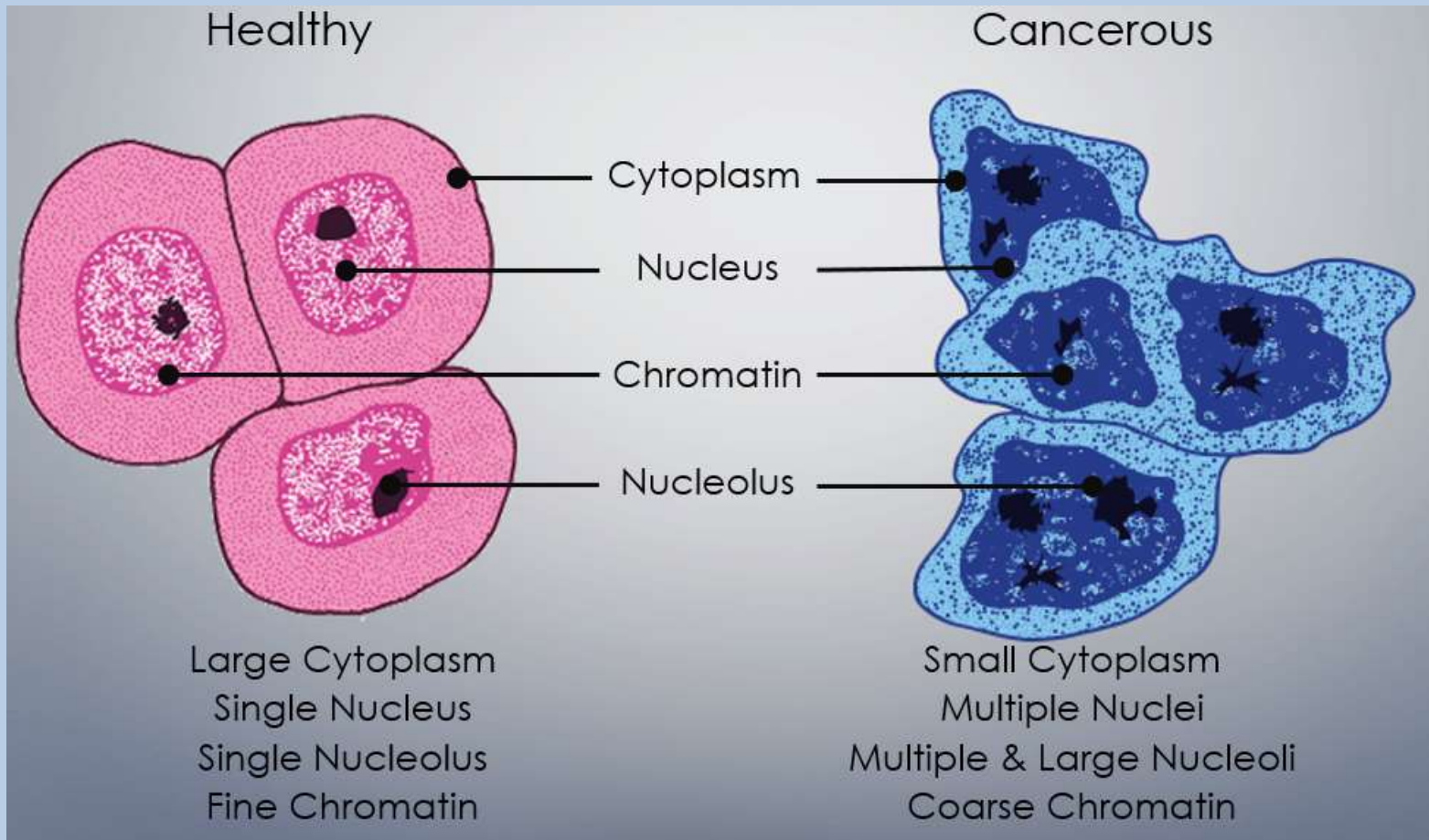


Cancerous



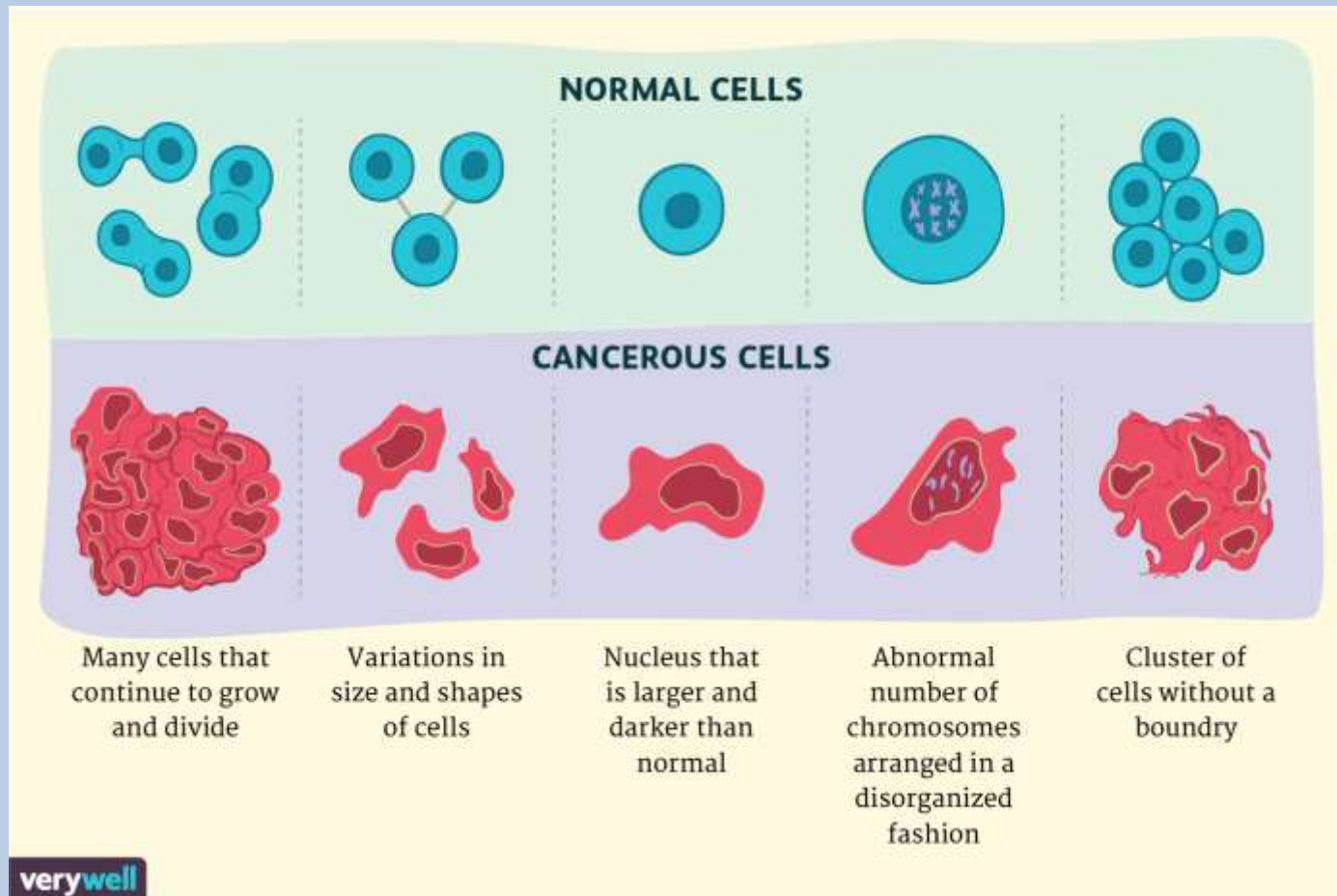
# Cancer

- **Cancer cells have different structures than healthy cells**



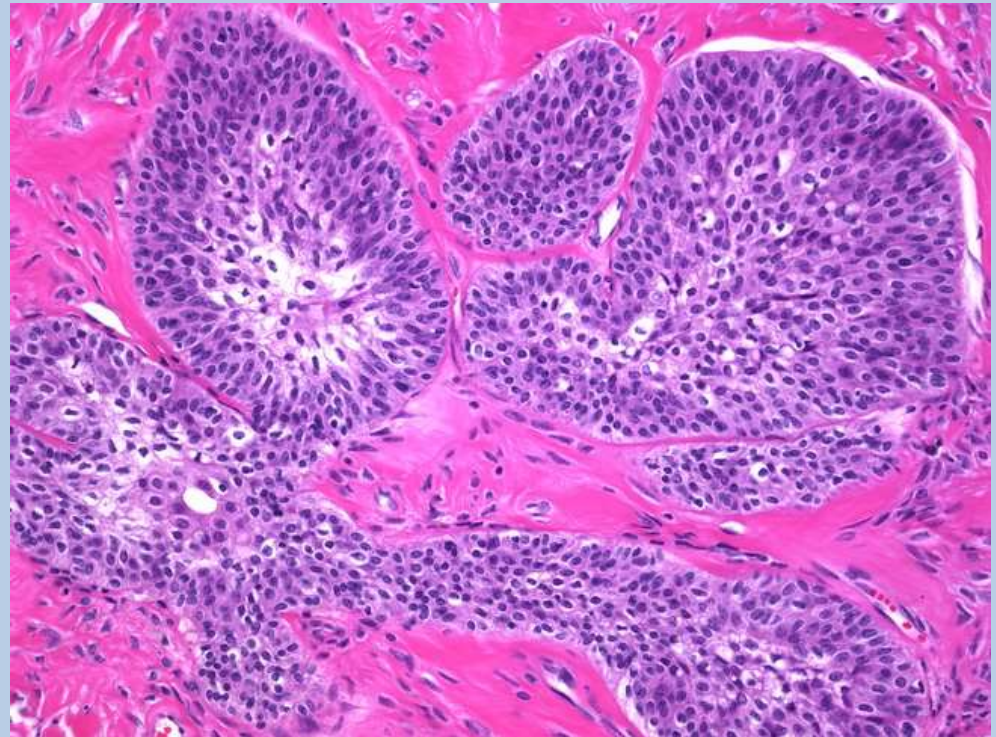
# Cancer

- Cancer cells have different structures from healthy cells



# Cancer

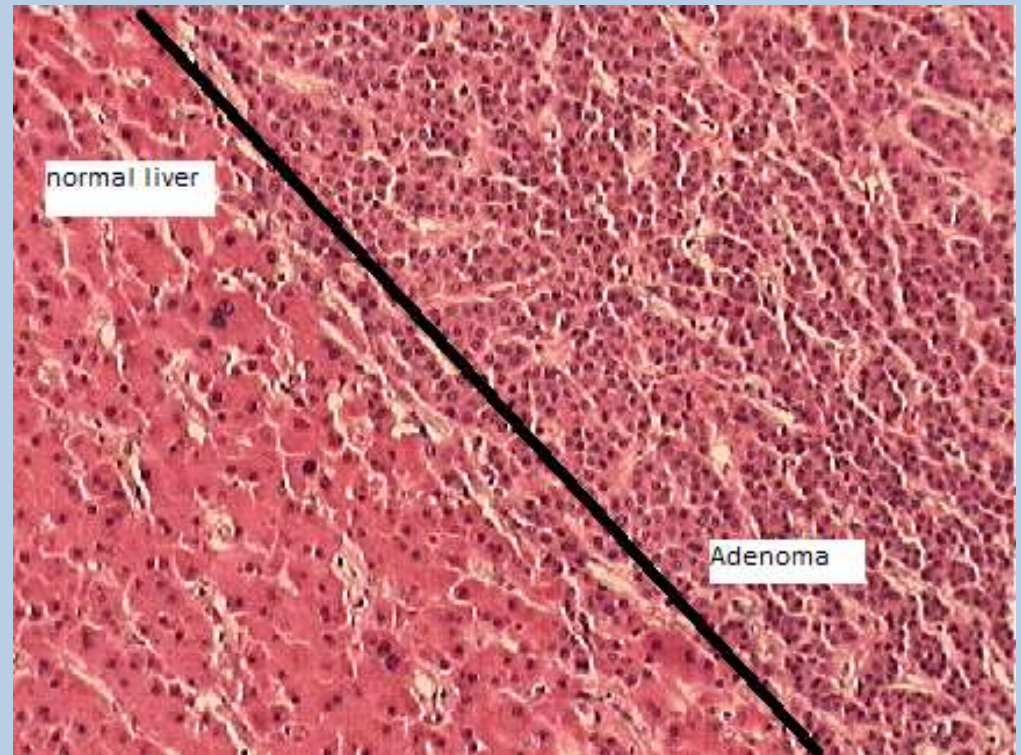
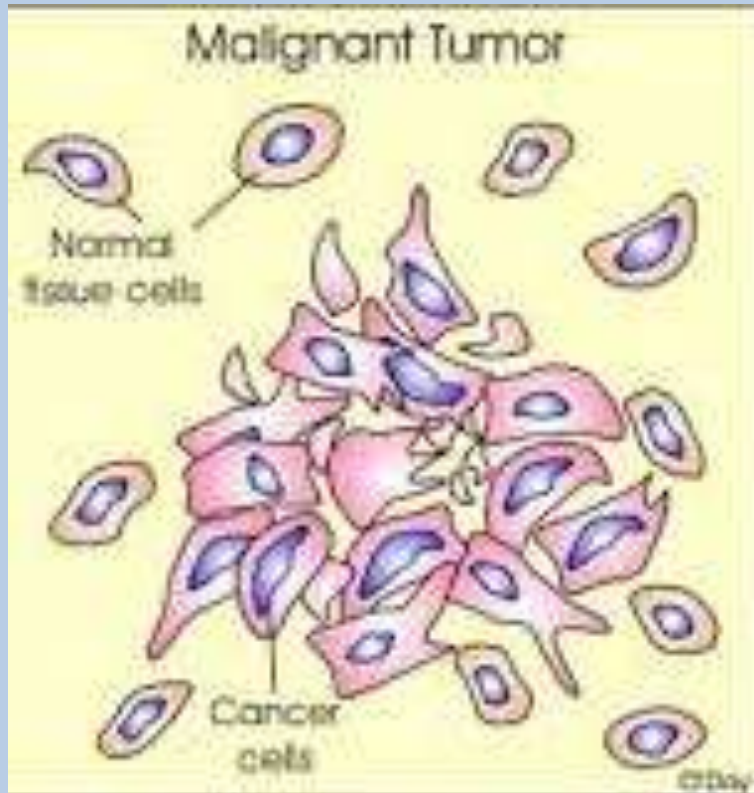
- **Benign tumors remain stable**





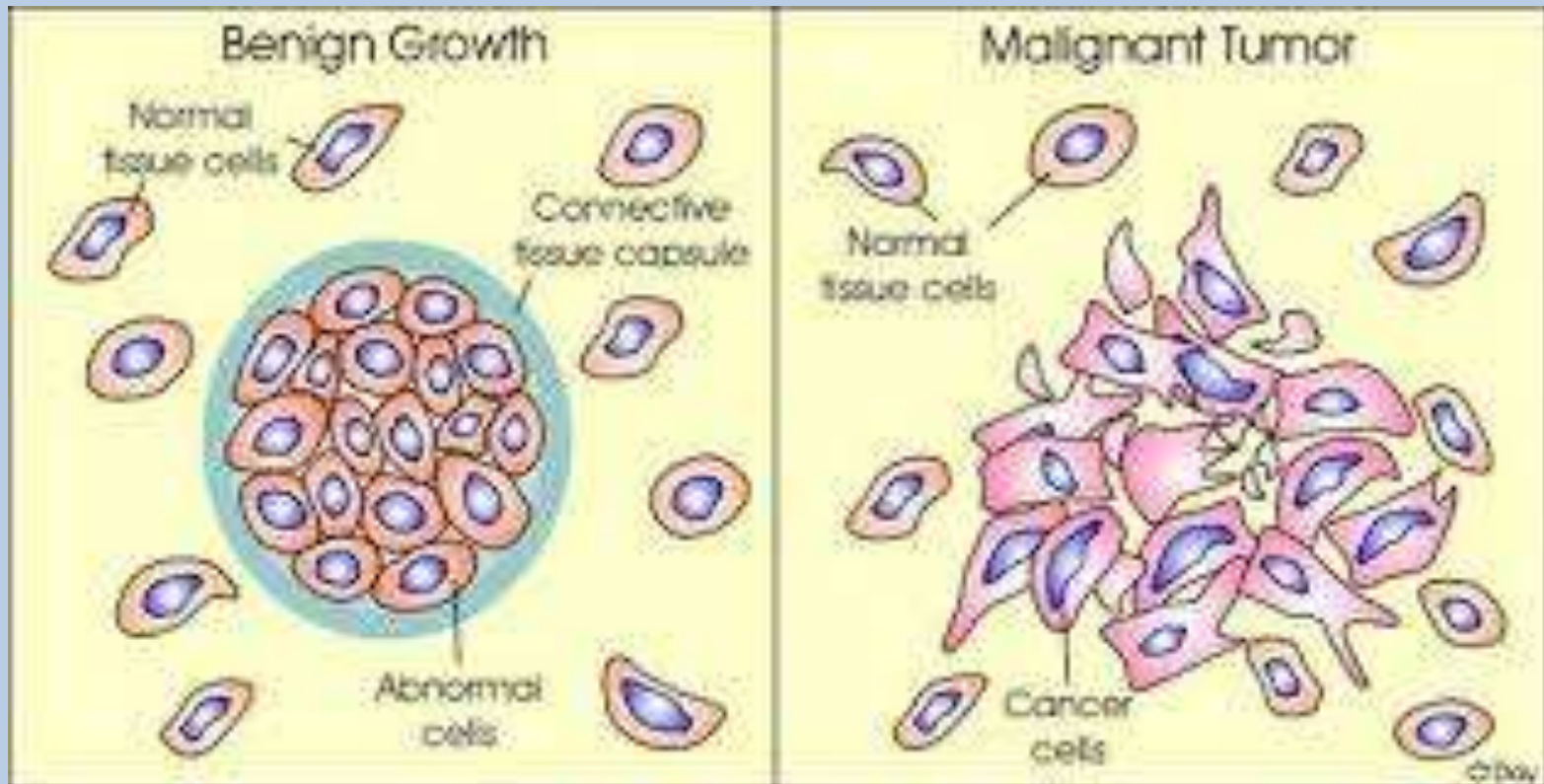
# Cancer

- Malignant tumors grow quickly and can metastasize (spread), affecting healthy tissue functions



# Cancer

- **Malignant tumors grow quickly and can metastasize (spread), affecting healthy tissue functions**



# Cancer

- **Why are malignant tumors bad? How do they affect the entire organism?**

# Cancer

- Why are malignant tumors bad? How do they affect the entire organism?
- If cells/tissues/organs aren't able to function, it disrupts *homeostasis* in the organism

# Cancer

- **What would cause uncontrolled cell division to begin?**



# Cancer

- **When genes that code for regulatory proteins get messed up (mutated), then the proteins are messed up (mutated), and cells can begin dividing uncontrollably**

# Cancer

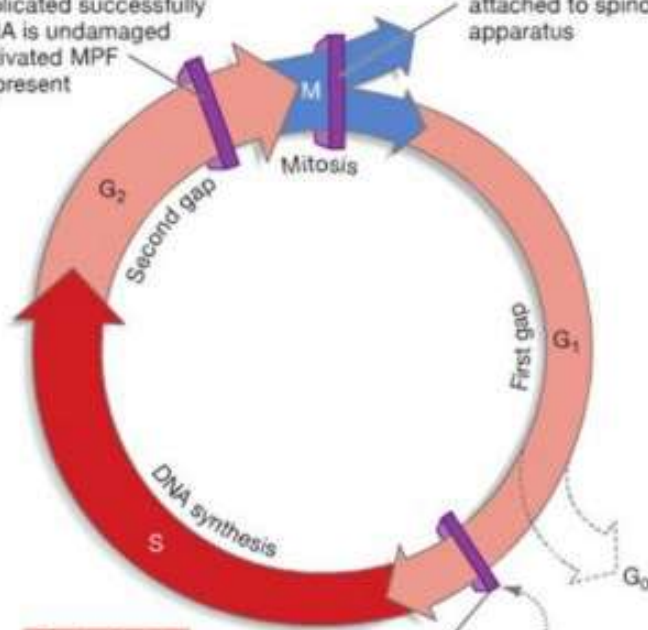
## CANCER

### G<sub>2</sub> checkpoint

- Pass this checkpoint if:
- chromosomes have replicated successfully
  - DNA is undamaged
  - activated MPF is present

### Metaphase checkpoint

- Pass this checkpoint if:
- all chromosomes are attached to spindle apparatus



### G<sub>1</sub> checkpoint

- Pass this checkpoint if:
- cell size is adequate
  - nutrients are sufficient
  - social signals are present
  - DNA is undamaged

Mature cells do not pass this checkpoint (they enter G<sub>0</sub> state)

FIGURE 11.12 The Three Cell-Cycle Checkpoints.

Image from "Mastering Biology", Pearson 2011

Mutation inactivates tumor suppressor gene

CELLS PROLIFERATE

Mutation inactivates DNA repair gene

Mutation of proto-oncogene creates an oncogene

Mutation inactivates several more tumor suppressor genes

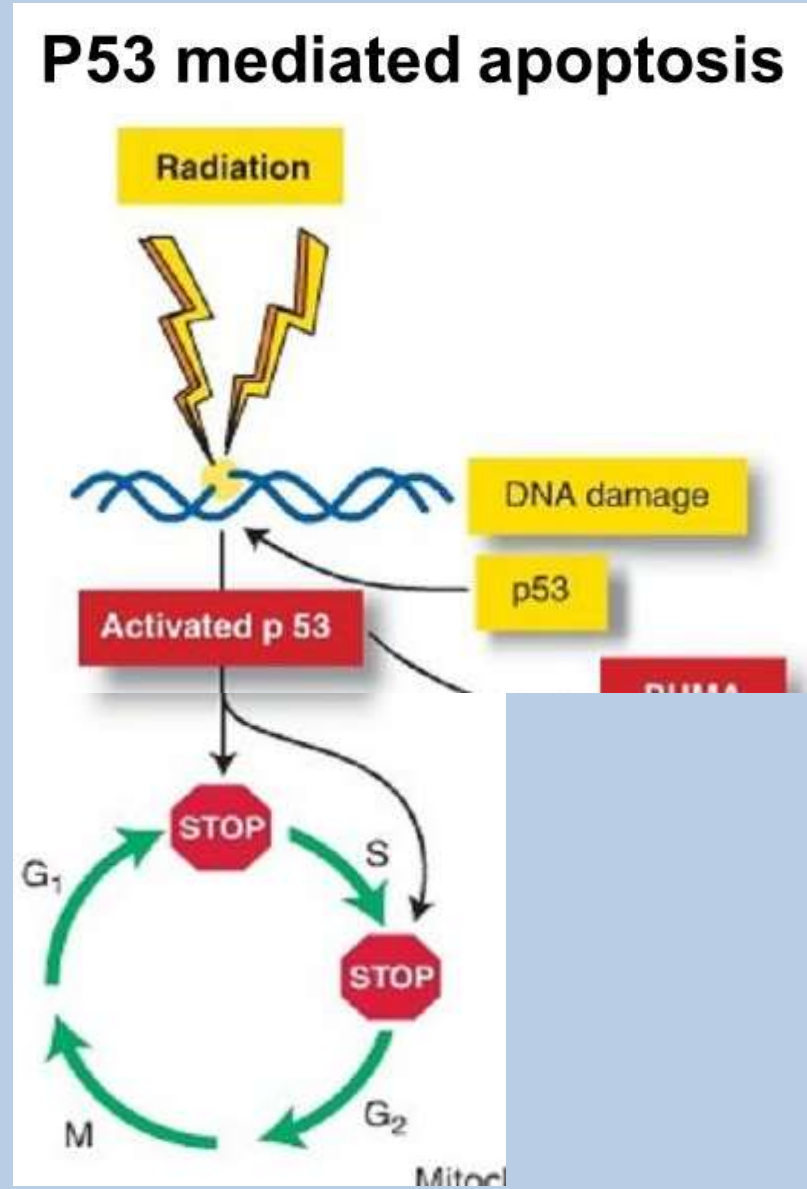


CANCER

Image courtesy of Google images

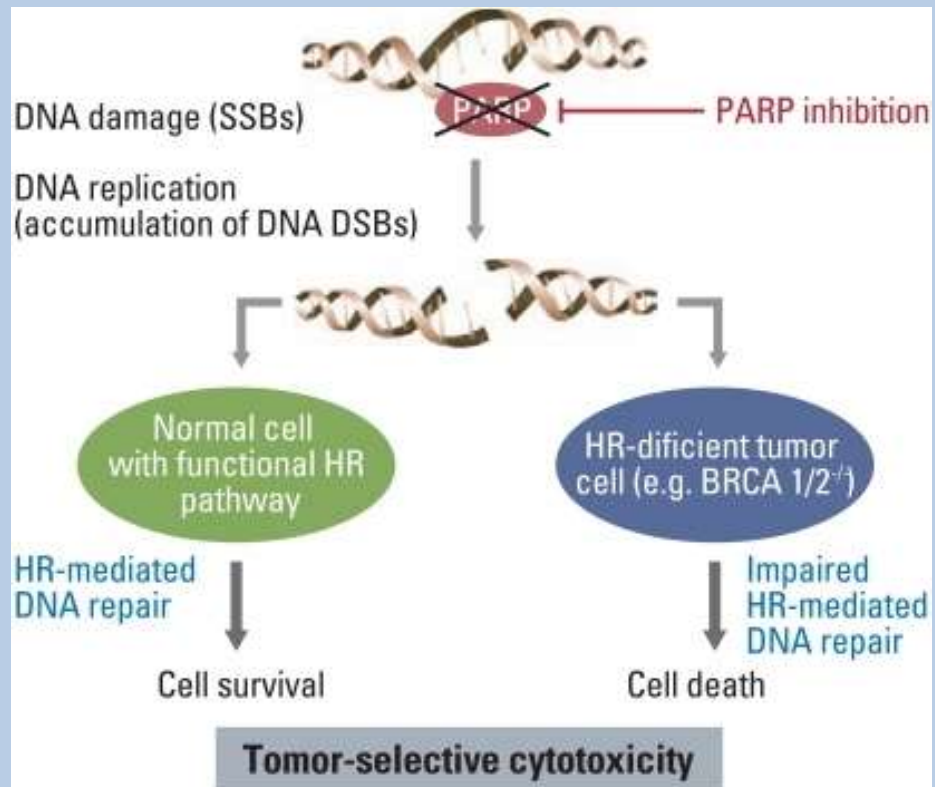
# Cancer

- One really important gene is **p53**, which codes for a protein that triggers apoptosis in abnormal cells



# Cancer

- Another really important gene is **BRCA1**, which codes for a protein that triggers apoptosis in abnormal cells



# Cancer

- These mutations can be caused by carcinogens (substances that can produce cancer)

# Cancer

- **In your group think of carcinogens you encounter during life**

# Carcinogens

*A Rough Guide to*  
**IARC CARCINOGEN CLASSIFICATIONS**

The International Agency for Research on Cancer (IARC) classifies substances to show whether they are suspected to cause cancer or not. It places substances into one of five categories depending on the strength of evidence for their carcinogenicity.

GROUP	WHAT DOES IT MEAN?	WHAT DOES IT INCLUDE?
<b>GROUP 1</b>	<b>CARCINOGENIC TO HUMANS</b> Sufficient evidence in humans. Causal relationship established.	Smoking, exposure to solar radiation, alcoholic beverages and processed meats.
<b>GROUP 2A</b>	<b>PROBABLY CARCINOGENIC TO HUMANS</b> Limited evidence in humans. Sufficient evidence in animals.	Emissions from high temp. frying, steroids, exposures working in hairdressing, red meat.
<b>GROUP 2B</b>	<b>POSSIBLY CARCINOGENIC TO HUMANS</b> Limited evidence in humans. Insufficient evidence in animals.	Coffee, gasoline & gasoline engine exhaust, welding fumes, pickled vegetables.
<b>GROUP 3</b>	<b>CARCINOGENICITY NOT CLASSIFIABLE</b> Inadequate evidence in humans. Inadequate evidence in animals.	Tea, static magnetic fields, fluorescent lighting, polyethylene.
<b>GROUP 4</b>	<b>PROBABLY NOT CARCINOGENIC</b> Evidence suggests no carcinogenicity in humans/animals.	<b>1</b> ONLY 1 CHEMICAL EVER PLACED IN THIS GROUP, OF ALL SUBSTANCES ASSESSED Caprolactam, which is used in the manufacture of synthetic fibres.

**THE IARC'S INDEX ONLY TELLS US HOW STRONG THE EVIDENCE IS THAT SOMETHING CAUSES CANCER. SUBSTANCES IN THE SAME CATEGORY CAN DIFFER VASTLY IN HOW MUCH THEY INCREASE CANCER RISK.**

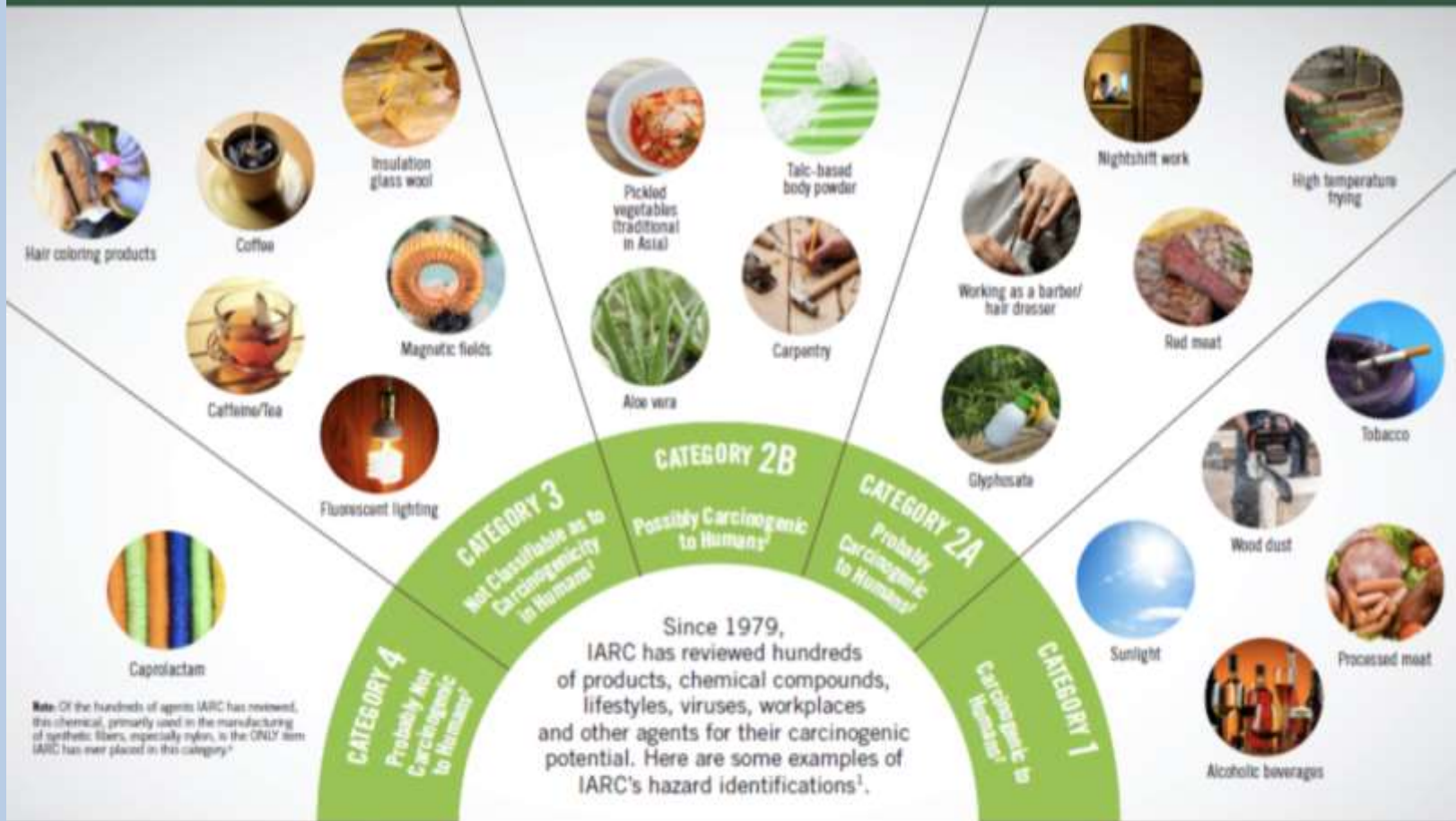
© COMPOUND INTEREST 2015 - WWW.COMPOUNDCHEM.COM | @COMPOUNDCHEM  
Shared under a Creative Commons Attribution-NonCommercial-NoDerivatives licence.

CC BY NC ND



# Carcinogens

## Examples of International Agency for Research on Cancer (IARC) Carcinogenic Classifications



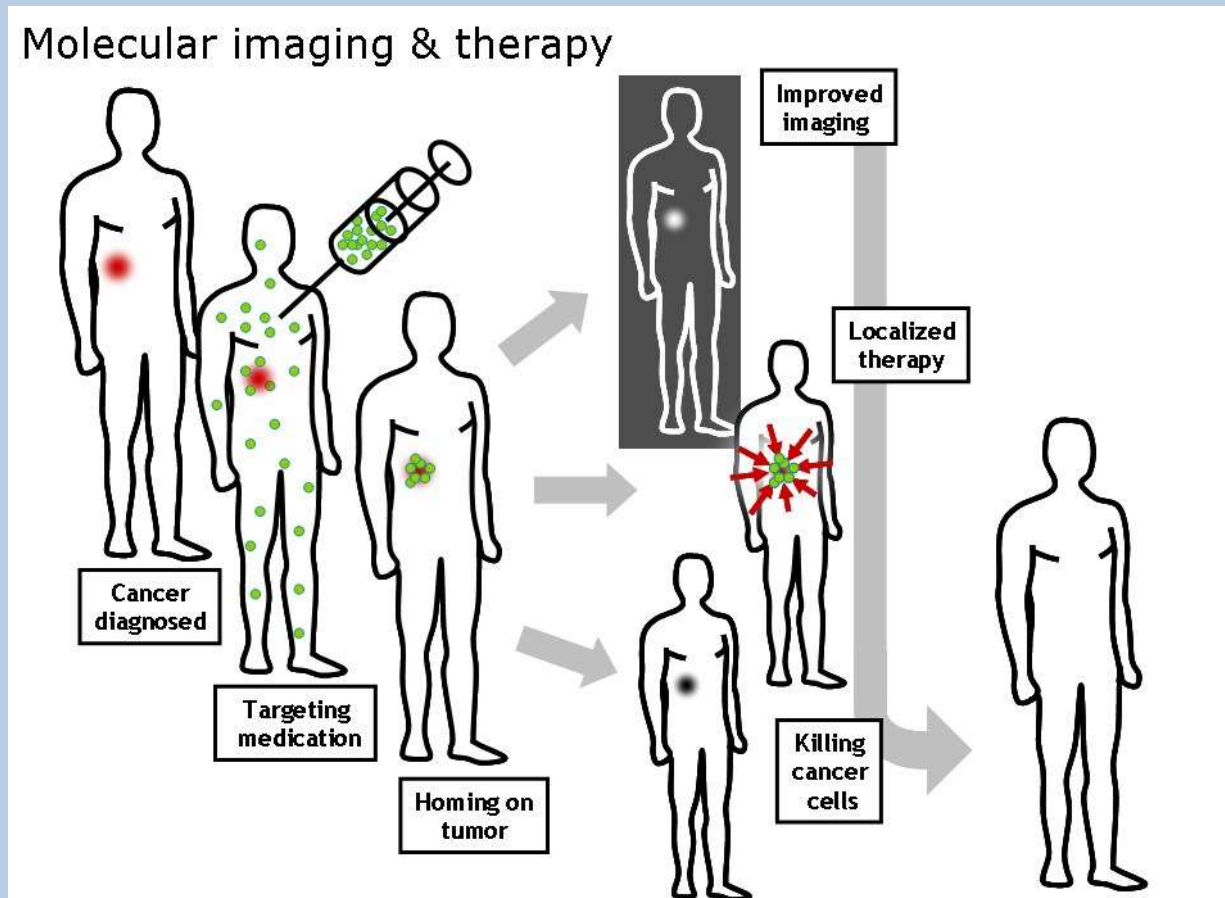
**Note:** Of the hundreds of agents IARC has reviewed, this chemical, primarily used in the manufacturing of synthetic fibers, especially nylon, is the ONLY item IARC has ever placed in this category<sup>2</sup>.

<sup>1</sup> <http://www.24d-reviews/IARC-and-24D.php>  
<sup>2</sup> <http://www.gmoanswers.com/ISNG/Classifications/ClassificationsAlphaOrder.pdf>  
<sup>3</sup> <http://www.epa.gov/white/pubs/white/2016-09/09documents/caprolactam.pdf>



# Cancer

- **New treatments aim to target only the cancer cells**



# Cancer

- **Treatments aim to kill the cancer cells, but also tend to kill surrounding cells, and cells that have fast division**
- **This causes uncomfortable side effects:**  
<https://www.youtube.com/watch?v=BmFEoCFDi-w>

# Cancer

- Decades of research have led to the current understanding of cancer, and researchers continue looking for new ways to prevent, and treat cancer:

<https://www.youtube.com/watch?v=22IGbAVWhro>

# Cancer

- **New treatments:**

<https://www.youtube.com/watch?v=gWuJdUJsLuo>

# Cancer Video

Let's learn how the cell cycle can lead to cancer:

[https://www.youtube.com/  
watch?v=lpAa4TWjHQ4](https://www.youtube.com/watch?v=lpAa4TWjHQ4)

# Cancer

**For more information,  
please visit the American  
Cancer Society website:**

**[Cancer.org](https://www.cancer.org)**