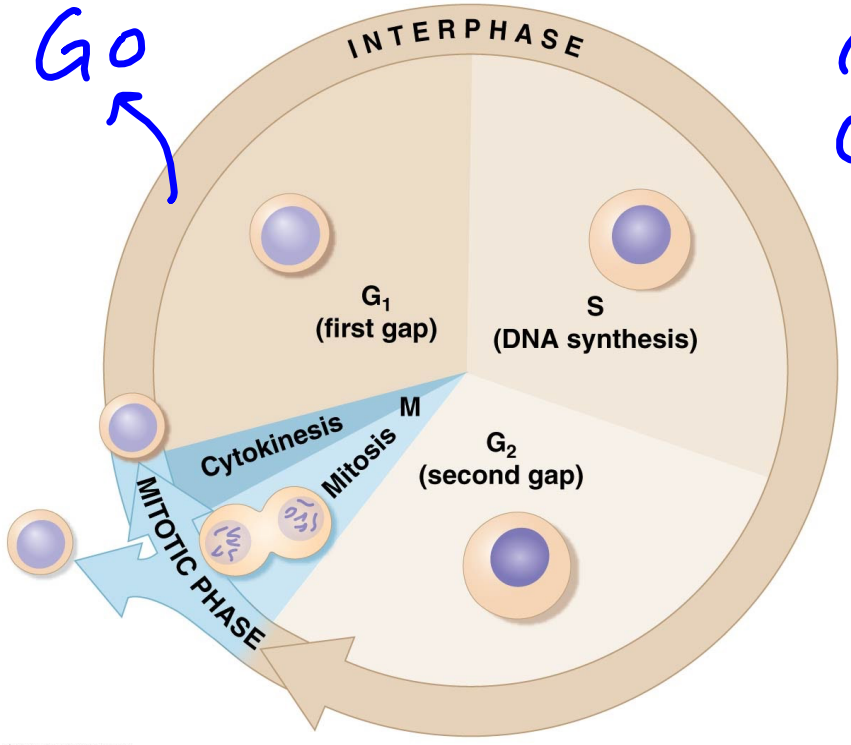
The Cell Cycle and Cancer

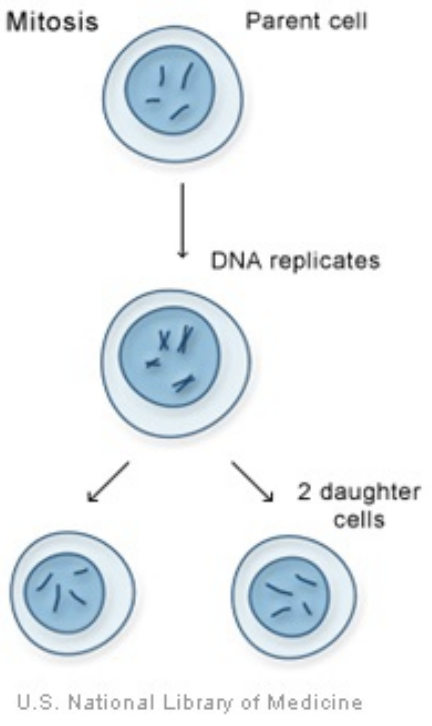


Go

cell division
cell differentiation

The Cell Cycle is to prepare the cell for division and to divide.

Cell division creates two "daughter" cells from one "parent" cell.



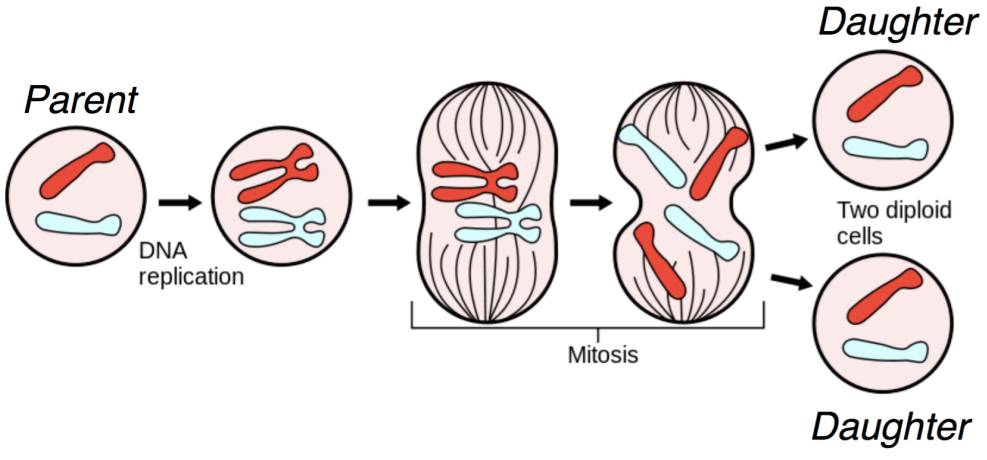
Why do cells divide?

1) Growth and development
   - ↓ bigger!
   - ↳ embryo → fetus → infant → toddler → child → ect.
2) Replace dead/damaged cells
   - ↳ injury, cells naturally die & need replacing
3) Reproduction
   - → Asexual → single-celled organisms
   - ↘ sexual → (meiosis) → (later)

Mitosis is the type of cell division we will focus on now.

The goal of **mitosis** is to create two daughter cells that are identical to the parent cell.

This requires the cell to replicate its DNA before splitting.

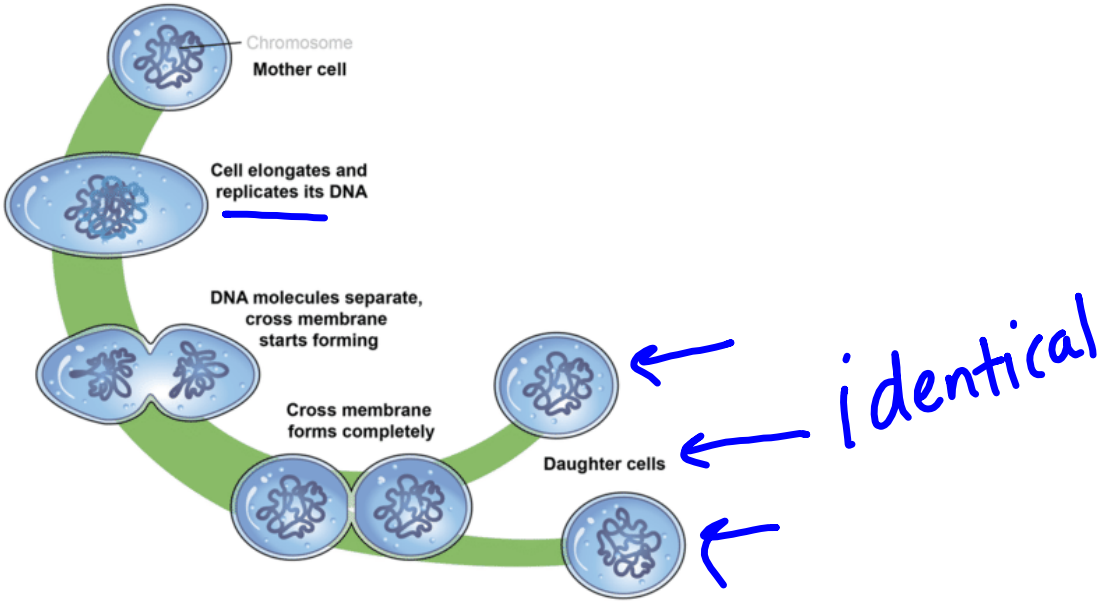


A cell's genetic information is called its **genome**.

In prokaryotes, it is often a single DNA molecule.

In eukaryotes, it consists of several molecules (Humans have 46).

Cell division in Prokaryotes (Binary Fission)

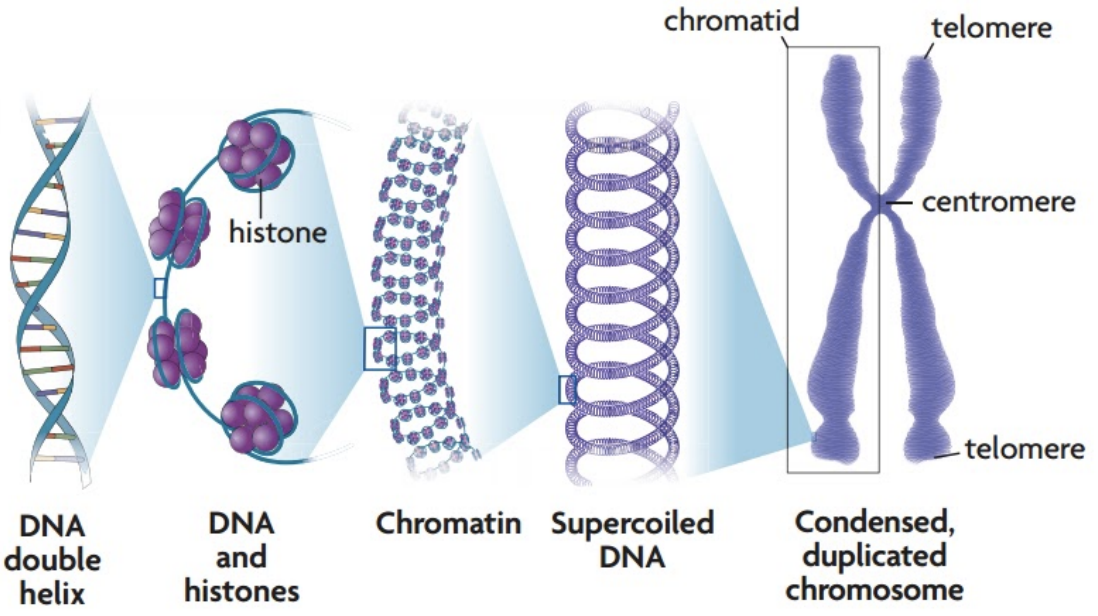


In Eukaryotes, the process is much more complicated.

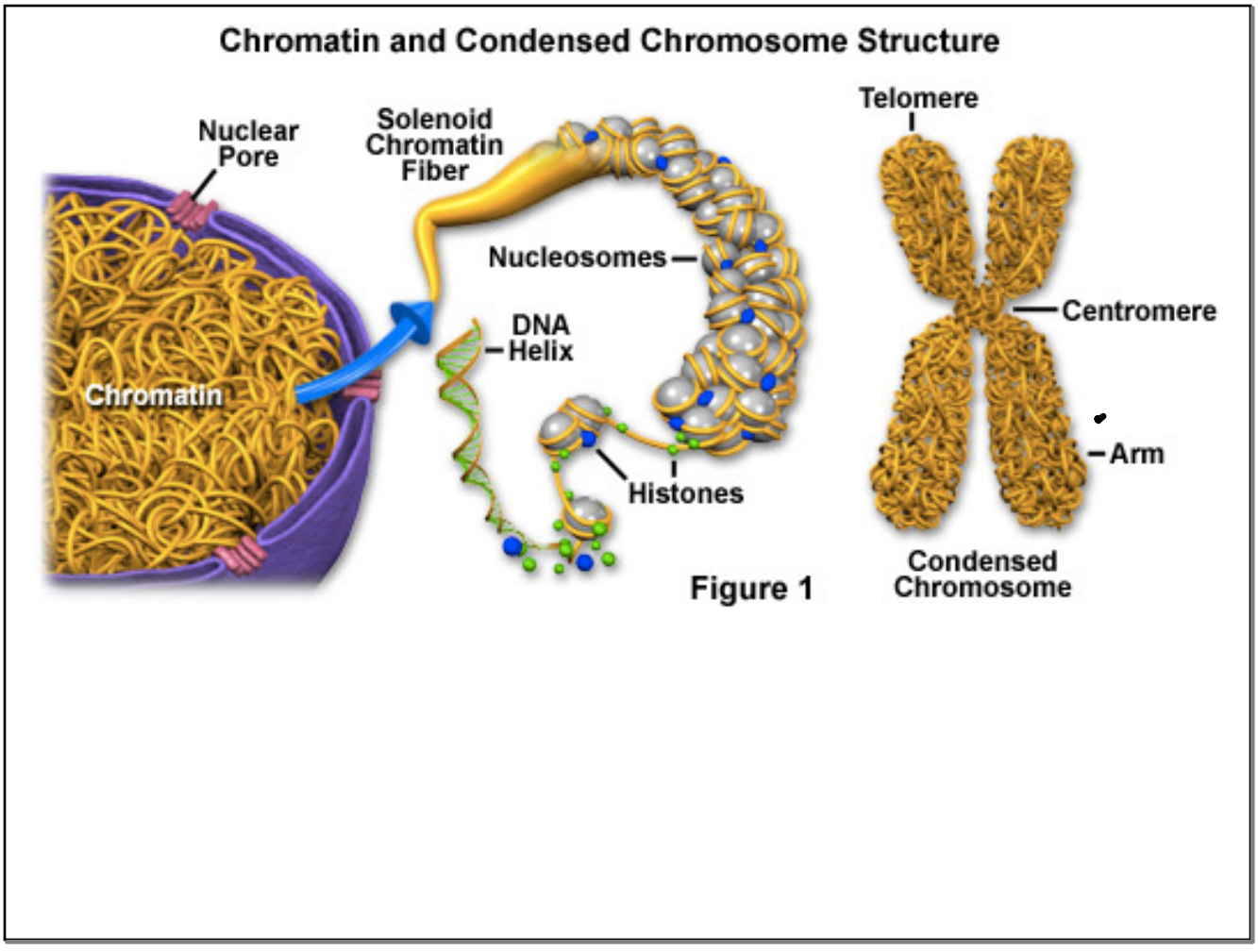
When preparing for cell division, DNA and its accessory proteins are condensed and stored in structures called **chromosomes**.

Usually, DNA is stored in a structure called **chromatin**. Chromatin also contains proteins, but is not condensed. Chromatin allows the cell to use the DNA.

Chromosome Structure



April 12, 2021

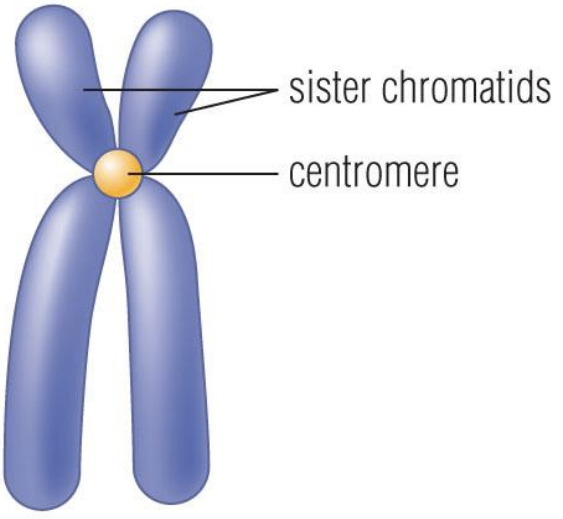


The 'Crazy C's!'

(why do you have to be like that, biology??)

chromatin, chromosome, centriole, centromere, centrosome, & kinetochore

Each duplicated chromosome consists of two sister **chromatids**, which contain identical copies of the chromosome's DNA.



The sister chromatids are held together at the **centromere**.

As the daughter cells are created, the sister chromatids are pulled apart. Each copy goes into one daughter cell.

The Stages of the Cell Cycle

Interphase

- G_1 – "gap" – cellular activities
- * S – Synthesis → DNA replication
- G_2 – prepare for division *

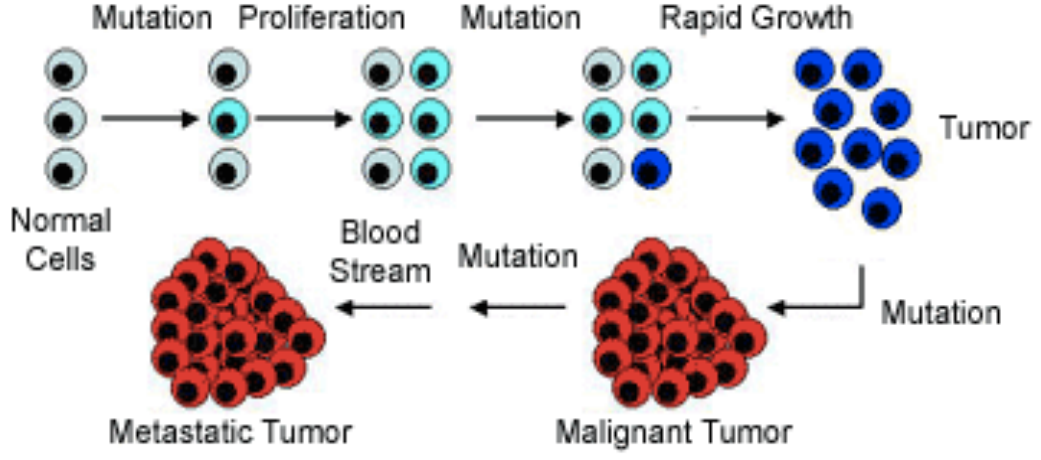
* = checkpoints

Mitosis

- Prophase
- * metaphase
- anaphase
- telophase

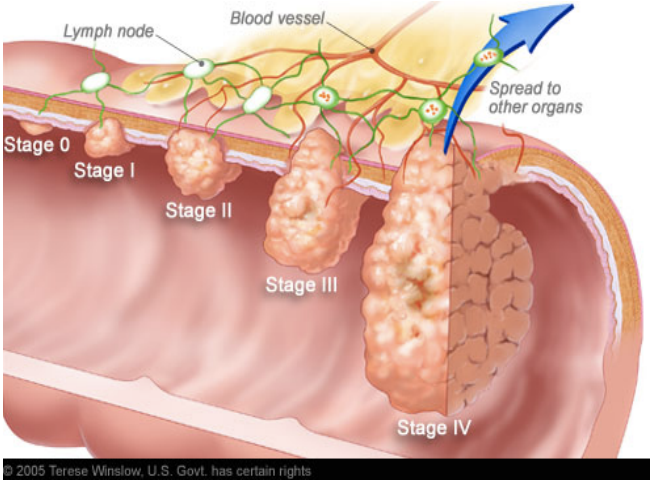
Cytokinesis – division of cytoplasm – cell plate / cell furrow

Cancer is a class of diseases caused by uncontrolled cell growth.



Typically, cancer is a disease of the aged because it requires the accumulation of multiple mutations.

The severity of each case of cancer has to do with the stage and tissue it has affected.

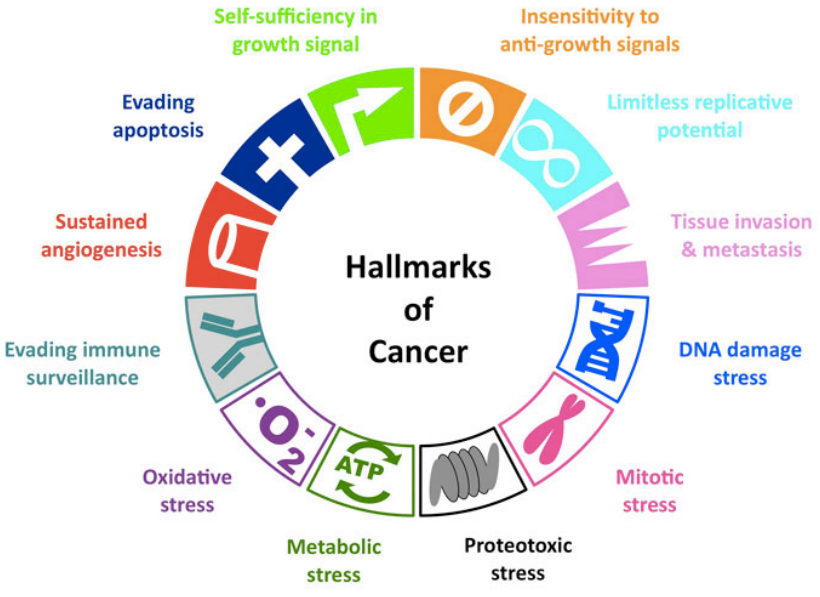


Carcinomas: from cells in tissues that protect the body from air and internal fluids

Sarcomas: from cells in supportive tissues

Leukemias and Lymphomas: from cells in the blood and immune system

The Hallmarks of Cancer



mutation
Change in
DNA
sequence.

Cancer arises from DNA mutations

-- Environmental Factors ← YOU!

radiation – U-V light
tanning beds ⊘

Smoking
chemicals (asbestos)

-- Genetic susceptibility

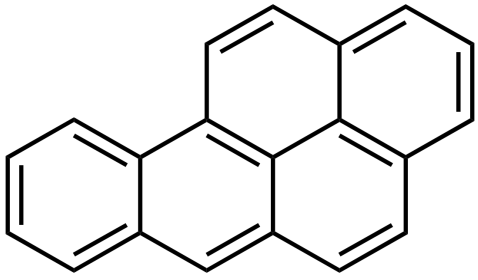
inherit gene – ex/ BRCA 1/2

A **carcinogen** is a chemical that is capable of causing cancer in living tissue.

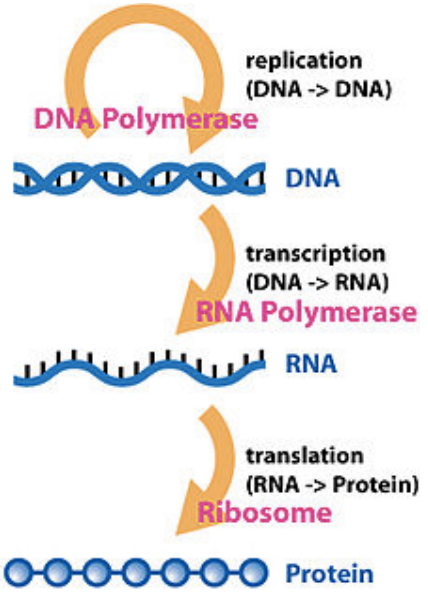
A **mutagen** is a chemical that is known to induce DNA mutations.

One class of dangerous chemical is called **PAHs** (polycyclic aromatic hydrocarbons).

These are a product of incomplete combustion and can be found in cigarette smoke.

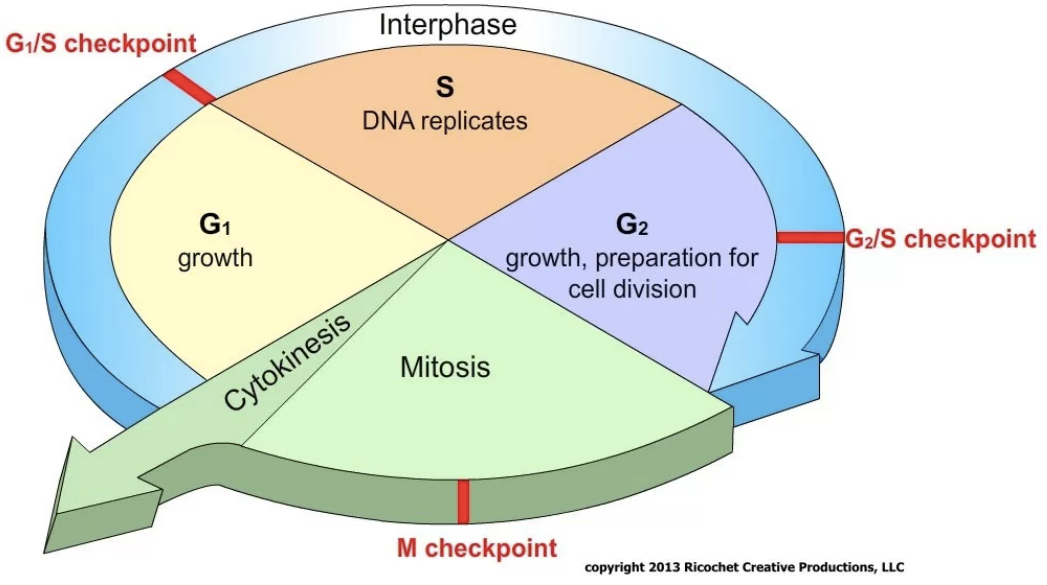


Normal DNA Processing



Some mutations produce fully functioning proteins.

However, if mutations kill the function of certain proteins, it will disrupt cell division.



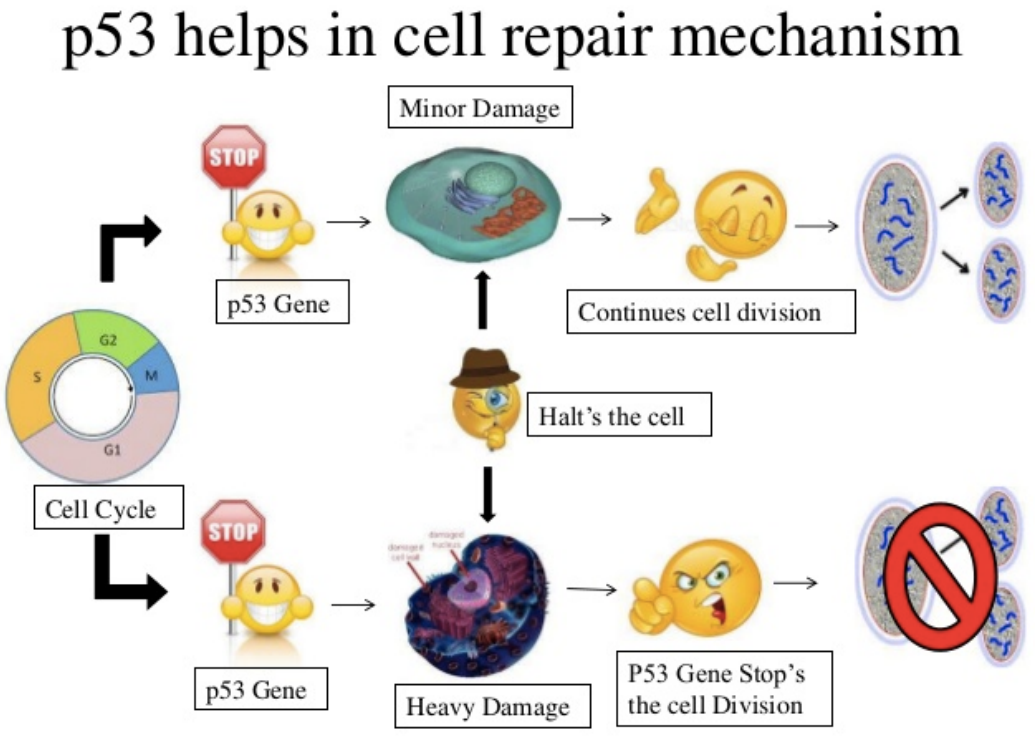
Mutations in two specific categories of genes can lead to cancer:

-- Tumor Suppressor Genes – "brake"

-- Oncogenes – "accelerator"

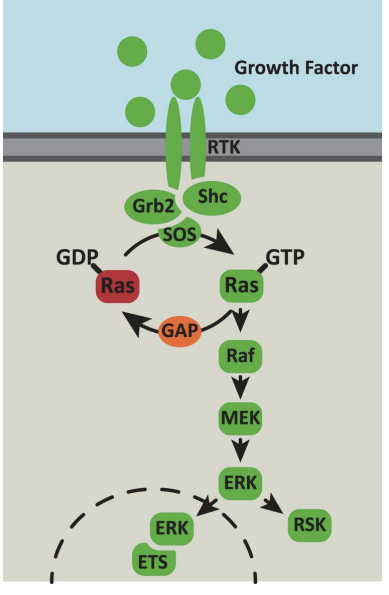
Tumor Suppressor genes inhibit cell growth.

Examples: p53 and BRCA1/BRCA2



Oncogenes promote cell growth. Usually, these are tightly controlled.

Example: RAS



Treatments for Cancer:

-- Chemotherapy

-- Immunotherapy

-- Radiation

-- Surgery

Big Picture Points:

-- Cancer is a family of similar diseases, not just one disease with one cure.

-- Cancer is caused by mutations.

-- Drugs are being developed to target specific proteins involved in cell signaling. Biomarkers can be used to target certain drugs for individual patients.