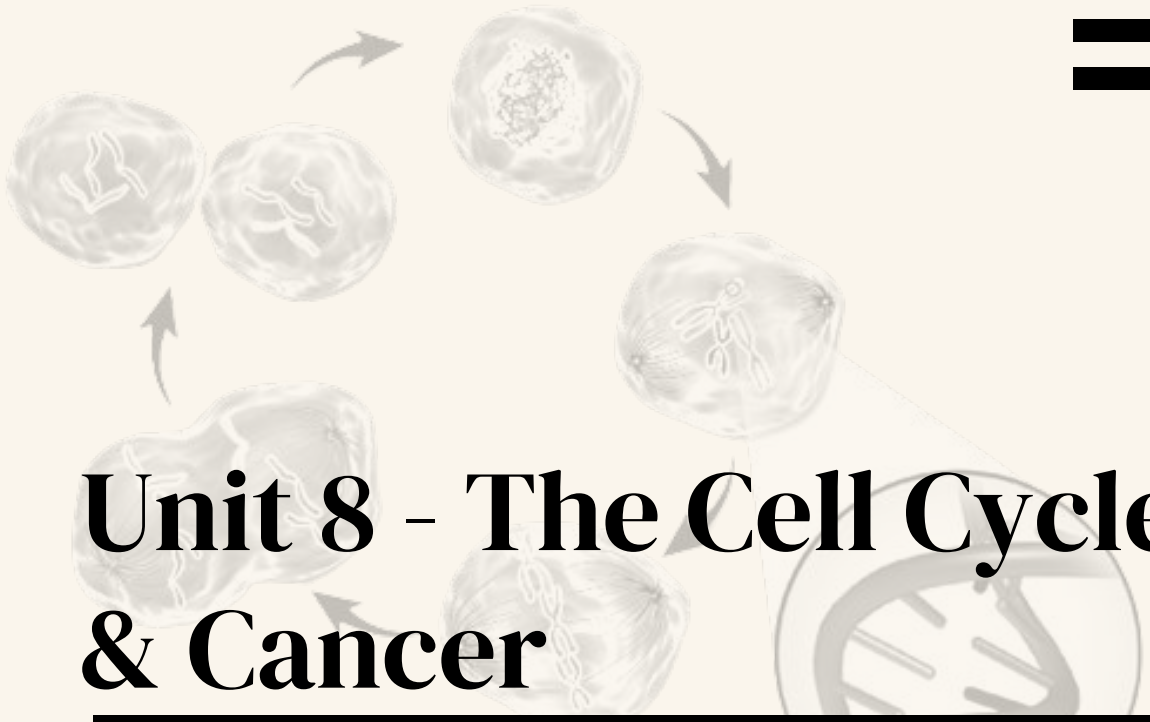
MAMMOTH

SCIENCE



Unit 8 - The Cell Cycle & Cancer

- *Know that the cell cycle is a repeating sequence of cellular growth and division during the life of an organism.*
- *Understand that cells divide to reproduce (in the case of a unicellular organism), to grow, and to replace worn out or damaged cells.*
- *Describe the stages of the cell cycle*
- *Know that the cell cycle in eukaryotes is controlled by proteins at three main checkpoints*
- *Recognize that if any of the genes necessary to make the proteins that regulate cell growth and division are mutated, the protein may not function, and the regulation of cell growth and division may be disrupted.*

MAMMOTH
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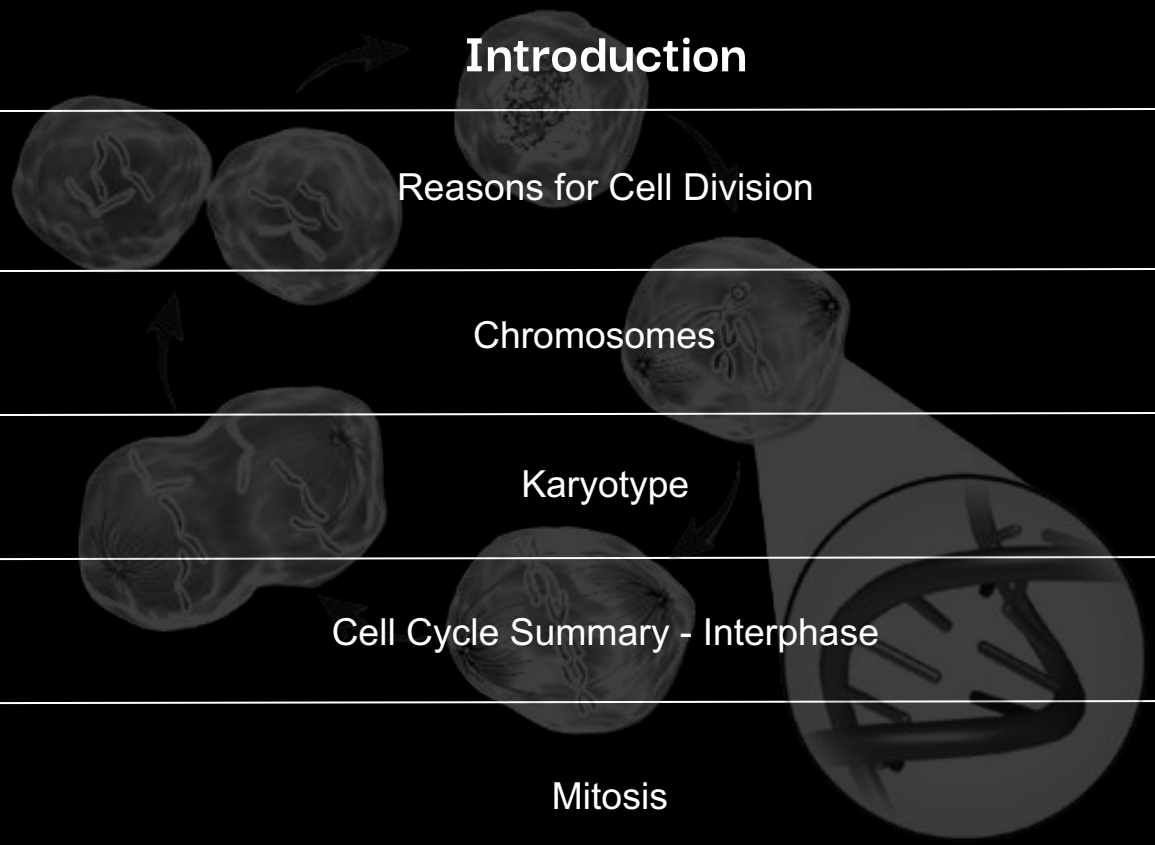
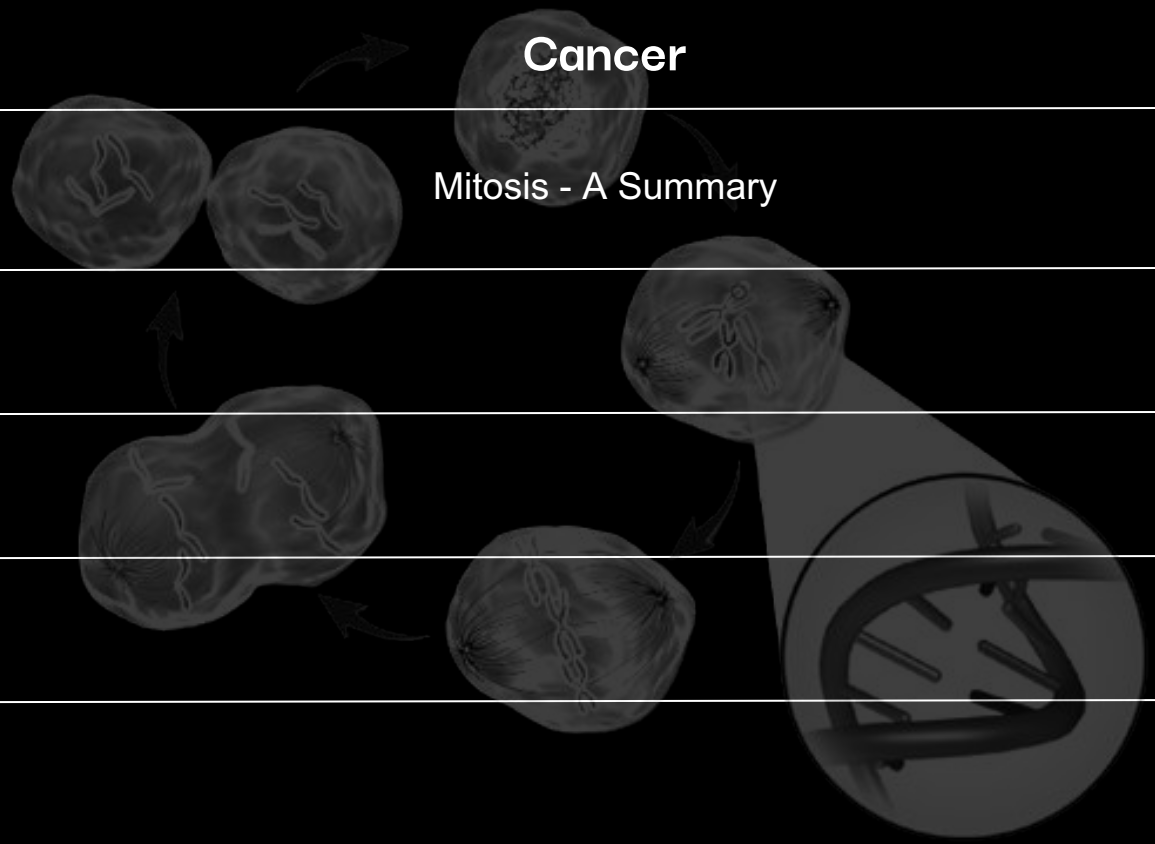
Menu



Menu

Cancer

Mitosis - A Summary

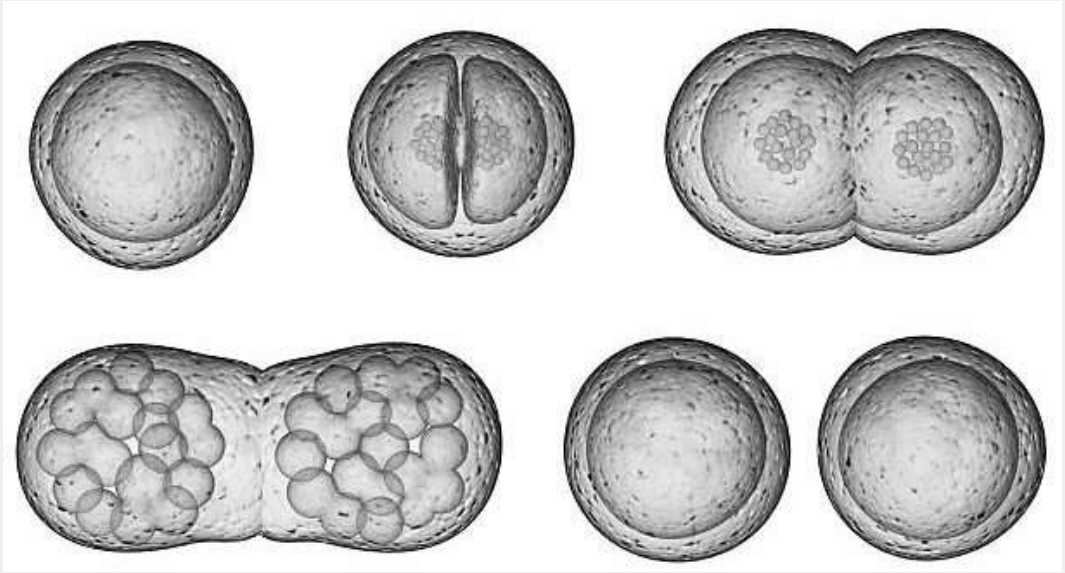


The Cell Cycle - Introduction

Introduction:

- All cells are derived from pre-existing cells
- New cells are produced for repair and to replace damaged or old cells
- Differs in Prokaryotes (bacteria - binary fission) and Eukaryotes (protists, fungi, plants, & animals)

Reasons for Cell Division



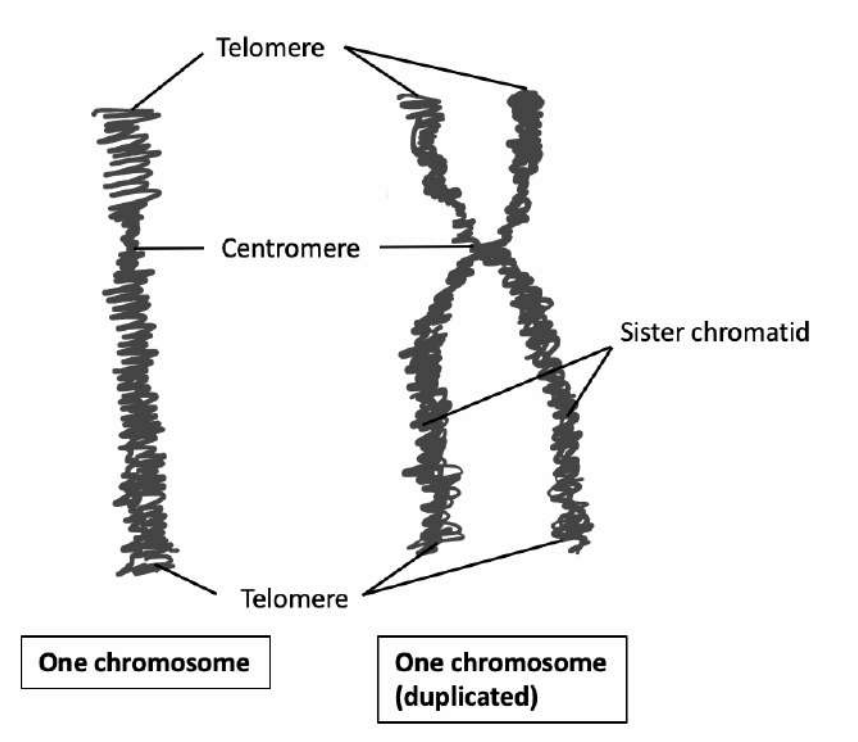
Reasons for Cell Division:

- **Cell Growth**
- **Repair** & **replacement** of damaged cell parts
- **Reproduction** of some species
- Why do cells need to replicate their genetic material (chromosomes) before they go through mitosis?
  - The instructions for making cell parts are encoded in the DNA, so each new cell must get a complete set of the DNA molecules
  - **DNA Replication:**
    - **DNA** must be **copied** or **replicated** **before** cell division
    - Each new cell will then have an **identical copy** of the **DNA**

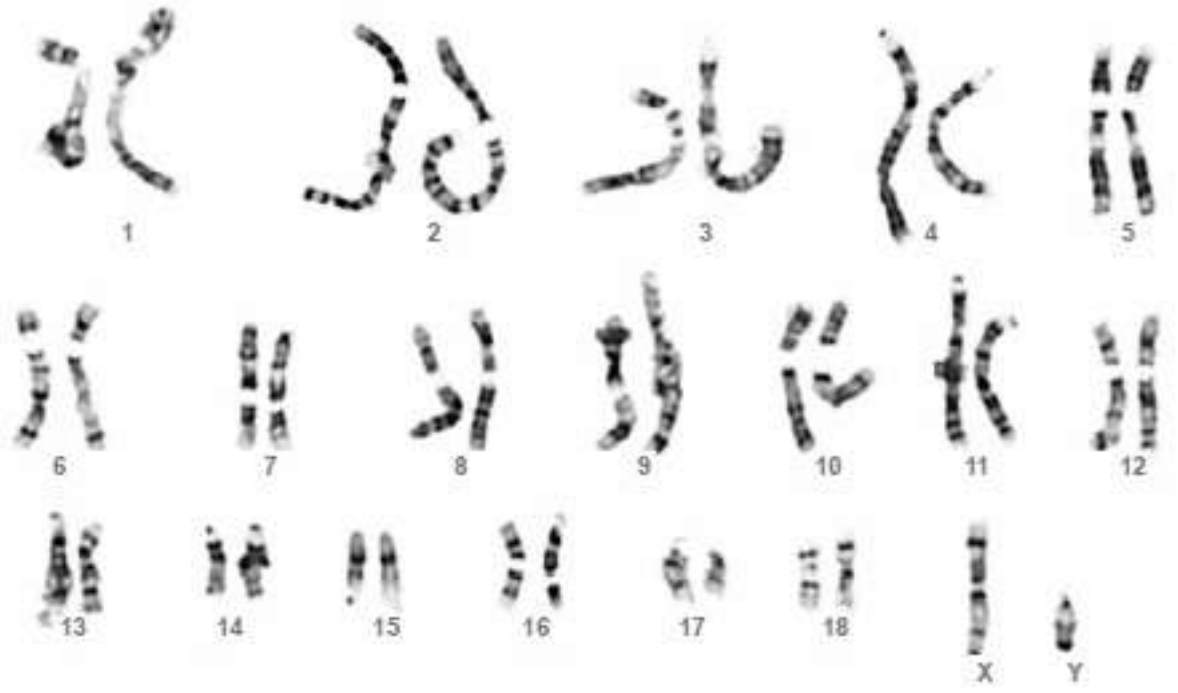
Chromosomes

Chromosomes

- Structure:
  - ➔ DNA is tightly coiled around proteins called histones. Further condensing forms a chromosome
- Replication:
  - ➔ When chromosomes replicate they go from one chromatid to two identical chromatids (called “sisters”) attached by the centromere.
  - ➔ When the chromatids are drawn apart toward opposite poles during Anaphase, the separated chromatids are now each called a chromosome.



Karyotype



Karyotype

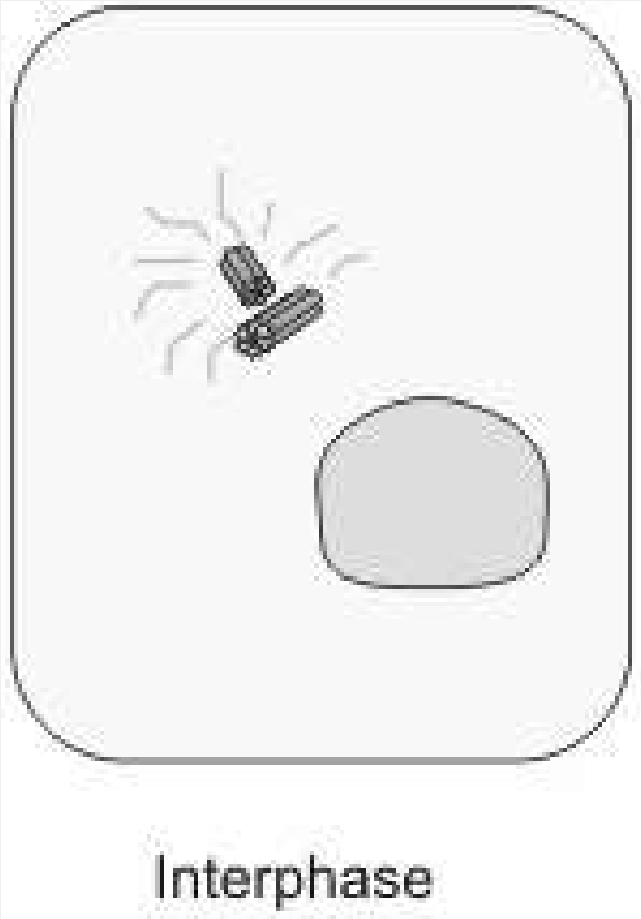
- ➔ A picture of the chromosomes from a human cell arranged in pairs by size
- ➔ First 22 pairs are called **Autosomes**
- ➔ Last pair are the **Sex Chromosomes**
- ➔ **XX female** or **XY male**
- ➔ Boy or Girl? The male parent & the ***Y chromosome*** decides

The Cell Cycle Summary - Interphase

The Cell Cycle

- Five Phases of the Cell Cycle:

1. **G1/ Gap 1 – Primary Growth Phase**
   - 1st growth stage after cell division
   - Cells **mature** by making **more cytoplasm & organelles**
   - Cell carries on its normal metabolic activities
2. **S – Synthesis Phase**
   - **DNA is copied** or **replicated**
3. **G2 / Gap 2 – Secondary Growth Phase**
   - 2nd Growth Stage
   - Occurs after DNA has been copied
   - All cell structures needed for division are made (e.g. **centrioles**)
   - Both **organelles** & **proteins** are **synthesized**



Mitosis

01

Mitosis - Overview

➔Division of the nucleus

➔Also called Karyokinesis

➔Only occurs in Eukaryotes

➔Has four stages

➔Doesn't occur in some cells such as brain cells

➔**Four Stages:**

02

Early Prophase

❑ **Early Prophase**

➔Chromatin in nucleus condenses to form visible chromosomes

➔Mitotic spindle forms from fibers in cytoskeleton or centrioles (animal)

03

Late Prophase

Late Prophase

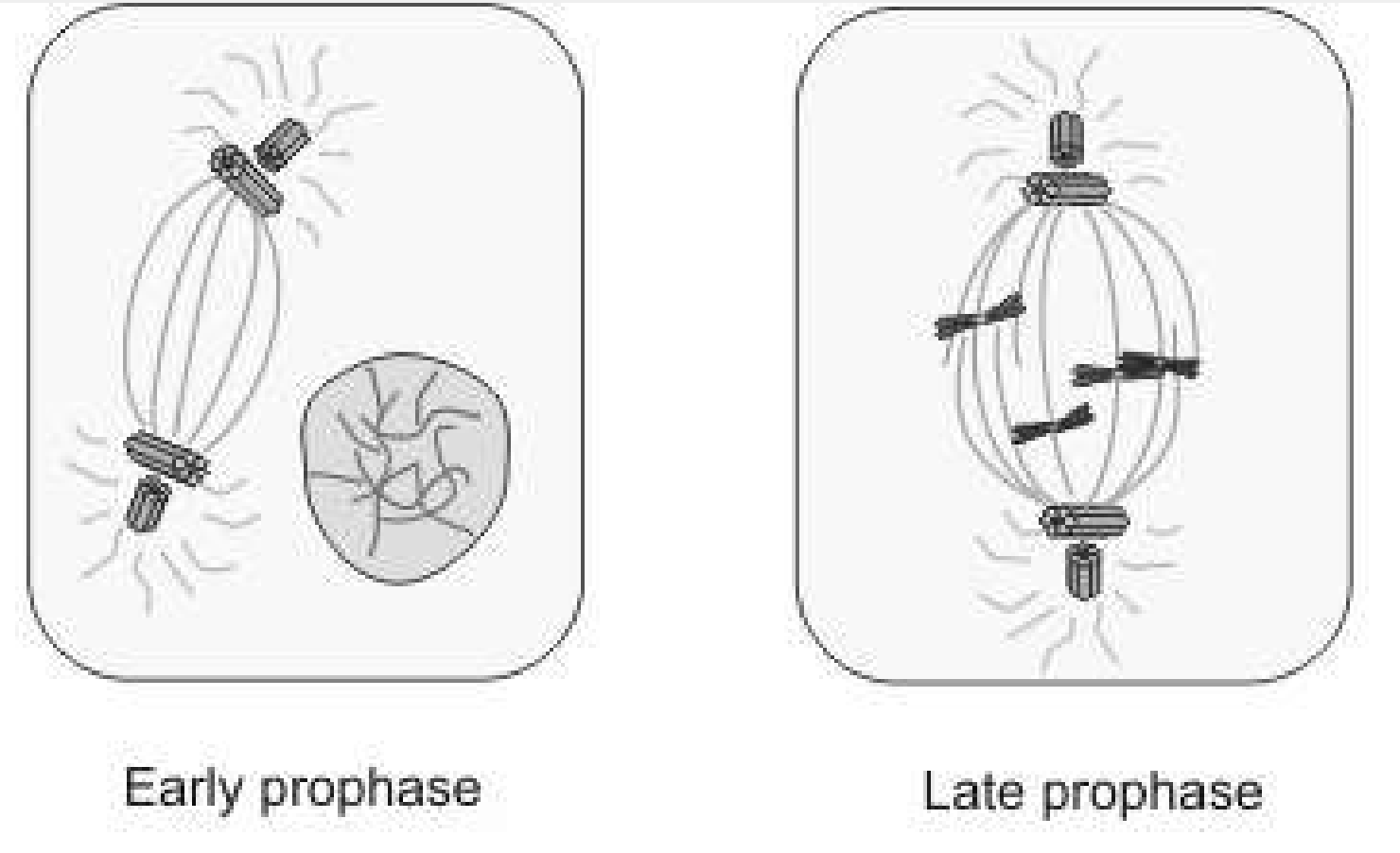
➔ Nuclear membrane & nucleolus are broken down

➔ Chromosomes continue condensing & are clearly visible

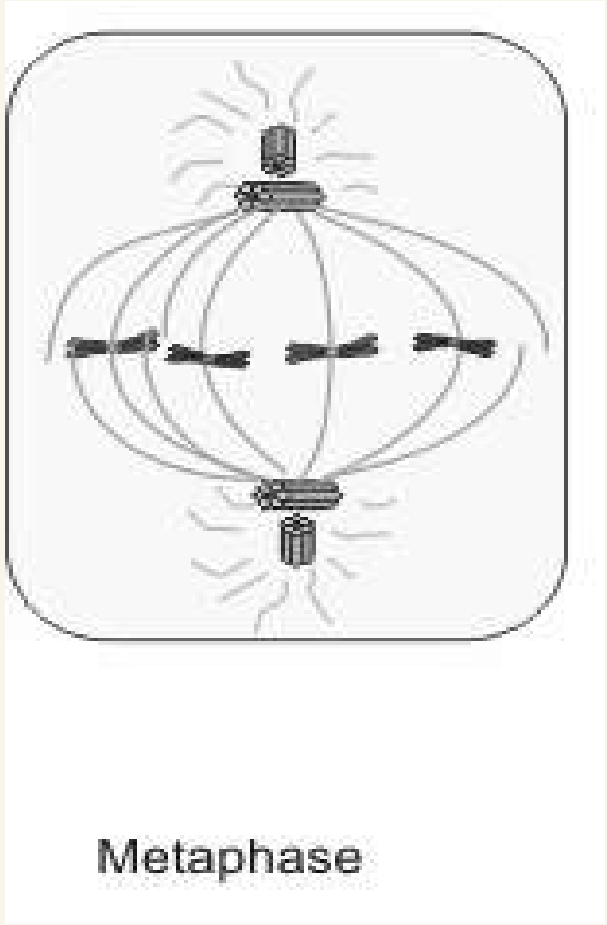
➔ Spindle fibers called kinetochores attach to the centromere of each chromosome

➔ Mitotic Spindle finishes forming - The mitotic spindle forms from the microtubules in plants and centrioles in animal cells. Polar fibers extend from one pole of the cell to the opposite pole. Kinetochore fibers extend from the pole to the centromere of the chromosome to which they attach. Asters are short fibers radiating from centriole

Prophase - Early & Late



Metaphase



Metaphase

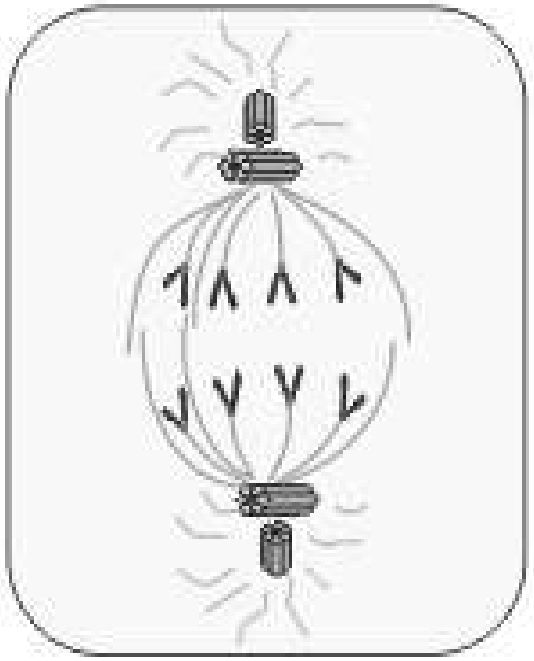
➔ Chromosomes, attached to the kinetochore fibers, move to the center of the cell

➔ Chromosomes are now lined up at the **equator / Middle**

Anaphase

Anaphase

- ➔ Occurs rapidly
- ➔ Sister chromatids are **pulled apart** to opposite poles of the cell by shortening kinetochore fibers
- ➔ Polar Microtubules elongate preparing for cytokinesis

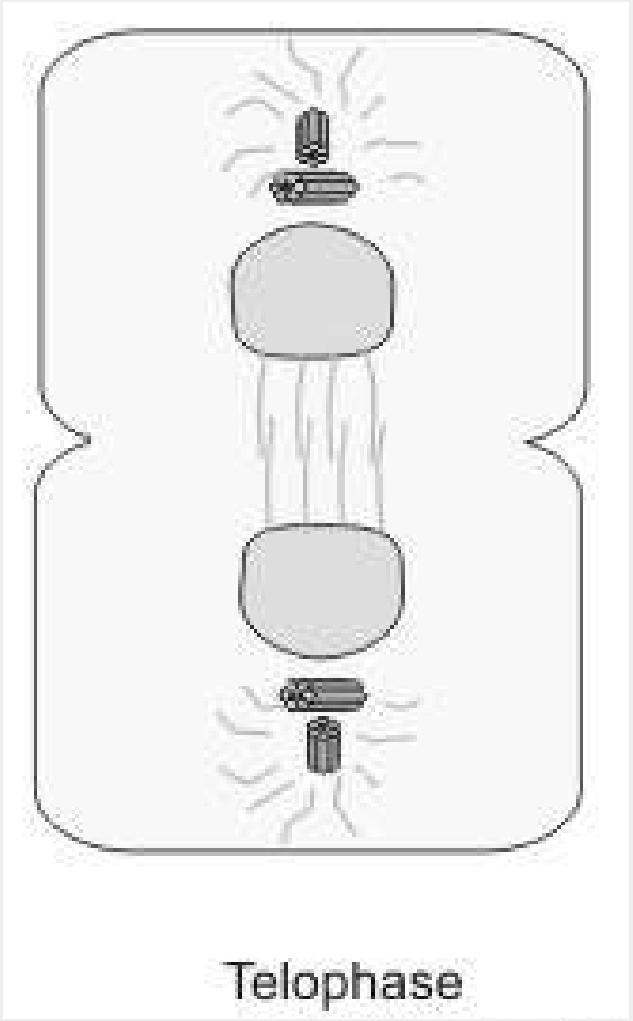


Anaphase

Telophase

Telophase

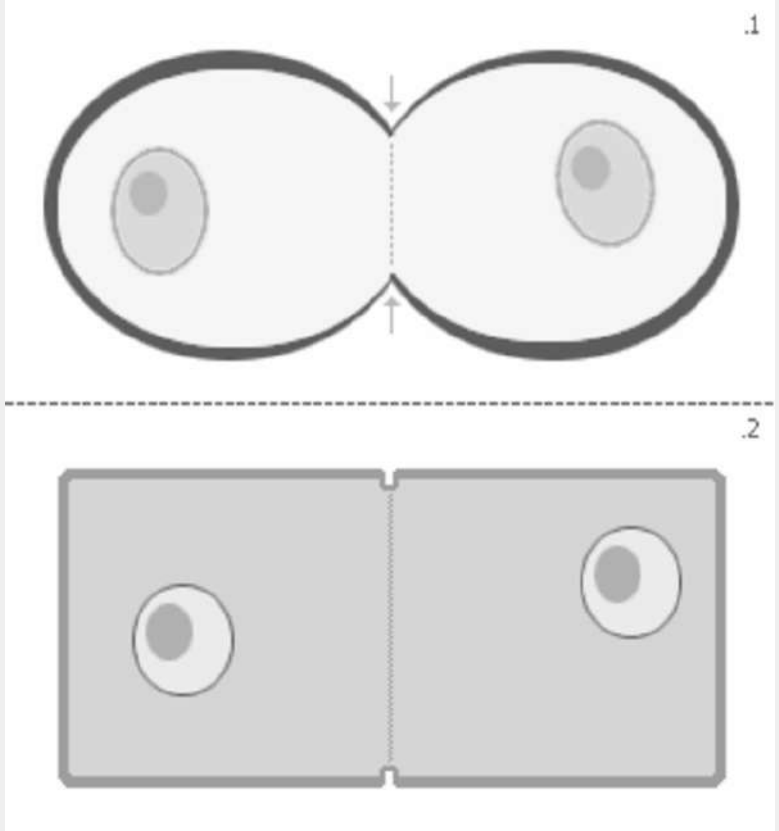
- ➔ **Sister chromatids** at opposite poles
- ➔ Spindle disassembles
- ➔ Nuclear envelope forms around each set of sister chromatids
- ➔ Nucleolus reappears
- ➔ **CYTOKINESIS** begins
- ➔ Chromosomes appear as chromatin



Cytokinesis

Cytokinesis

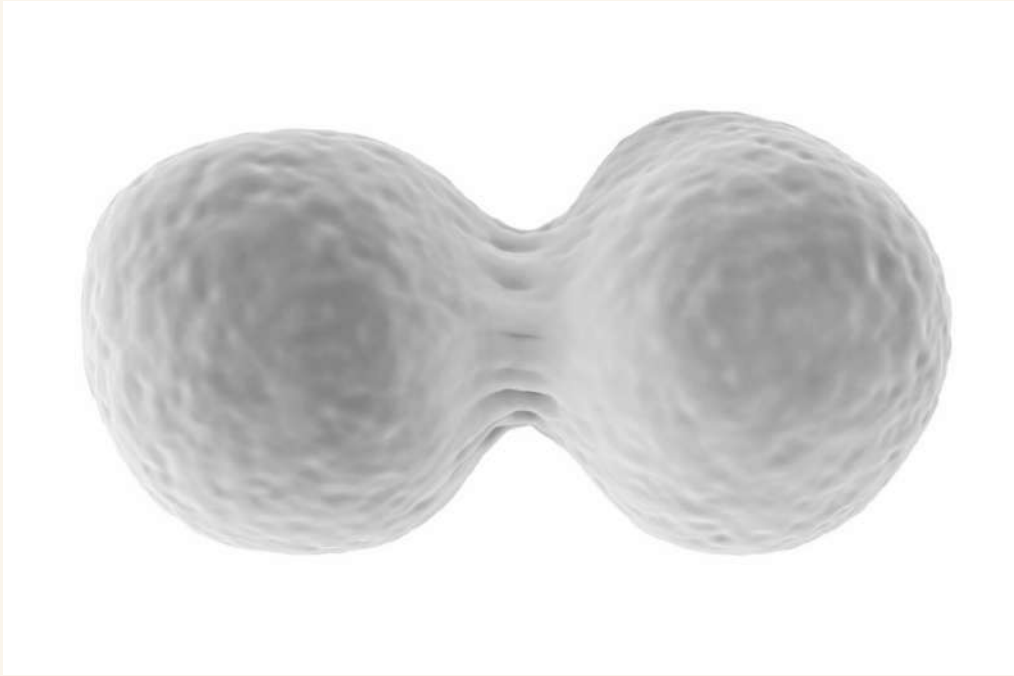
- ➔ Means **division of the cytoplasm**
- ➔ Division of cell into two, identical halves called daughter cells
- ➔ In **plant cells, cell plate f**orms at the equator to divide cell
- ➔ In **animal cells, cleavage furrow** forms to split cell



Daughter Cells

Daughter Cells

- Have the same number of chromosomes as each other and as the parent cell from which they were formed
  - ➔ **Identical** to each other, but smaller than **parent cell**
  - ➔ Must grow in size to become mature cells (G1 of Interphase)

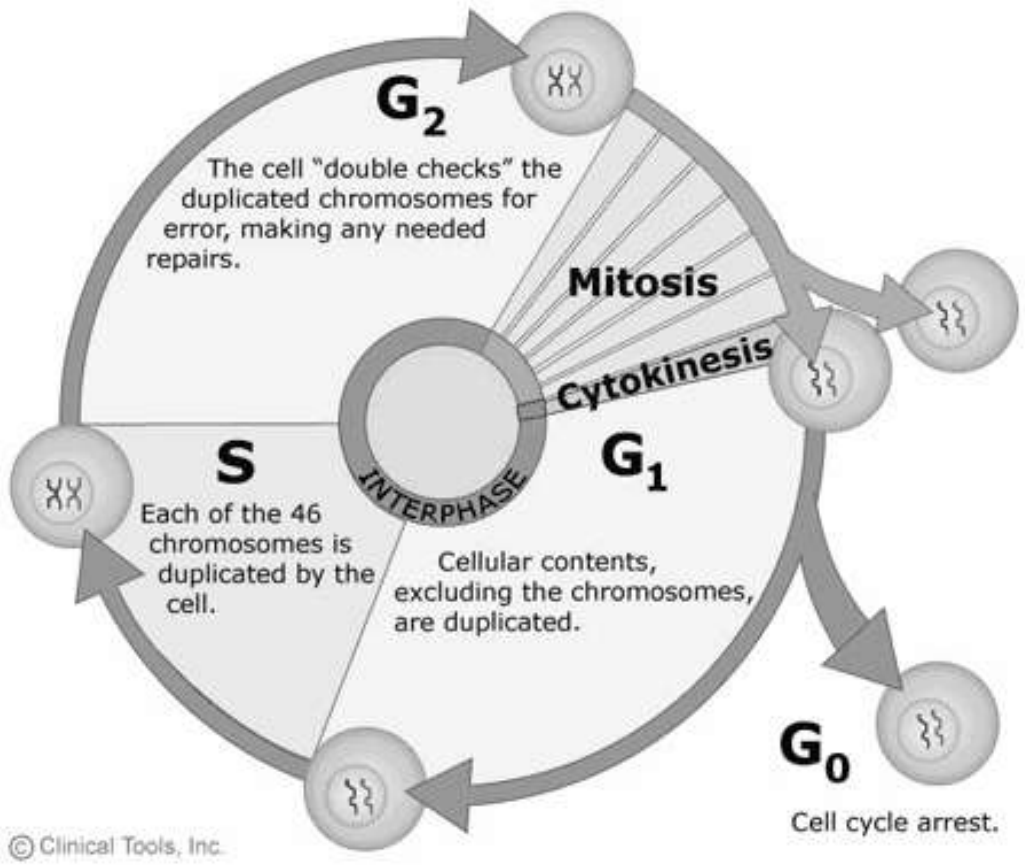


Cancer

Uncontrolled Mitosis:

- If mitosis is not controlled, unlimited cell division occurs causing cancerous tumors
- At **Checkpoint G_0** . The cell has a decision to make - keep replicating, go perform its function, or **Apoptosis**- Cell death. If the cell is beyond its normal replication cycle or has mutations and keeps dividing- Cancer.
- **Oncogenes** are special proteins that increase the chance that a normal cell develops into a tumor cell
- **What is Cancer?**
  - Cancer is essentially a **disease of mitosis** - the normal 'checkpoints' regulating mitosis are ignored or overridden by the cancer cell. Cancer begins when a single cell is **transformed**, or converted from a normal cell to a cancer cell.
  - Often this is because of a change in function or a **mutation** that occurs in one of several **genes** that normally function to control growth.

Cancer Continued

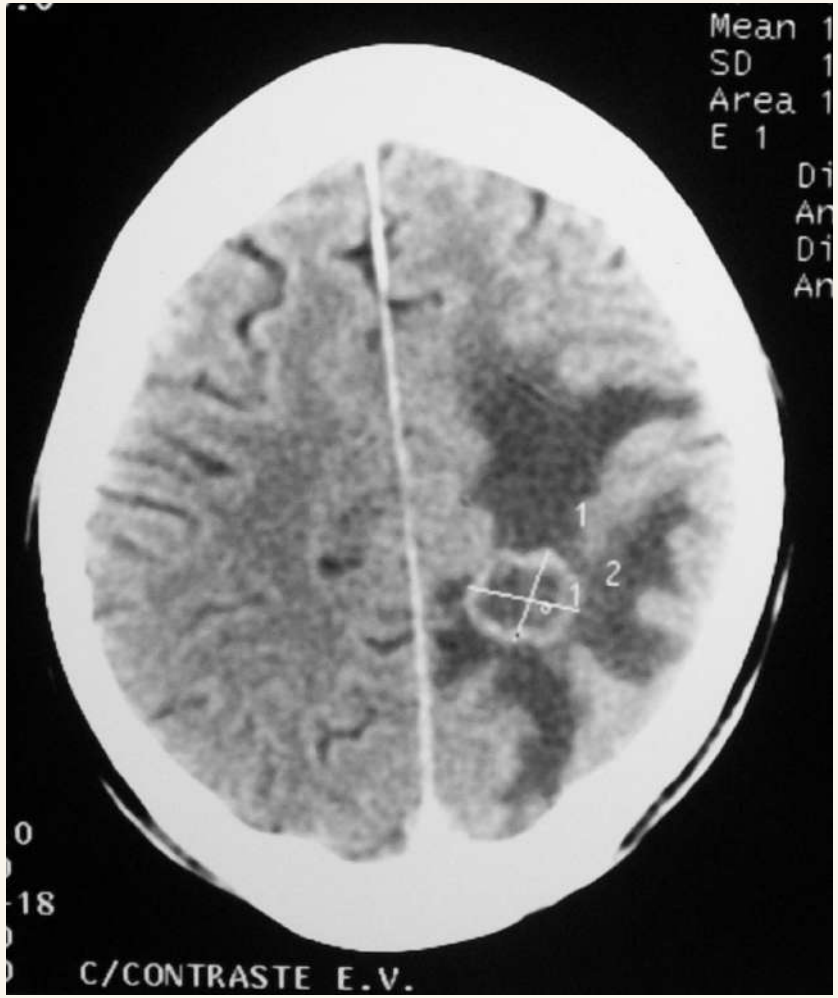


Examples:

- ➔ The **p53 gene, the** "guardian of the genome", usually functions to properly control the cell cycle. However, p53 is mutated in over 50% of all human cancers.
- ➔ **The BRCA-1 gene, the "Breast Cancer Gene"** normally functions to suppress tumor formation; but if a **gene** contains **mutations** such that BRCA1 does not work properly, tumor formation can begin (Note: mutations in this gene do not mean that a person will develop breast cancer, just that they have an increased risk for breast cancer).

Tumors

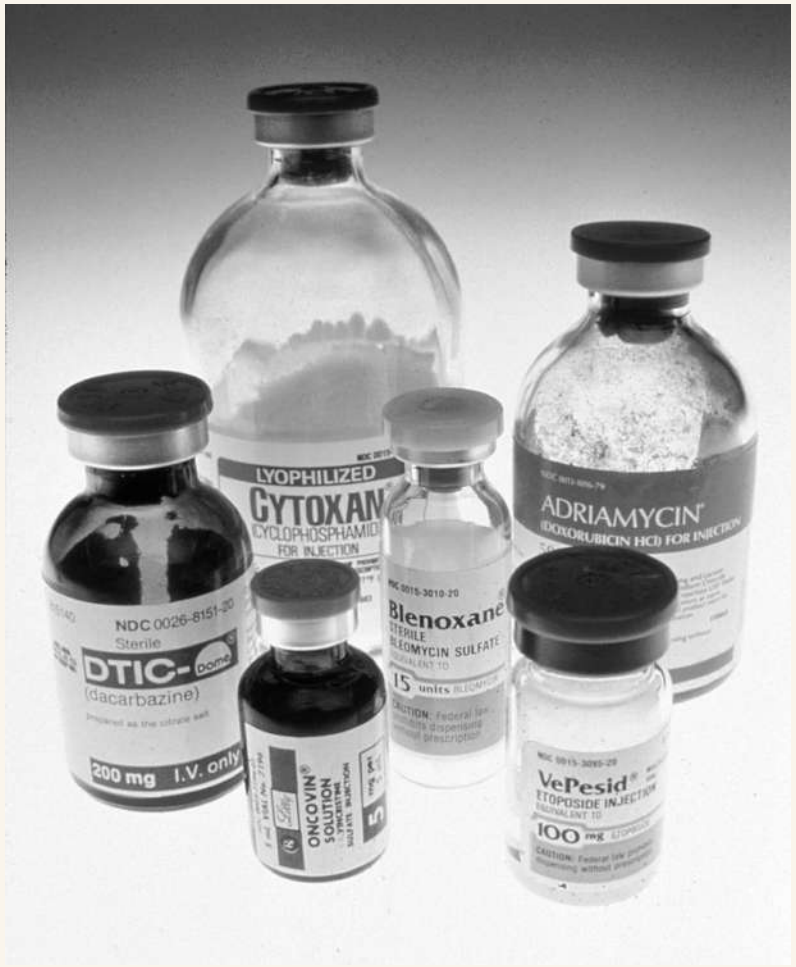
- ➔ Once these crucial **Cell Cycle genes** start behaving abnormally, cancer cells start to proliferate wildly by repeated, uncontrolled mitosis.
- ➔ **Tumors - Good Cells gone Bad...?** The cancer cells proliferate to form a mass of cancer cells called a tumor. As the tumor grows larger, it begins to release proteins from the cell to attract new blood vessel growth (this is called *angiogenesis*). At this point the tumor contains ~ 1 million cells and is about the size of a '*bb*'.
    1) **Benign**: tumor cells remain at the original site. Can be removed surgically or killed by radiation, usually eliminating any further cancer development at that site.
    2) **Malignant**: some tumor cells send out signals that tell the body to produce a new blood vessel at the tumor site. These cells not only have their own food and oxygen supply, they also have an avenue for escape to a new part of the body - through the new blood vessel and into the bloodstream. Cells that break away from the tumor begin to spread to surrounding tissues (via the bloodstream or lymph) and start new tumors = *metastasis*. Usually surgery is performed to remove the tumor, followed by radiation and chemotherapy.



Characteristics of Cancer

- Cancer cells are frequently **"immortal ":** whereas normal cells divide about 50 times and they die, cancer cells can go on dividing indefinitely if supplied with nutrients
- Cancer cells often have unusual numbers of chromosomes or mutations in chromosomes. Aging (production of toxic oxygen "free radicals"), exposure to toxins (like components of tobacco tar), mutagens (like ultraviolet light) all cause mutations in genes and cancer; but normal errors in DNA replication can lead transformation of the cell if they occur in a crucial gene.
- Cancer cells may also have an abnormal cell surface; instead of **"sticky "** to its neighboring cells, cancer cells tend to "round up" and break attachments to its neighbors cells, allowing for metastasis.
- Cancer cells ignore the usual density-dependent inhibition of growth in cell culture (or in body tissues), multiplying after contact with other cells are made, piling up until all nutrients are exhausted.

Cancer - Treatments



Stopping cancer cell growth:

- ➔ **Chemotherapy Drugs** stop DNA synthesis/ replication:
- ➔ Adriamycin and Cytoxan prevent DNA from unwinding properly,
- ➔ **5FU** inhibits incorporation of T nucleotides
- ➔ **Methotrexate and 5-MP** prevent cells from making nucleotides
- ➔ **ARA-C** is a C nucleotide "mimic" that gets incorporated and stops further DNA synthesis - No DNA replication, no new cancer cells!

The Cell Cycle - A Summary

Why	Growth & Repair
When	From fertilization until death
Where	Somatic/Body cells - skin, muscle, bone, tissues, etc…
Outcomes	2- Genetically Identical Daughter cells

Thank you!

Do you have any questions?

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xxx- xxx-xxxx