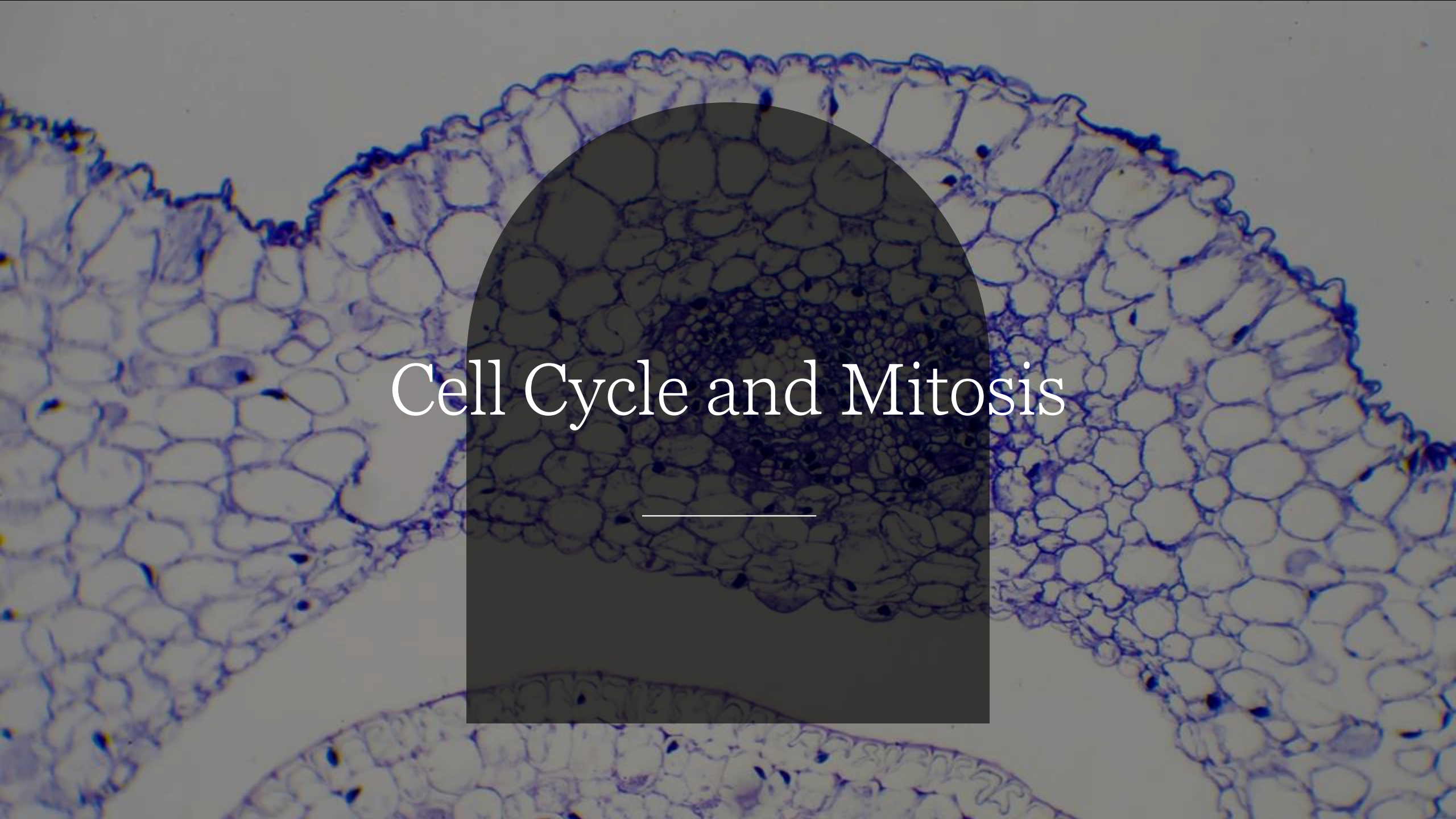
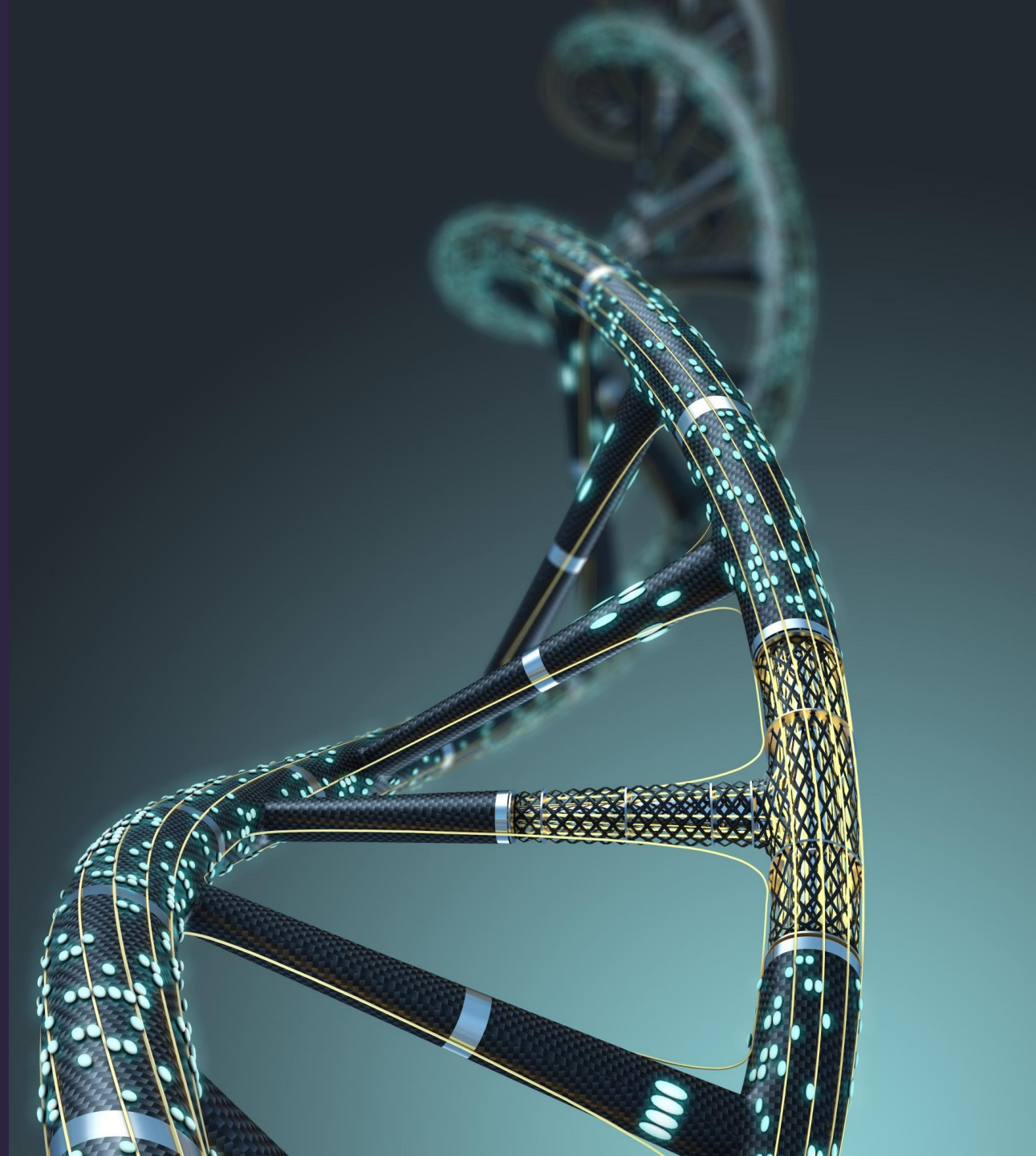


Cell Cycle and Mitosis

DNA – Genes and Traits

- Recall that DNA is a double helix shaped molecule made of a sugar-phosphate backbone
- The "rungs" of the DNA "ladder" are made of 4 possible nucleic acid bases

  Adenine, Guanine, Cytosine, and Thymine
- The nucleotide sequence allows for codes to be stored

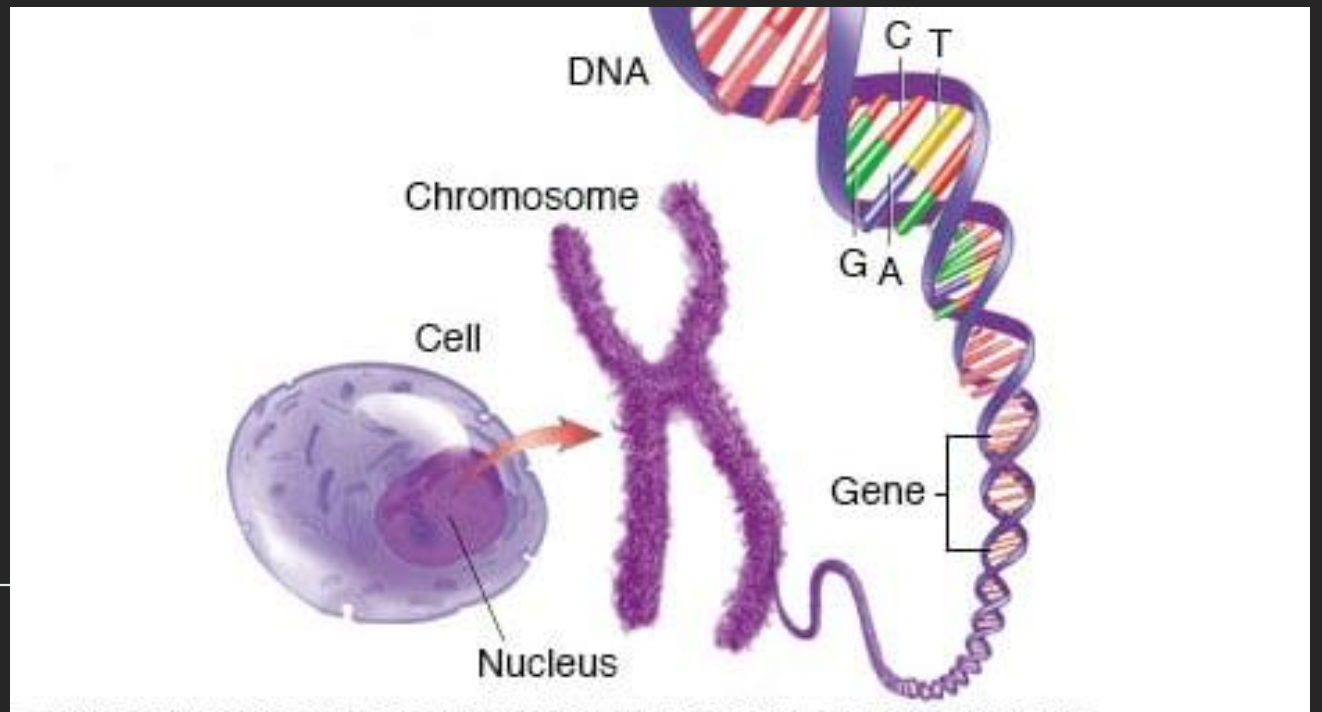


DNA – Genes and Traits

- Only certain sections of the DNA code for proteins, the rest has other purposes
- The parts that code for a proteins are called **Genes**

•One or more of the proteins that the genes code for lead to qualities in the organism. These Qualities are called **Traits**

•Example Traits: Eye Colour, Hair Colour, Height, Connected or Detached Ear Lobe, Pesticide Resistance, Blood Type, Skin Tone, ...

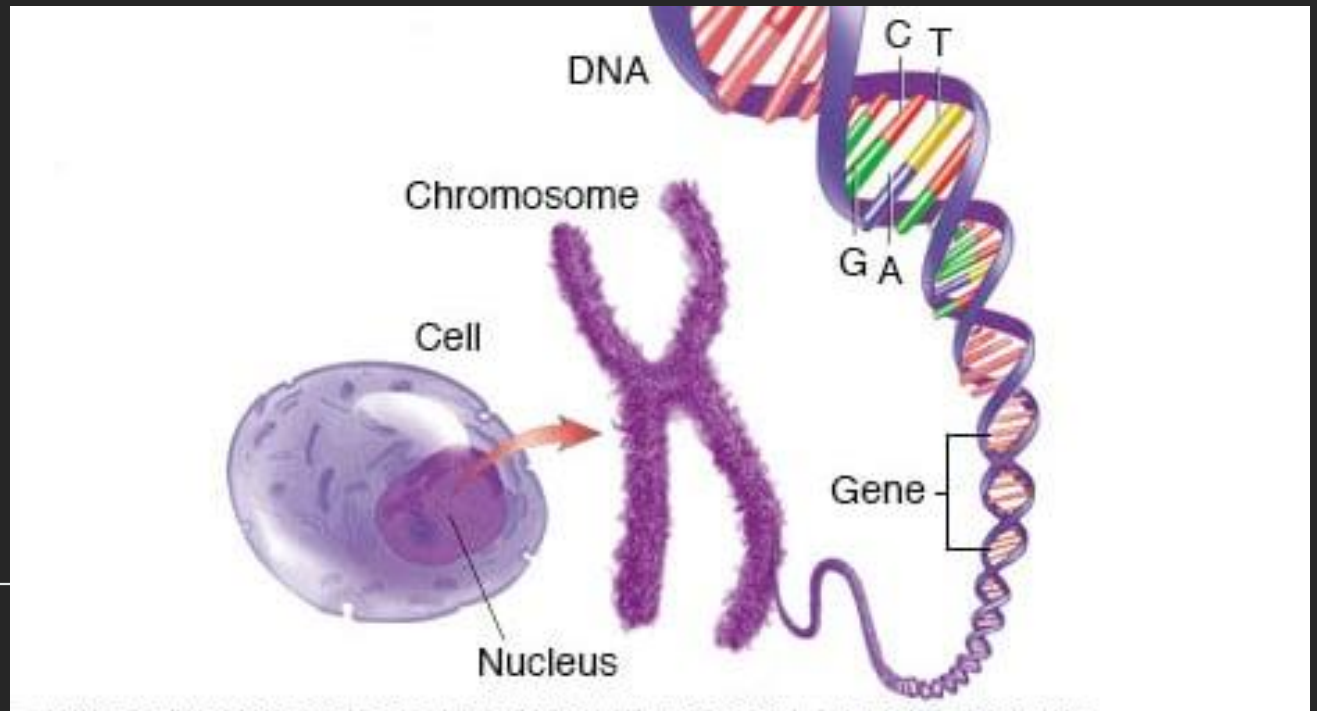


DNA - Organization

- Humans have 3 **Billion base pairs** (nucleic acid "rungs")
- To organize and use the DNA efficiently, the DNA is wound up into a compact structure called a **chromosome.** Genes are unwound only when needed.

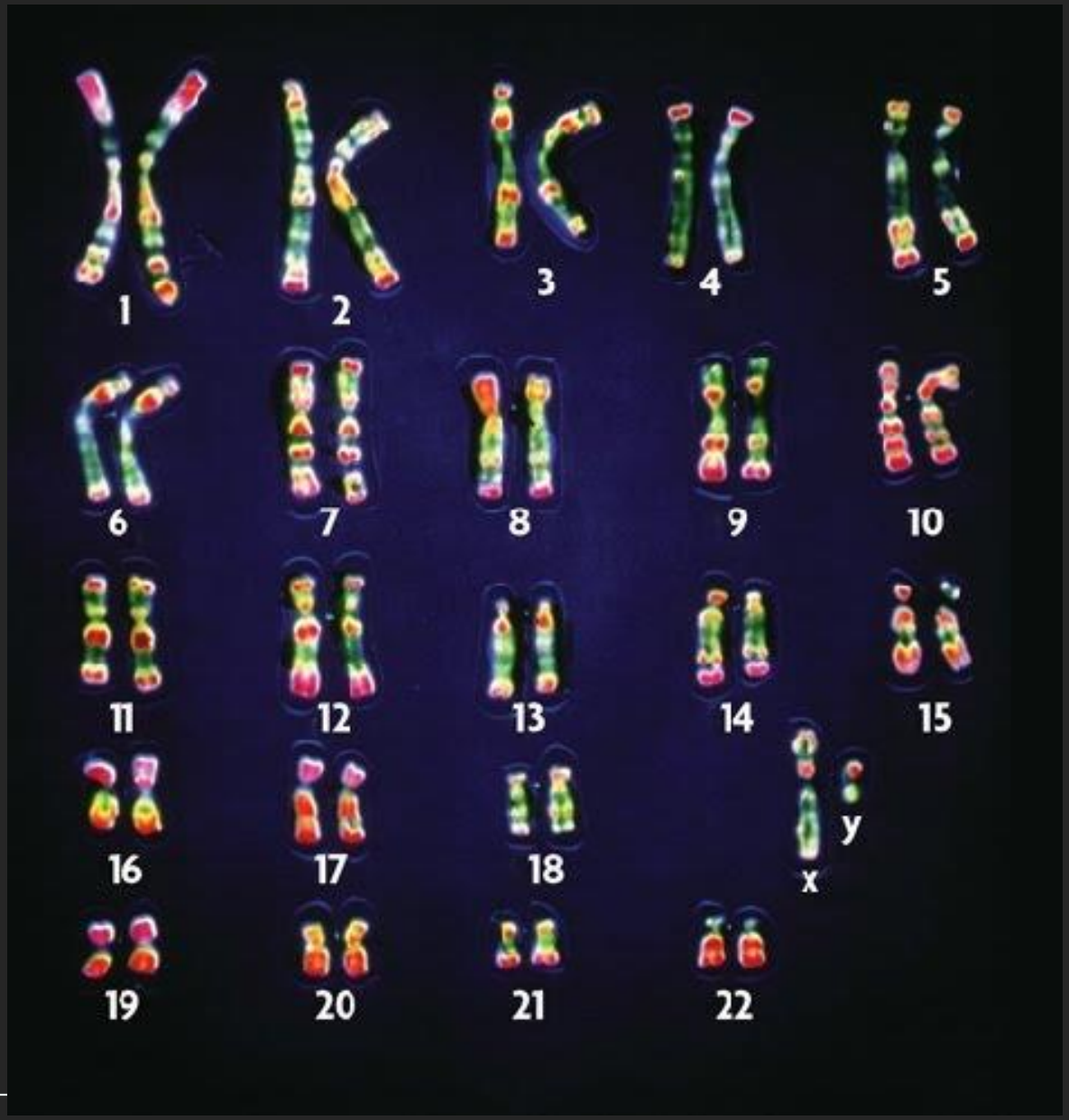
•Humans have 46 total chromosomes, 23 chromosomes from a mother, 23 chromosomes from a father

•Each chromosome is connected in the center by a protein structure called a centromere



Human Karyotype

- The chromosomes from the mother match up to the chromosomes of the father, with similar genes
- Example, Chromosome #1 will an eye colour gene on mother and father's copy
- Parental Chromosomes that match up are called **homologous chromosomes**
- The exception is the "23rd" chromosome, which is the one linked to sexual anatomy (not gender identity)
- XX is for female, XY is for male



Chromosome Number

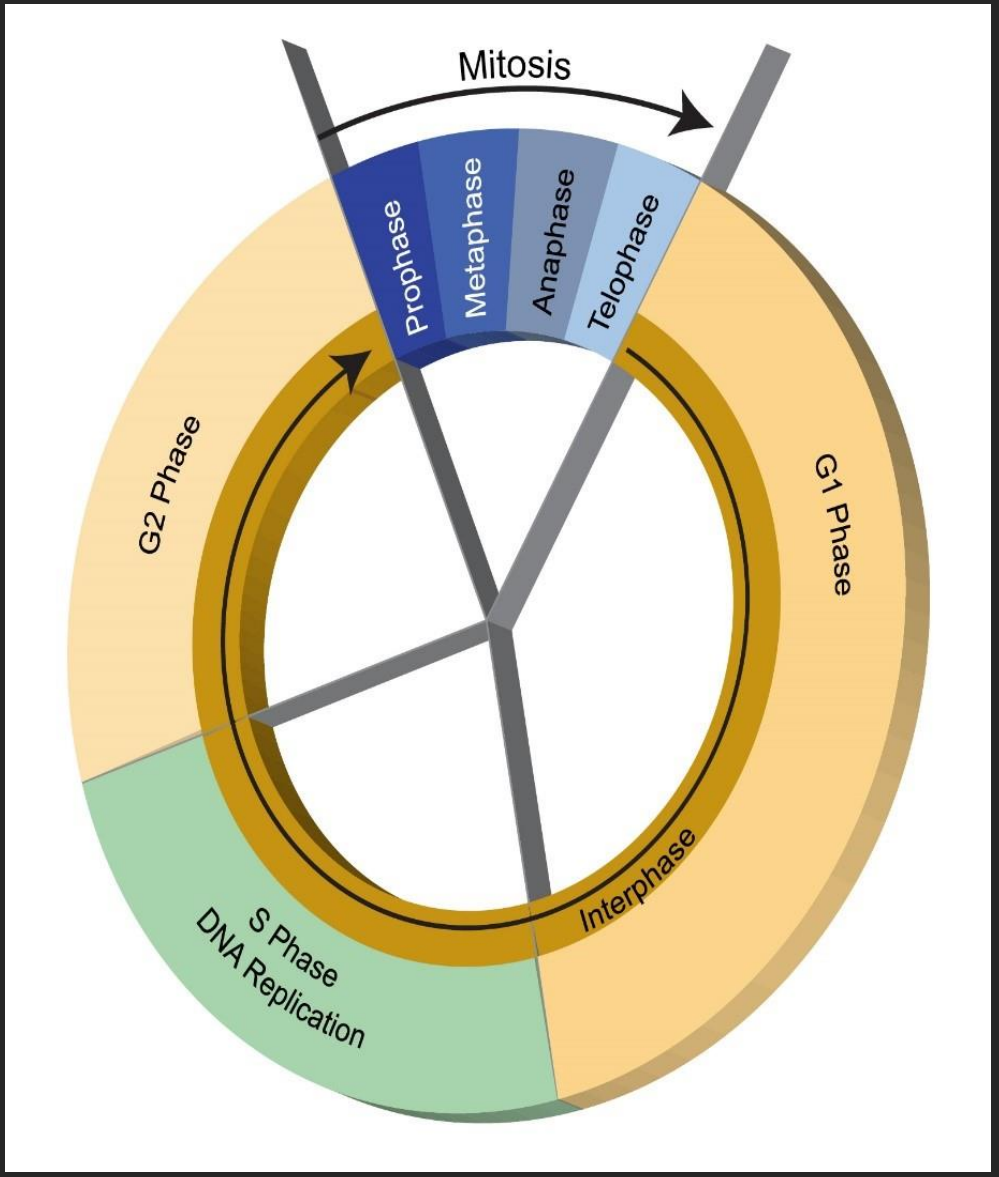
- Chromosome number will differ in different types of organisms

Table 4.1 Comparison of Chromosome Number in Various Organisms

Organism	Chromosome Number	Organism	Chromosome Number
	46		20
	60		80
	78		44

Cell cycle

- During a cell's life, it will be in different stages of a cycle.
- The cycle is the timeline for the stages that lead to duplicating a cell
- Most of the cell's time will be spent in the phase called **interphase** that is made of 3 smaller stages, Growth phase 1 (G1), synthesis phase (S), and growth phase 2 (G2)
- The cell grows in G1 and G2 to prepare for duplication
- There is also a G0 phase, to temporarily stop dividing



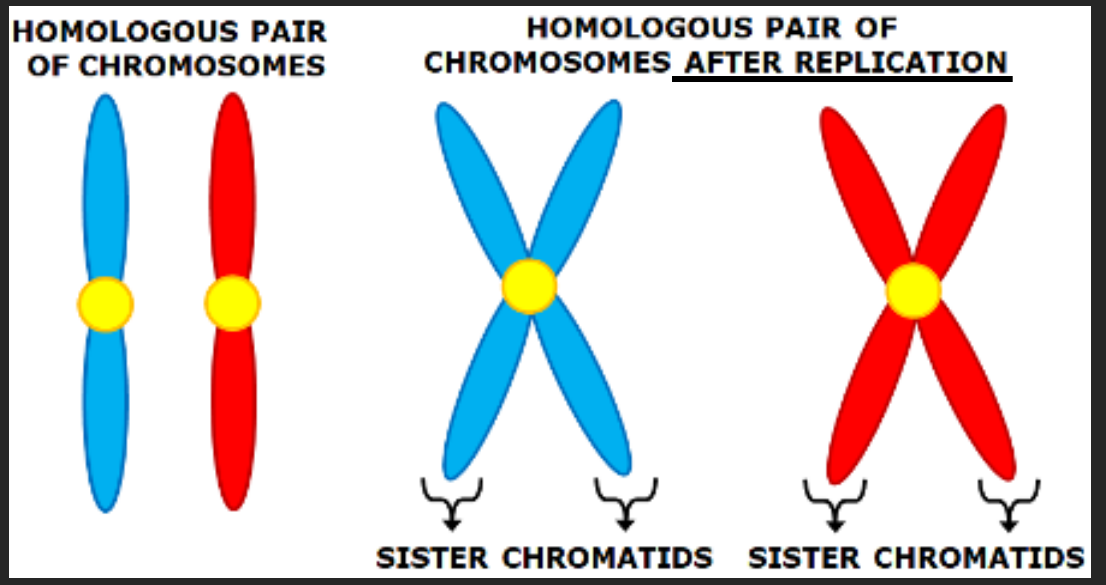
Cell Cycle – S Phase

- The S phase is where the DNA is **duplicated/synthesized**
- When the synthesis step occurs, a copy of the DNA from the mother and father is made, called **sister chromatids**.

Left Blue chromosome = DNA from Father

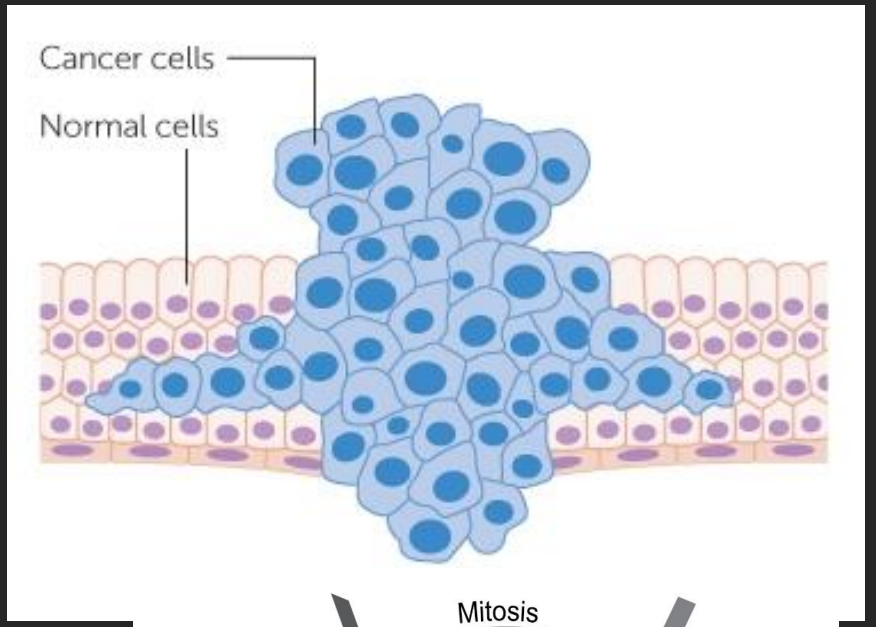
Right Red chromosome = DNA from Mother

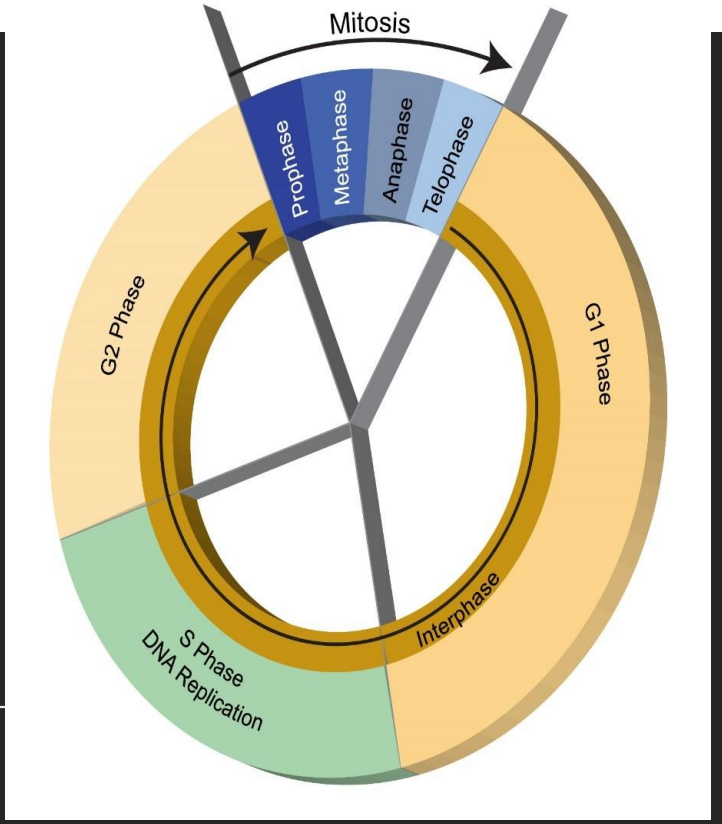
<u>Note:</u> you want your new cell to have one copy from the mother and one copy from the father



Cell Cycle - Cancer

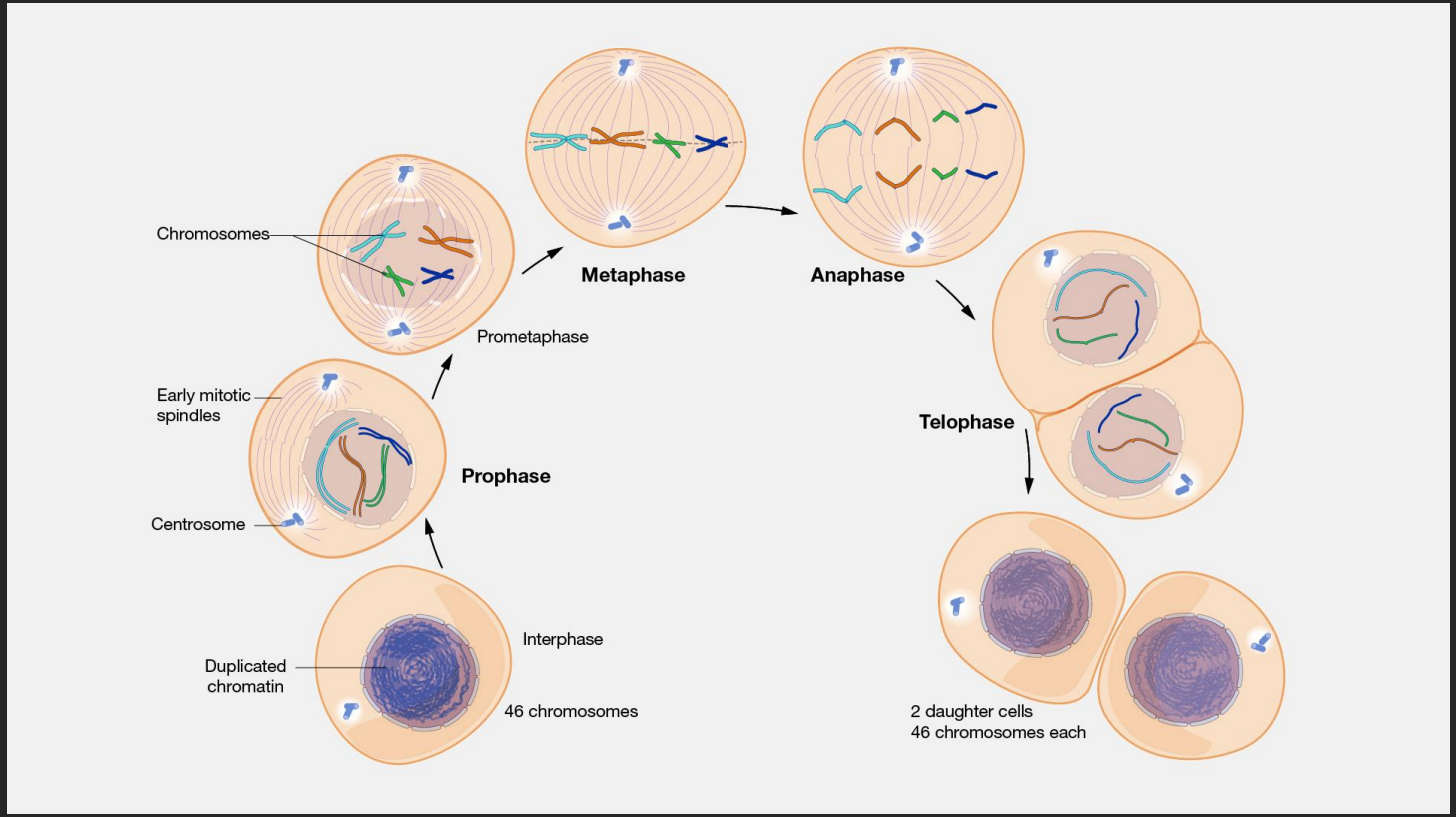
- After the three steps of interphase, the cell will enter mitosis, which is the actual process of dividing the cell up into two
- Before each stage, the cell checks to make sure everything is alright to continue
- If these checkpoints are skipped, the cell will divide uncontrollably forever, causing the condition of cancer
- When Cancer occurs, too many cells will be made, causing lumps called tumors to form. The Tumors sap nutrients from the organism
- Any cell in the human body can get cancer





Mitosis

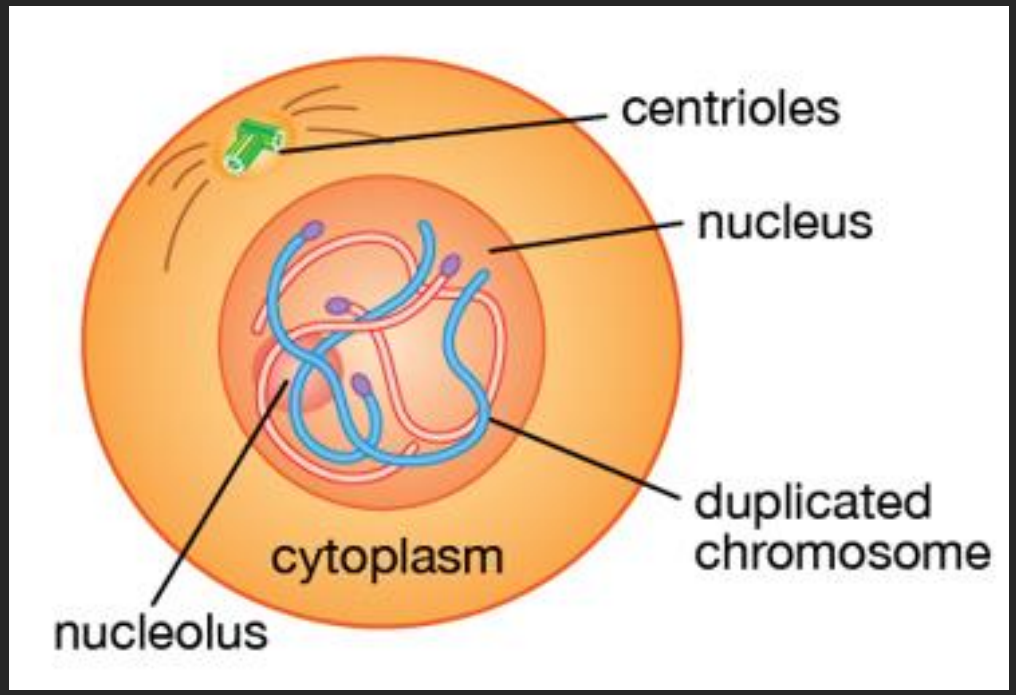
- Mitosis is the name of the process where the contents of a cell's nucleus divides. This includes the main event of separating the duplicated DNA into each new cell



- The chromosomes can handled by an organelle called the **centriole**, which can form a special microtubule skeleton called the **mitotic spindle**.
- The spindle attached to the centromeres of the chromosomes and can move them around.

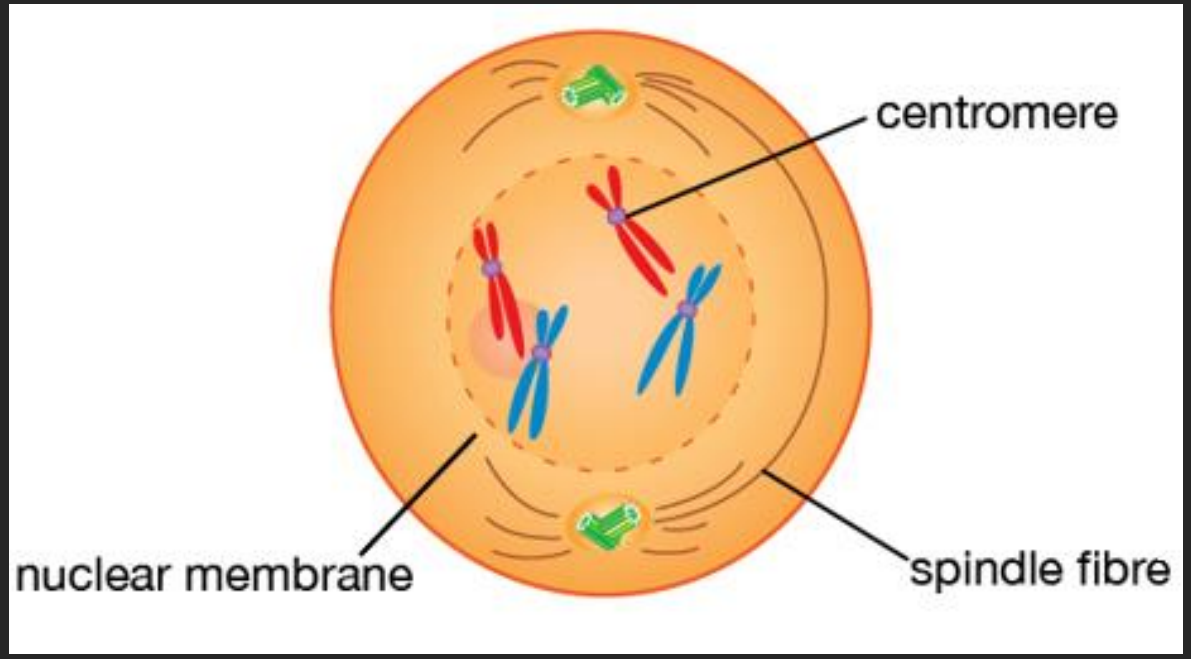
Right before mitosis - Interphase

- The phase where the cell grows and gains nutrients for cell division
- The DNA/chromosome will be duplicated in the **S** phase.
- The nucleus is present
- This beginning cell is called the **parent** cell



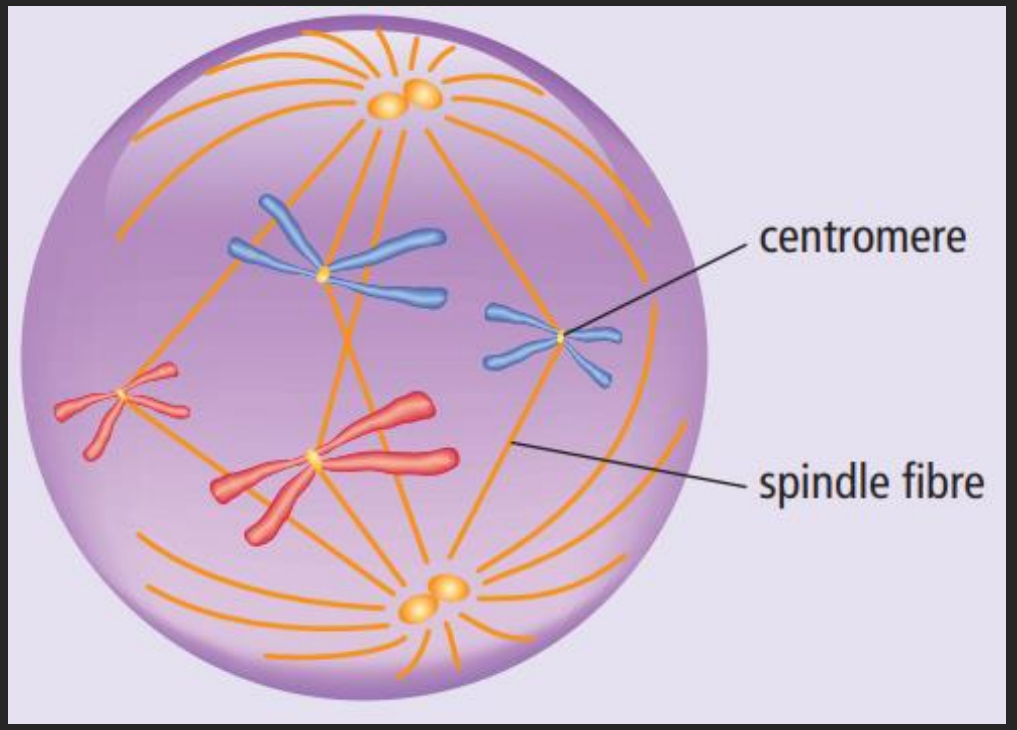
Step 1 – Early Prophase

- The chromosomes are connected together in their **center** by the **centrosome** (also called **centromeres**).
- The centriole divides into two and each new centriole move to opposite ends of the cell.
- The centrioles begin making the mitotic **spindle fibers**
- The nuclear membrane (and nucleolus) begins to **disappear**.



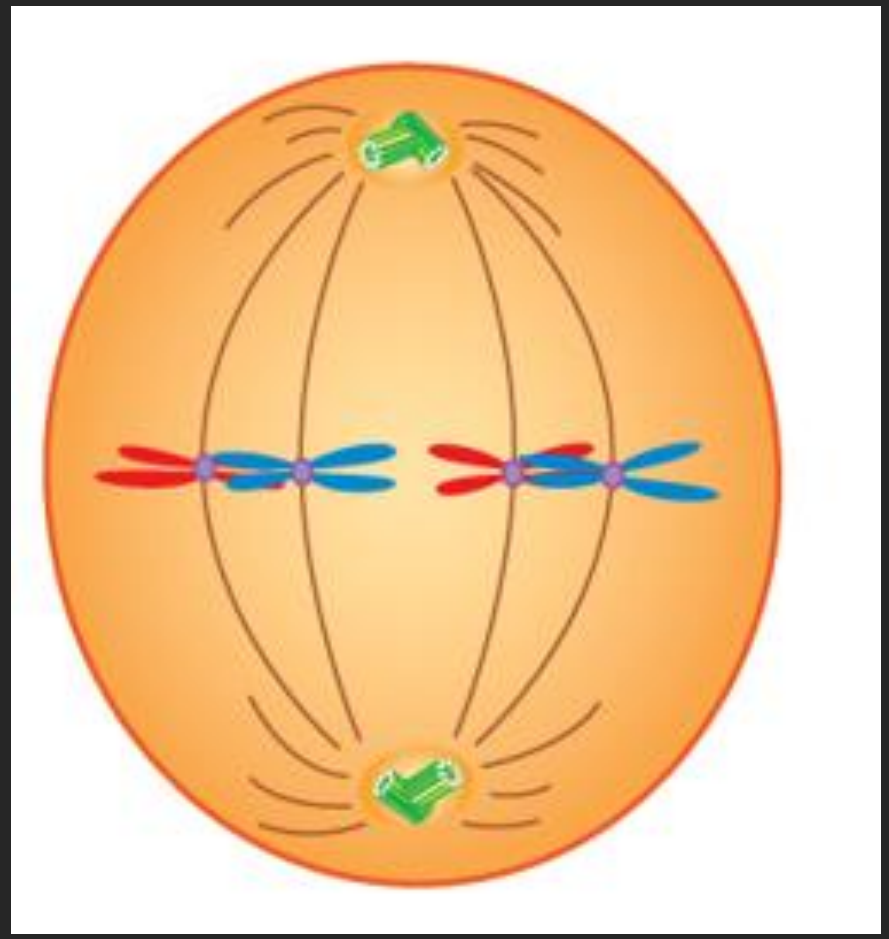
Step 1 – Late Prophase

- The nuclear membrane is gone
- The mitotic spindle has now attached to each centromere



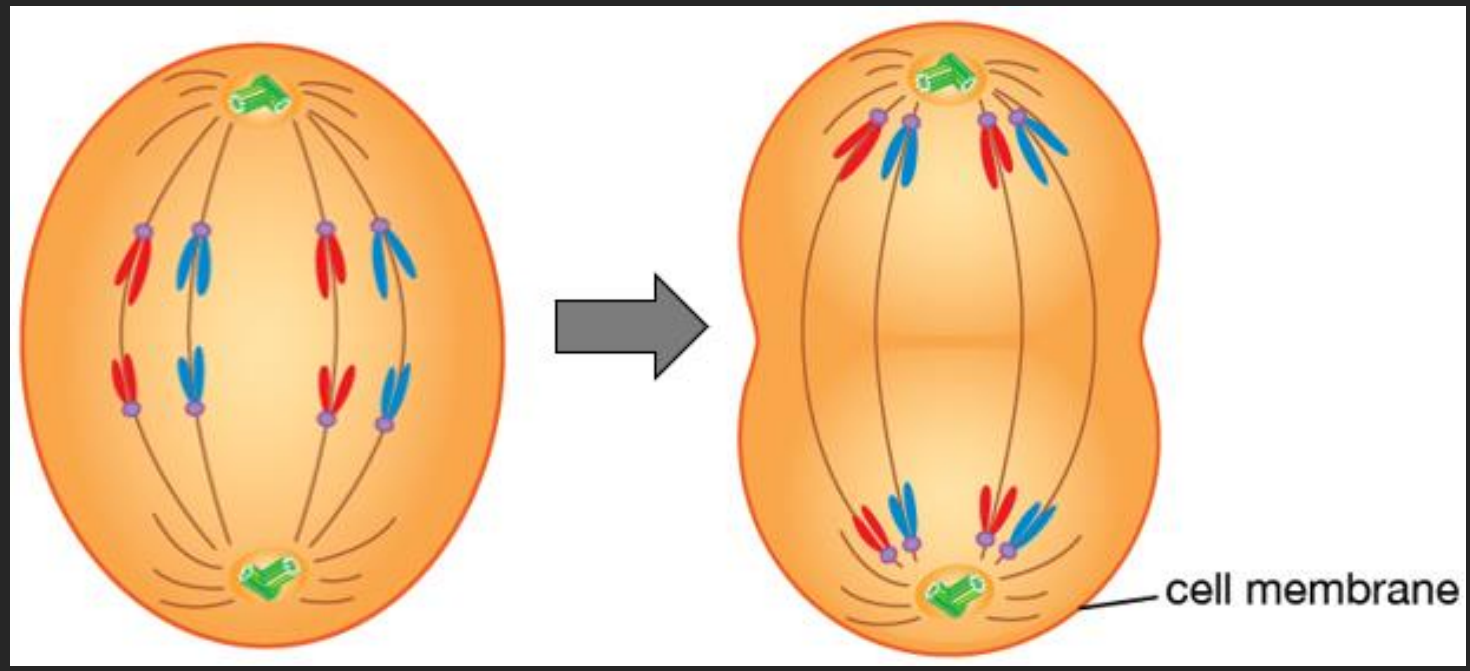
Step 2 - Metaphase

- The chromosome pairs are pulled to the middle of the cell by the spindle fiber and organize into a line.



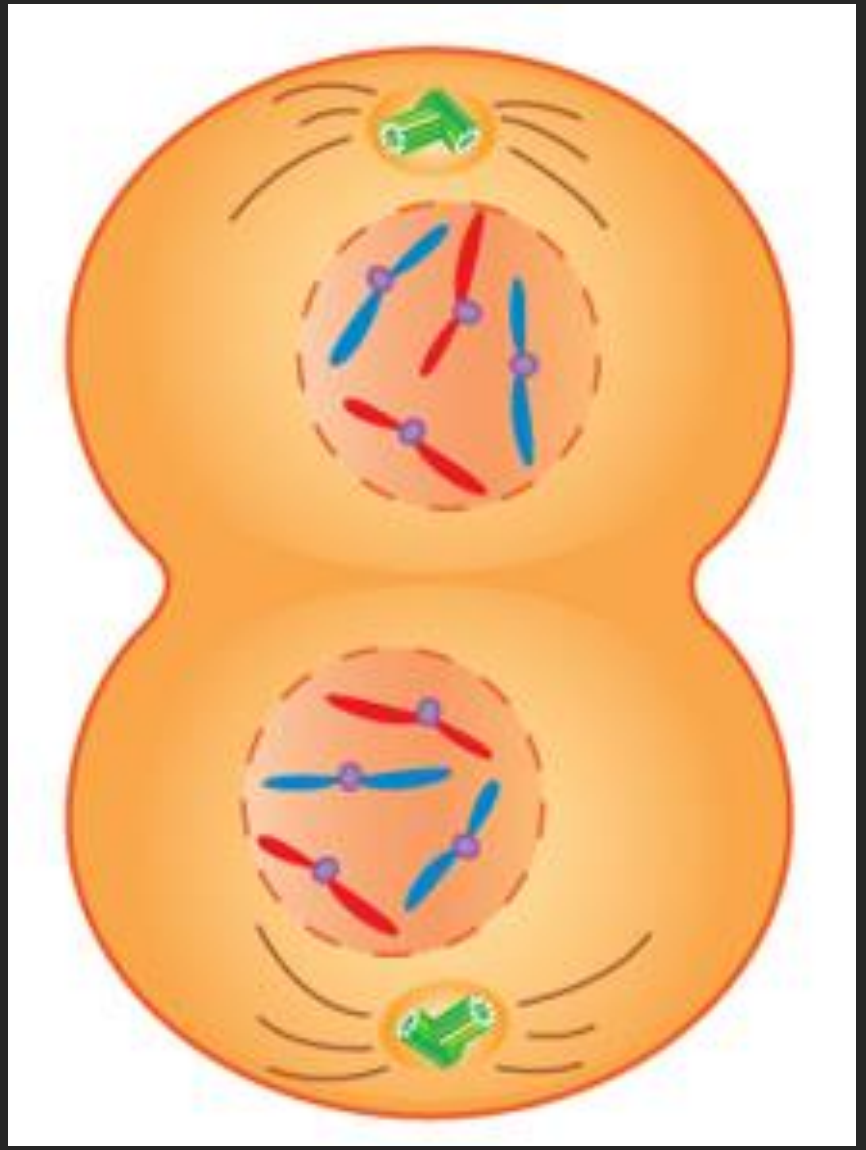
Step 3 - Anaphase

- The mitotic spindle pulls the chromosome pairs apart.
- The spindle pulls one copy of each chromosome to each side of the cell.
- The **cell membrane** begins to pinch at the center



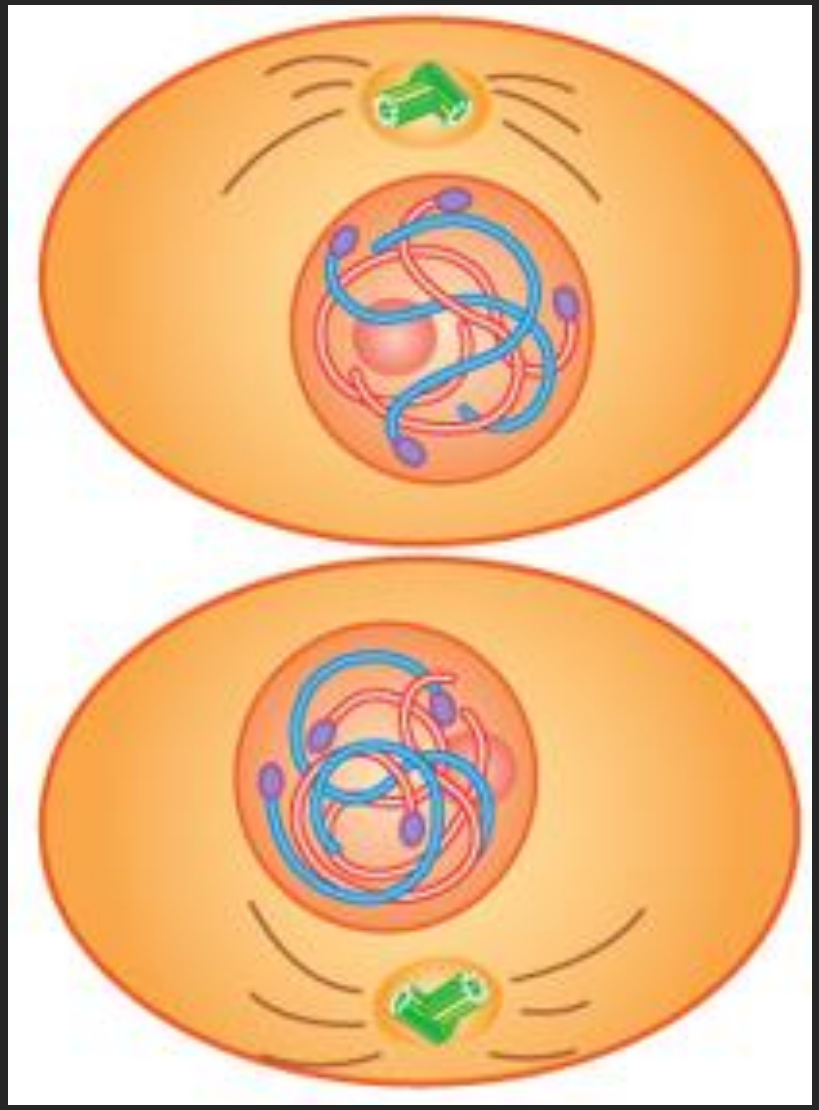
Step 4 - Telophase

- The mitotic spindle releases the chromosomes and disassembles
- A new **nuclear membrane** forms around the chromosomes at each end of the cell
- The cell membrane has finished constricting in the middle and is about to pinch off



After Mitosis – Cytokinesis

- Not technically a part of mitosis
- Cyto means cell, and kinesis means cut. The word literally translates to "Cell Cut!". This is where the two new cells separate.
- Each new cell is called a **daughter cell** and they are identical
- Each cell will contain the same number of chromosomes as the **parent cell**



Failure to separate chromosomes

- If the chromosomes fail to separate correctly, conditions can be caused by different numbers of chromosomes
- Example: if a cell has three copies of chromosome 21, the result is down syndrome
- Example: If a cell does not have an X chromosome, the result is death of the cell

Chromosomes	Syndrome
Autosomes	
Trisomy 13	Patau syndrome
Trisomy 18	Edward syndrome
Trisomy 21	Down syndrome
Sex chromosomes, female	
X0	Turner syndrome
XXX	triple X syndrome (trisomy X)
XXXX	tetrasomy
Sex chromosomes, male	
Y0	nonviable
XYY	XYY syndrome
XXY	Klinefelter syndrome
XXXY	Klinefelter syndrome
XXYY	Klinefelter syndrome

Table 15.7 Aneuploid abnormalities of human chromosomes