General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

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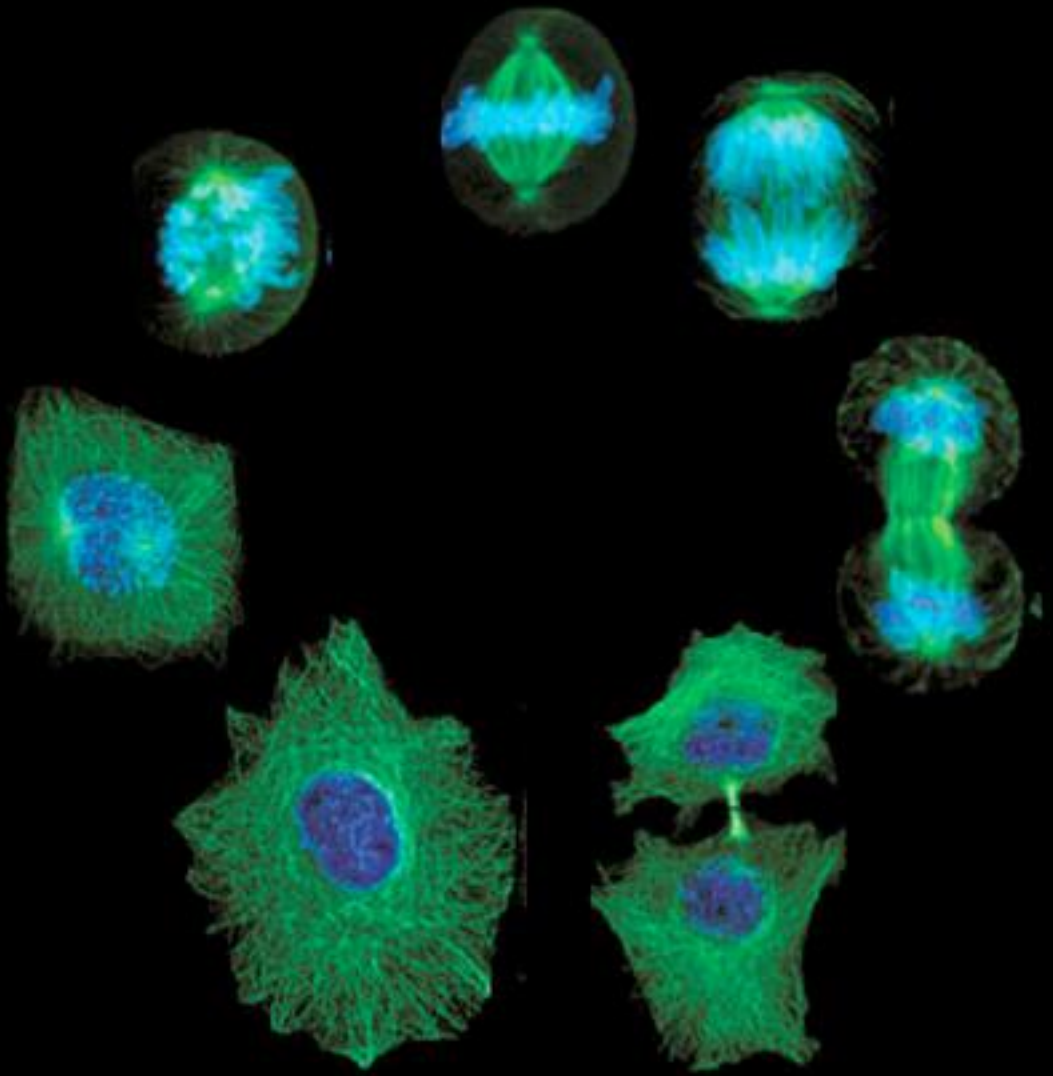
Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER
Lecture:https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:
Exams (4): 20% Each
Quizzes: 20% Average

ASEXUAL REPRODUCTION

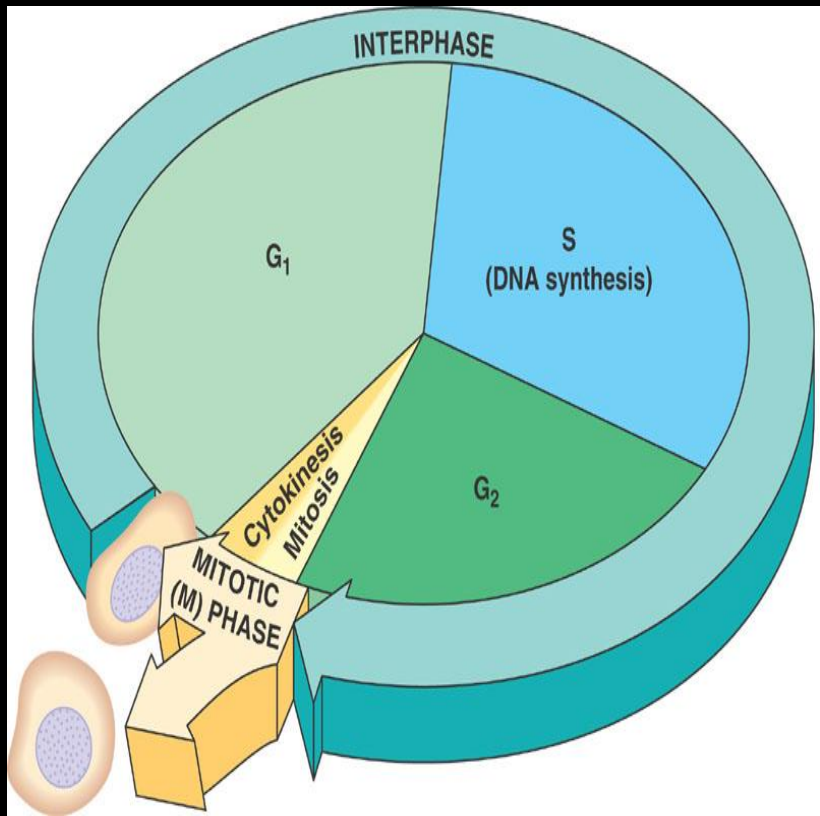


Cell Division

- Because all cells come from other cells
- Cell division is crucial for reproduction, growth and continuity of life
- Three Purposes:
  - Reproduction (for unicellular organisms) called binary fission
  - Growth and Development
  - Tissue Renewal
- *Almost* always – cell division creates two identical "daughter" cells.
- Cell Cycle - the process of how cells coordinate cell division

The Cell Cycle

- An orderly set of stages and substages between one **division** and the next
- Just prior to next division:
  - The cell grows larger
  - The number of organelles doubles
  - The DNA is replicated
- The two major stages of the cell cycle:
  - Interphase, and
  - Mitosis



Interphase

Most of the cell cycle is spent in interphase

- **G_1 Phase:**
  - Recovery from previous division
  - Cell doubles its organelles
  - Accumulates raw materials for DNA synthesis
- **S Phase**:
  - DNA replication (synthesis)
  - Chromosomes enter with 1 chromatid each
  - Chromosomes leave with 2 identical chromatids each
- **G_2 Phase:**
  - Between DNA replication and onset of mitosis
  - Cell synthesizes proteins necessary for division

Mitotic (M) Stage

- Includes:
  - **Mitosis (karyokinesis)**
    - Nuclear division
    - Daughter chromosomes distributed to two daughter nuclei
  - **Cytokinesis**
    - Cytoplasm division
    - Results in two genetically identical daughter cells

The Cell Cycle

M phase – mitosis

Shortest phase (~1hr)

G1 phase – first "gap"

Longest phase

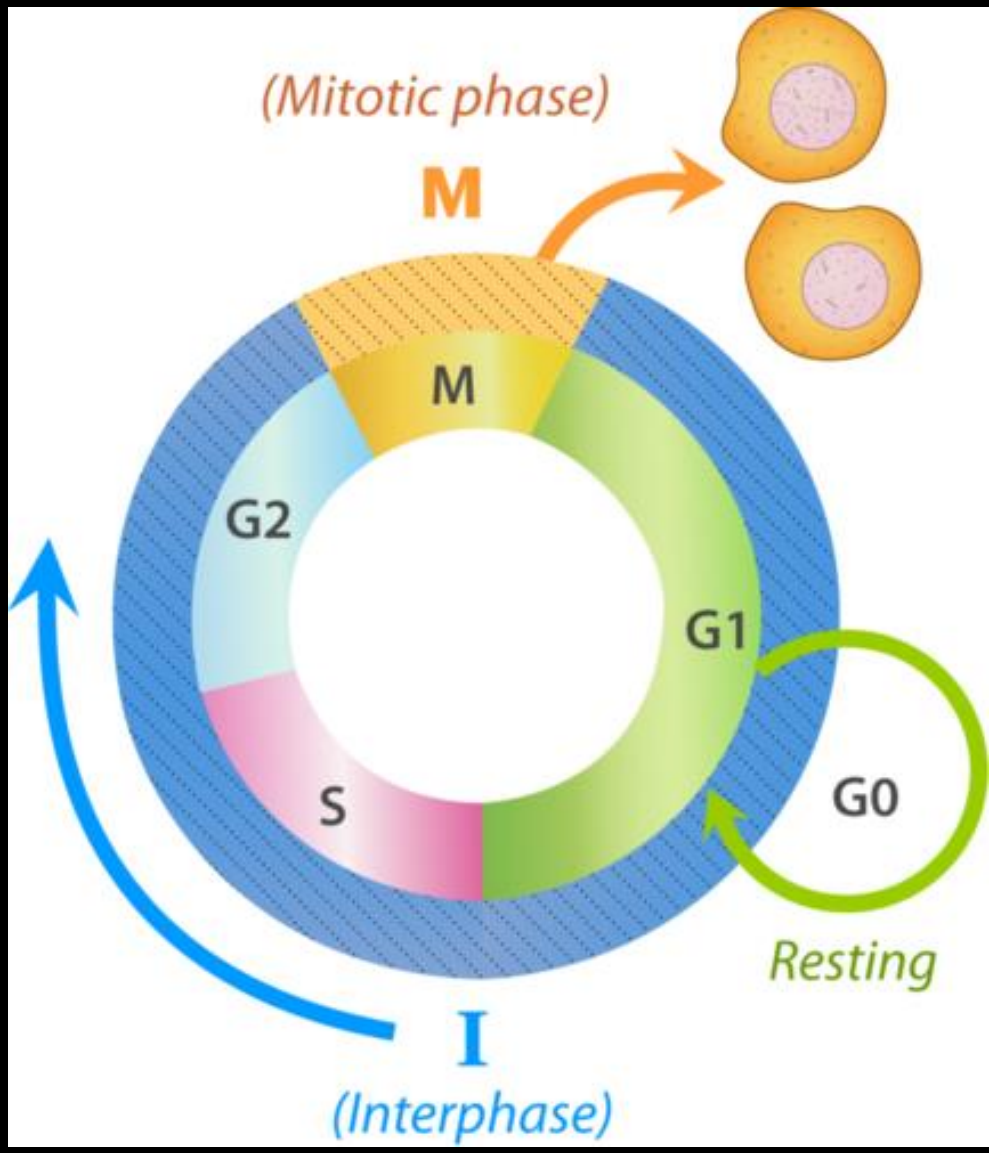
S phase – DNA Synthesis

G2 phase – second "gap"

G0: Cells that are not growing or dividing at all

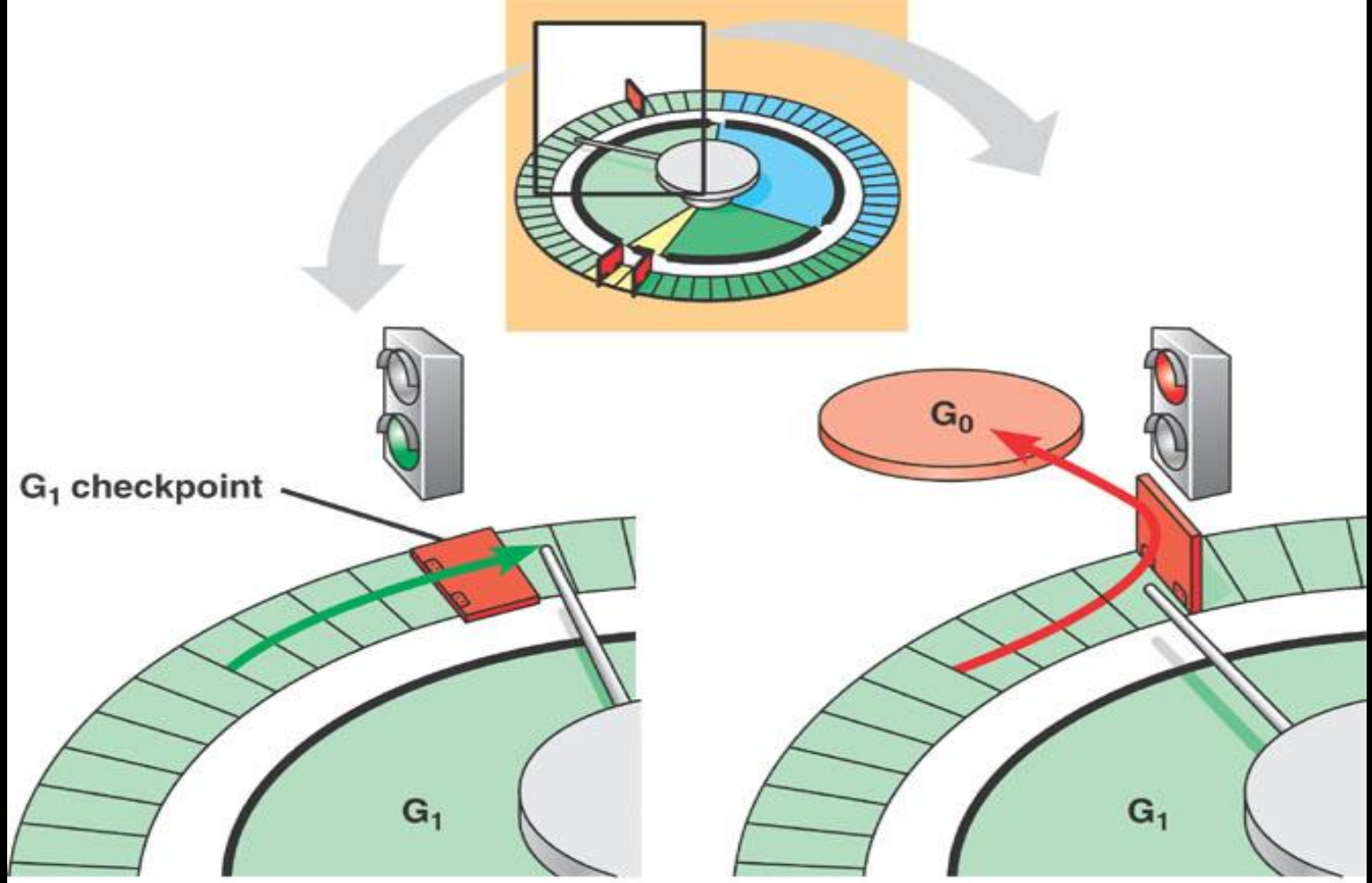
Interphase = G0+G1+S+G2

i.e., NOT mitosis!



Cell Cycle Control

- Cell cycle controlled by internal and external signals
  - **External signals**
    - **Growth factors**
    - Received at the plasma membrane
    - Cause completion of cell cycle
  - **Internal signals**
    - Family of proteins called **cyclins**
    - Increase and decrease as cell cycle continues
    - Without them cycle stops at G_1, M or G_2
    - Allows time for any damage to be repaired

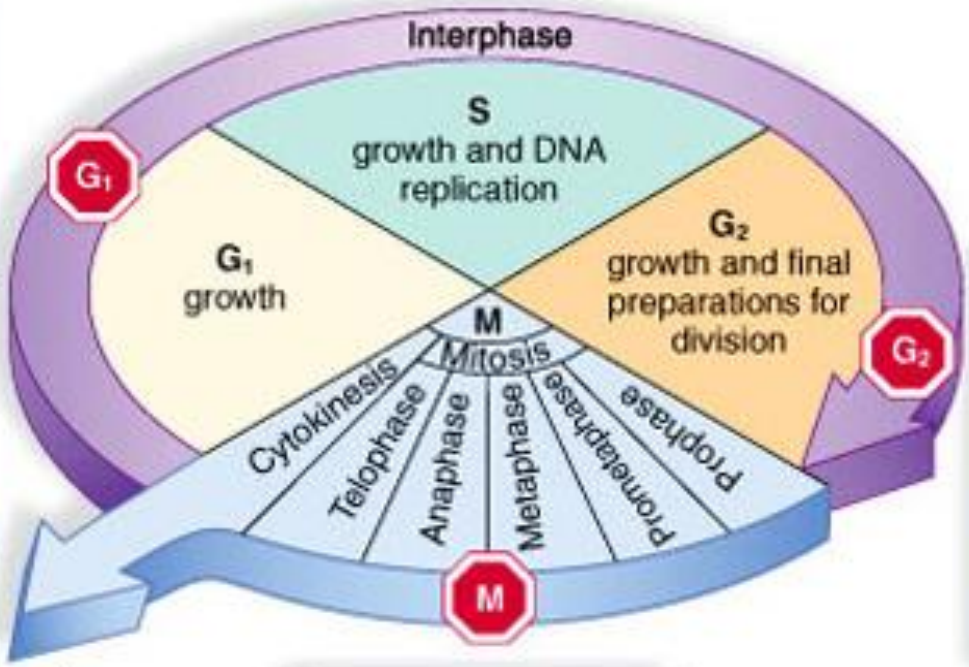


(a) If a cell receives a go-ahead signal at the G_1 checkpoint, the cell continues on in the cell cycle.

(b) If a cell does not receive a go-ahead signal at the G_1 checkpoint, the cell exits the cell cycle and goes into G_0, a nondividing state.

The Cell Cycle: possible check points

G_1 checkpoint
Cell cycle checkpoint. Apoptosis will occur if DNA is damaged and cannot be repaired. Otherwise, the cell is committed to divide.



b.

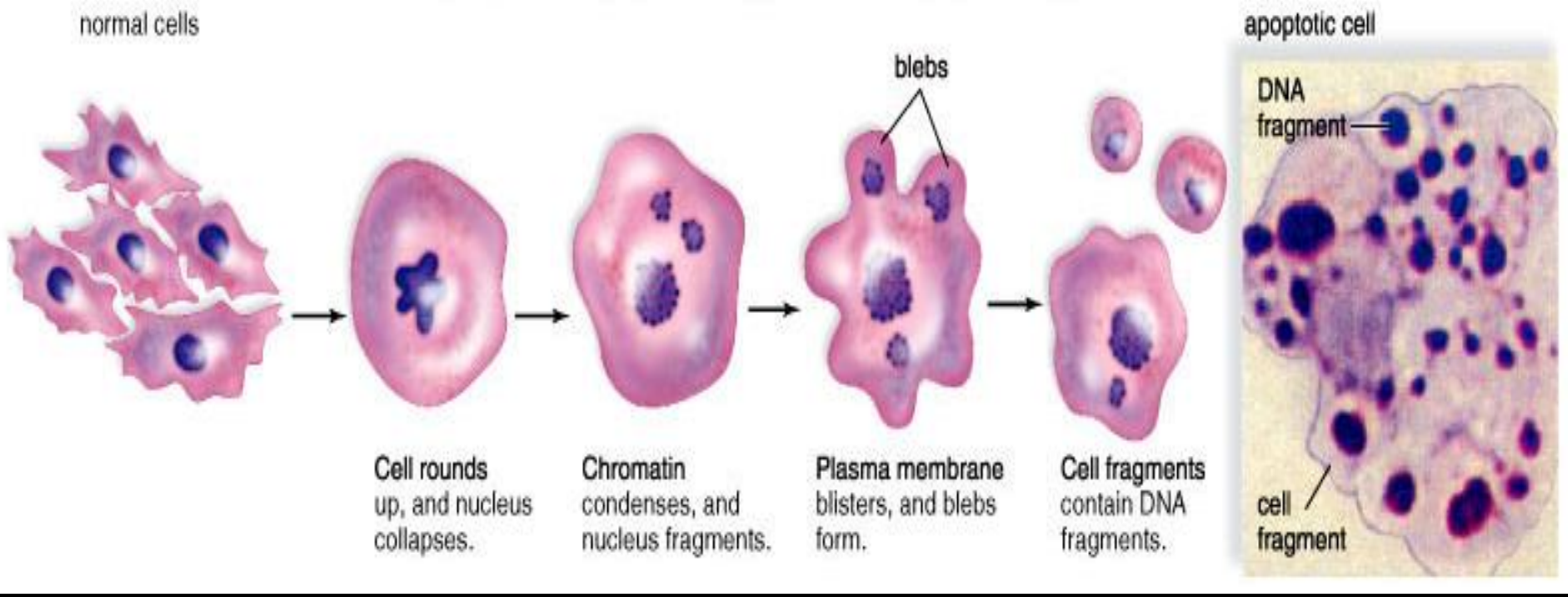
G_2 checkpoint
Mitosis checkpoint. Mitosis will occur if DNA has replicated properly. Apoptosis will occur if DNA is damaged and cannot be repaired.

M checkpoint
Spindle assembly checkpoint. Mitosis will not continue if chromosomes are not properly aligned.

Apoptosis

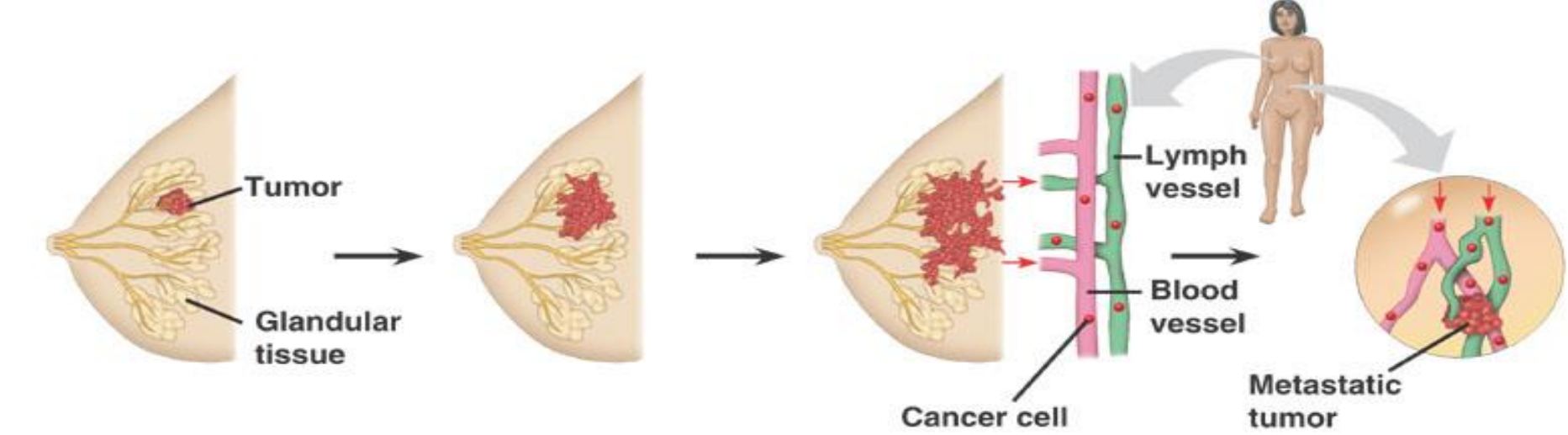
- Often defined as **programmed cell death**
- Mitosis and apoptosis are opposing forces
  - Mitosis increases cell number
  - Apoptosis decreases cell number
- Cells harbor **apoptosis enzymes** (caspases)
  - Ordinarily held in check by inhibitors
  - Can be unleashed by internal or external signals
- **Signal protein P53**
  - Stops cycle at G_1 when DNA damaged
  - Initiates DNA attempt at repair
    - If successful, cycle continues to mitosis
    - If not, apoptosis is initiated

Apoptosis


normal cells
blebs
apoptotic cell
DNA fragment
cell fragment
Cell rounds up, and nucleus collapses.
Chromatin condenses, and nucleus fragments.
Plasma membrane blisters, and blebs form.
Cell fragments contain DNA fragments.

Regulation of the cell cycle

- The control of cell division is highly regulated
- During growth and development, lots of cell division
- In a mature animal
  - Some cells can grow, but never (rarely) divide (nerve, muscle cells)
  - Some are ALWAYS dividing (skin, gut, blood cells)
  - Some divide only during certain times (wound repair, tissue remodeling)
- Control of cell division must be very tightly controlled, because…
  - Errors in this control may result in uncontrolled growth… **CANCER**
  - Factors that drive cell growth & division are potential <u>proto-oncogenes</u>
  - Factors that restrain cell growth & division are potential <u>tumor suppressors</u>



Carcinogenesis = development of cancer

TABLE 9.2

Cancer Cells Versus Normal Cells

Cancer Cells	*Normal Cells*
Nondifferentiated cells	Differentiated cells
Abnormal nuclei	Normal nuclei
Do not undergo apoptosis	Undergo apoptosis
No contact inhibition	Contact inhibition
Disorganized, multilayered	One organized layer
Undergo metastasis and angiogenesis	

Mitosis

- is “nuclear division” of *Somatic Cells* (soma = body)
  - Gametes do Meiosis, not mitosis
- The two copies of the genome are segregated equally to two genetically identical daughter cells
- **Four Phases** of Mitosis:
  - Prophase, Metaphase, Anaphase, Telophase
- Status of the cell BEFORE mitosis: (Interphase)
  - DNA has been duplicated.
  - Chromosomes unwound as chromatin, inside the nuclear envelope
  - Centrosomes have duplicated (but still paired together)

Mitosis: Preparation

- **DNA** is in very long threads
  - **Chromosomes**
  - Stretched out and intertangled between divisions
  - DNA is associated with histone proteins
  - Collectively called chromatin
- Before mitosis begins:
  - Chromatin condenses (coils) into distinctly visible chromosomes
  - Each species has a characteristic chromosome number
    - Humans 46
    - Corn 20
    - Goldfish 94

Chromosome Number

- Most familiar organisms **diploid** (two chromosomes of each kind)
  - Haploid = one chromosome of each type

Humans have 23 different types of chromosomes

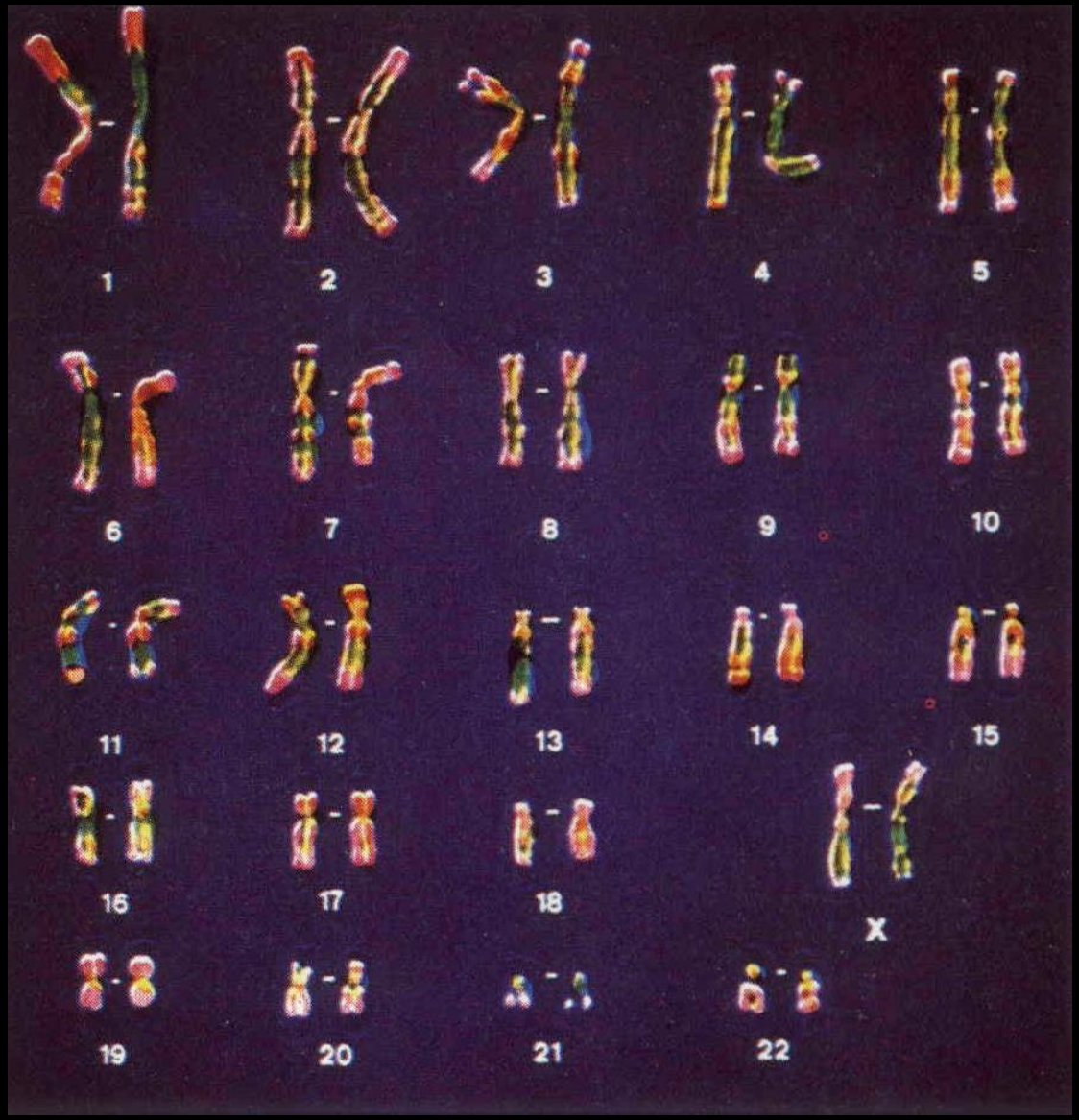
- Each type is represented twice in each body cell (Diploid)
- Only sperm and eggs have one of each type (haploid)

- The n number for humans is **n=23**
  - Two representatives of each type
  - Makes a total of **2n=46** in each nucleus
    - One set of 23 from individual's father (paternal)
    - Other set of 23 from individual's mother (maternal)

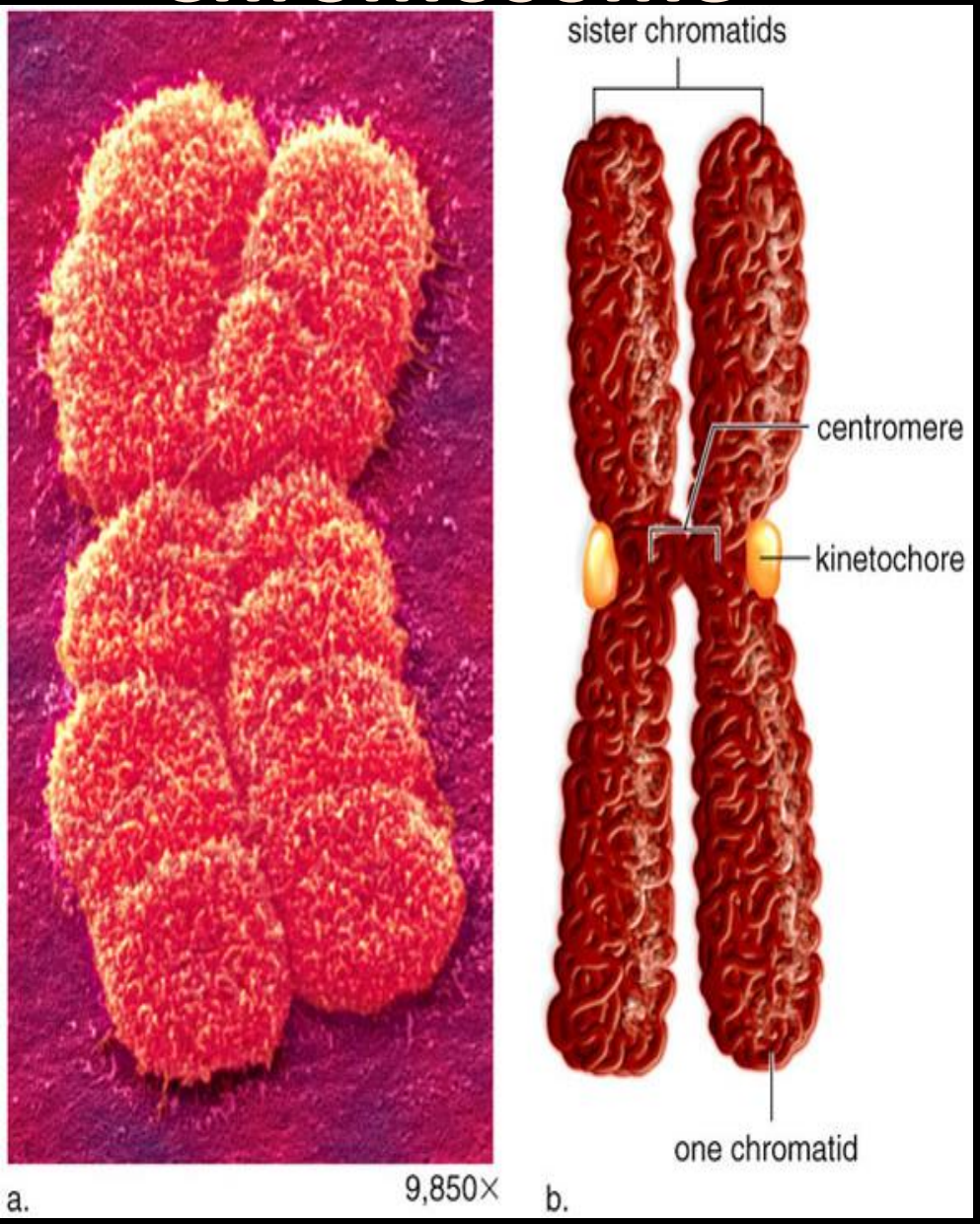
A karyogram

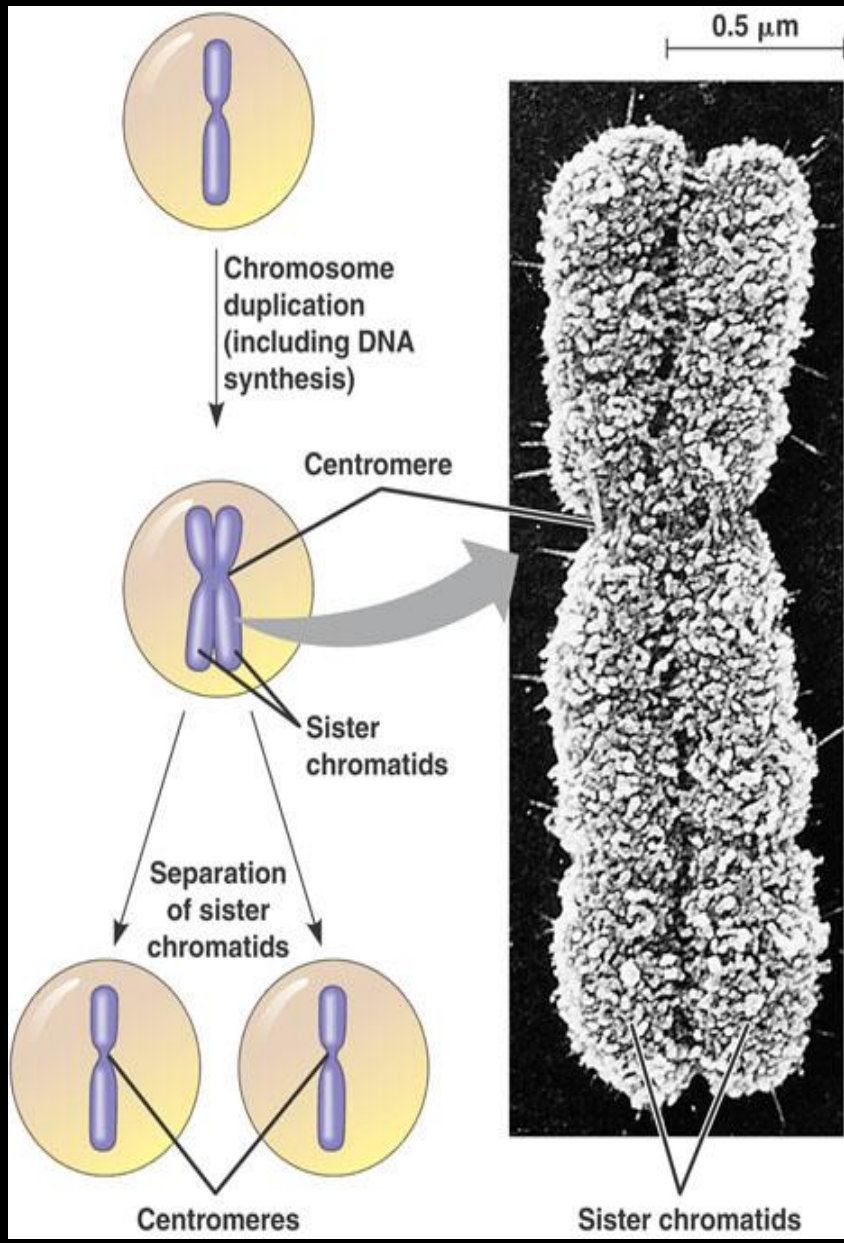
Chromosome:

- Chroma: color
- Soma: body



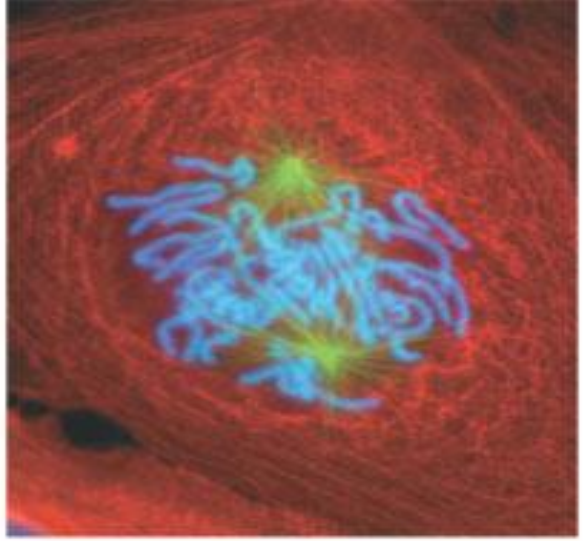
Duplicated Chromosome

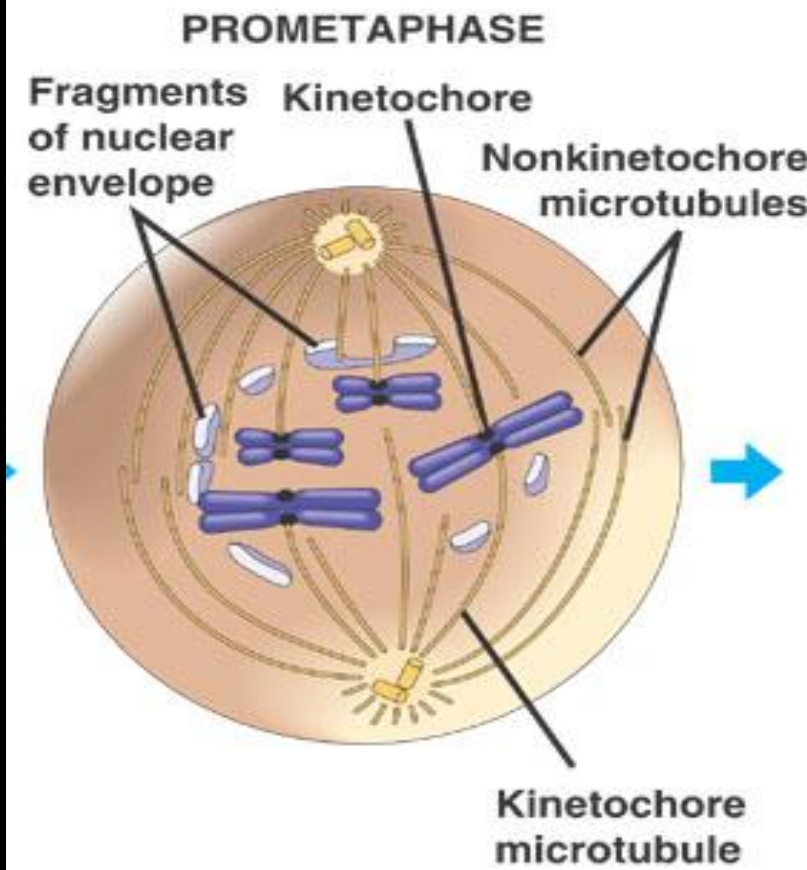




Prophase

- Chromosomes condense (become visible)
  - Sister chromatids can be seen
- Nucleoli disappear
- Mitotic Spindle begins to form
  - This is made of microtubules from the centrosomes
  - “asters” appear
  - Centrosome pair separates
- The nuclear envelope dissolves





Metaphase

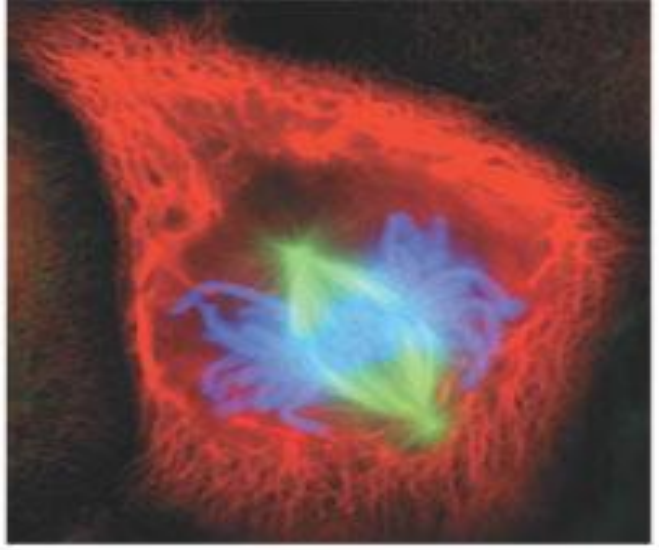
(longest phase of M, ~20min)

Centrosomes aligned opposite of each other

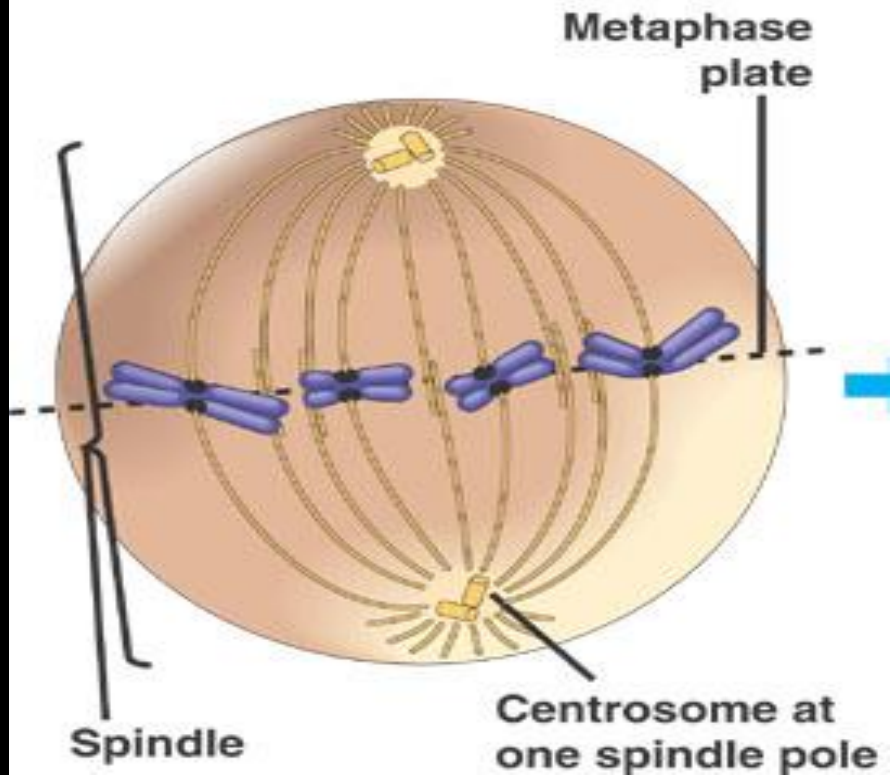
Chromosomes line up:

- centromeres on the metaphase plate (imaginary)
- Kinetochores of sister chromatids attached to opposite spindle poles

Spindle Apparatus fully formed



METAPHASE



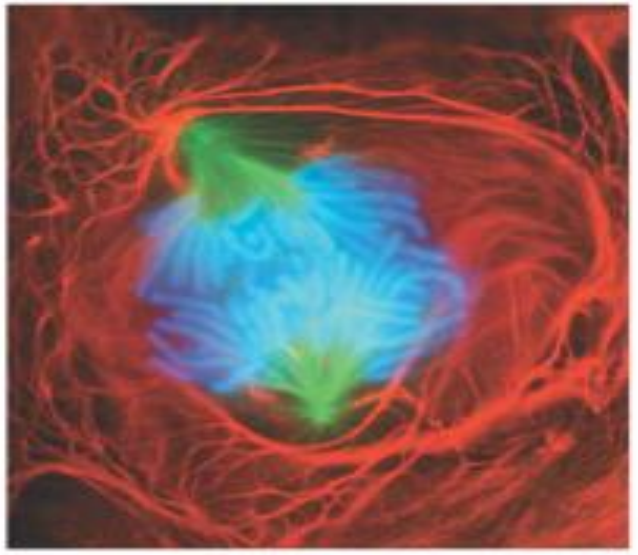
Anaphase

(shortest phase)

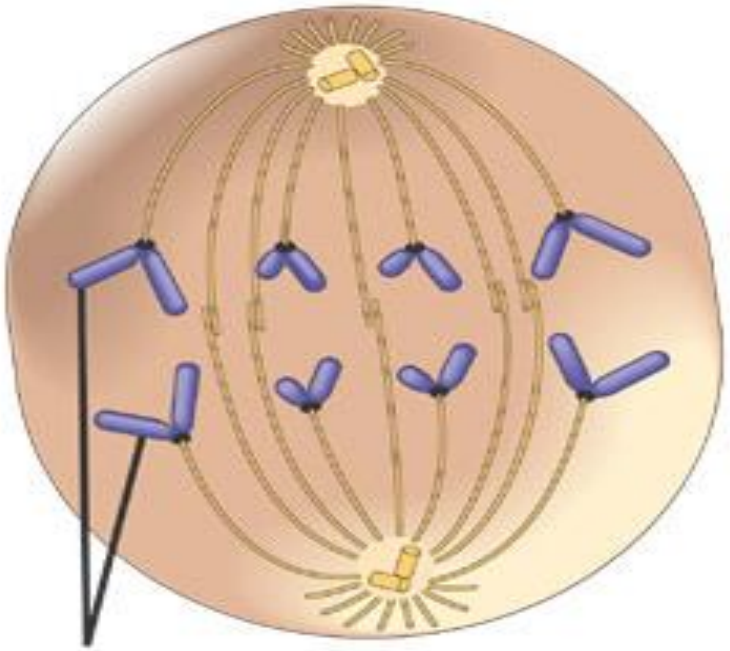
Sister chromatids separate

- Pulled apart by spindle
- Begin migrating toward opposite spindle poles
- Now, each is an independent chromosome

The cell elongates



ANAPHASE



Daughter chromosomes

Telophase

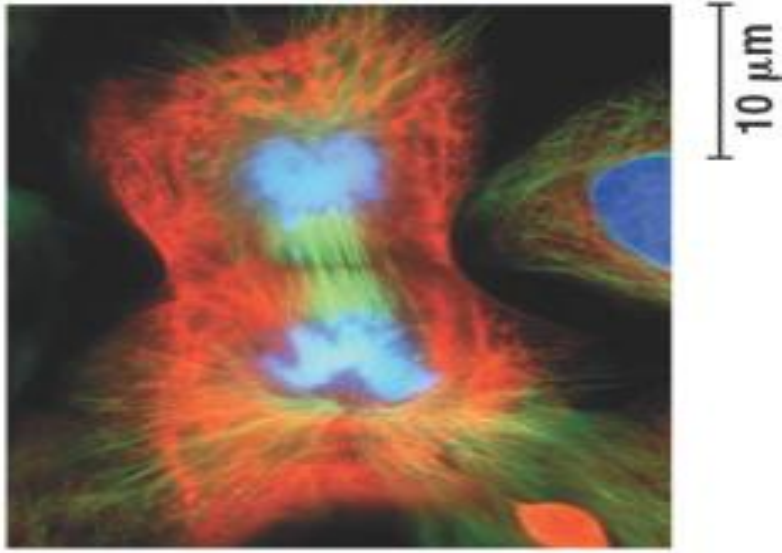
Two separate “daughter” nuclei begin to form, with separate nuclear envelopes

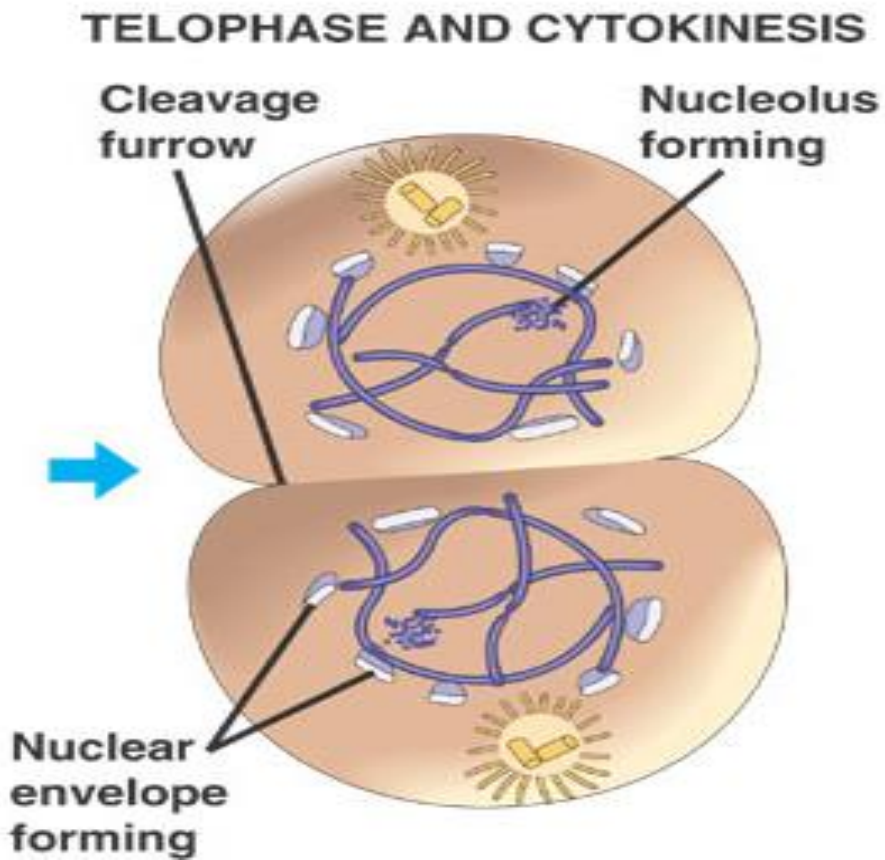
Chromosomes begin to de-condense

Cytokinesis

Cytokinesis is already well underway when cells finish telophase

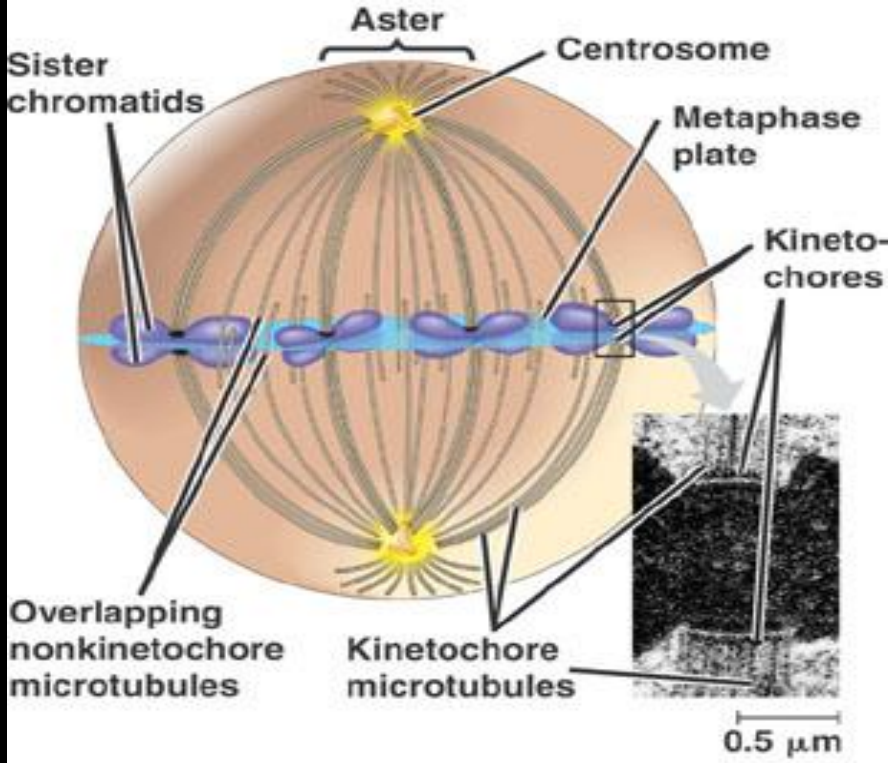
The cleavage furrow forms and pinches the cell into two

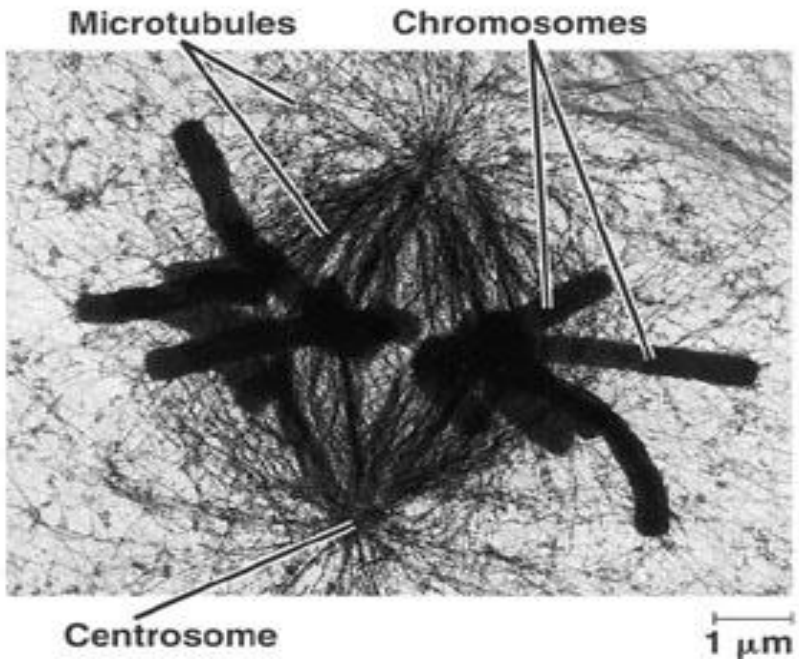




The Mitotic Spindle

- Made of MTs
- Anchored by two centrosomes
  - Centrosome = MTOC (microtubule organizing center) Non-dividing cells have only one centrosome
    - When a cell divides, the centrosome duplicates during S phase
- Attach to chromosomes at kinetochores (centromere)



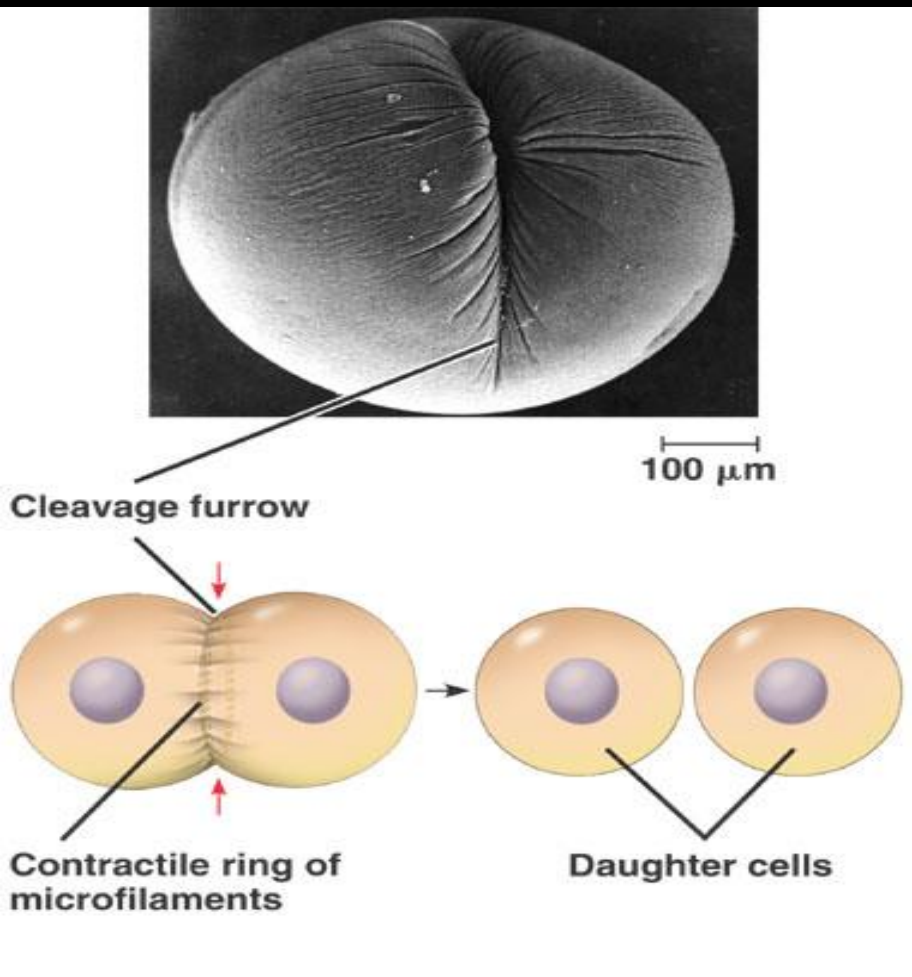


Animal vs. Plant Cells

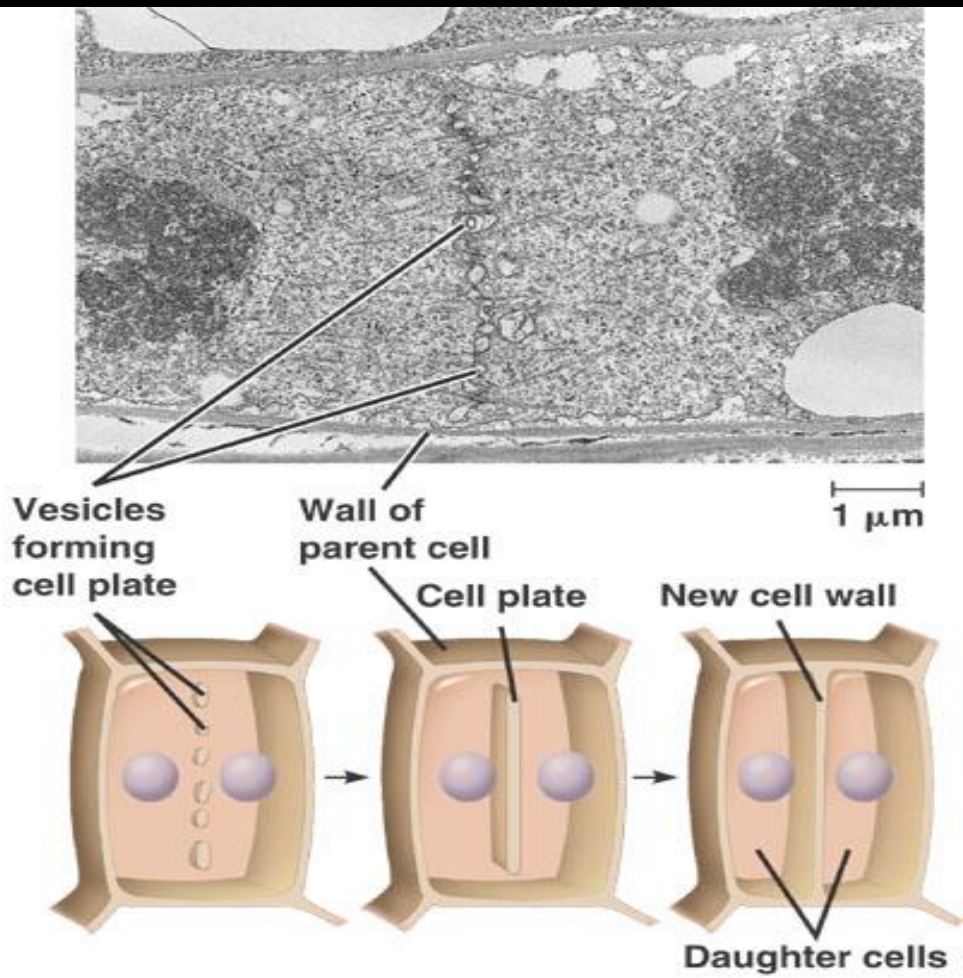
For cytokinesis in plants, a cell plate develops:

- Made by vesicles from the Golgi that begin to form a cell wall between the daughter cells

In animals – a cleavage furrow pinches the cell into two.

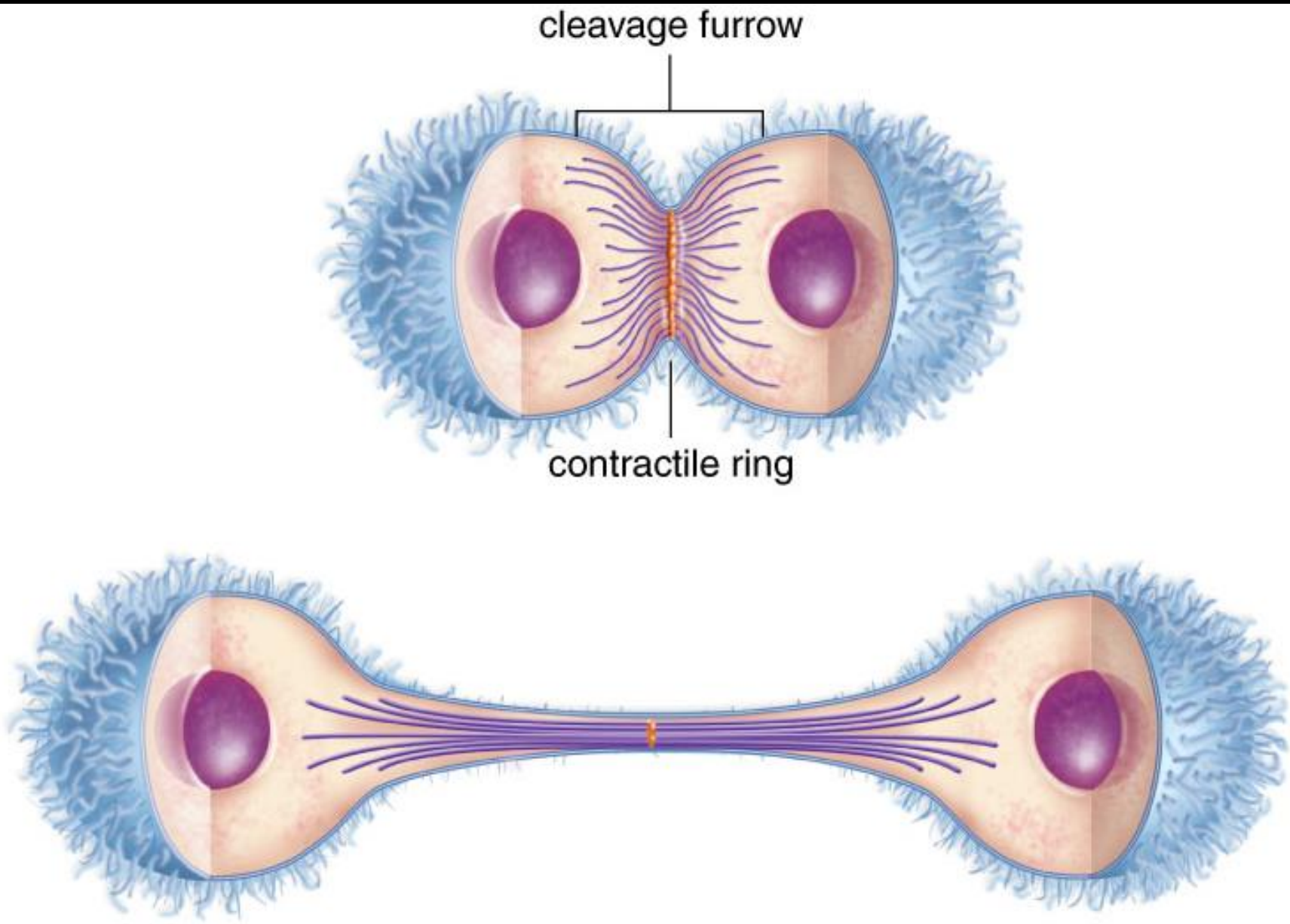


(a) Cleavage of an animal cell (SEM)

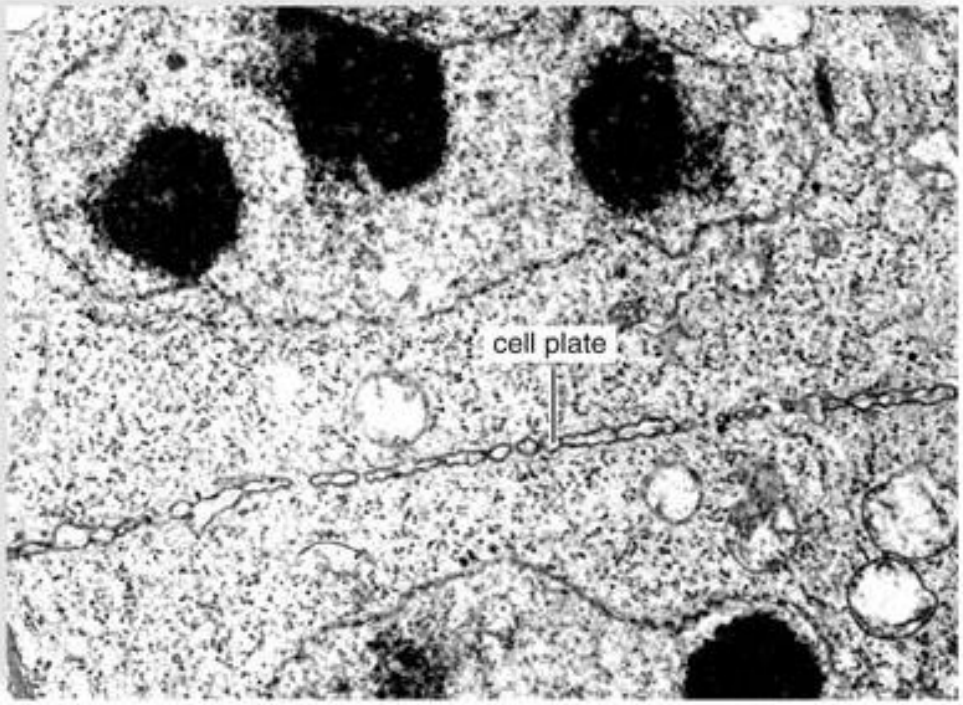


(b) Cell plate formation in a plant cell (TEM)

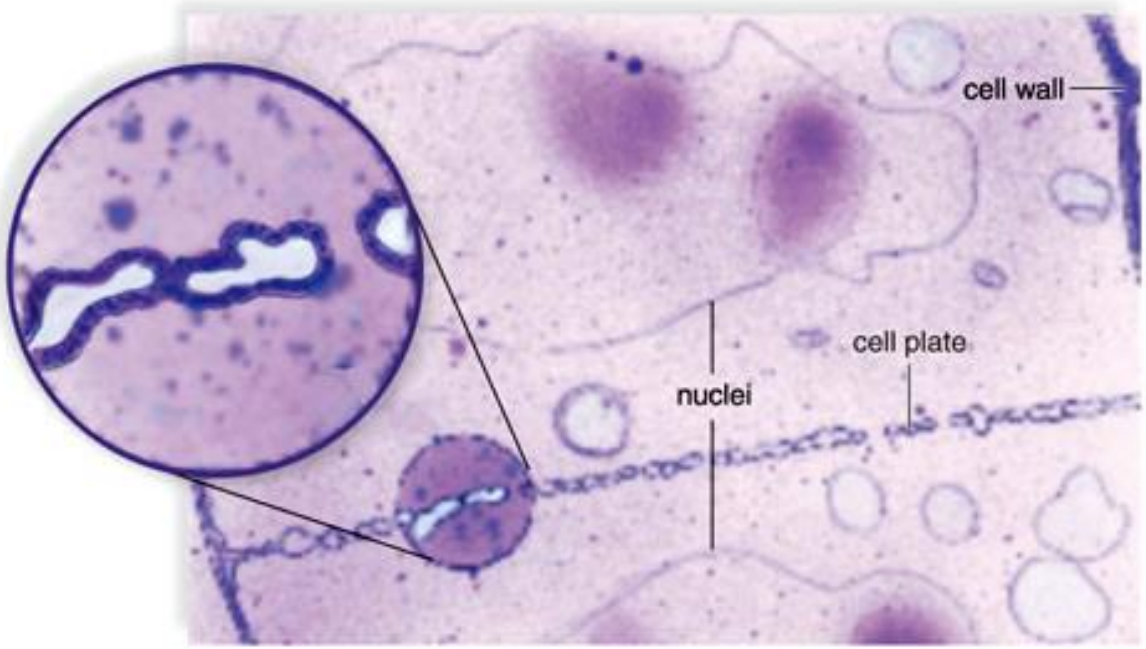
Cytokinesis in Animal Cells



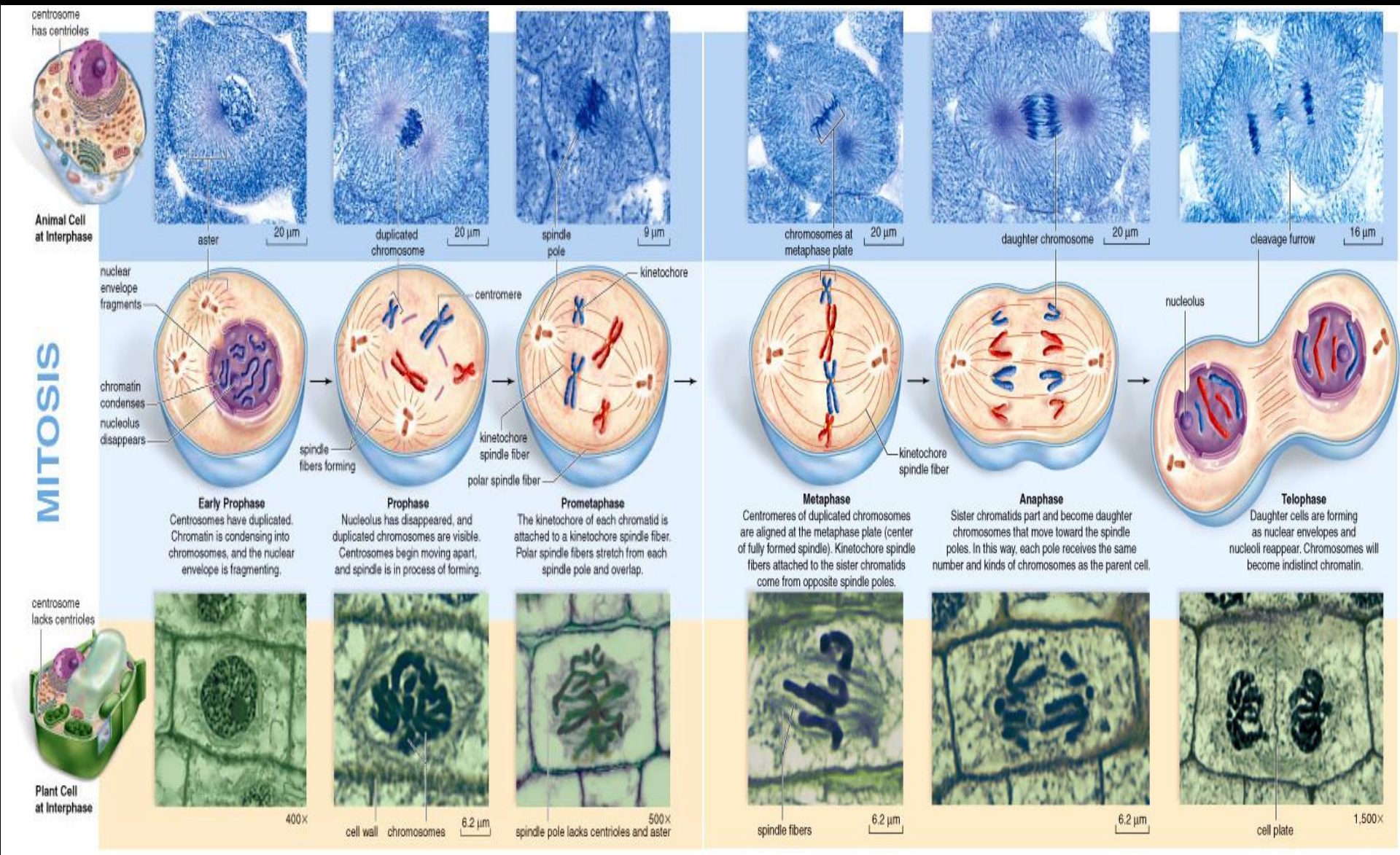
Cytokinesis in Plant Cells

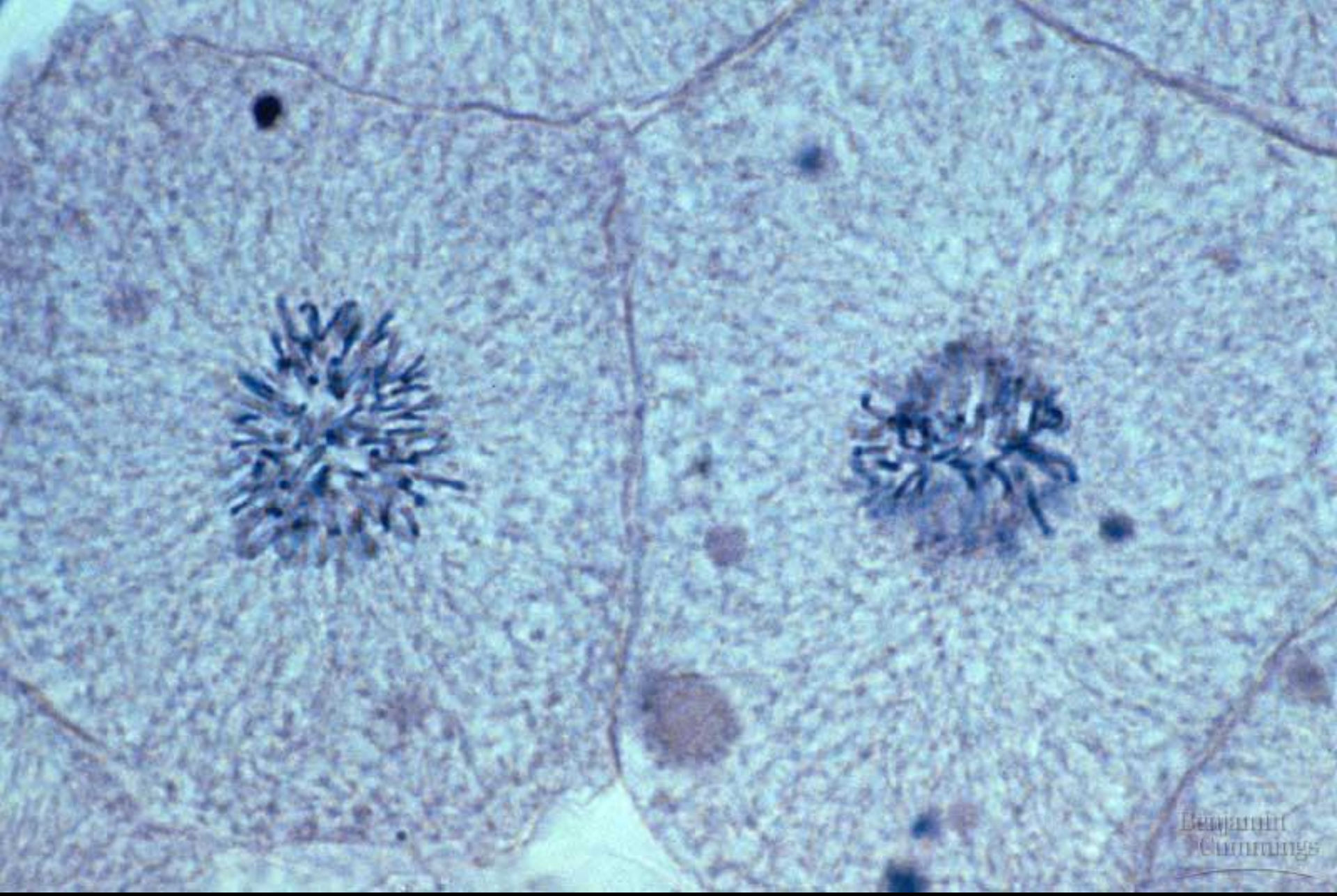


Vesicles containing cell wall components fusing to form cell plate

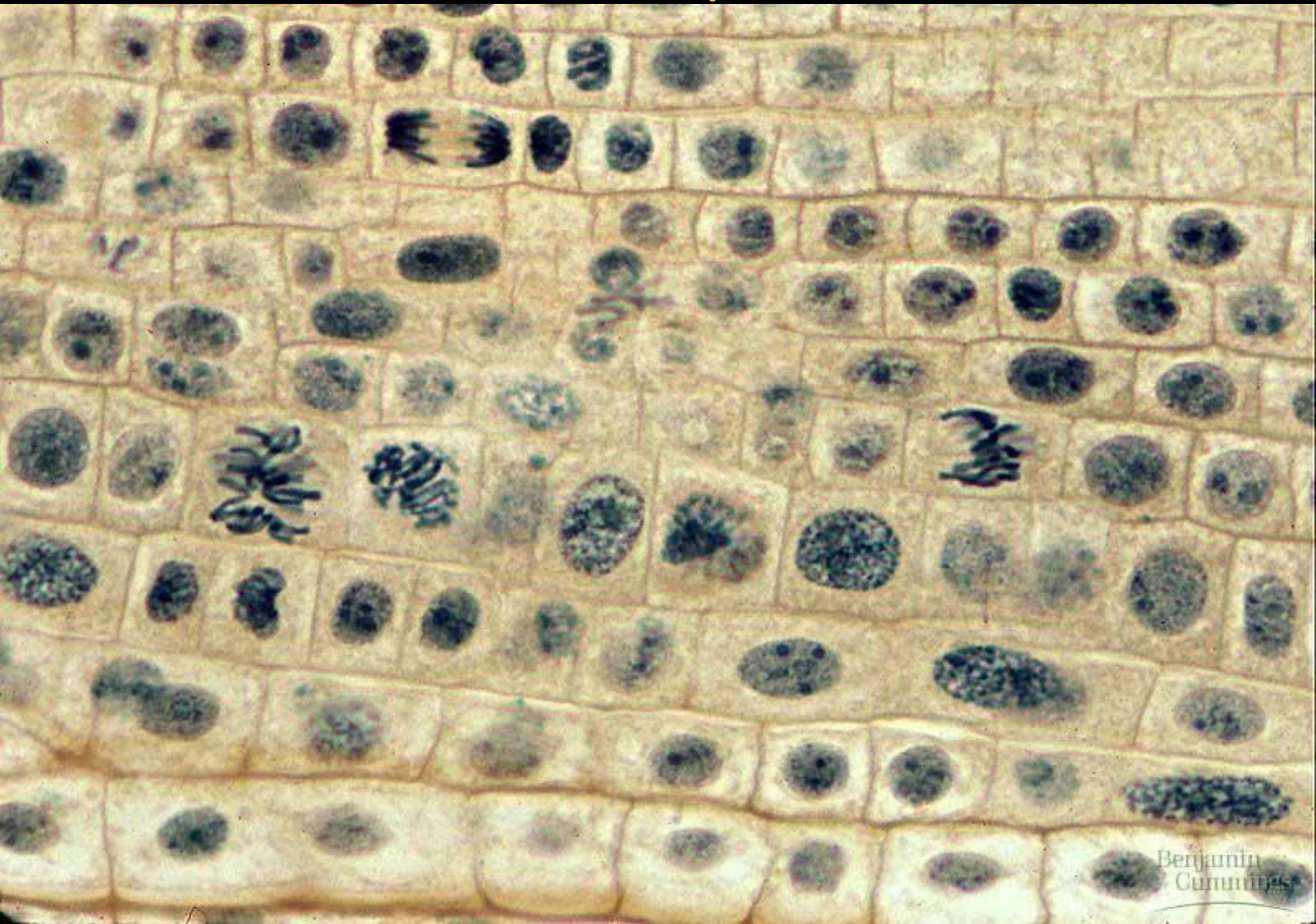


Mitosis in Animal and Plant Cells




Benjamin
Cummings

Guess that phase!



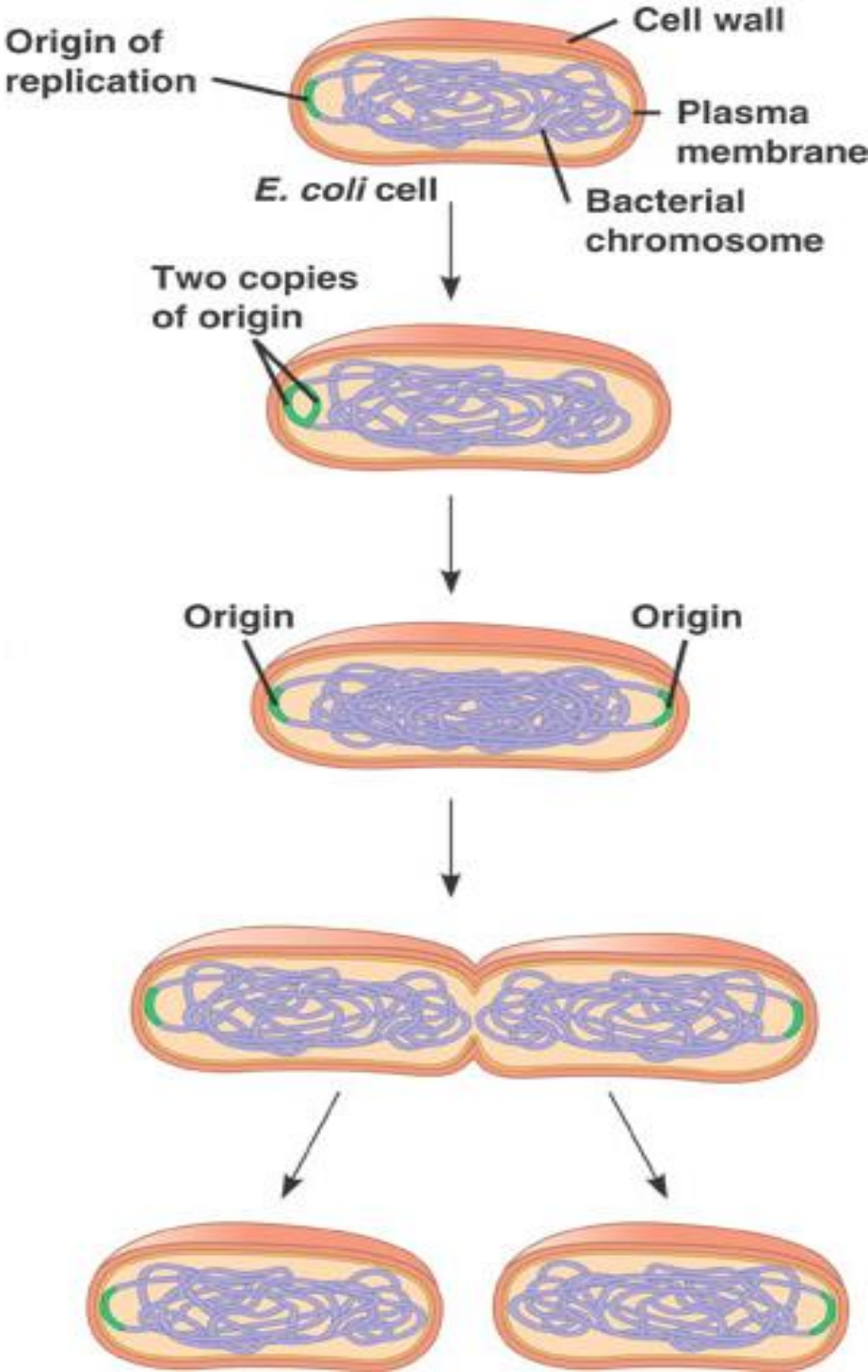
Binary Fission

Mitosis of **bacteria** results in two genetically identical offspring.

Remember, bacteria have just one circular chromosome and it is connected to the PM.

After DNA replication, the two copies of the chromosome are connected to the PM opposite sides of the cell

As the cell grows, the PM and cell form a furrow and pinch into two cells.



Binary Fission of Prokaryotes

1. Attachment of chromosome to a special plasma membrane site indicates that this bacterium is about to divide.

2. The cell is preparing for binary fission by enlarging its cell wall, plasma membrane, and overall volume.

3. DNA replication has produced two identical chromosomes. Cell wall and plasma membrane begin to grow inward.

4. As the cell elongates, the chromosomes are pulled apart. Cytoplasm is being distributed evenly.

5. New cell wall and plasma membrane has divided the daughter cells.