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• The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.

• Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.

• Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.

• Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.

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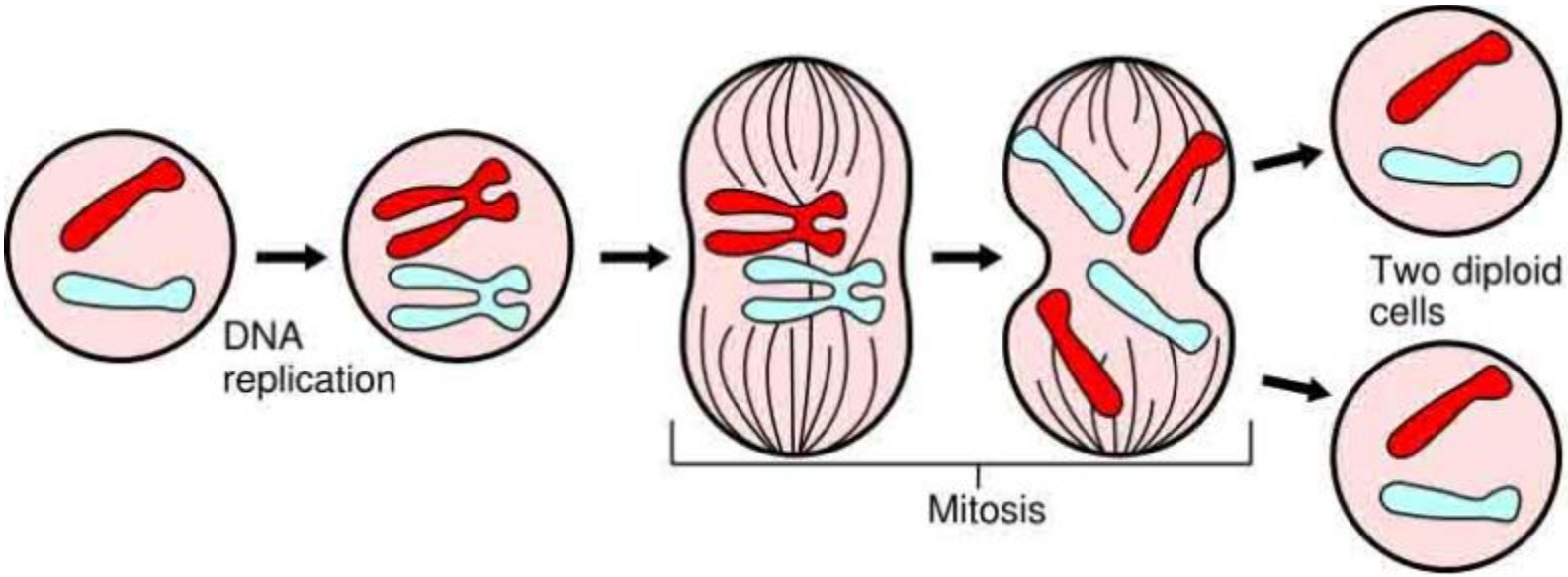
Image: Compound microscope objectives, T. Port



Genetics:
Mitotic Cell Division

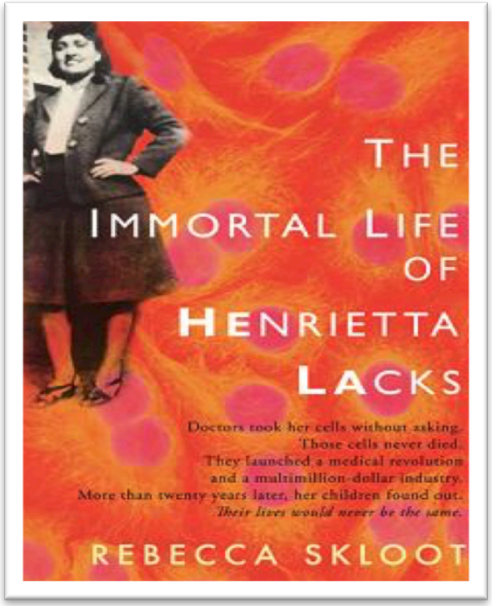
Image: Overview of Mitosis, Mysid

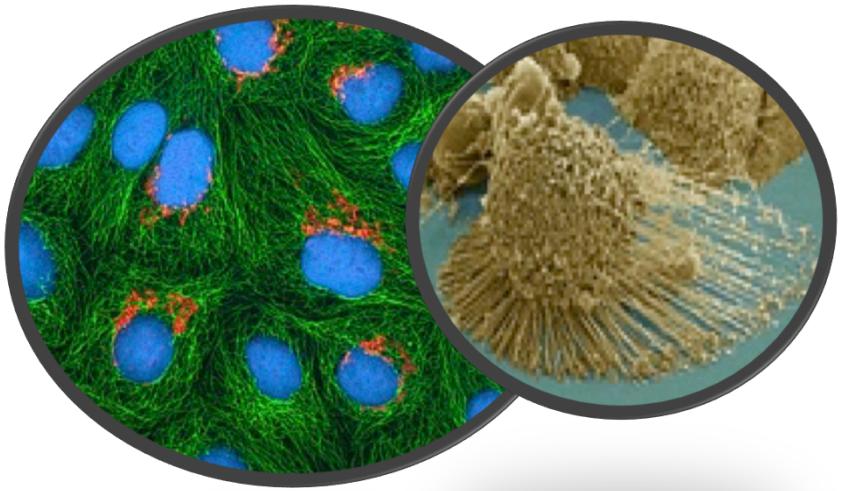
Everyday Cell Biology

Who was Henrietta Lacks and why were her cells so important to medical science?

Let's explore the amazing story of Henrietta Lacks and her immortal cells.

Q: *What does the Henrietta Lacks story have to do with mitosis?*





Watch a video of HeLa cells dividing in vitro.

Images: Book, "The Immortal Life of Henrietta Lacks by Rebecca Skloot; Apoptotic HeLa cell, Wiki; Fluorescence image of cultured HeLa cells, Wiki

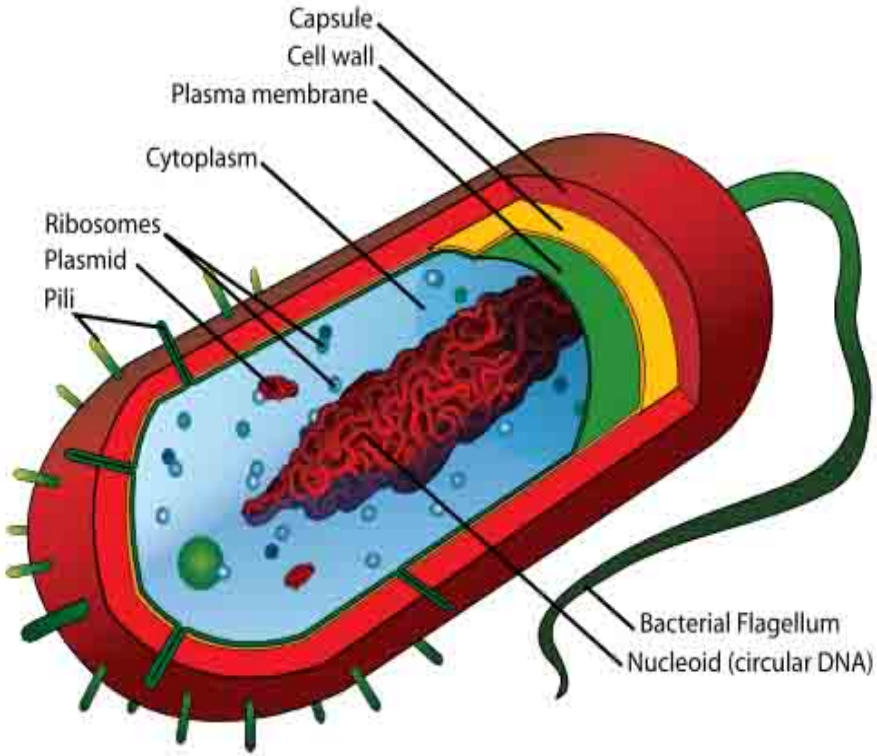
Why do cells divide?

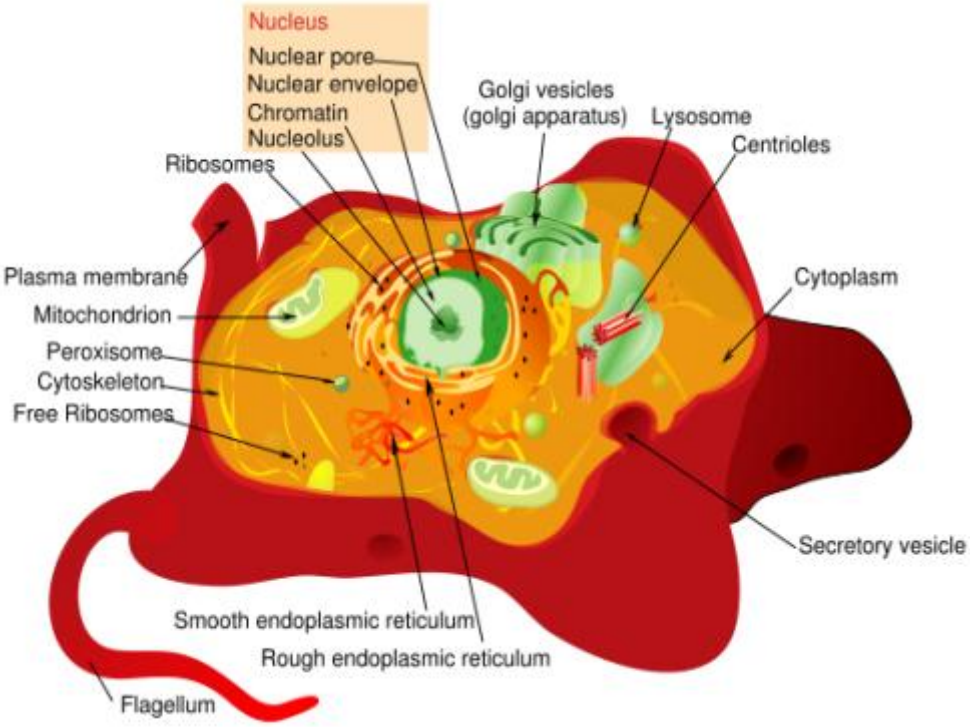
- _____
- _____
- _____
- _____

Images Ciliate dividing, TheAlphaWolfc

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Two Basic Types of Cells

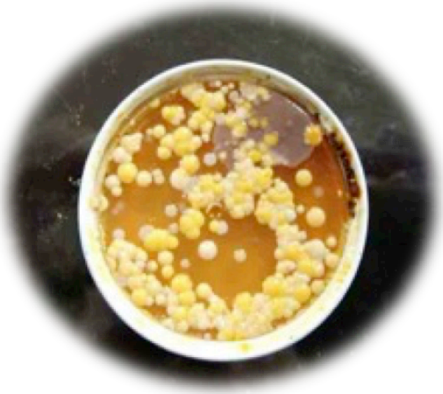




From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Images: Prokaryotic Cell Diagram & Eukaryotic Cell Diagram, M. Ruiz

Prokaryotic Cell Division:
Reproduction



- Prokaryotic chromosome is a circular loop of DNA called a **nucleoid**.

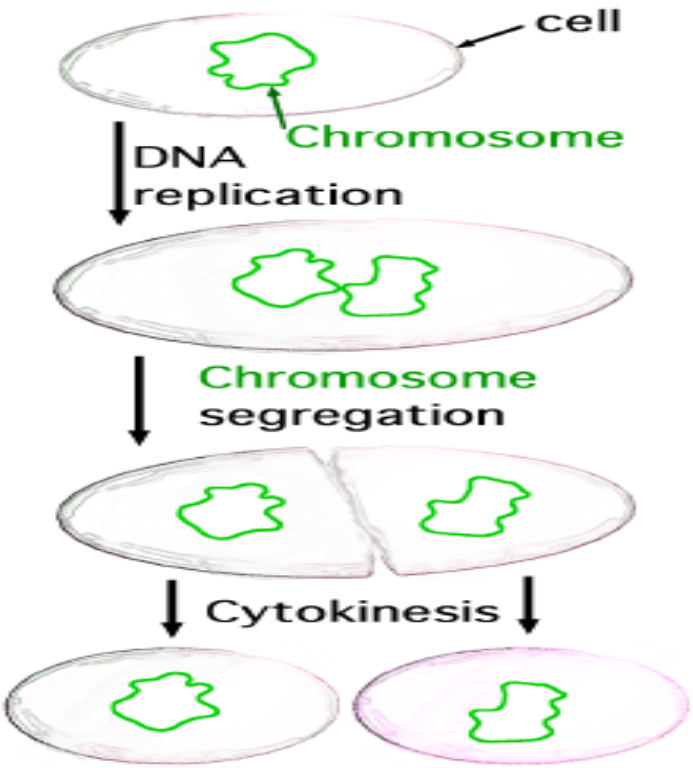
- **Q**: What is the process of prokaryotic cell division called?

1. Chromosome attaches to plasma membrane.

2. Chromosome is replicated.

3. Cell elongates; new plasma membrane and cell wall are added between chromosomes, pushing them towards opposite ends of cell.

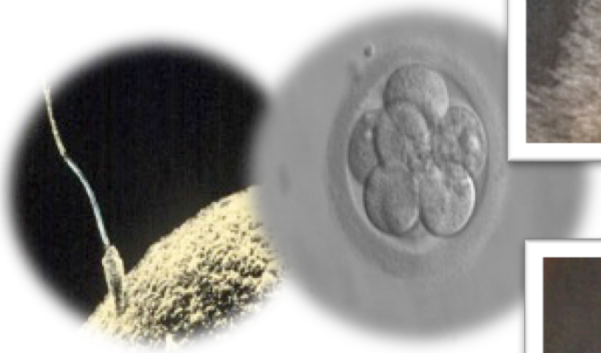
4. Parent cell is divided into two identical daughter cells.

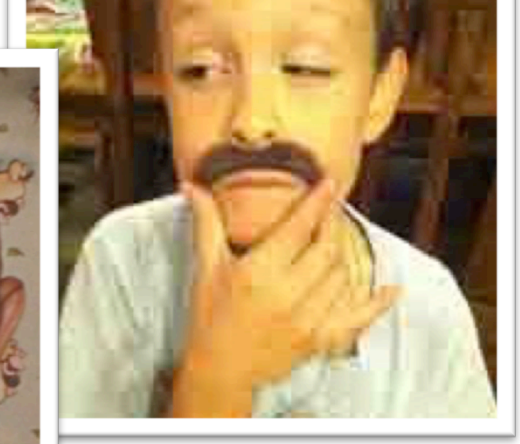


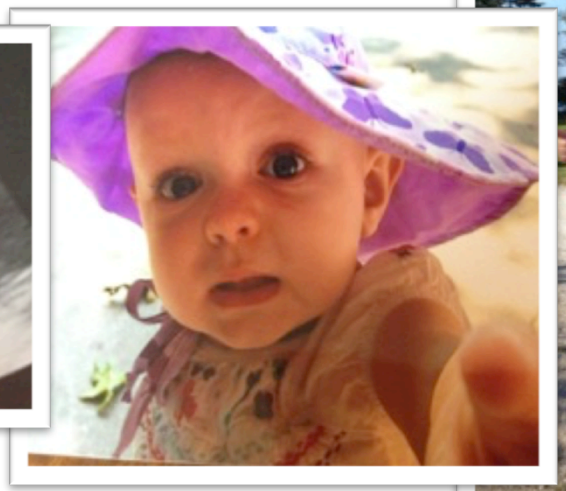
Images: Bacterial colonies on MacConkey's agar, T Port; Bacterial colonies on arm plate, TP ort Binary Fission, JW Schmidt

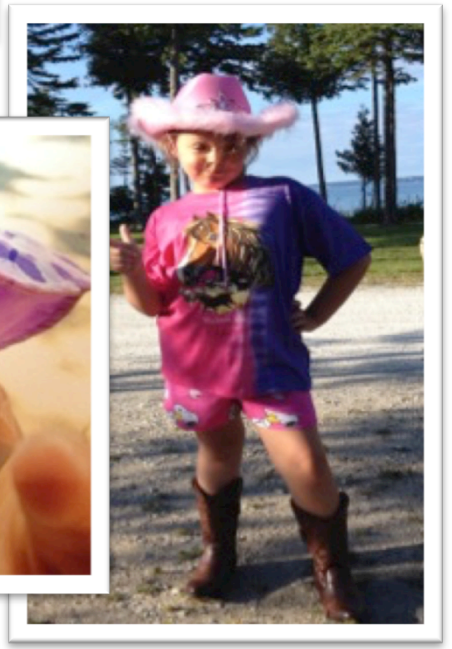
Eukaryotic Cell Division:

Growth, Development, Repair, Reproduction









Images: Sperm & egg, Wikipedia;; Morula, Wiki; My son and daughter, T. Port

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

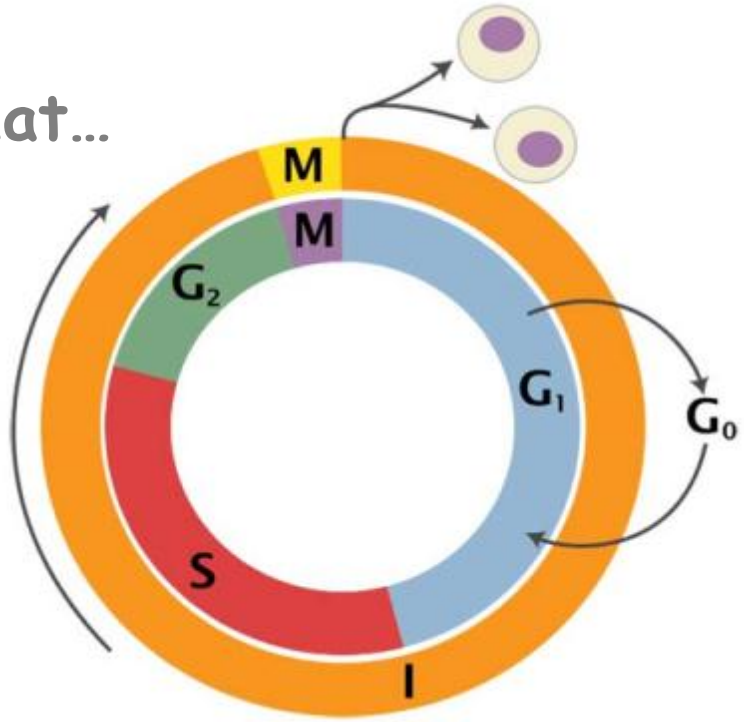
Eukaryotic Cell Cycle

Like prokaryotic cell cycle, in that…

- Cell grows.

- DNA is replicated.

- Mitotic cell division produces daughter cell identical to the parent.



Different from prokaryotic cell cycle, in that…

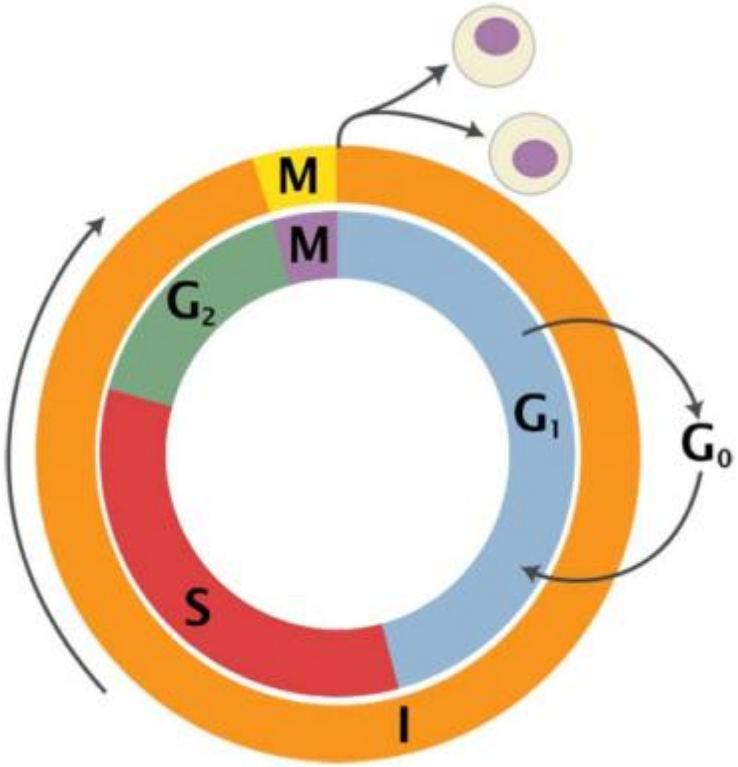
- Eukaryotic cells have more DNA on many linear chromosomes.
(Q: How many do humans have?).

- The timing of replication and cell division is highly regulated.

Image: Cell cycle by Richard Wheeler

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Eukaryotic Cell Cycle



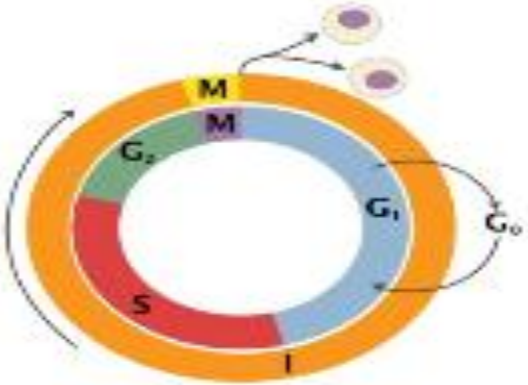
2 major phases:

- _____ (3 stages)
  - DNA uncondensed

- _____ (4 stages + cytokinesis)
  - Nuclear division & division of cytoplasm
  - DNA condensed

Image: Cell cycle by Richard Wheeler

From the Virtual Cell Biology Classroom on ScienceProfOnline.com



Interphase

Non-dividing state With 3 sub-stages:

___ – cell grows in size
– organelles replicated

___ – replication of DNA
– synthesis of proteins associated with DNA

___ – synthesis of proteins associated with mitosis

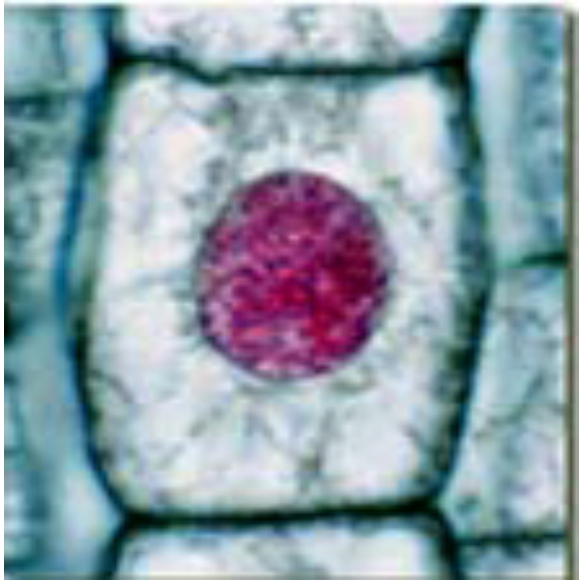
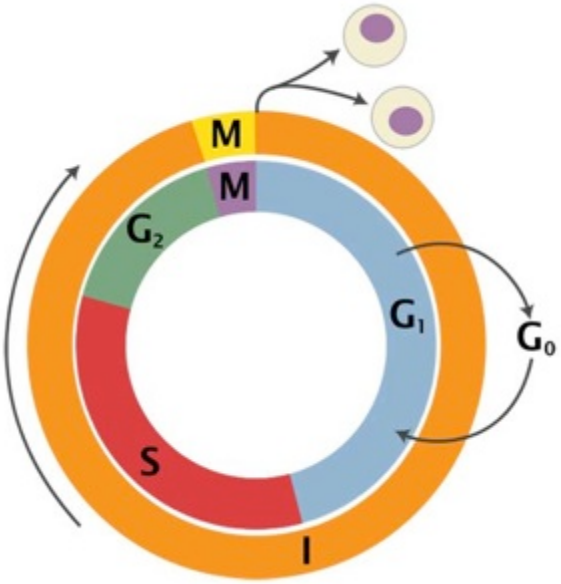


Image: Cell cycle by Richard Wheeler; Interphase in Onion Cell Drawing & Photo, Source Unknown

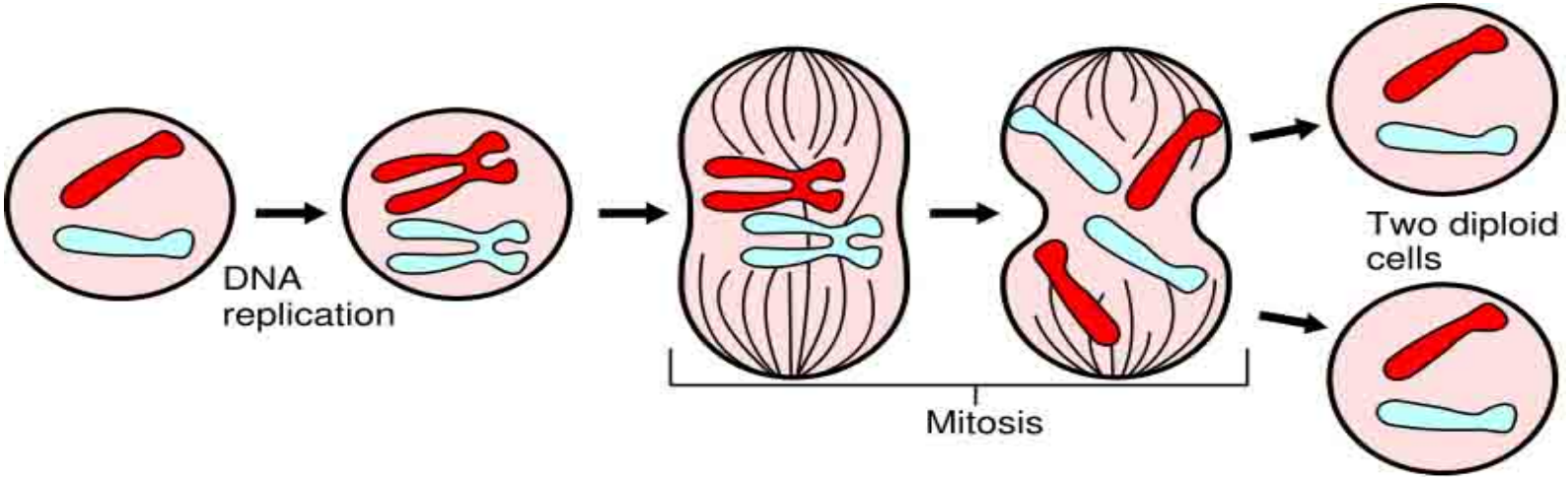
Mitosis



Division of **somatic** cells (non-reproductive cells) in eukaryotic organisms.

A single cell divides into two identical daughter cells.

Daughter cells have same # of chromosomes as does parent cell.



Images: Cell cycle by Richard Wheeler; Overview of Mitosis, Mysid

What is cell division of reproductive cells?

Meiosis

- A single germ cell divides into four unique daughter cells.

- Daughter cells have half the # of chromosomes as parent cell.

- We will discuss meiosis in out next lecture. **Now, back to mitosis…**

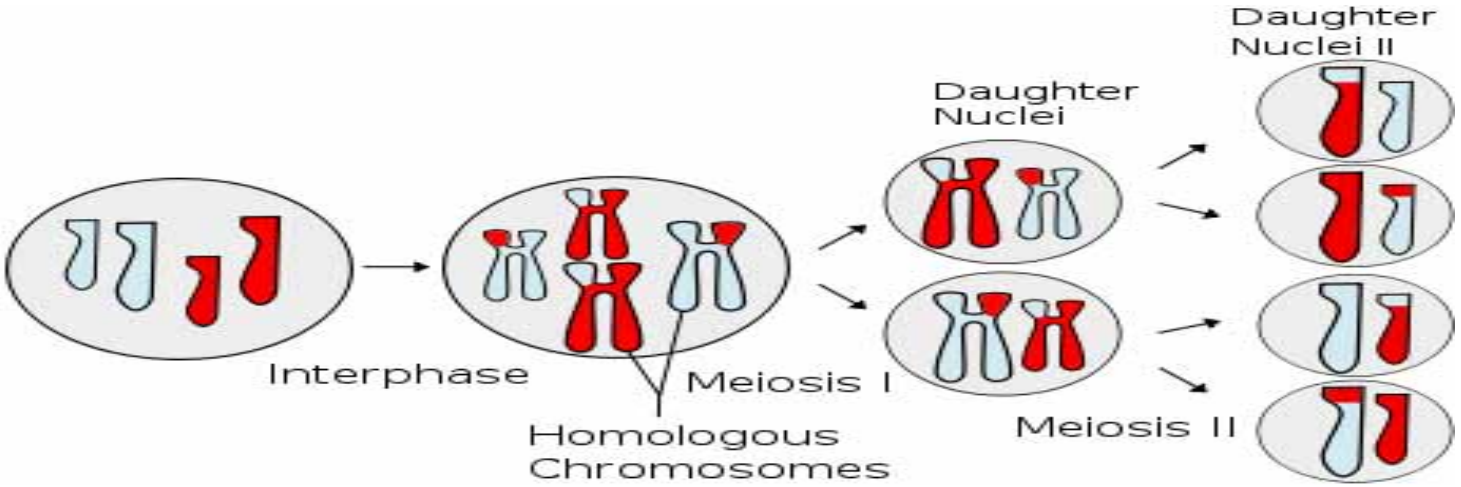


Image: Overview of Meiosis, National Institutes of Health

Packing for the move…

When cell is not dividing…

- DNA molecules in extended, uncondensed form = **chromatin**

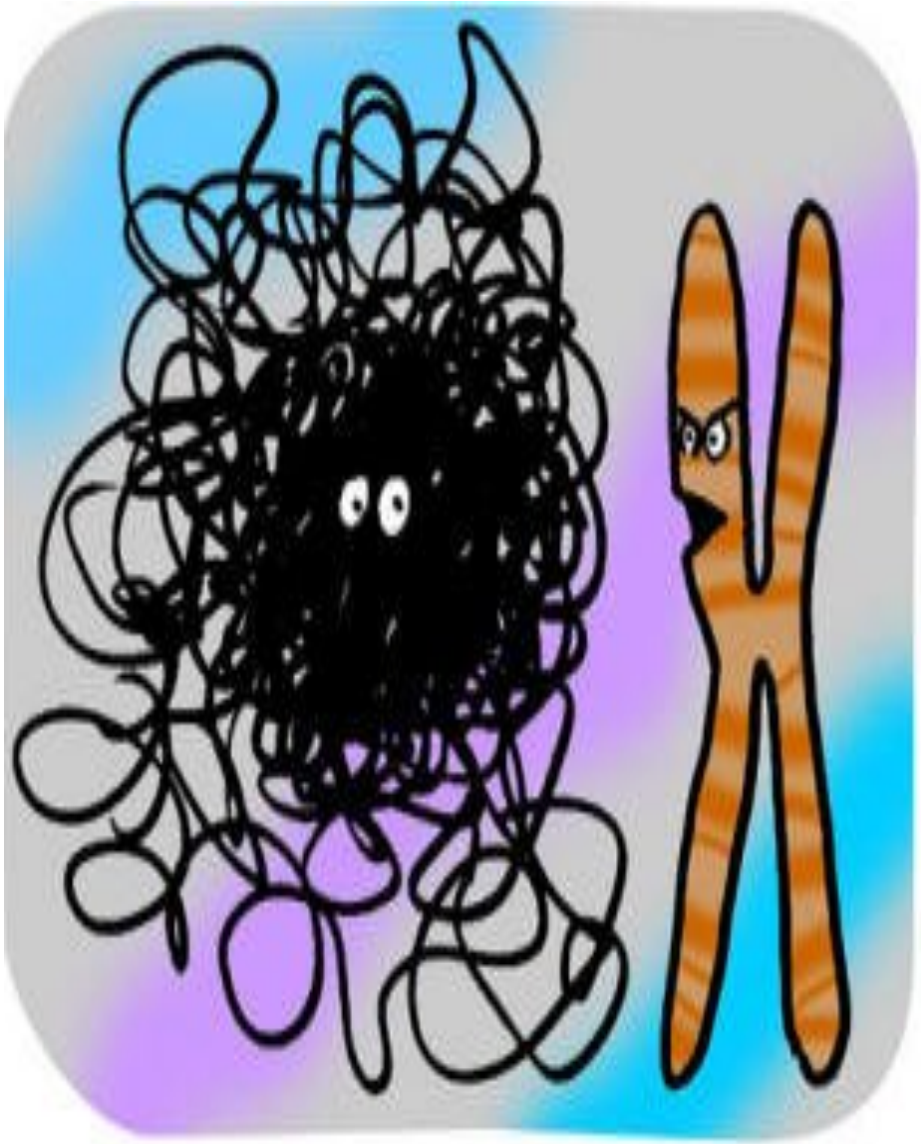
- Cell can only replicate and transcribe DNA when in extended state.

When cell is preparing for division…

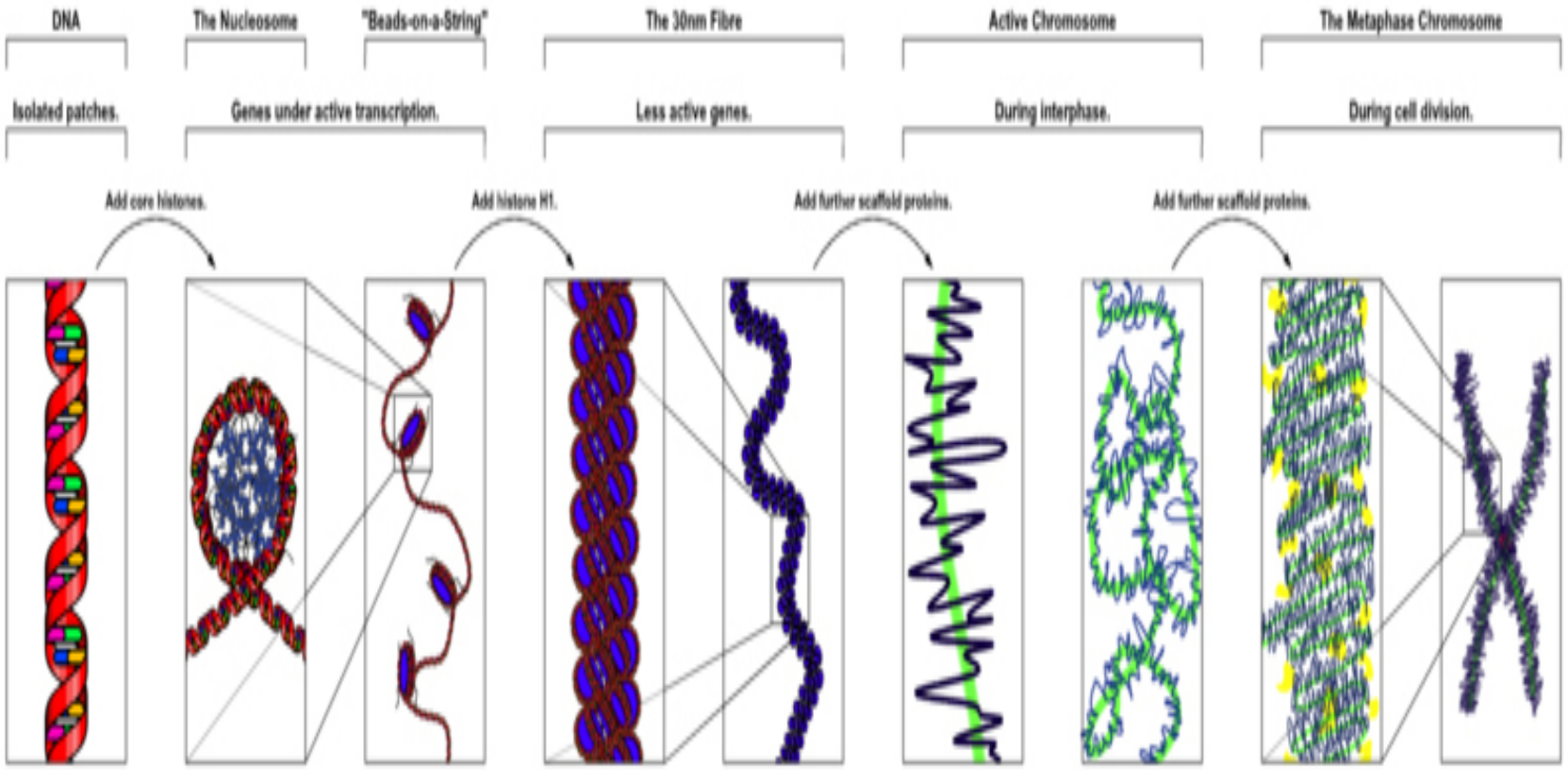
- DNA molecules condense to form **chromosomes** prior to division.

– each chromosome is a single molecule of DNA

– easier to sort and organize the replicated DNA into daughter cells



Packing for the move…



From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Image: Chromatin structures, Zephyris

Mitosis

4 sub-phases:

1st – Prophase

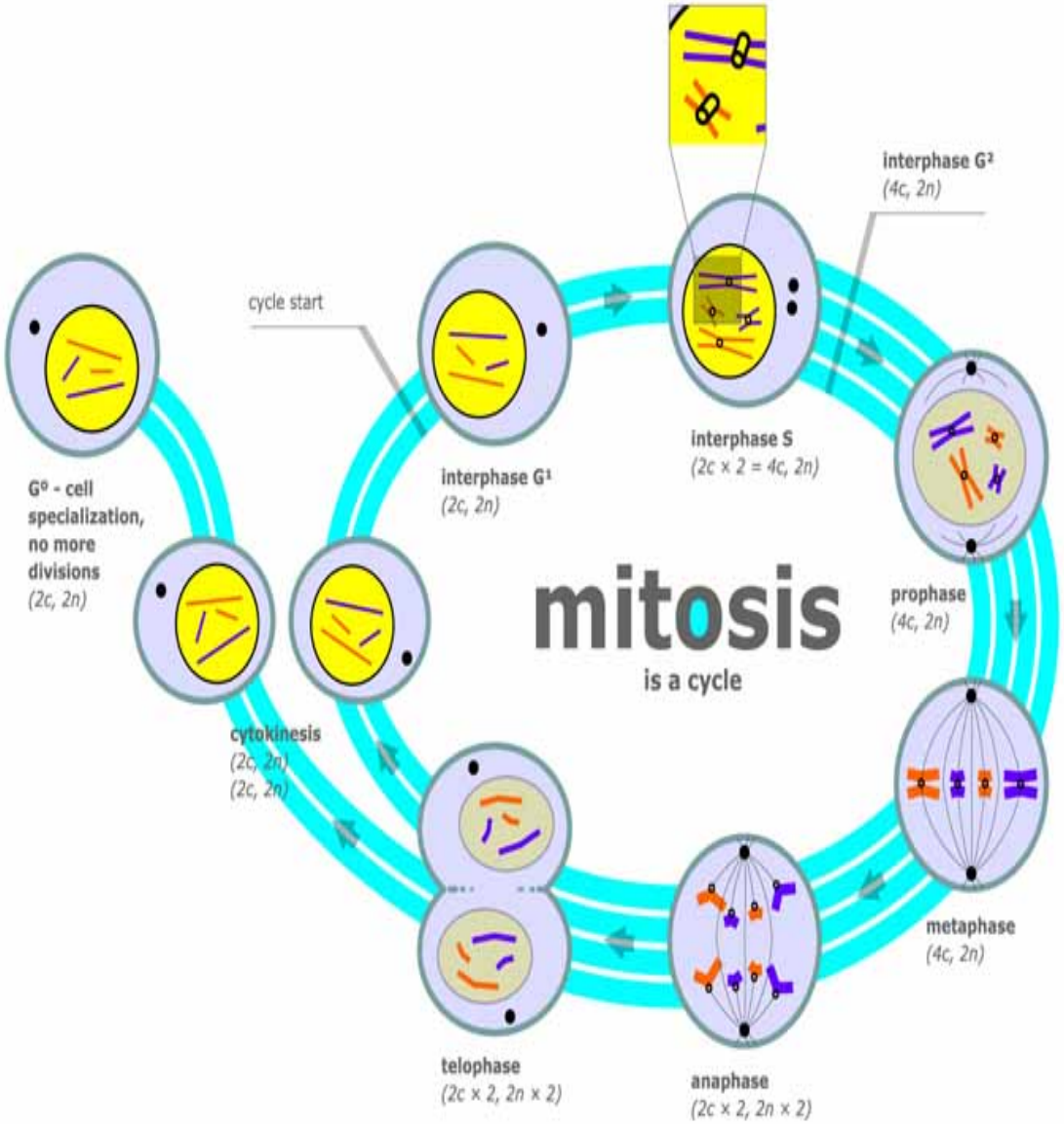
2nd – Metaphase

3rd – Anaphase

4th – Telophase

followed by

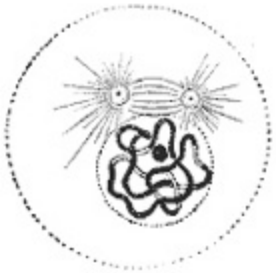
Cytokinesis



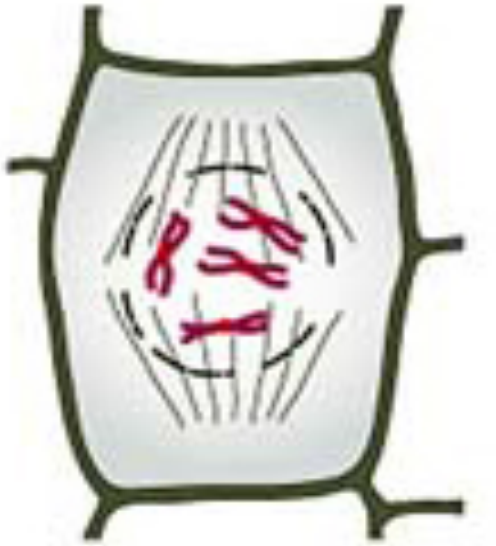
Secret to remembering phases in order…

Image: Mitosis diagram, Marek Kultys

From the Virtual Cell Biology Classroom on ScienceProfOnline.com



1. Prophase



3 Major Events

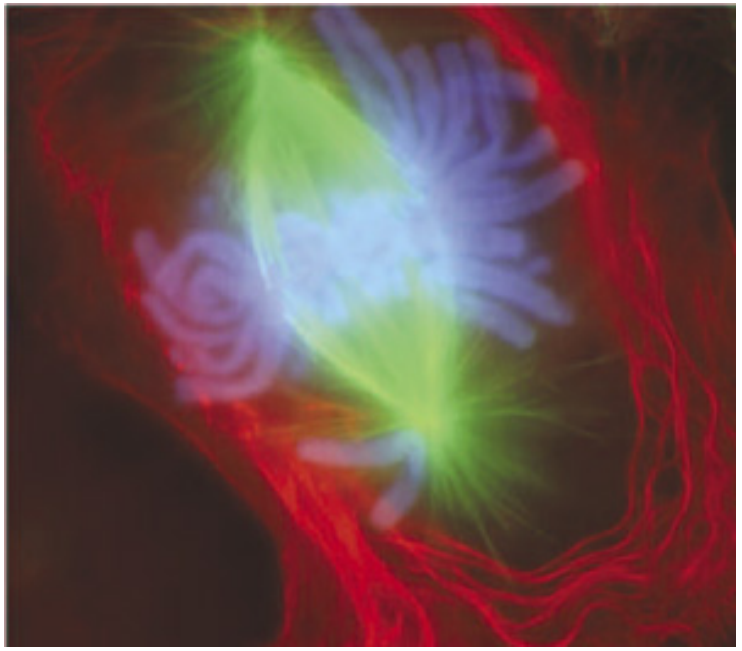
- chromosomes condense

- spindle fibers form

- chromosomes are captured by spindle

Images: Prophase drawing, Henry Gray's Anatomy of the Human Body; Prophase Onion Cell Drawing & Photo, Source Unknown

Mitotic Spindle Forms

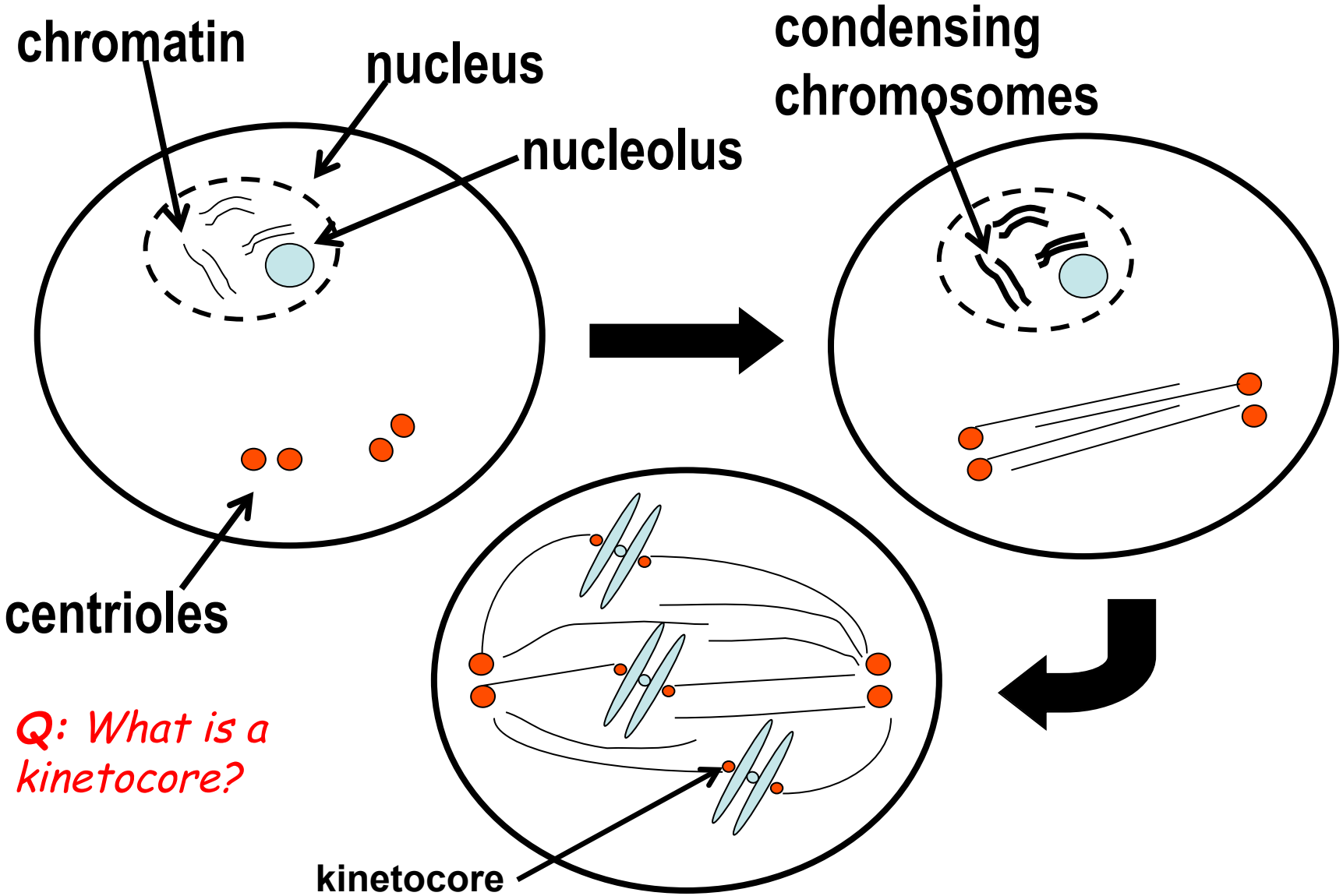


Fluoresced eukaryotic cell. Chromosomes in blue. Mitotic spindle apparatus in green.

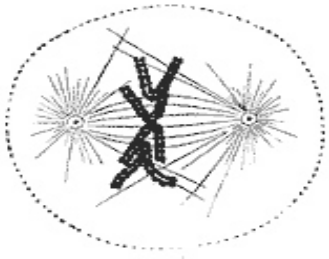
- spindle fibers are specialized **microtubules**
  - spindle fibers radiate out from **centrioles**, forming the "aster"
    - centrioles occur in pairs, and are duplicated during interphase

Image: Fluoresced cell, National Institutes of Health

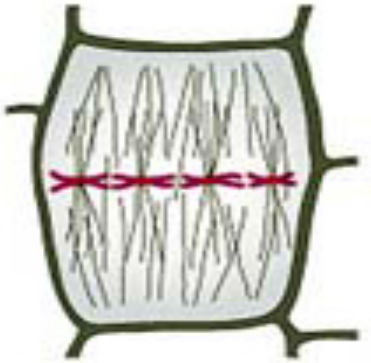
Prophase



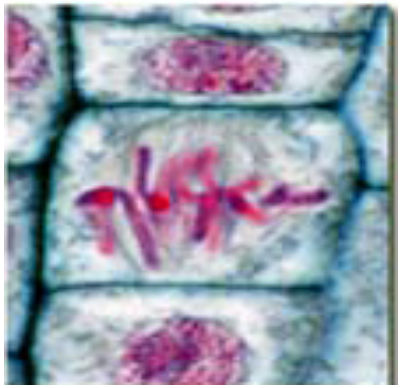
Q: What is a kinetocore?

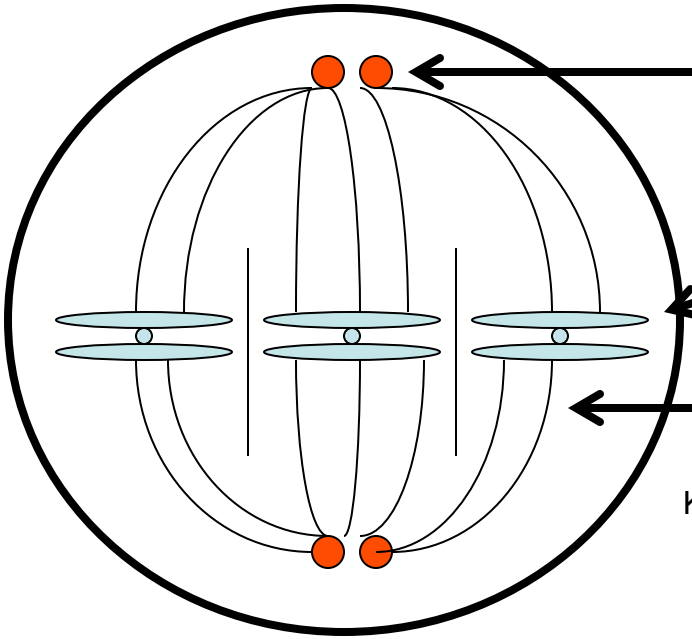


2. Metaphase



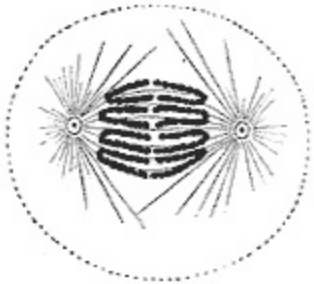
- chromosomes align along equator of the cell, with one kinetochore facing each pole



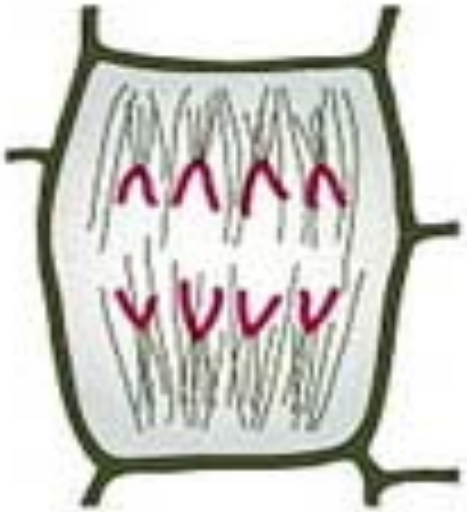


Kinetocores not pictured in this illustration.

Images: Metaphase drawing, Henry Gray's Anatomy of the Human Body; Metaphase Onion Cell Drawing & Photo, Source Unknown

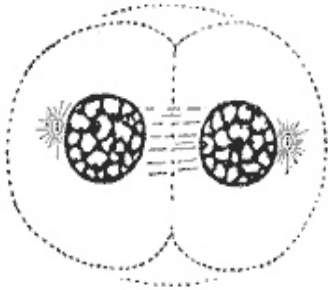


3. Anaphase



- sister chromatids separate
- spindle fibers attached to kinetochores **shorten** and **pull** chromatids towards the poles.
- free spindle fibers **lengthen** and **push** poles of cell apart

Images: Anaphase drawing, Henry Gray's Anatomy of the Human Body; Anaphase Onion Cell Drawing & Photo, Source Unknown



4. Telophase

- spindle fibers disintegrate

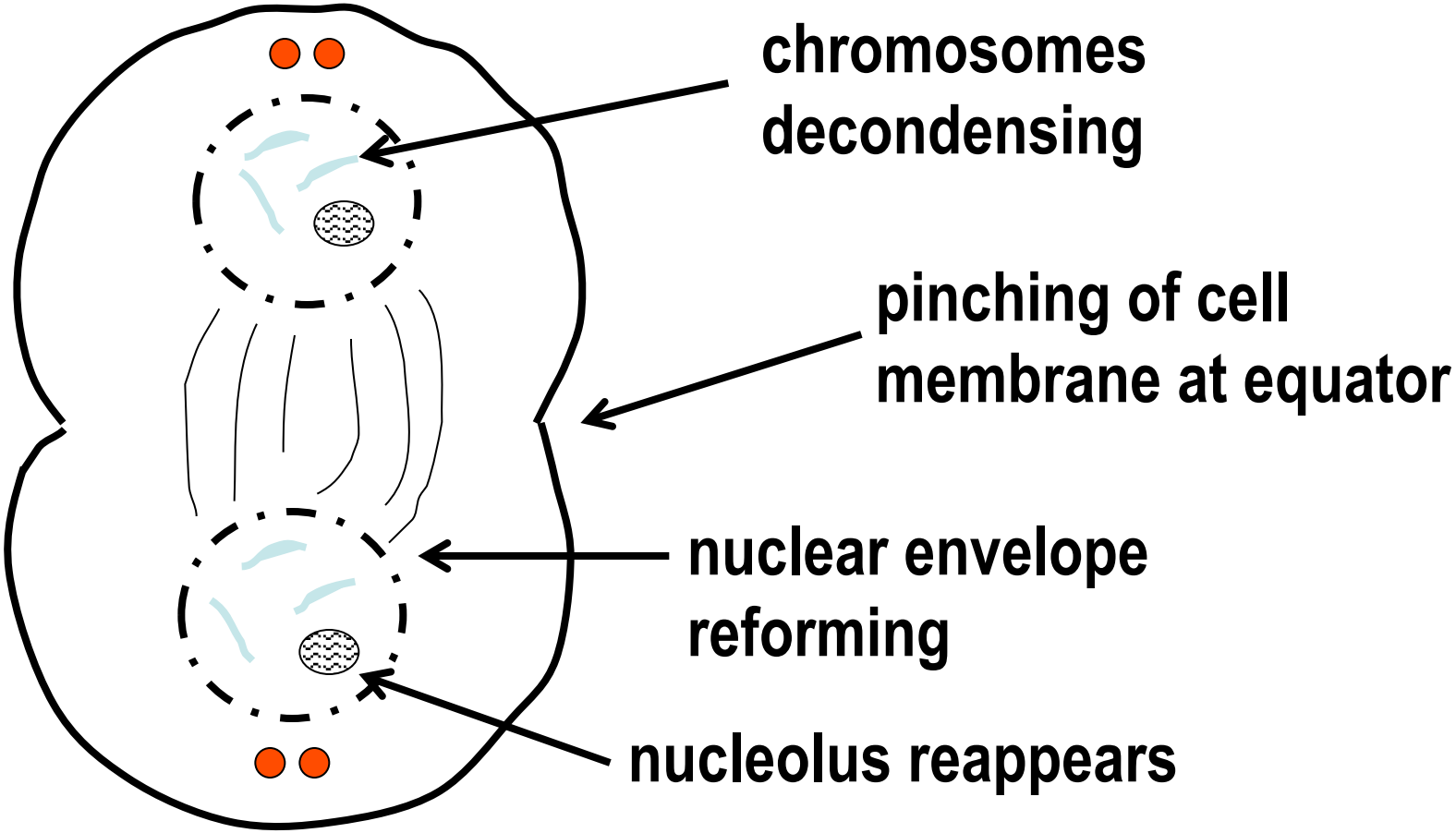
- nuclear envelopes form around both groups of chromosomes

- chromosomes revert to their extended state

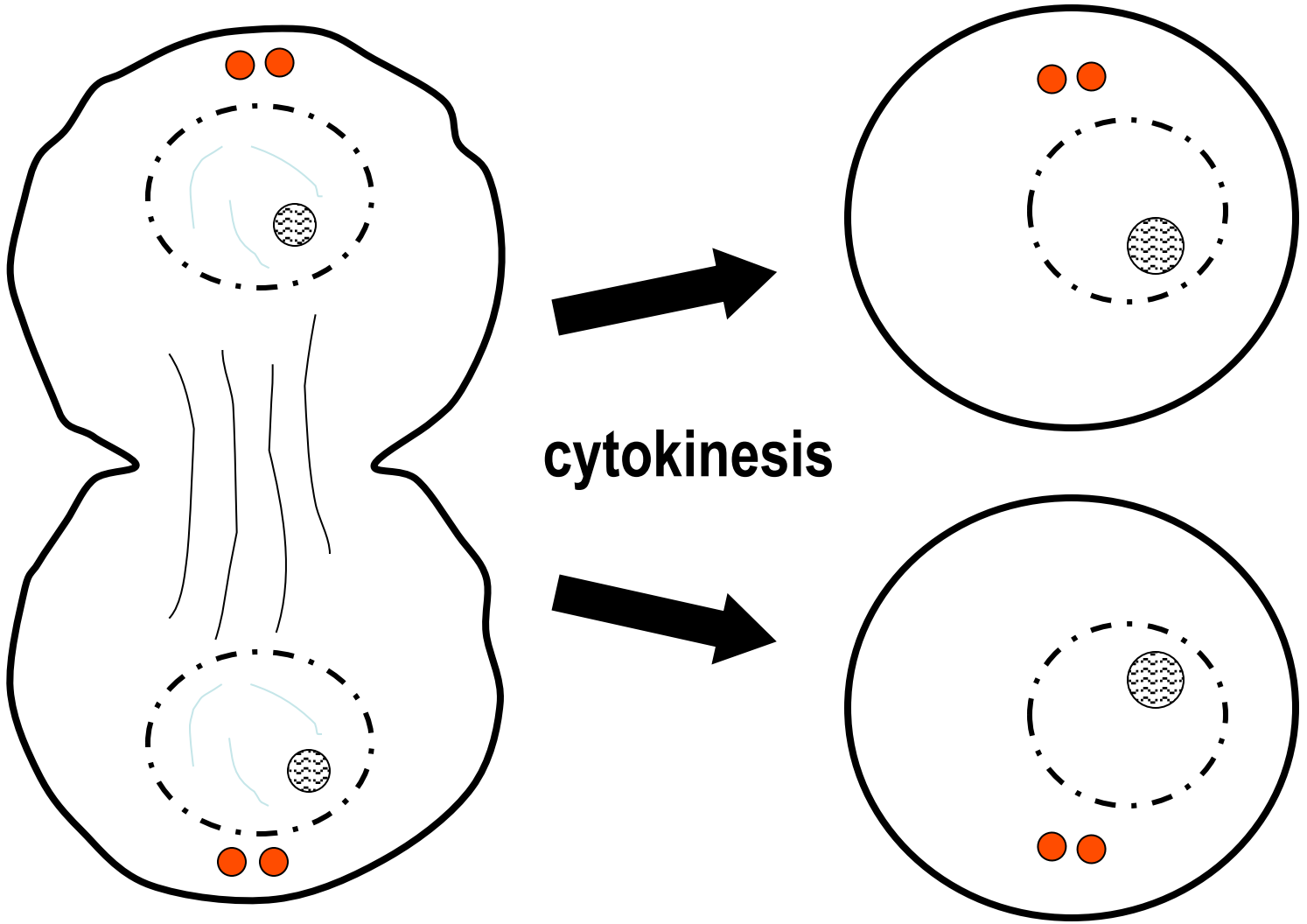
- cytokinesis occurs, enclosing each daughter nucleus into a separate cell

Images: Telophase drawing, Henry Gray's Anatomy of the Human Body; Telophase Onion Cell Drawing & Photo, Source Unknown

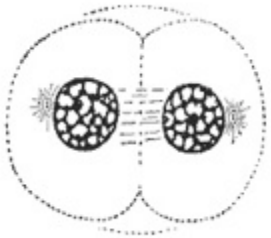
Early Telophase



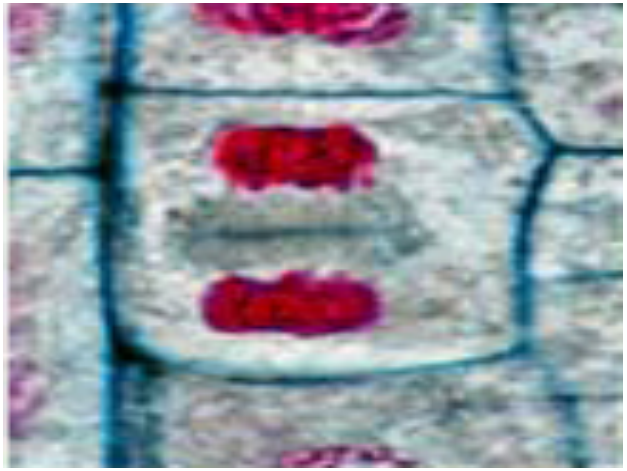
Nucleolus = Small, round site within nucleus, composed of protein & RNA. Involved in ribosomal RNA synthesis & formation of ribosomes.



Late Telophase



Cytokinesis – Plant vs. Animal Cell

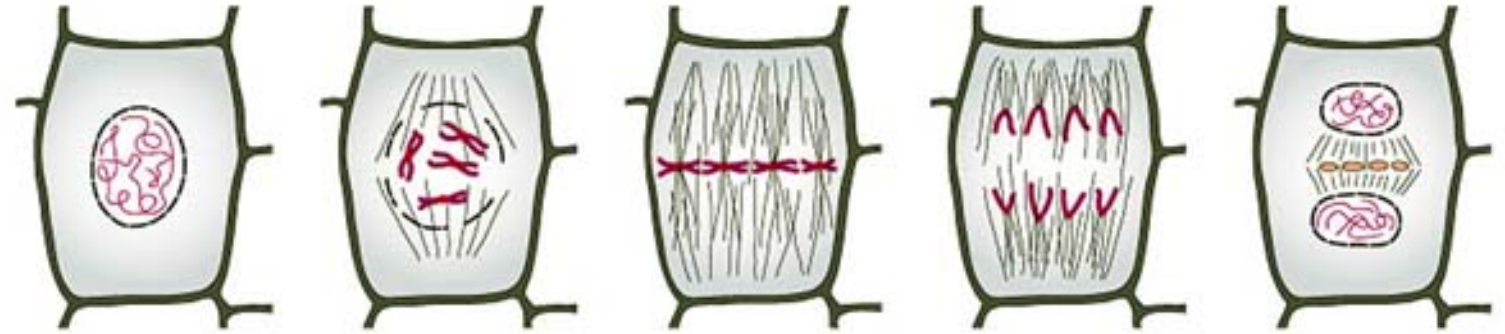


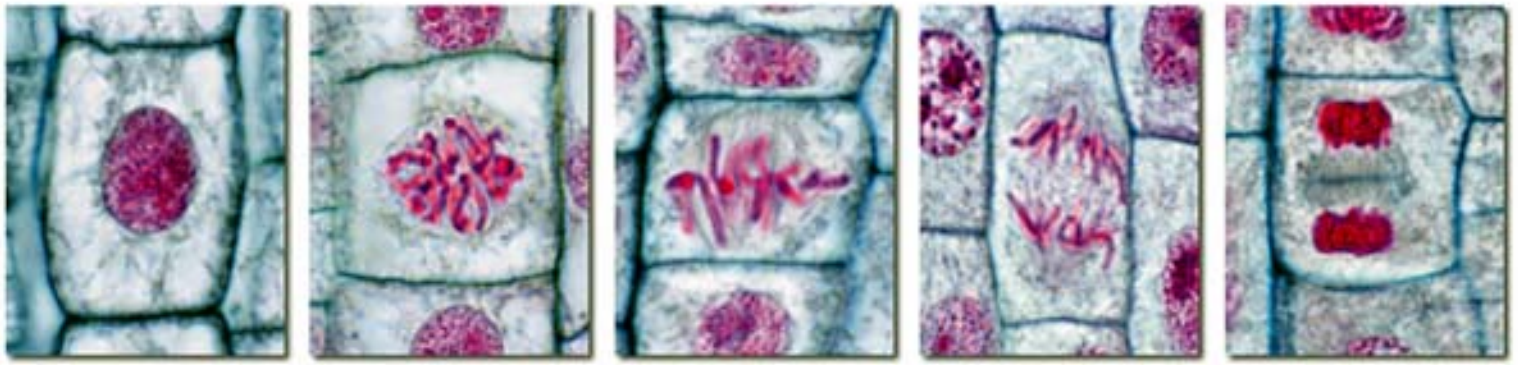
- **Plant cells** undergo cytokinesis by forming a cell plate between the two daughter nuclei.

- **Animal cells** undergo cytokinesis through the formation of a cleavage furrow. A ring of microtubules contract, pinching the cell in half.

Images: Telophase drawing, Henry Gray's Anatomy of the Human Body; Ciliate dividing, TheAlphaWolf; Telophase Onion Cell Photo, Source Unknown

Stages of Mitosis



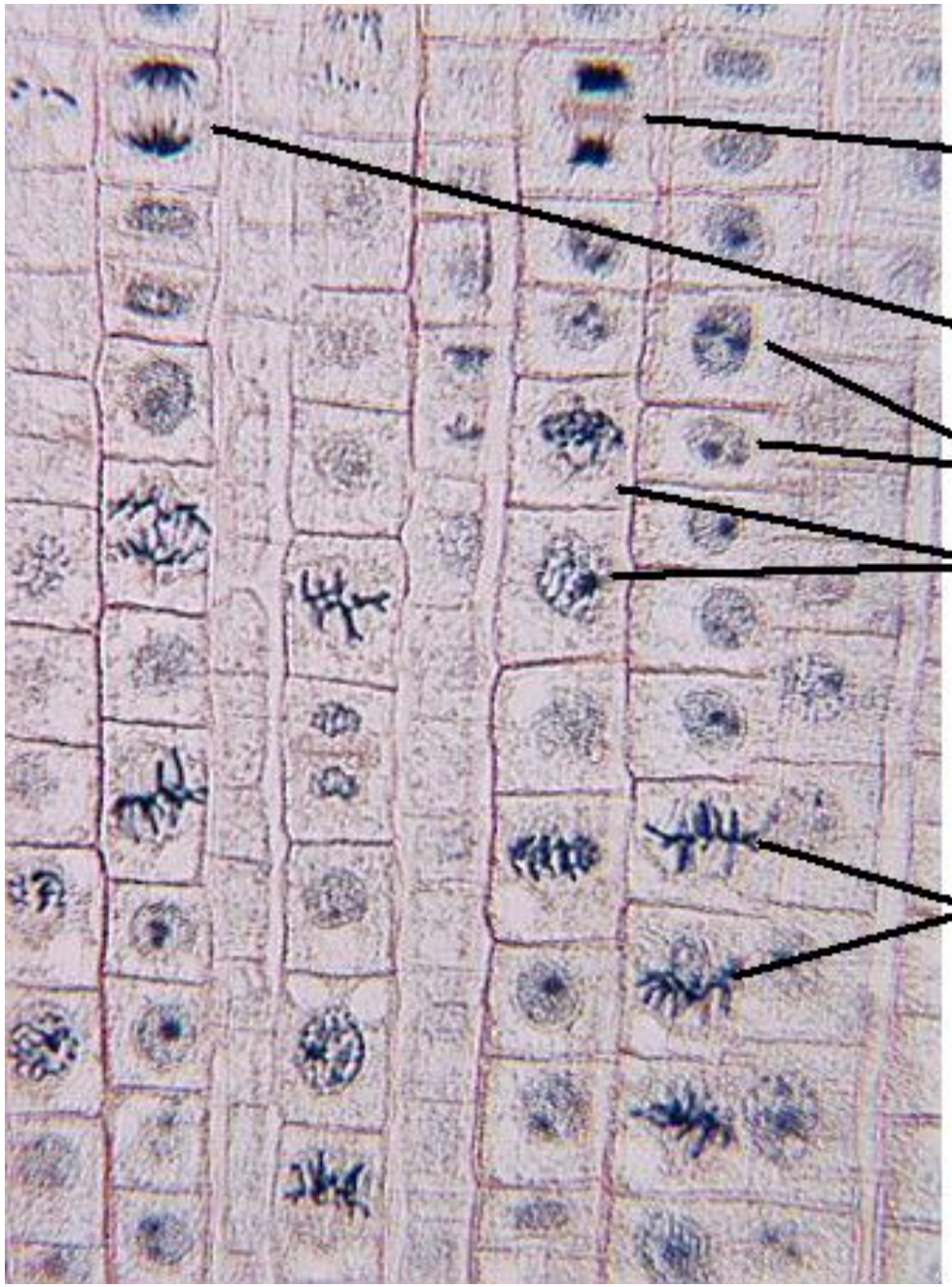


REVIEW!

Mitosis Animations

1. Mitosis & Cytokinesis from McGraw-Hill
2. Mitosis Interactive Animation from Cells Alive

Image: Onion Cell Drawing & Photo, Source Unknown

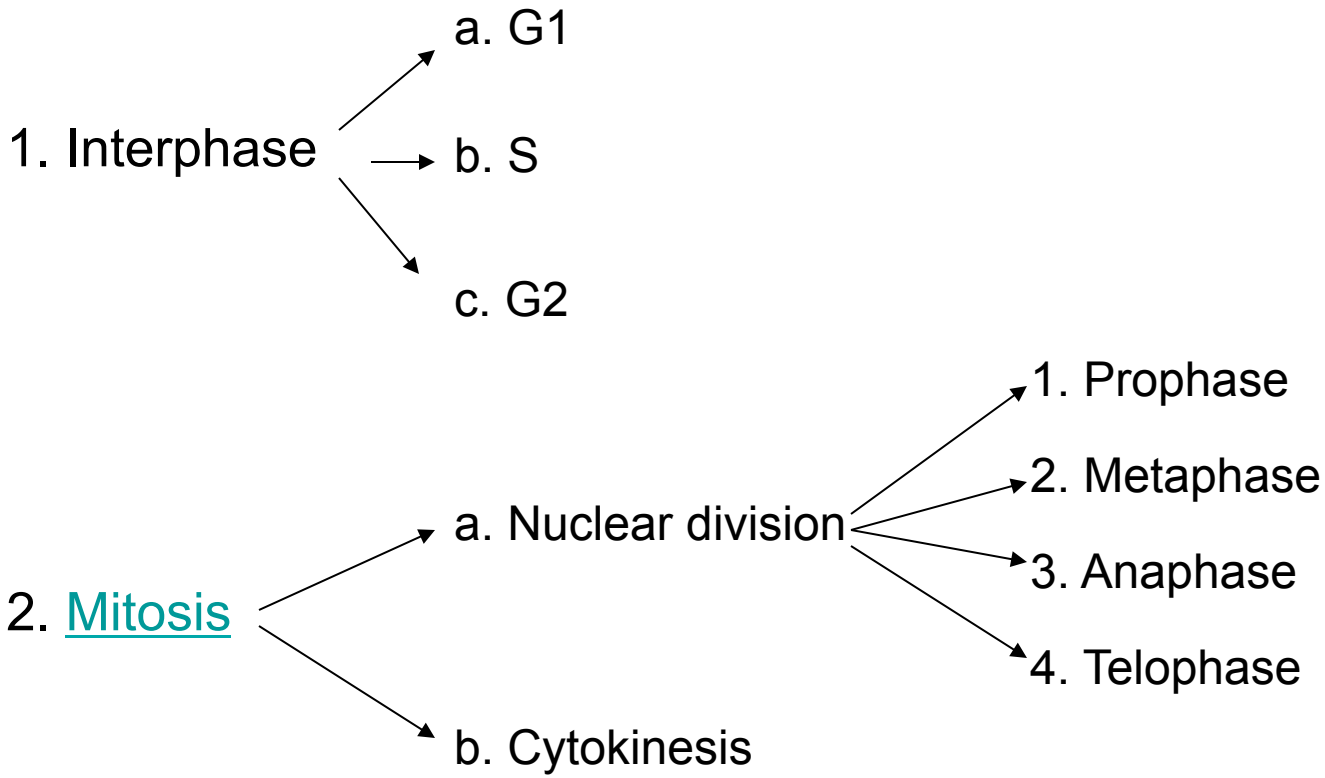


Lets play…

"Guess That Phase!"

Image: Onion Cells Photo, Source Unknown

Phases and Sub-phases of Cell Division

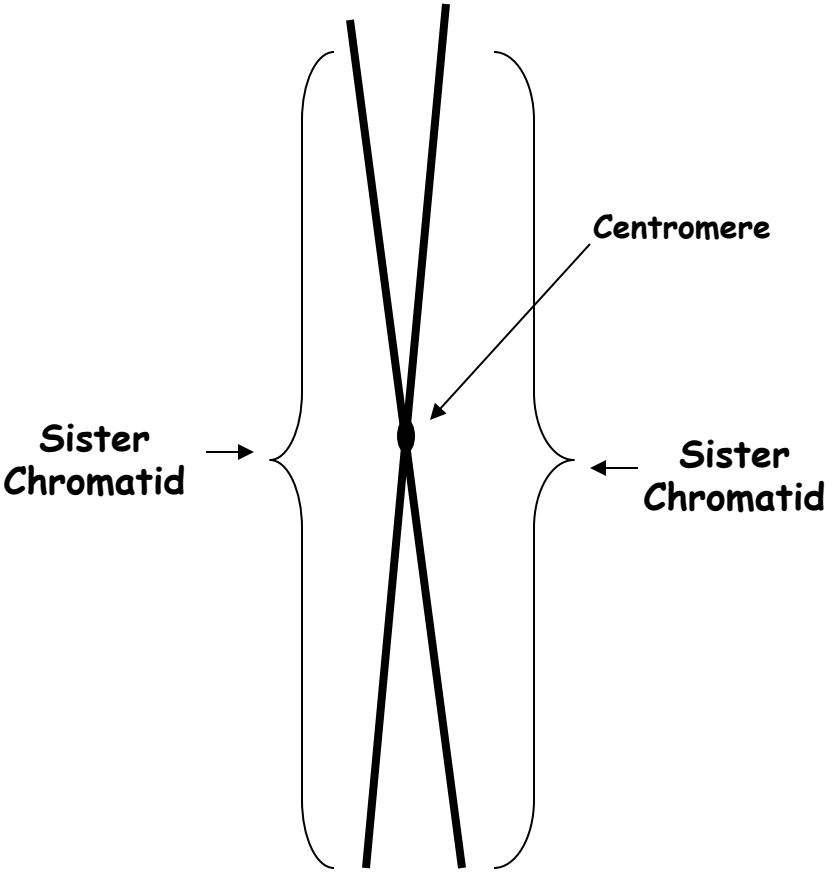


Drawing and Labeling Chromatin

You are going to see chromatin & chromosomes depicted in many of the following slides and in the class activity you will be doing. So we need to learn how to draw and label them.

Unreplicated
Uncondensed
Chromosome

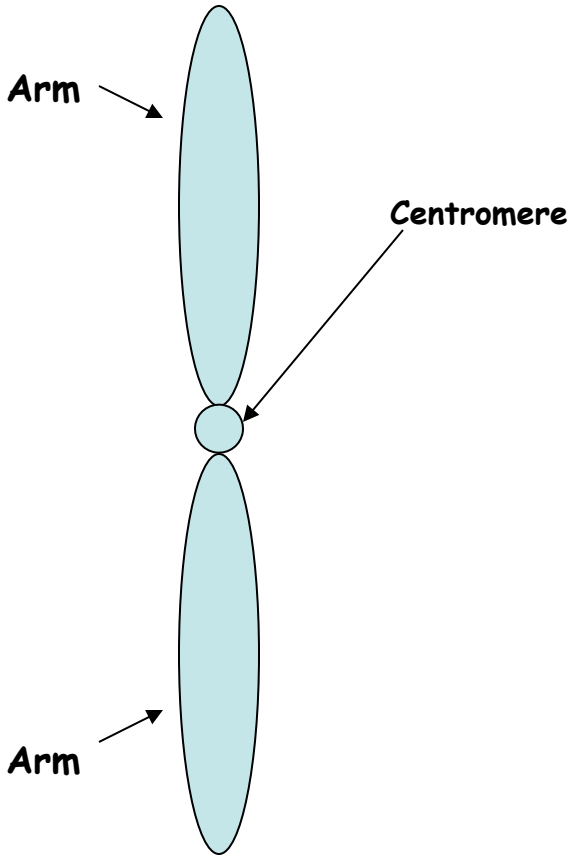
(chromatin)



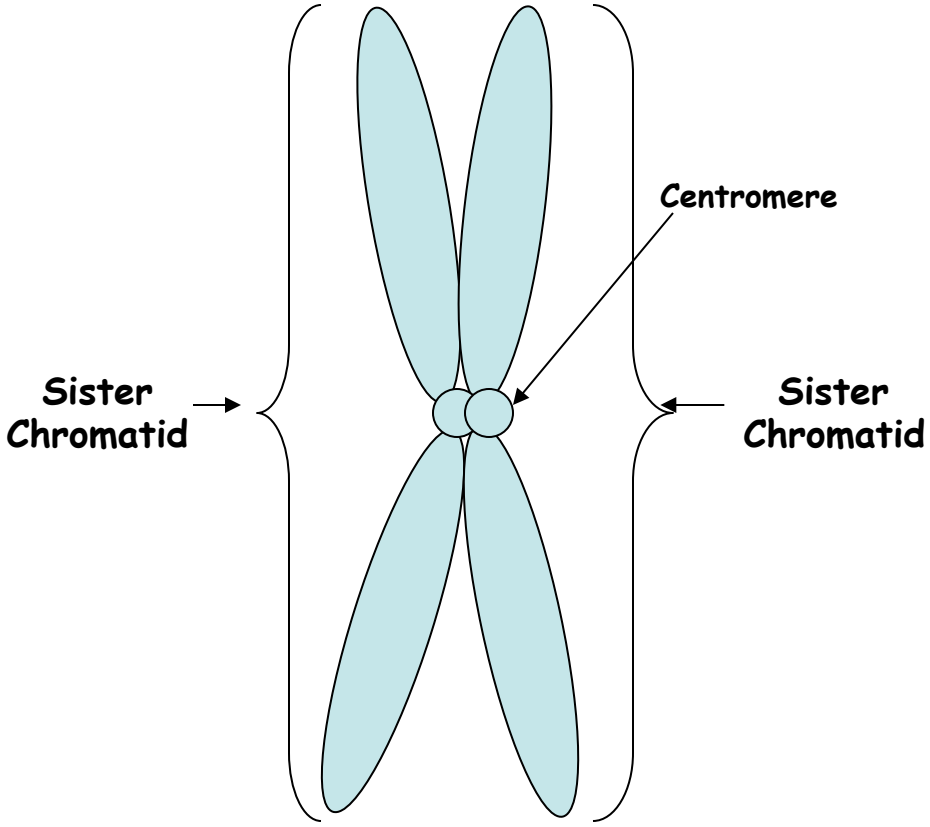
Replicated
Uncondensed
Chromosome

(chromatin)

Drawing and Labeling Chromosomes



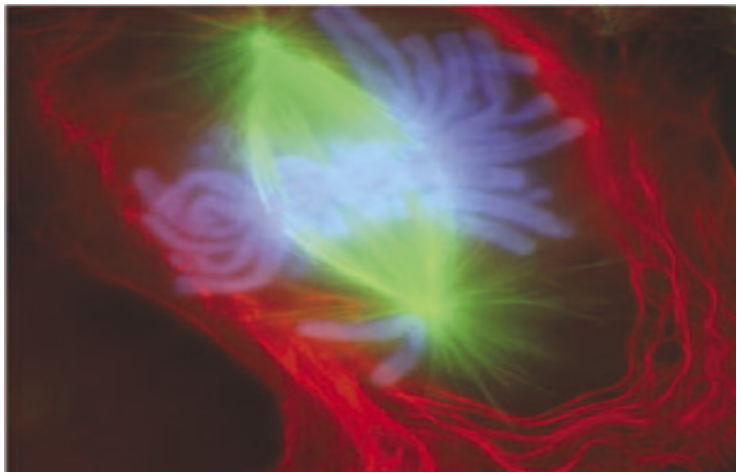
Unreplicated
Condensed
Chromosome



Replicated
Condensed
Chromosome

Mitosis Demo & Practice

See the ScienceProfOnline Virtual Cell Biology Classroom **Genetics: Mitotic Cell Division** for a printable Word .doc of this assignment.



- Break up into groups & get kit.
- Each kit should have:
  - 6 duplicated chromosomes
  - 4 pieces of string
  - plastic centromere pieces
- Use chromosome kits to work through the stages of mitosis.
- BEFORE you start writing on your Mitosis Worksheet, make sure that you have modeled the stages of mitosis with the chromosome kits. (If your group needs help, raise your hand & I will come over assist.)

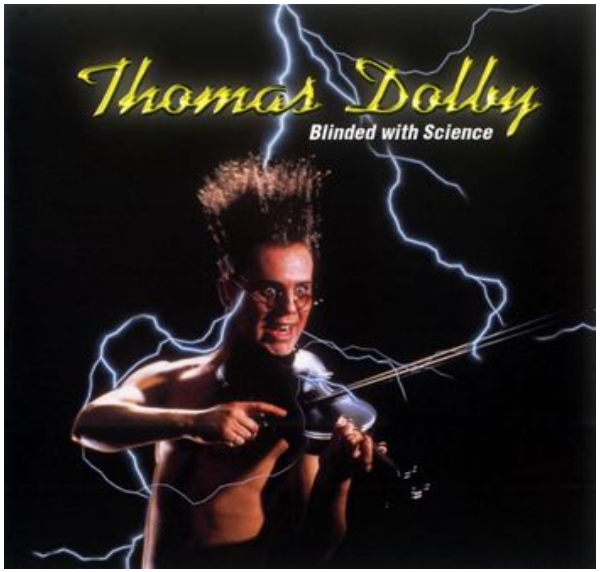
Confused?

Here are links to fun resources that further explain mitosis:

Smart Links

- Mitosis Main Page on the Virtual Cell Biology Classroom of Science Prof Online.
- "Imitosis" music video by Andrew Bird.
- DNA Replication step-through animation by John Kyrk.
- Mitosis & Cytokinesis animated video by McGraw-Hill.
- Mitosis animation, step-through and quiz, Sadava, et al., *Life: The Science of Biology*, 9th Edition, Sinauer Associates.
- Mitosis step through animation from CellsAlive.com
- Cell Cycle step through animation from Cells Alive.com.
- Detailed Animation of Mitosis
- Video of Mitosis taking place in a Cell Under Magnification.
- Video of Fish Eggs Dividing
- "That Spells DNA" song by Jonathan Coulton.

(You must be in PPT slideshow view to click on links.)



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Do yourself a favor. Use the…

Virtual Cell Biology Classroom *(VCBC)* !

The VCBC is full of resources to help you succeed, including:

- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

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Images: Blinded With Science album, Thomas Dolby; Endomembrane system, Mariana Ruiz, Wiki