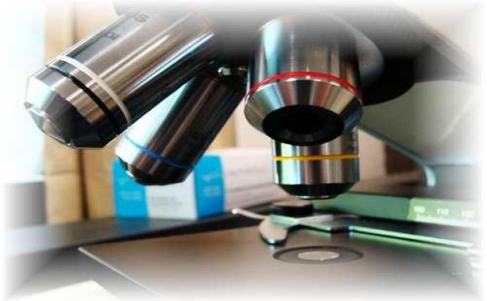

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• The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check 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.

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• 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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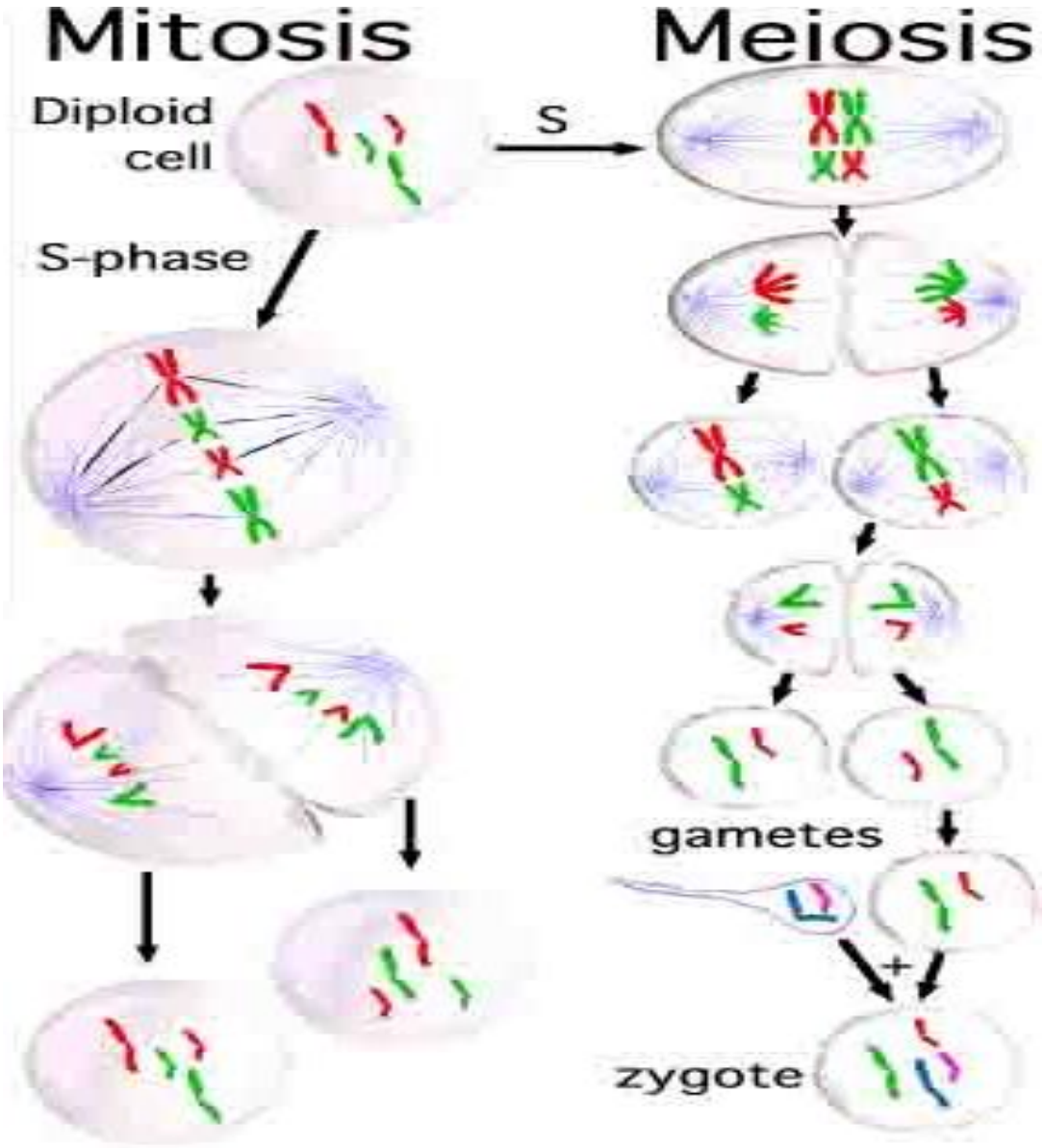
Image: Compound microscope objectives, T. Port



Cell Division

Mitosis & Meiosis

Image: Cell Division, Wikipedia

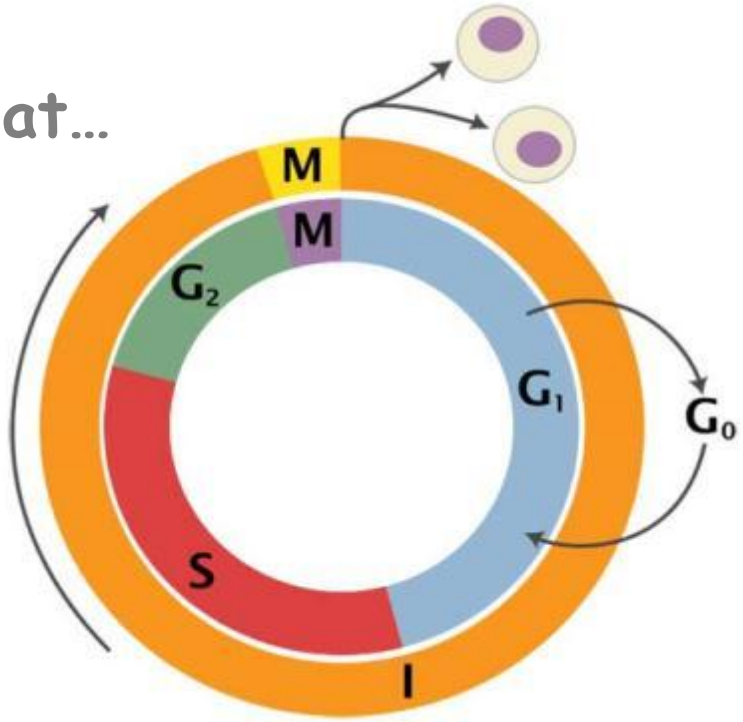
Eukaryotic Cell Cycle

Like prokaryotic cell cycle, in that…

- Cell grows.

- DNA is replicated.

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



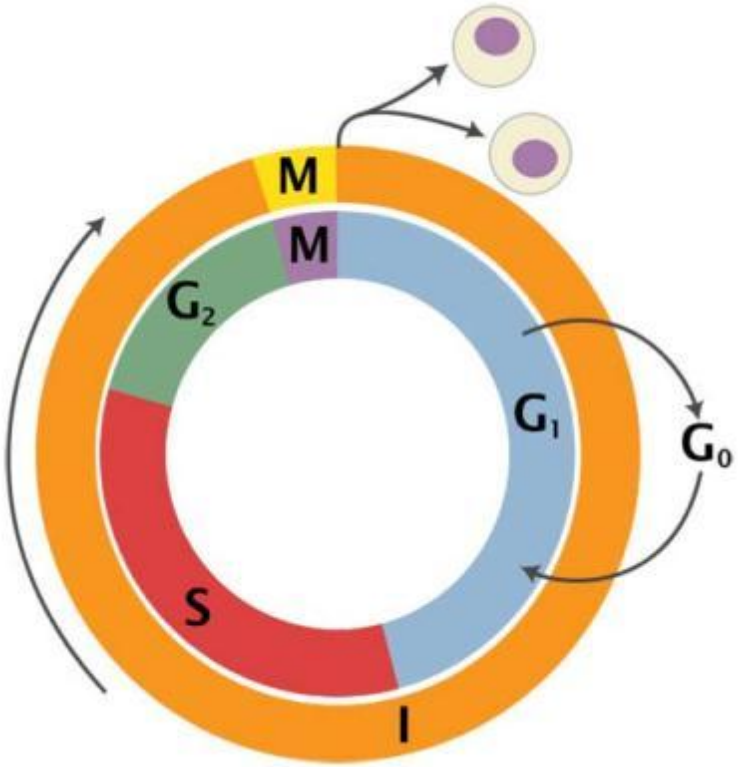
Different from prokaryotic cell cycle, in that…

- 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

Eukaryotic Cell Cycle



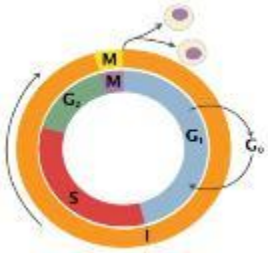
2 major phases:

- _____ (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

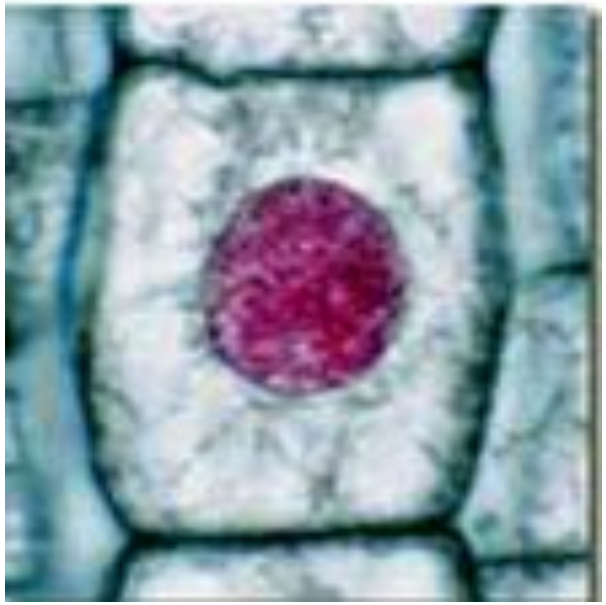
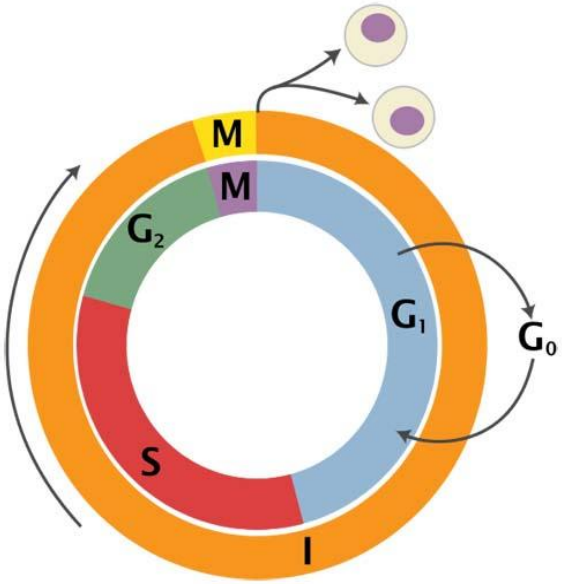


Image: Cell cycle by Richard Wheeler; Interphase in Onion Cell Drawing & Photo, Source Unknown

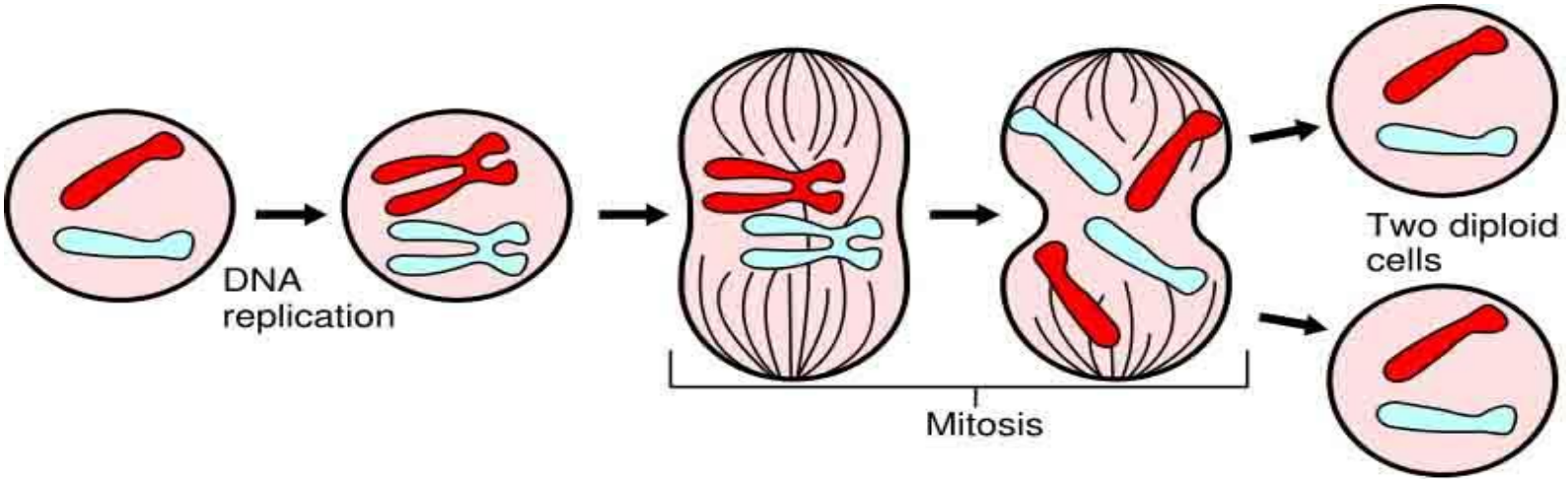
Mitosis



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

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

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

Mitosis

4 sub-phases:

1st – Prophase

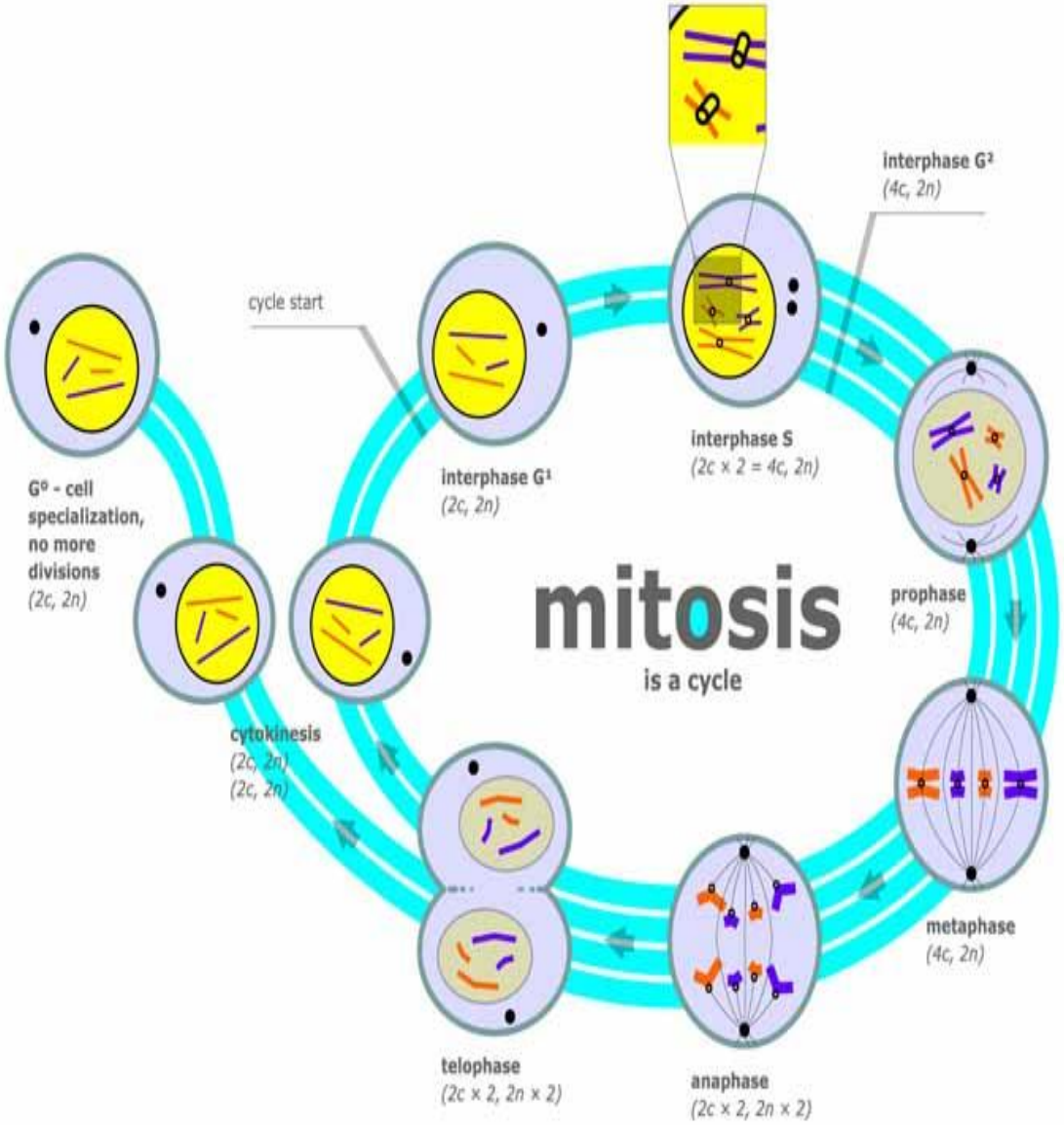
2nd – Metaphase

3rd – Anaphase

4th – Telophase

followed by

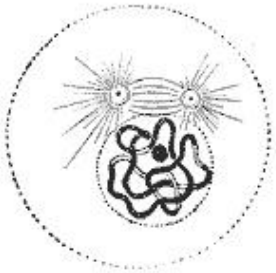
Cytokinesis



Secret to remembering phases in order…

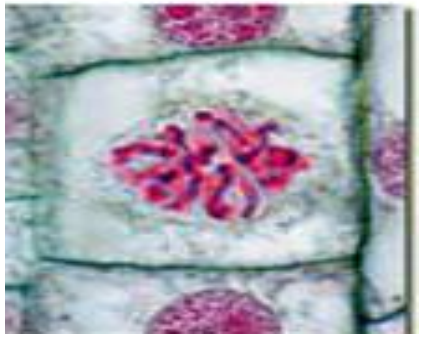
Image: Mitosis diagram, Marek Kultys

From the Virtual Cell Biology Classroom on ScienceProfOnline.com



1. Prophase

3 Major Events

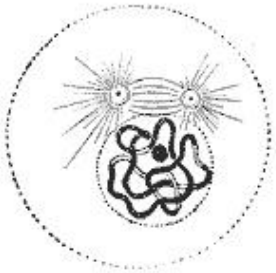


- chromosomes condense

- 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



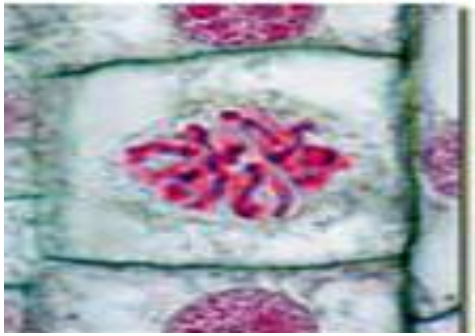
1. Prophase

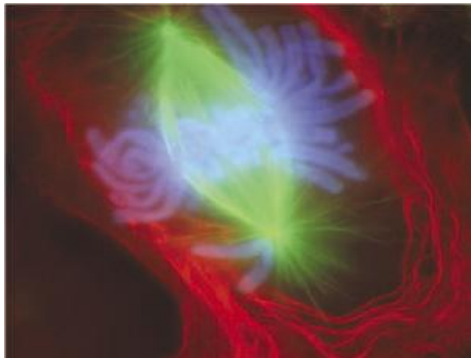
3 Major Events

- chromosomes condense

- spindle fibers form
  (spindle fibers are specialized microtubules radiating out from centrioles)

- chromosomes are captured by spindle

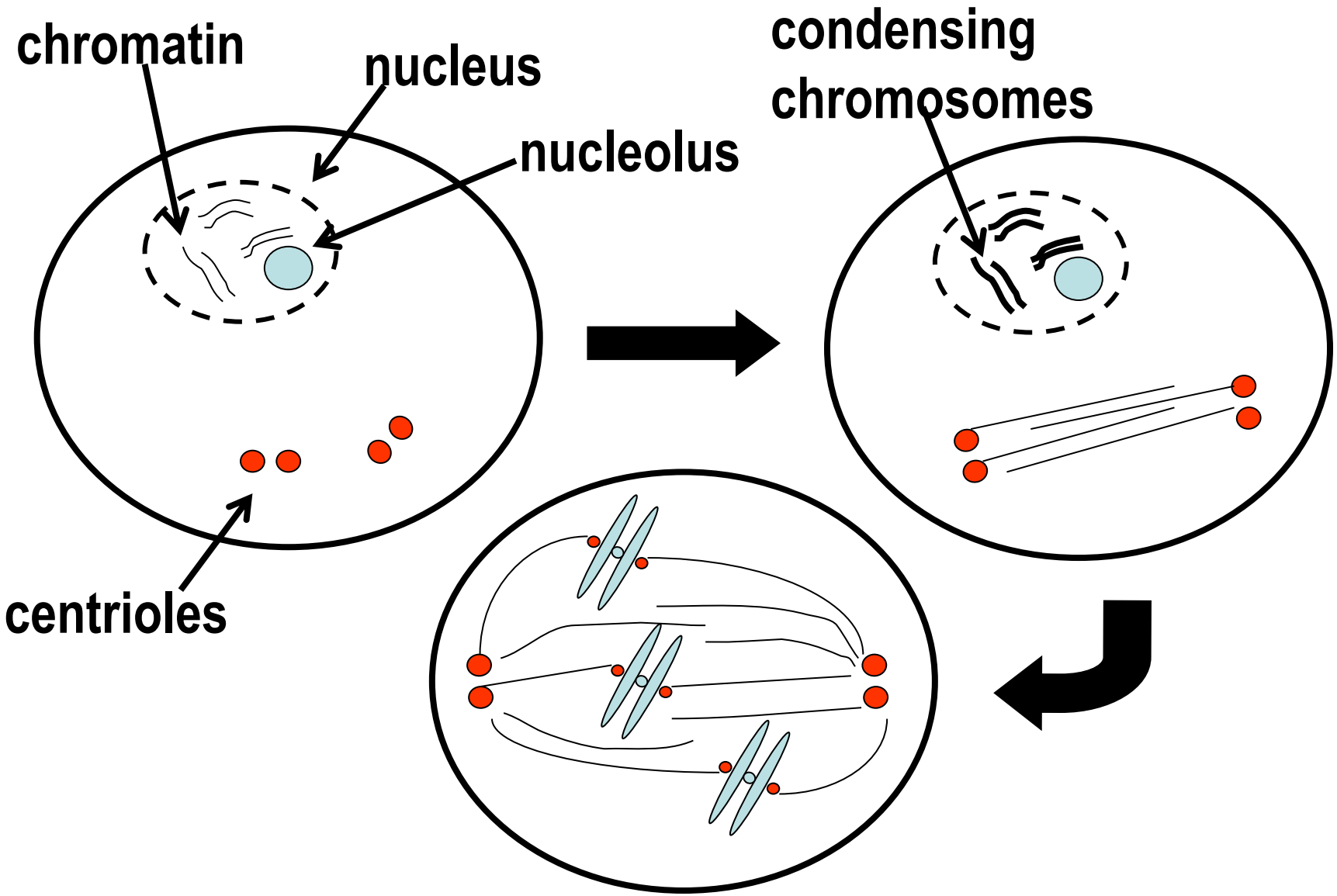


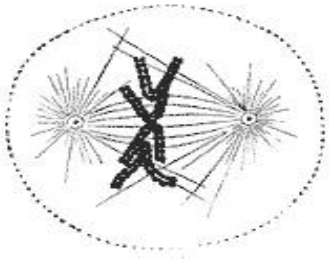


Fluoresced eukaryotic cell. Chromosomes in blue. Mitotic spindle apparatus in green.

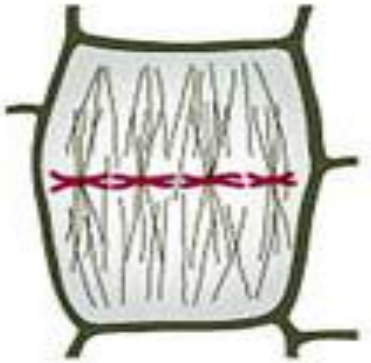
Images: Prophase drawing, Henry Gray's Anatomy of the Human Body; Prophase Onion Cell Drawing & Photo, Source Unknown, Fluoresced cell, National Institutes of Health

Prophase

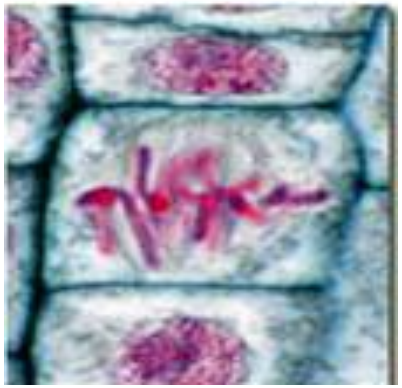

chromatin
nucleus
nucleolus
condensing
chromosomes
centrioles

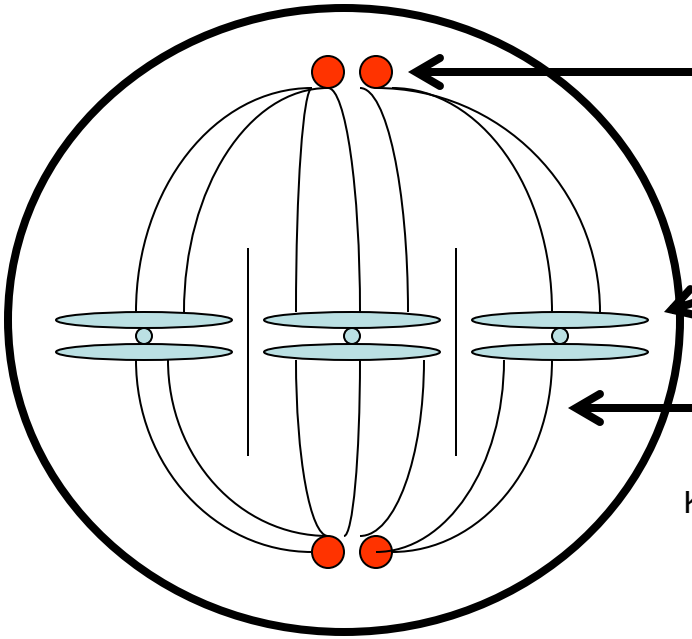


2. Metaphase



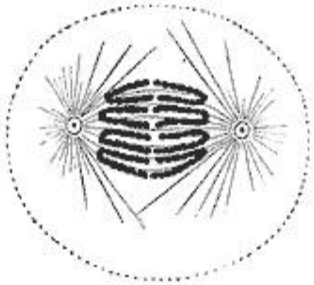
- chromosomes align along equator of the cell, with one kinetochore facing each pole



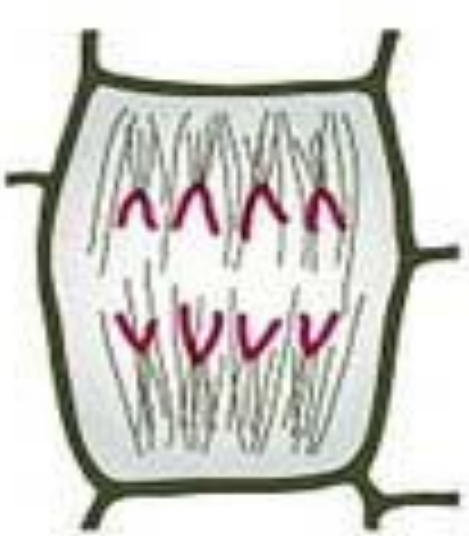


Kinetocores not pictured in this illustration.

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

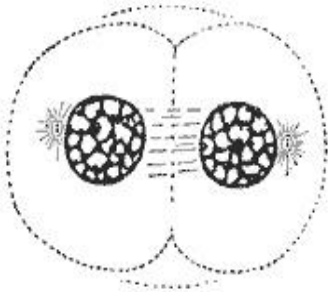


3. Anaphase



- 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

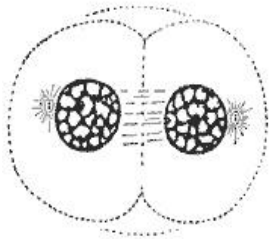
Images: Anaphase drawing, Henry Gray's Anatomy of the Human Body; Anaphase Onion Cell Drawing & Photo, Source Unknown



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



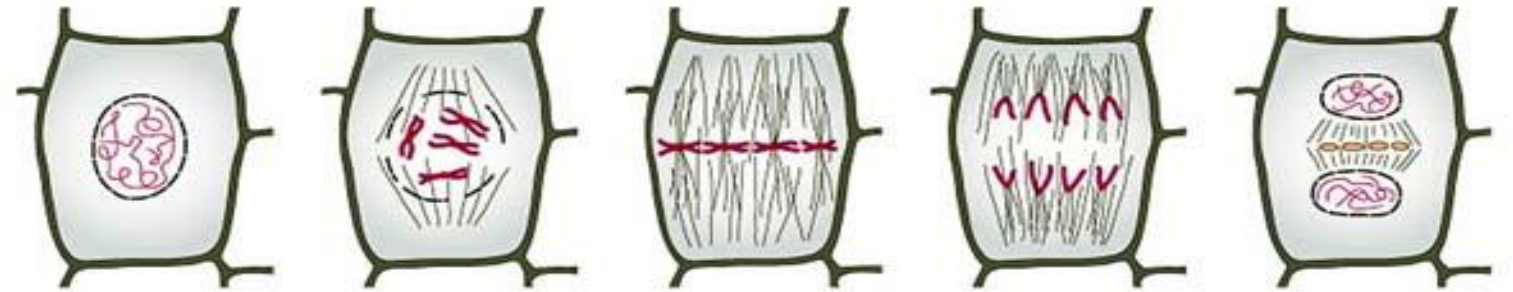
Cytokinesis – Plant vs. Animal Cell

- **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
3. How Cell Divide: Comparison of Binary Fission & Mitosis from Glencoe

Image: Onion Cell Drawing & Photo, Source Unknown

Genetics Terminology

SEXually reproducing eukaryotes, have 2 types of body cells…

1. **somatic cells**

2. **sex cells**
   (a.k.a. gametes)

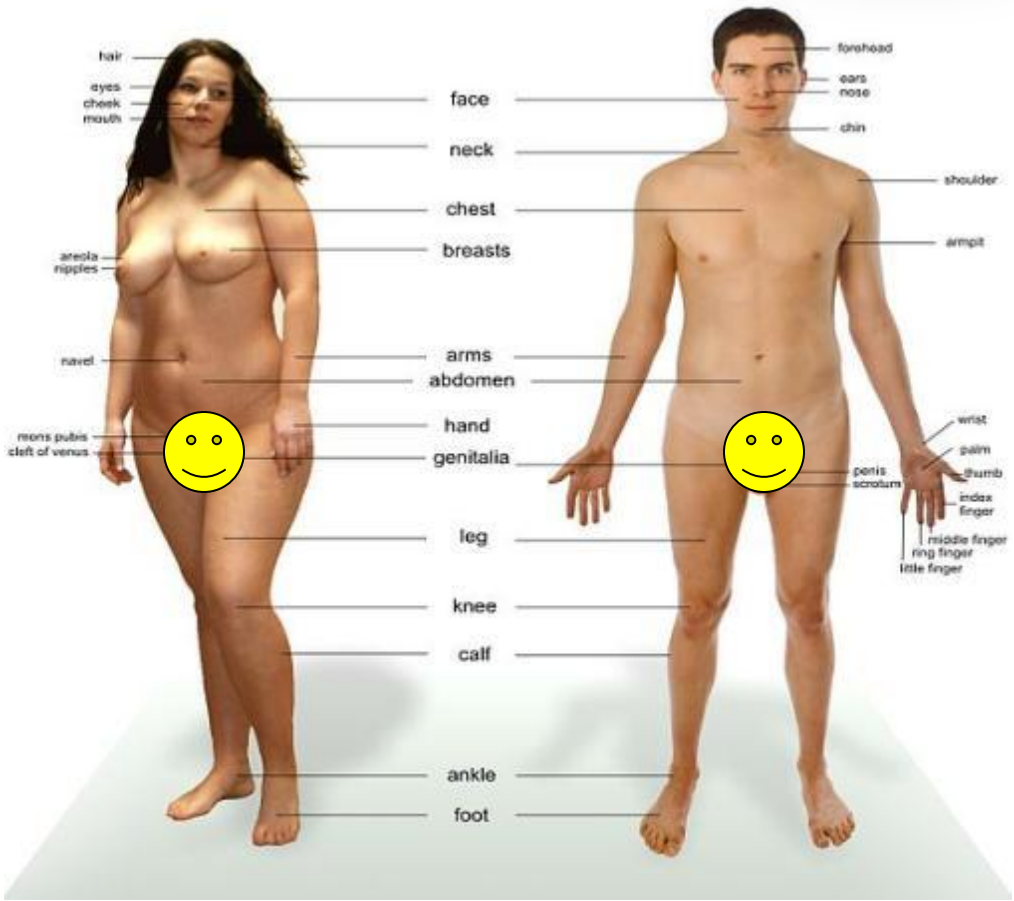


Image: Superficial human anatomy, Mikael Häggström& Rainer Zenz; Sperm & egg, Wikipedia

What is cell division of gametes called?

Meiosis

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

- Daughter cells have half the # of chromosomes as parent cell, so they considered **haploid**.

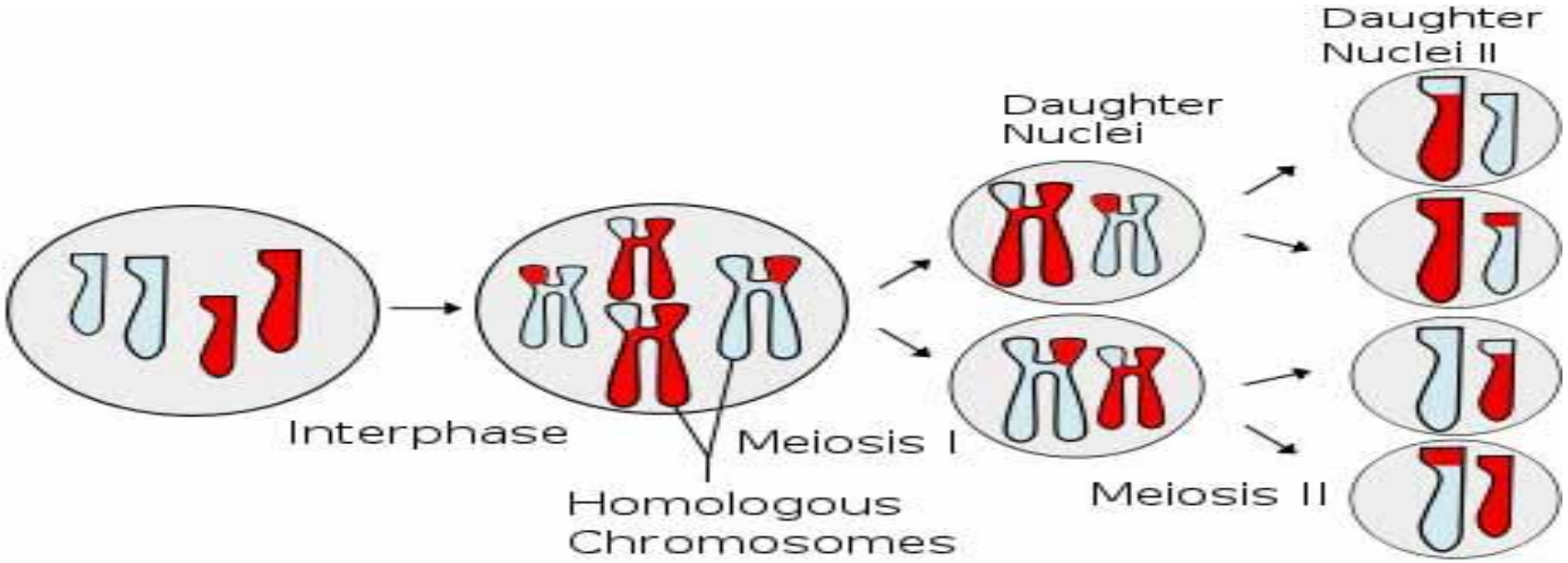
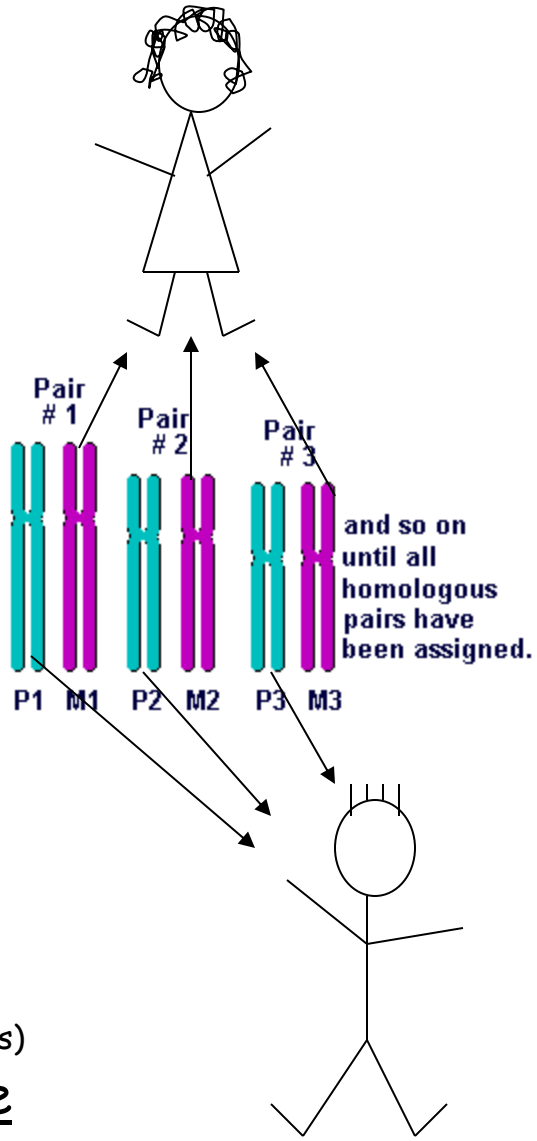


Image: Overview of Meiosis, National Institutes of Health

Genetics Terminology: Ploidy

Refers to the number of sets of chromosomes in cells.

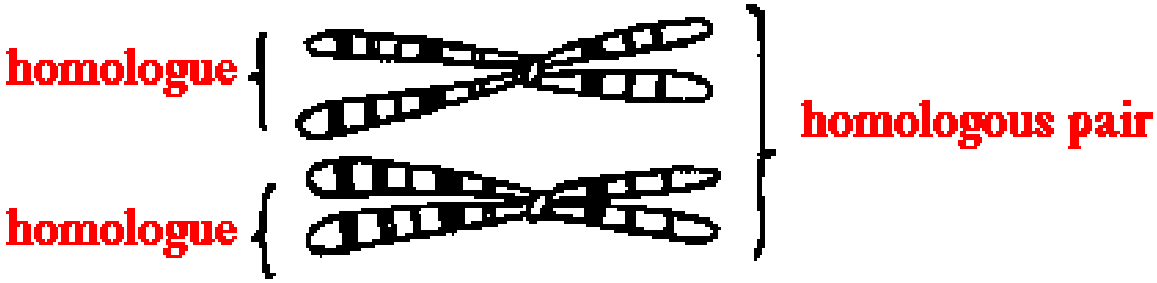
- **Haploid** – one copy of each chromosome
  - designated as "n", the number of chromosomes in one "set"
  - gametes
- **Diploid** – two sets of chromosomes
  - two of each chromosome
  - designated as "2n"
  - somatic cells



Diploid organisms receive one of each type of chromosome from female parent (maternal chromosomes) and one of each type of chromosome from male parent (paternal chromosomes)

Genetics Terminology: Homologues

Chromosomes exist in homologous pairs in diploid (2n) cells.

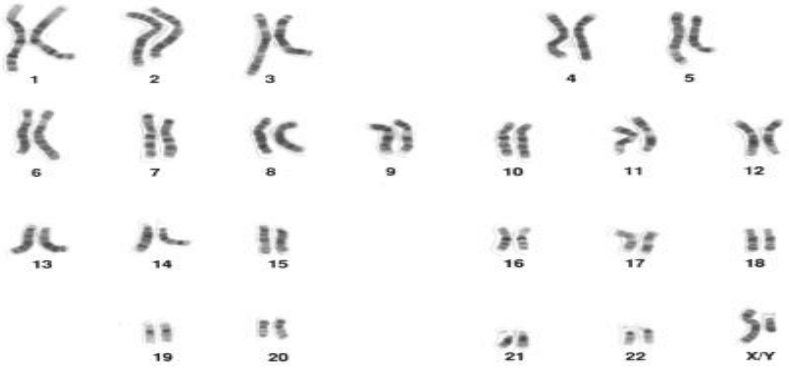


Exception: **Sex chromosomes** (X, Y).

Other chromosomes, known as **autosomes**, they have homologues.

Karyotype

- Q: Which, of the top two karyotypes is replicated?
- Q: How many homologous pair in each karyotype?
- Q: How is the bottom karyotype different from the top two?



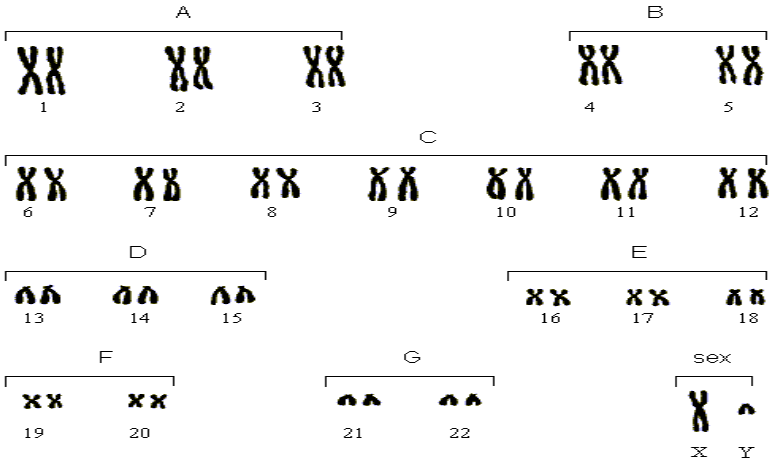


Image: Karyotype, National Human Genome Research Institute

Asexual Reproduction

- Many single-celled organisms reproduce by splitting, budding.

- Some multicellular organisms can reproduce asexually, produce **clones** (*offspring genetically identical to parent*).

- **Q**: What type of cell division is asexual reproduction?

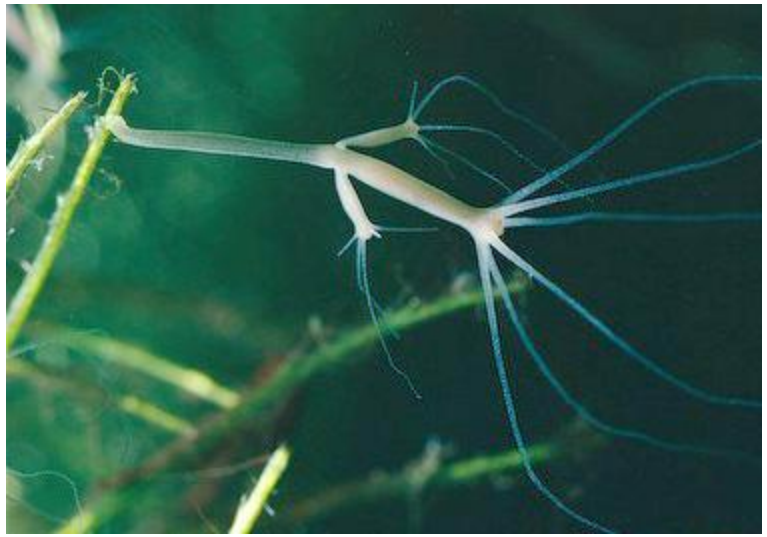
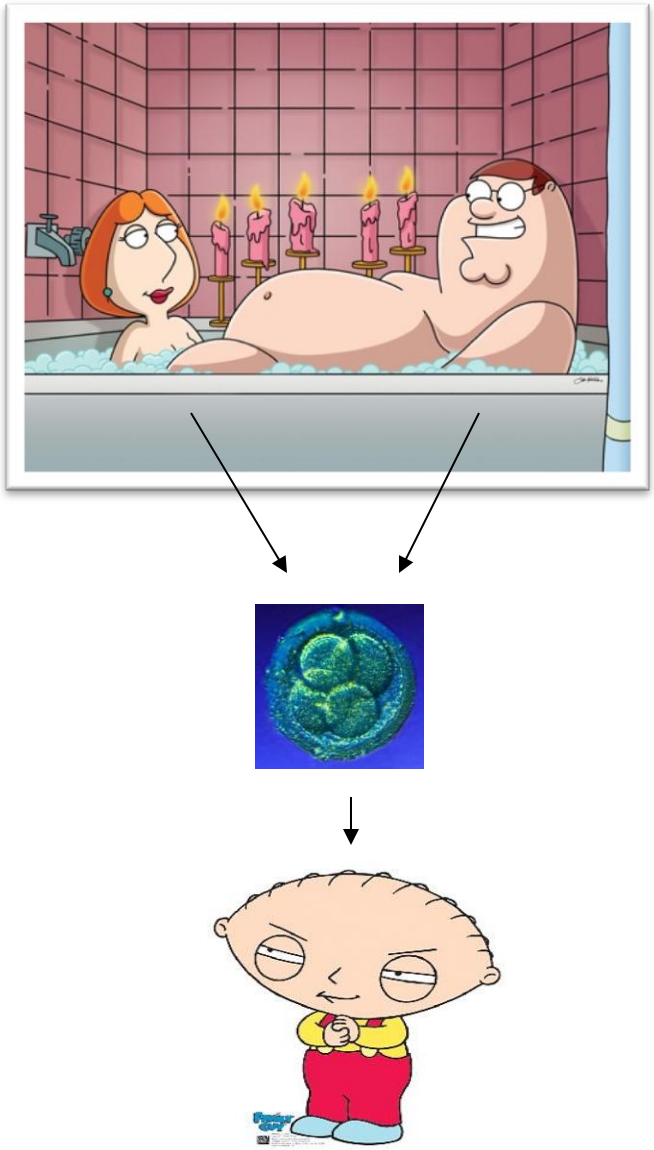


Image: Paatrick Star, Nickelodeon; Hydra budding, Lifetrance;

Sexual Reproduction

- Fusion of two **gametes** to produce a single zygote.
- Introduces greater genetic variation, allows genetic recombination.
- With exception of self-fertilizing organisms, zygote has gametes from two different parents.



Peter + Lois = Stewie

Images: Peter, Lois & Stewie, The Family Guy

Sexual reproduction in humans …

- At fertilization, 23 chromosomes are donated by each parent.
  (total = 46 or 23 pairs).

- **Gametes** (sperm/ova):
  - Contain 22 autosomes and 1 sex chromosome.
  - Are haploid (haploid number *"n" = 23 in humans*).

- Fertilization results in diploid zygote.
  - Diploid cell; *2n = 46*. (*n = 23 in humans*)

- **Q**: Most cells in the body are produced through what type of cell division?

- Only gametes are produced through **meiosis**.

Image: Superficial human anatomy, Mikael Häggström& Rainer Zenz; Sperm & egg, Wikipedia

Meiosis - Sex Cell (Gamete) Formation

In meiosis, there are **2** divisions of the nucleus:

meiosis I

&

meiosis II

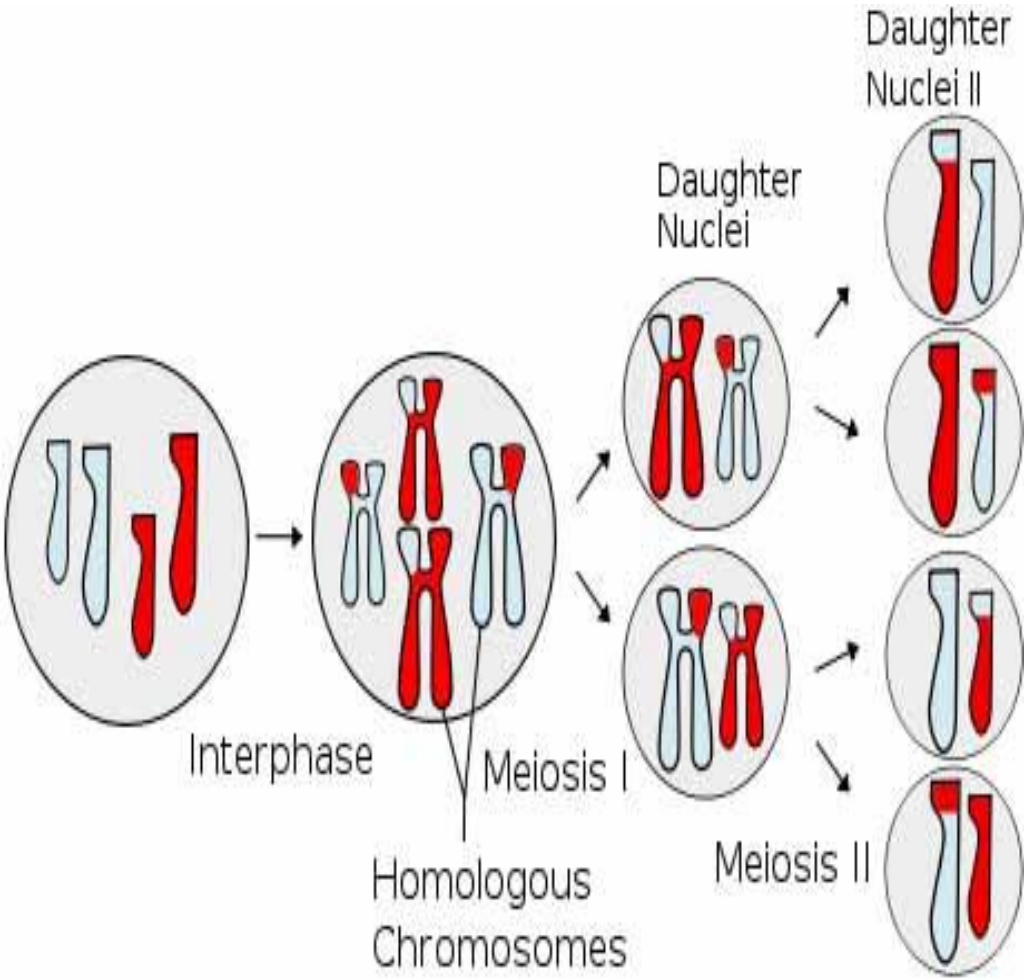
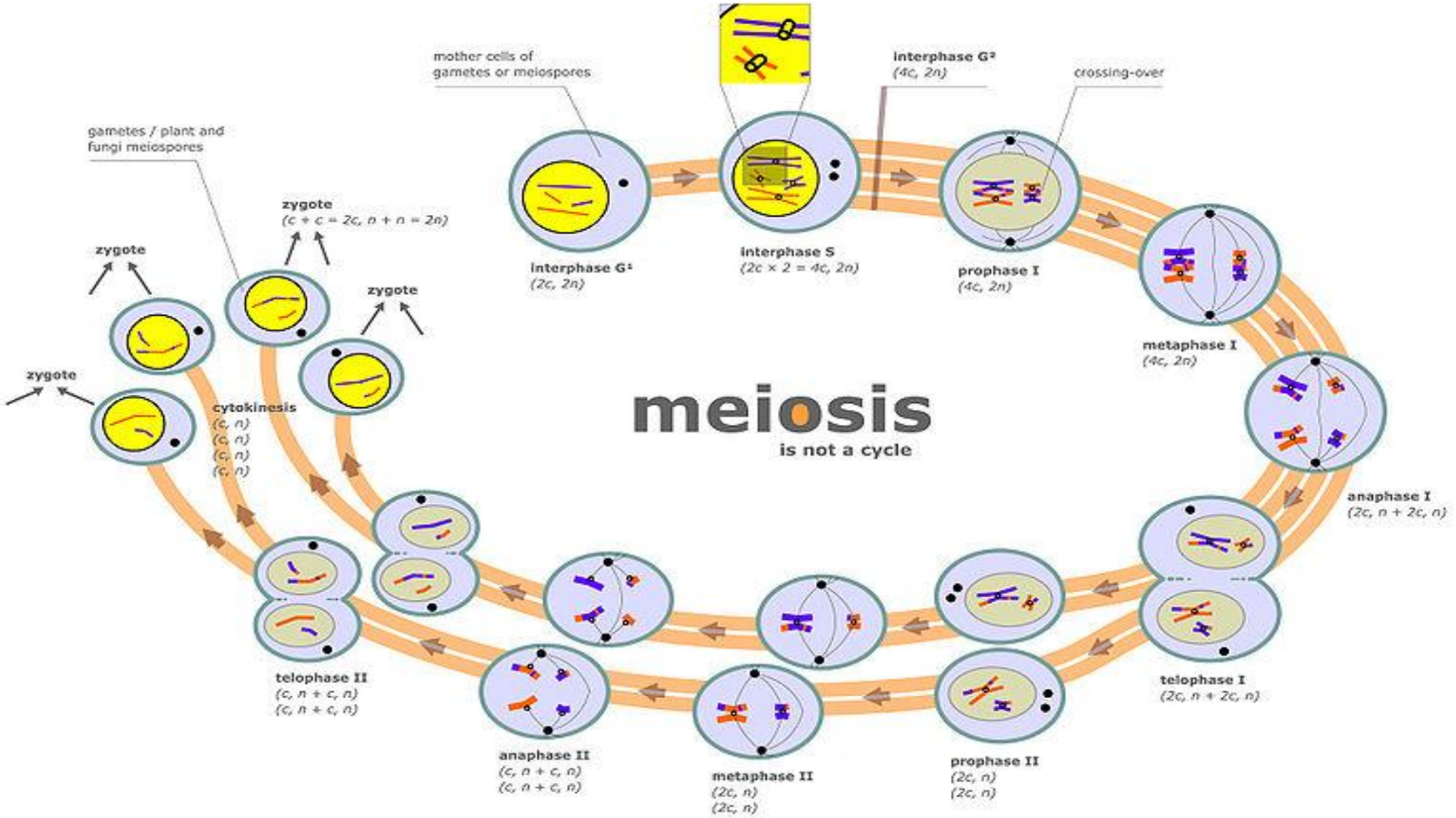


Image: Overview of Meiosis, National Institutes of Health

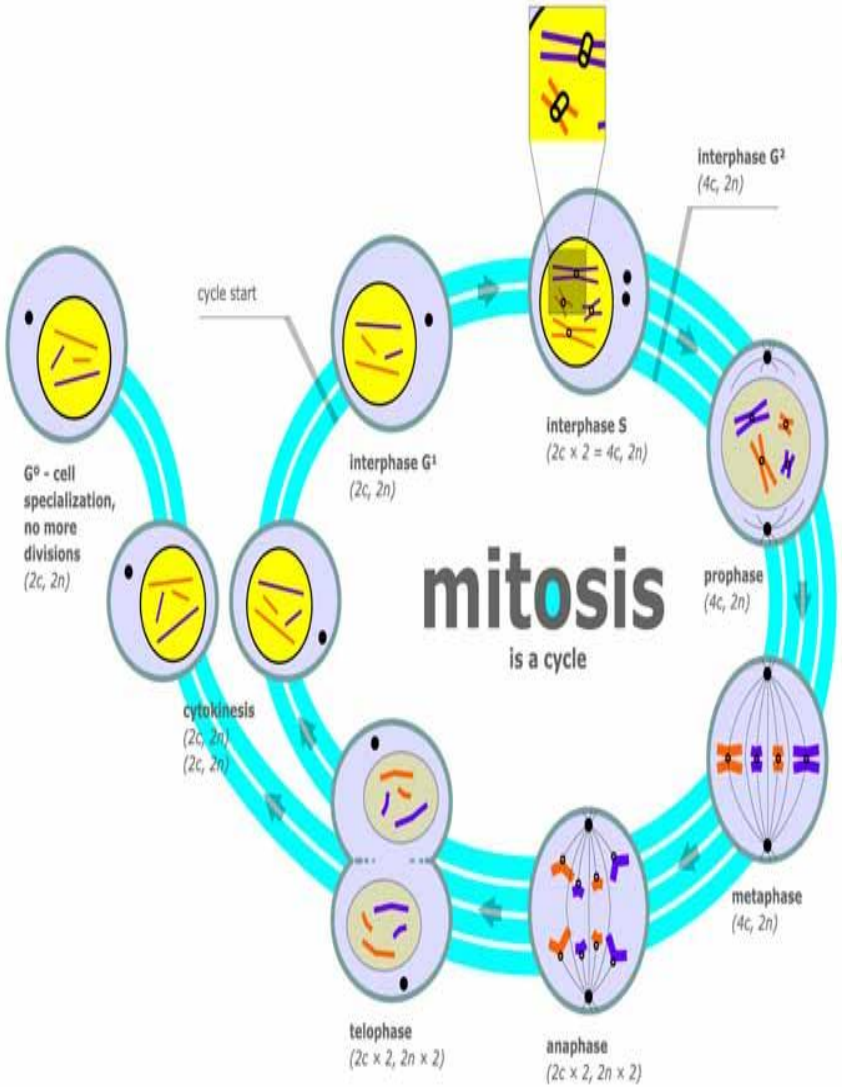


REVIEW!

Meiosis Animations

1. How Meiosis Works from McGraw-Hill
2. Meiosis Interactive Animation from Cells Alive

Image: Meiosis diagram, Marek Kultys



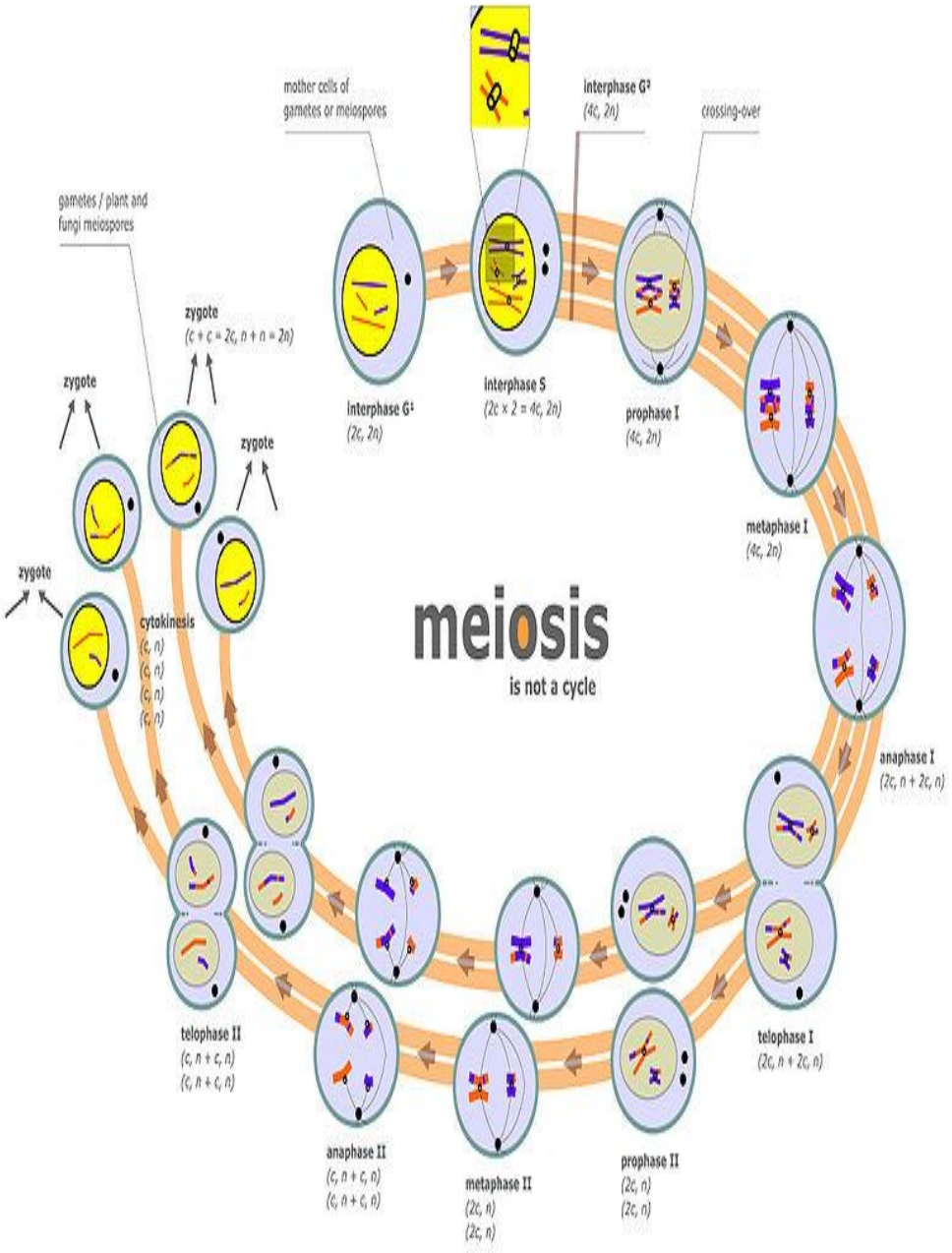


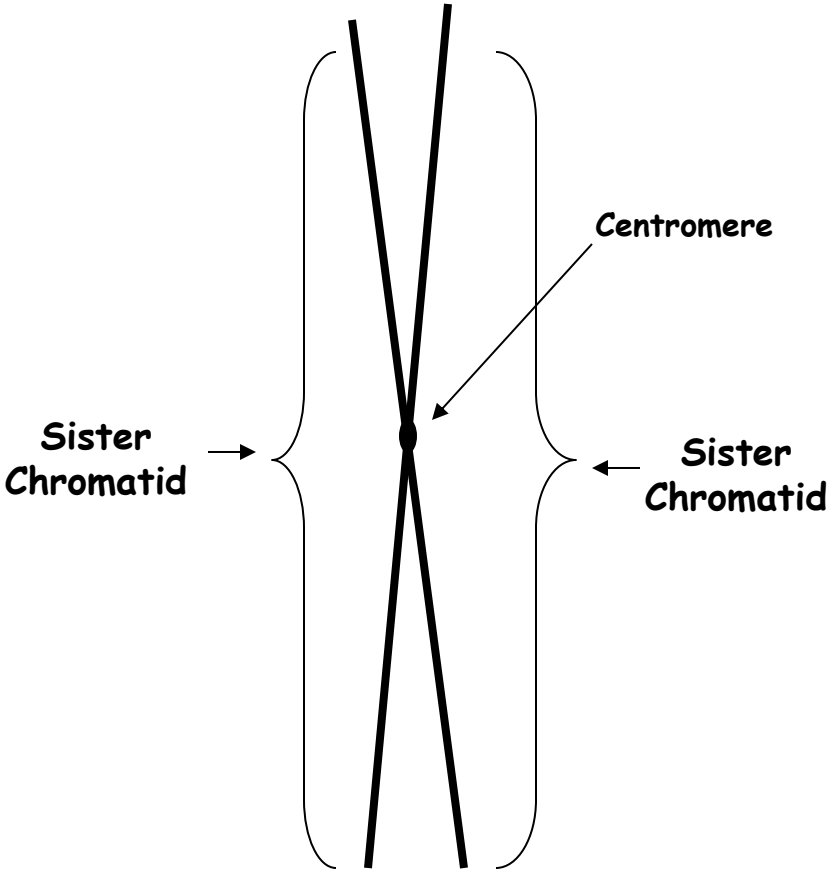
Image: Mitosis diagram & Meiosis diagram, Marek Kultys

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Drawing and Labeling Chromosomes

Unreplicated
Uncondensed
Chromosome

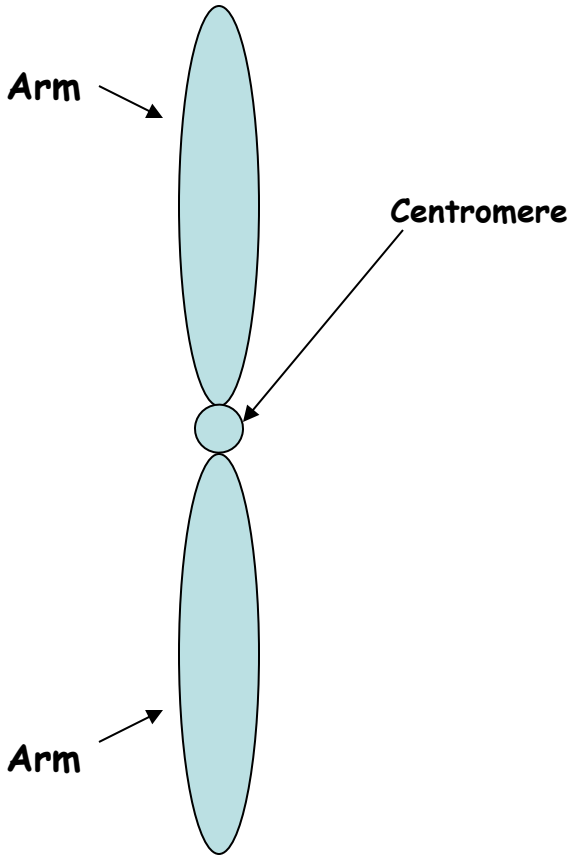
(chromatin)



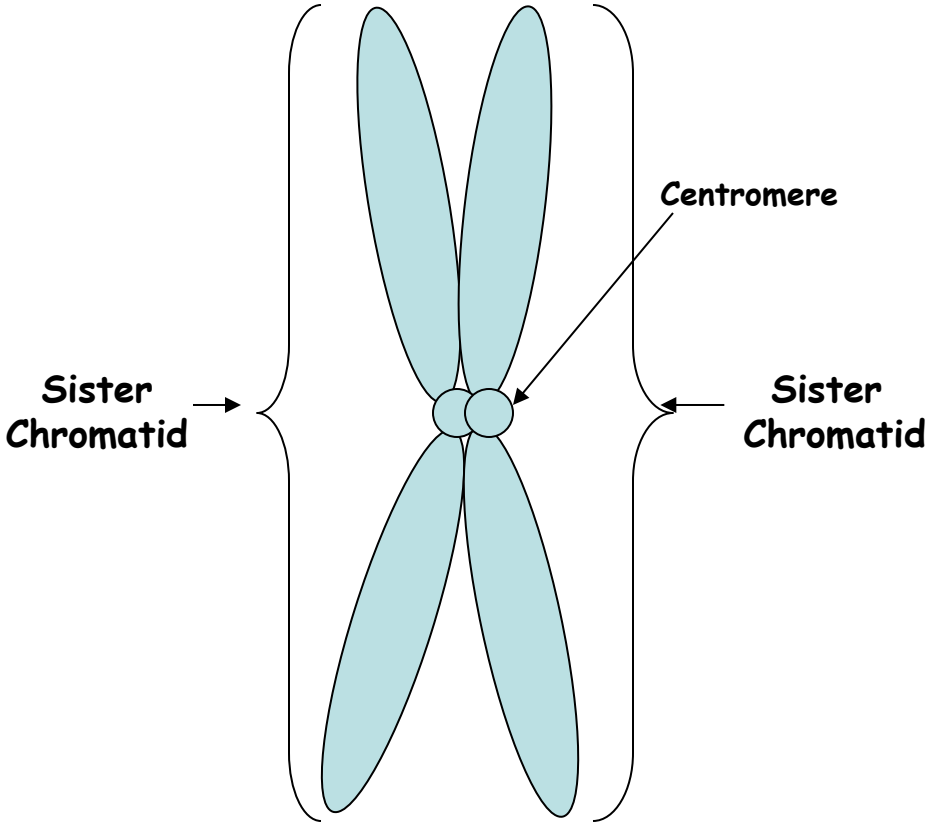
Replicated
Uncondensed
Chromosome

(chromatin)

Drawing and Labeling Chromosomes

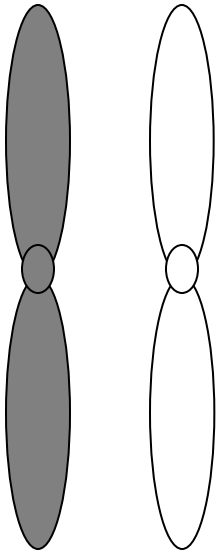


Unreplicated
Condensed
Chromosome

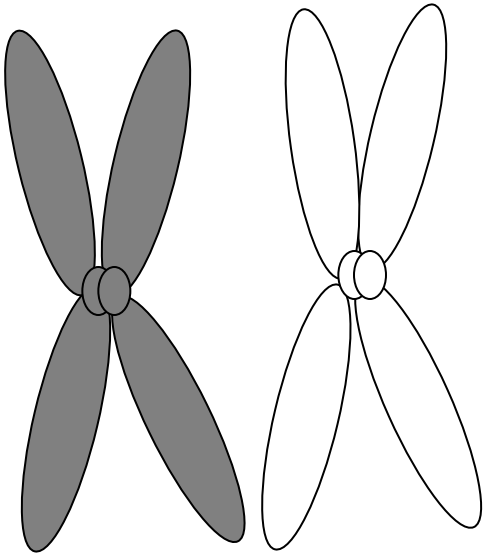


Replicated
Condensed
Chromosome

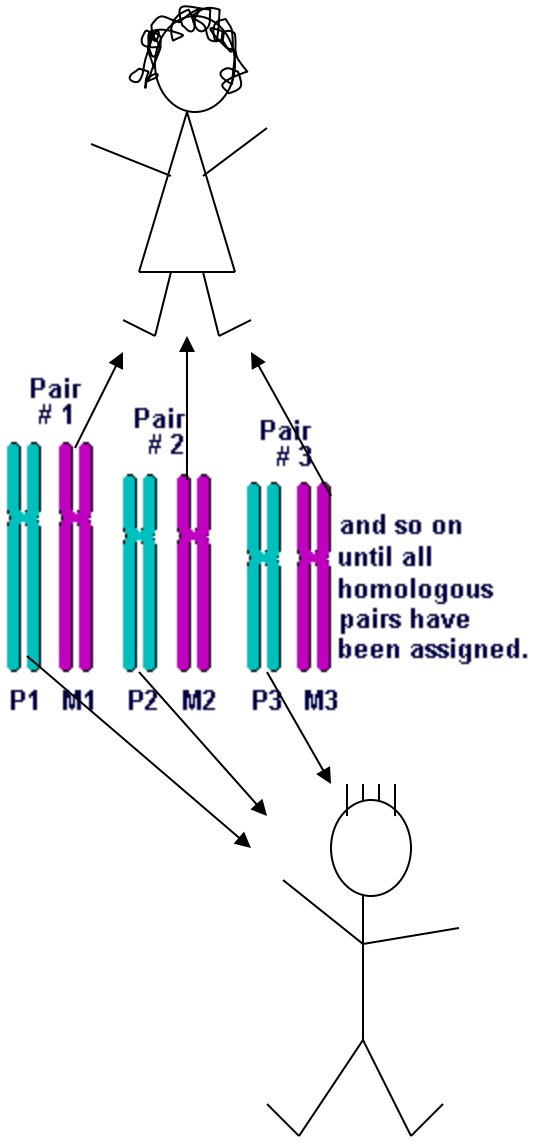
Drawing & Labeling Homologous Chromosomes



Unreplicated, Condensed, Homologous Chromosomes

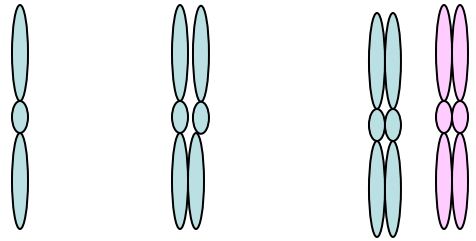


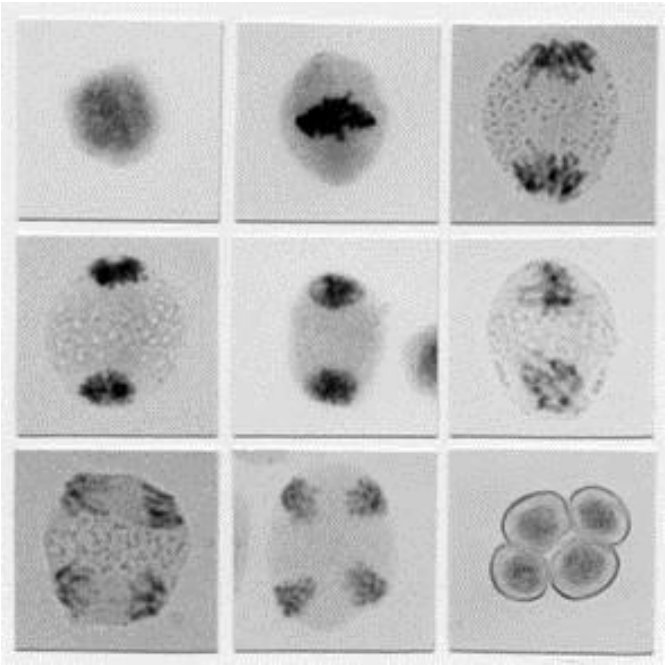
Replicated, Condensed, Homologous Chromosomes



Mitosis & Meiosis Demo & Practice

- Break up into groups & get kit.
- Each kit should have:
  - 6 duplicated chromosomes (3 sets of homologues).
  - 4 pieces of string
  - plastic centromere pieces
- Use chromosome kits to work through the stages of mitosis & meiosis.
- BEFORE you start writing on your Mitosis Worksheet or Meiosis Worksheet, make sure that you have modeled the stages of Meiosis with the chromosome kits. (If your group needs help, raise your hand & I will come over assist.)
- You can find Word documents of theses Worksheets on the Cell Division: Mitosis & Meiosis Lecture Main Page of the Virtual Cell Biology Classroom.





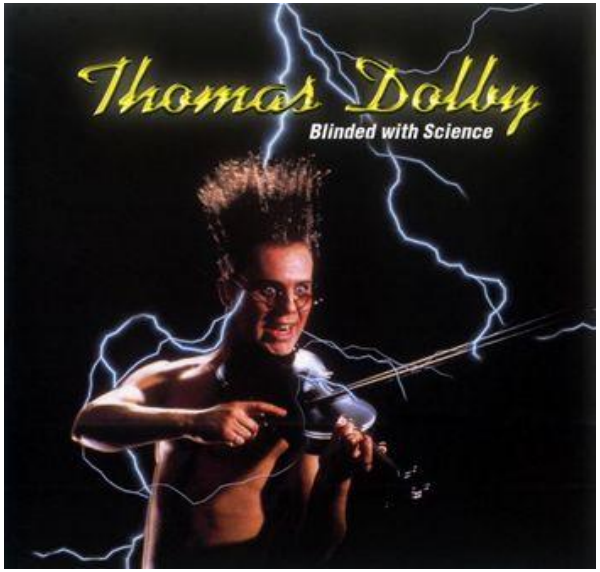
Confused?

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.
- "That Spells DNA" song by Jonathan Coulton.

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



Are you feeling blinded by science?

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

You can access the Virtual Cell Biology Classroom (VCBC) on the Science Prof Online website **www.ScienceProfOnline.com**

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