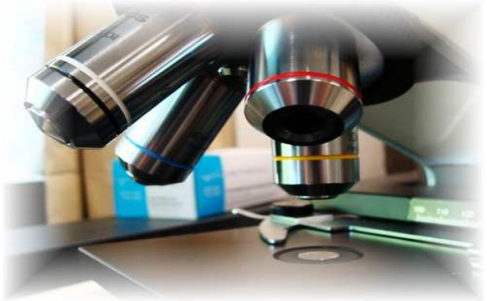


About Science Prof Online PowerPoint Resources

• Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.

• 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.

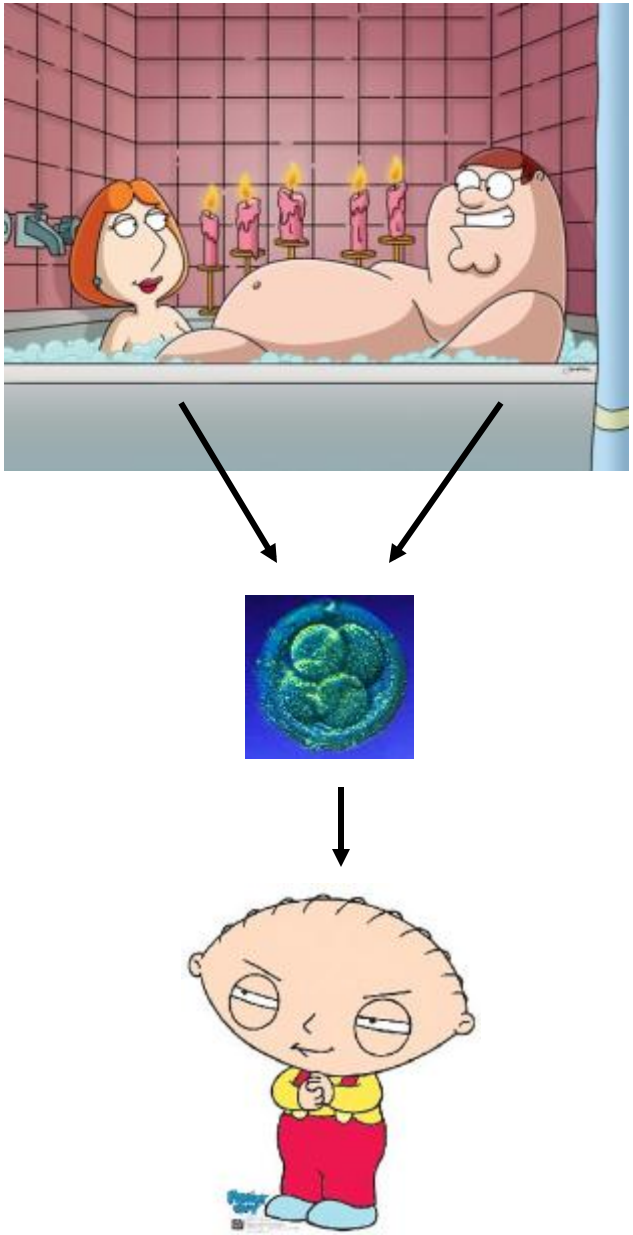
• Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.

• 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.

Alicia Cepaitis, MS
Chief Creative Nerd
Science Prof Online
Online Education Resources, LLC
alicia@scienceprofonline.com

Tami Port, MS
Creator of Science Prof Online
Chief Executive Nerd
Science Prof Online
Online Education Resources, LLC
info@scienceprofonline.com

Image: Compound microscope objectives, T. Port



Genetics

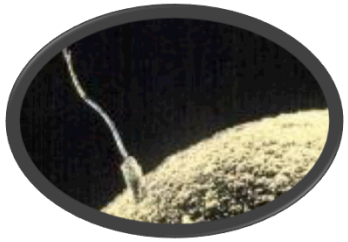
Cell Division:

Meiosis & Sexual Reproduction

Images: Peter, Lois & Stewie, The Family Guy

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Genetics Terminology



SEXually reproducing eukaryotes, have 2 types of body cells…

1. **somatic cells**

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

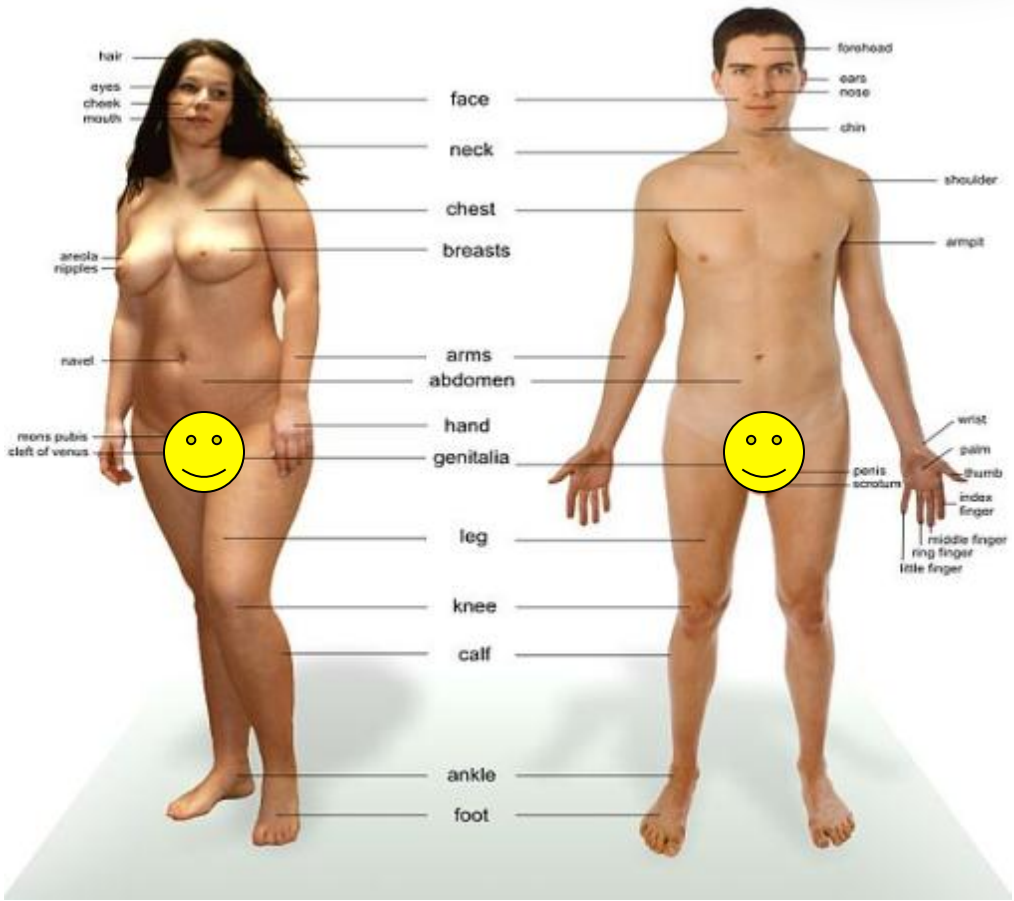


Image: Superficial human anatomy, Mikael Häggström& Rainer Zenz; Sperm & egg, Wikipedia

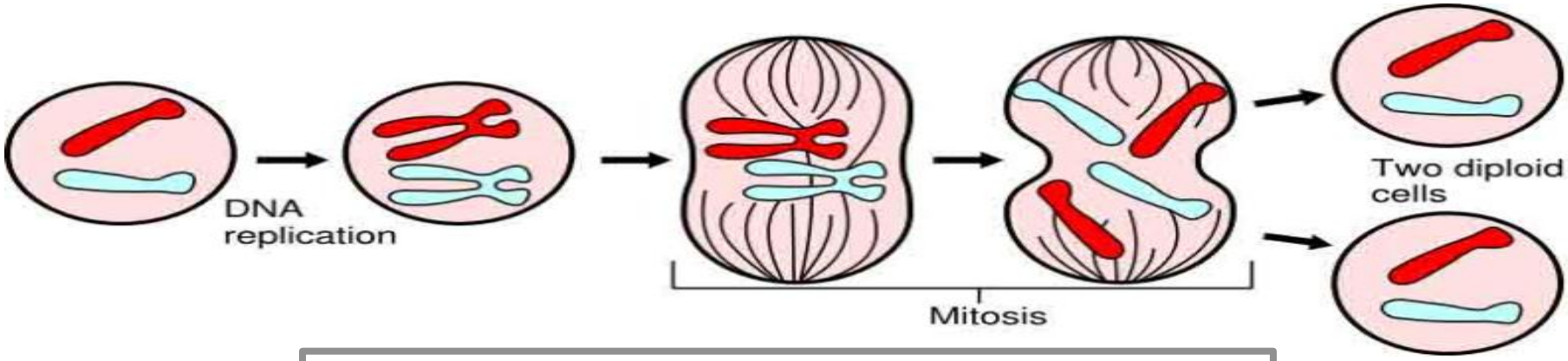
From the Virtual Cell Biology Classroom on ScienceProfOnline.com

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, so they are considered **diploid**.



REVIEW!

Mitosis Animations

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

Image: Overview of Mitosis, Mysid

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**.

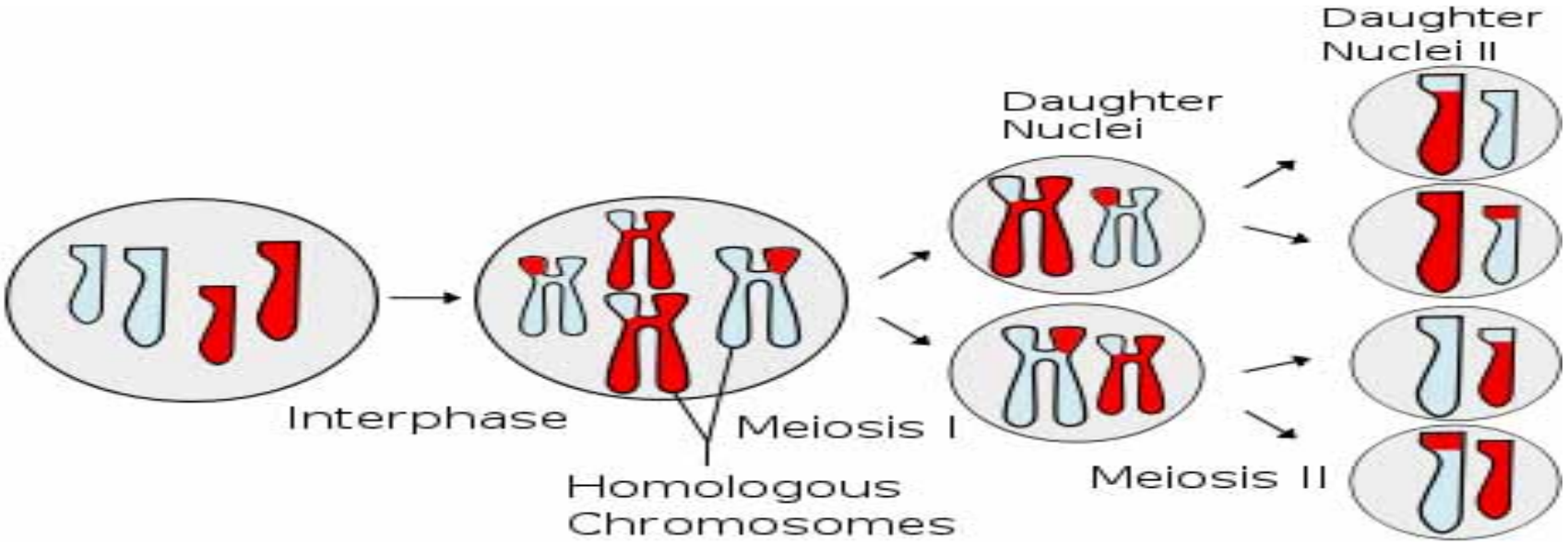
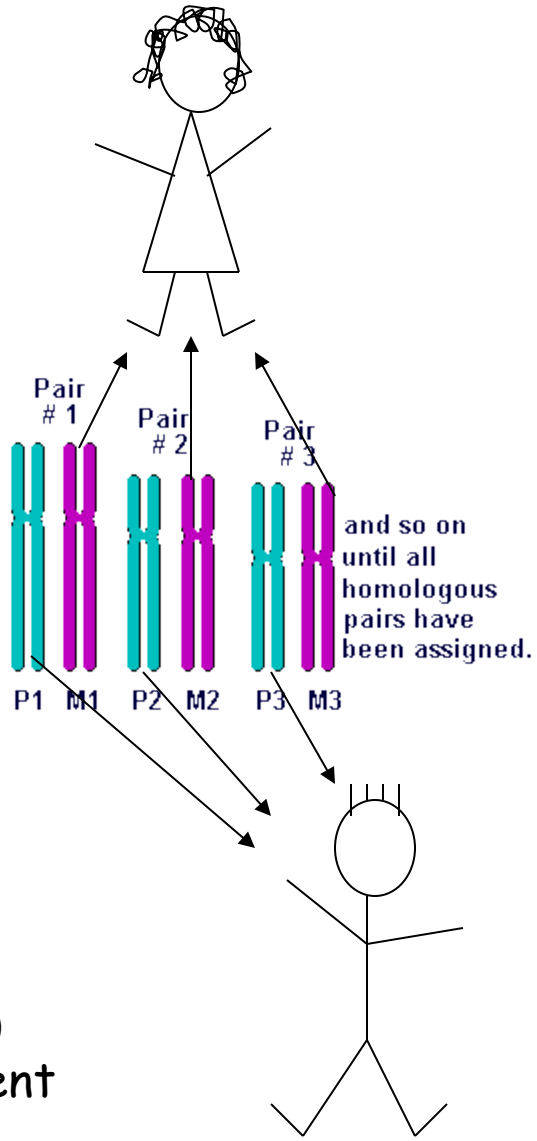


Image: Overview of Meiosis, National Institutes of Health

Genetics Terminology: Ploidy

Refers to the number of sets of chromosomes in cells.

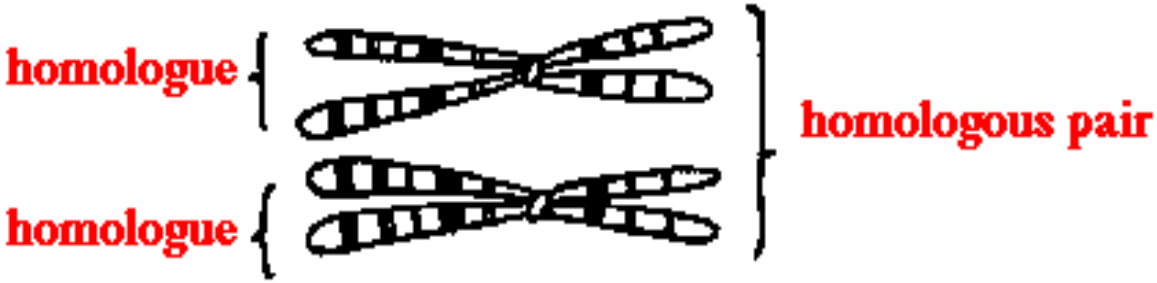
- **Haploid** – one copy of each chromosome
  - designated as "n", the number of chromosomes in one "set"
  - gametes
- **Diploid** – two sets of chromosomes
  - two of each chromosome
  - designated as "2n"
  - somatic cells



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

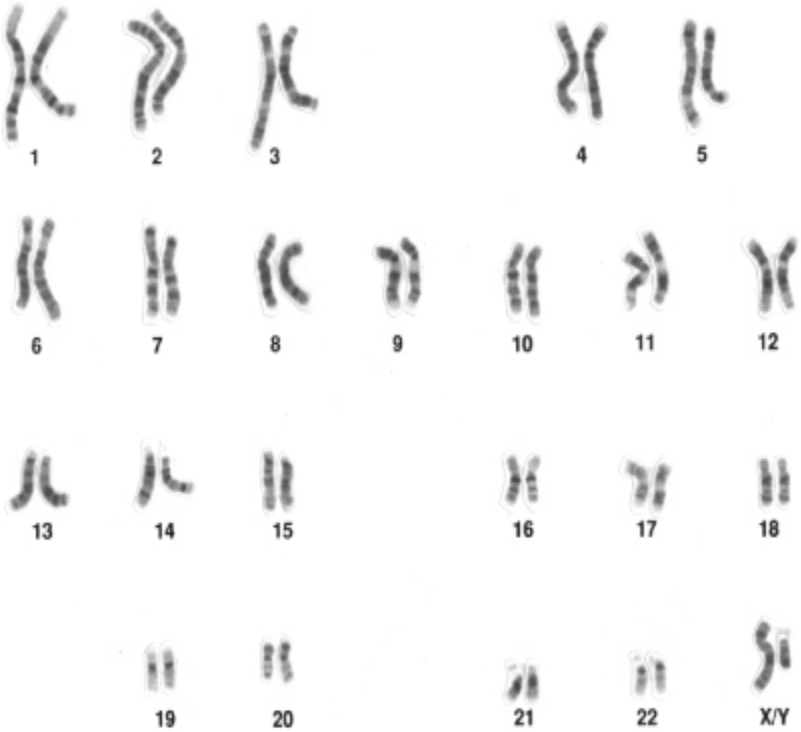
Chromosomes exist in homologous pairs in diploid (2n) cells.

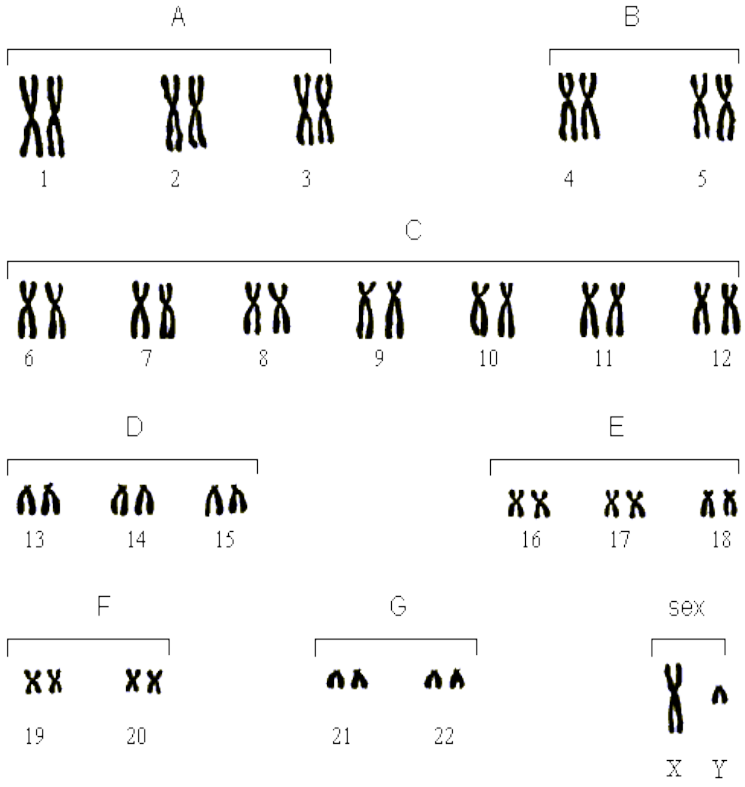


Exception: **Sex chromosomes** (X, Y).

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

Genetics Terminology: Karyotypes





Q: Which, of the two karyotypes above, is replicated?

Q: How many homologous pair in each karyotype?

Image: Karyotype, National Human Genome Research Institute

Karyotype

- **Q**: Describe each of the three karyotypes to the right.

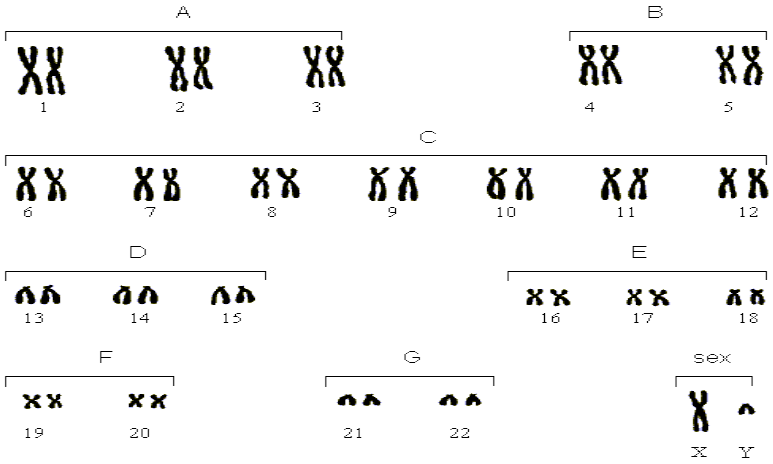


Image: Karyotype, National Human Genome Research Institute

Asexual Reproduction

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

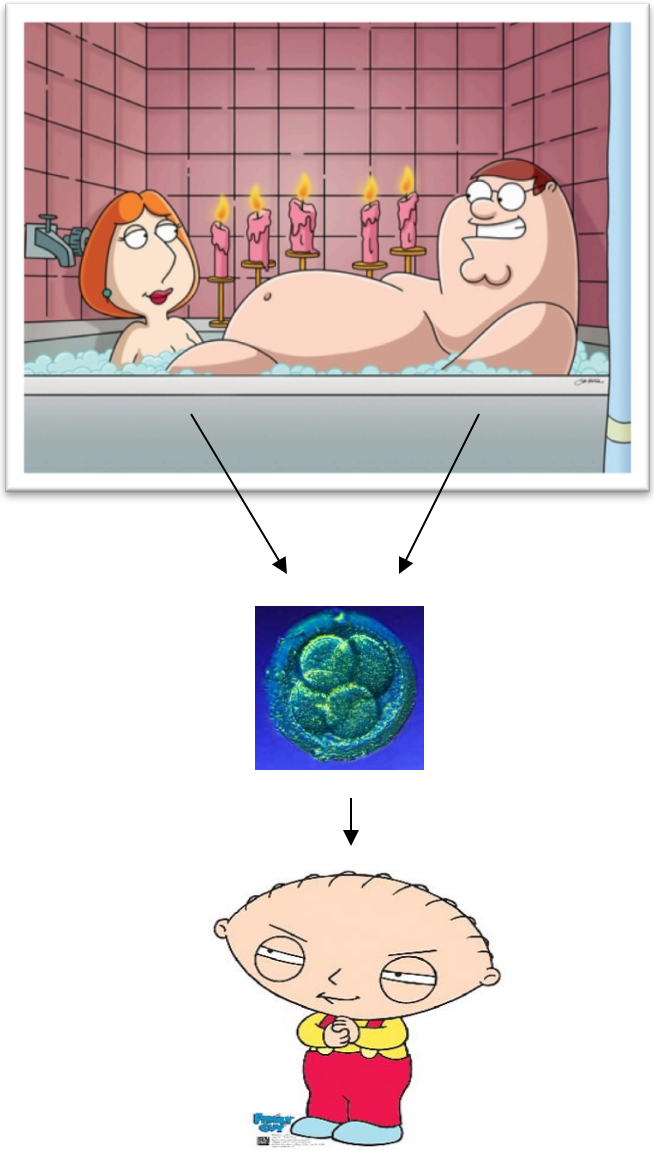
- Some multicellular organisms can reproduce asexually, produce **clones** (*offspring genetically identical to parent*).

- **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

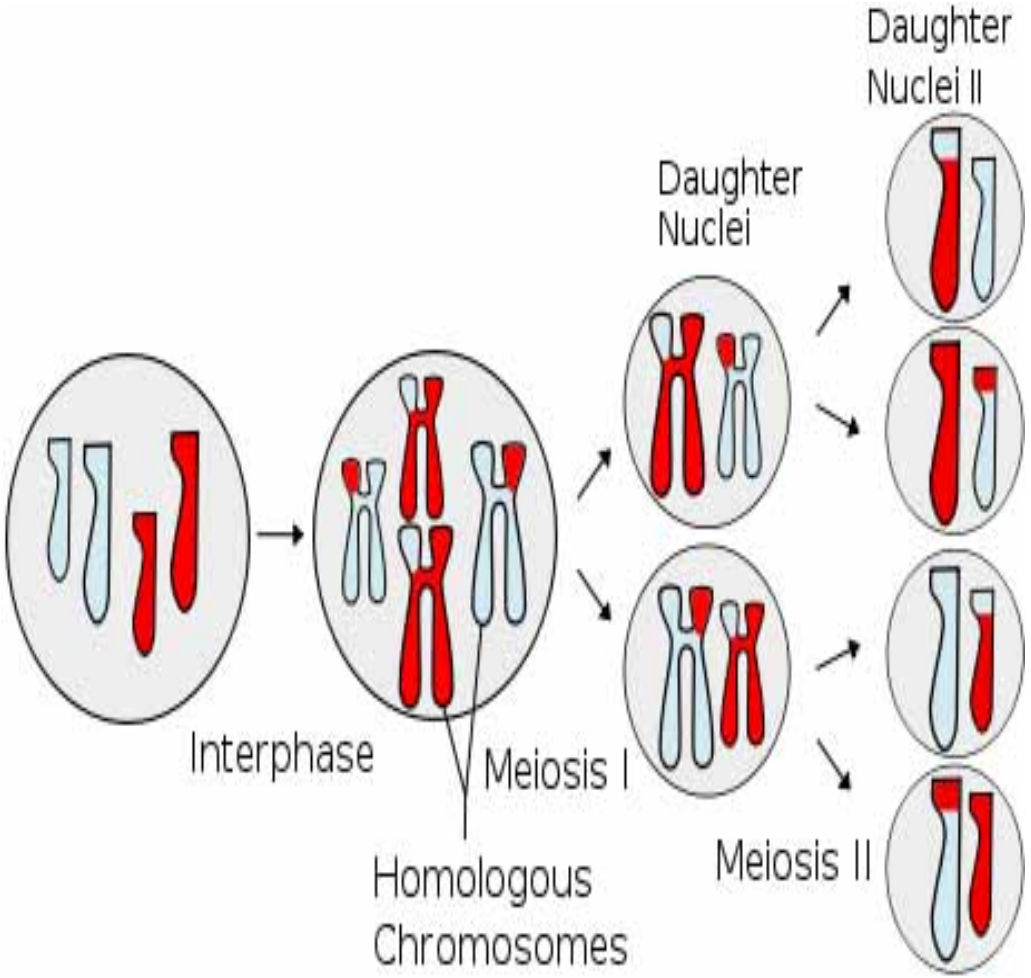
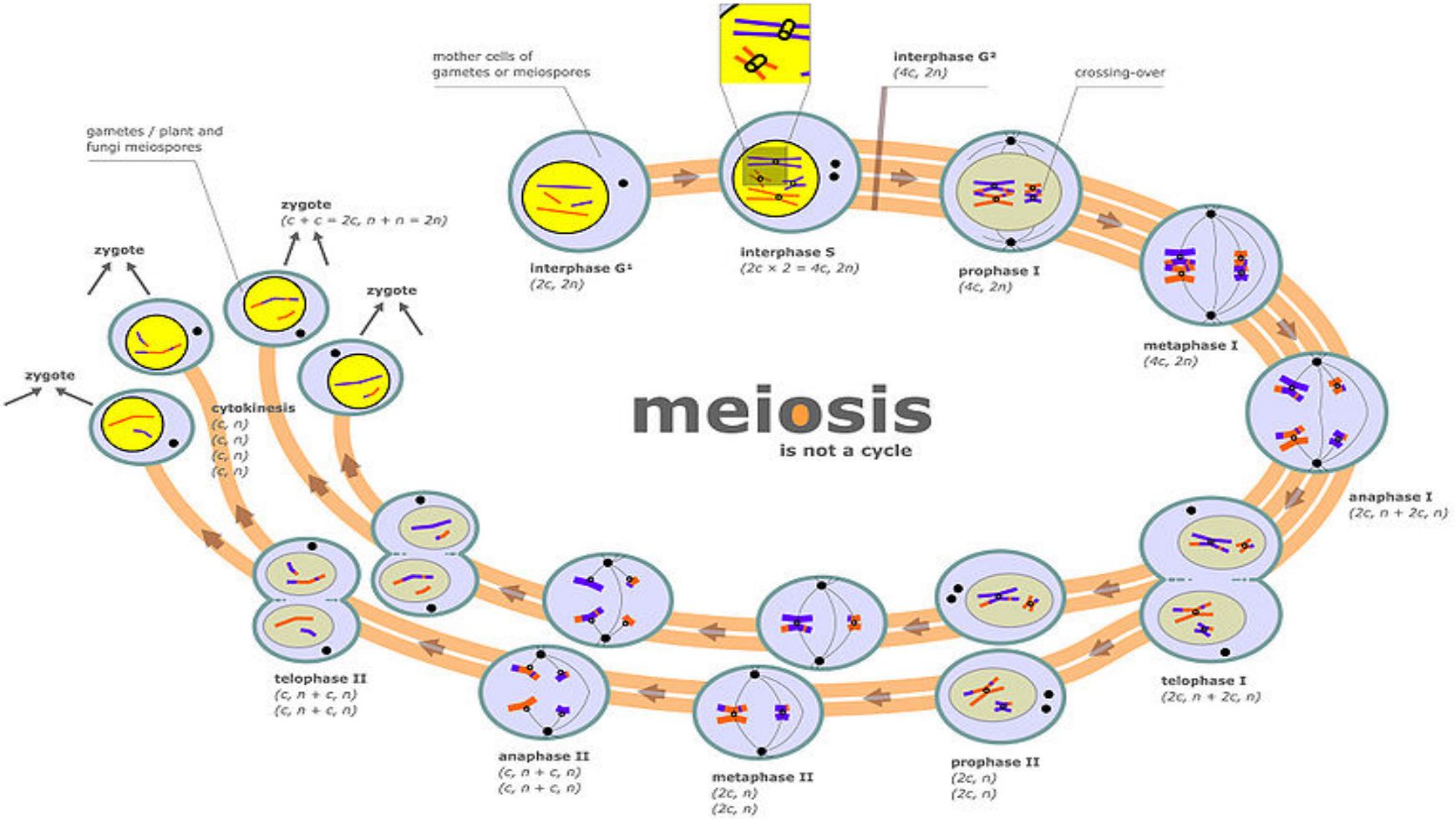


Image: Overview of Meiosis, National Institutes of Health



REVIEW!

Meiosis Animations

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

Image: Meiosis diagram, Marek Kultys

Meiosis & Sexual Reproduction

Life Cycle

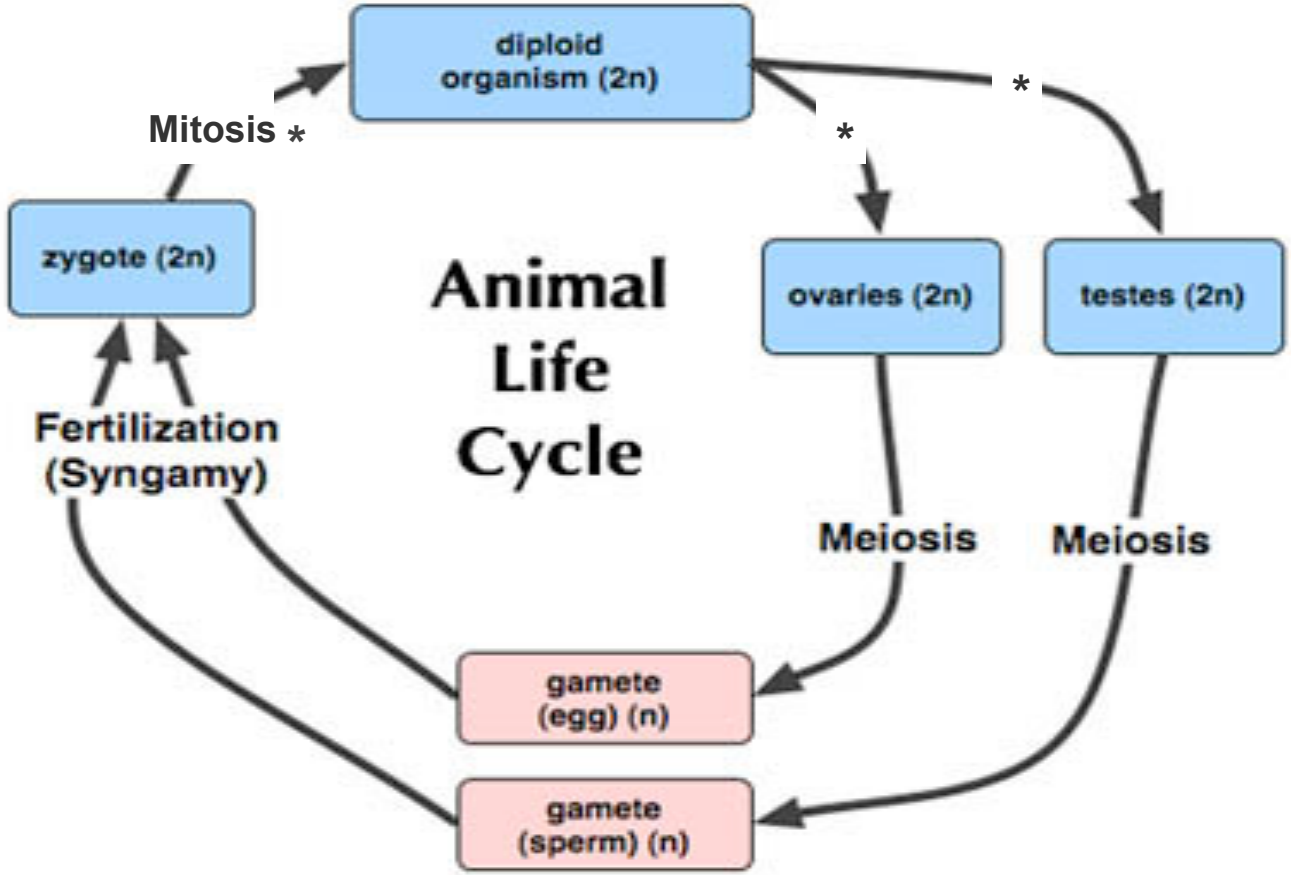
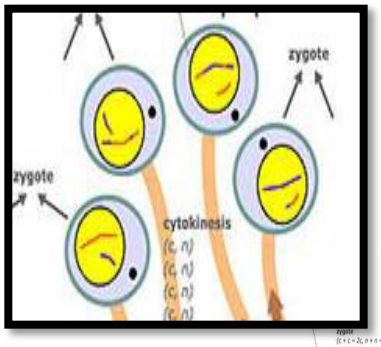
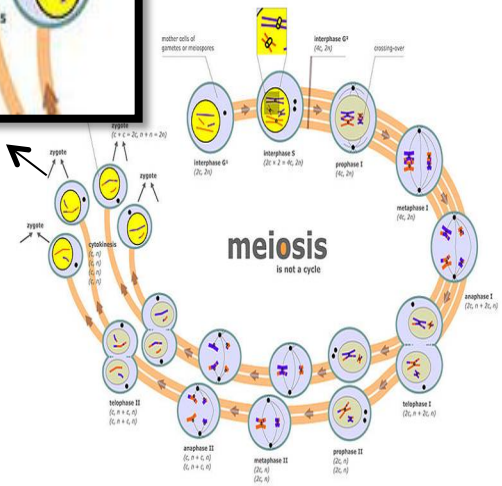


Image: Animal Life Cycle, Dr. T's Bio 328 Genetics

Genetic Variation in Diploid Organisms

- Fusion of sperm and egg results in unique offspring.
- But not only because the young are a product of two individuals with different genetic makeup.
- Meiosis "shuffles" the genes so that the an individual's gametes are genetically different from one another.





How is this shuffling accomplished?

Image: Meiosis diagram, Marek Kultys

Genetic shuffling of Meiosis I

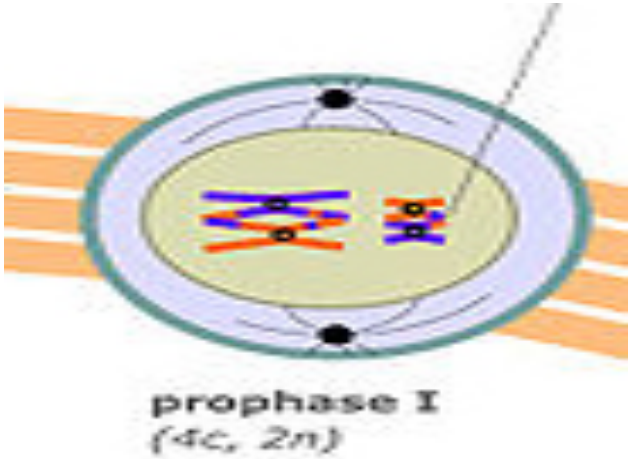
In addition to a new combination of chromosomes resulting from **fertilization**, there are also events in Meiosis I that shuffle the genes.

1. **Crossing over** in Prophase I.

2. **Independent assortment** in Metaphase I.

Crossing Over

- Homologues break at identical locations, then rejoin opposite partners.
- This creates new combinations of the alleles on each chromosome.
- Occurs randomly several times on every chromosome.
- Results in mixing of the genes you inherited from your parents.



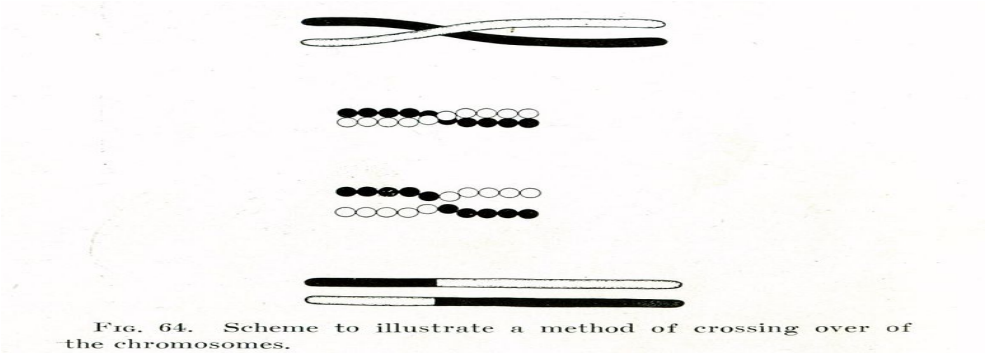


FIG. 64. Scheme to illustrate a method of crossing over of the chromosomes.

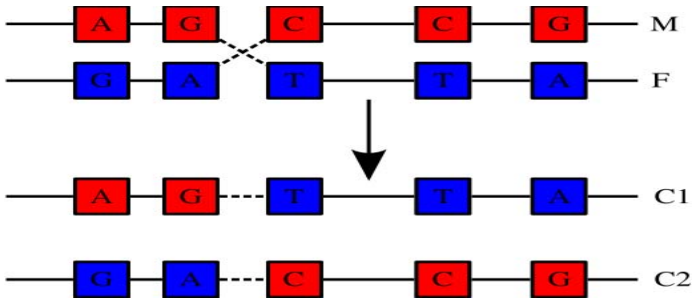
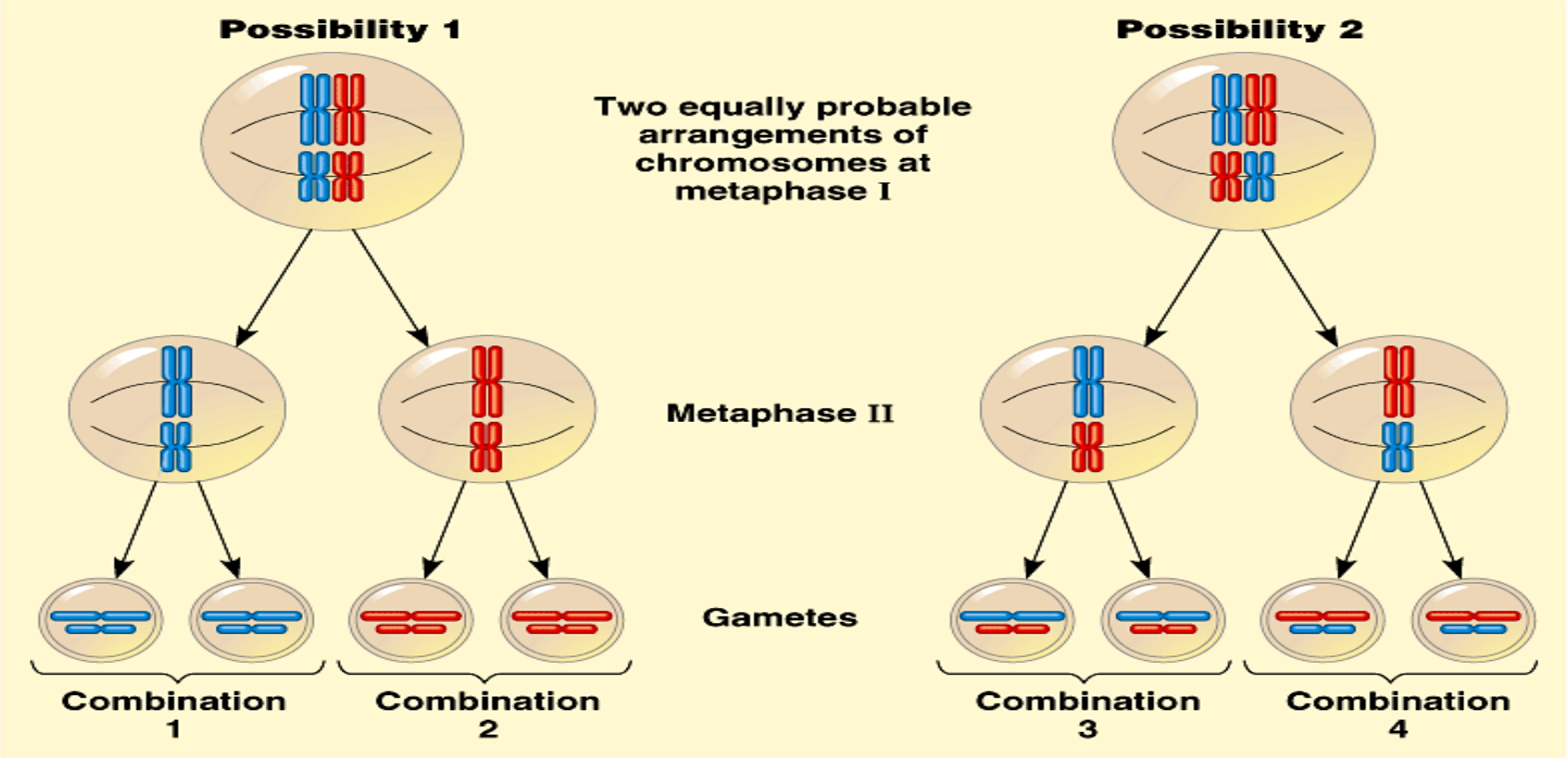


Image: Meiosis diagram, Marek Kultys ; Crossing over, Thomas Hunt Morgan, Molecular crossing over, David Hall

Independent Assortment



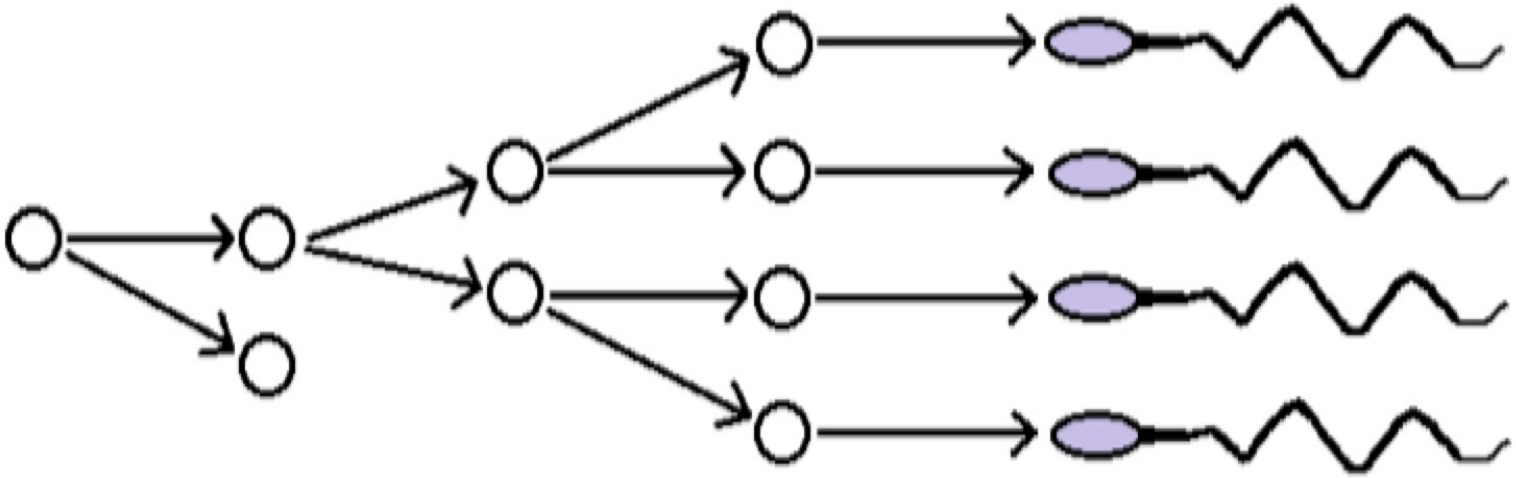
REVIEW!

Independent Assortment Animations

1. Independent Assortment from Sinauer Associates
2. Random Orientation of Chromosomes During Meiosis from McGraw-Hill

Spermatogenesis

Males produce sperm throughout life, after the onset of puberty, about 1,500 sperm per second.



Spermatogonium *Spermatocyte I* *Spermatocyte II* *Spermatid* *Spermatozoa*

Clark et al. (2004)
Eguizabel et al. (2011)

Easley et al. (2012)

Gejisen et al. (2004)

Hayashi et al. (2011)
Toyooka et al. (2003)

Image: Spermatogenesis, Wiki

Oogenesis

Oogenesis in females is probably complete either before or shortly after birth.

During oogenesis, three polar bodies develop as the mature ovum is generated.

Polar bodies contain little cytoplasm and eventually degenerate.

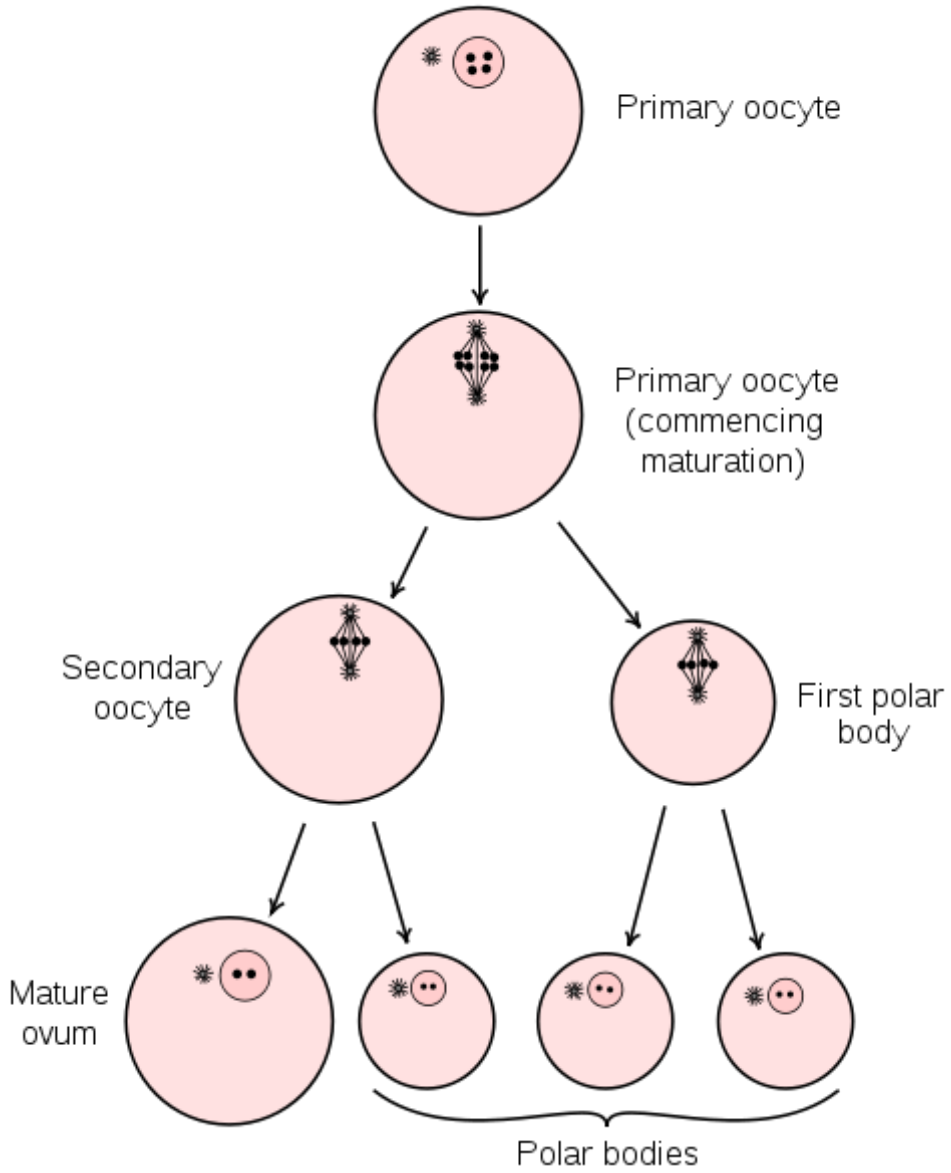


Image: Oogenesis, Wiki

Mitosis vs. Meiosis

- 2n
- Clone
- Same genetic information in parent cell and daughter cell.
- Give me another one just like the other one!

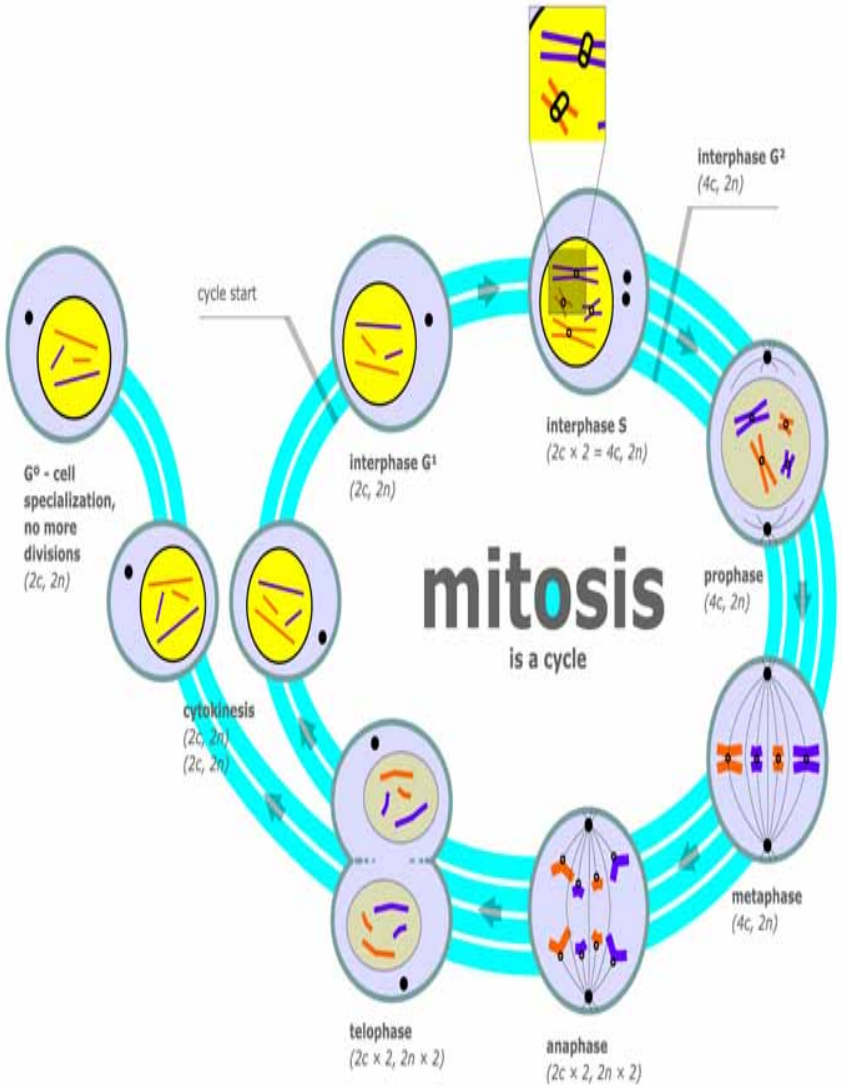
- 1n
- Daughter cells different from parent cell and from each other.
- Daughter cells have $\frac{1}{2}$ the number of chromosomes as somatic cell.
- Shuffling the genes
  (Mix it up!)
- See animation "Unique Features of Meiosis" from McGraw-Hill

REVIEW!

Animations Comparing Mitosis & Meiosis

Quiz 1 and Quiz 2

from McGraw-Hill



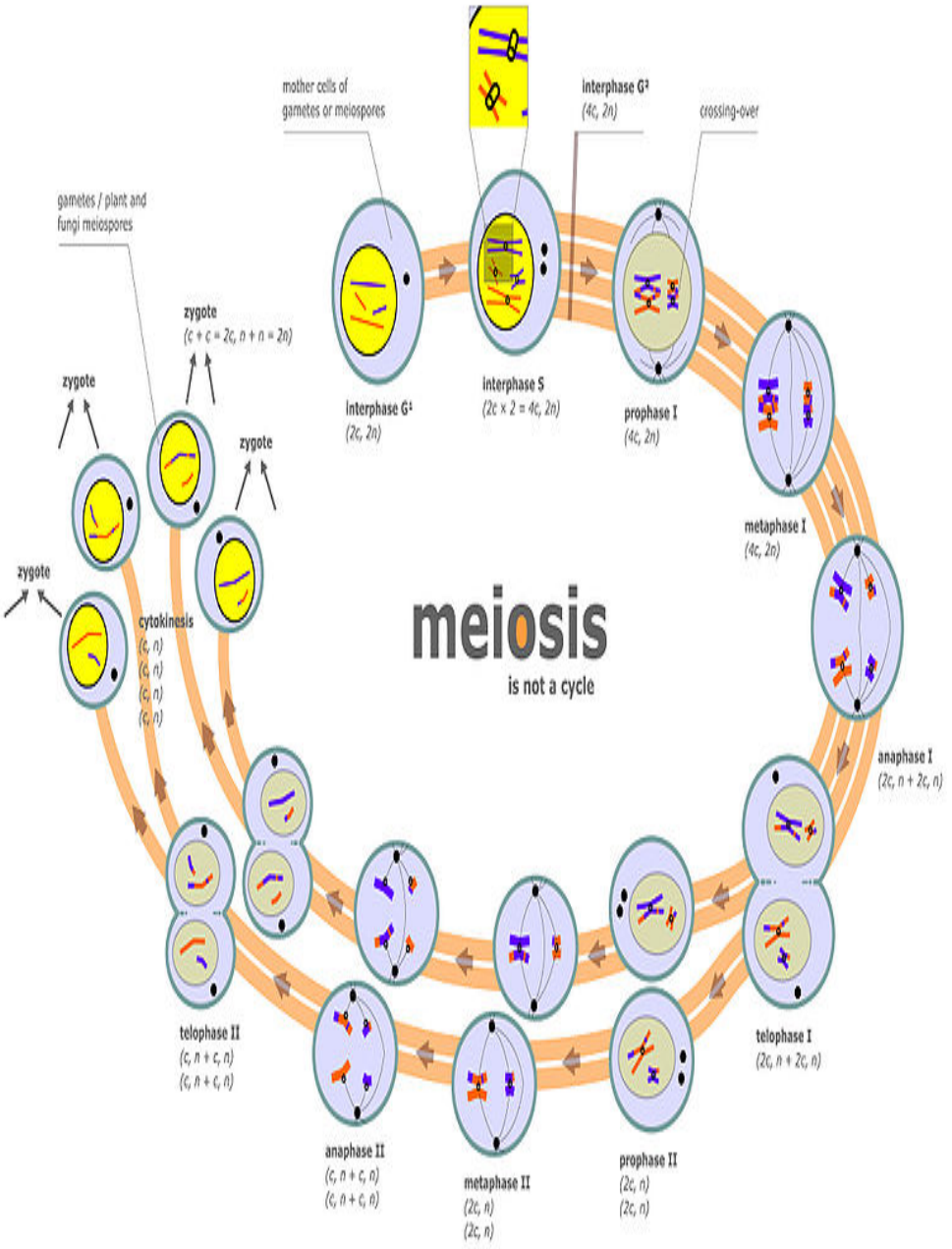


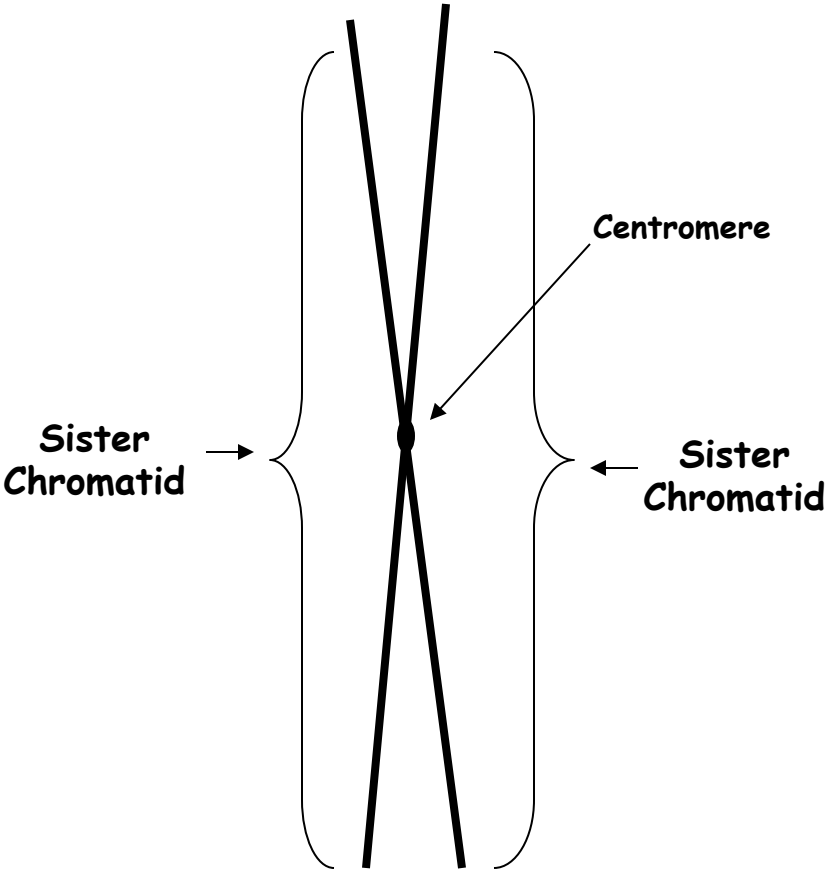
Image: Mitosis diagram & Meiosis diagram, Marek Kultys

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Drawing and Labeling Chromosomes

Unreplicated
Uncondensed
Chromosome

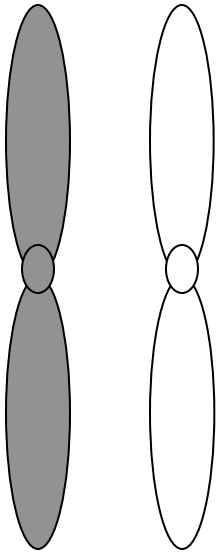
(chromatin)



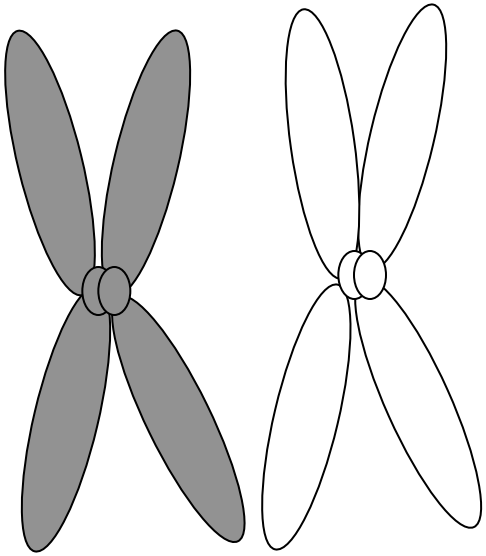
Replicated
Uncondensed
Chromosome

(chromatin)

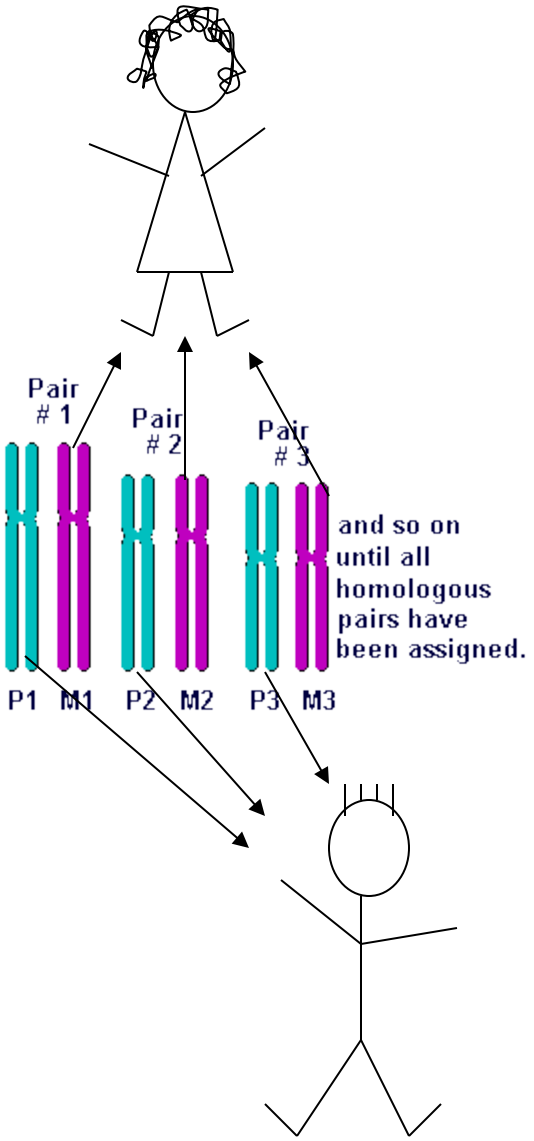
Drawing & Labeling Homologous Chromosomes



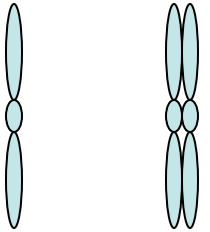
Unreplicated, Condensed, Homologous Chromosomes



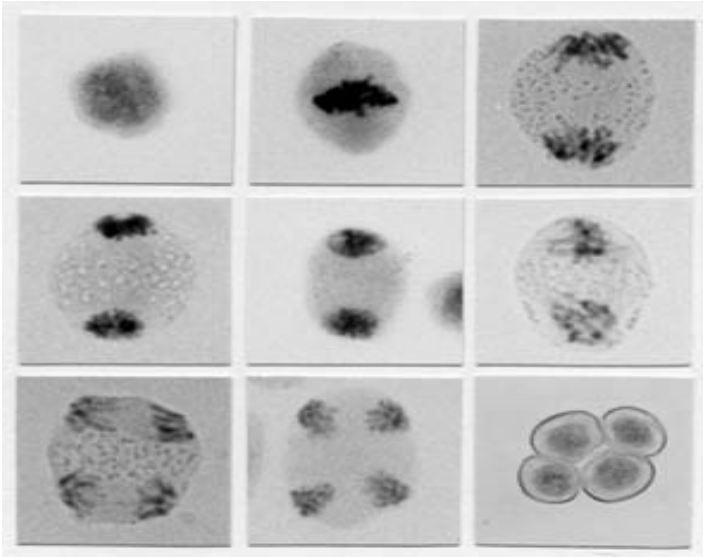
Replicated, Condensed, Homologous Chromosomes



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 meiosis.
- BEFORE you start writing on your 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.)
- Do not depict cross-over in your diagrams. You need to be able to track the journey of each individual chromosome from start to finish.



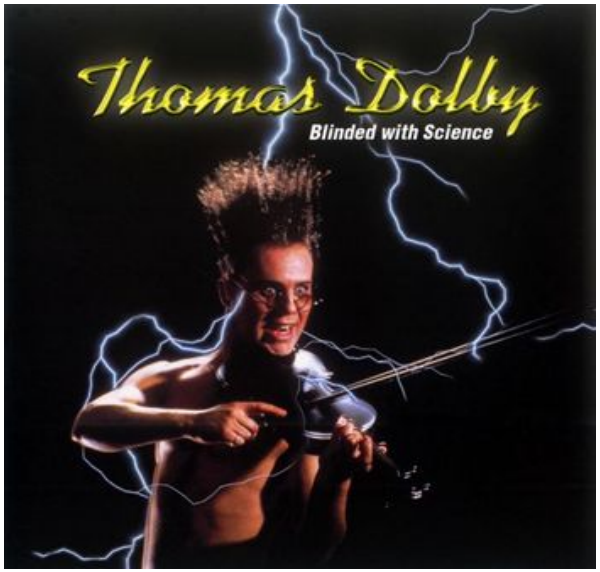
See the ScienceProfOnline Virtual Cell Biology Classroom **Genetics: Cell Division - Meiosis & Sexual Reproduction** for a printable Word .doc of this assignment.

Confused?

Here are links to fun resources that further explain meiosis:

Smart Links

- Meiosis Main Page on the Virtual Cell Biology Classroom of Science Prof Online.
- "Meiosis: Where the Sex Starts", video from Crash Course Biology
- Meiosis animation, step-through and quiz, Sadava, et al., *Life: The Science of Biology*, 9th Edition, Sinauer Associates.
- Meiosis step through animation from CellsAlive.com.
- "X & Y" song by Coldplay
- Meiosis animation from McGraw-Hill.
- Independent Assortment animation from Sinauer Associates.
- "Let's Talk About Sex" music video by Salt 'n' Pepa.

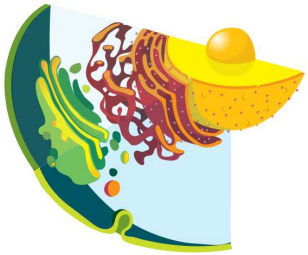


Are you feeling blinded by science?

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 VCBC by going to the Science Prof Online website
www.ScienceProfOnline.com

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