



# **SNS COLLEGE OF TECHNOLOGY**

(An Autonomous Institution)

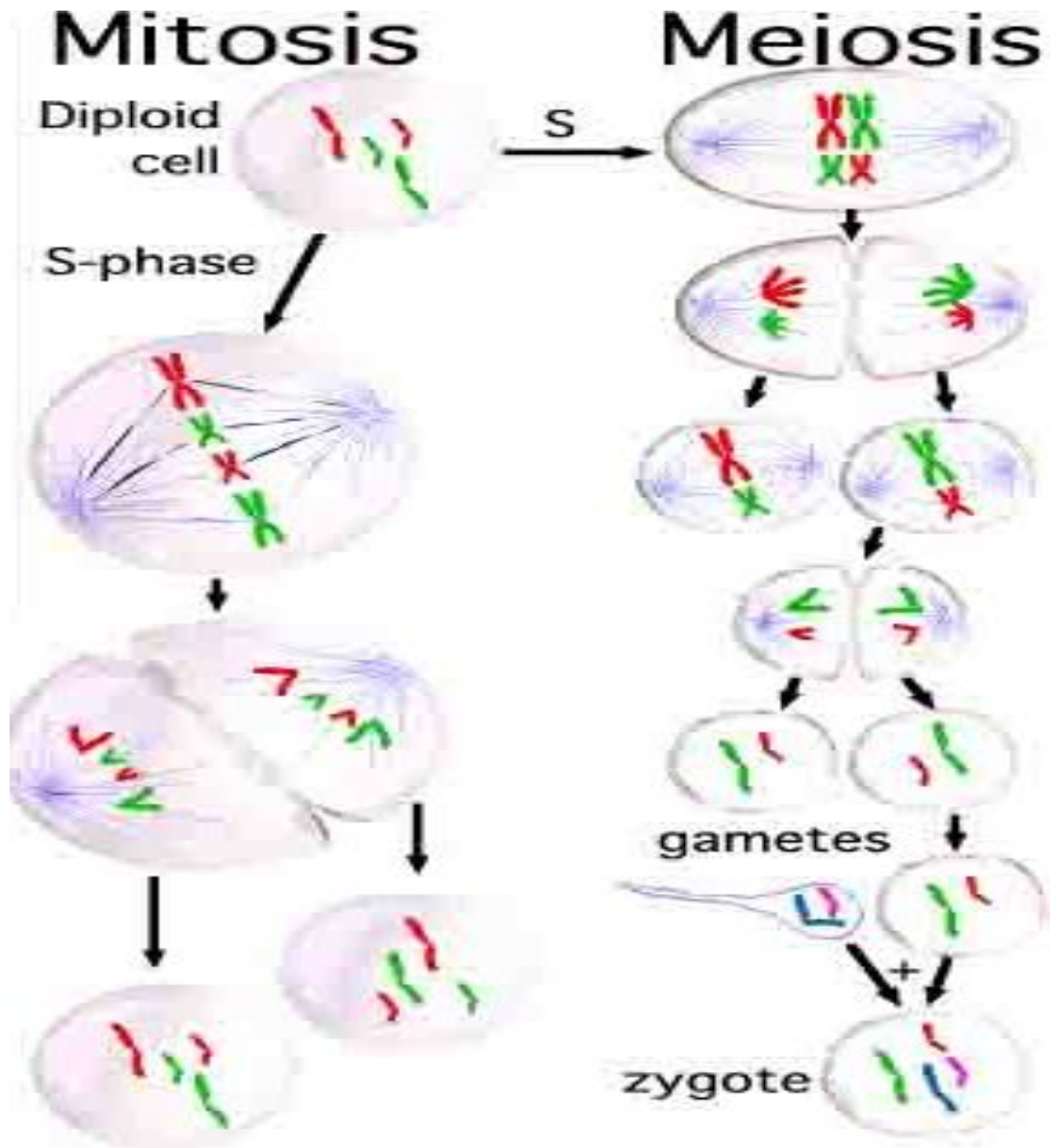
**COIMBATORE-35**

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## **19GET277 / Biology For Engineers IV YEAR / VII SEMESTER UNIT-III: GENETICS AND IMMUNE SYSTEM**

# **MITOSIS AND MEIOSIS**



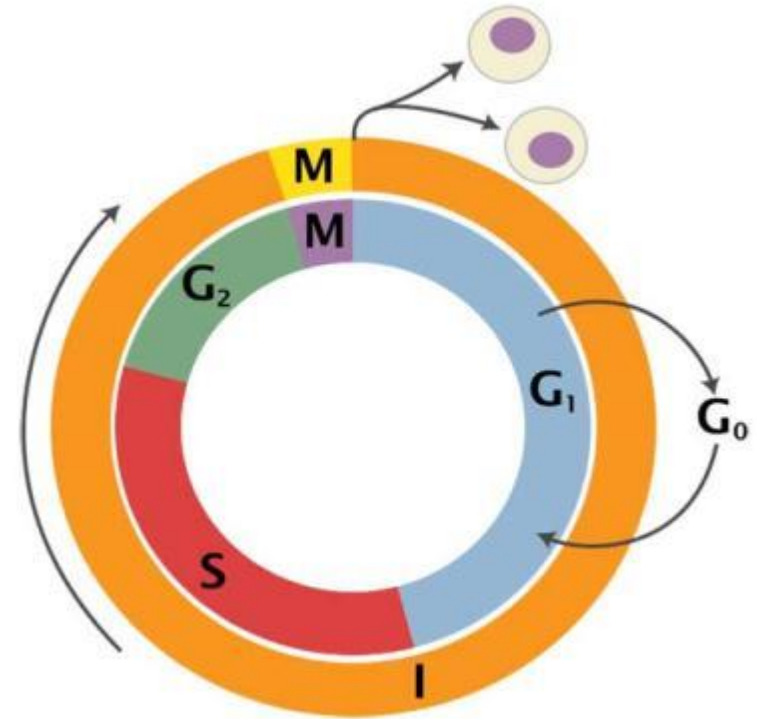
# Cell Division

## Mitosis & Meiosis

# Eukaryotic Cell Cycle

- Cell grows.
- DNA is replicated.
- Mitotic cell division produces daughter cells identical to the parent.
- Repeat.

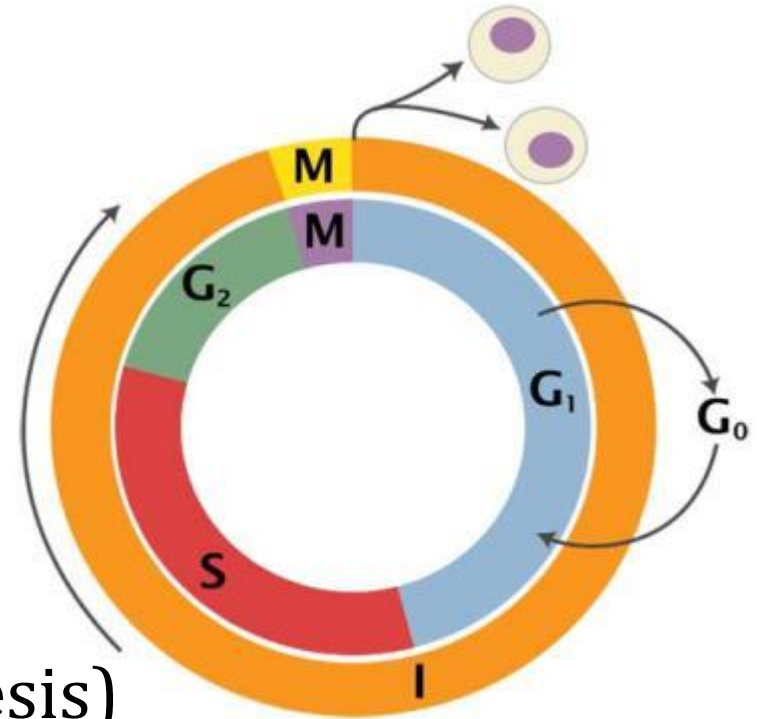
The timing of replication and cell division is highly regulated.

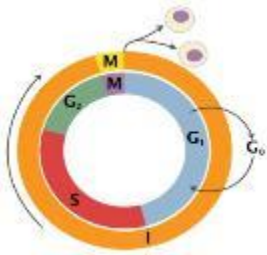


# Eukaryotic Cell Cycle

2 major phases:

- **Interphase** (3 stages)
  - DNA is not condensed
- **Mitosis** (4 stages + cytokinesis)
  - Nuclear division & division of cytoplasm
  - DNA condensed





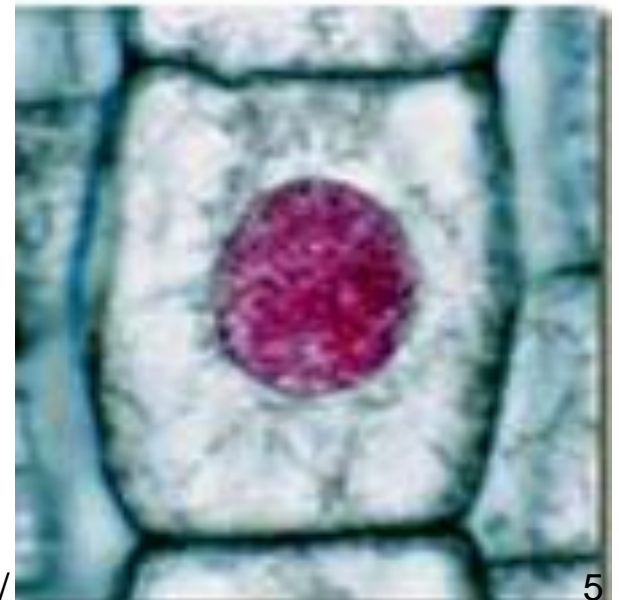
# Interphase

**Non-dividing state  
with 3 sub-stages:**

Gap 1 – cell grows in size  
– organelles replicated

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

Gap 2 – synthesis of proteins  
associated with mitosis

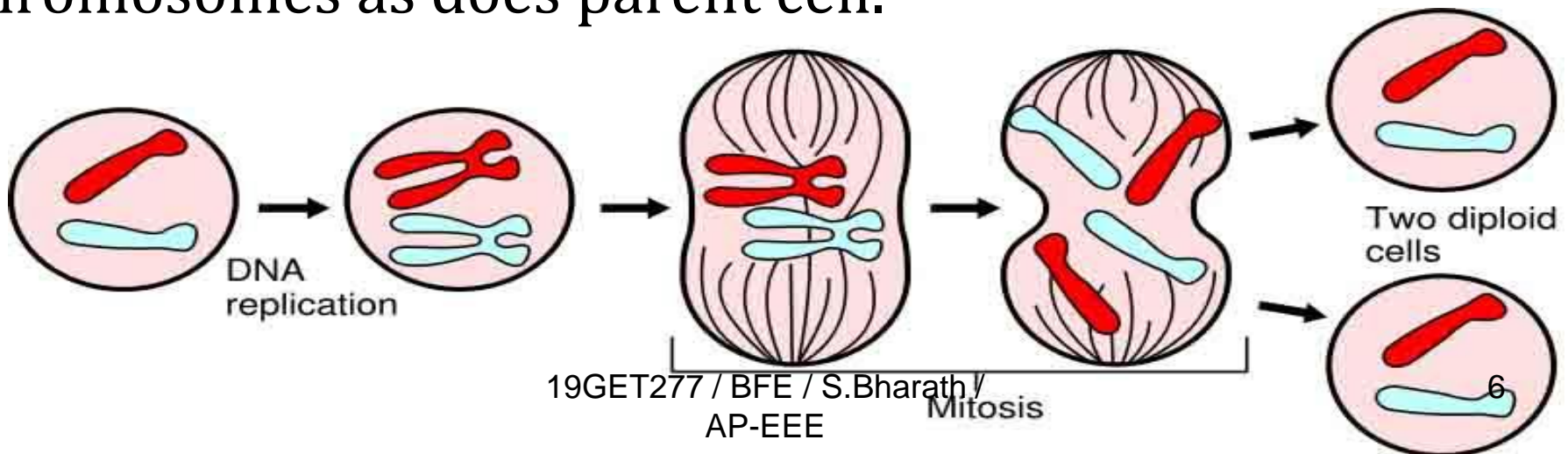
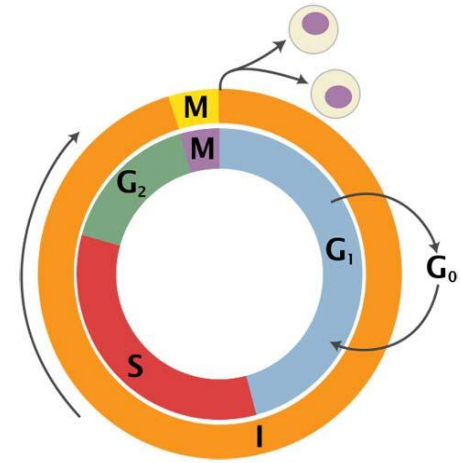


# Mitosis

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

A single cell divides into two identical daughter cells.

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



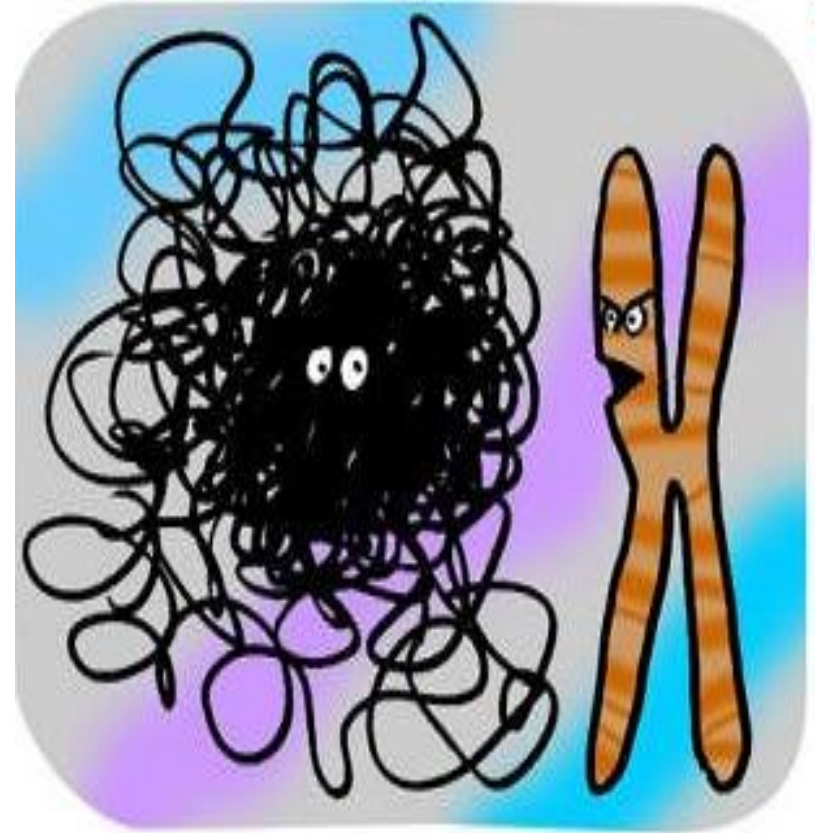
# Packing for the move...

## When the cell is not dividing...

- DNA molecules are in extended, uncondensed form = **chromatin**
- Cell can only replicate and transcribe DNA when it is in the extended state.

## When the 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



Dude, mitosis starts in five minutes...  
I can't believe you're not condensed yet.

# Mitosis

4 sub-phases:

1<sup>st</sup> – Prophase

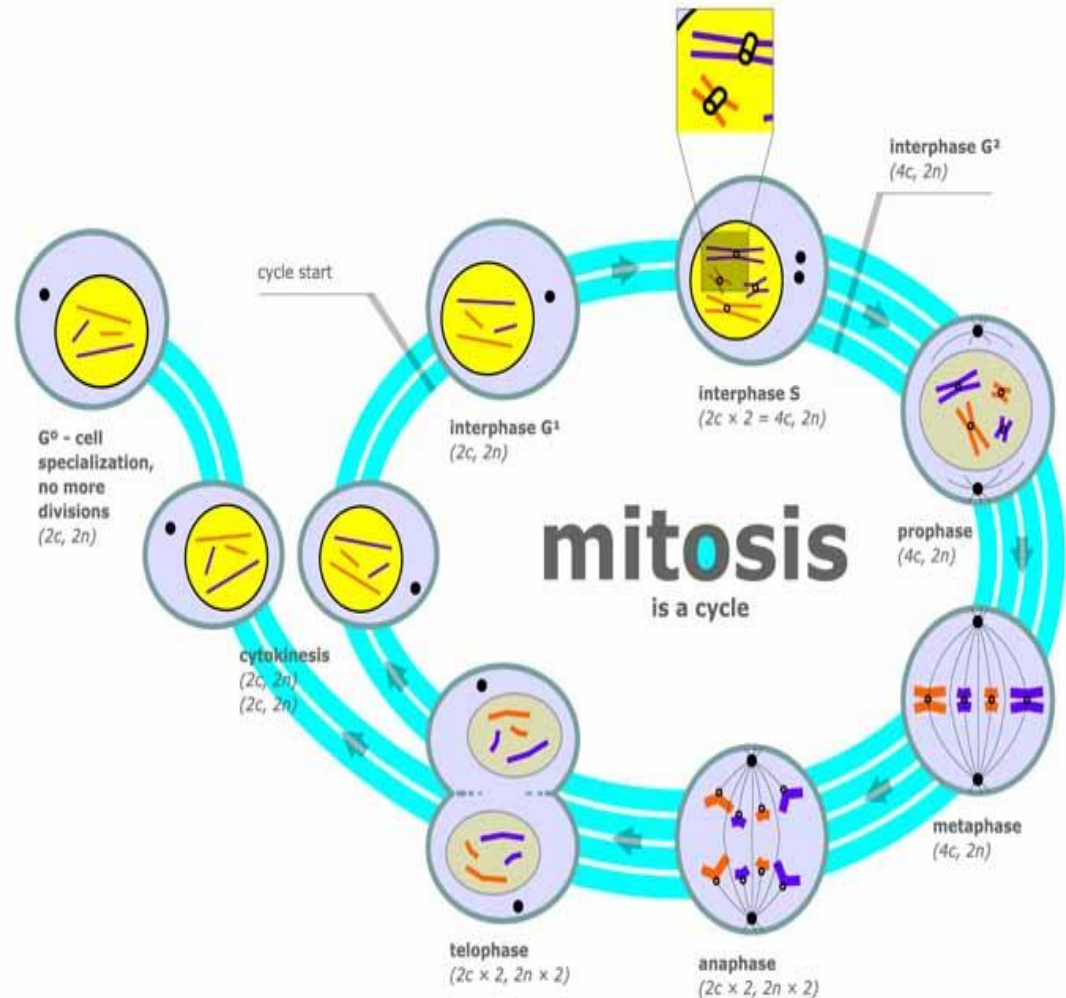
2<sup>nd</sup> – Metaphase

3<sup>rd</sup> – Anaphase

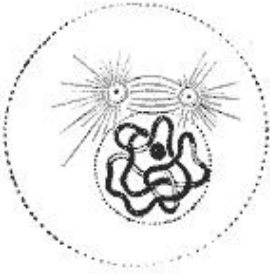
4<sup>th</sup> – Telophase

*followed by*

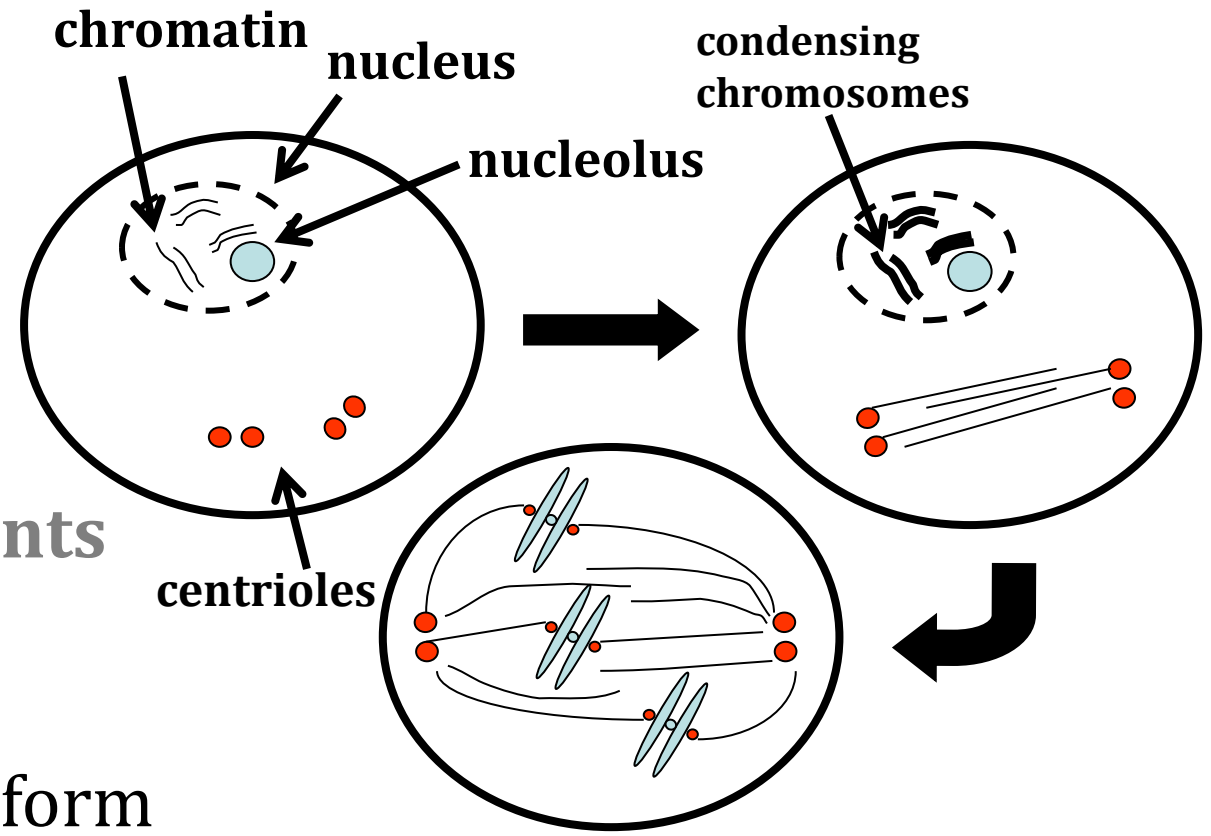
**Cytokinesis**





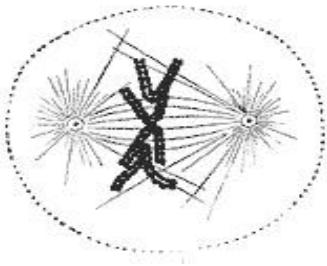


# 1. Prophase

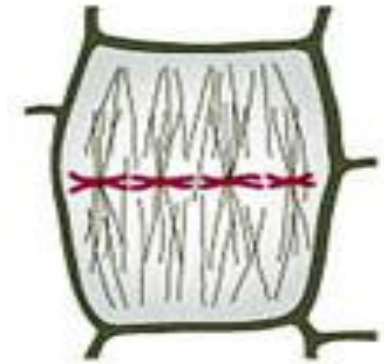


## Three Major Events

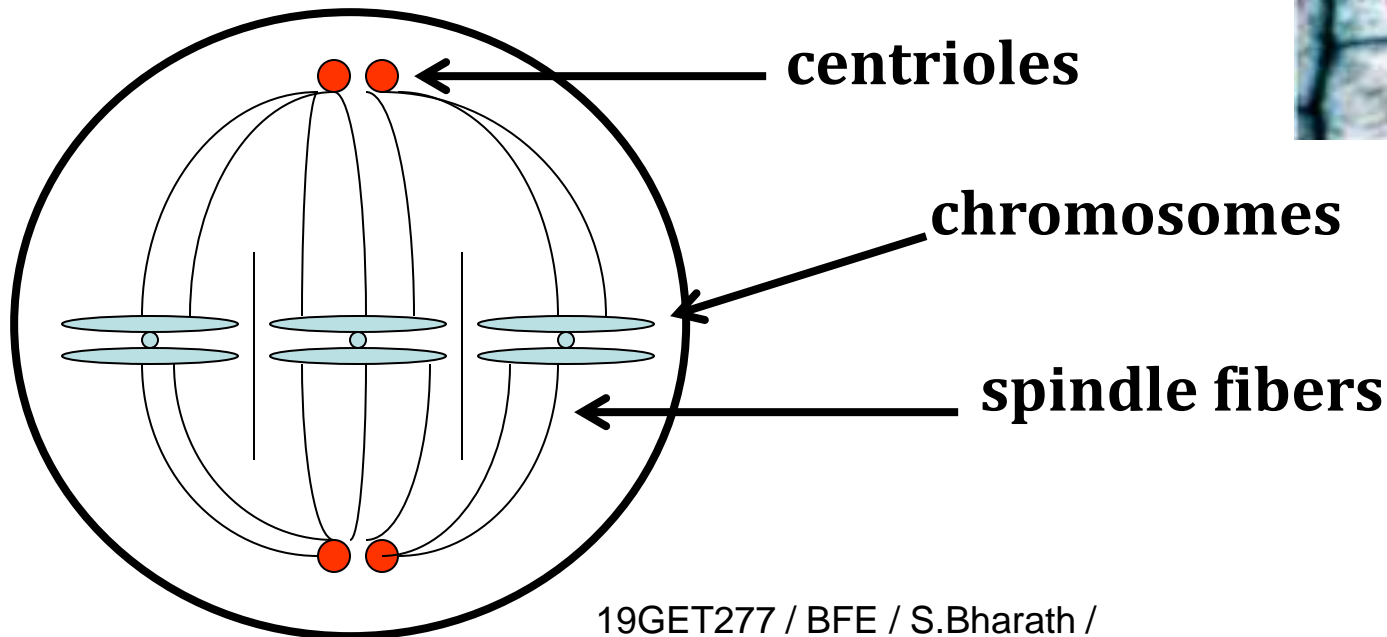
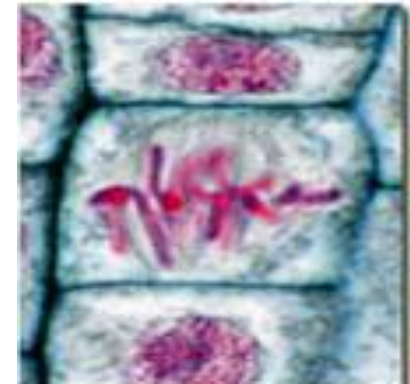
1. chromosomes condense
2. spindle fibers form
  1. (spindle fibers are specialized microtubules radiating out from centrioles)
3. chromosomes are captured by spindle

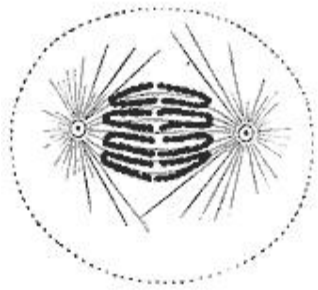


## 2. Metaphase



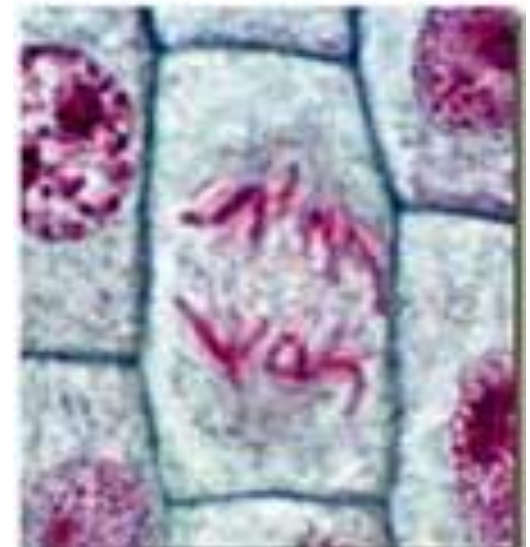
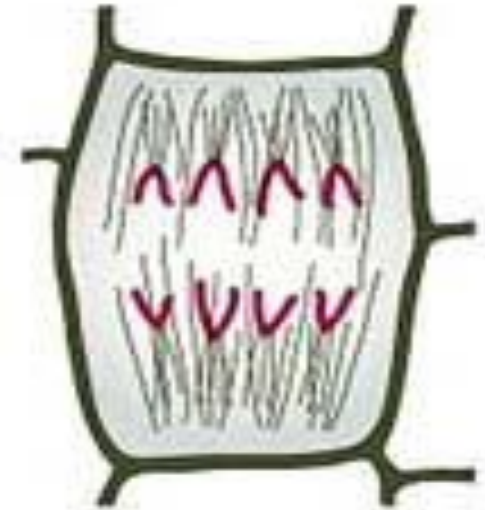
- chromosomes align along the equator of the cell, with one chromatid facing each pole

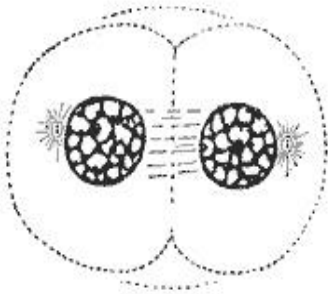




# 3. Anaphase

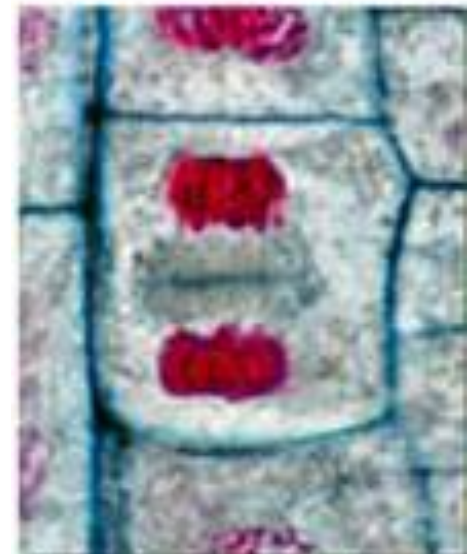
- sister chromatids separate
- spindle fibers attached to kinetochores **shorten** and **pull** chromatids towards the poles.
- free spindle fibers **lengthen** and **push** the poles of the cell apart

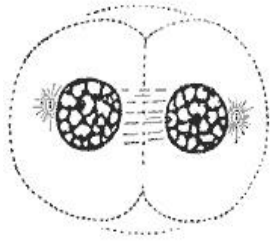




## 4. Telophase

- 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





# Cytokinesis – Plant vs. Animal Cell



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

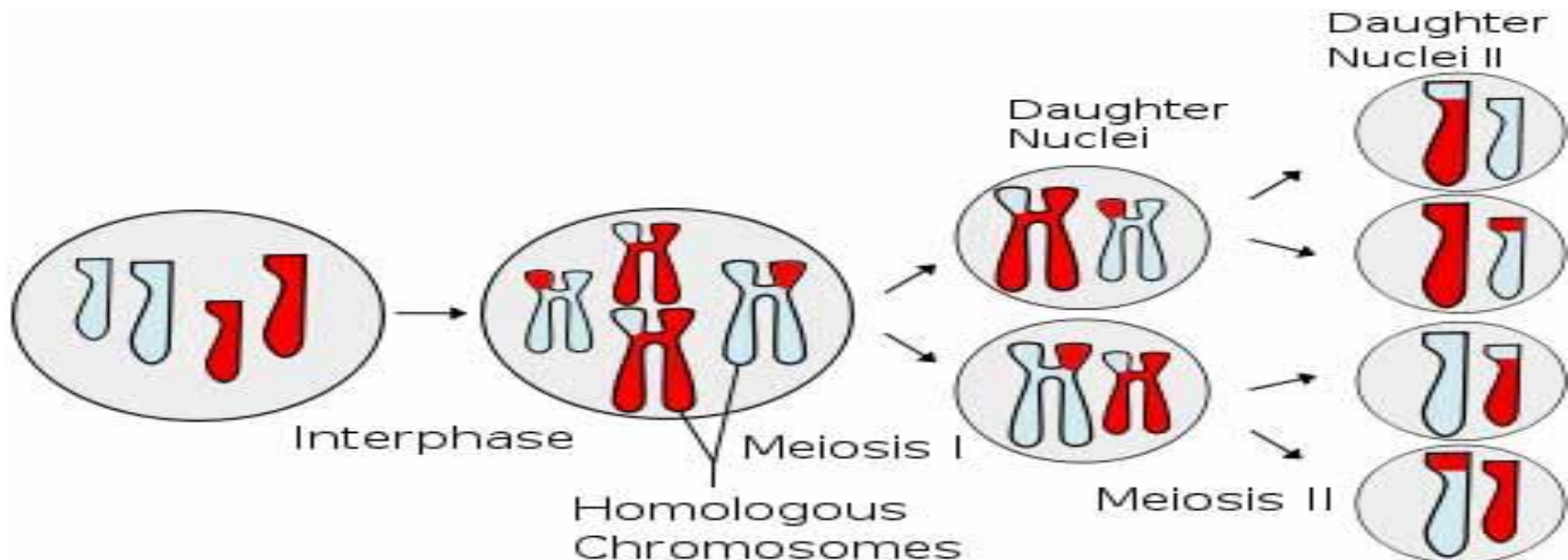


- **Animal cells** undergo cytokinesis through the formation of a cleavage furrow. A ring of microtubules contract, pinching the cell in half.

# 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 are considered **haploid**.



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AP-EEE

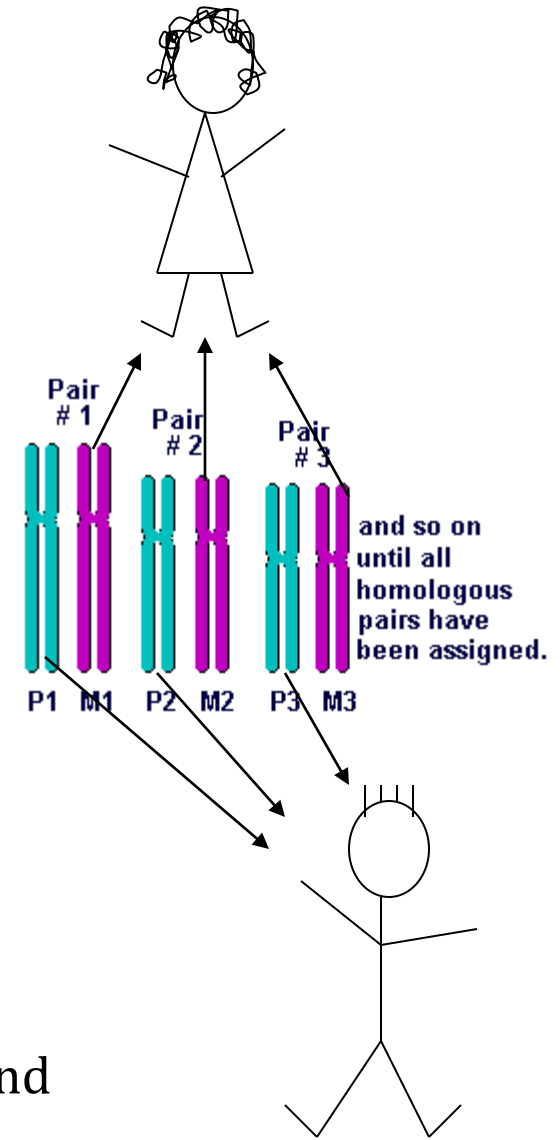
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# Genetics Terminology: Ploidy

Refers to the number of sets of chromosomes in cells.

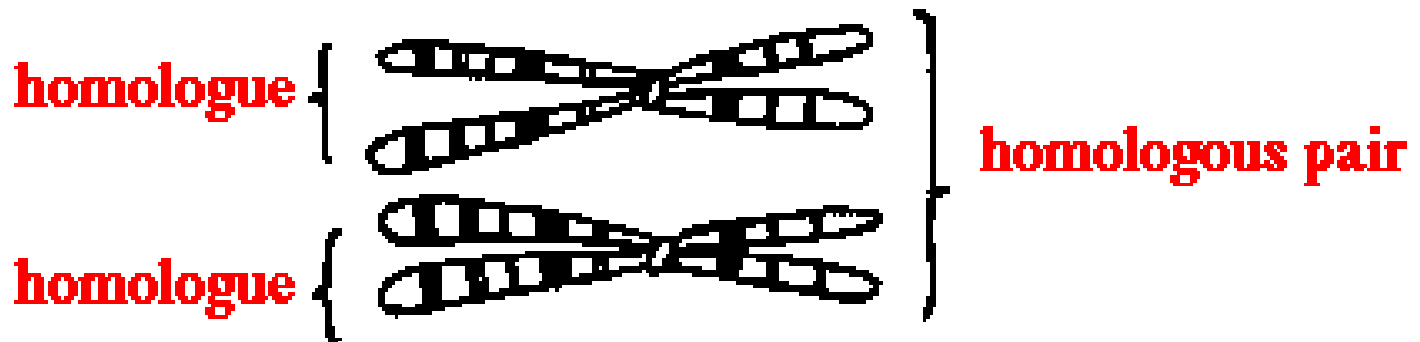
- **Haploid** – one copy of each chromosome
  - designated as “ $n$ ”, the number of chromosomes in one “set”
  - gametes
- **Diploid** – two sets of chromosomes (two of each chromosome)
  - designated as “ $2n$ ”
  - somatic cells

**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.

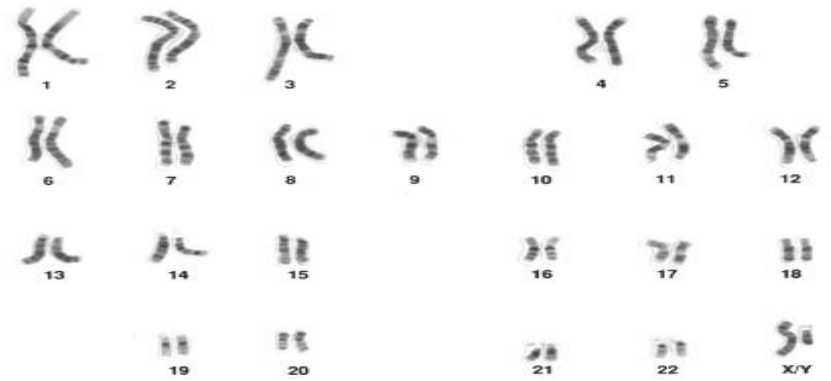


Exception: **Sex chromosomes** (X, Y).

All other chromosomes (**autosomes**) have homologues.

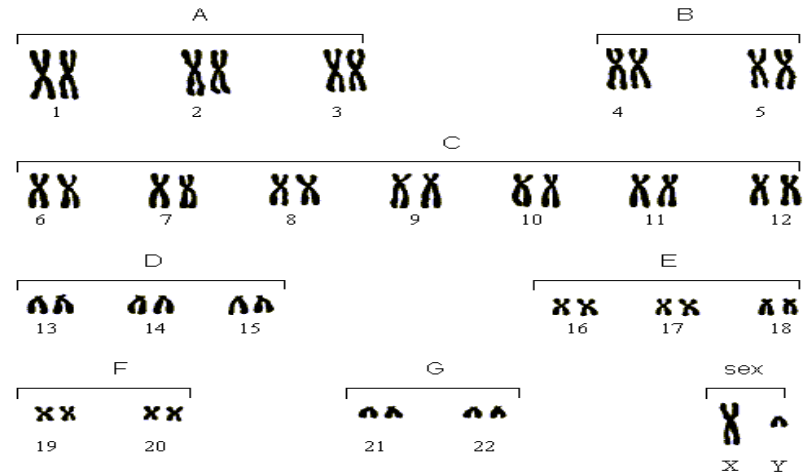


# Karyotype



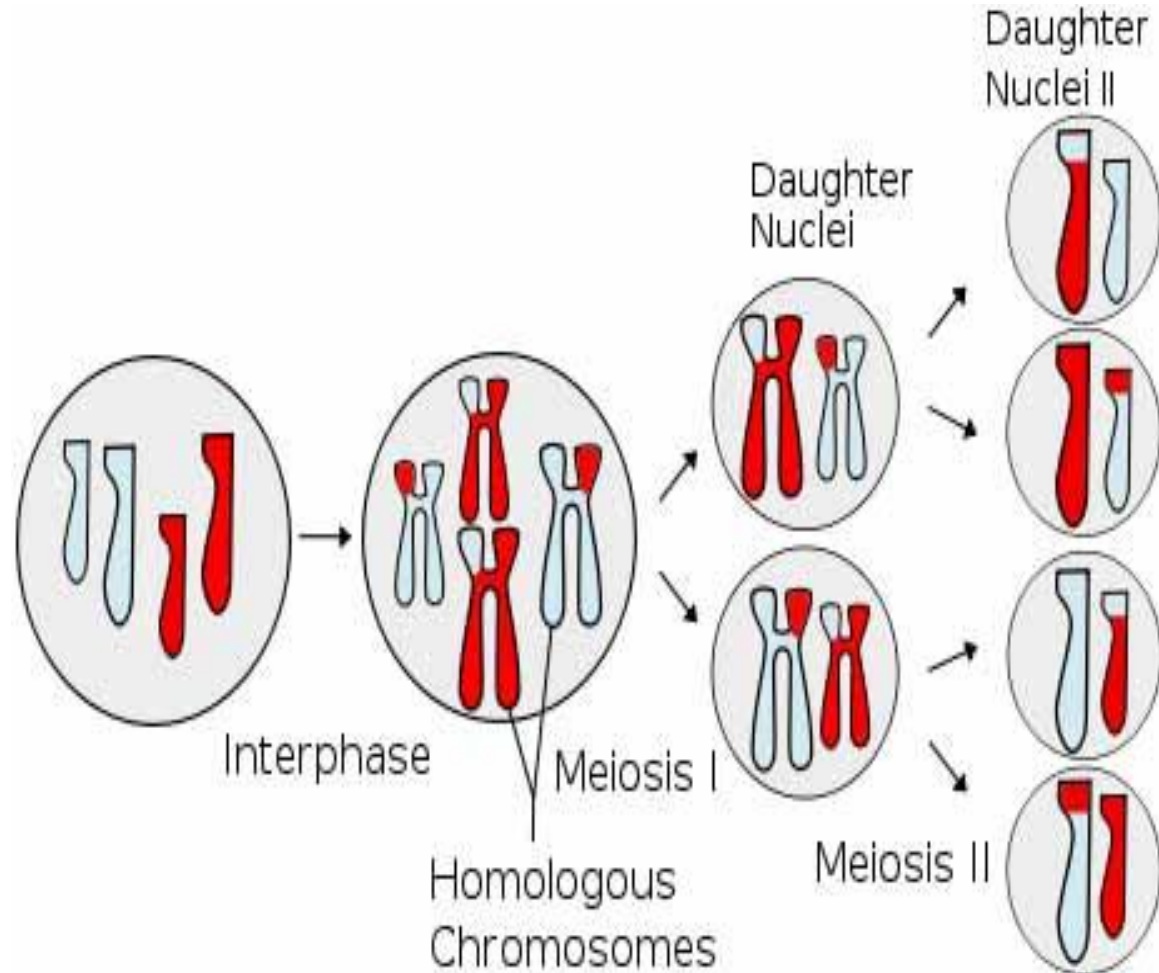
- **Q:** How many homologous pairs are in each karyotype?

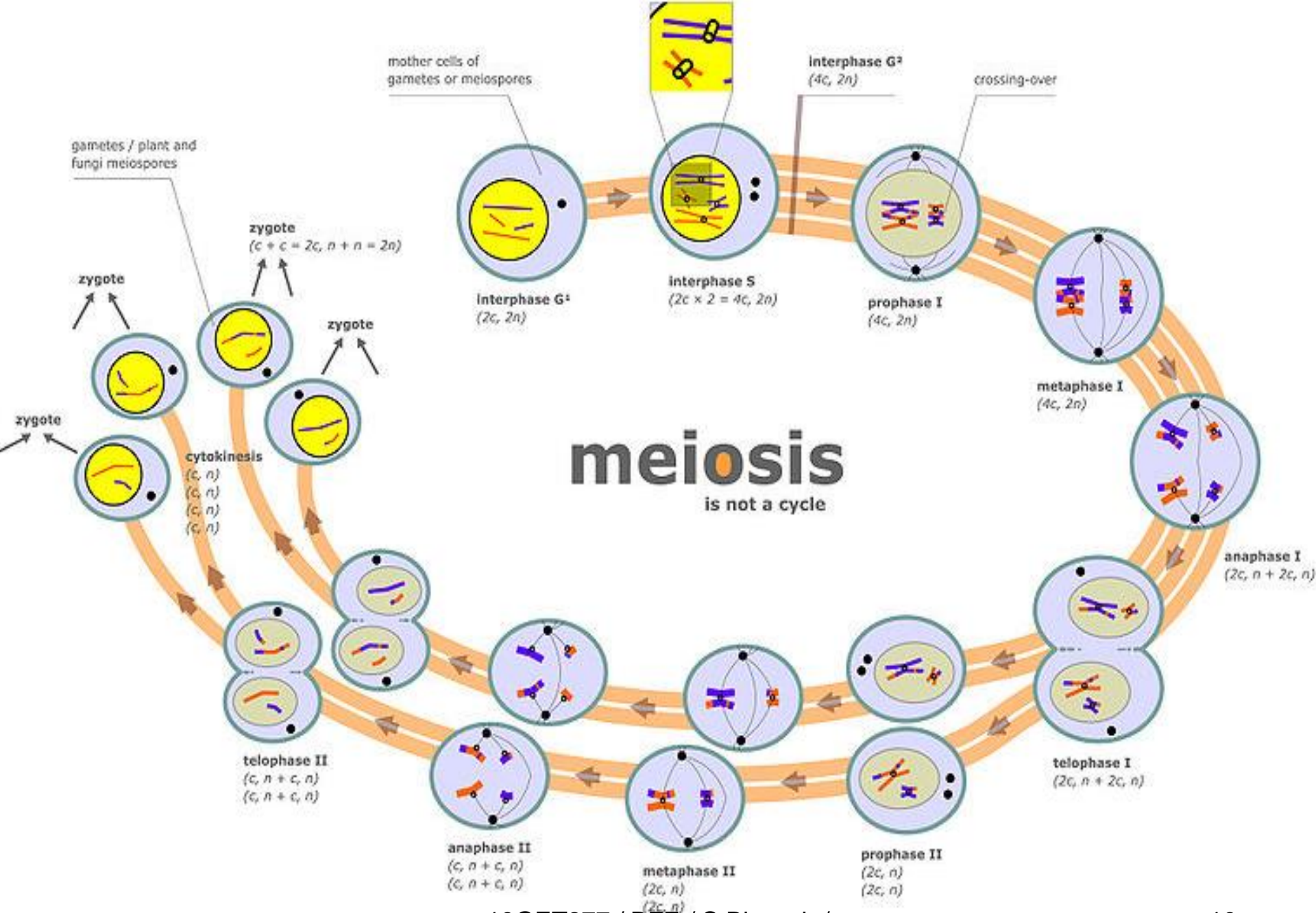
- **Q:** How is the bottom karyotype different from the top two?



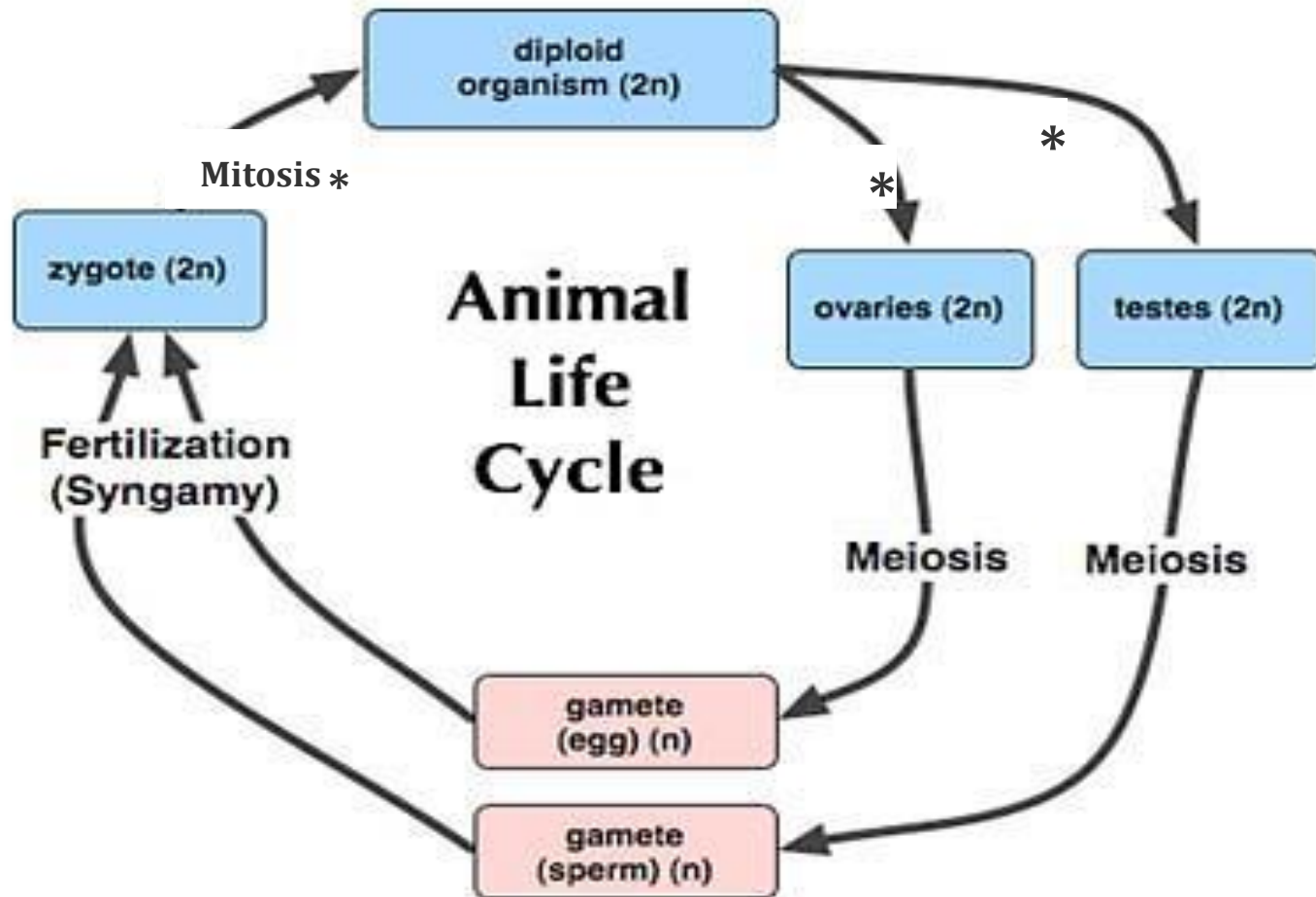
# Meiosis - Sex Cell (Gamete) Formation

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





# Meiosis & Sexual Reproduction Life Cycle



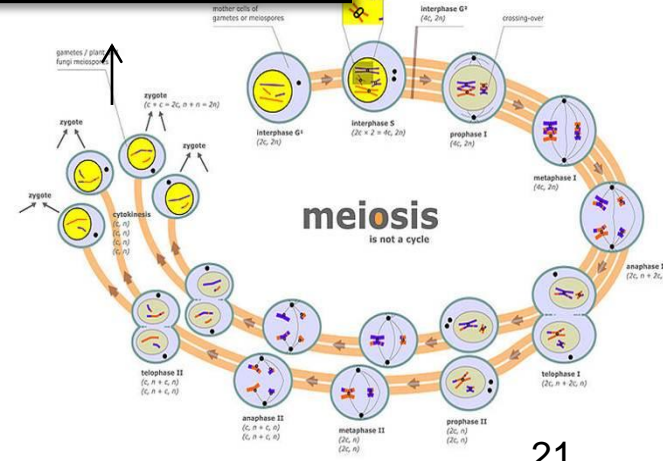
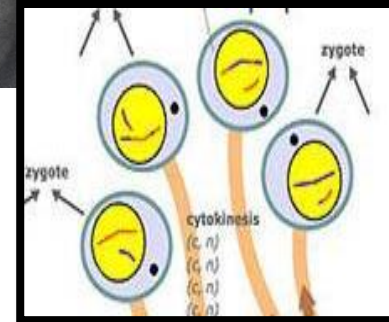
# Genetic Variation in Diploid Organisms



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 also “shuffles” the genes so that the an individual’s gametes are genetically different from one another.



How is this shuffling accomplished? 19GET277 / REF / S. Bharath / AP-EEE

# Genetic shuffling of Meiosis I

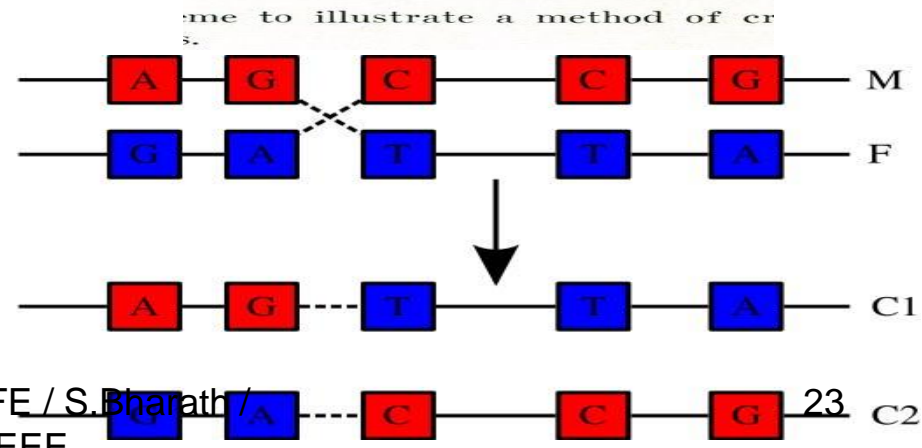
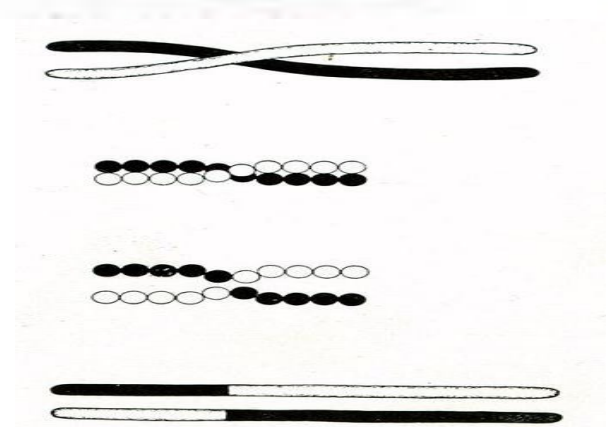
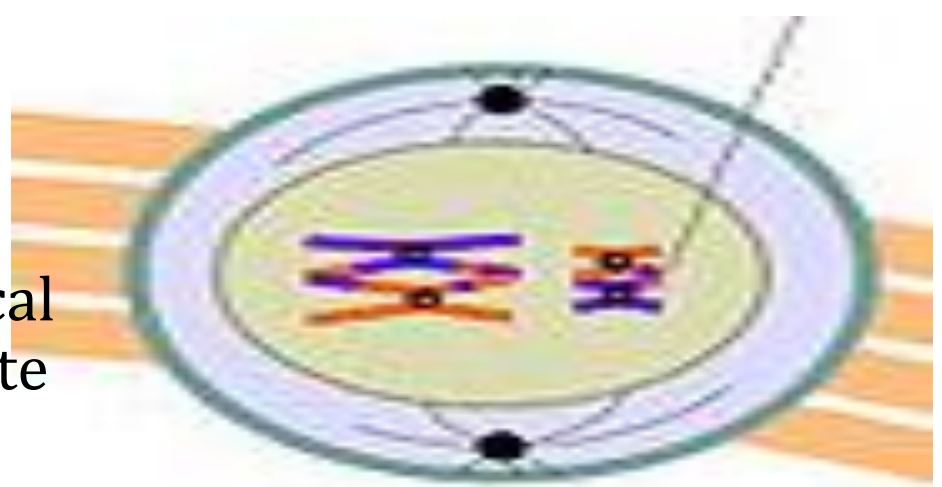
In addition to a new combination of chromosomes resulting from **fertilization**, there are also events in Meiosis I that shuffle the genes.

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

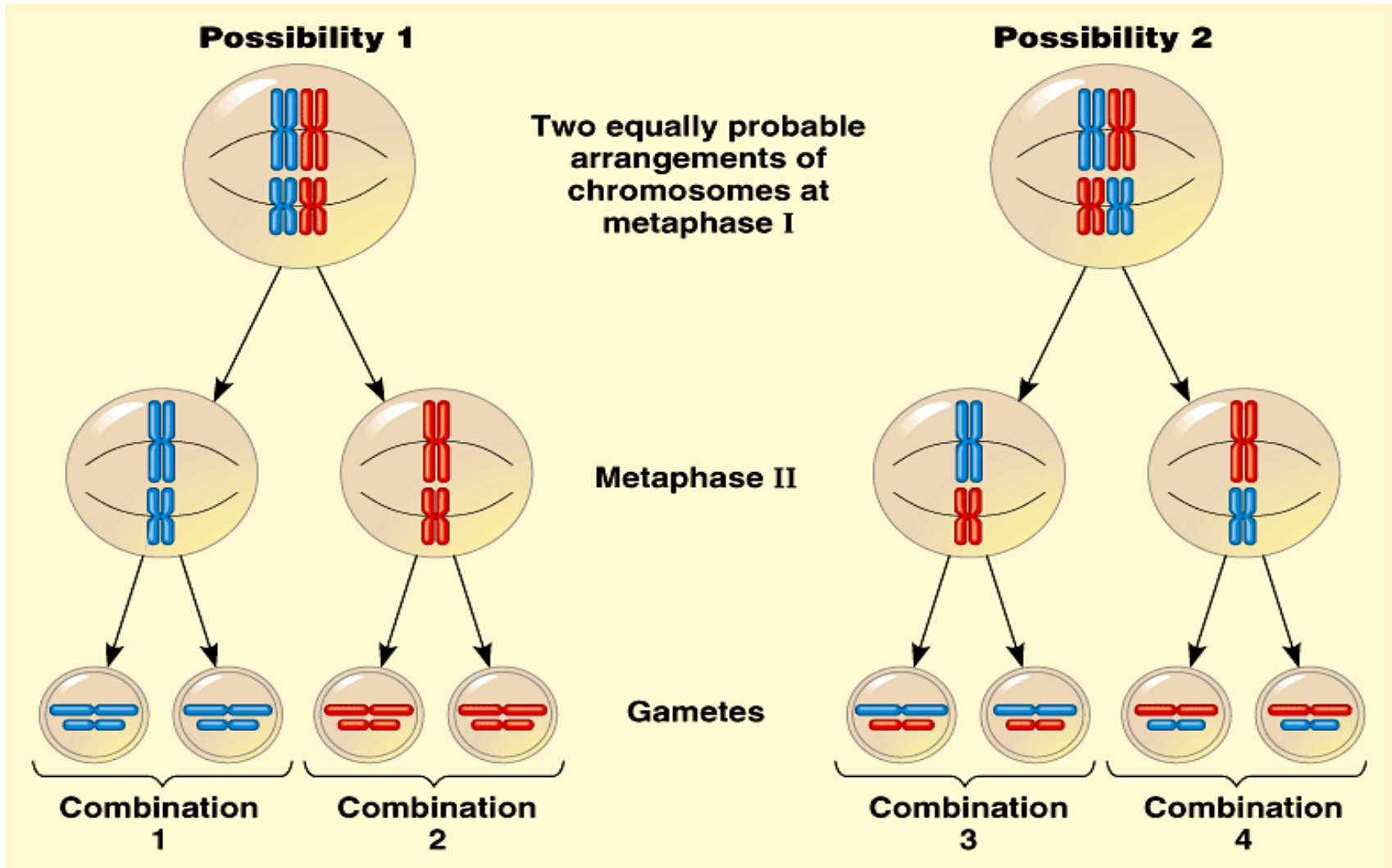
2. **Independent assortment** in Metaphase I.

# 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.



# Independent Assortment

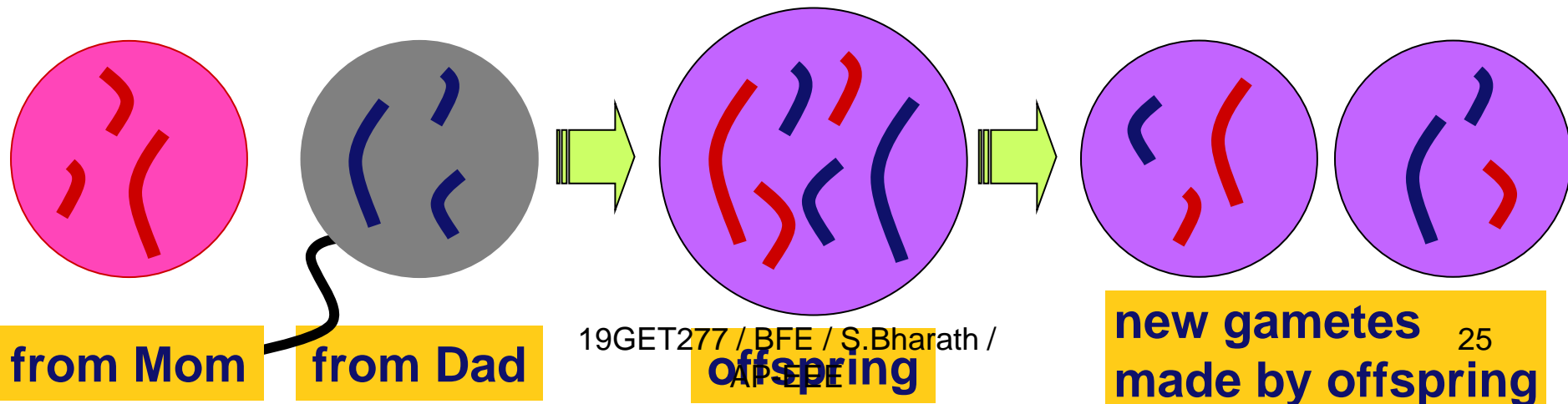


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# Variation from genetic recombination

- Independent assortment of chromosomes
  - meiosis introduces genetic variation
  - gametes of offspring do not have same combination of genes as gametes from parents
    - random assortment in humans produces  $2^{23}$  (8,388,608) different combinations in gametes



# Mitosis

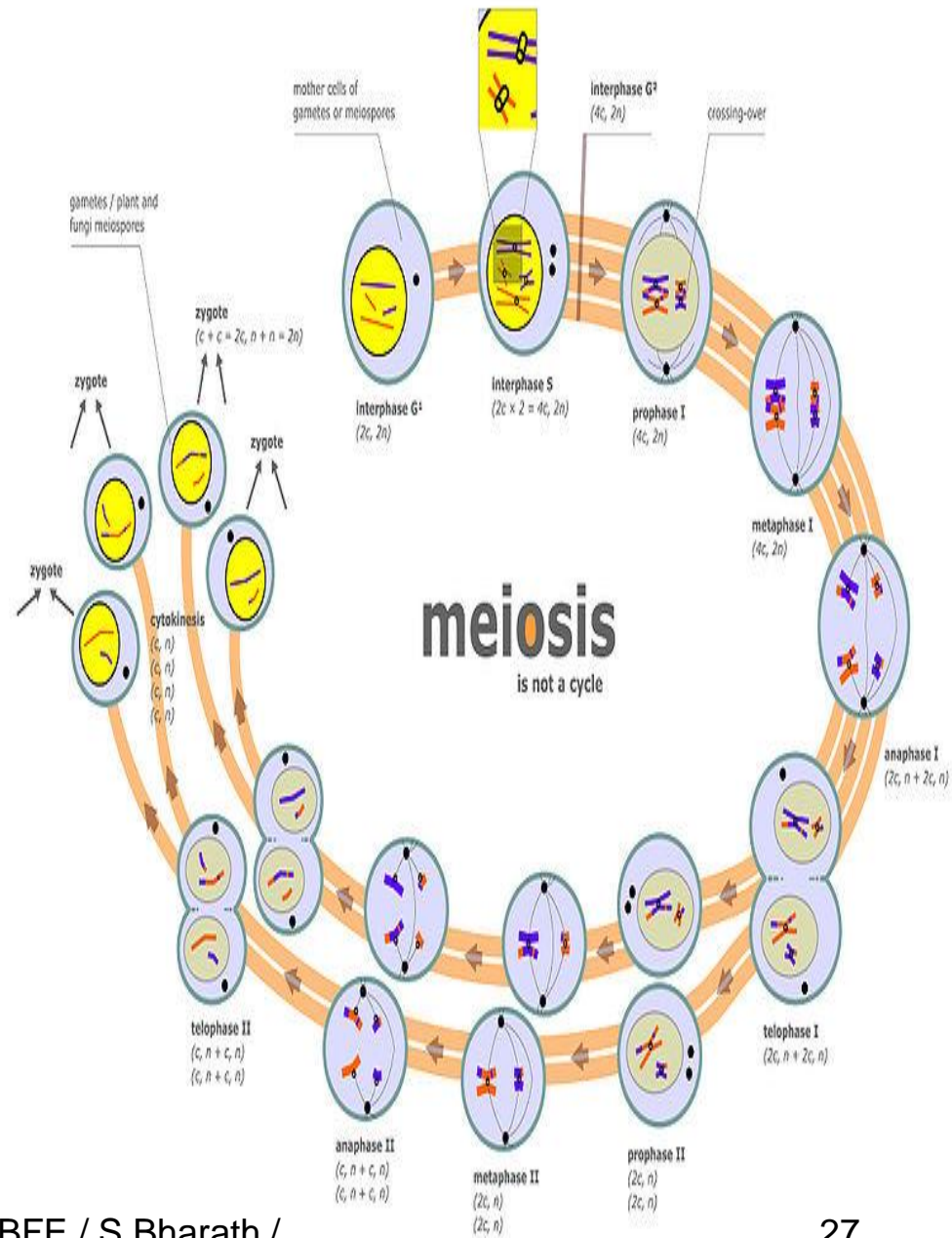
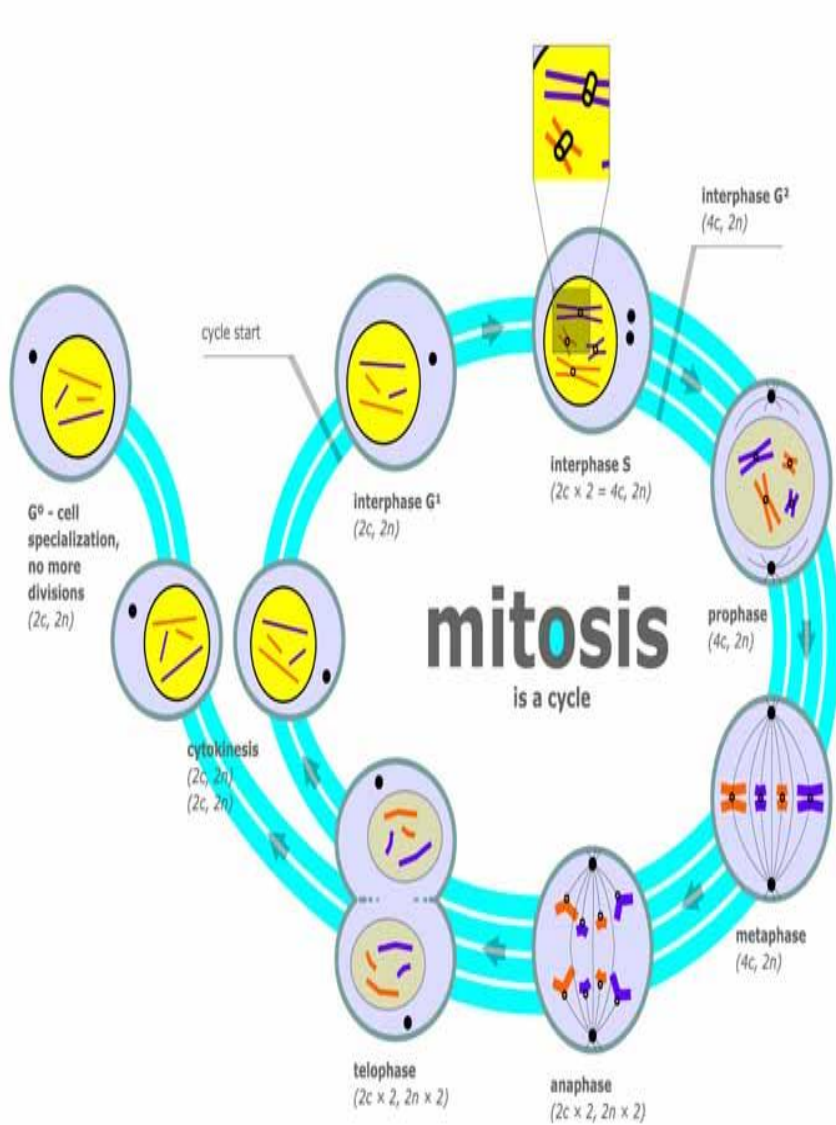
vs.

# Meiosis

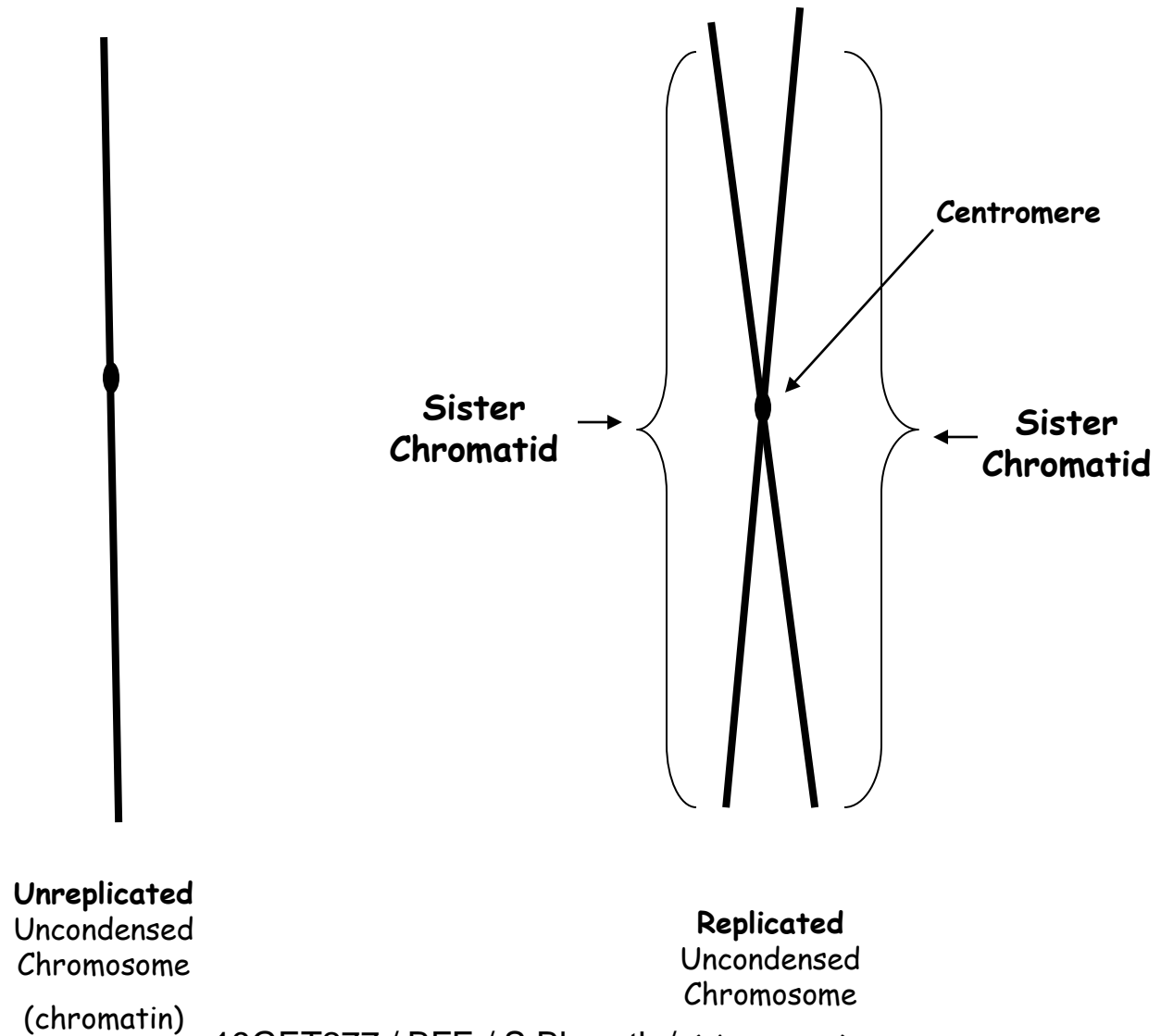
- $2n$
- Clone
- Same genetic information in parent cell and daughter cell.
- Give me another one just like the other one!

- $1n$
- 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!)

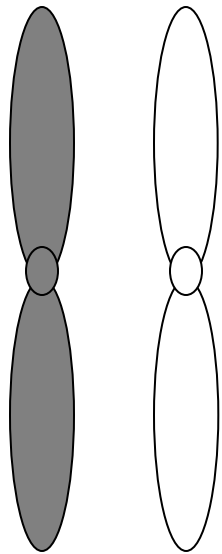




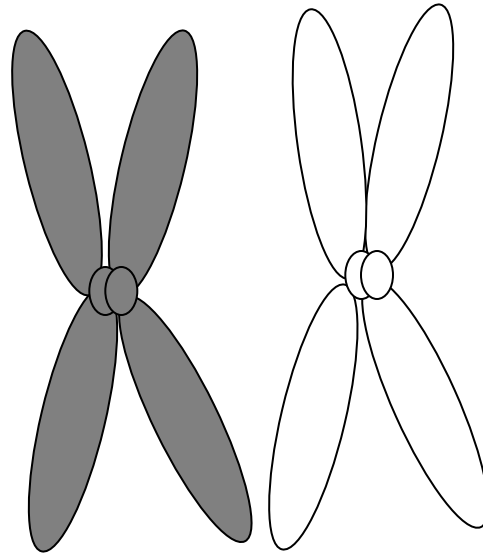
# Drawing and Labeling Chromosomes



# Drawing & Labeling Homologous Chromosomes



Unreplicated,  
Condensed,  
Homologous  
Chromosomes



Replicated,  
Condensed,  
Homologous  
Chromosomes

