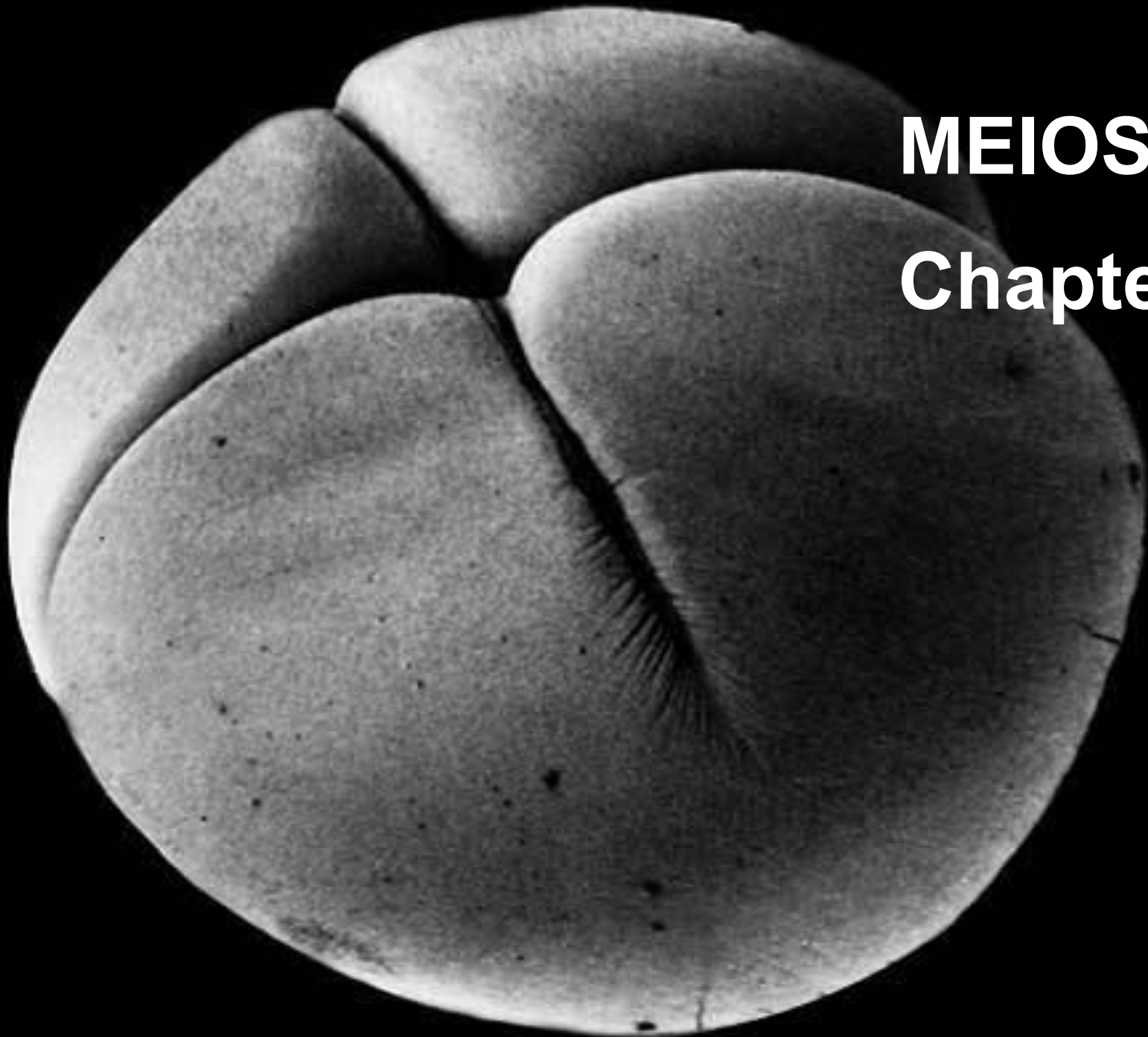


# MEIOSIS

## Chapter 10



# MITOSIS

VS

# MEIOSIS

Attack of the clones!



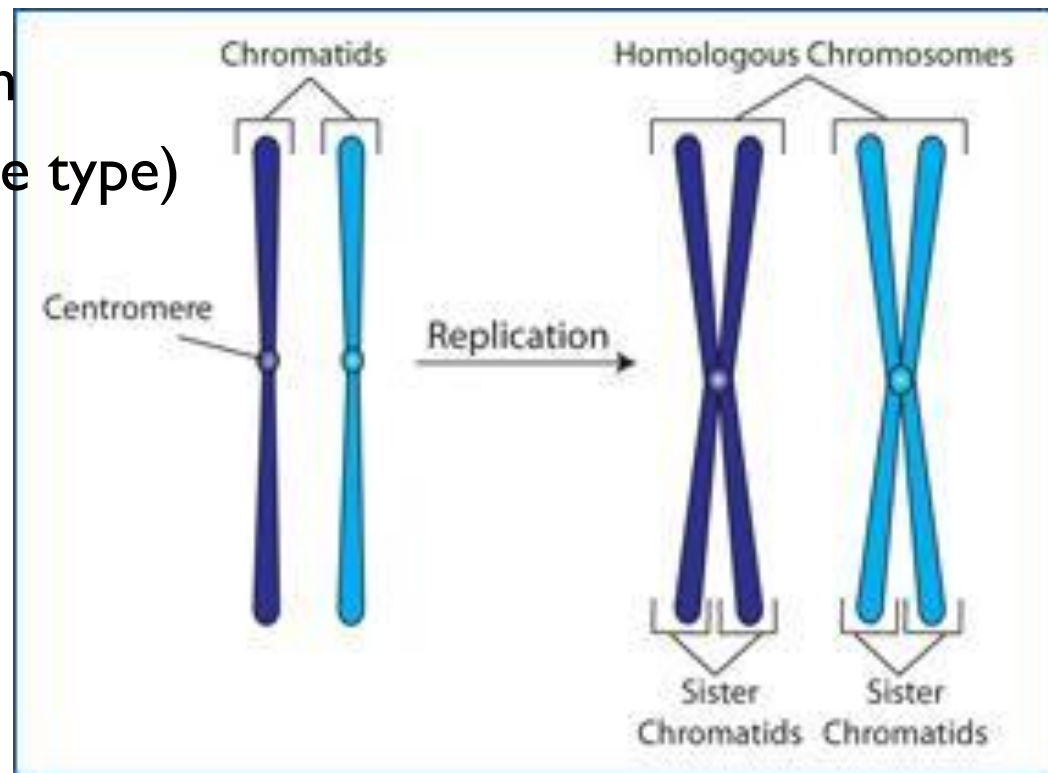
#Amoeba Sisters

# Chromosome Number

- Organisms with 2 parents must inherit a single copy of every gene from each parent
- When this organism produces gametes, those 2 sets of genes must be separated so that each gamete contains just 1 set of genes

# Human have...

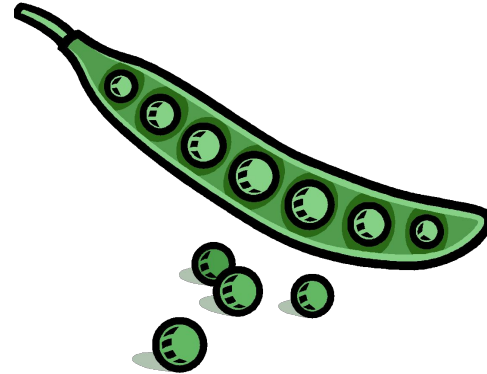
- 46 chromosomes
- Each parent contributes 23 chromosomes
  - Result is 23 pairs or 46 total
  - The pairs are called Homologous chromosomes
    - Have same length
    - Centromere position
    - Same traits (not same type)
      - Ear lobes
      - Eye color



# Chromosome Number

- All species have a specific number of chromosomes

- Humans = 46
- Fruit fly = 8
- Garden pea = 14
- Frog = 26
- Dog = 78



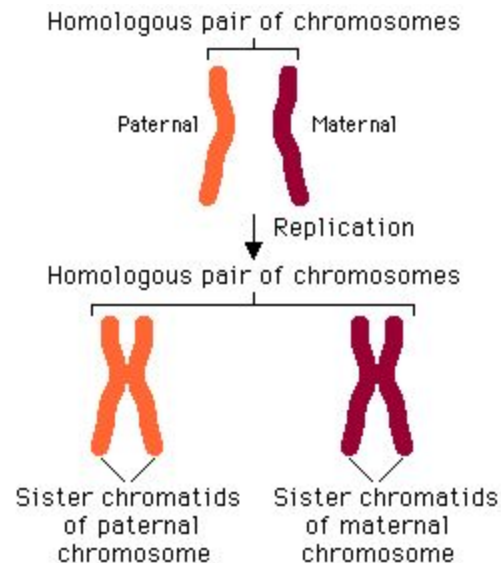
# Chromosome # = Organism

<b>Organism</b>	<b>Chromosome number</b>	<b>How many from each parent</b>	<b>Diploid number</b>	<b>Haploid number</b>
<b>Human</b>	<b>46</b>			
<b>Fruit flies</b>	<b>8</b>			
<b>Garden peas</b>	<b>14</b>			
<b>Chimpanzees</b>	<b>48</b>			
<b>Dogs</b>	<b>78</b>			
<b>Amoeba</b>	<b>50</b>			



# Homologous chromosomes

- The 2 sets of chromosomes from the male and female parent



# DIPLOID

- *A cell that contains both sets of homologues chromosomes*
- This means the cell has 2 complete sets of duplicated chromosomes AND 2 complete sets of genes from each parent
- This is called 2N
- Example: *skin, hair, tooth, bone*, All cells except for reproductive cells



# HAPLOID

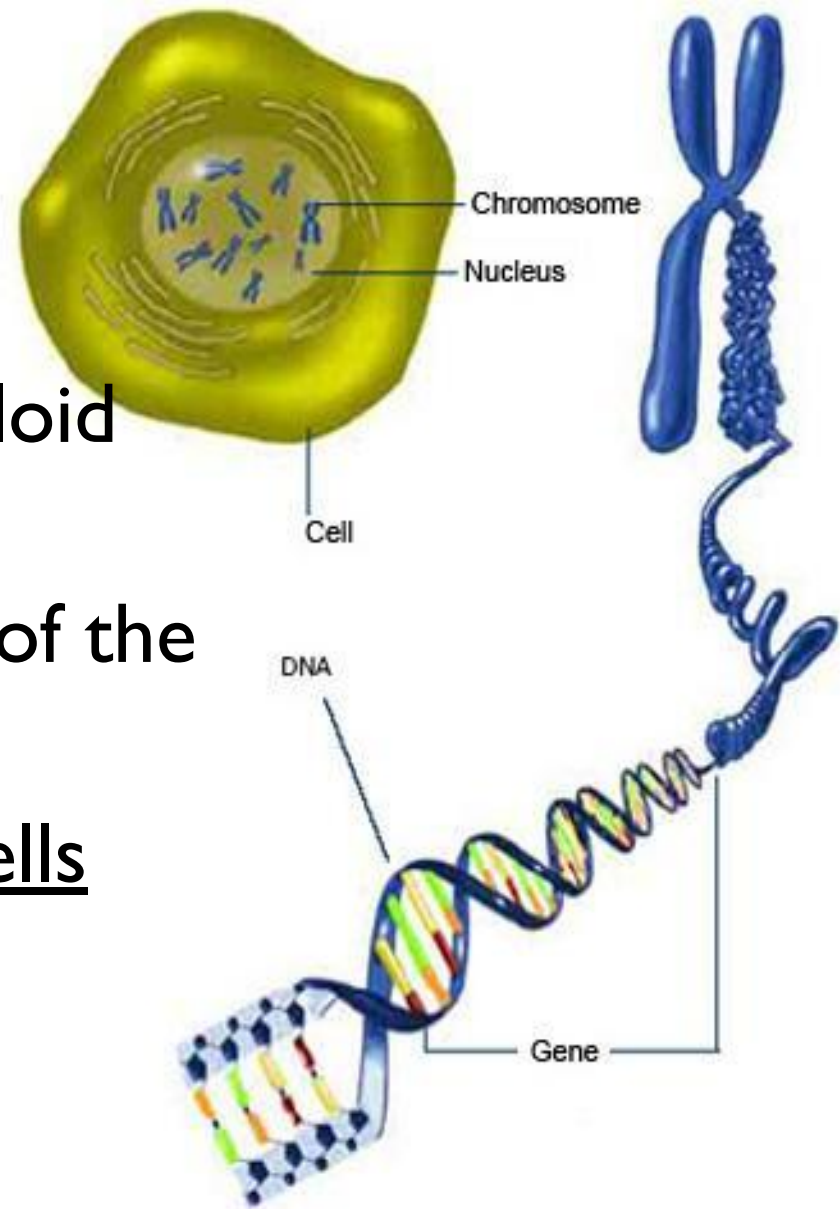
- *A cell that contains a single set of chromosomes*
- This means a haploid cell has **1 set** of chromosomes
- This is the “**N**”
- Examples= **gametes**
  - Females: egg, ovum, ootid (oogenesis)
  - Males: sperm (spermatogenesis)

# Phases of meiosis

- How are haploid (**N**) gamete cells produced from diploid (**2N**) cells?
- Meiosis is a process in which the number of chromosomes per cell is cut in half through the separation of homologous chromosomes

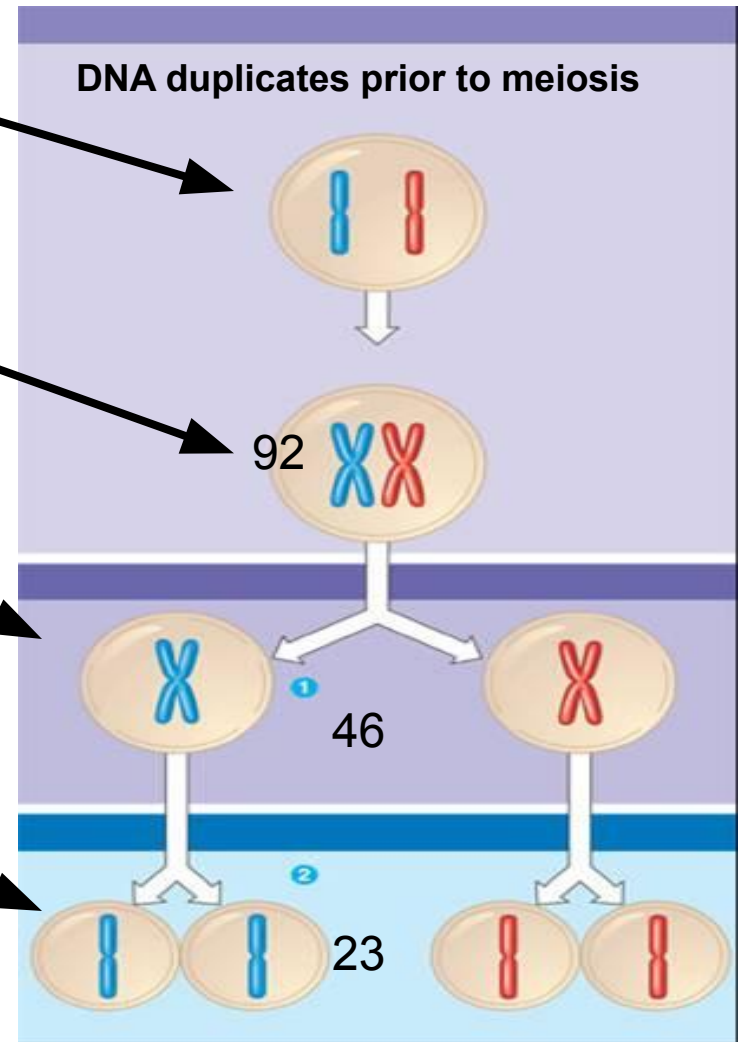
# Meiosis

- Meiosis produces haploid gametes
- There are 2 divisions of the nucleus
- Results in 4 haploid cells



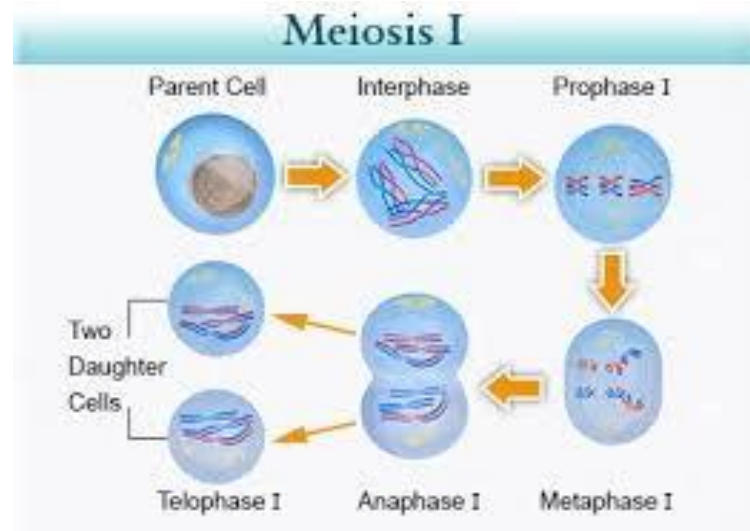
# Meiosis

- Homologous pair after last mitosis
- Homologous pair in Interphase
- Separation of pairs at end of Meiosis I
- Separation of chromatids at end of meiosis II
- 92 □ 46 □ 23



# Meiosis I

- This is the first division of the nucleus
- Must go thru interphase
  - This means the chromosomes are duplicated
  - Each replicated chromosome consist of 2 identical chromatids joined at the center



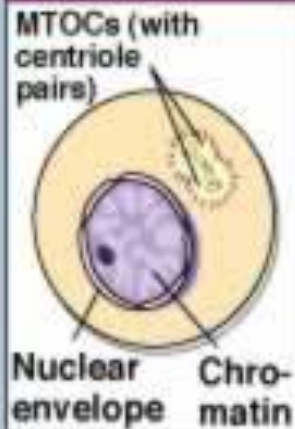
# VOCABULARY Check

- Gametes
- Diploid
- Haploid
- Homologous Chromosomes
- $n$
- $2n$

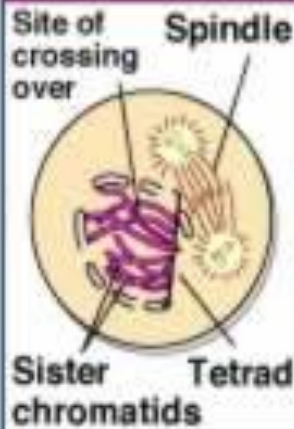


## MEIOSIS I

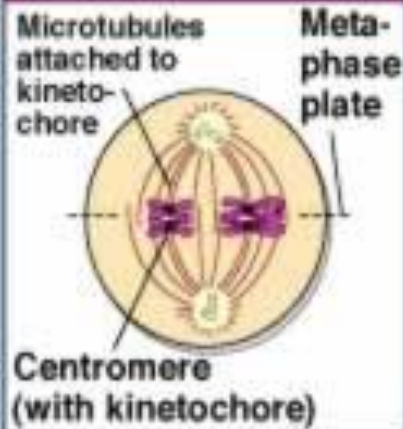
### INTERPHASE I



### PROPHASE I



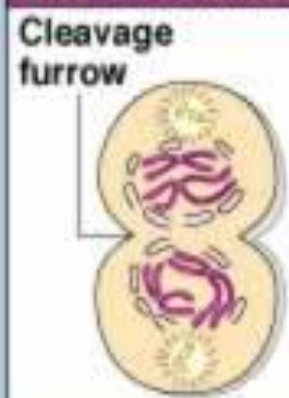
### METAPHASE I



### ANAPHASE I



### TELOPHASE I AND CYTOKINESIS



## MEIOSIS II

### PROPHASE II



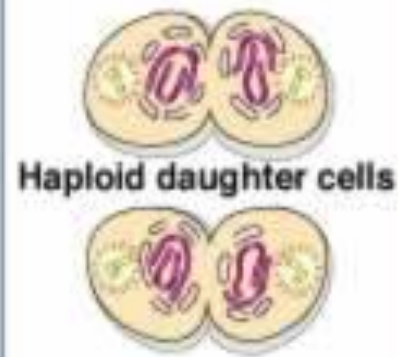
### METAPHASE II



### ANAPHASE II



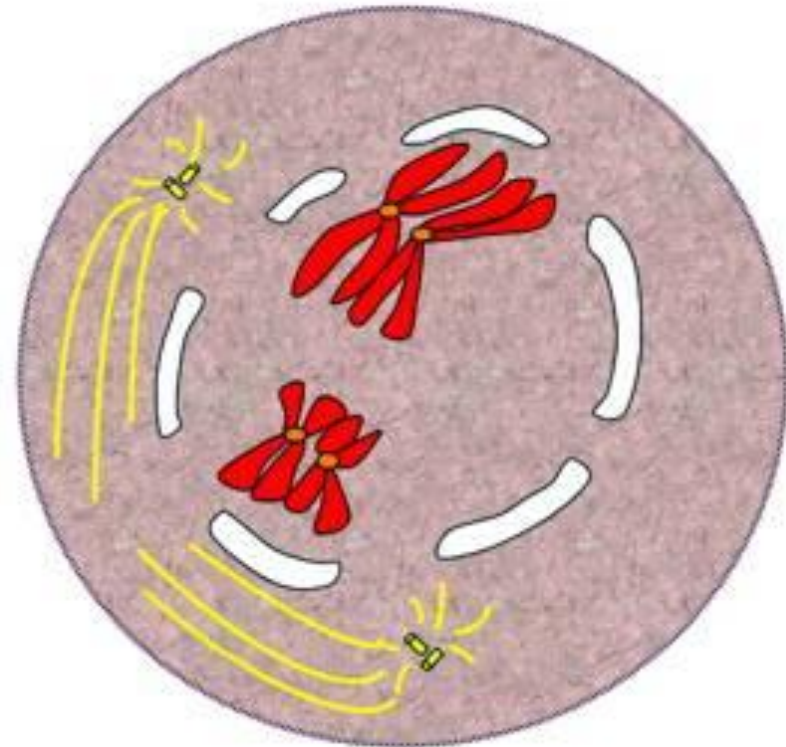
### TELOPHASE II AND CYTOKINESIS





# PROPHASE I

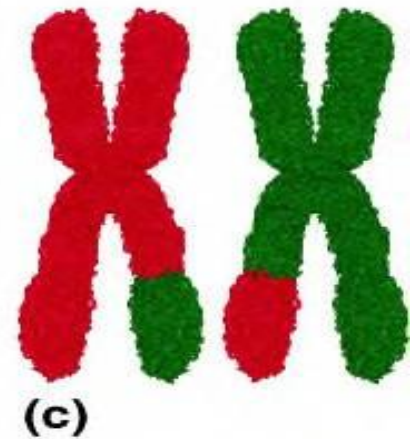
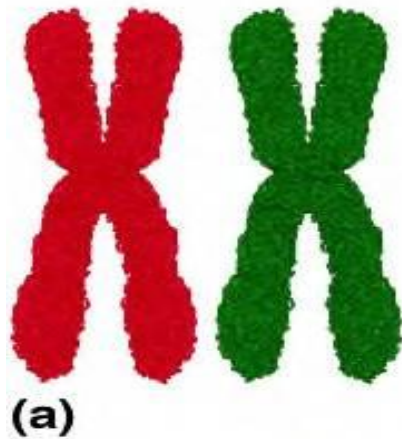
- Pairing of homologous chromosome pairs
  - Each chromosome has 2 chromatids
- Spindle fibers bind to centromere
- This forms a tetrad



# What is Crossing Over?

- These tetrads go thru crossing over
- Produces exchange of genetic info
- animation on picture

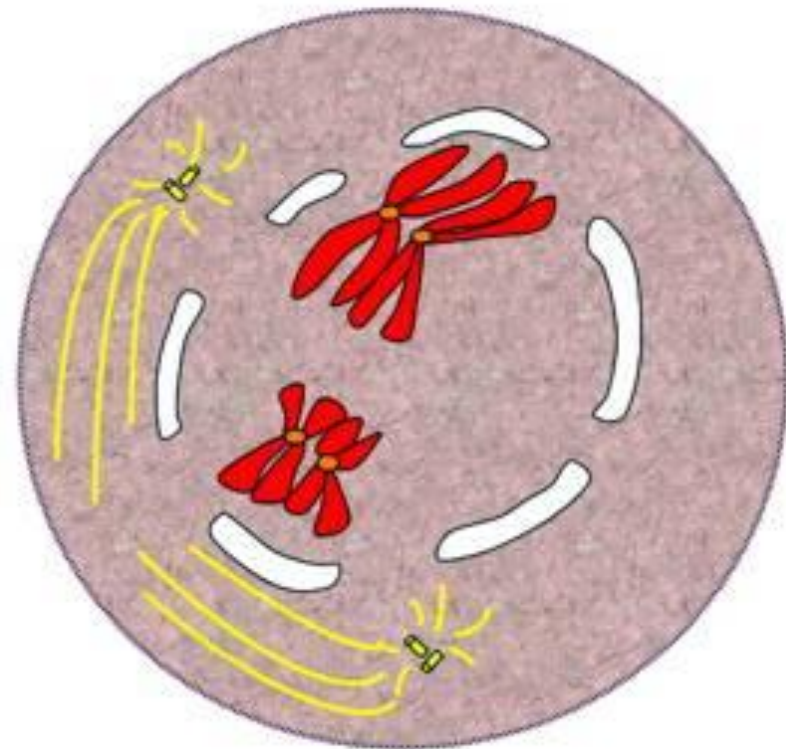
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# Prophase I

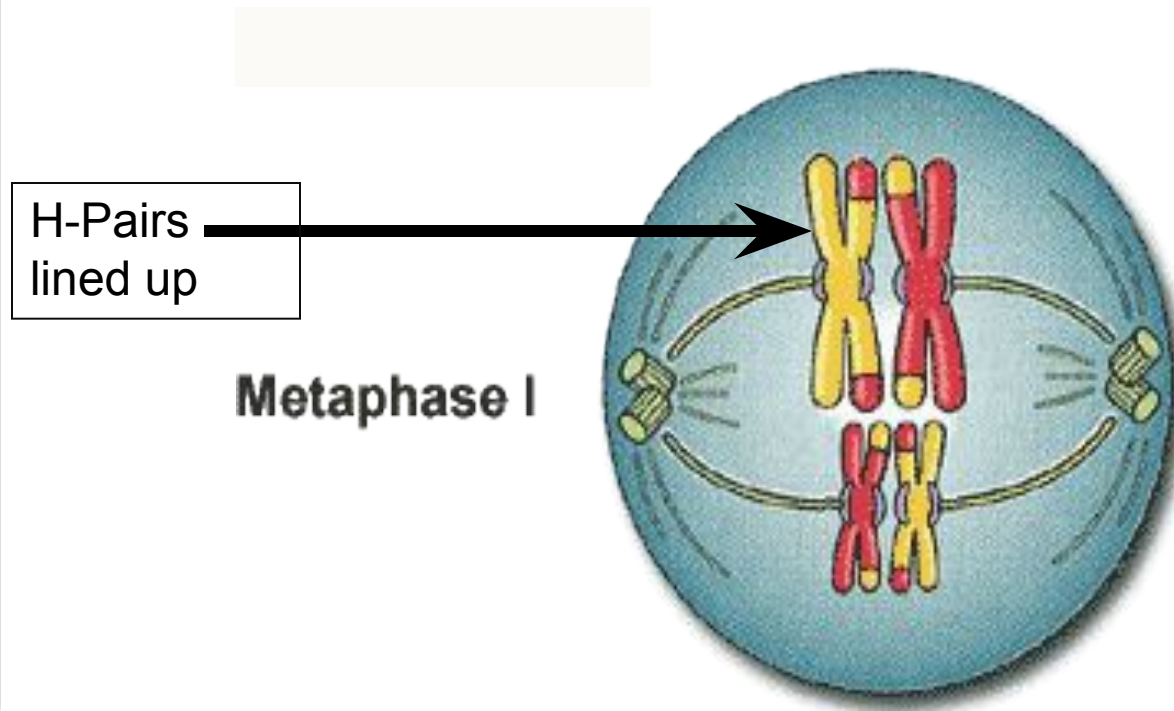
- Each replicated chromosome pairs with its corresponding homologous pair
- Nuclear membrane dissolves

Let's Draw it



# METAPHASE I

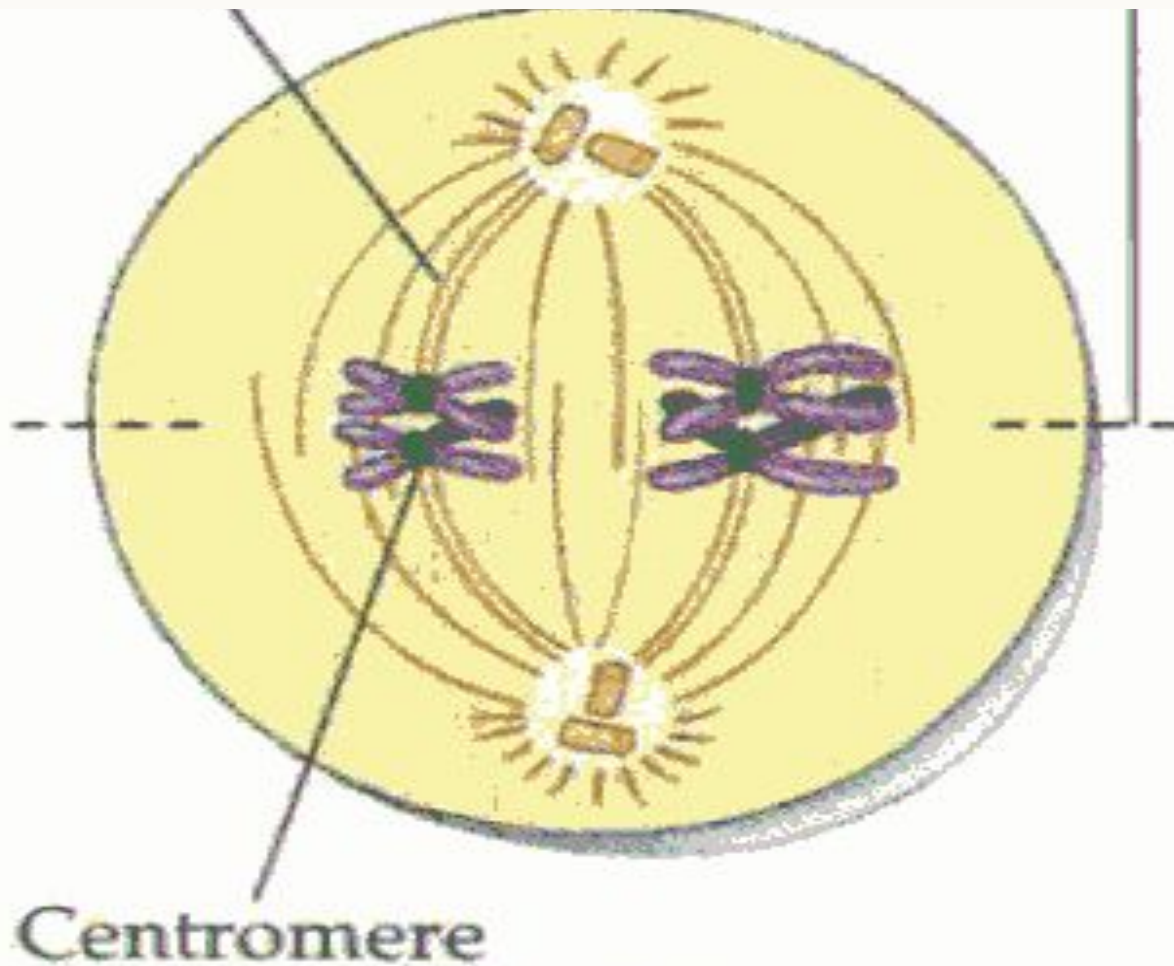
- Paired homologous chromosomes line up across the center of the cell
- Spindle fibers have moved the tetrad to the center





# METAPHASE I

Let's Draw it

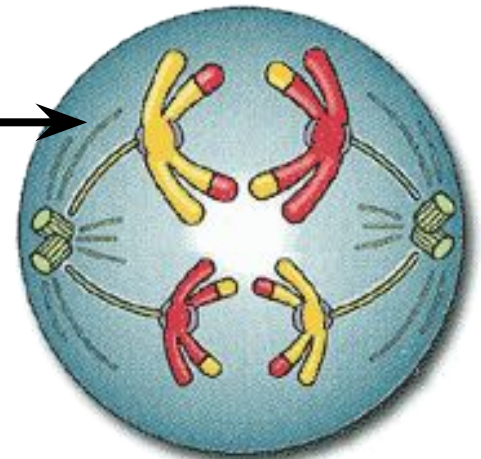


# ANAPHASE I

- Homologous chromosomes separate and move to opposite poles of cell
- Chromosome number is reduced from  $2n$  to  $n$  since the tetrad pair separated
  - Each chromosome consists of 2 sister chromatids

H-pairs  
pulled apart  
to opposite  
sides

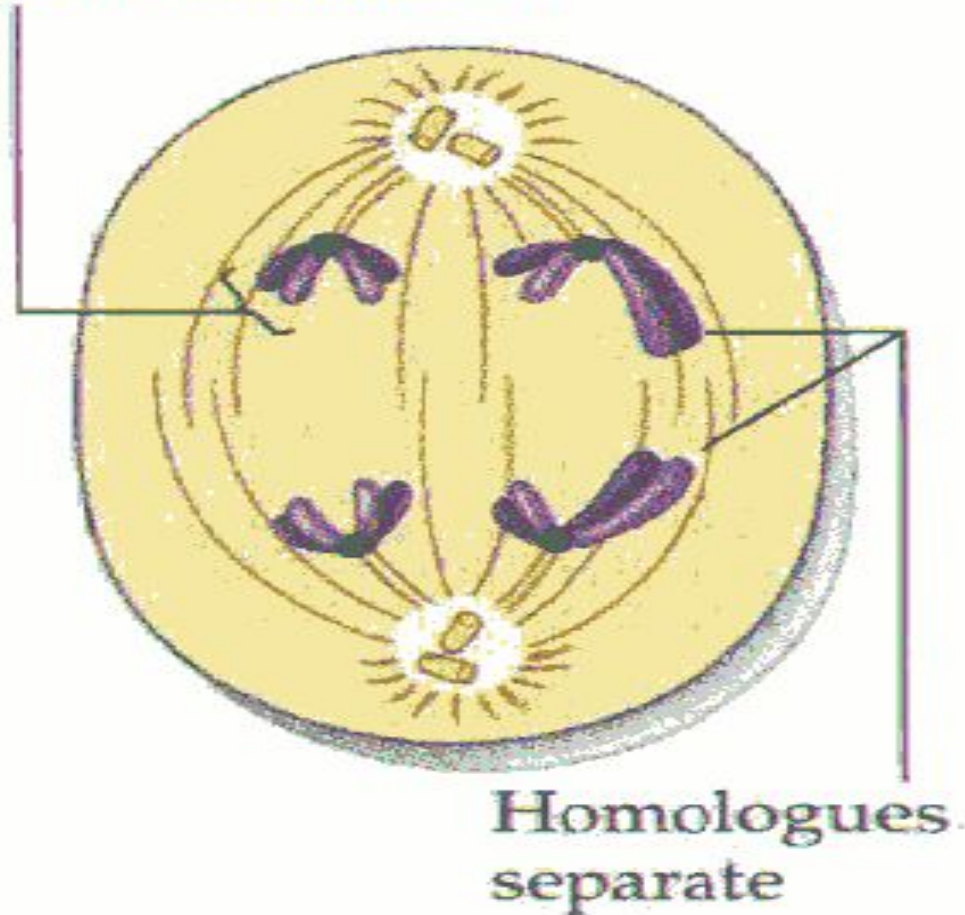
Anaphase I



# ANAPHASE I

Sister chromatids  
remain attached

Let's Draw it





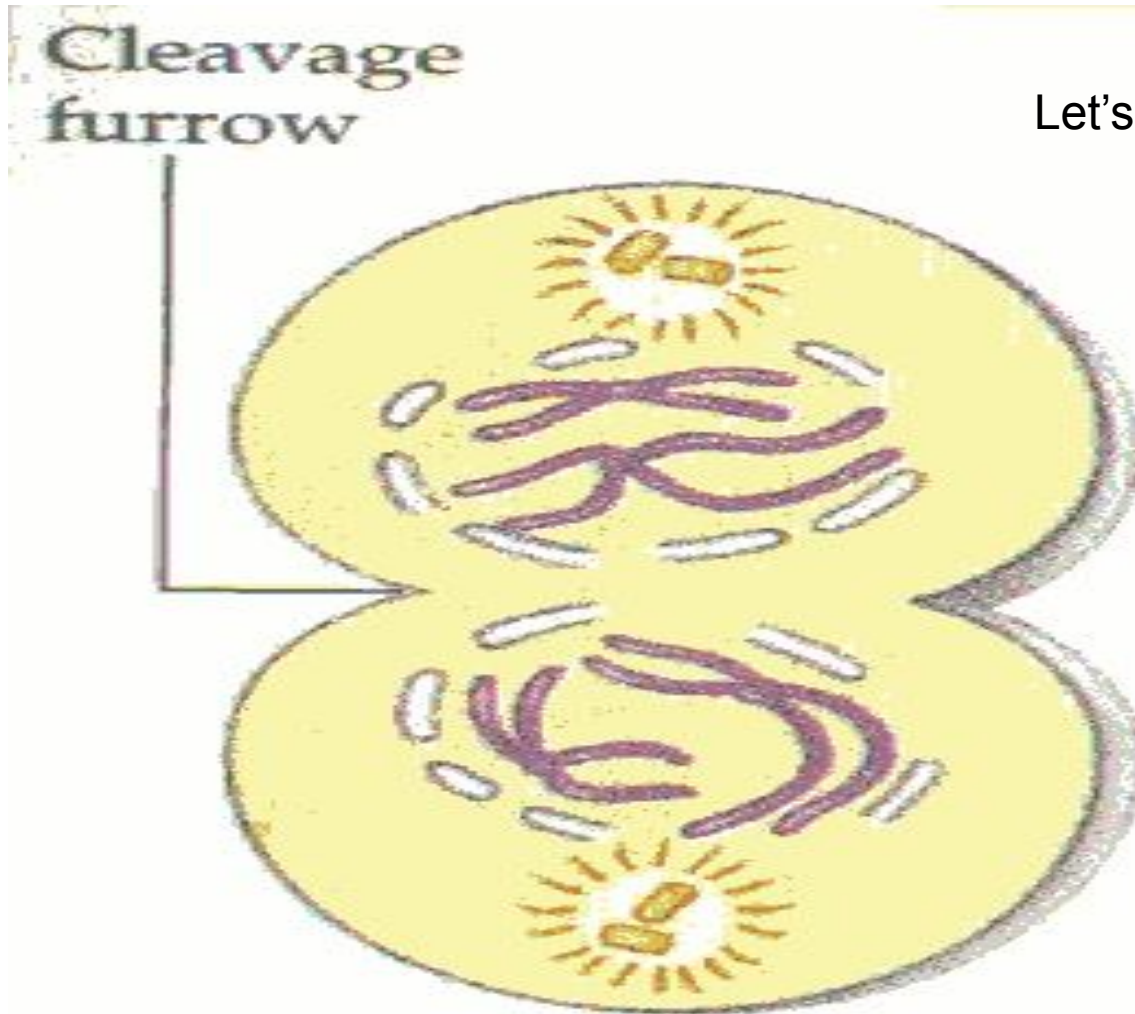
# TELOPHASE I & CYTOKINESIS I

- Nuclear membrane reforms around each cluster of chromosomes
- Cytokinesis follows by pinching the cytoplasm in half
- This results in creating 2 new cells
- These are different from each other
- Must go through Meiosis II to get the proper chromosome number

**Telophase I**

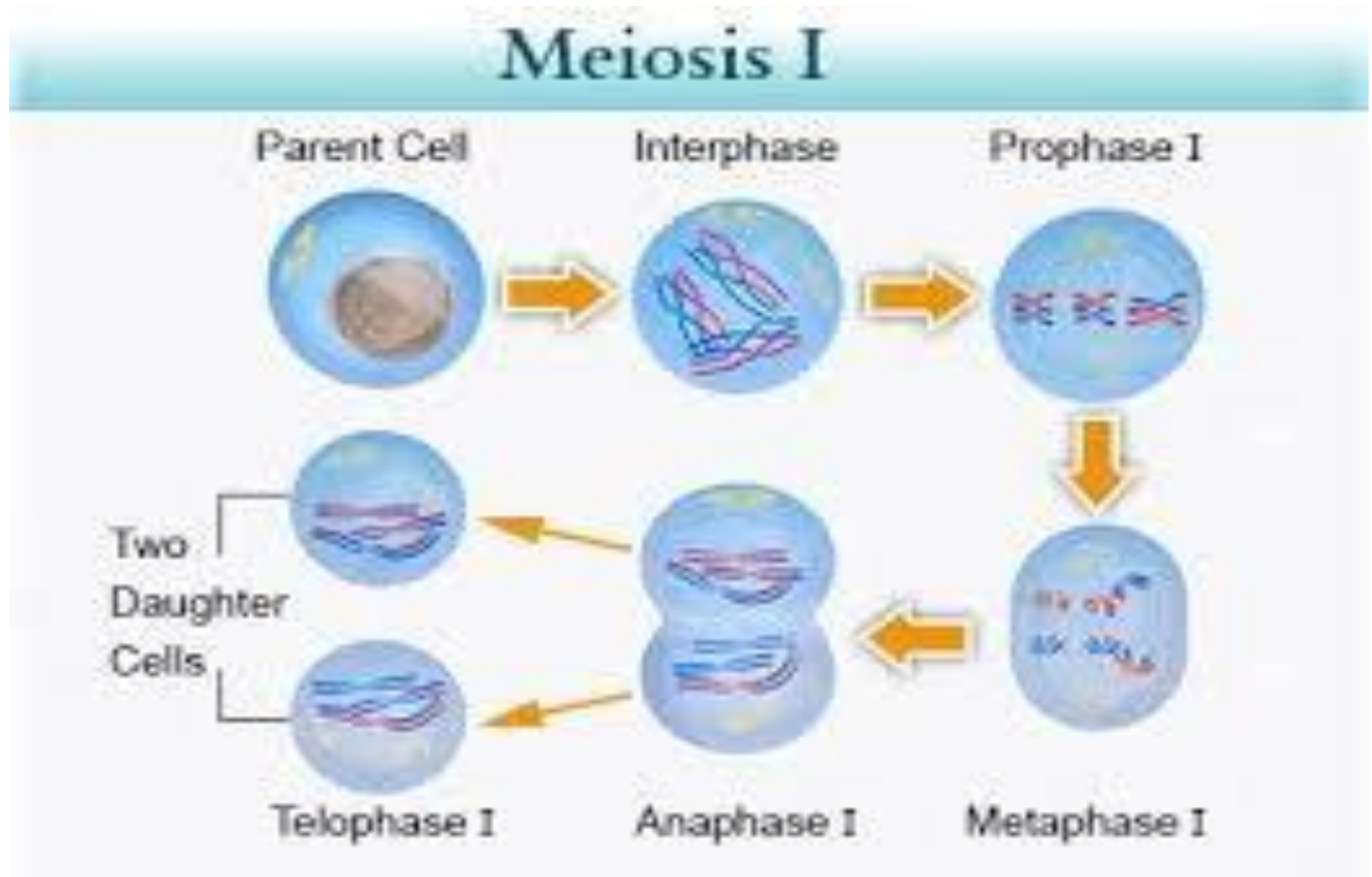


# TELOPHASE I & CYTOKINESIS I



Let's Draw it

# The process of Meiosis I



# Result of Meiosis I

- 2 new cells that have different combinations of genes within them
- Cells are haploid since they contain half the number of chromosomes as the original cell



Click on disk



# Vocabulary Check

- Crossing over
- Diploid
- $2n$
- Haploid
- $n$
- Homologous chromosomes

# Meiosis II

- Starts in interphase but Synthesis phase (DNA replication) does NOT occur
- Why is this important?

# PROPHASE II

- Chromosomes become visible
- What do they look like?

Let's Draw it

Prophase II





# METAPHASE II

- Chromosomes line up randomly at the equator of the cell

Metaphase II

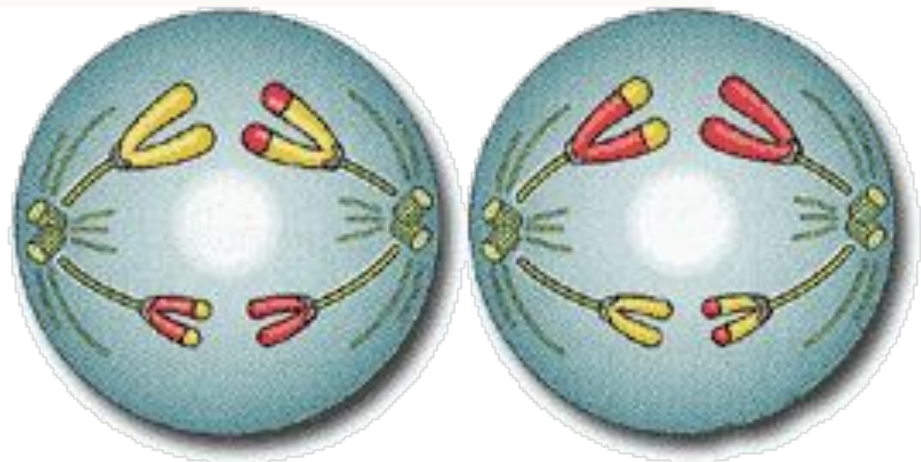
Let's Draw it



# ANAPHASE II

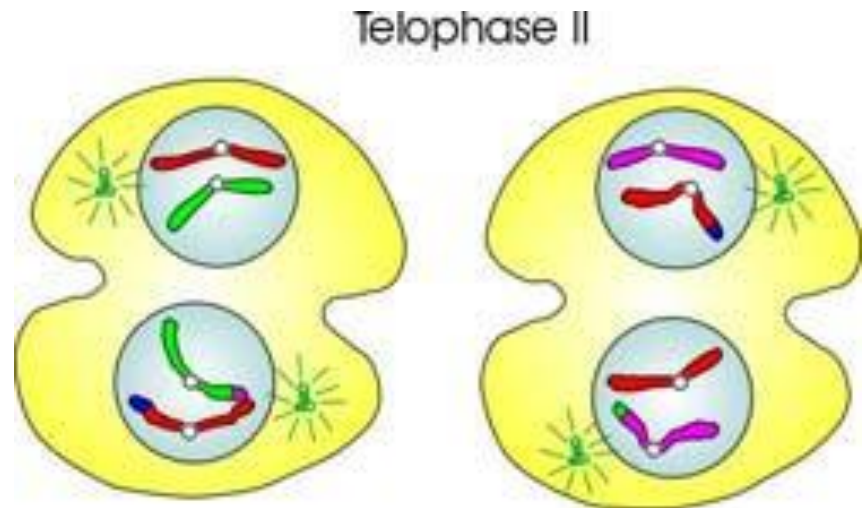
- Chromosomes splits
- Sister chromatids separate and move to opposite poles of the cell

Let's Draw it



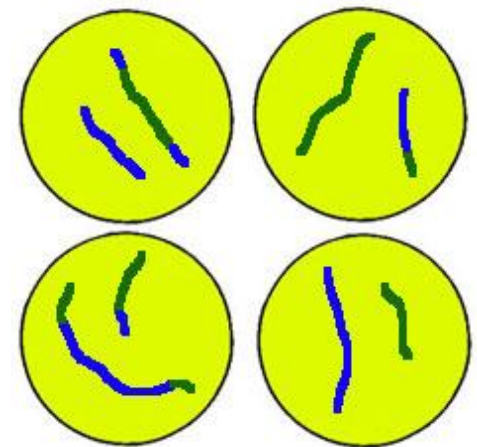
# TELOPHASE II

- nuclei form around each set of chromosomes
- Each nuclear membrane reforms
- Cytoplasm divides in half creating 4 cells
- The end result of meiosis II is 4 haploid daughter cell



# Cytokinesis II

- All resulting cells are genetically different to each other
- Creation of eggs for females
- Creation of sperm for males
- Humans will have 23 chromosomes in each gamete
- This is the “n” amount



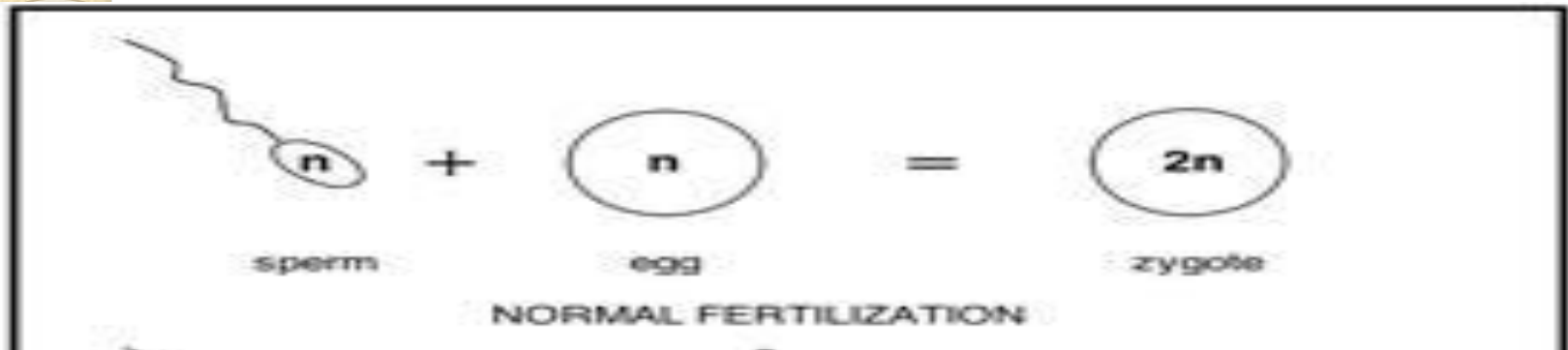
# Animation of Meiosis

- <http://www.sumanasinc.com/webcontent/animations/content/meiosis.html>





# Gametes to Zygotes



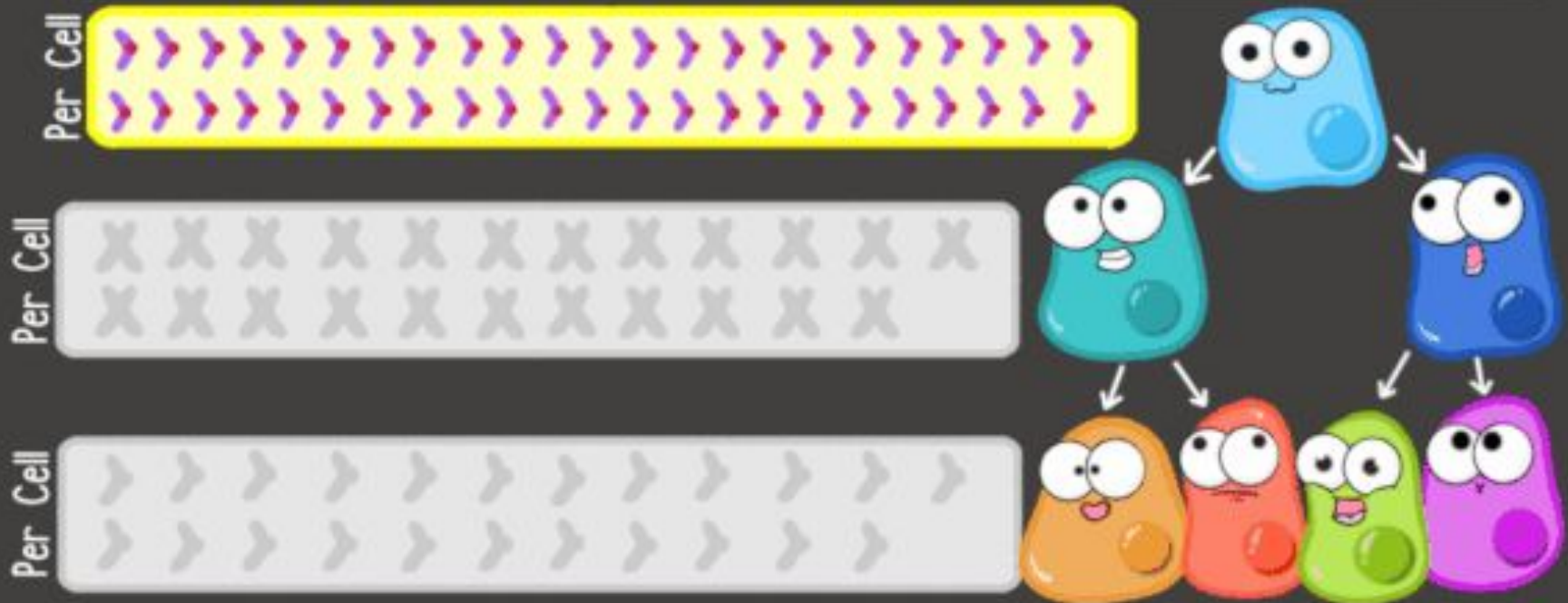
- After the egg gamete gets fertilized by the sperm gamete
- This is called a zygote
- This zygote will undergo many divisions by mitosis eventually forming a new organism



# CHROMOSOMES...DEMYSTIFIED!

(in Humans)

## Meiosis:

	Before Interphase	After Interphase	After Meiosis I	After Meiosis II
Chromosomes	46	46	23	23
Chromatids	46	92	46	23



-  = Chromosome with 1 chromatid
-  = Chromosome with 2 chromatids



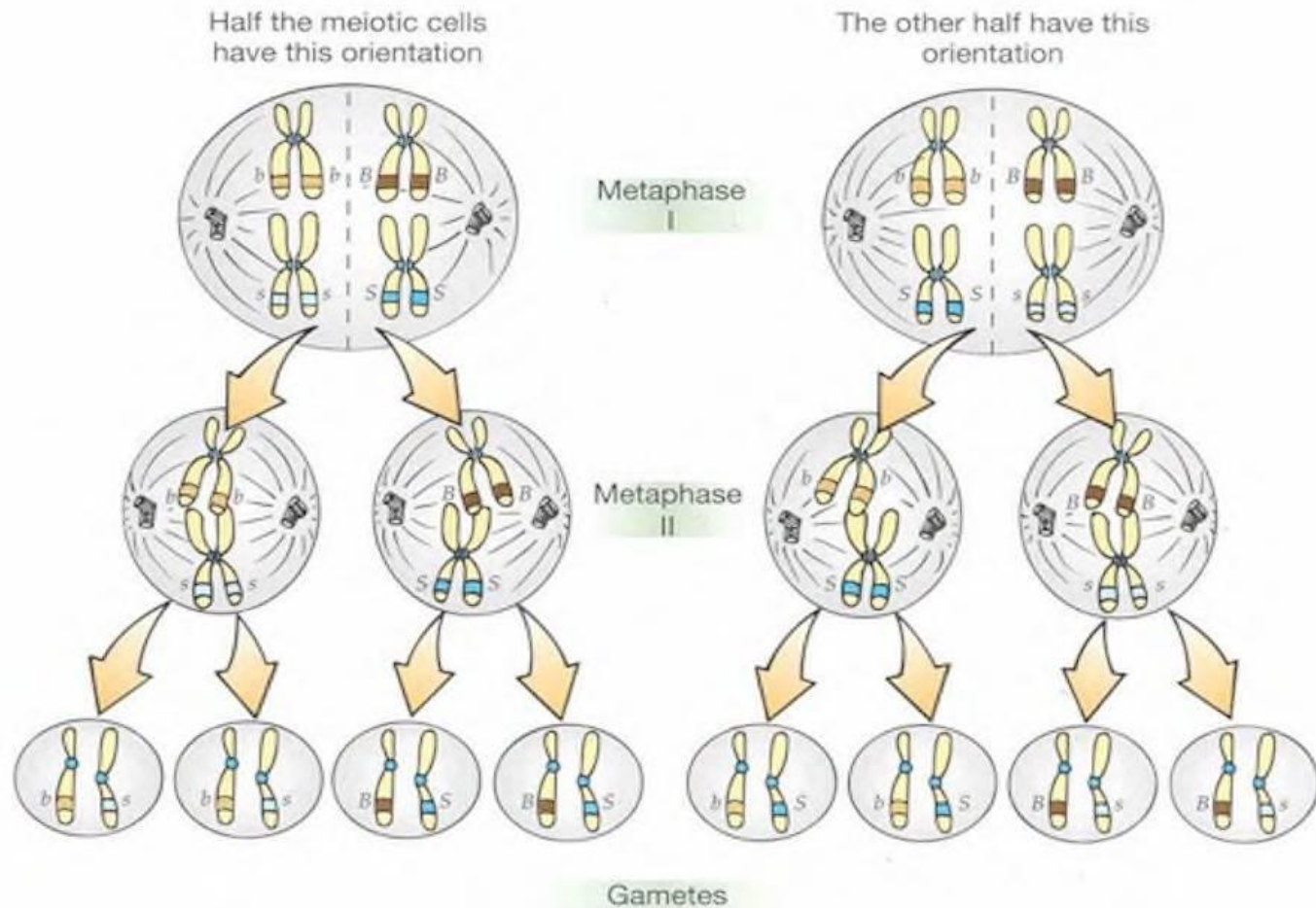
# GENETIC VARIATION

- 3 types
  - **INDEPENDENT ASSORTMENT**
  - **CROSSING OVER**
  - **RANDOM FERTILIZATION**

# Independent Assortment

- The random distribution of homologous chromosomes during meiosis
- Each 23 pairs of chromosomes separates independently of each other
- $2^{23}$  combinations of gametes with different gene combinations can be produced from 1 original cell
- So it is a matter of chance that YOU are YOU because there are 8 million different options of what possible chromosomes are in each gamete
- This occurs during metaphase I and it is completely random how the chromosomes line up with each in the middle

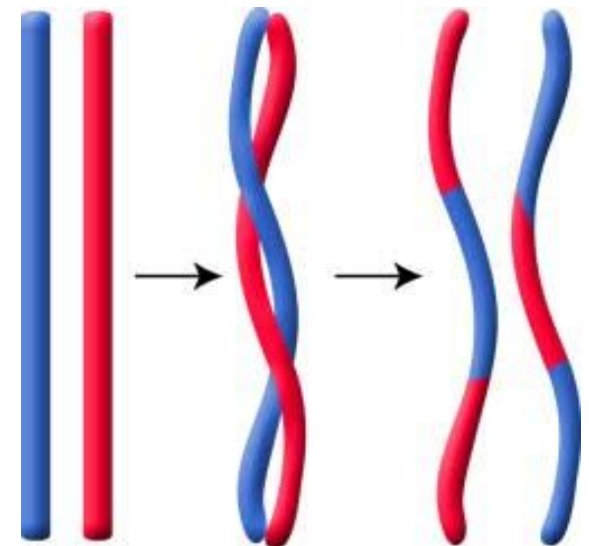
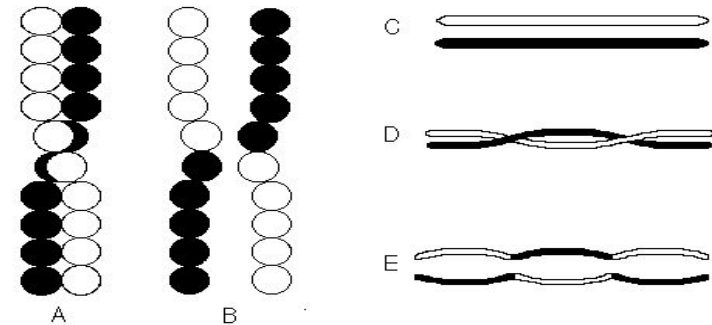
# Independent Assortment



# Crossing Over

- a chromatid on one h-pair are broken or exchanged with the corresponding chromatids of the other h-pair
- occurs in first step(Prophase I)
- more types of gametes that are different
  - which makes them practically unlimited in number
- This is why you look like your parents but never exactly like them

Chromosome Crossing-over





# Genetic Variation

- In humans, each gamete receives one chromosome from each 23 pairs of chromosomes
- Each of the 23 pairs that offspring receives is by chance





# Random Fertilization

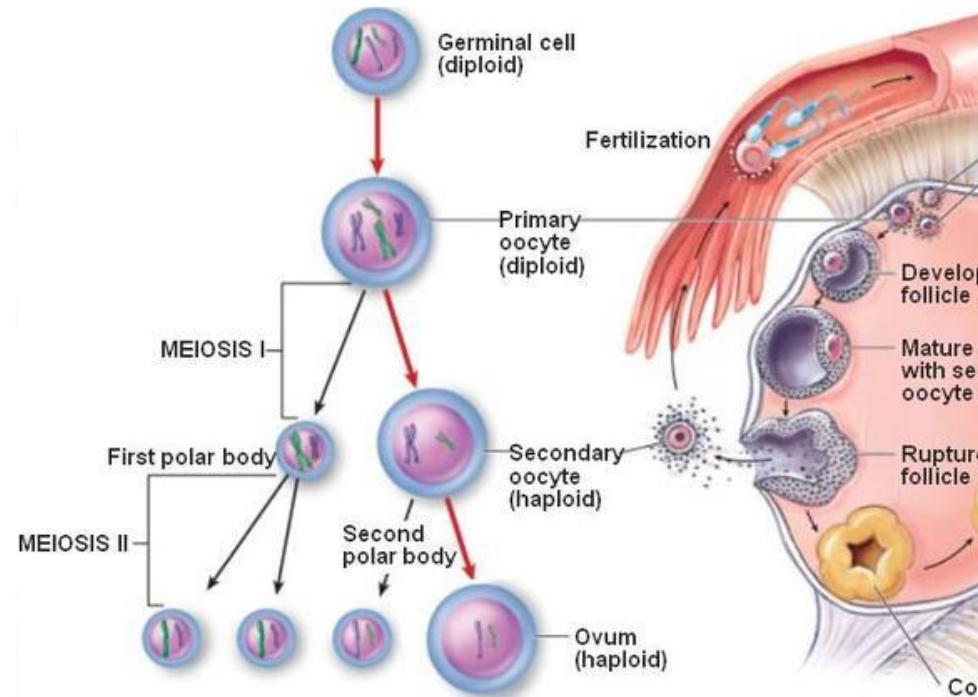
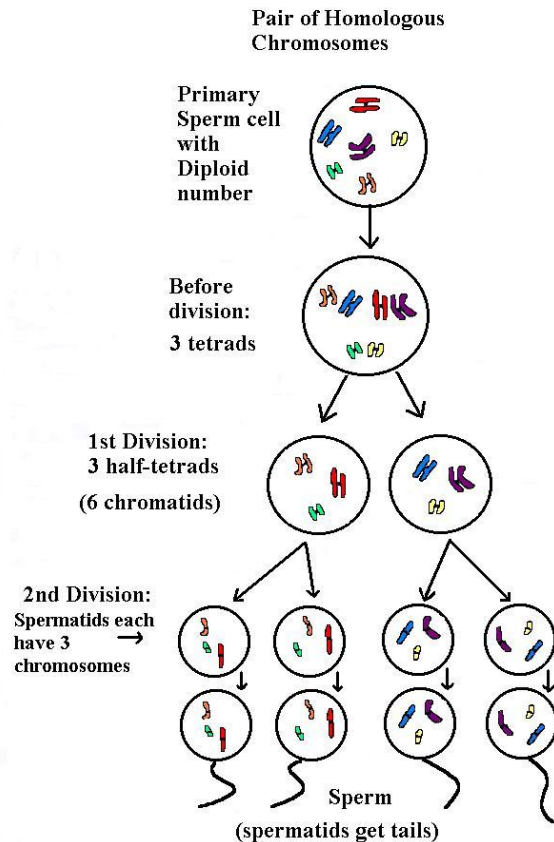
- Zygote is a fertilized egg cell
- This is a random joining of 2 gametes which gives 64 trillion options
- Any sperm could have fertilized any egg creating a zygote (AKA you)... if a different egg was fertilized you would not be here!!

# Importance of Genetic Variation

- The joining of gametes is essential to evolution
- No genetic process produces more variation than meiosis
- Evolution will increase as genetic variation increases
  - Racehorse breeding?
  - Sheep/cattle size

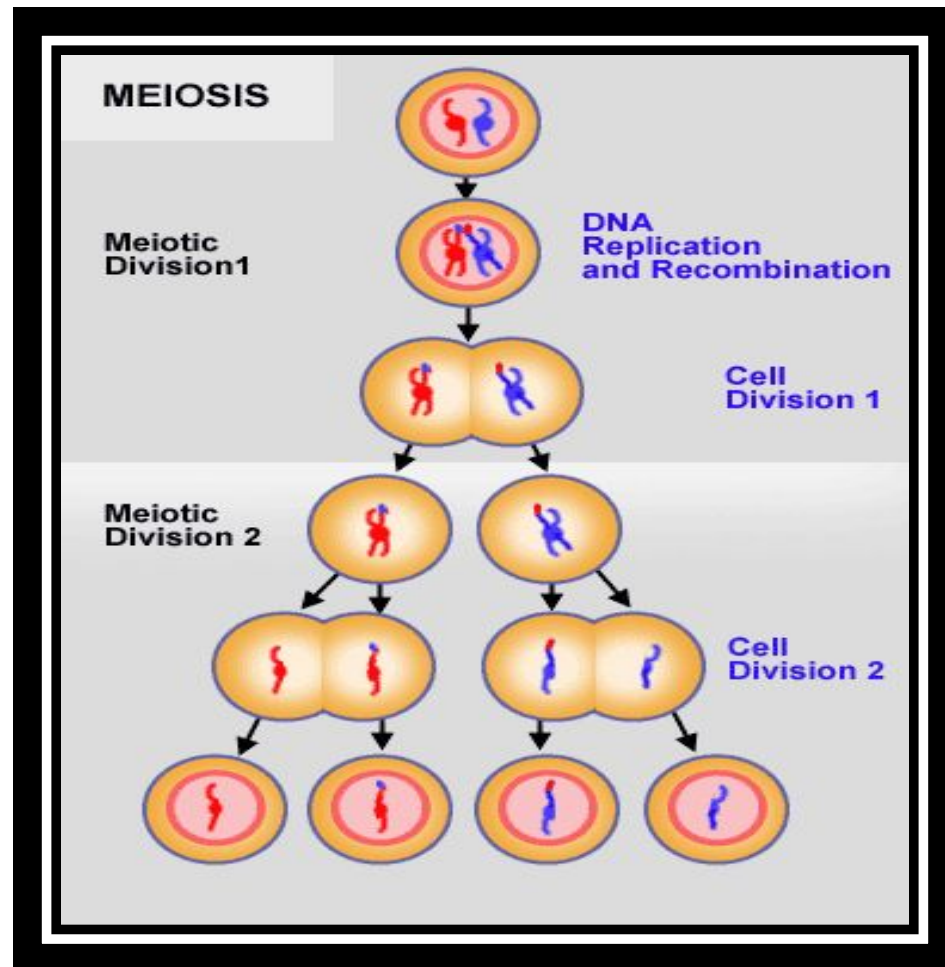
# Males vs Females Meiosis

Males	Females
Spermatogenesis	Oogenesis
Form 4 sperm cells	Form 1 egg and 3 polar bodies
Occurs in testis	Occurs in ovaries
Occurs continuously in a males life	Stops after menopause



# 3 key features of Meiosis

- Unique Features of Meiosis [click on picture](#)



# Mistakes

- <http://www.sumanasinc.com/webcontent/animations/content/mistakesmeiosis/mistakesmeiosis.html>



# Vocabulary Check

- Independent Assortment
- Spermatogenesis
- Oogenesis
- Ootid

# Mitosis –vs- Meiosis

	MITOSIS	MEIOSIS
<i>How many divisions?</i>	one	two
<i>How many and where does <b>DNA</b> replication occur?</i>	one time in Interphase (S phase)	one time in Interphase I
<i>Total number of cells produced</i>	2	4
<i>How do the cells look?</i>	identical	different
<i>What type of cells does it occur in?</i>	body cells	gametes/sex cells
<i>Why does each process occur?</i>	Growth and repair	To reproduce more of that particular organism

# Essential Questions

- How does the reduction in chromosome number occur during meiosis?
- What are the stages of meiosis?
- What is the importance of meiosis in providing genetic variation?
- ***Vocabulary:*** *gene, homologous chromosomes, gamete, haploid, fertilization, diploid, crossing over, independent assortment*