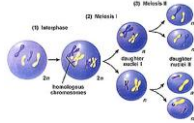
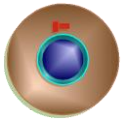


## Meiosis & Sexual Reproduction




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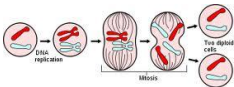
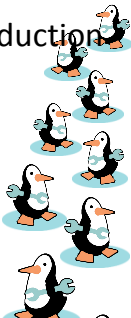
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## Cell division / Asexual reproduction

- Mitosis
  - produce cells with same information
    - identical daughter cells
  - exact copies
    - clones
  - same amount of DNA
    - same number of chromosomes
    - same genetic information




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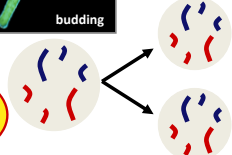
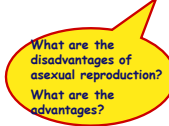
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## Asexual reproduction

- Single-celled eukaryotes
  - yeast (fungi)
  - Protists
    - *Paramecium*
    - *Amoeba*
- Simple multicellular eukaryotes
  - *Hydra*




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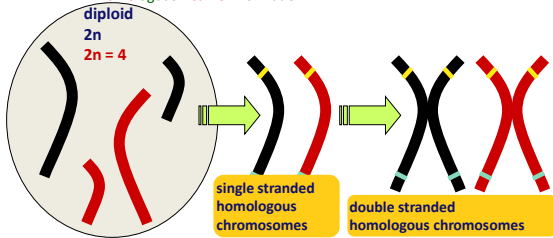
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## Homologous chromosomes

- Paired chromosomes
  - both chromosomes of a pair carry "matching" genes
    - control same inherited characters
    - homologous = same information




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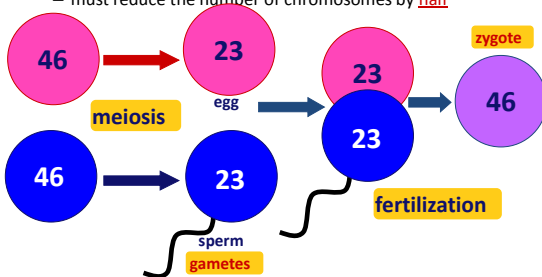
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## How do we make sperm & eggs?

- Must reduce 46 chromosomes → 23
  - must reduce the number of chromosomes by half




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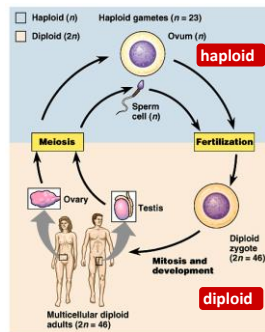
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## Meiosis: production of gametes

- Alternating stages
  - chromosome number must be reduced
    - diploid → haploid
    - $2n \rightarrow n$ 
      - humans: 46 → 23
    - meiosis reduces chromosome number
    - makes gametes
  - fertilization restores chromosome number
    - haploid → diploid
    - $n \rightarrow 2n$




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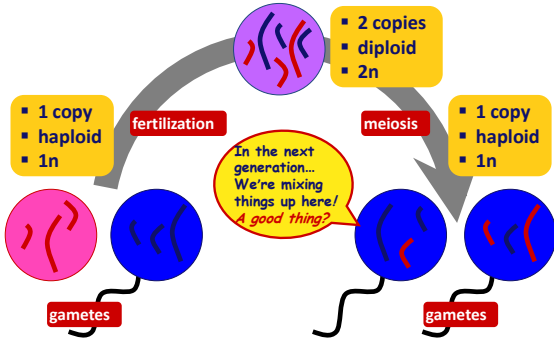
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### Sexual reproduction lifecycle




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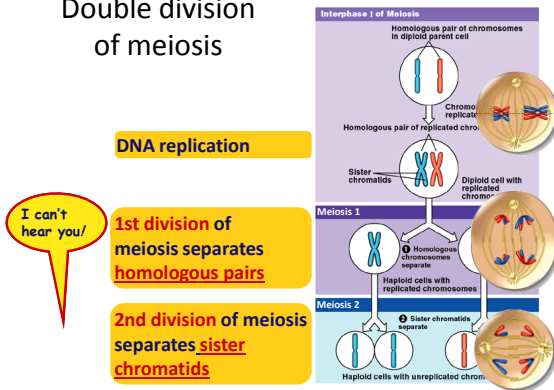
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### Double division of meiosis




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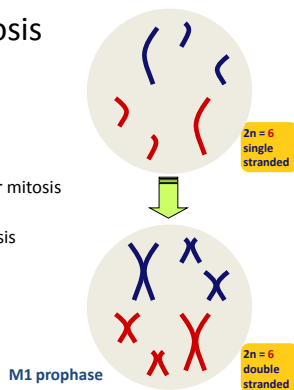
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### Preparing for meiosis

- 1st step of meiosis
  - Duplication of DNA
  - Why bother?
    - meiosis evolved after mitosis
    - convenient to use "machinery" of mitosis




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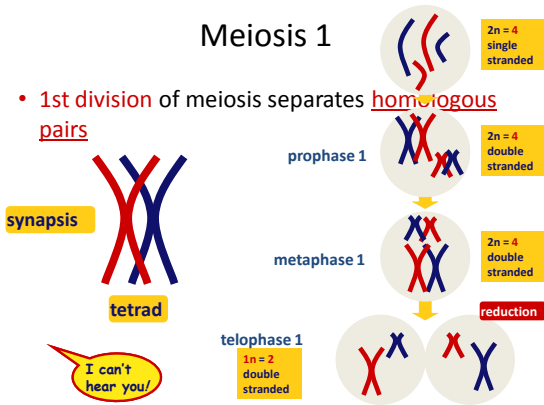
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## Meiosis 1




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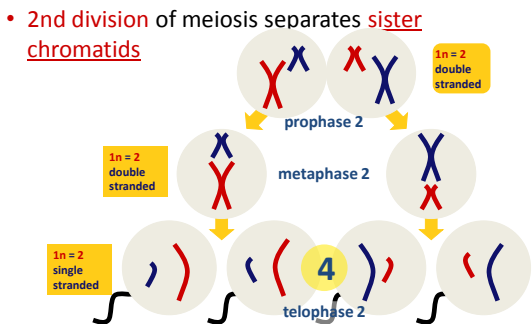
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## Meiosis 2




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## Steps of meiosis

- Meiosis 1
  - interphase
  - prophase 1
  - metaphase 1
  - anaphase 1
  - telophase 1
- Meiosis 2
  - prophase 2
  - metaphase 2
  - anaphase 2
  - telophase 2

**1st division of meiosis separates homologous pairs**  
 (2n → 1n)  
 "reduction division"

**2nd division of meiosis separates sister chromatids**  
 (1n → 1n)  
 \* just like mitosis \*

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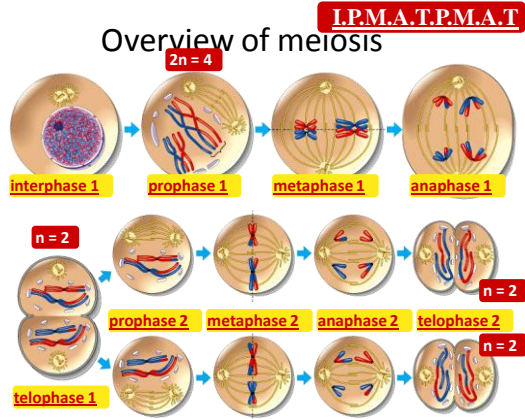
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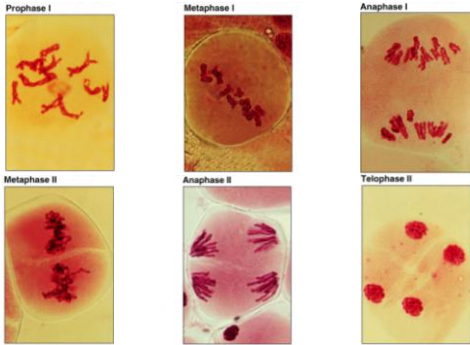
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### Meiosis 1 & 2




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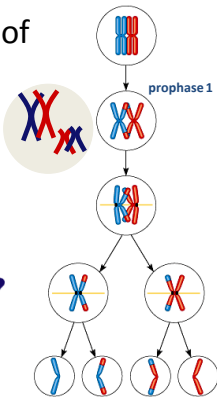
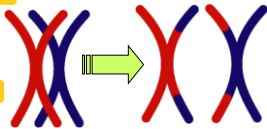
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### Trading pieces of

- **Crossing over**
  - during **Prophase 1**, sister chromatids intertwine
  - homologous pairs swap pieces of chromosome
    - DNA breaks & re-attaches

synapsis

tetrad




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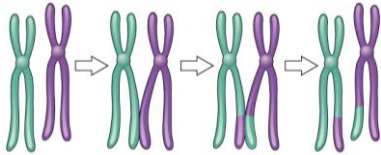
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## Crossing over

- 3 steps
  - cross over
  - breakage of DNA
  - re-fusing of DNA

What are the advantages of crossing over in sexual reproduction?




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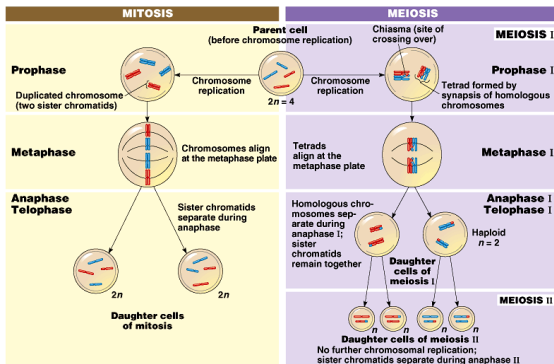
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## Mitosis vs. Meiosis




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## Mitosis vs. Meiosis

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Mitosis                             <ul style="list-style-type: none"> <li>– <u>1 division</u></li> <li>– daughter cells genetically <u>identical</u> to parent cell</li> <li>– produces <u>2 cells</u></li> <li>– <u><math>2n \rightarrow 2n</math></u></li> <li>– produces <u>cells for growth &amp; repair</u></li> <li>– no crossing over</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Meiosis                             <ul style="list-style-type: none"> <li>– <u>2 divisions</u></li> <li>– daughter cells genetically <u>different</u> from parent</li> <li>– produces <u>4 cells</u></li> <li>– <u><math>2n \rightarrow 1n</math></u></li> <li>– produces <u>gametes</u></li> <li>– <u>crossing over</u></li> </ul> </li> </ul> |
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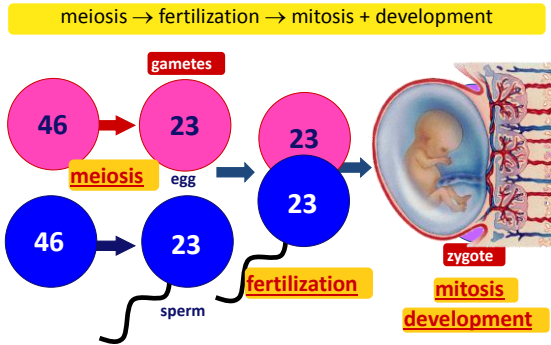
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## Putting it all together...




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## The value of sexual reproduction

- Sexual reproduction introduces genetic variation
  - genetic recombination
    - independent assortment of chromosomes
      - random alignment of homologous chromosomes in Metaphase 1
    - crossing over
      - mixing of alleles across homologous chromosomes
    - random fertilization
      - which sperm fertilizes which egg?
- Driving evolution
  - providing variation for natural selection




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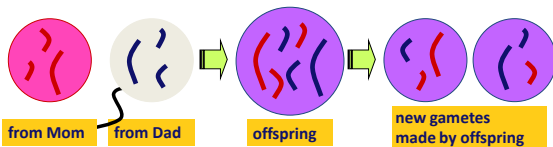
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## Variation from genetic recombination

- 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




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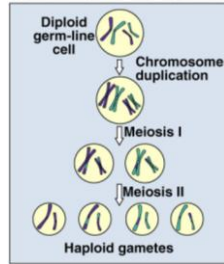
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## Variation from crossing over

- Crossing over creates completely new combinations of traits on each chromosome
  - creates an infinite variety in gametes




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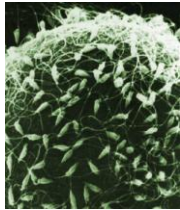
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## Variation from random fertilization

- Sperm + Egg = ?
  - any 2 parents will produce a zygote with over 70 trillion ( $2^{23} \times 2^{23}$ ) possible diploid combinations




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## Sexual reproduction creates variability

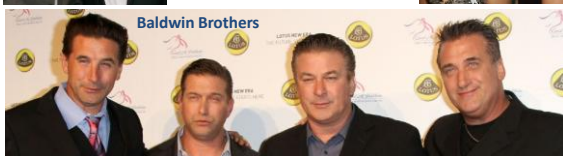
Sexual reproduction allows us to maintain both genetic similarity & differences.



Ben and Casey Affleck



Zoey and Emily Deschanel



Baldwin Brothers

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