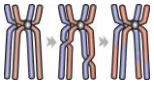
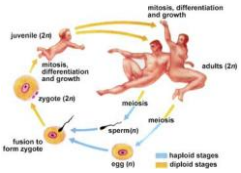
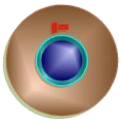
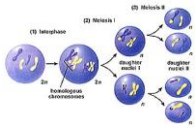




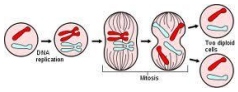
Meiosis & Sexual Reproduction

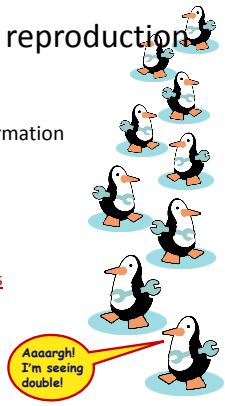




Cell division / Asexual reproduction

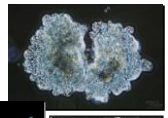
- Mitosis
  - produce cells with same information
    - identical daughter cells
  - exact copies
    - clones
  - same amount of DNA
    - same number of chromosomes
    - same genetic information

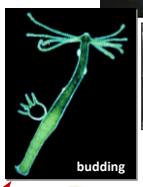


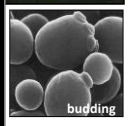


Asexual reproduction

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





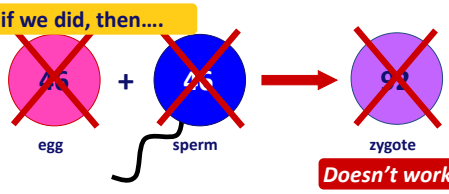


How about the rest of us?

- What if a complex multicellular organism (like us) wants to reproduce?
  - joining of egg + sperm
- Do we make egg & sperm by mitosis?

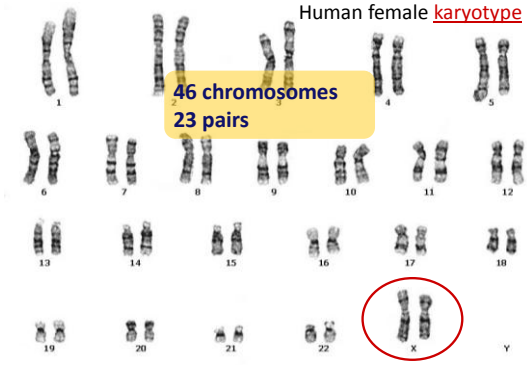
No!

What if we did, then….

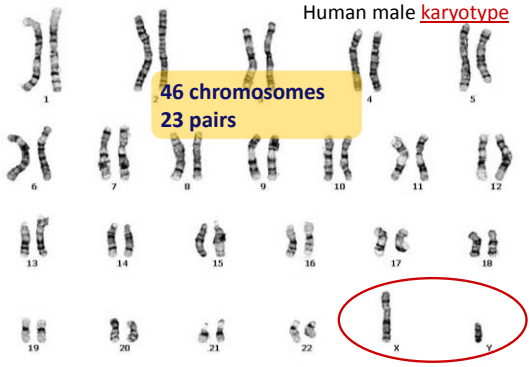


Doesn't work!

Human female karyotype

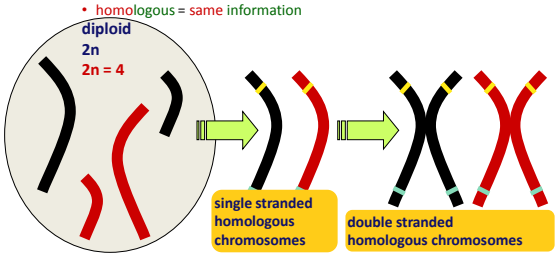


Human male karyotype



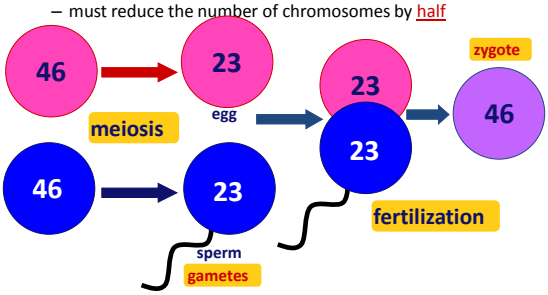
Homologous chromosomes

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



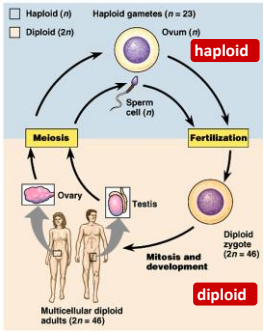
How do we make sperm & eggs?

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

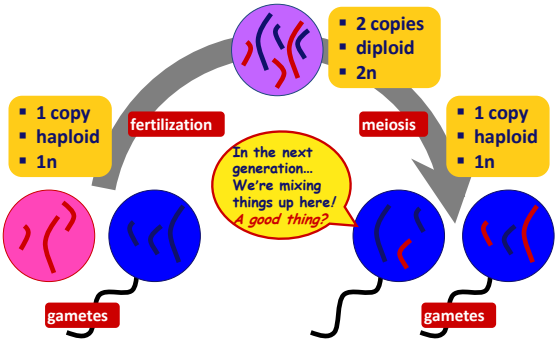


Meiosis: production of gametes

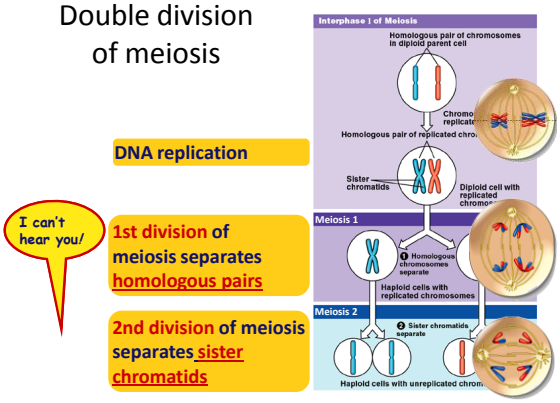
- Alternating stages
  - chromosome number must be reduced
    - diploid → haploid
    - 2n → n
      - humans: 46 → 23
    - meiosis reduces chromosome number
    - makes gametes
  - fertilization restores chromosome number
    - haploid → diploid
    - n → 2n



Sexual reproduction lifecycle

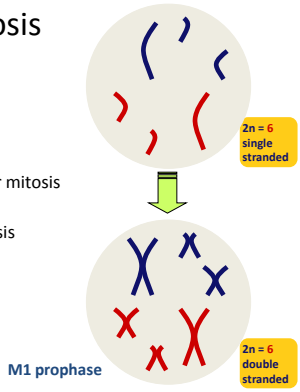


Double division of meiosis



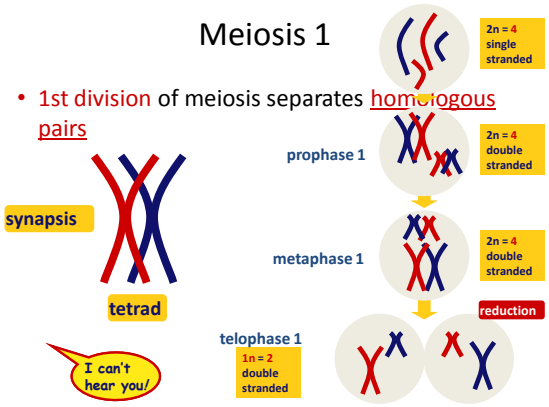
Preparing for meiosis

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



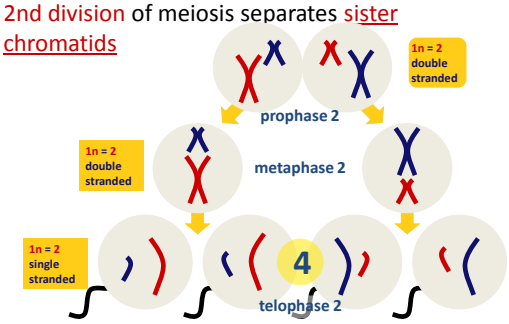
Meiosis 1

- 1st division of meiosis separates homologous pairs



Meiosis 2

- 2nd division of meiosis separates sister chromatids



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"

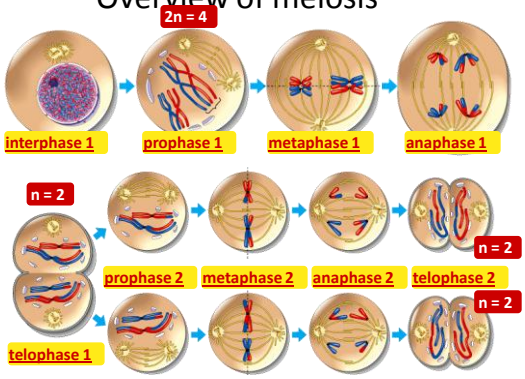
2nd division of meiosis separates sister chromatids

(1n → 1n)

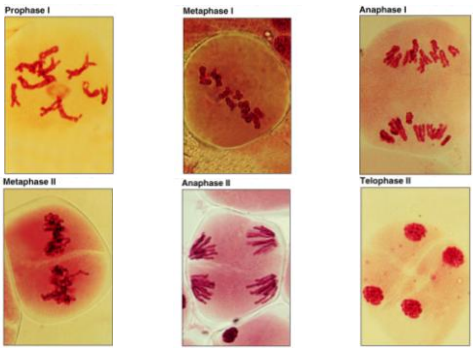
*** just like mitosis ***

Overview of meiosis

I.P.M.A.T.P.M.A.T

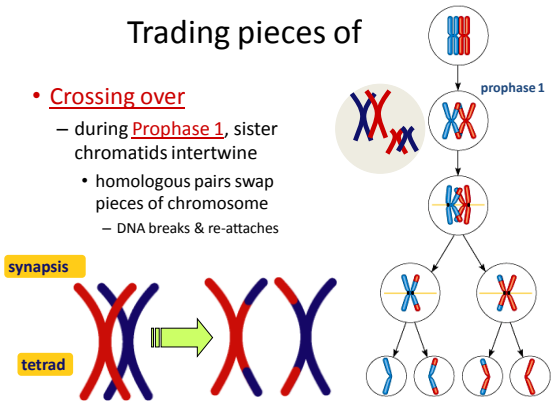


Meiosis 1 & 2



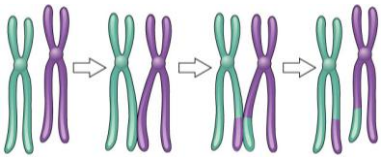
Trading pieces of

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

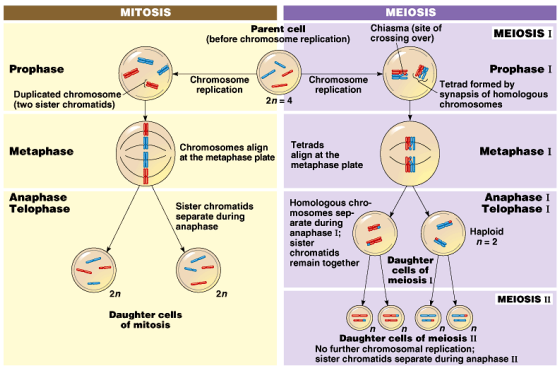


Crossing over

- 3 steps
  - cross over
  - breakage of DNA
  - re-fusing of DNA
- New combinations of traits



Mitosis vs. Meiosis

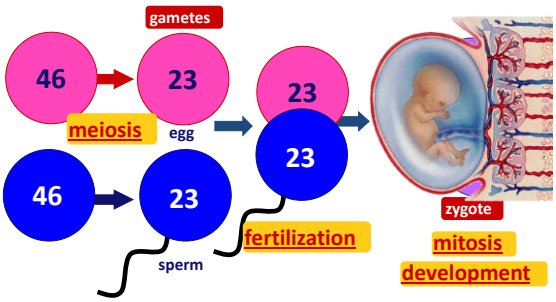


Mitosis vs. Meiosis

- Mitosis
  - 1 division
  - daughter cells genetically identical to parent cell
  - produces 2 cells
  - 2n → 2n
  - produces cells for growth & repair
  - no crossing over
- Meiosis
  - 2 divisions
  - daughter cells genetically different from parent
  - produces 4 cells
  - 2n → 1n
  - produces gametes
  - crossing over

Putting it all together…

meiosis → fertilization → mitosis + development

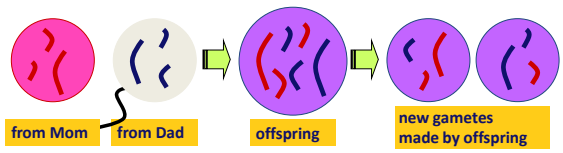


The value of sexual reproduction

- 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

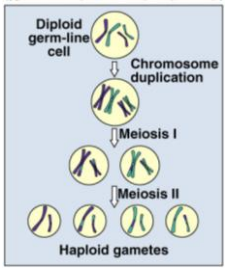
Variation from genetic recombination

- 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



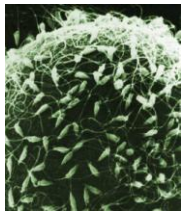
Variation from crossing over

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



Variation from random fertilization

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

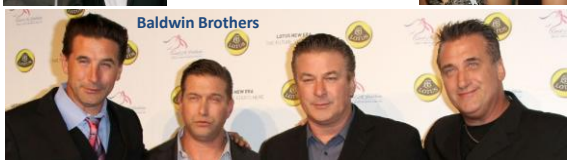


Sexual reproduction creates variability

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

Ben and Casey Affleck

Zooey and Emily Deschanel



Baldwin Brothers