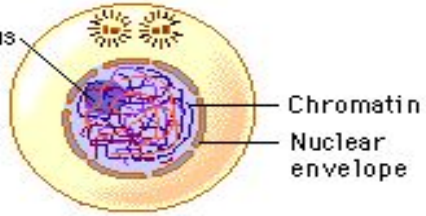
Meiosis

Sexual Reptroduction

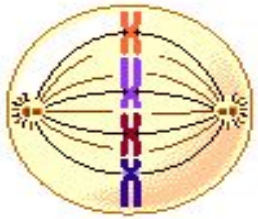
Review of the Cell Cycle and Mitosis

Interphase
The nucleolus and the nuclear envelope are distinct and the chromosomes are in the form of threadlike chromatin.

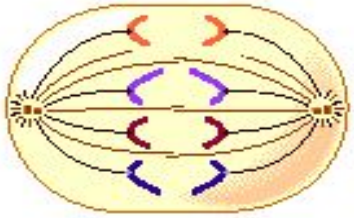


Prophase
The chromosomes appear condensed, and the nuclear envelope is not apparent.

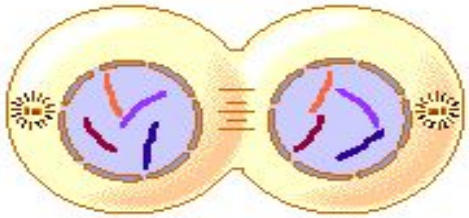
Metaphase
Thick, coiled chromosomes, each with two chromatids, are lined up on the metaphase plate.



Anaphase
The chromatids of each chromosome have separated and are moving toward the poles.



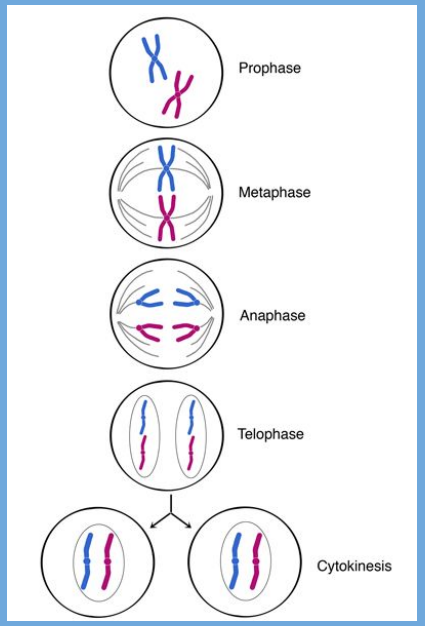
Telophase
The chromosomes are at the poles, and are becoming more diffuse. The nuclear envelope is reforming. The cytoplasm may be dividing.



Cytokinesis
Division into two daughter cells is completed.

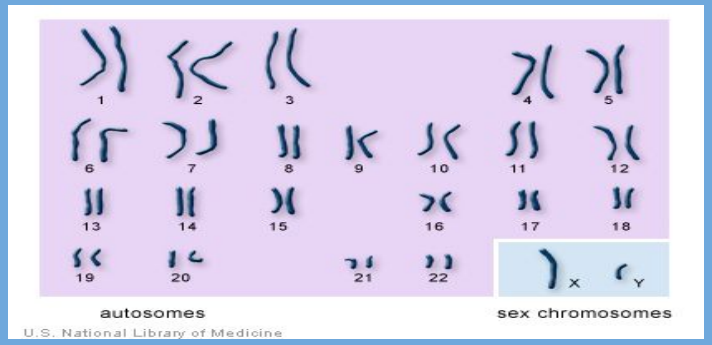
Mitosis Review

- A form of asexual reproduction
  - This means that it only requires ONE organism! (ex. skin cells dividing)
  - For growth and repair of somatic (body) cells
  - Result in 2 cells identical to the original (parent) cell



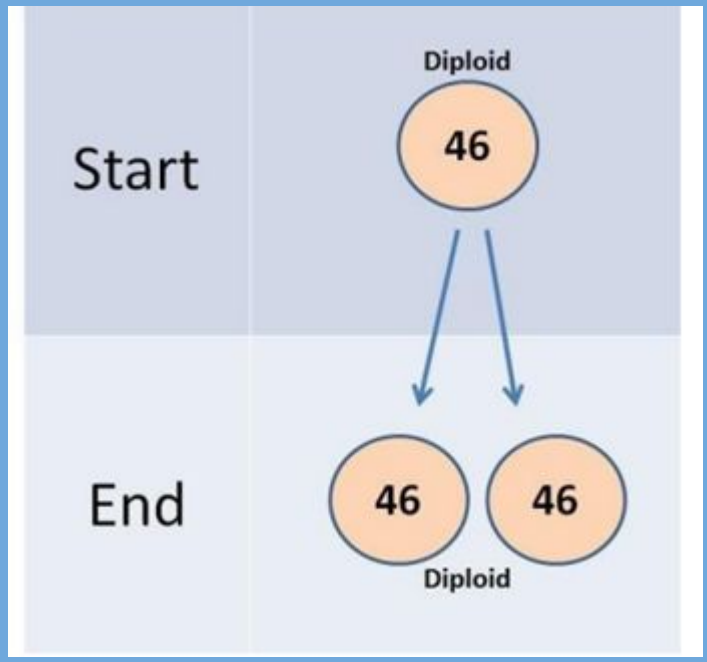
Mitosis Review

- Recall that DNA is condensed into chromosomes
- Humans have a total of 46 different chromosomes per cell (23 pairs)
  - 22 of the pairs are autosomes (present in all)
  - BUT one pair that are the sex chromosome, either an XX or XY - determines your gender
- When Mitosis occurs, each new cell will have 46 chromosomes, just like the original

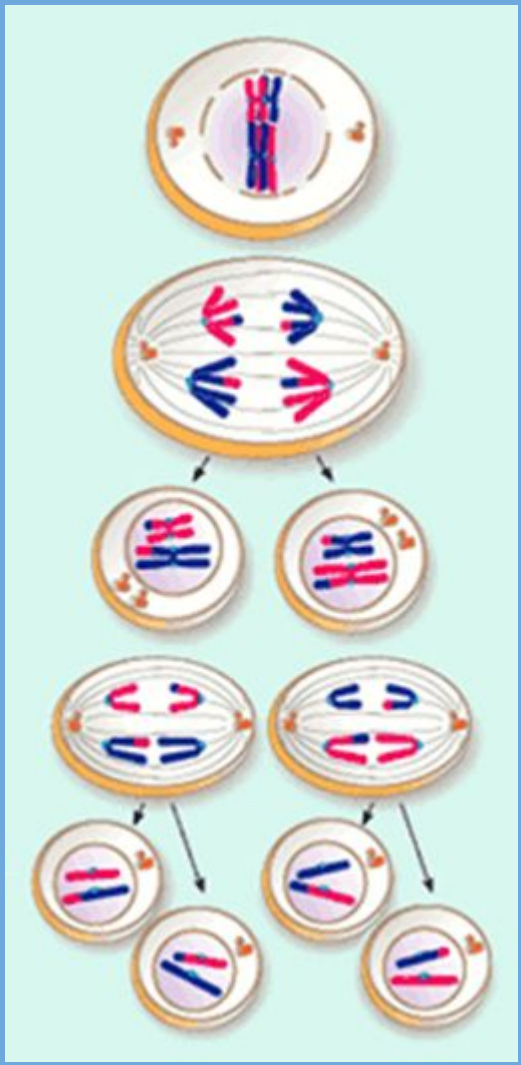


Mitosis Review

- The cells produced in Mitosis are diploid
  - *Diploid* cells contain two complete sets (2n) of chromosomes



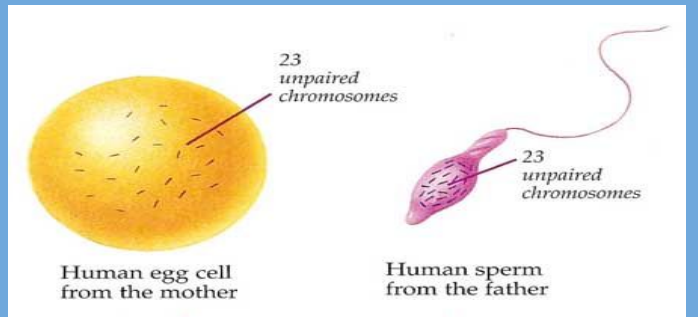
Meiosis



Meiosis

Meiosis is a form of Sexual Reproduction

- This means that it takes 2 organisms to make a new organism
- Results in 4 daughter cells that are NOT identical to the parent cells
- These daughter cells are called gametes (sperm and egg cells) that combine to make a new organism



Meiosis

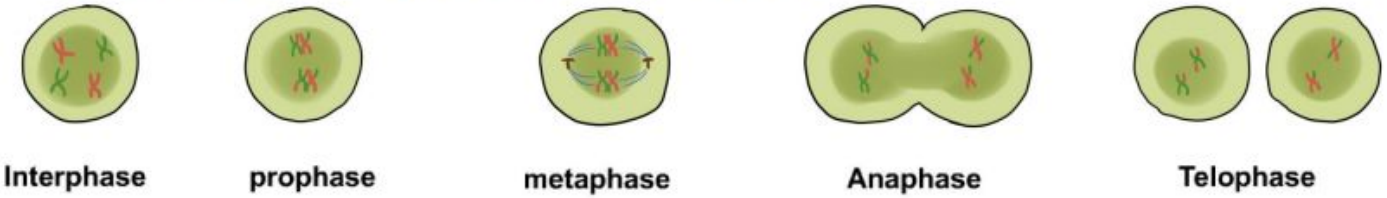
- The **Male Gamete** is the **Sperm** and is produced in the male gonad, **Testes**.

- The **Female Gamete** is the **Ovum (ova = pl.)** and is produced in the female gonad, **Ovaries**.

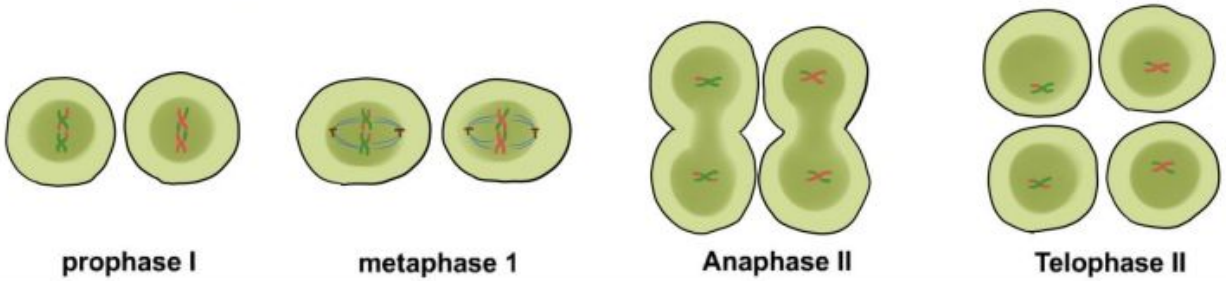
Meiosis

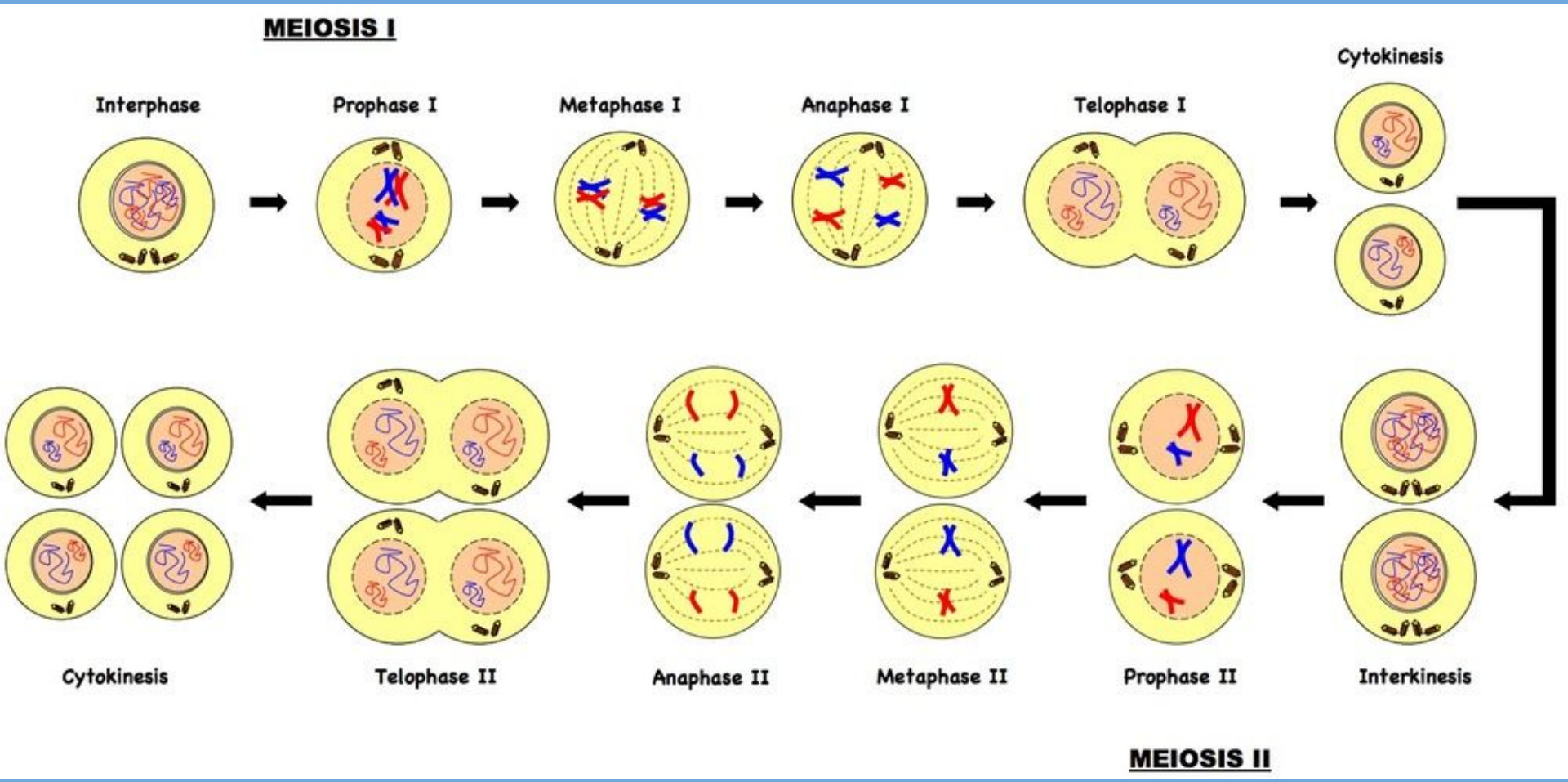
There are two phases in meiosis

- In Meiosis I, the cell divides



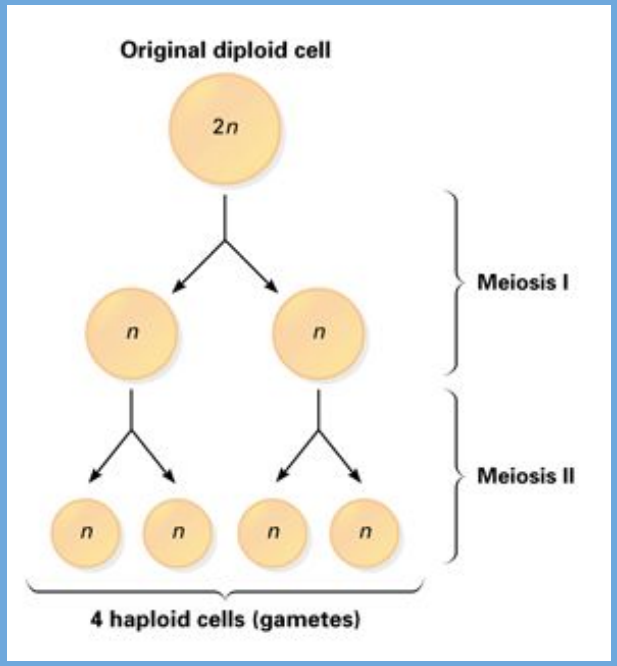
- In Meiosis II, the cells divide again, creating 4 cells




MEIOSIS I
Interphase
Prophase I
Metaphase I
Anaphase I
Telophase I
Cytokinesis
Interkinesis
Prophase II
Metaphase II
Anaphase II
Telophase II
Cytokinesis
MEIOSIS II

Meiosis

- The cells produced in ***meiosis***
  - ***Haploid*** - meaning they only contain half of chromosomes of a diploid cell (n)
  - Each new cell will have 23 chromosomes, half of the original!



Meiosis

- Why only half?
  - The haploid gametes (egg and sperm) fuse during fertilization to make a diploid cell (2n)
  - The new diploid cell is called a zygote and it will grow into a new organism

Mitosis Overview

- Asexual Reproduction
- Growth and repair of somatic cells
- One diploid (2n) cell
- 46 chromosomes
- Divides Once
- Produces two identical cells each with 46 chromosomes

Meiosis Overview

- Sexual Reproduction
- A diploid (2n) cell divides twice
- Produces four different haploid gametes (n) each with half of the original chromosomes(23)
- Gametes are the sperm and egg cells
- Two gametes combine to form a diploid zygote (2n) with original chromosomes (46)

Mitosis vs Meiosis

	Mitosis	*Meiosis*
Type of Reproduction		
Purpose		
Number of Divisions		
Number of Cells Produced		
Number of Chromosomes		

Mitosis vs Meiosis

	Mitosis	*Meiosis*
Type of Reproduction	*Asexual*	*Sexual*
Purpose	*Growth and Repair*	*Create Gametes (which fuse to make a new organism)*
Number of Divisions	*1*	*2*
Number of Cells Produced	*2 identical diploid (2n) cells*	*4 unique haploid (n) cells*
Number of Chromosomes	*Remains the same as original (46 in humans)*	*Half the original (23 in humans)*

Meiosis Video

Vocabulary Review

- Define the following Terms
  - Mitosis
  - Meiosis
  - Haploid
  - Diploid
  - Gametes
  - Zygote
  - Asexual Reproduction
  - Sexual Reproduction
  - Autosomal Cells
  - Somatic Cells

Meiosis and Genetics

Why is Meiosis Important?

- Leads to a greater genetic diversity

Meiosis and Genetics

What is genetic diversity?

- Traits that are inherited independently of one another, allowing organisms to be genetically different

Do you and your parents, siblings and family members look **exactly alike?*

Meiosis and Genetics

- Groups with varying genetics have a greater chance to survive and flourish
  - Example: being resistant to disease, tolerant to cold
- Genetic diversity reduces the incidence of unfavorable traits
  - Example: Inbreeding, which can cause genetic flaws to become more common

Sources of Genetic Diversity

- **Random Fertilization**
- **Independent Assortment**
- **Crossing Over**
- **Mutations**

Sources of Genetic Diversity

Random Fertilization

- nonspecific unions of chromosomes during meiosis make genetic variations possible

- Sexual Reproduction produces the largest amount of variation, which is essential for the survival of a population.

Sources of Genetic Diversity

Independent Assortment

- Produces 2^n distinct gametes, where n = the number of unique chromosomes

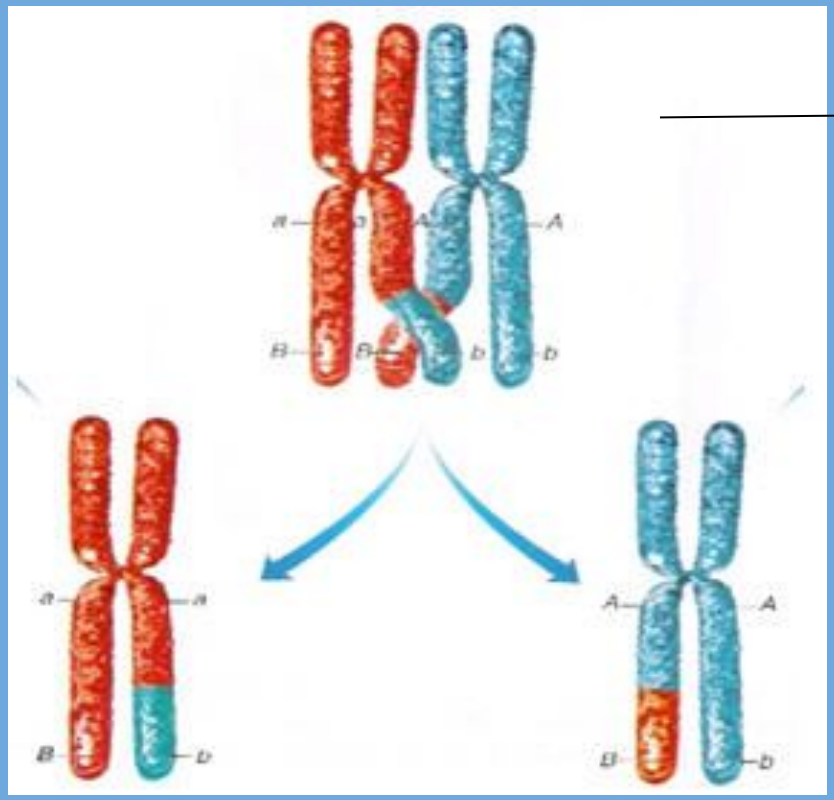
In humans, n = 23 and 2^{23} = 6,000,000 (that is a lot of diversity)

Sources of Genetic Diversity

Crossing Over

- During meiosis, homologous chromosomes (a set, 1 maternal + 1 paternal) undergo this process
  - The exchange of genetic material between chromosomes
  - result in *greater* diversity

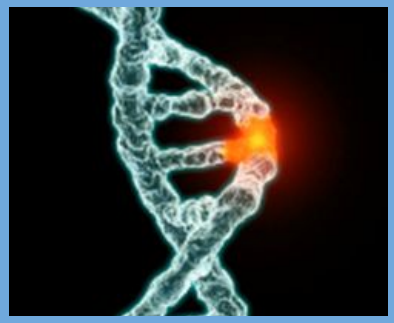
Crossing Over



Tetrad
(set of 4)

This increases the differences in the gametes!

Sources of Genetic Diversity



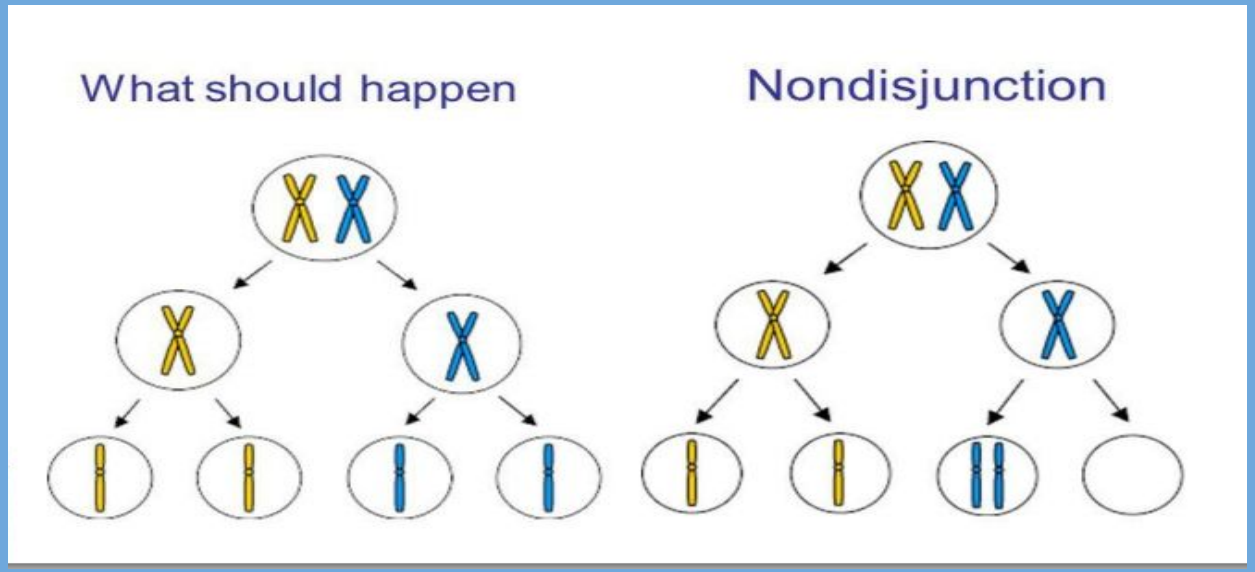
Gene Mutation

- Can cause variations in genes by introducing new traits into a population
- Mutations that can be passed down are those found in the gametes
- Mutations, such as tobacco smoke altering lung cells, cannot be passed down

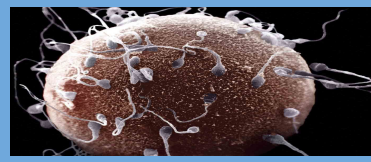
Sources of Genetic Diversity

Gene Mutation: Nondisjunction

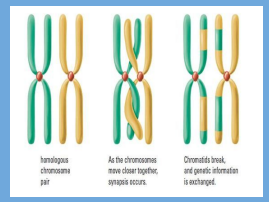
- This is the failure of homologous chromosomes to separate correctly during cell division.



Review of Concept

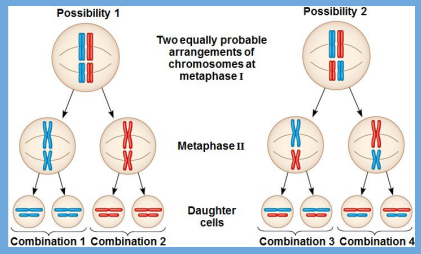


- Random Fertilization - any set of genes has an equal opportunity of combining to be passed to the offspring

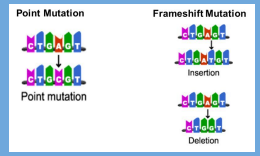


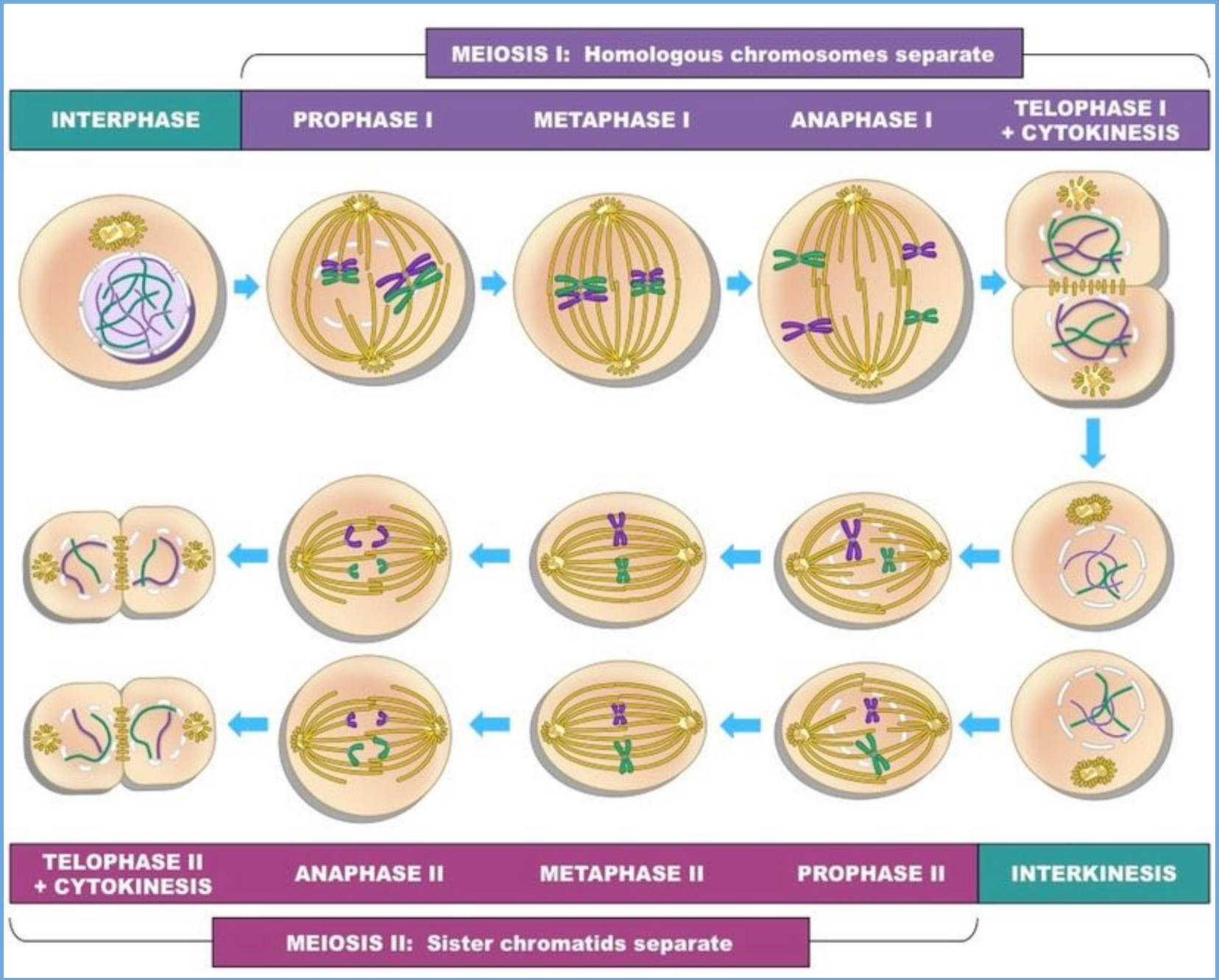
- Crossing Over - chromosomes exchange traits

- Independent Assortment - each allele is separate from one another



- Gene Mutation - introduction of altered genes in a population (not all can be passed down



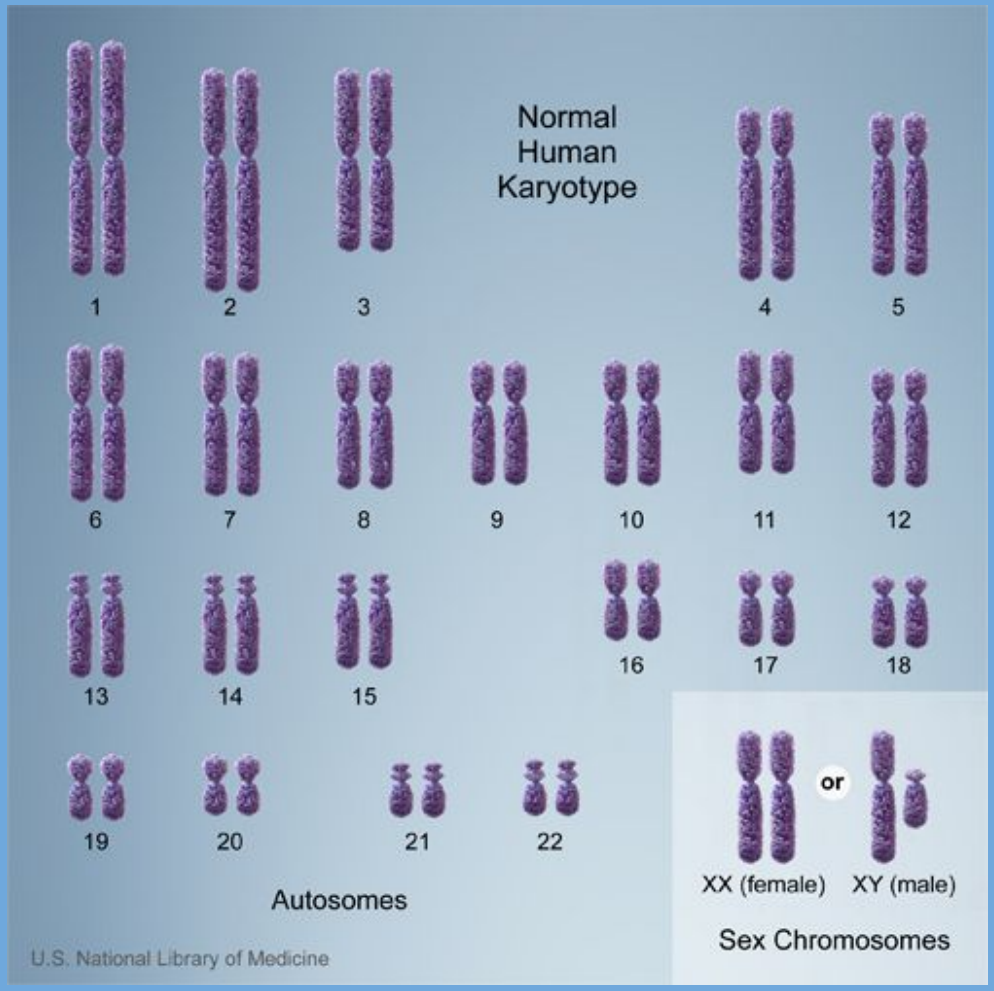

MEIOSIS I: Homologous chromosomes separate
INTERPHASE
PROPHASE I
METAPHASE I
ANAPHASE I
TELOPHASE I + CYTOKINESIS
INTERKINESIS
PROPHASE II
METAPHASE II
ANAPHASE II
TELOPHASE II + CYTOKINESIS
MEIOSIS II: Sister chromatids separate

Karyotype

Map of an individuals chromosomes

Usually completed to check for genetic disorders

Each cell contains the same genetic information therefore they only examine one cell



Karyotype

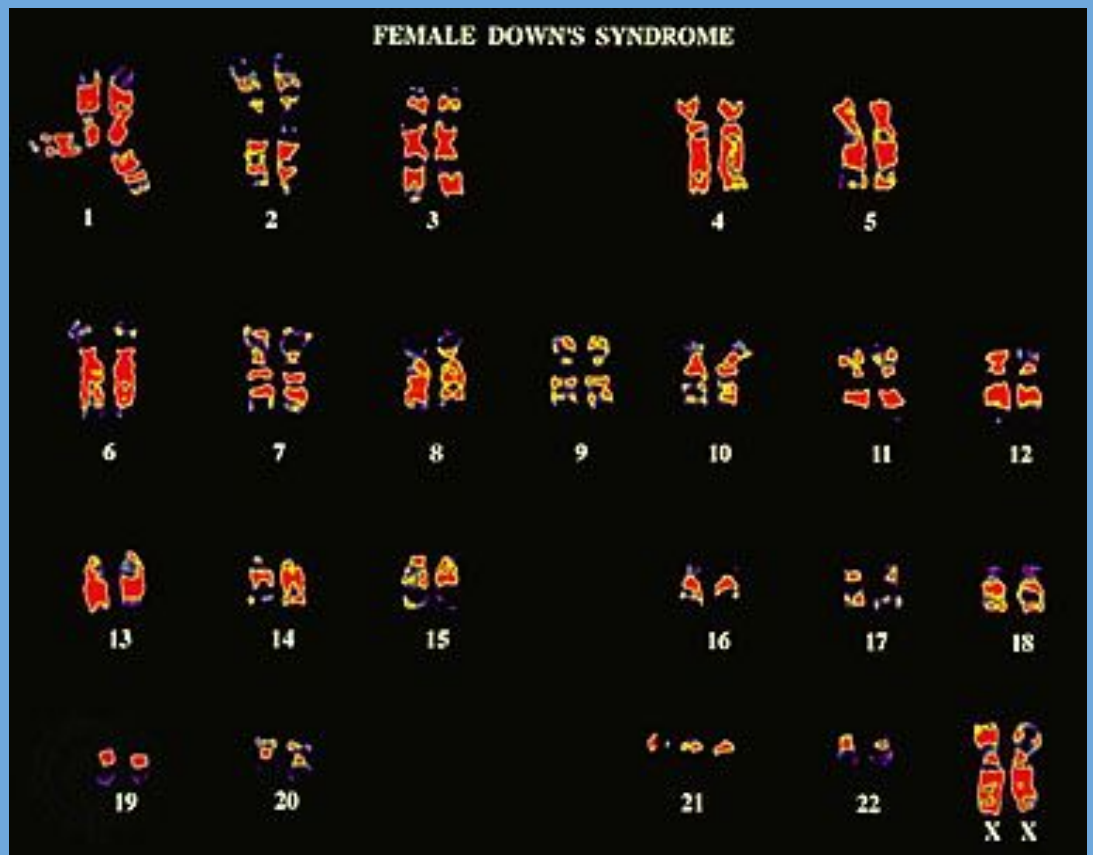
Making a Karyotype

- Each homologous pair is matched
  - according to size, shape, location of centromere and band patterns
- Autosomal (or somatic) chromosomes are matched first, the first 22 pairs
- The 23rd, pair (sex chromosomes) are placed at the end

This allows you to look for any abnormalities within the chromosomes.

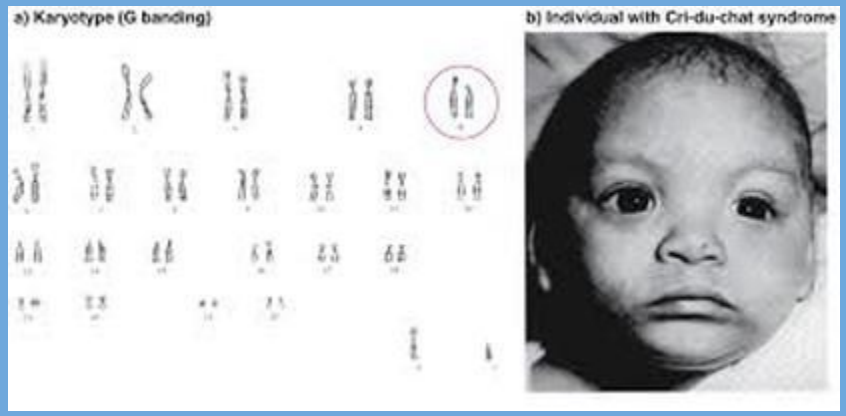
Chromosomal Abnormalities

- Trisomy 21 or Down's Syndrome, extra chromosome on the 21st pair



Chromosomal Abnormalities

Cri-du-Chat Syndrome - abnormal larynx development, caused by a break in a chromosomes (*aka deletion)*

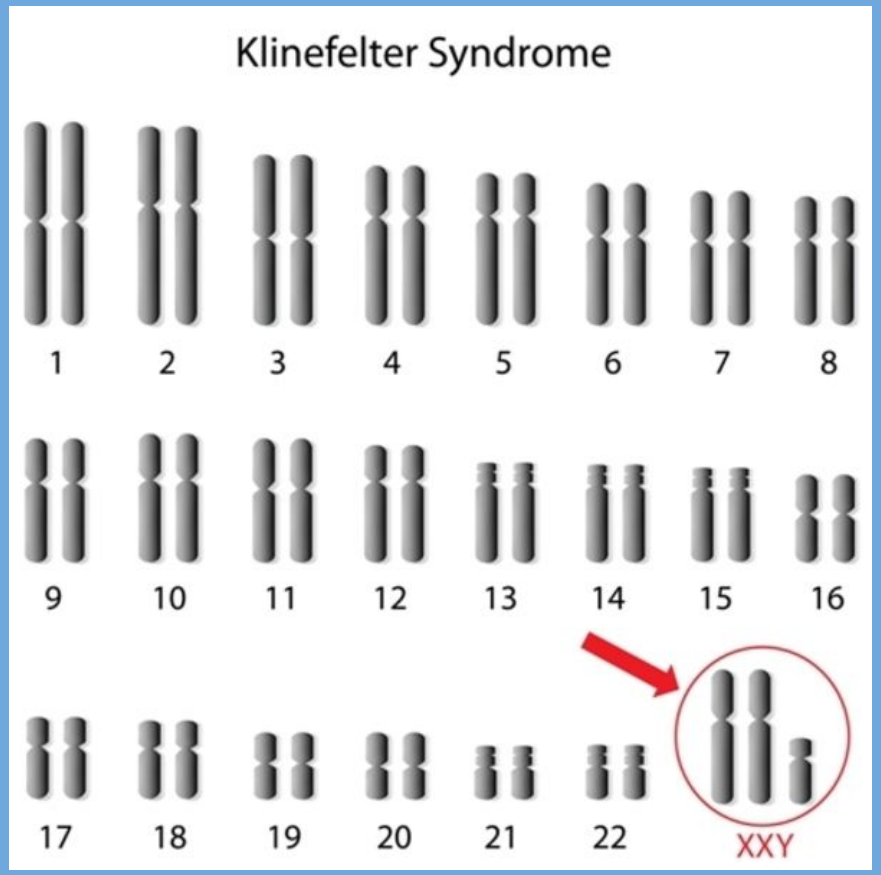


- *High pitched cry*
- *Low birth weight*
- *Delayed growth*
- *Wide-set eyes*
- *Webbing in fingers or toes*

Chromosomal Abnormalities

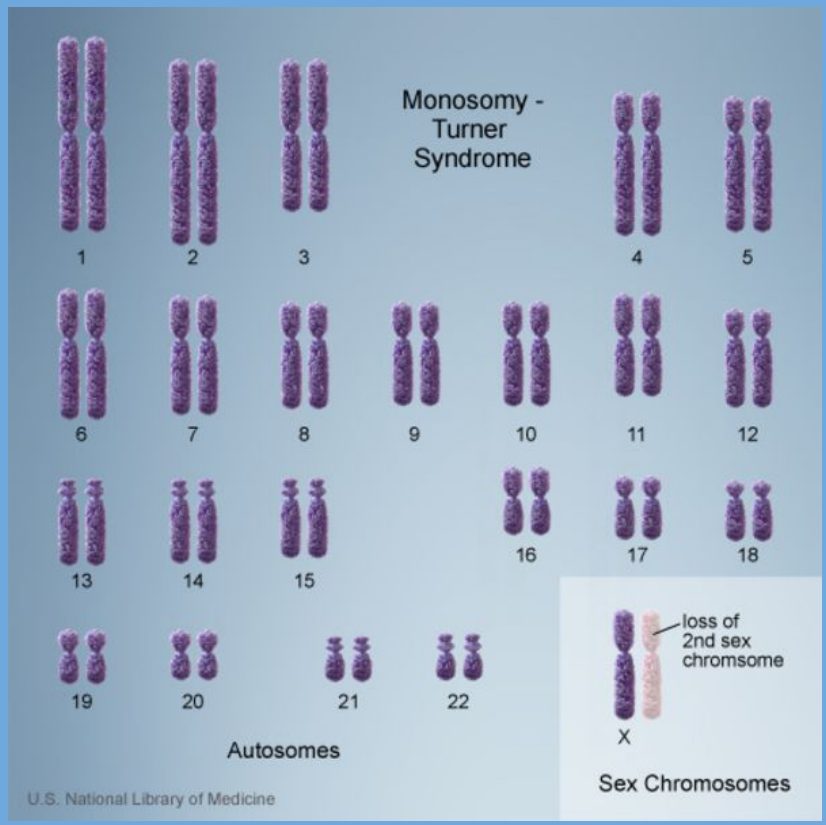
47, XXY or Klinefelter Syndrome - has two X chromosomes on the 23rd pair

- *Lower IQ*
- *Tall stature*
- *Gynecomastia*
- *Infertility*



Chromosomal Abnormalities

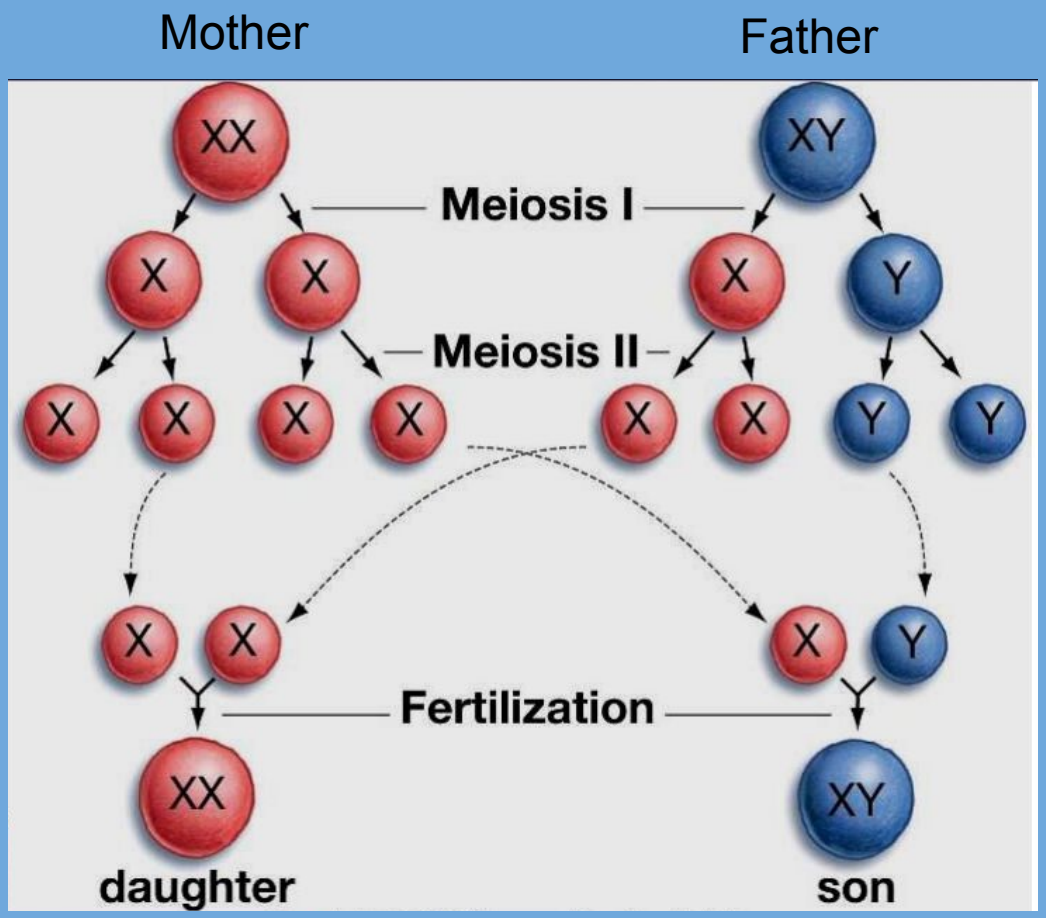
Turner Syndrome - missing or incomplete X chromosome on the 23rd pair



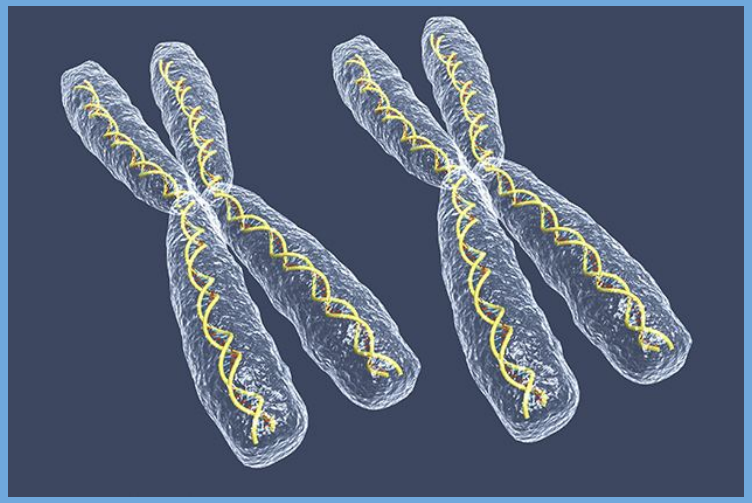
- Short stature
- Low hairline
- Short fingers/toes
- Infertility

What determines the sex of a child?

The Sex of a Child



The Sex of a Child



Vocabulary Review

- Define the following Terms
  - Homologous Chromosome
  - Random Fertilization
  - Independent Fertilization
  - Crossing Over
  - Gene Mutation
  - Nondisjunction
  - Genetic Diversity
  - Karyotype
  - Trisomy Syndrome
  - Cri-de-Chat Syndrome
  - Klinefelter Syndrome
  - Turner Syndrome

Mitosis and Meiosis

Event	Mitosis	Meiosis
DNA replication	Occurs during interphase before nuclear division begins	Occurs once, during the interphase before meiosis I begins
Number of divisions	One, including prophase, metaphase, anaphase, and telophase	Two, each including prophase, metaphase, anaphase, and telophase
Synapsis of homologous chromosomes	Does not occur	Synapsis is unique to meiosis: During prophase I, the homologous chromosomes join along their length, forming tetrads (groups of four chromatids); synapsis is associated with crossing over between nonsister chromatids
Number of daughter cells and genetic composition	Two, each diploid ($2n$) and genetically identical to the parent cell	Four, each haploid (n), containing half as many chromosomes as the parent cell; genetically nonidentical to the parent cell and to each other
Role in the animal body	Enables multicellular adult to arise from zygote; produces cells for growth and tissue repair	Produces gametes; reduces chromosome number by half and introduces genetic variability among the gametes