

10.1 Meiosis

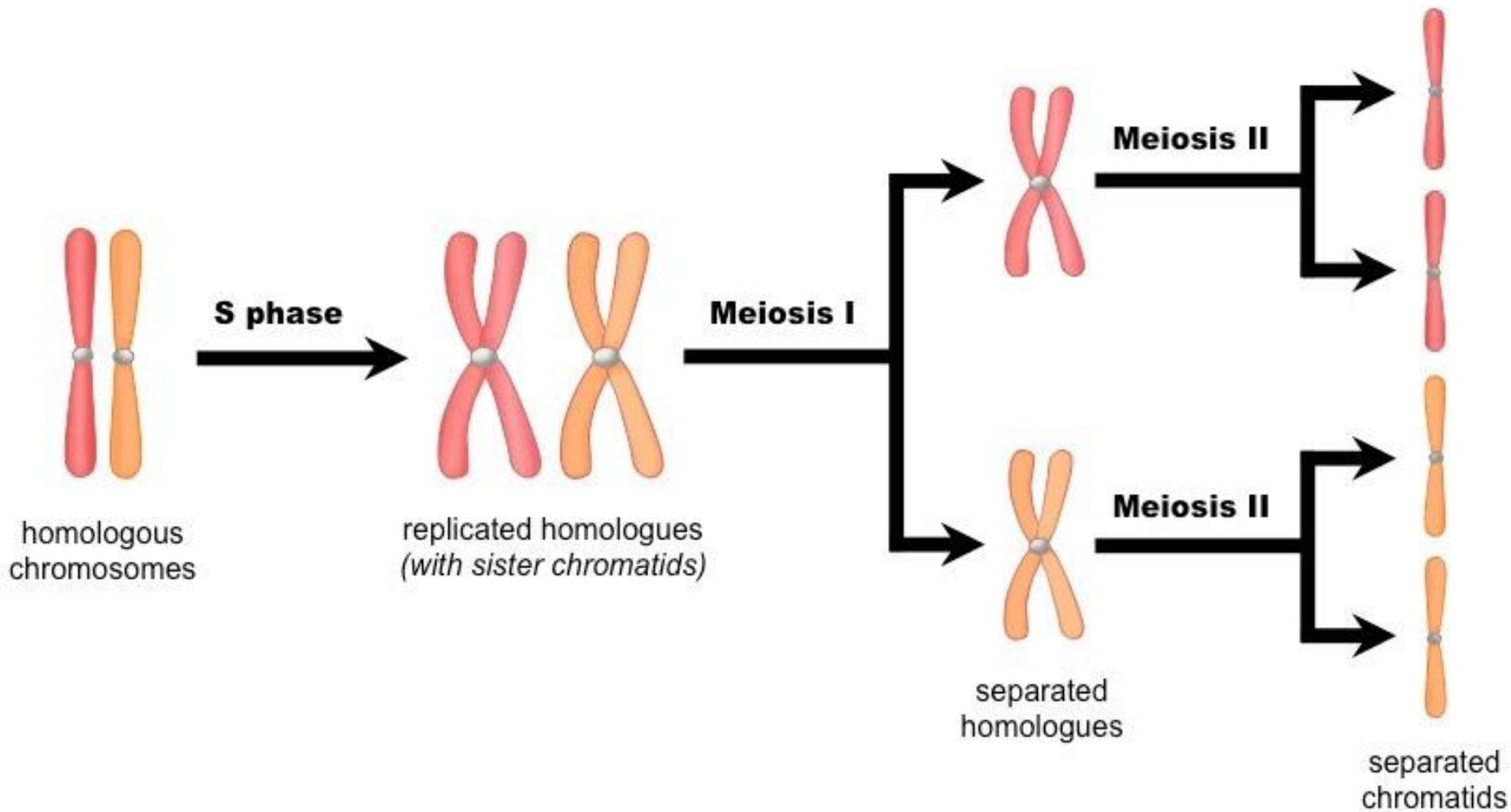
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Chromosome Replication

Occurs during Interphase (an active period that precedes meiosis and prepares the cell for division)

- ❖ DNA is replicated during the *S phase* of interphase, resulting in chromosomes that contain two identical DNA strands
 - creates *sister chromatids* which are held together by a central region called the centromere
- ❖ If DNA replication did not occur prior to meiosis = no need for a 2nd meiotic division
 - The fact that DNA replication does occur suggests that meiosis evolved from mitosis (where initial DNA replication is necessary)
 - increases the potential for genetic recombination to occur (more variation)

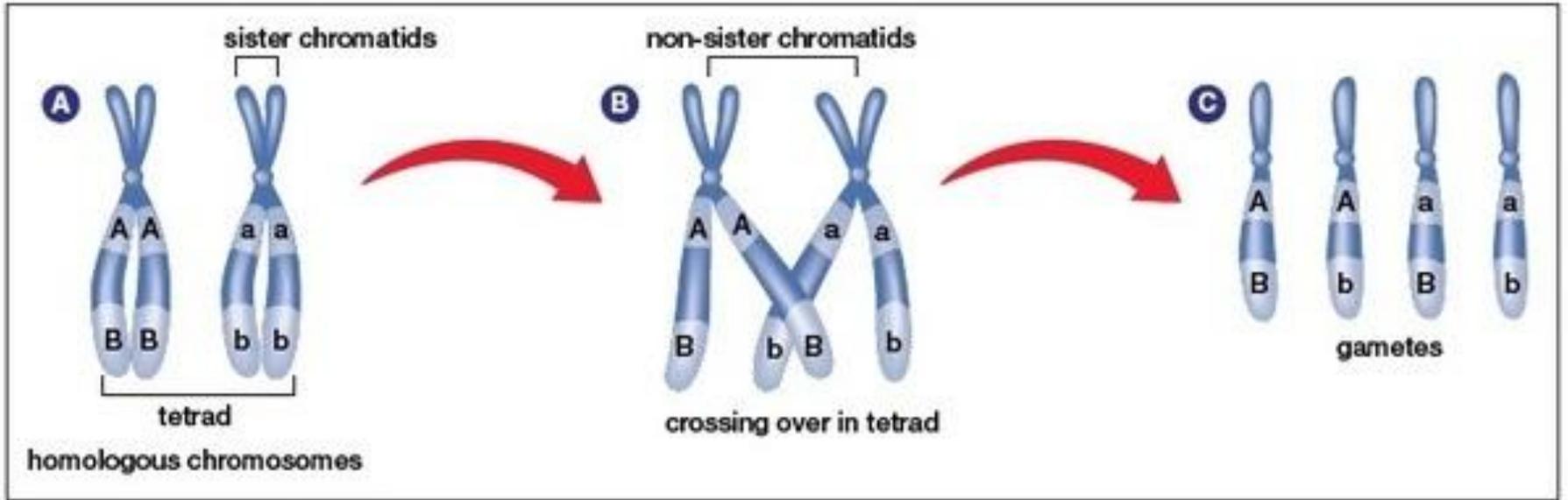


Exchange of Genetic Material

Crossing over is the exchange of DNA material between nonsister homologous chromatids.

- **Occurs during Prophase 1 of meiosis**
- **Homologous chromosomes line up**
- **Non-sister chromatids break and recombine with one another to exchange genetic material**

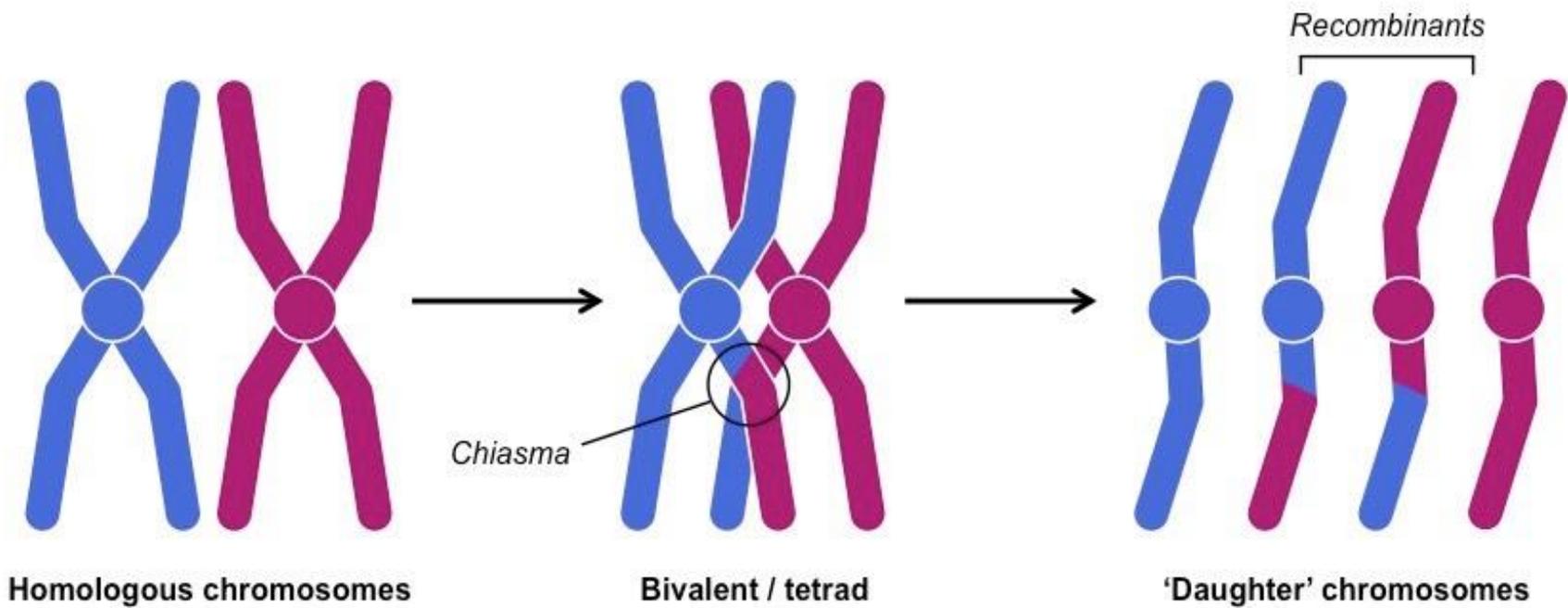
Exchange of Genetic Material: Crossing Over



Chiasmata Formation

Chiasmata formation between non-sister chromatids can result in the exchange of alleles.

- ❖ Synapsis = process during prophase 1 where chromosomes connect
- ❖ In synapsis, non-sister chromatids break and recombine with their partner
 - **AKA crossing over**
- ❖ Chiasmata = **points of exchange** where non-sister chromatids stay connected
 - **Holds the homologous chromosomes together** until Anaphase 1



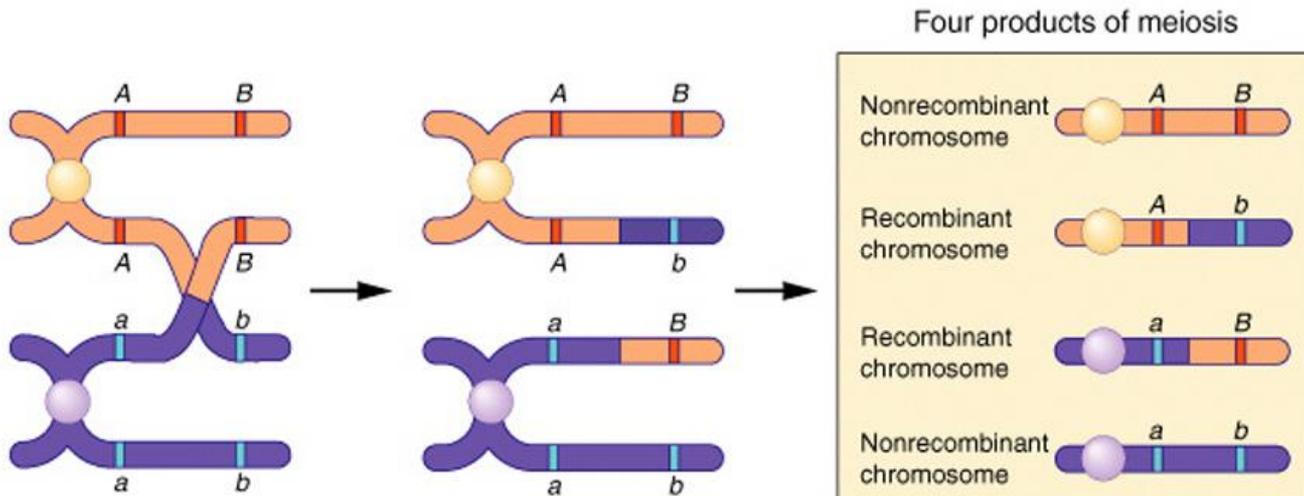
New Combinations of Alleles

Crossing over produces new combinations of alleles on the chromosomes of the haploid cells

- ❖ increases the genetic diversity of potential offspring
- ❖ Independent Assortment
 - Allele combination is completely random

Crossing Over of Alleles

Allele: DNA coding that determines unique characteristic traits; hair color, eye color, height



Natural Selection

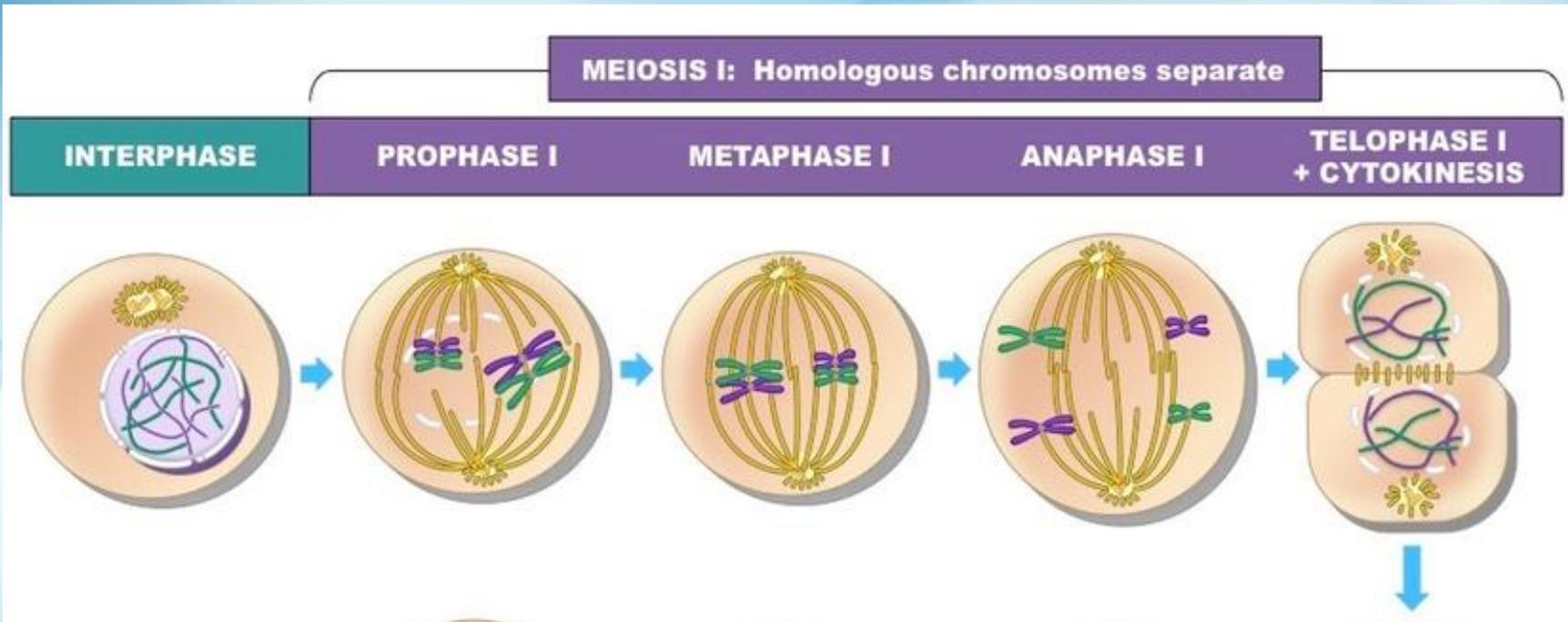
- ❖ **Crossover creates new gene combinations of alleles on a single chromosome**
 - **This Leads to genetic variance**
- ❖ **Variation = one of the pillars of natural selection**
- ❖ **Sexual reproduction provides greater diversity through diversity in combination of alleles**

Meiosis 1

The first meiotic division is a reduction division (diploid → haploid) where homologous chromosomes are separated.

- ❖ **P-1:** Chromosomes condense, membrane dissolves, crossing over occurs
- ❖ **M-1:** Spindle fibres connect at centromeres and align them along the middle
- ❖ **A-1:** Spindle fibres split the pairs of chromosomes, homologous chromosomes move to opposite poles
- ❖ **T-1:** Chromosomes decondense, nuclear membrane *may* reform, cell divides (cytokinesis) to form two haploid daughter cells

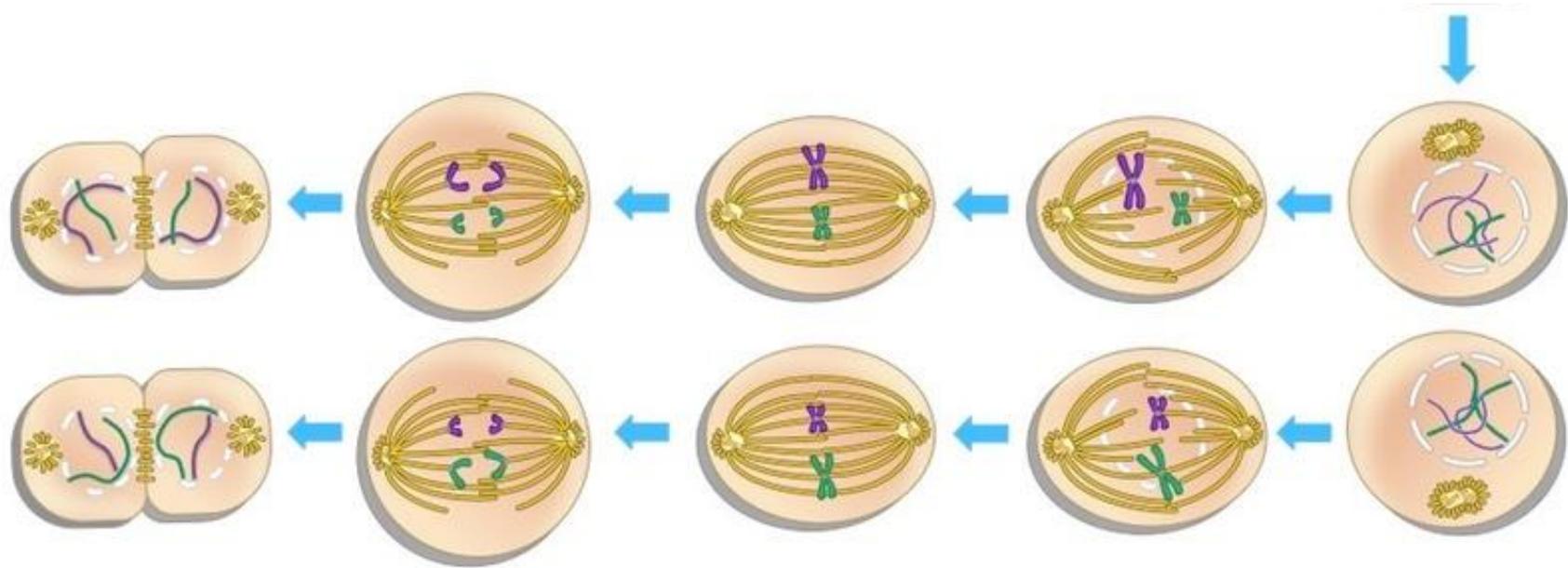
Meiosis 1



Meiosis 2

The second division separates sister chromatids (which may not be identical due to crossing over in prophase 1)

- **P-11:** Chromosomes condense, membrane dissolves, centrosomes move to opposite poles (perpendicular to before)
- **M-11:** Spindle fibres from opposing centrosomes attach to chromosomes (at centromere) and align them along the middle
- **A-11:** Spindle fibres contract and separate the sister chromatids, chromatids (now called chromosomes) move to opposite poles
- **T-11:** Chromosomes decondense, nuclear membrane reforms, cells divide (cytokinesis) to form four haploid daughter cells



**TELOPHASE II
+ CYTOKINESIS**

ANAPHASE II

METAPHASE II

PROPHASE II

INTERKINESIS

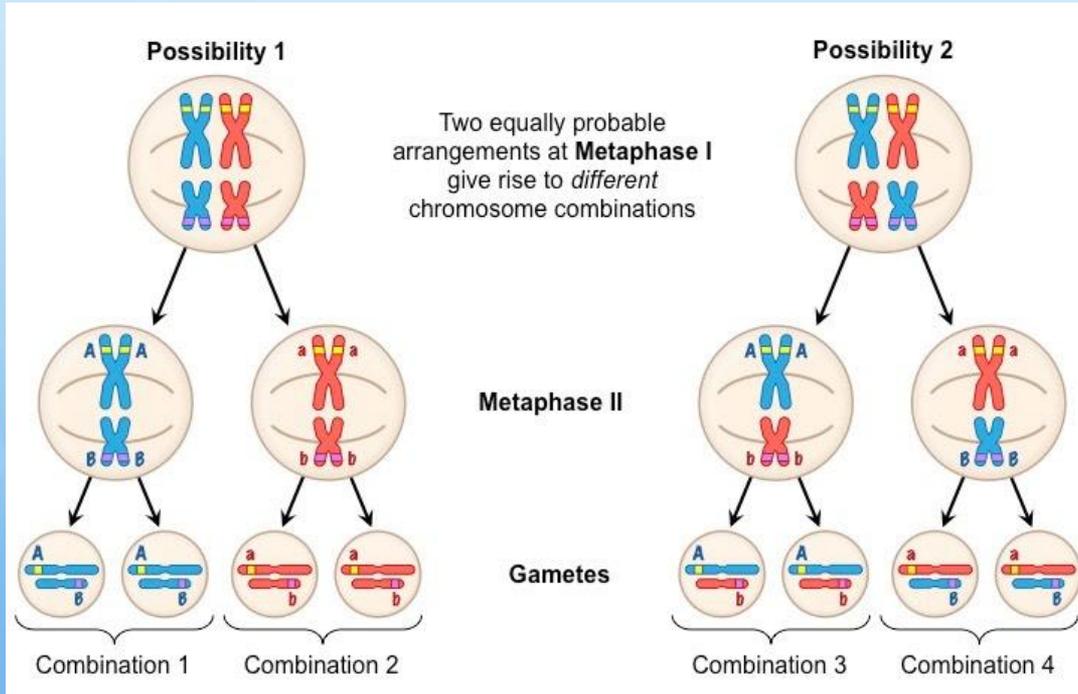
MEIOSIS II: Sister chromatids separate

Independent Assortment

Independent Assortment: Describes how pairs of alleles separate from one another during gamete formation

- ❖ The inheritance of one gene/trait is independent to the inheritance of any other gene/trait
- ❖ During metaphase one each chromosome lines up at the equator of the cell in a random orientation
- ❖ This means an allele on one chromosome has an equal chance of being paired with, or separated from, any allele on another chromosome

Independent Assortment



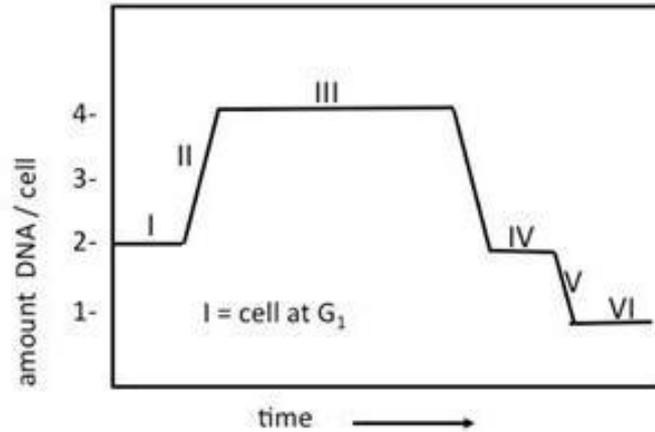
There are over 8,324,608 possible combinations of 23 chromosomes in a gamete

Overall Summary

- ❖ Chromosome replicate during interphase before meiosis
- ❖ Crossing over is the exchange of genetic material
 - Leads to genetic variation/exchange of alleles
- ❖ Homologous chromosomes separate in meiosis
- ❖ Unlike mitosis, each individual haploid cell is different from one another
- ❖ Meiosis=Mitosis twice + Crossing over

DBQ

Change in DNA content of a cell undergoing *meiosis*



1. Label each Roman Numeral on the graph as it's phase of the cell cycle. (G₁, G₂, T₁, T₂, M₂, S)
2. At which stages are the cells diploid cells and haploid cells?
3. Explain what happens during stages 1-3 that produces so much DNA per cell. What phase are these 3 stages known as?
4. When Down Syndrome occurs, something known as nondisjunction occurs, where Chromosome 21 is copied twice, and the gamete then has 24 chromosomes. At which stage does nondisjunction occur? Would this affect how much DNA exists per cell and therefore affect the graph?