Biology

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Meiosis

Special type of cell division necessary for sexual reproduction in eukaryotes, such as animals, plants and fungi

The number of sets of chromosomes in the cell undergoing meiosis is reduced to half the original number, typically from diploid to haploid

The cells produced by meiosis are either gametes (sperm in male or ova in female) or otherwise usually spores from which gametes are ultimately produced in land Plants

Meiosis

- Fertilization or syngamy – union of male (haploid) and female (haploid) gametes to form the zygote (diploid)

Syngamy, i.e. union of male and female gametes to form the zygote is one of the fundamental cytological and genetic events in the life cycle of sexually reproducing plants and animals. In *syngamy,* all the chromosomes of male (n) and female (n) gametes come together to form a diploid zygote (2n). The gametes are haploid (n), i.e. they possess half the number of chromosomes of the somatic cell (2n). Such a natural phenomenon requires a counterbalancing event where by doubling in the number of chromosomes at *syngamy* is offset by a nuclear division that halves the amount of chromatin per nuclei again prior to gamete formation. Such a reduction division is fundamental rule in all the sexually reproducing plants and animals. This is called *meiosis.*

Meiosis

- Meiosis occurs in eukaryotic life cycles involving sexual reproduction
- It always Occurs in reproductive cells (meiocyte)
- In lower plant meiosis occurs after fertilization in zygote
- In higher plant it occurs before fertilization in the time of gamete creation
- Occurs in the testes in males (Spermatogenesis)
- Occurs in the ovaries in females (Oogenesis)
- *During meiosis, DNA replicates once, but the nucleus divides twice*

Meiosis

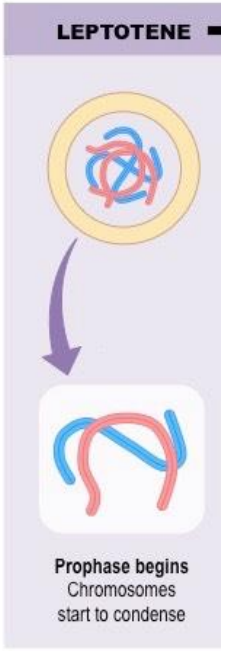
- Meiosis I: the reduction division -- diploid mother cell produces 2 haploid cells.

1. Prophase I
    i. Leptotene
    ii. Zygotene
    iii. Pachytene
    iv. Diplotene
    v. Diakinesis
2. Metaphase I
3. Anaphase I
4. Telophase I

Meiosis – Prophase 1

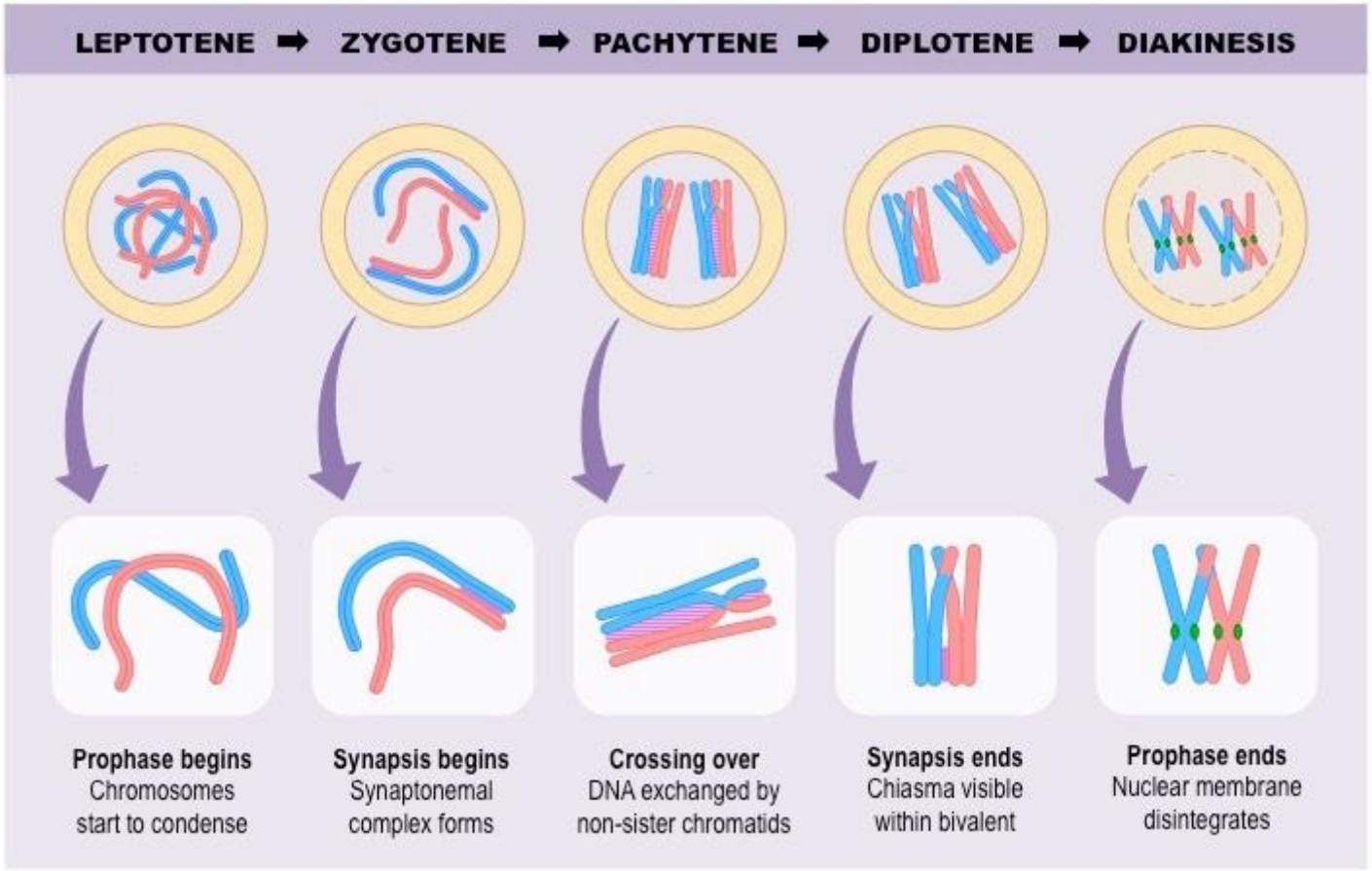
- During prophase I, DNA is exchanged between homologous chromosomes in a process called homologous recombination. This often results in chromosomal crossover.
- The paired and replicated chromosomes are called bivalents or tetrads.
- The process of pairing the homologous chromosomes is called synopsis.
- At this stage, non-sister chromatids may cross-over at points called chiasmata (plural; singular chiasma)

Meiosis – Prophase 1 – Leptotene



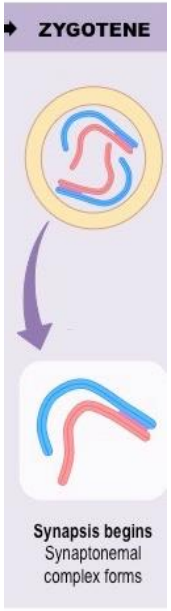
- The first stage of prophase I is the Leptotene stage
- Leptotene also known as Leptonema from Greek words meaning thin threads
- During this stage, individual chromosomes begin to condense into long strands within the nucleus
- However the two sister chromatids are still so tightly bound that they are indistinguishable from one another

Meiosis – Prophase 1 – Leptotene

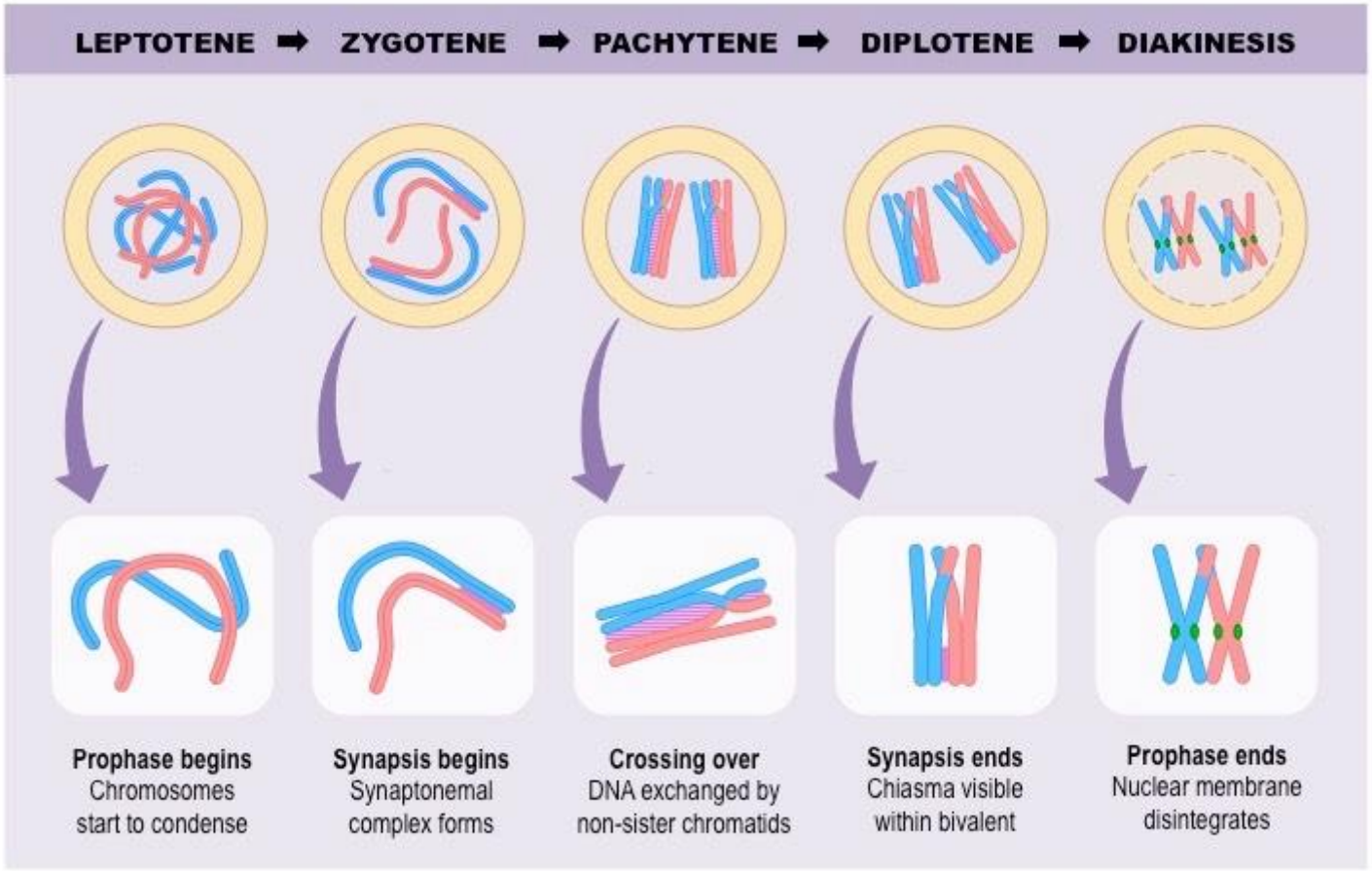


Meiosis – Prophase 1 – Zygotene

- The ***zygotene stage,*** also known as zygonema, from Greek words meaning "paired threads"
- Zygotene, occurs as the chromosomes approximately line up with each other into homologous chromosomes.
- The combined homologous chromosomes are said to be bivalent



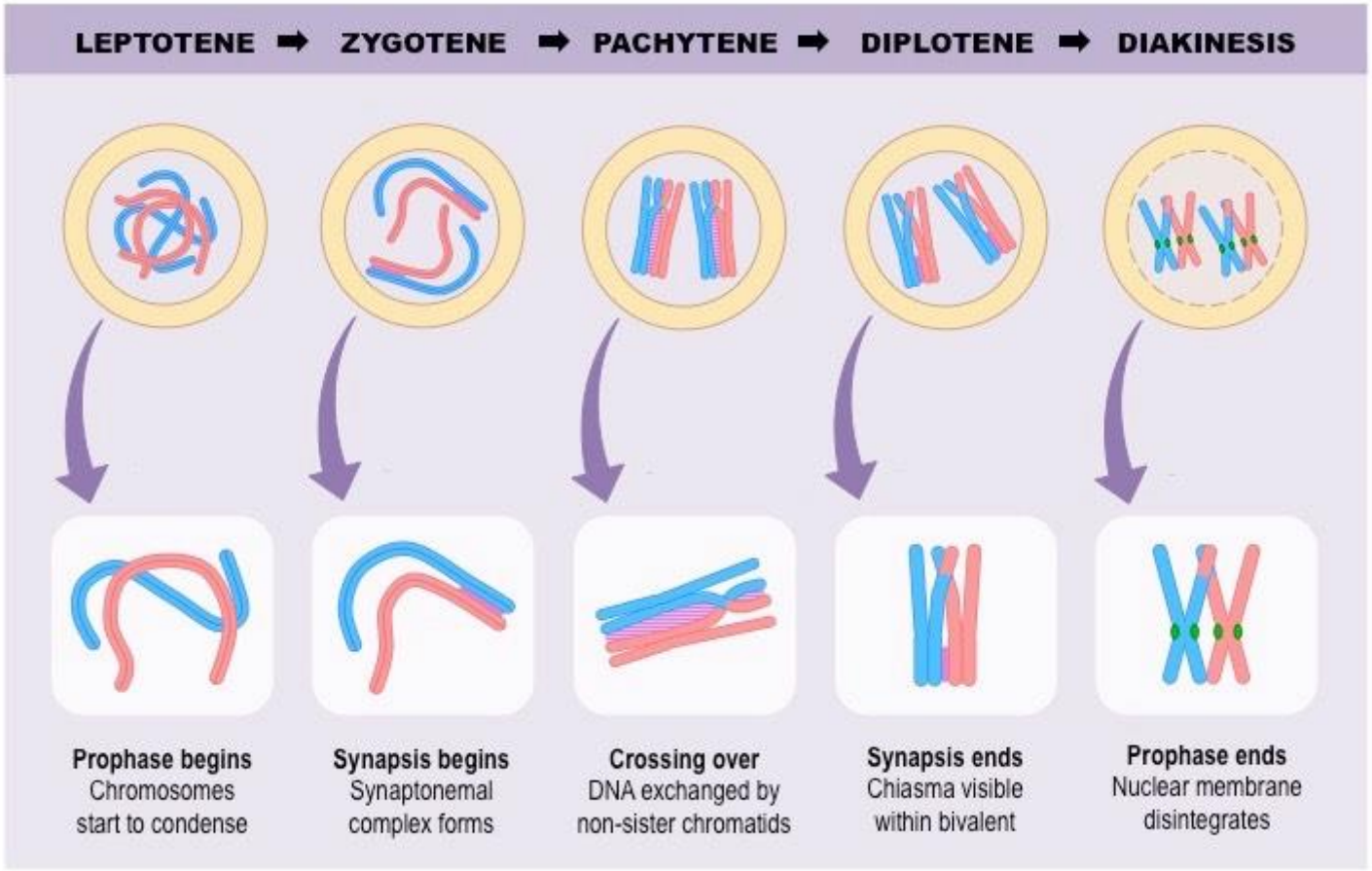
Meiosis – Prophase 1 – Zygotene



Meiosis – Prophase 1 - Pachytene

- In pachynema, the homologous chromosomes become much more closely associated. This process is known as synapses
- The synapsed homologous pair of chromosomes is called a tetrad, because it consists of four chromatids
- It can't be observed until the next stage, but the synapsed chromosomes may undergo crossing over in pachynema
- The chromosomes continue to condense

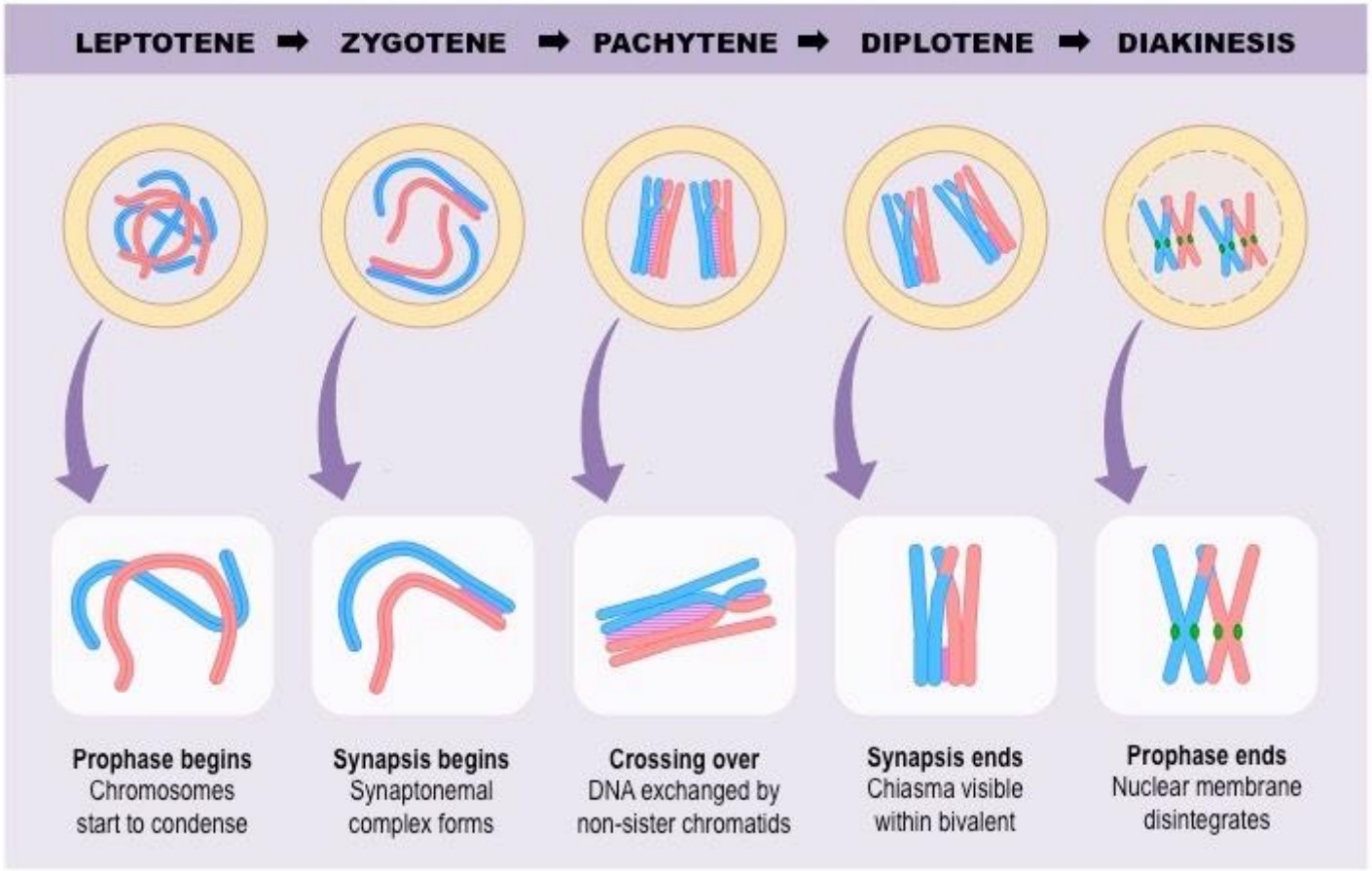
Meiosis – Prophase 1 - Pachytene



Meiosis – Prophase 1 – Diplotene

- During the diplotene stage, also known as diplonema, from Greek words meaning "two threads,“
- The homologous chromosomes separate from one another a little
- The chromosomes themselves uncoil a bit, allowing some transcription of DNA

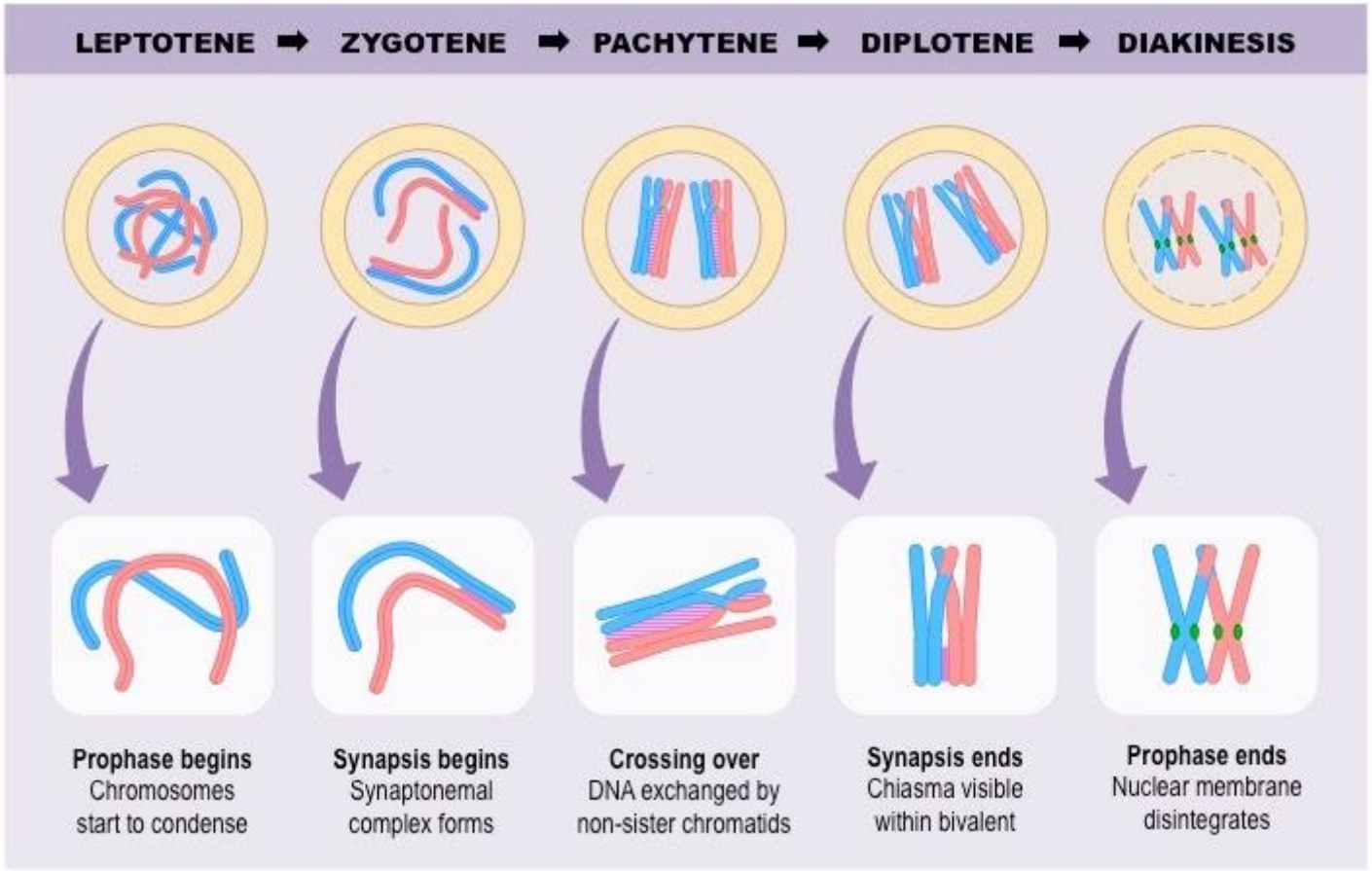
Meiosis – Prophase 1 - Pachytene

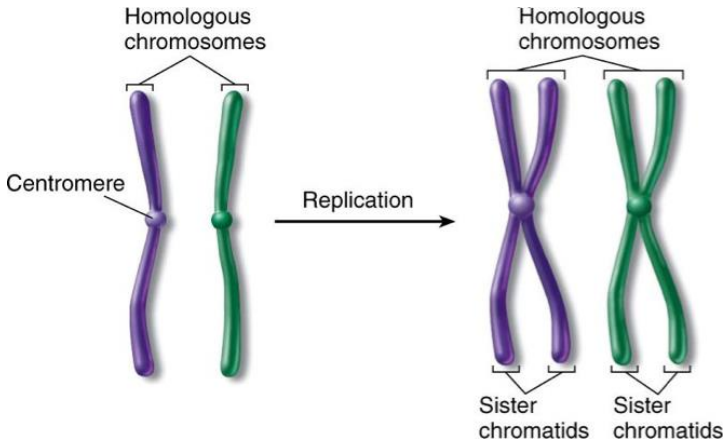


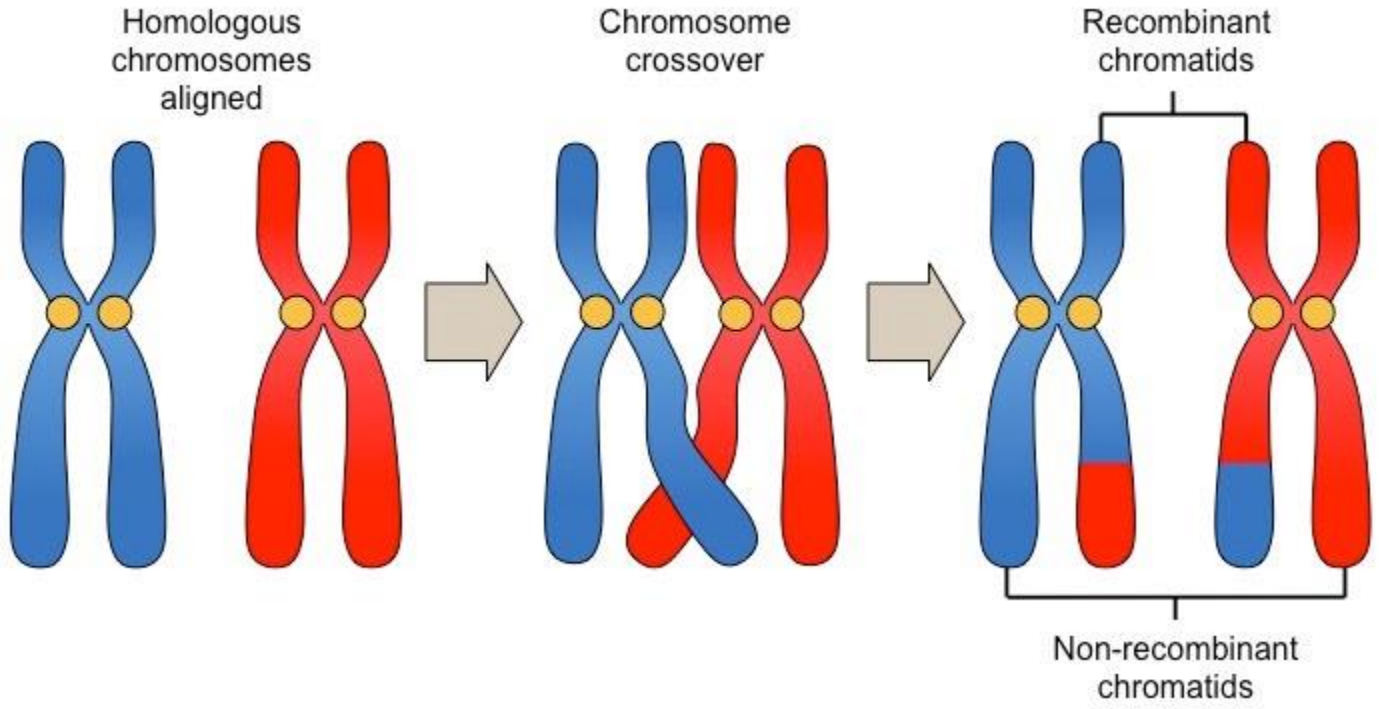
Meiosis – Prophase 1 - Diakinesis

- Chromosomes condense further during the diakinesis stage, from Greek words meaning "moving through.“
- This is the first point in meiosis where the four parts of the tetrads are actually visible.
- In this stage, the homologous chromosomes separate further, and the chiasmata terminalize . Making chiasmata clearly visible

Meiosis – Prophase 1 - Pachytene

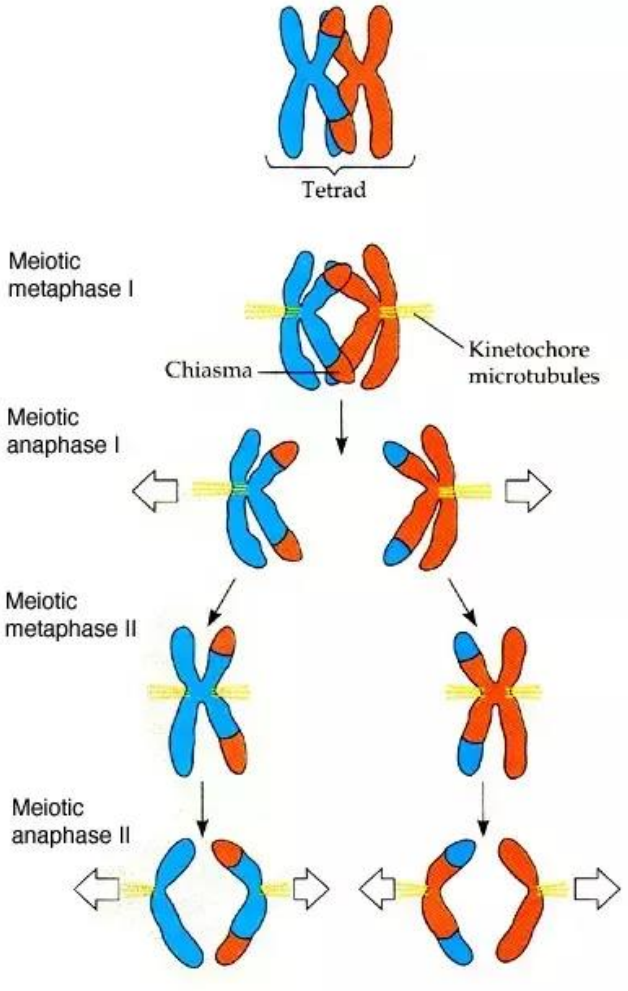



Homologous chromosomes
Centromere
Replication
Homologous chromosomes
Sister chromatids
Sister chromatids


Homologous chromosomes aligned
Chromosome crossover
Recombinant chromatids
Non-recombinant chromatids

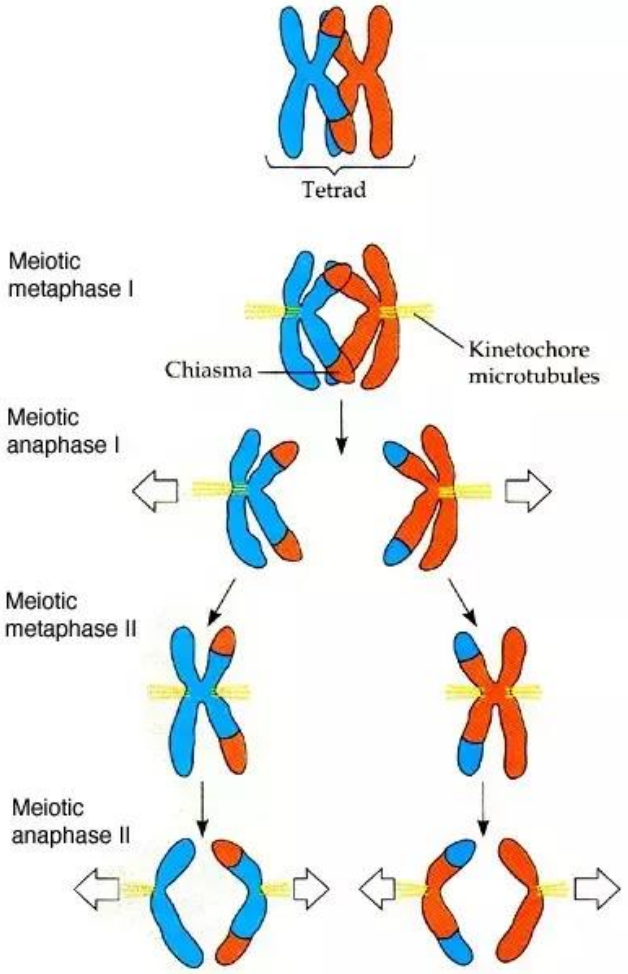
Meiosis – Metaphase 1

- Metaphase 1 is the second phase of Meiosis
- The tetrads from prophase I line up in the middle of the dividing cell randomly
- Spindle fibers attach to the tetrads from both ends of the cell



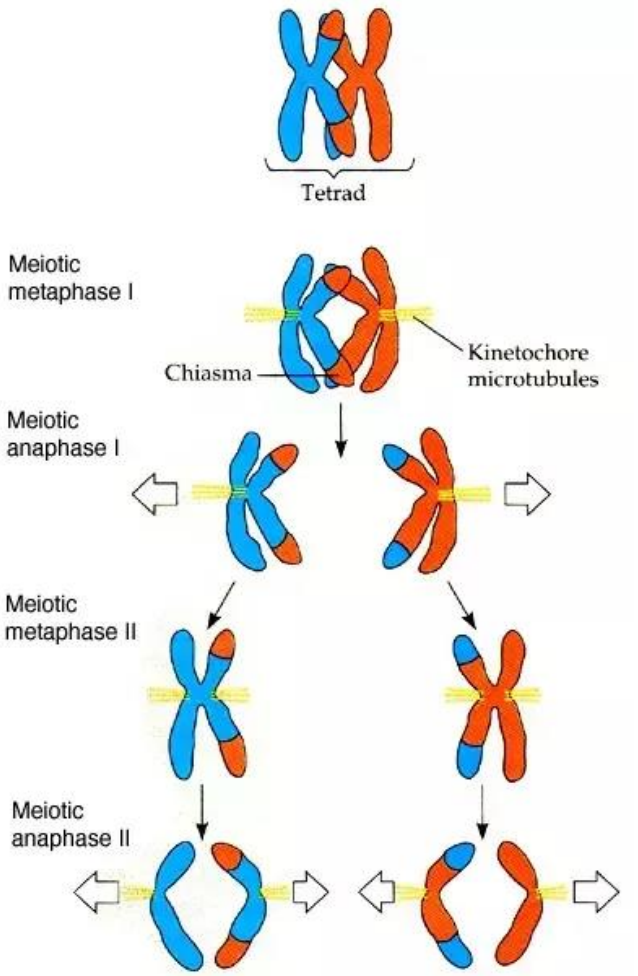
Meiosis – Anaphase 1

- Anaphase I begins when the two chromosomes of each bivalent separate and start moving toward opposite poles of the.
- In anaphase I the sister chromatids remain attached at their centromeres and move together toward the poles.



Meiosis – Telophase 1

- The homologous chromosome pairs reach the poles of the cell.
- The homologous chromosome pairs complete their migration to the two poles
- A nuclear envelope reforms around each chromosome set, the spindle disappears, and cytokinesis follows

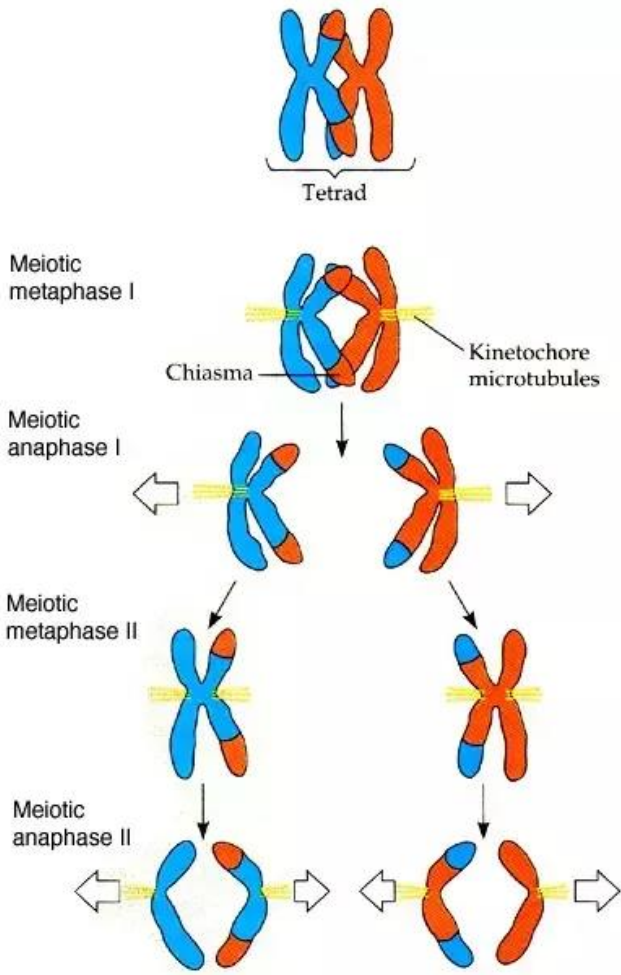


Meiosis – Prophase 2

- Meiosis II begins without any further replication of the chromosomes. In prophase II, the nuclear envelope breaks down and the spindle apparatus forms
- While chromosome duplication took place prior to meiosis I, no new chromosome replication occurs before meiosis II
- The centrioles duplicate. This occurs by separation of the two members of the pair, and then the formation of a daughter centriole perpendicular to each original centriole.
- The two pairs of centrioles separate into two centrosomes
- The nuclear envelope breaks down, and the spindle apparatus forms

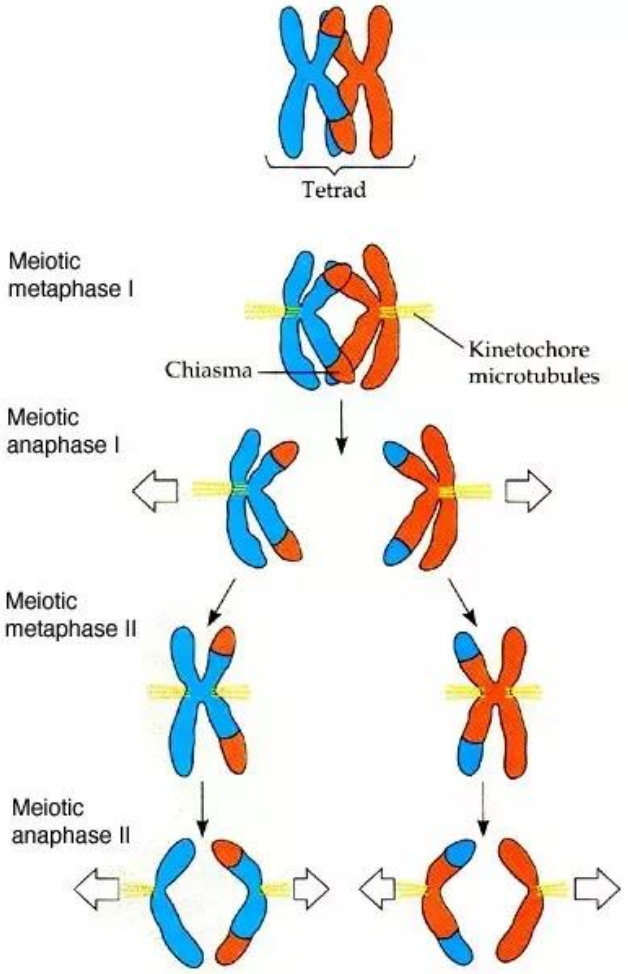
Meiosis – Metaphase 2

- The chromosomes become arranged on the metaphase plate
- Centromeres are arranged in a line called equatorial plate of invisible spindle apparatus
- Previously occurring nuclear membrane is not present



Meiosis – Anaphase 2

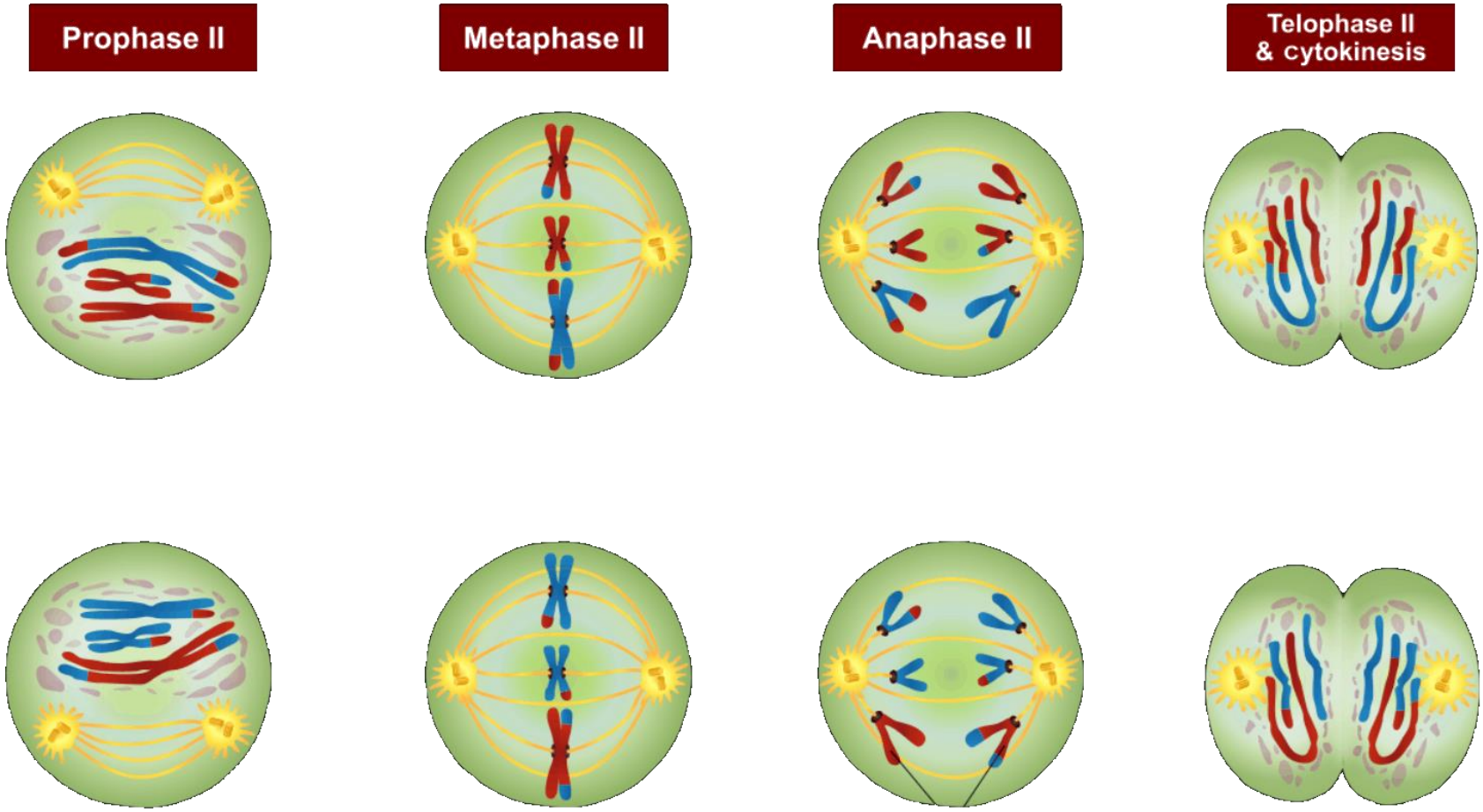
- The centromeres separate and the sister chromatids now individual chromosomes move toward the opposite poles of the cell
- The separated chromatids are now called chromosomes in their own right



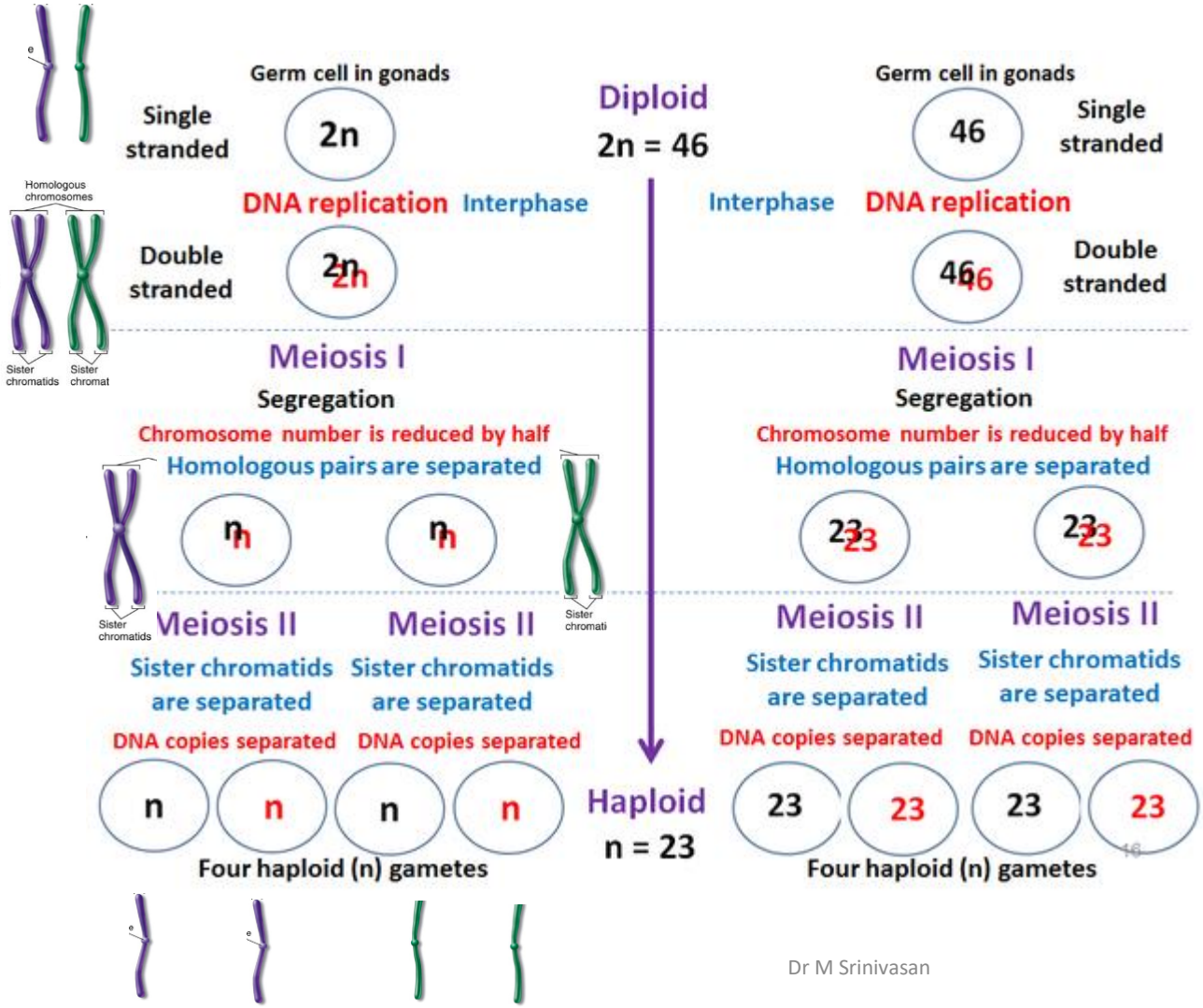
Meiosis – Telophase 2

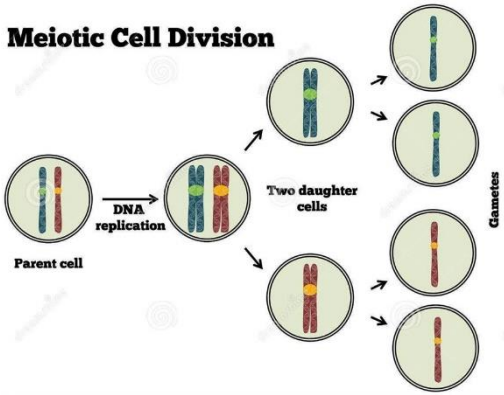
- Nuclear envelope forms around each set of chromosomes
- Nucleolus appears in each nucleus
- Chromosomes lengthen and become indistinct

Meiosis II


Prophase II
Metaphase II
Anaphase II
Telophase II & cytokinesis

Meiosis – Chromosome reduction

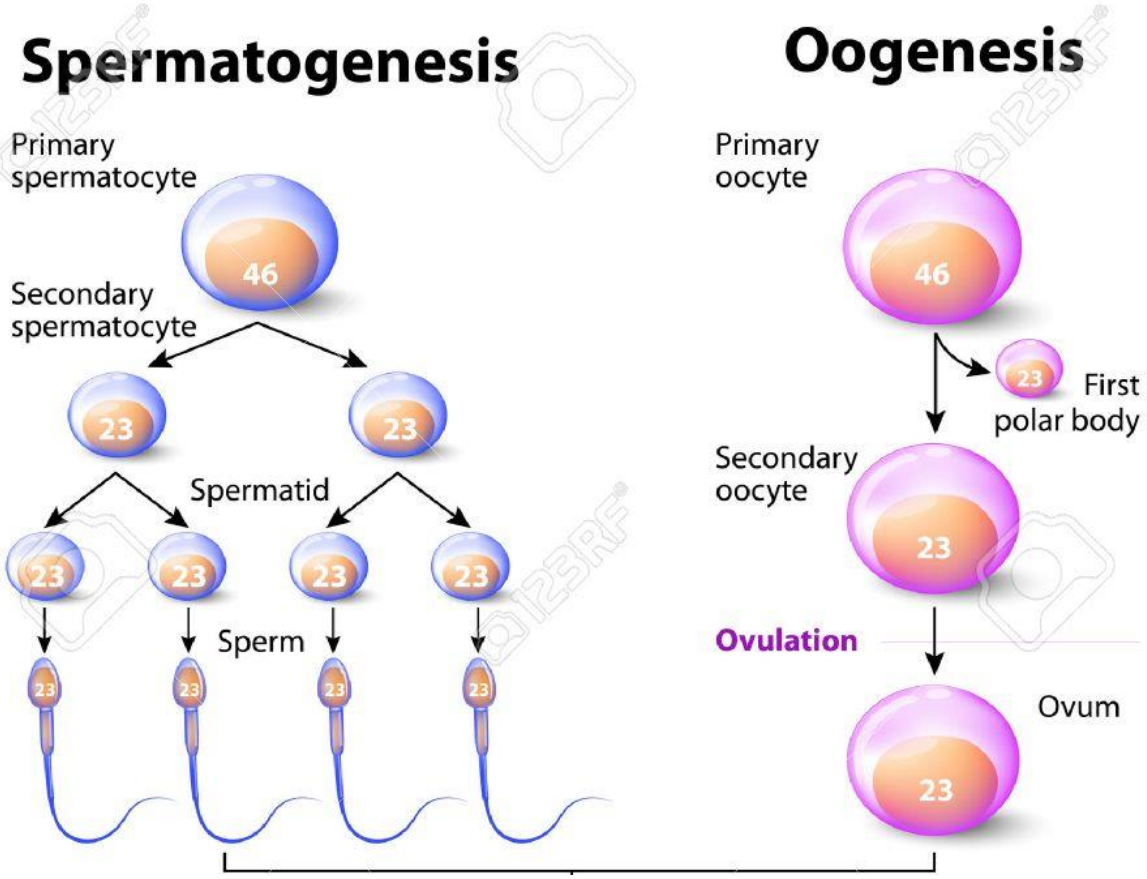




Difference in mitosis vs meiosis

Mitosis	Meiosis
Occurs in body cells	Occurs in reproductive cells
Number of chromosomes remains the same in the daughter cells	Number of chromosomes is halved in the daughter cell
Daughter cells are identical to parent cells and each other	Daughter cells are genetically different to the parent cells and each other
Two daughter cells are formed	Four daughter cells are formed
Homologous chromosomes do not come together	Homologous chromosomes come together
There is no exchange of genetic material between Chromosomes	There is exchange of genetic material between chromosomes

Meiosis in humans



Meiosis in humans