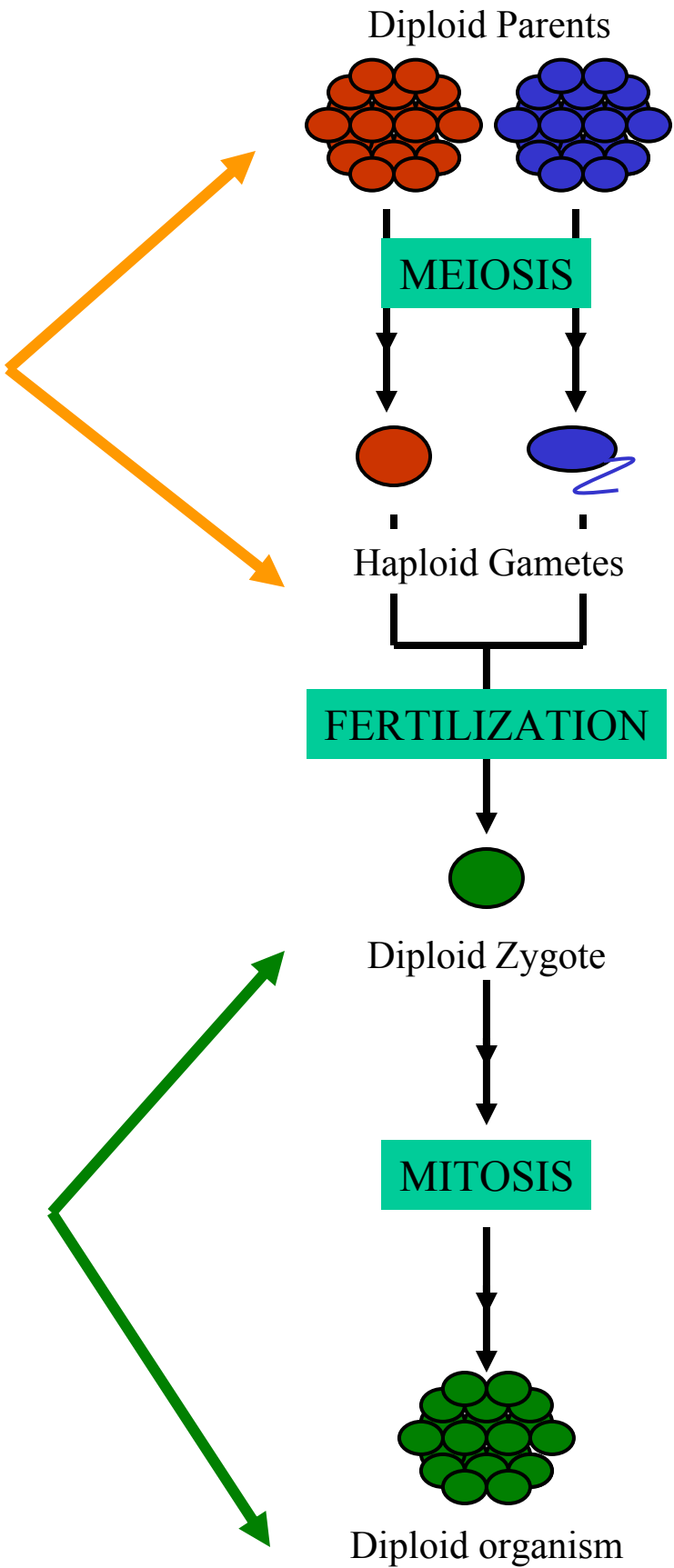


The Gametic Cell Cycle

The Somatic Cell Cycle



Activities of meiosis that differ from mitosis

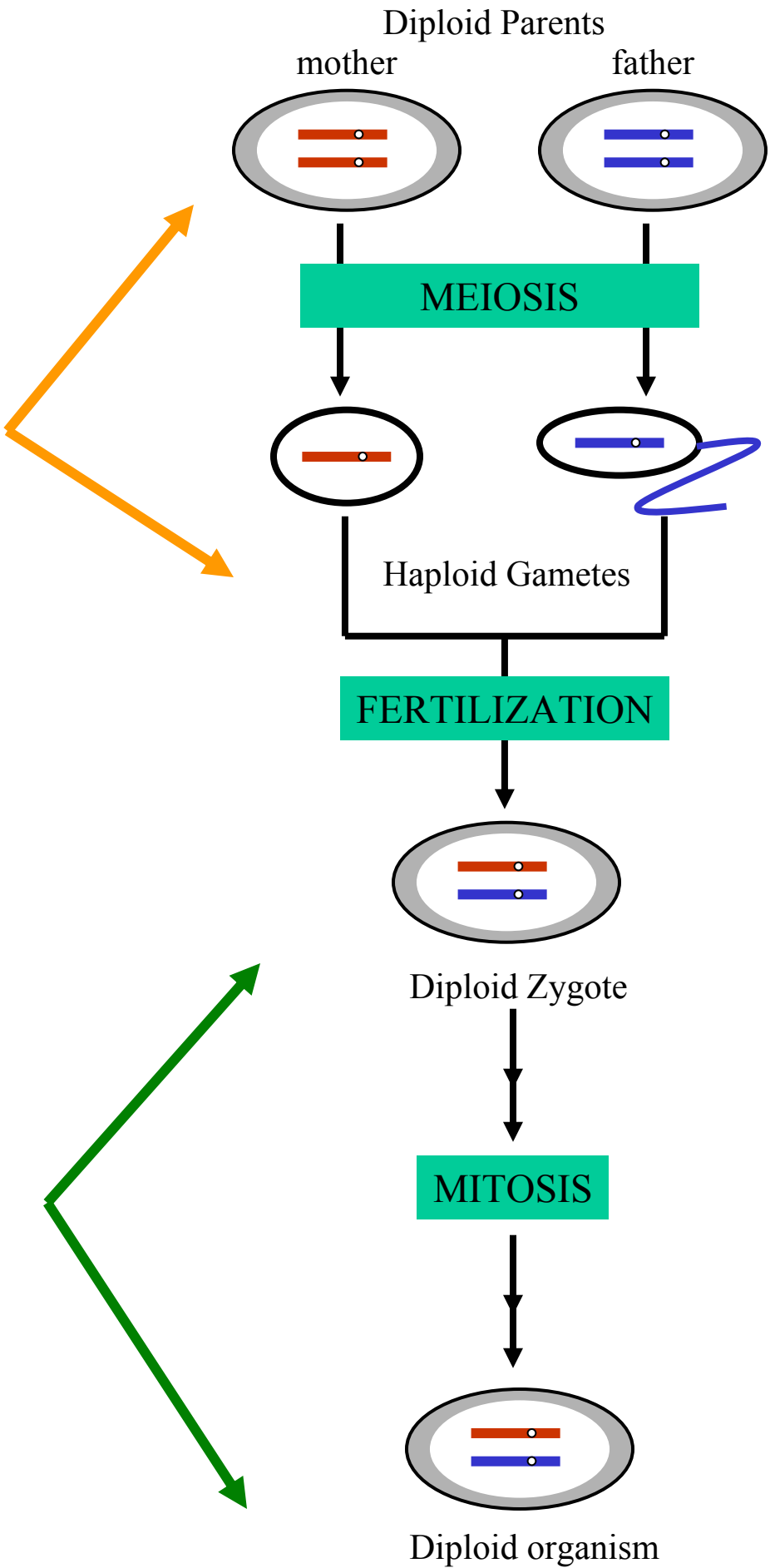
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Activities of meiosis that differ from mitosis

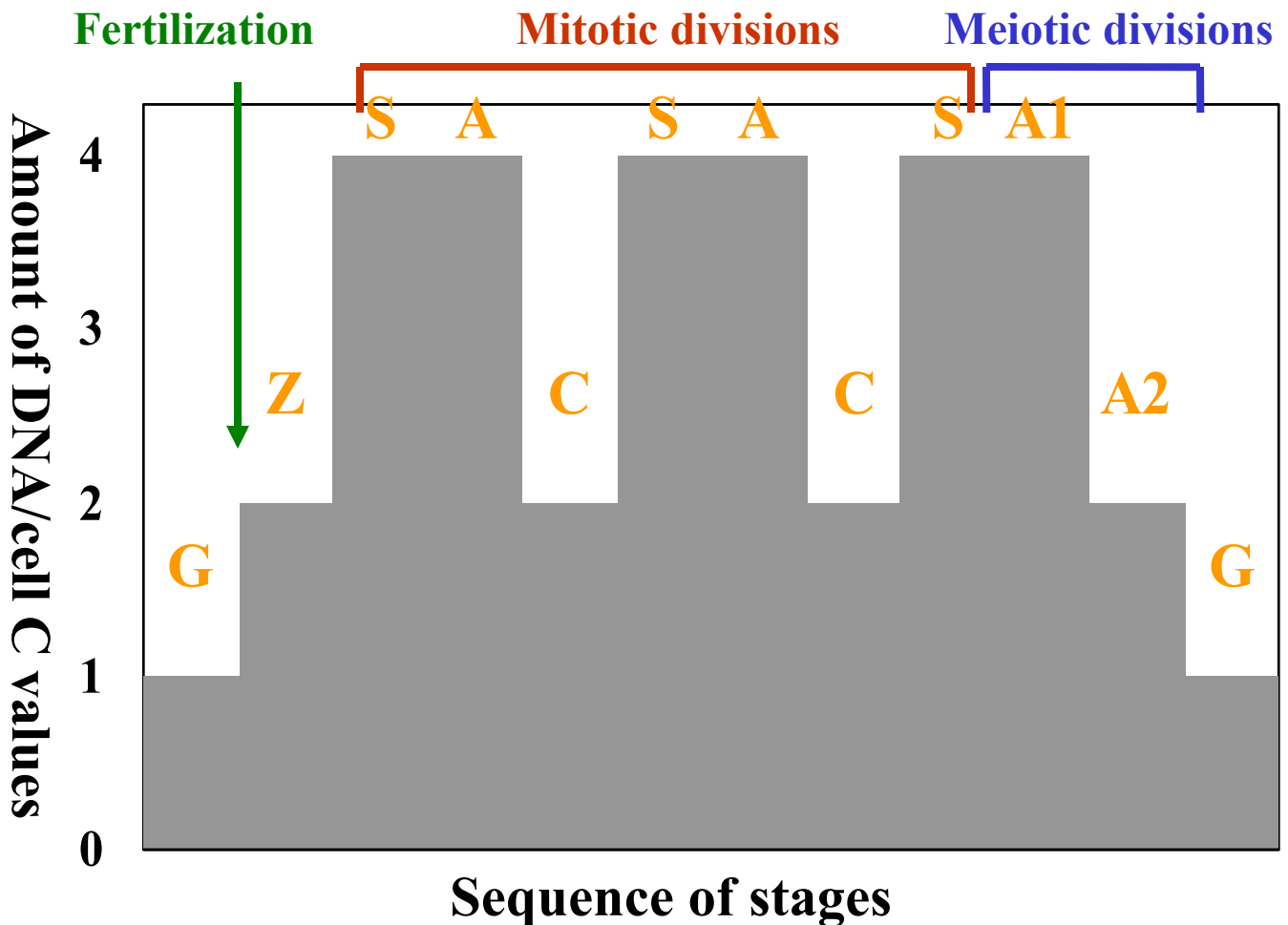
- Pairing of homologous chromosomes
- Crossing over between homologues
- Reduction of chromosome number
- Slow pace of meiotic prophase
- Requirement of two cell divisions instead of one to complete the process
- Lack of an S-period between the two divisions

The Gametic Cell Cycle

The Somatic Cell Cycle

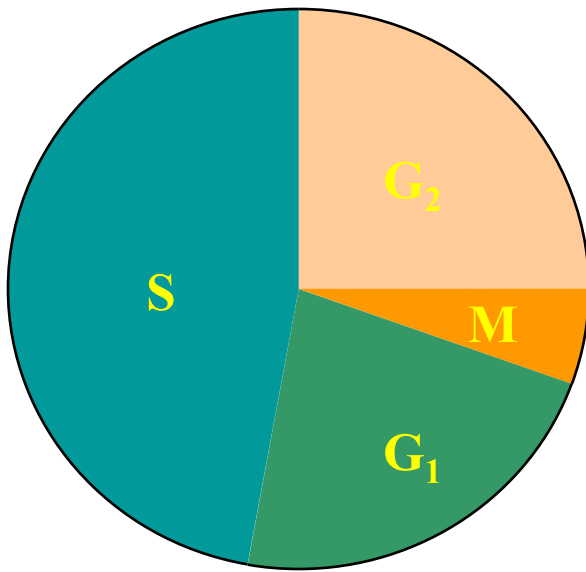


Life cycle of a sexually reproducing organism correlated with the amount of DNA per cell

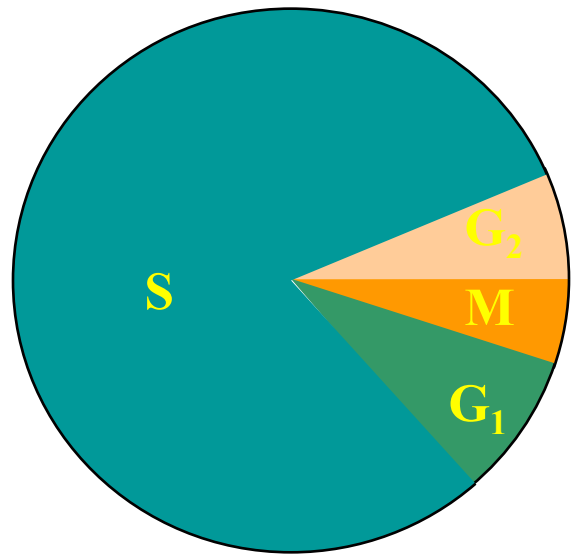


G= Gamete, **Z**=Zygote, **S**=Period of DNA synthesis,
A=Mitotic Anaphase, **C**=Somatic Cells, **A1**=First meiotic
 anaphase, **A2**= Second meiotic anaphase

In preparation to switch from a mitotic to meiotic sequence of events timing adjustments are made



Mitosis



Meiosis

For example: Somatic cell cycle time of wheat anthers immediately preceding meiosis:

Normal cell cycle time	25 hours
Second penultimate cell cycle time	35 hours
Premeiotic cell cycle time	55 hours

Meiosis

A process in diploid eukaryotes that results in gametes or spores with only one member of each original homologous pair of chromosomes per nucleus.

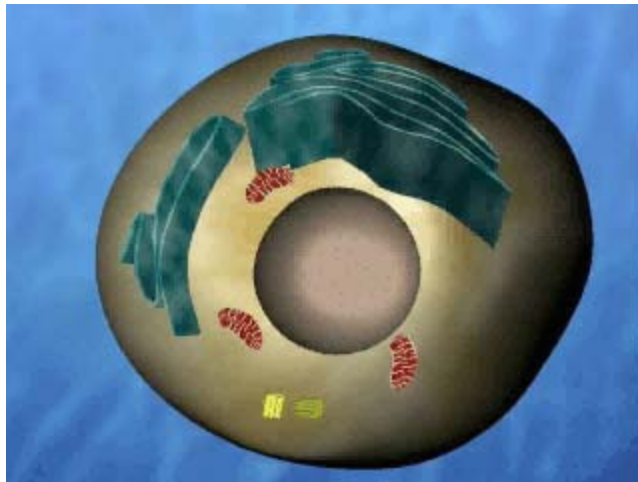
Stages of mitosis:

- **Interphase**
- **Prophase I**
 - a) Leptotene
 - b) Zygotene
 - c) Pachytene
 - d) Diplotene
 - e) Diakinesis
- **Metaphase I**
- **Anaphase I**
- **Telophase I**
- **Prophase II**
- **Metaphase II**
- **Anaphase II**
- **Cytokinesis**

Stages of Meiosis

➤ Preleptotene:

- ✓ Corresponds generally to G_2 of a mitotic division
- ✓ Chromosomes are duplicated
- ✓ Chromosomes are randomly dispersed in nucleus, no evidence of pairing

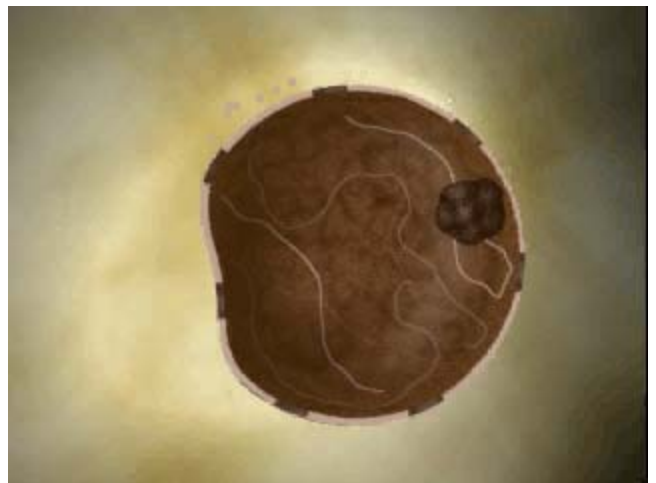
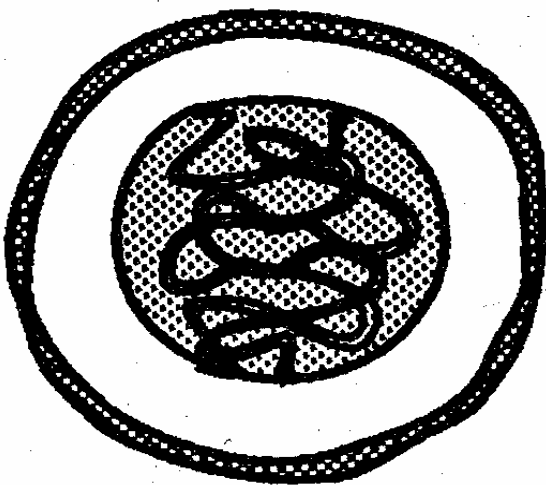


Preleptotene

Stages of Meiosis

➤ Leptotene (thin-thread stage):

- ✓ Although DNA synthesis has occurred, no longitudinal doubleness is evident with light microscopy
- ✓ Chromosome contraction is evident
- ✓ Each chromosome develops a lateral component of a nucleoprotein complex between its two chromatids

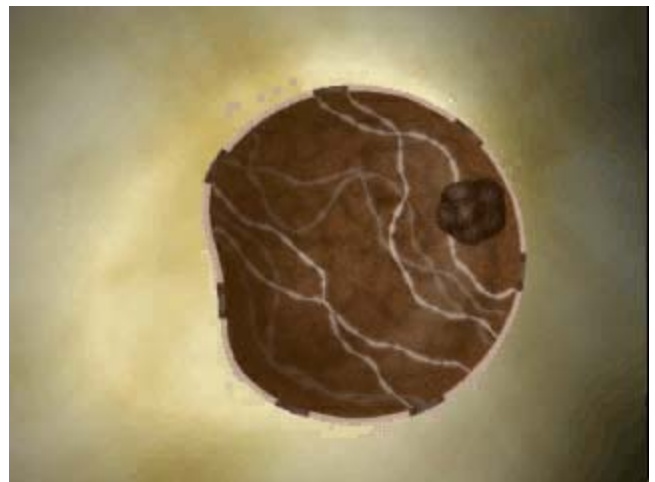
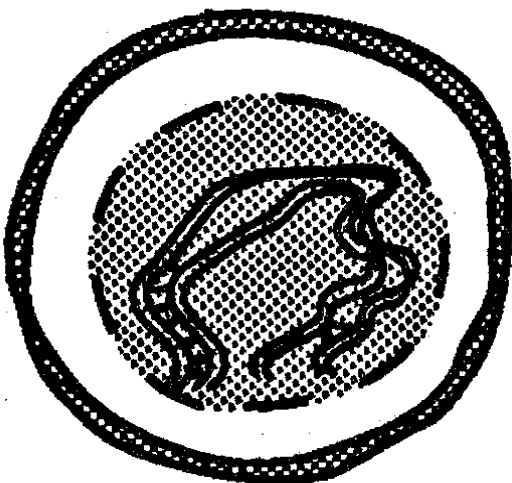


Leptotene

Stages of Meiosis

➤ Zygotene (yoked-thread stage):

- ✓ Synapsis or pairing of homologues is initiated
- ✓ Pairing is initiated at one or more sites along the length of the chromosomes and proceeds to bring the homologous pairs into alignment along their entire length
- ✓ The lateral elements of the two chromatids combine with a central core to form the **synaptonemal complex**

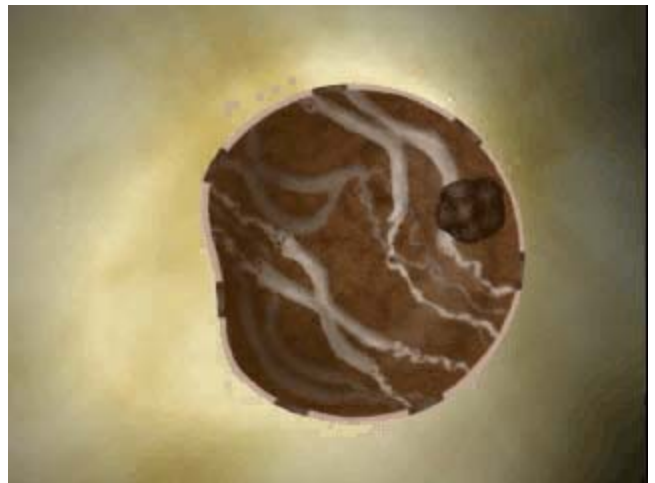
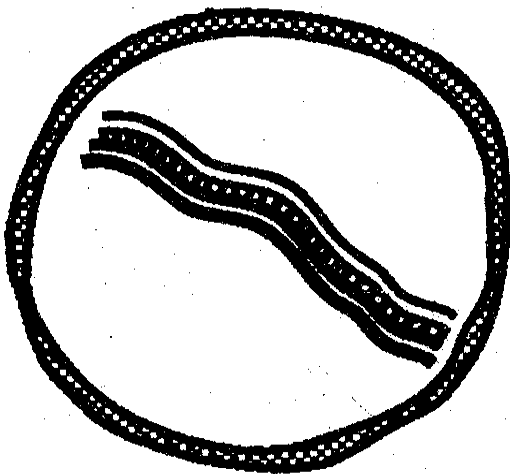


Zygotene

Stages of Meiosis

➤ Pachytene (thick-thread stage):

- ✓ The **synaptonemal complex (SC)** is complete with chromosome synapsis from end to end
- ✓ The chromosomes are visibly thicker because they have paired and contracted and appear to be present in a haploid number
- ✓ Each chromosome can be recognized to be two closely appressed homologues
- ✓ The paired homologues are called bivalent

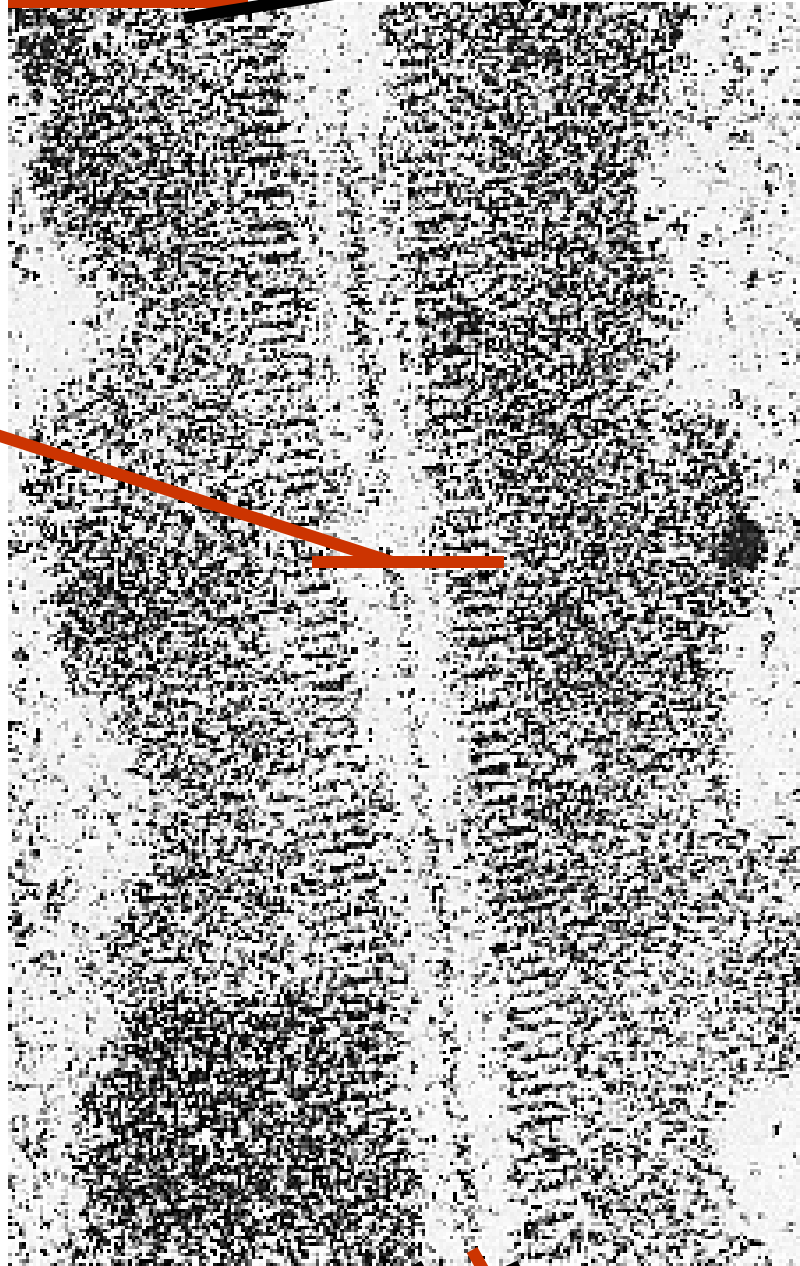


Pachytene

Chromatids

Homologous
Chromosomes

Synaptonemal
Complex



Lateral elements

Central element

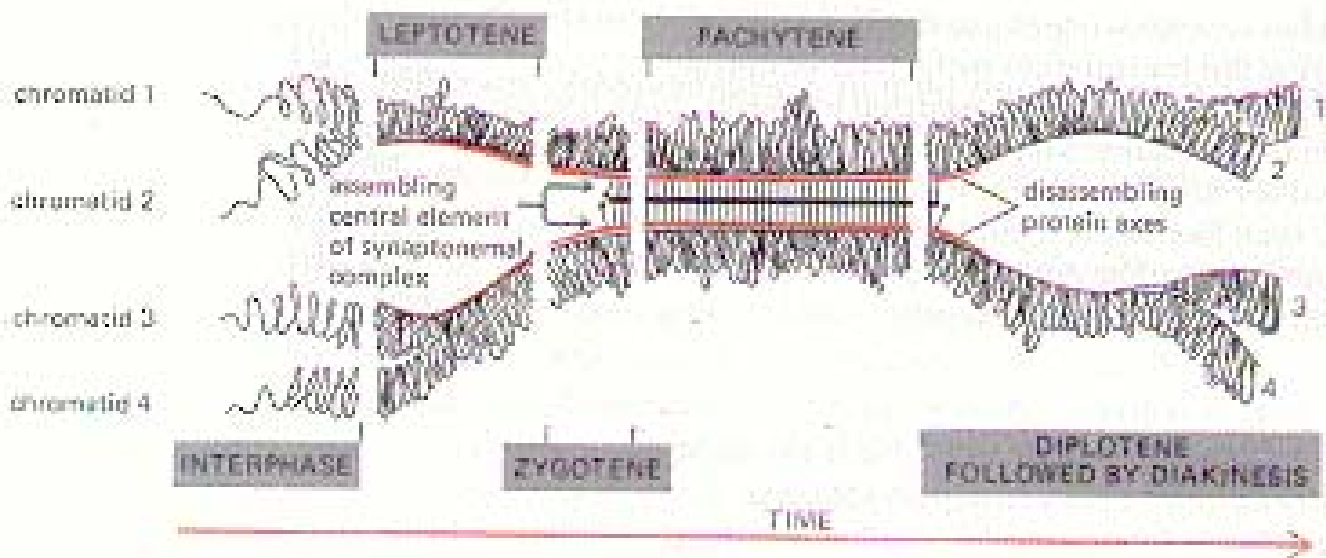
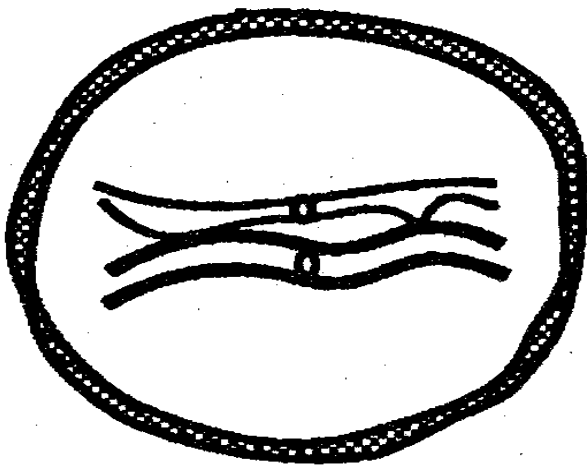


FIGURE 11-11 Synaptonemal complex formation and disassembly during meiosis.

Stages of Meiosis

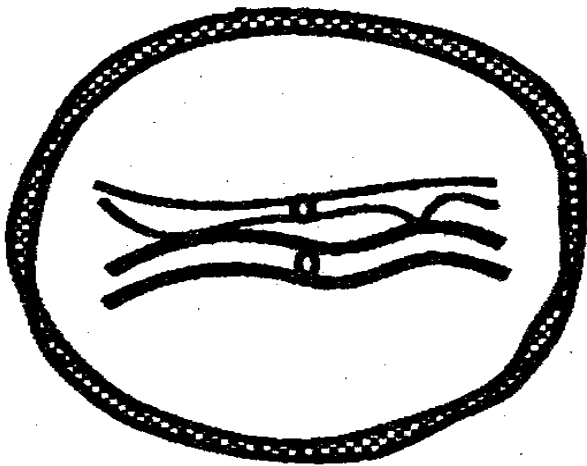
- **Diplotene (double stage):**
 - ✓ The termination of pachytene coincides with the dissolution of the synaptonemal complex
 - ✓ The chromosomes condense further
 - ✓ The sister chromatids becomes clearly evident



Diplotene

Stages of Meiosis

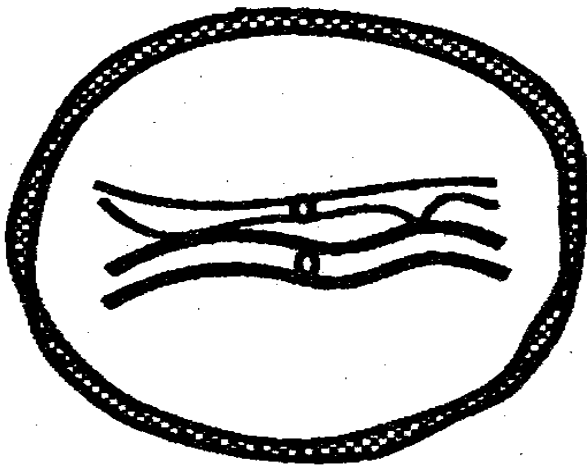
- **Diplotene (double stage):**
- ✓ The paired chromosomes are held together at one or more points along their length
 - a. The points of contact are called chiasma, which are the points of chromatid exchange that help preserve the bivalent structure
 - b. As chromosomes continue to contract the chiasmata tend to move toward the ends of paired homologues



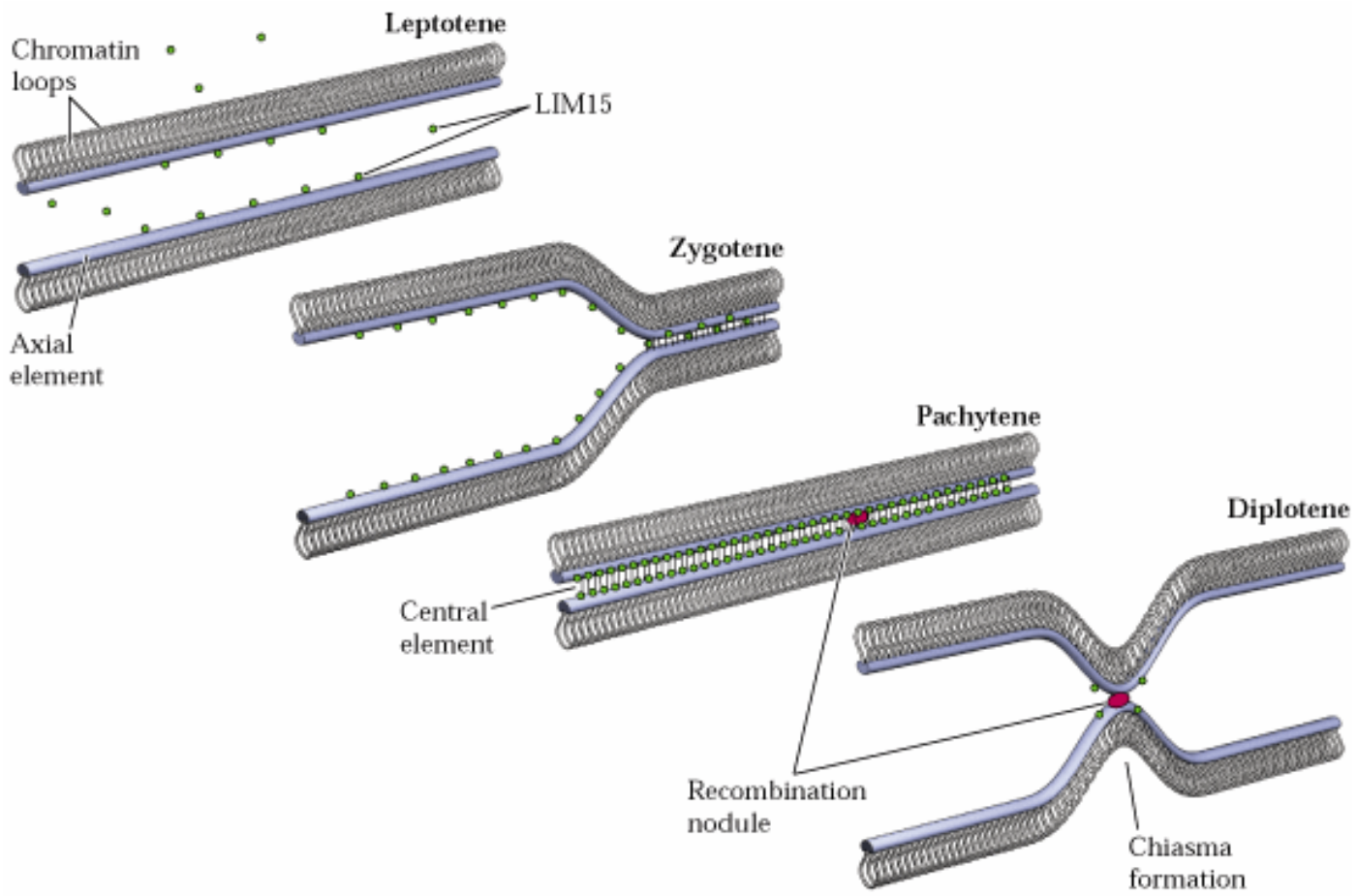
Diplotene

Stages of Meiosis

- **Diplotene (double stage):**
- ✓ Diplotene in the human female may persist 12 to 50 years and is usually lengthy in all vertebrates
 - a. The prolonged diplotene is often called dictyoene stage to distinguish it from typical diplotene
 - b. At this state chromosome de-condense and engage in RNA synthesis. In extreme cases chromosomes can become highly active (i.e. Lampbrush chromosomes).



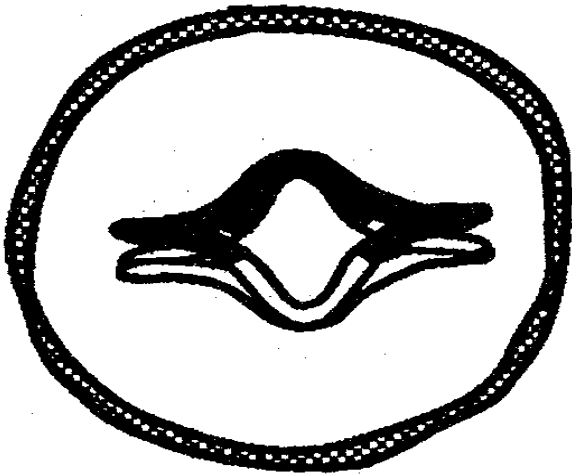
Diplotene



Stages of Meiosis

➤ Diakinesis (through movement):

- ✓ Further contraction of the bivalents occurs
- ✓ Bivalents become dispersed throughout the cell
- ✓ Nuclear envelope breaks down

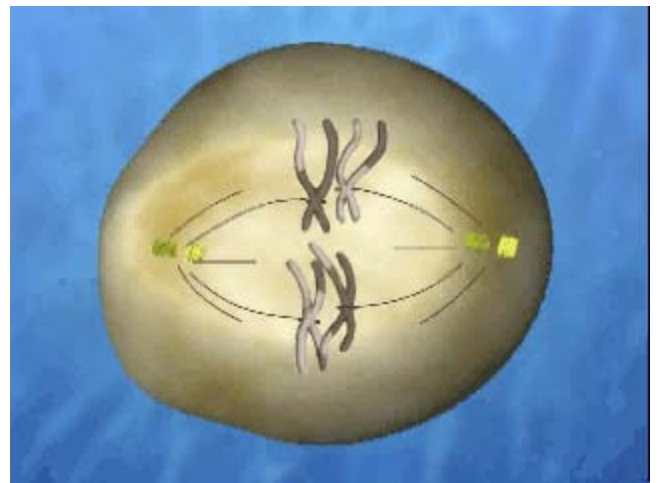
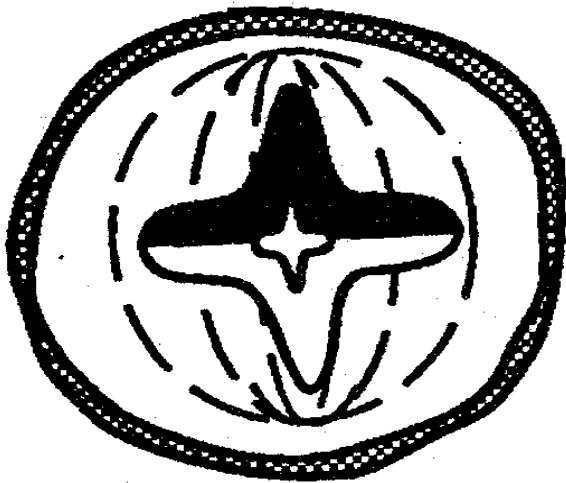


Diakinesis

Stages of Meiosis

➤ Metaphase I:

- ✓ The bivalents have moved to the center of the cell
- ✓ The nuclear envelope has disappeared
- ✓ The spindle has been fully formed and bivalents have ceased movement toward the equatorial plate
- ✓ The homologues of each bivalent are co-oriented in a position midway between the poles and are still joined at the previously formed chiasmata

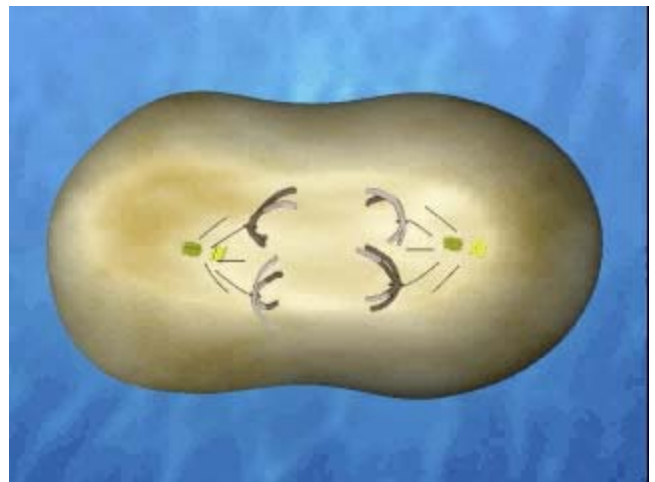
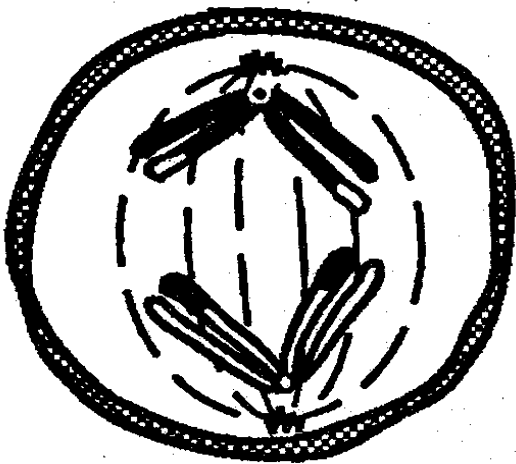


Metaphase I

Stages of Meiosis

➤ Anaphase I:

- ✓ The chromosomes move from the metaphase plate to the poles
- ✓ The centromeres of a homologue in a bivalent remain functionally undivided as they move poleward so that whole chromosome instead of chromatids segregate
- ✓ Each anaphase group is made up of a complete haploid set of chromosomes instead of a diploid number of chromatids as in mitosis
- ✓ Each anaphase group has a $2C$ DNA content

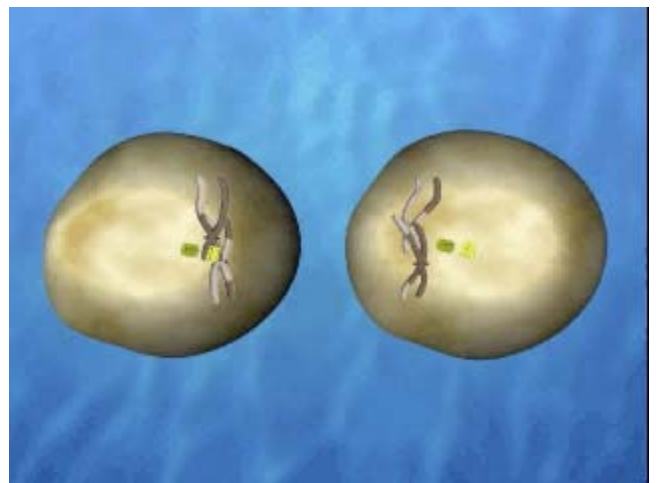
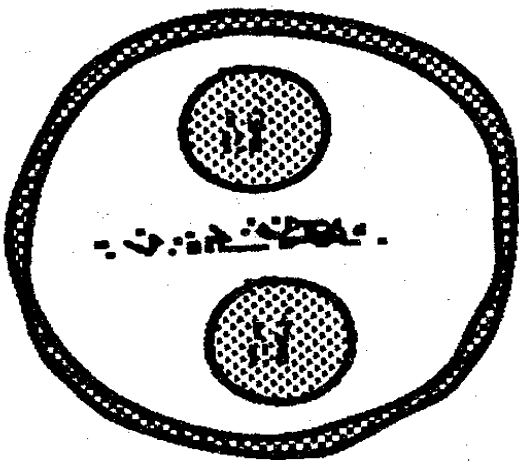


Anaphase I

Stages of Meiosis

➤ Telophase I:

- ✓ The movement of chromosomes to the respective poles is completed
- ✓ The spindles disappear
- ✓ The chromosomes go into diffuse interphase stage
- ✓ A nuclear membrane and nucleoli is formed (i.e. dyads in monocots)
- ✓ Division of cytoplasm (i.e. cytokinesis) may occur or may be delayed until mitosis II is completed

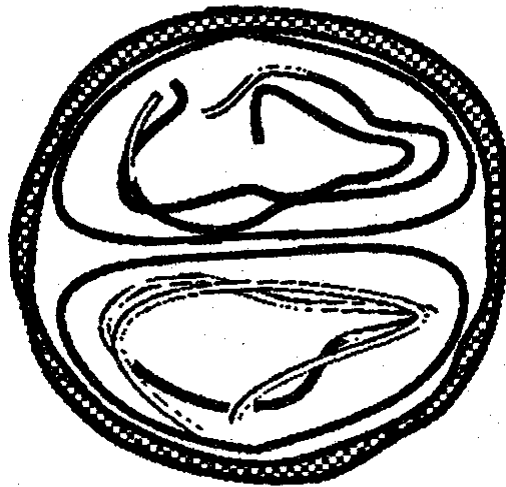


Telophase I

Stages of Meiosis

➤ Prophase II:

- ✓ The chromatids condense into easily recognized structures from their relaxed uncoiled state in the preceding interstage nucleus
- ✓ No S period of DNA synthesis occurs between the two mitotic divisions

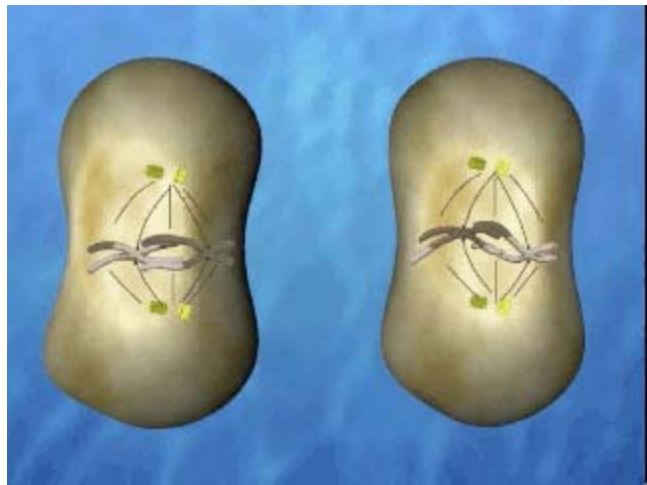
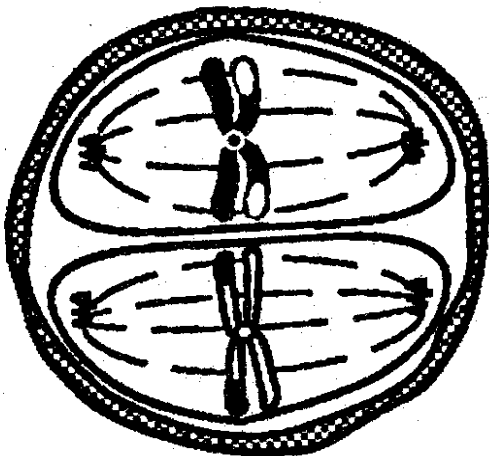


Prophase II

Stages of Meiosis

➤ Metaphase II:

- ✓ The spindles appear and attach to the chromosomes
- ✓ Sister chromatid pairs are aligned near the spindle with centromeres still associated
- ✓ The centromeres orient toward opposite poles and are lined up on the metaphase plate (this is called auto-orientation to distinguish the process from co-orientation of bivalents at metaphase I)

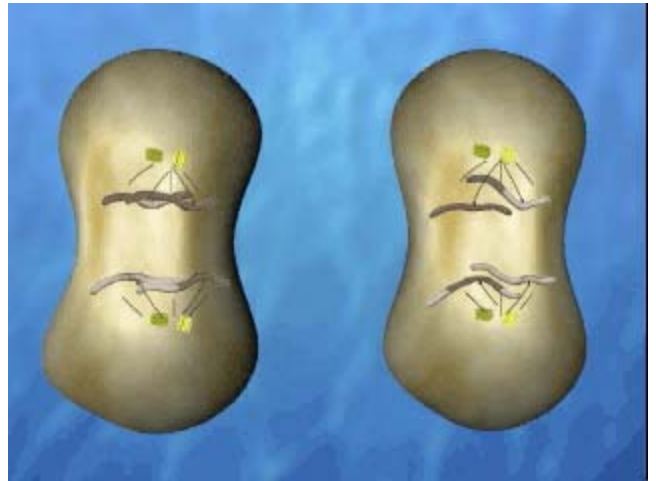
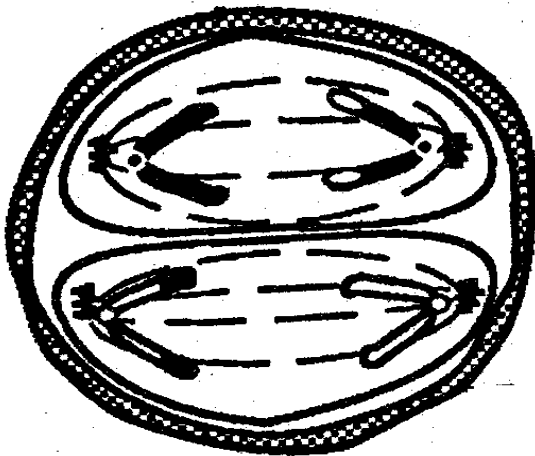


Metaphase II

Stages of Meiosis

➤ Anaphase II:

- ✓ The kinetochores separate longitudinally
- ✓ Sister chromatid pairs separate with one member of each pair moving toward the poles

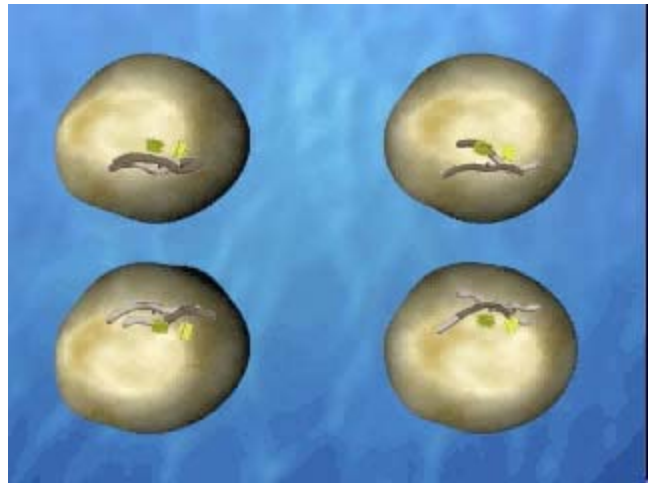
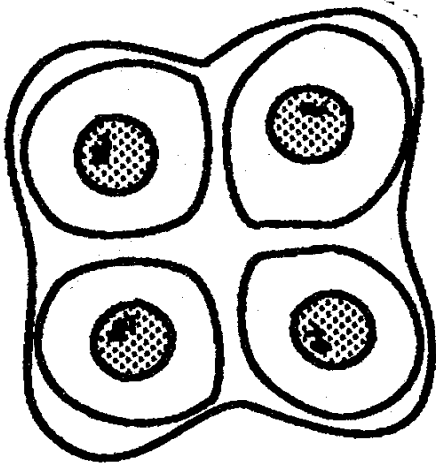


Anaphase II

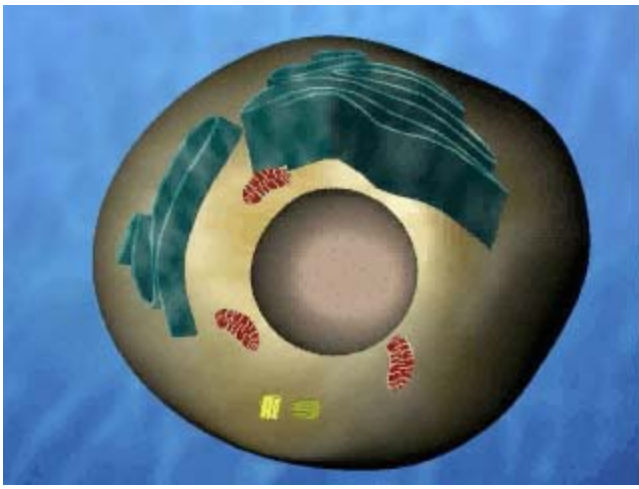
Stages of Meiosis

➤ Telophase II & Cytokinesis:

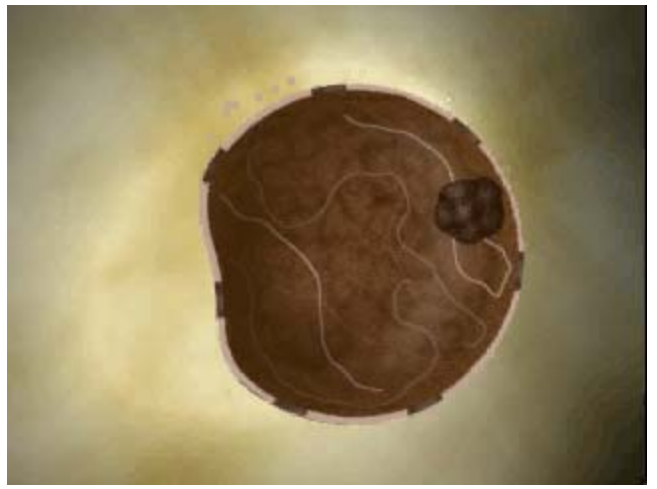
- ✓ Chromatids reach opposite poles and poleward movement ceases
- ✓ New nuclear envelope is formed around each diploid chromosome set
- ✓ Chromosomes begin to de-condense
- ✓ Cytokinesis follows, and the fate of the resulting four haploid cells depends on whether the organism is an animal or plant, and male or female



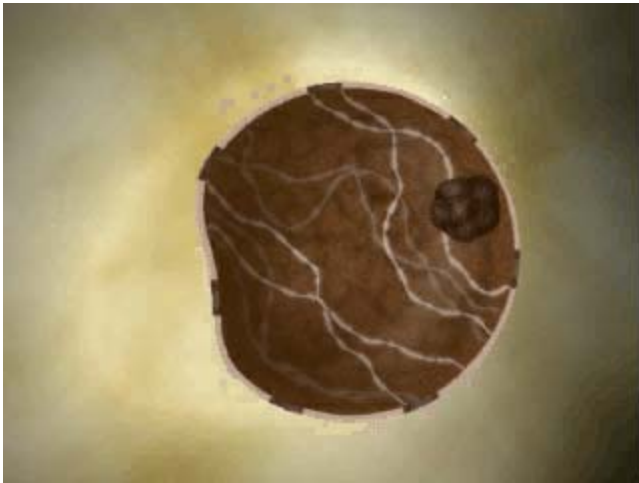
Telophase II & Cytokinesis



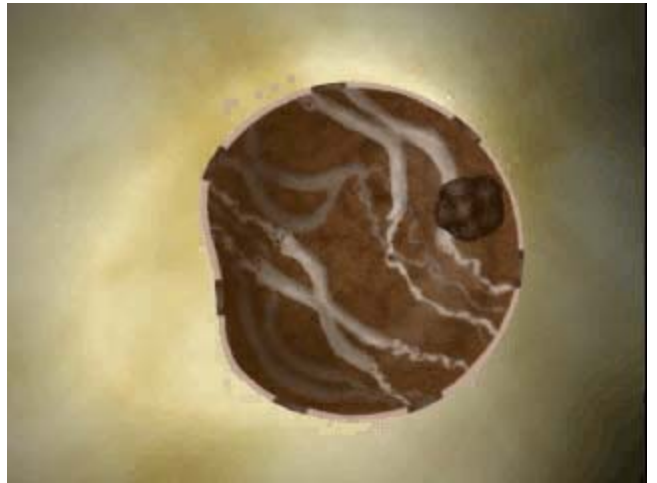
Preleptotene



Leptotene



Zygotene



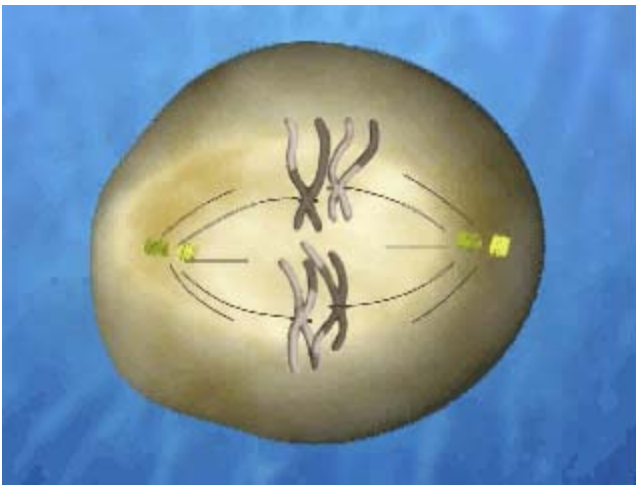
Pachytene



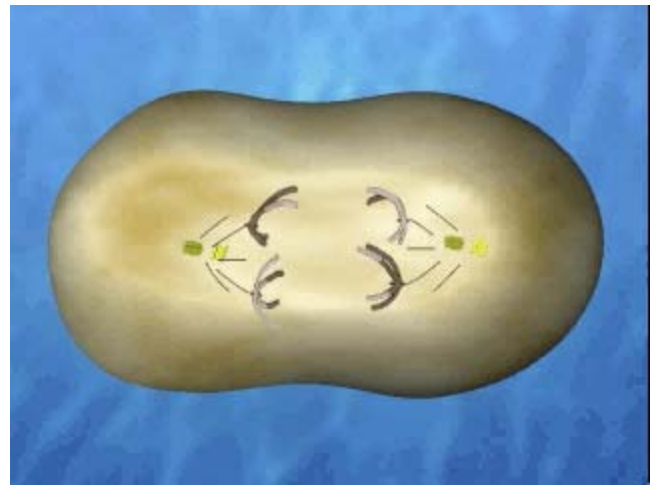
Diplotene



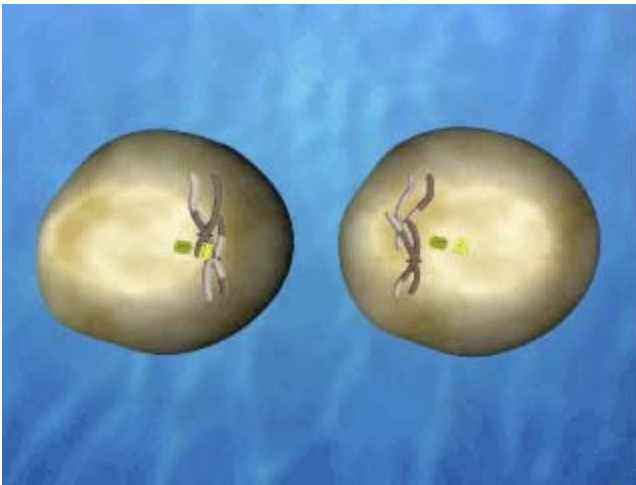
Diakinesis



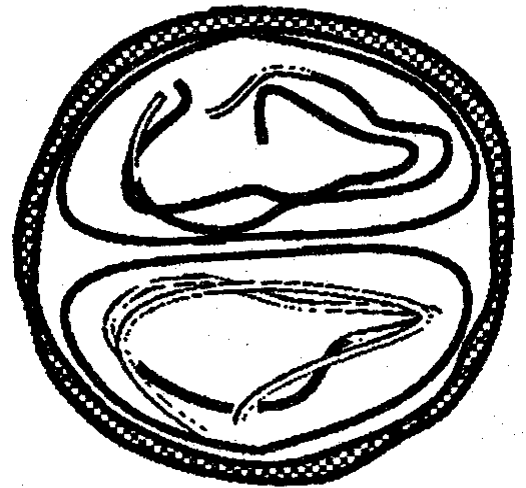
Metaphase I



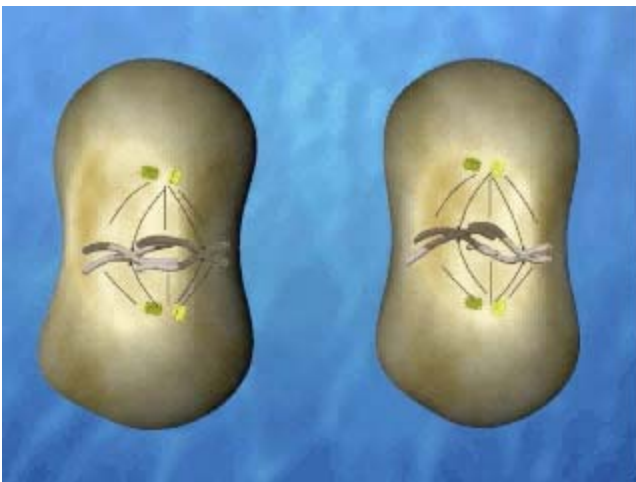
Anaphase I



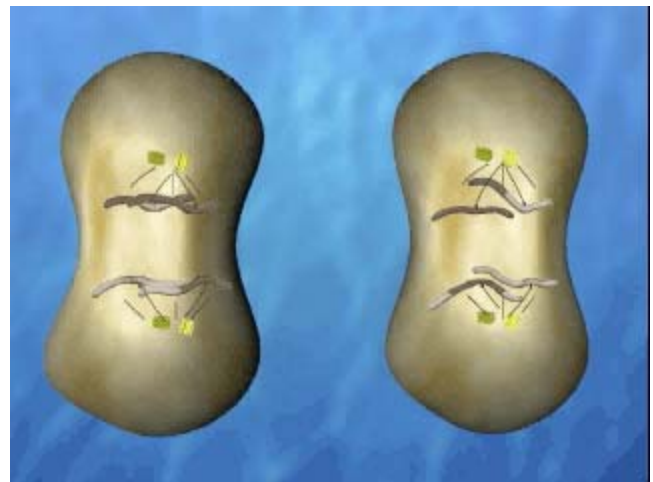
Telophase I



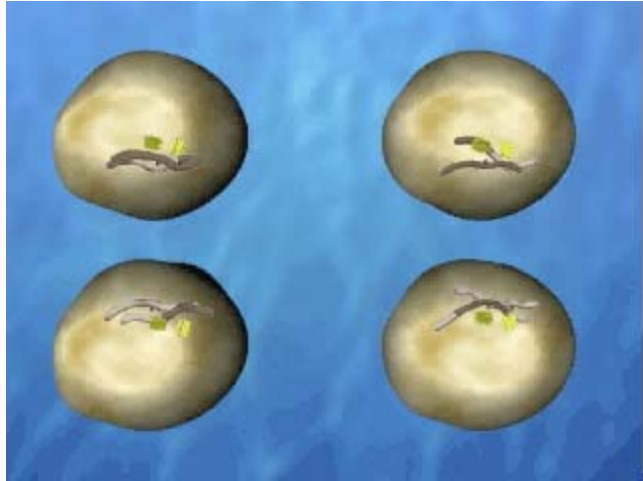
Prophase II



Metaphase II



Anaphase II



Telophase II & Cytokinesis

Glossary of terms

Meiosis: A process in diploid eukaryotes that results in gametes or spores with only one member of each original homologous pair of chromosomes per nucleus.

Homologous chromosomes: Members of a pair of essentially identical chromosomes each coming from the parents that synapse during meiosis.

Syaptonemal complex: A proteinaceous complex that apparently mediates synapsis during zygotene stage and then disintegrates.

Bivalent: Structures, formed during prophase of meiosis I, consisting of the synapsed homologous chromosomes. Equivalent to tetrad of chromatids.

Dyad: Two sister chromatids attached to the same centromere. Two cells formed as a result of meiosis I in monocots.

Chiasmata: X-shaped configurations seen in tetrads during the latter stages of prophase I of meiosis. They represent physical crossovers (singular: chiasma).

Nucleolus: The globular, nuclear organelle formed at the nucleolar organizer. Site of ribosomal RNA construction.