

# **Genetic and Biotechnology in Aquaculture**

- References

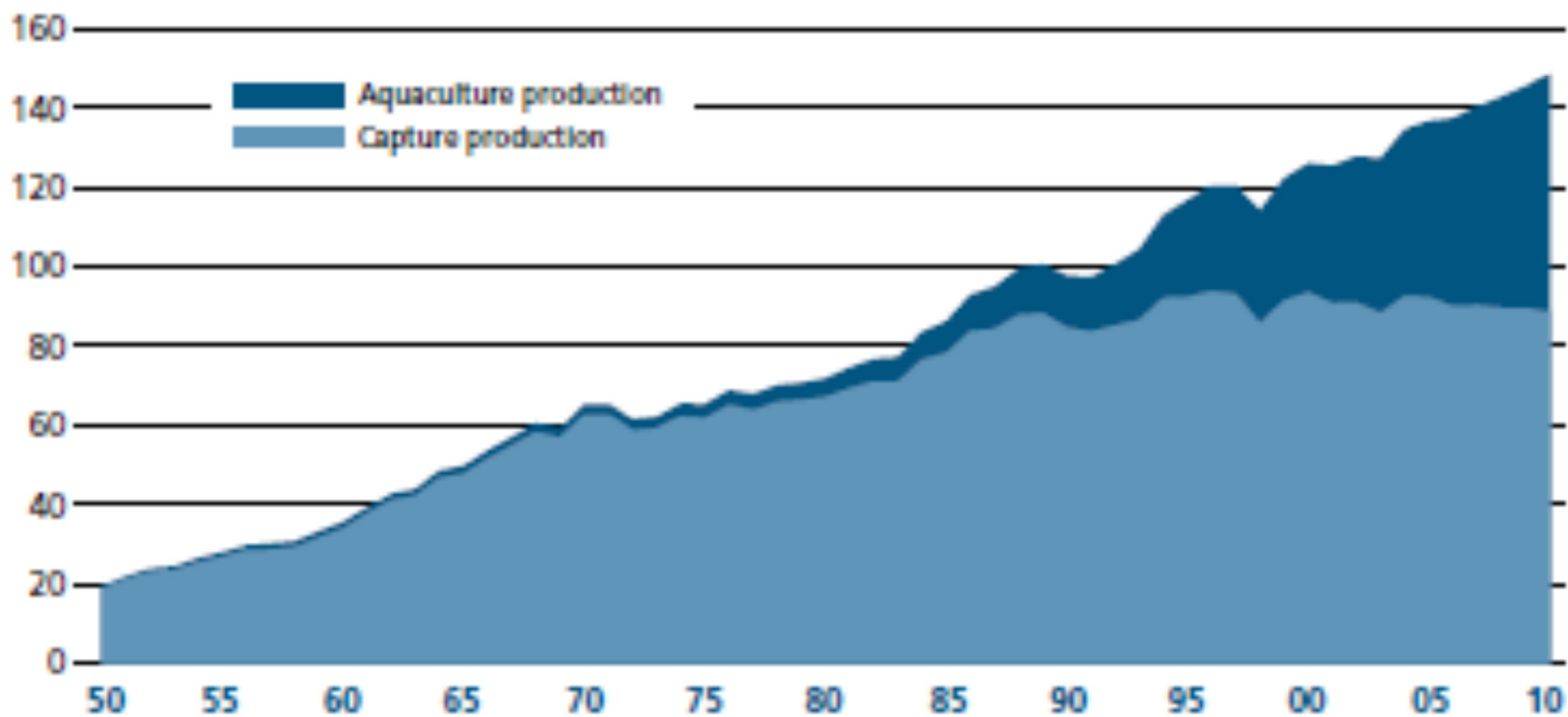
- Selective Breeding Programmes for Medium-Sizes Farms (By: Douglas Tave, 1995)

- Biotechnology and Genetics in Fisheries and Aquaculture (By: A.R. Beaumont and K. Hoare, 2003)

- Aquaculture and Fisheries Biotechnology, Genetic Approaches (By: Rex A. Dunham, 2004)

## World capture fisheries and aquaculture production

Million tonnes



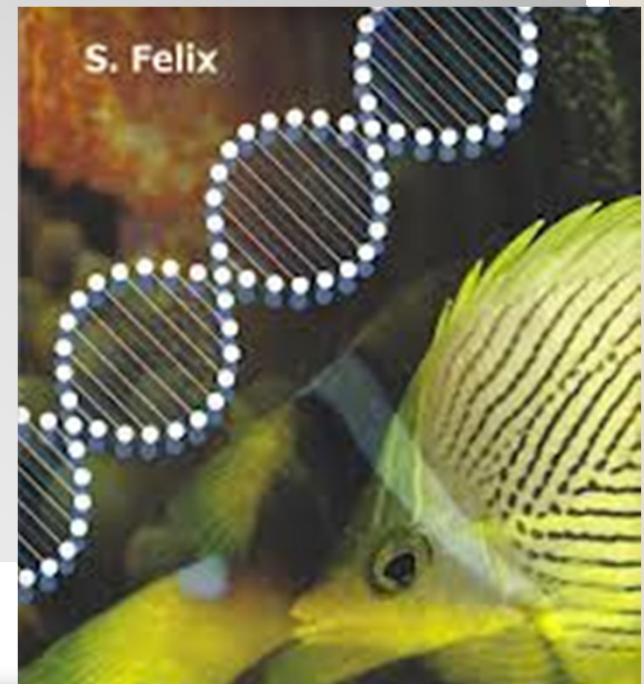
# Introduction

- Two ways that a fish farmer can increase fish production:
  - 1) To increase the size of the fish farm
  - 2) To increase yield
    - by environmental manipulations, such as the increased use of lime, fertilizers, feeds, and/or improved water quality management
    - by growing genetically improved fish

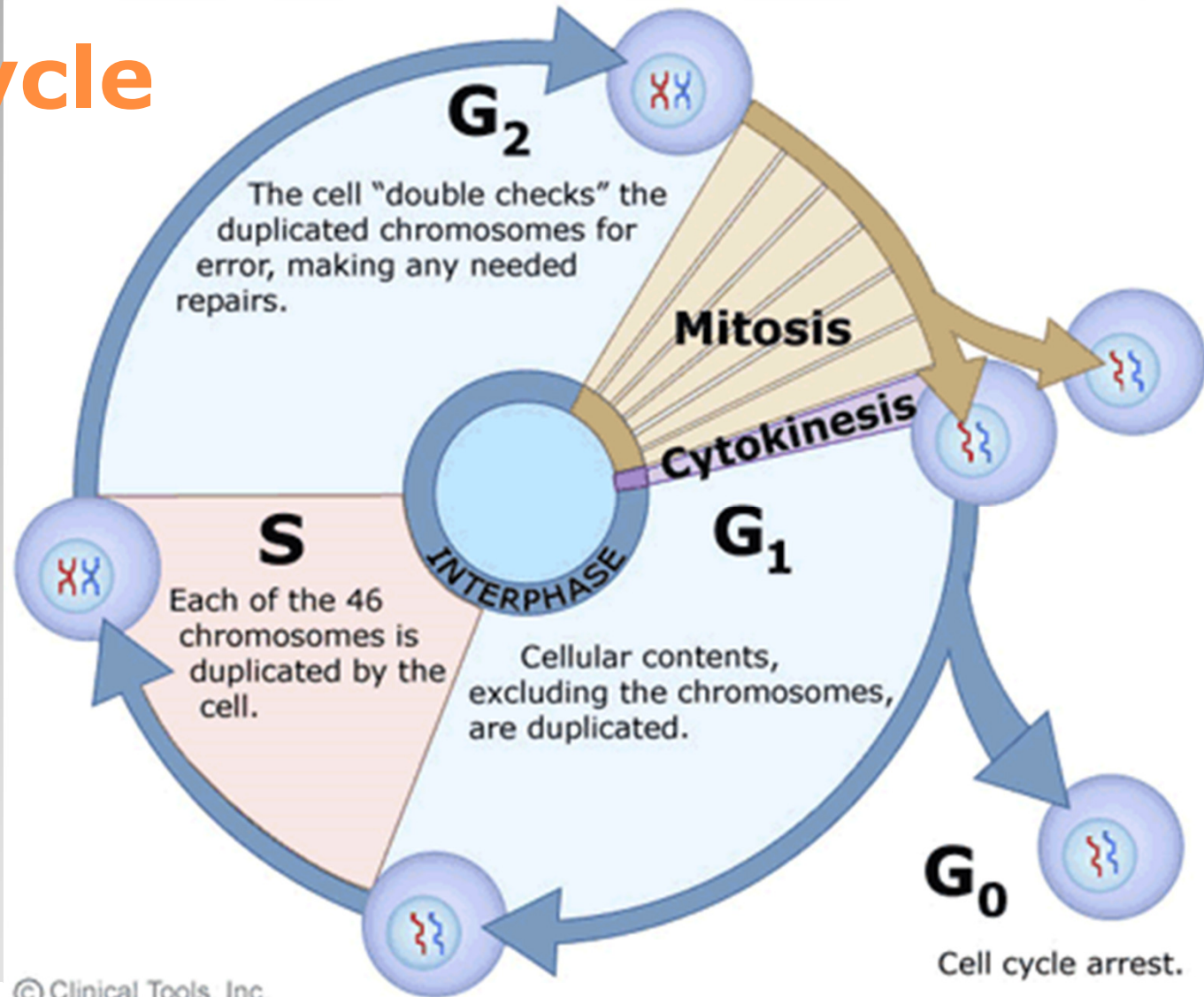
- **Genetics:** The science of heredity and variation.
- **Biotechnology:** is the use of living systems and organisms to develop or make useful products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use.

# Application of Biotechnology in Aquaculture

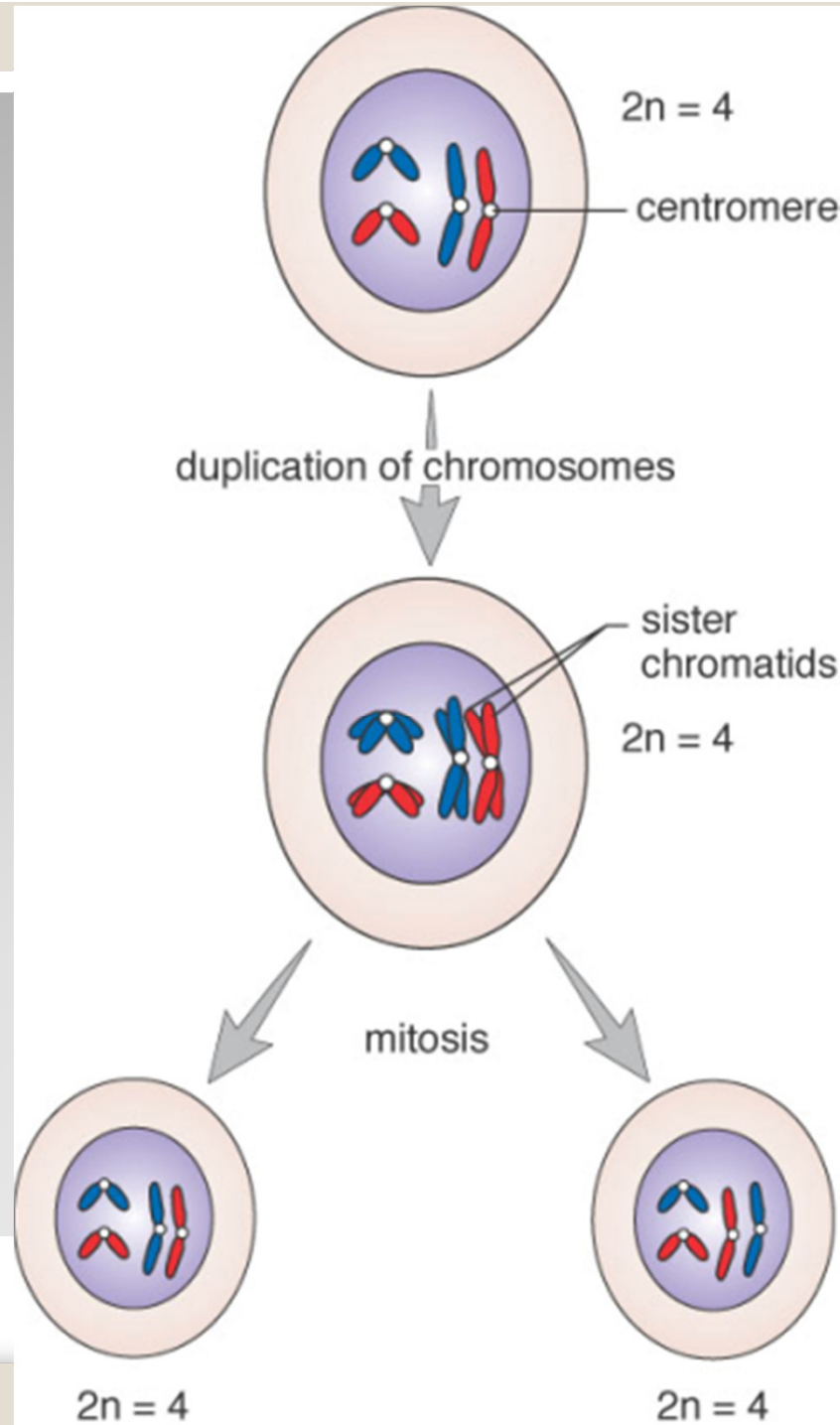
- 1) Genetic engineering and chromosome set manipulation
  - 1-1) Transgenesis
  - 1-2) induction sterility
  - 1-3) Sex reversal
    - 1-3-1) Feminization
    - 1-3-2) Masculinization
  - 1-4) Hybridization
  - 1-5) Gynogenesis
  - 1-6) Androgenesis
- 2) Control of reproduction
- 3) Control of diseases
- 4) Cryopreservation of gametes
- 5) Nutriation



# Cell cycle

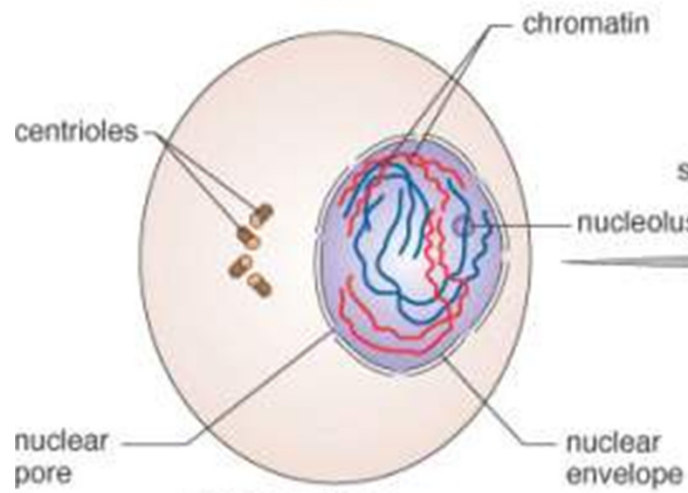


# Mitosis



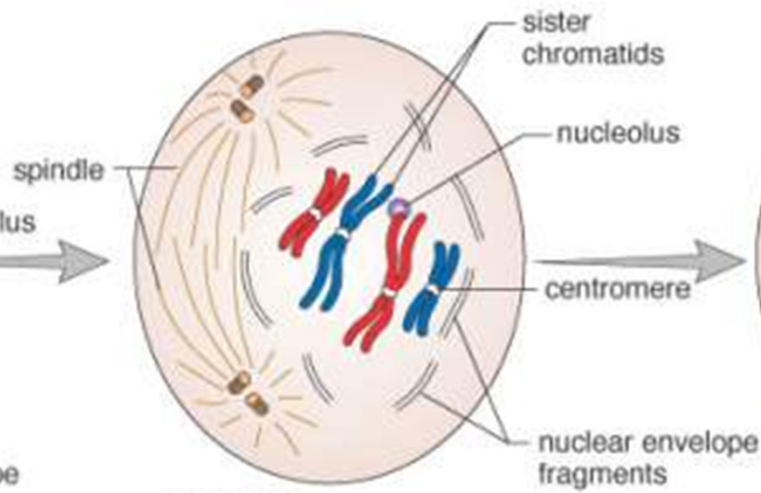


## Interphase

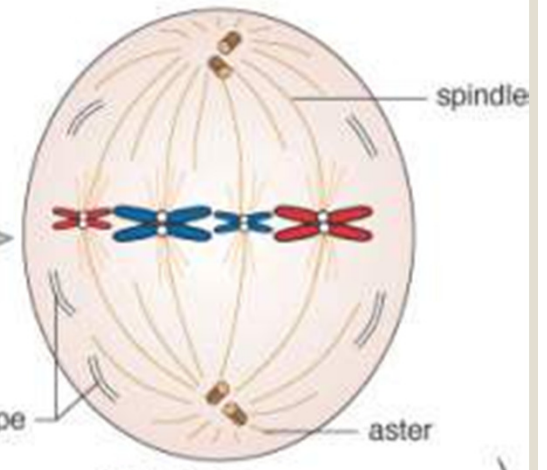


**Late interphase**  
Chromatin is condensing into chromosomes.

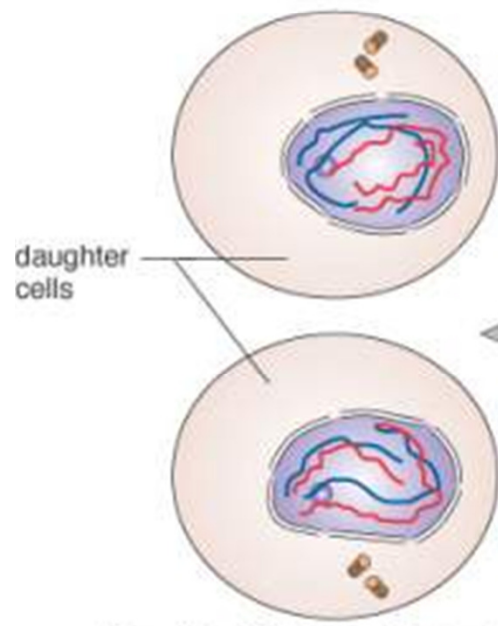
## Mitosis



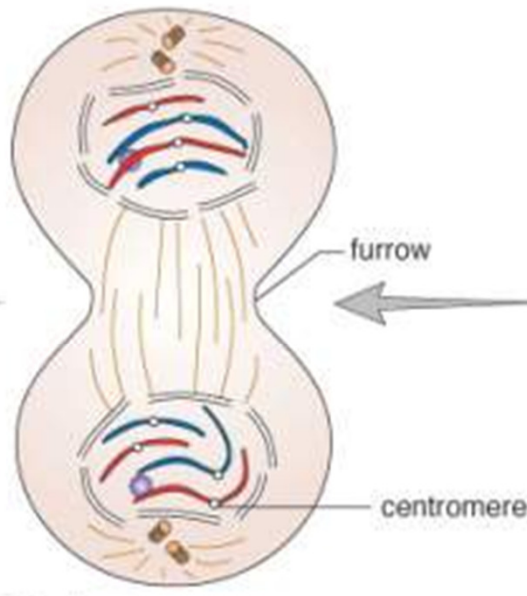
**Prophase**  
Duplicated chromosomes are scattered.



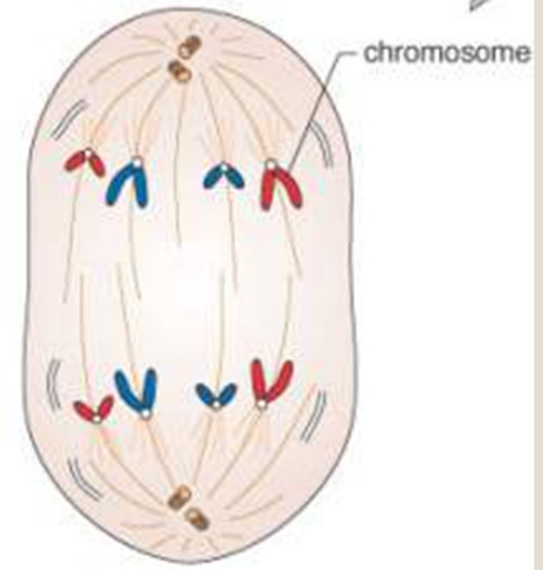
**Metaphase**  
Chromosomes are aligned at the equator of the spindle.



**Daughter Cells: Early interphase**  
Chromosomes are decondensing.



**Telophase**  
Daughter nuclei are forming and spindle is disappearing.



**Anaphase**  
Daughter chromosomes are moving to the poles.

# Meiosis I in males (Spermatogenesis)

## Meiosis I in Males

**Prophase I**  
chromosomes begin to condense

homologous chromosomes pair  
crossing over occurs

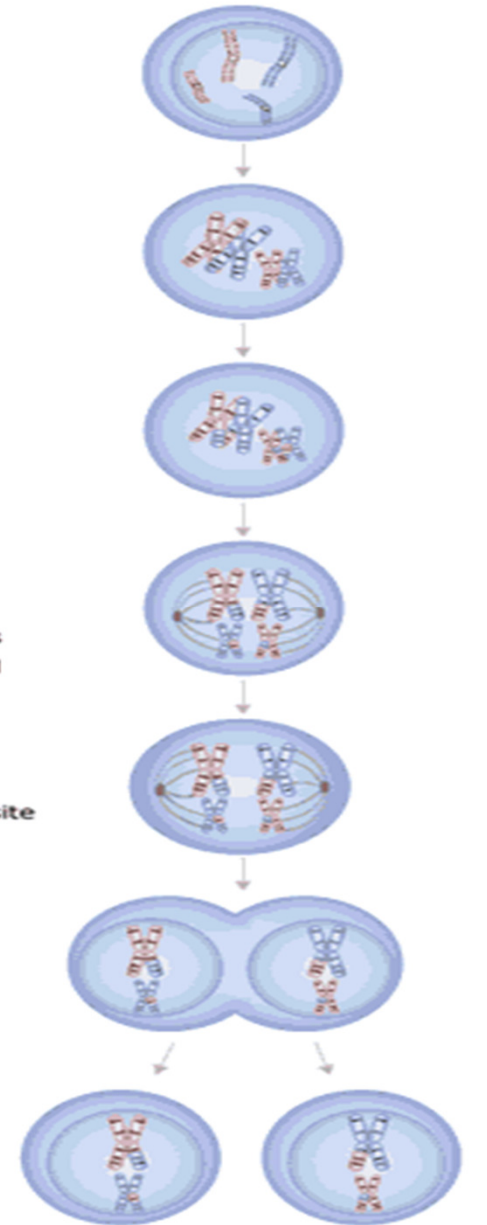
recombinant chromosomes

**Metaphase I**  
spindle fibers attach to chromosomes  
chromosomes line up in center of cell

**Anaphase I**  
chromosomes start to move to opposite  
ends of cell as spindle fibers shorten

**Telophase I**  
chromosomes reach opposite ends  
nuclear membrane forms

**Cytokinesis**  
cell division occurs



sperm cell precursor      sperm cell precursor

- **Prophase I**

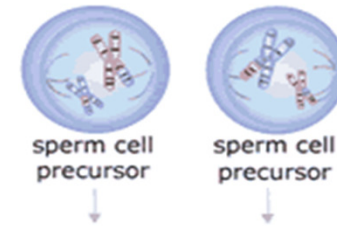
- The homologous chromosomes pair and exchange DNA to form recombinant chromosomes. Prophase I is divided into five phases:
- **Leptotene**: chromosomes start to condense.
- **Zygotene**: homologous chromosomes become closely associated (synapsis) to form pairs of chromosomes (bivalents) consisting of four chromatids (tetrads).
- **Pachytene**: crossing over between pairs of homologous chromosomes to form chiasmata (sing. chiasma).
- **Diplotene**: homologous chromosomes start to separate but remain attached by chiasmata.
- **Diakinesis**: homologous chromosomes continue to separate, and chiasmata move to the ends of the chromosomes

# Meiosis II in males (Spermatogenesis)

## Meiosis II in Males

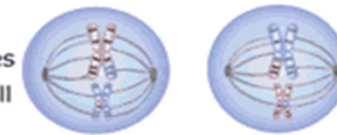
### Prophase II

chromosomes begin to condense  
nuclear membrane dissolves  
spindle fibers form



### Metaphase II

spindle fibers attach to chromosomes  
chromosomes line up in center of cell



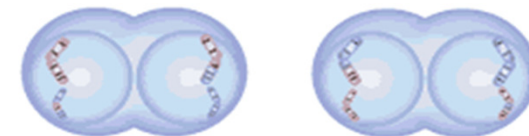
### Anaphase II

centromeres divide and sister chromatids move to opposite ends of cell as spindle fibers shorten



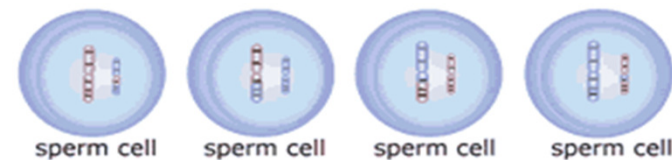
### Telophase II

chromosomes reach opposite ends  
nuclear membrane forms



### Cytokinesis

cell division occurs

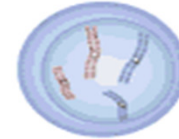


# Meiosis I in females (Oogenesis)

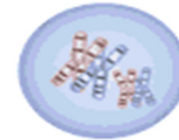
## Meiosis I in Females

### Prophase I

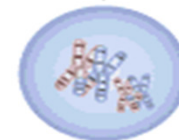
chromosomes begin to condense



homologous chromosomes pair  
crossing over occurs

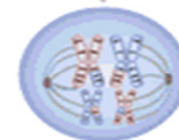


recombinant chromosomes



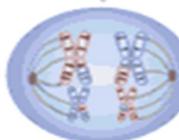
### Metaphase I

spindle fibers attach to chromosomes  
chromosomes line up in center of cell



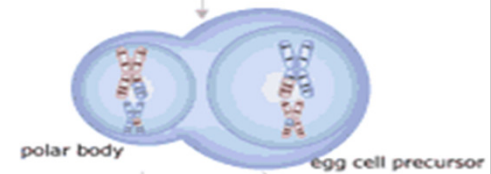
### Anaphase I

chromosomes start to move to opposite  
ends of cell as spindle fibers shorten



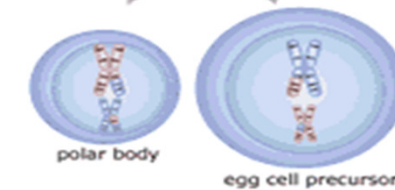
### Telophase I

chromosomes reach opposite ends  
nuclear membrane forms



### Cytokinesis

cell division occurs

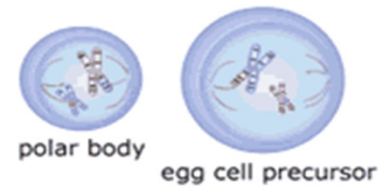


# Meiosis II in females (Oogenesis)

## Meiosis II in Females

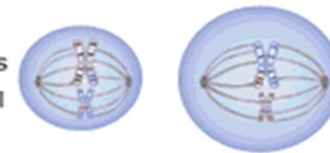
### Prophase II

chromosomes begin to condense  
nuclear membrane dissolves  
spindle fibers form



### Metaphase II

spindle fibers attach to chromosomes  
chromosomes line up in center of cell



### Anaphase II

centromeres divide and sister chromatids move to opposite ends of cell as spindle fibers shorten



### Telophase II

chromosomes reach opposite ends  
nuclear membrane forms



### Cytokinesis

cell division occurs

