MEIOSIS

Organisms that reproduce Sexually are made up of two different types of cells.

1. **Somatic Cells** are "body" cells and contain the normal number of chromosomes ….called the "Diploid" number (the symbol is **2n**). Examples would be … skin cells, brain cells, etc.

2. **Gametes** are the "sex" cells and contain only ½ the normal number of chromosomes…. called the "Haploid" number (the symbol is **n**)….. Sperm cells and ova are gametes.

n = number of chromosomes in the set… so….2n means 2 chromosomes in the set…. Polyploid cells have more than two chromosomes per set… example: 3n (3 chromosomes per set)

Gametes

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

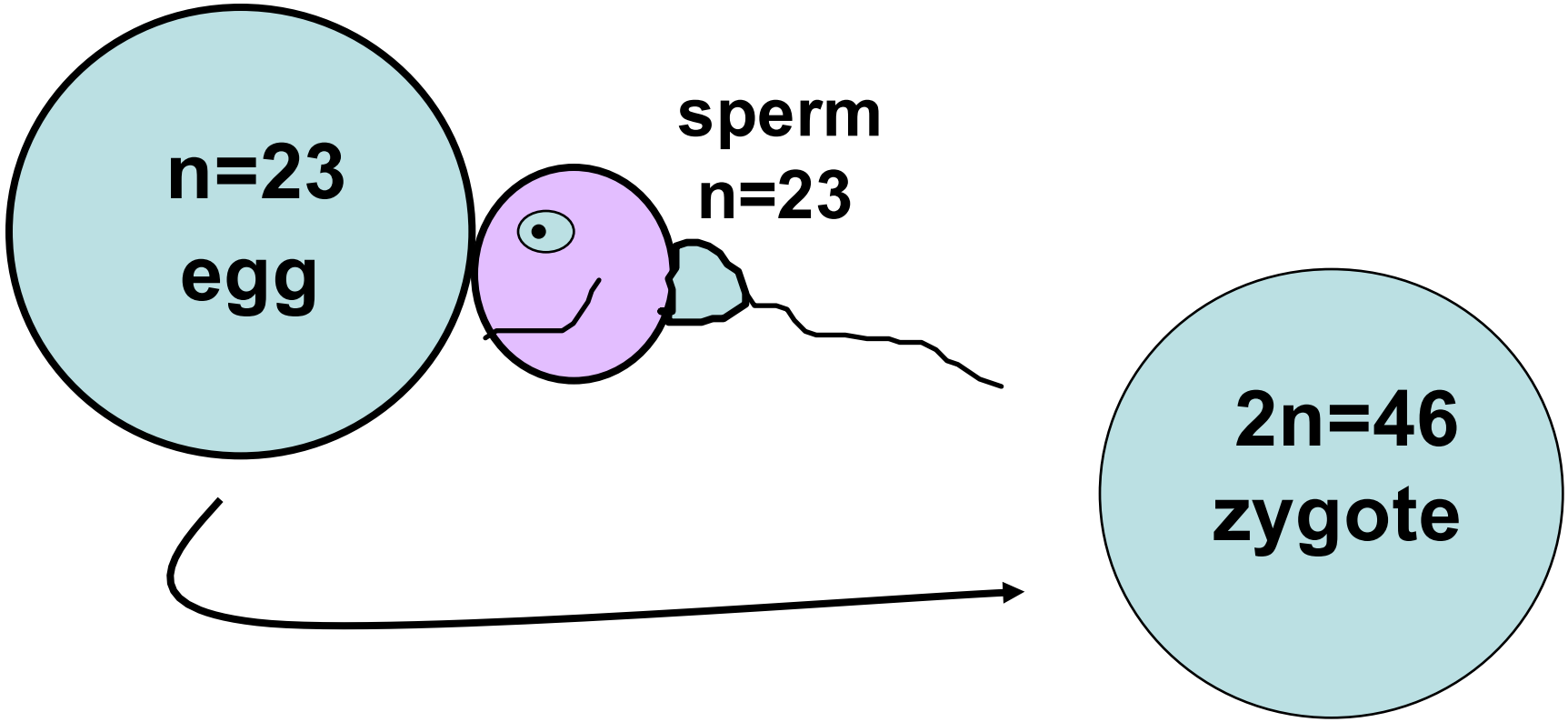
- The **Female Gamete** is the **Ovum (ova = pl.)** and is produced in the female gonad the **Ovaries**.

During **Ovulation** the ovum is released from the ovary and transported to an area where **fertilization**, the joining of the sperm and ovum, can occur…… fertilization, in Humans, occurs in the Fallopian tube. **Fertilization results in the formation of the Zygote. (fertilized egg)**

Sperm + Ovum (egg) —fertilization→ **Zygote**

Fertilization

- The fusion of a **sperm** and **egg** to form a **zygote**.
- A zygote is a fertilized egg



Chromosomes

- **If an organism has the Diploid number (2n) it has two matching homologues per set. One of the homologues comes from the mother (and has the mother's DNA)…. the other homologue comes from the father (and has the father's DNA).**

- **Most organisms are diploid. Humans have 23 sets of chromosomes… therefore humans have 46 total chromosomes….. The diploid number for humans is 46 (46 chromosomes per cell).**

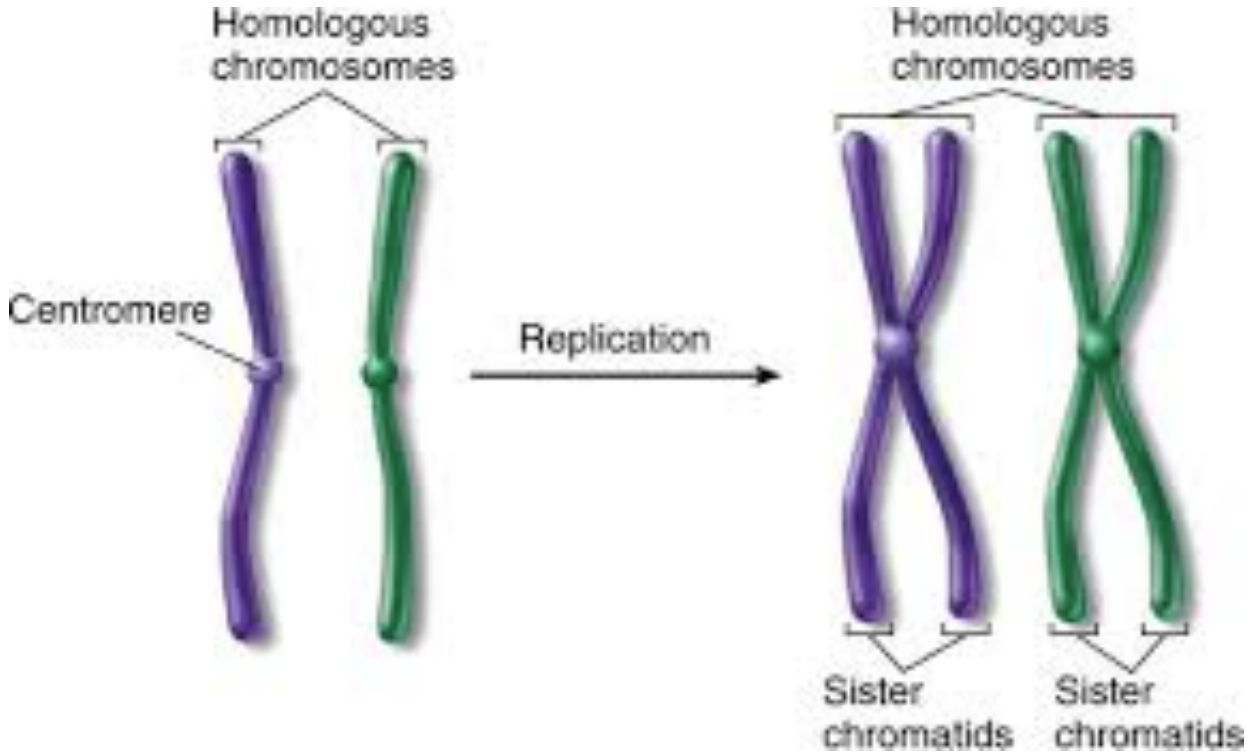
Homologous Chromosomes

- Pair of chromosomes (maternal and paternal) that are similar in shape and size.
- Homologous pairs carry genes controlling the same inherited traits.
- Humans have 23 pairs of homologous chromosomes.

22 pairs of autosomes

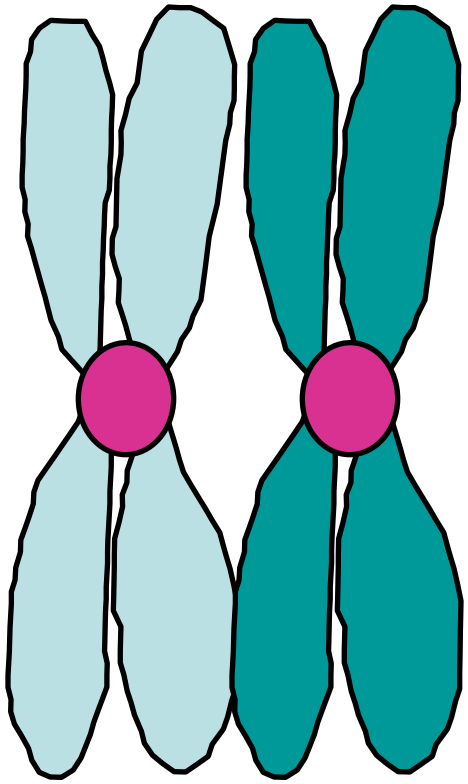
1 pair of sex chromosomes

Homologous Chromosomes

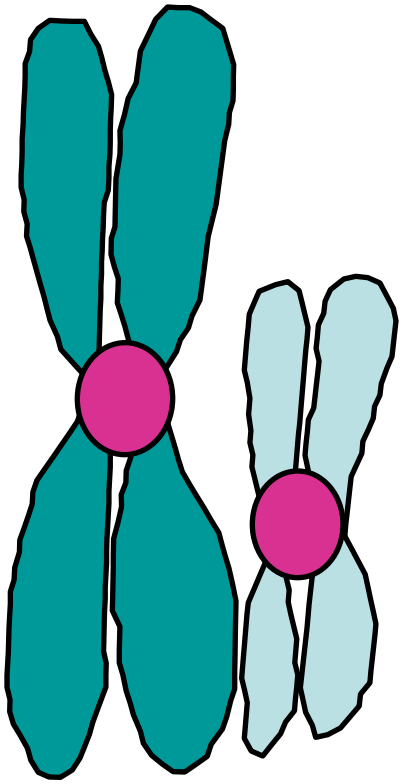


Sex Chromosomes

The Sex Chromosomes code for the sex of the offspring.
**** If the offspring has two "X" chromosomes it will be a female.**
**** If the offspring has one "X" chromosome and one "Y" chromosome it will be a male.**



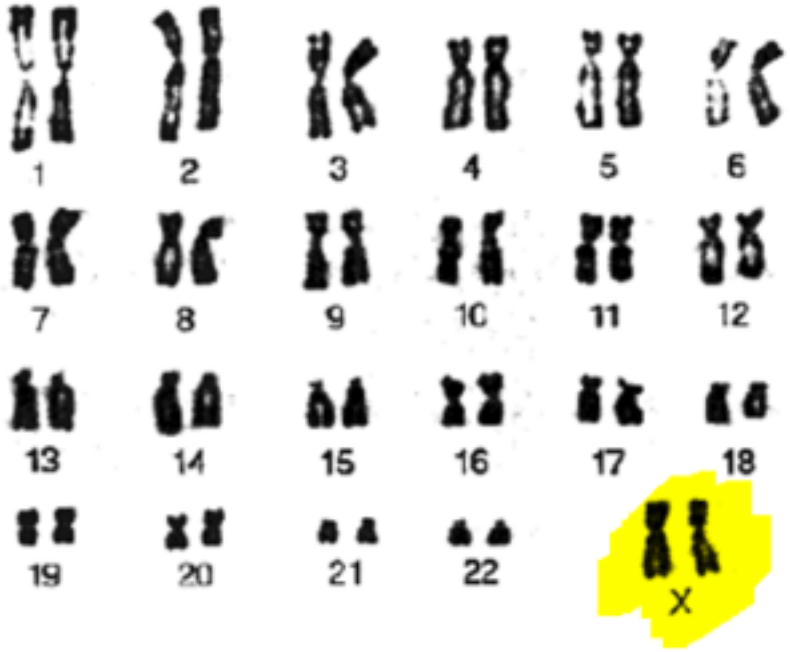
In Humans the "Sex Chromosomes" are the 23rd set



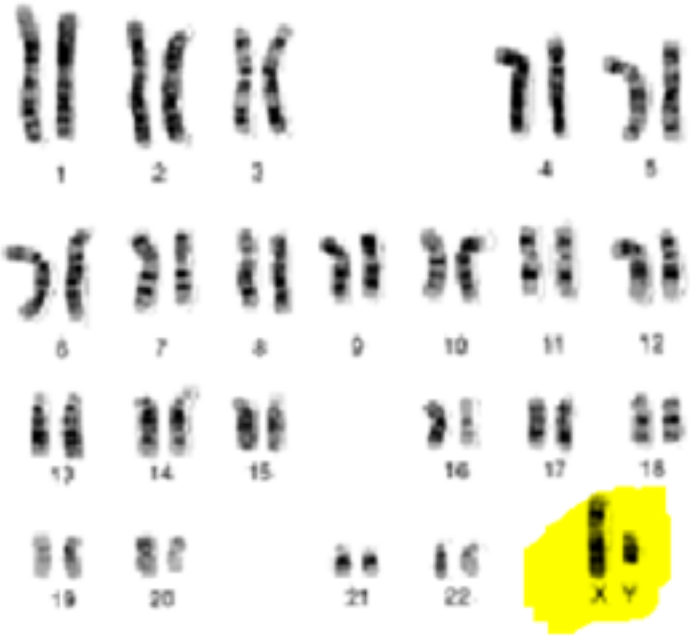
XX chromosome - female

XY chromosome - male

Sex Chromosomes



Female



Male

Meiosis

is the process by which "gametes" (sex cells) , with half the number of chromosomes, are produced.

During Meiosis diploid cells are reduced to haploid cells

Diploid (2n) → Haploid (n)

If Meiosis did not occur the chromosome number in each new generation would double…. The offspring would die.

Meiosis

Meiosis is Two cell divisions

(called meiosis I and meiosis II)

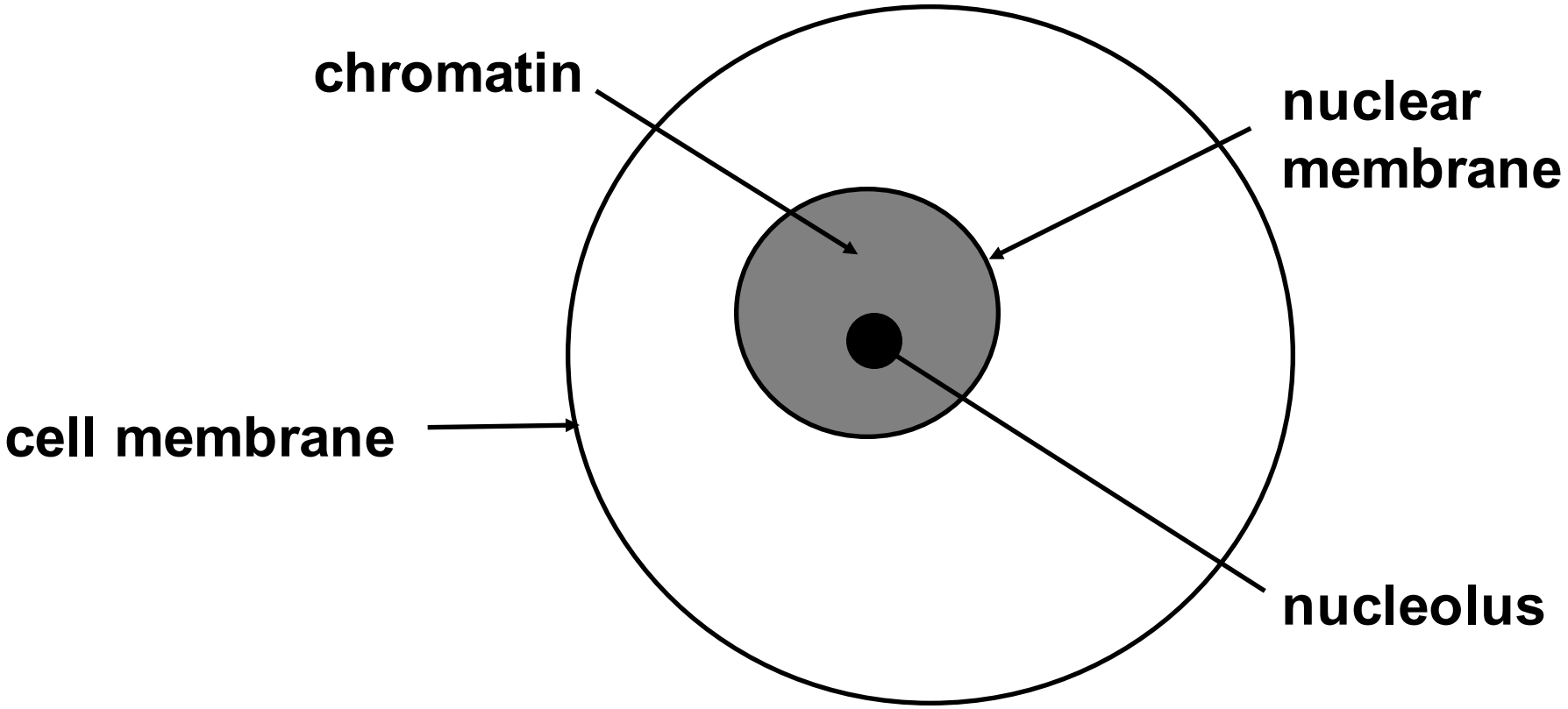
with only one duplication of chromosomes.

Interphase I

- Similar to **mitosis** interphase.
- **Chromosomes** replicate
- Each duplicated **chromosome** consist of two identical sister **chromatids** attached at their **centromeres**.
- **Centriole** pairs also replicate.

Interphase

- **Nucleus** and **nucleolus** visible.



Meiosis I (four phases)

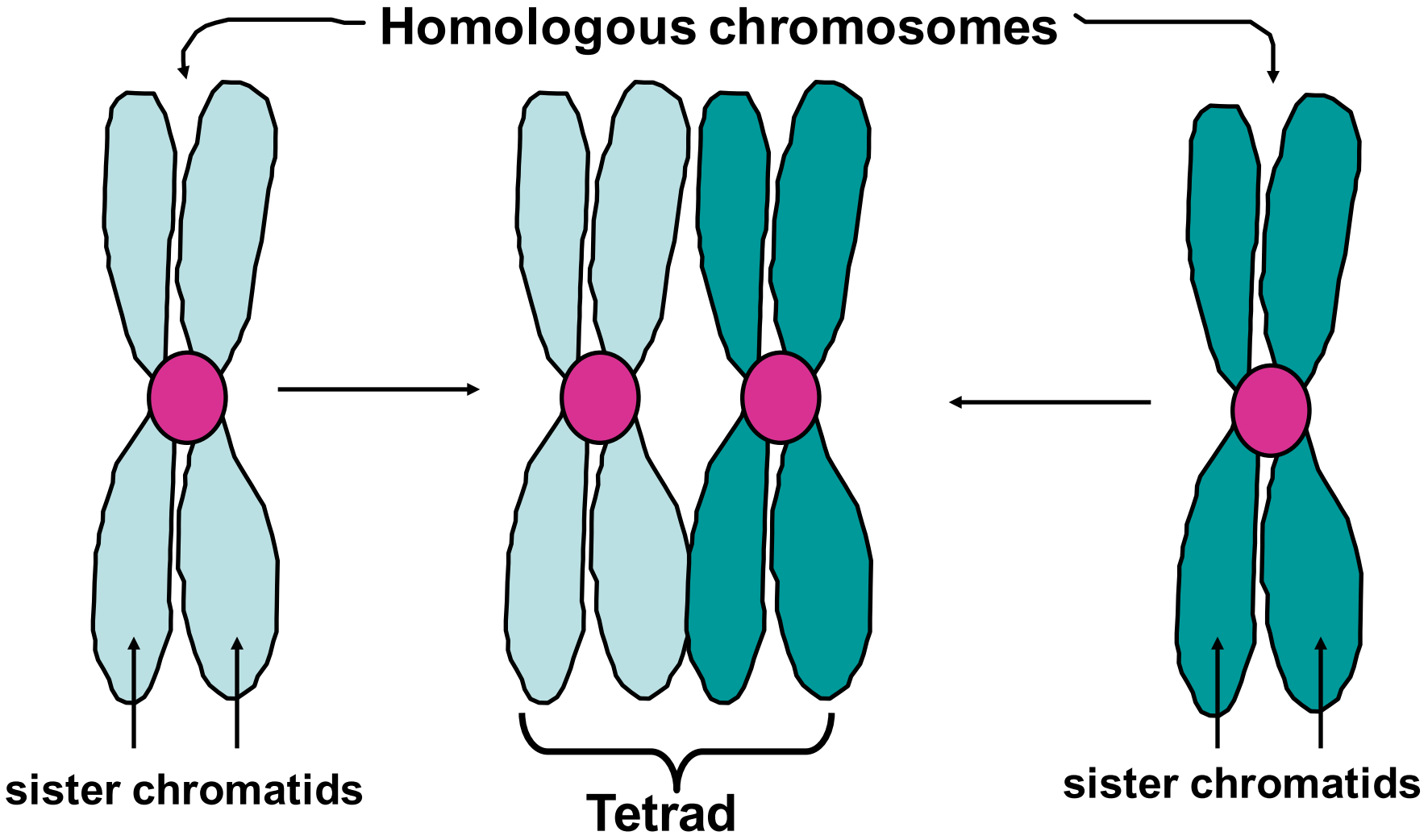
- **Cell division** that reduces the **chromosome** number by **one-half.**

- **four phases**:
  a. **prophase I**
  b. **metaphase I**
  c. **anaphase I**
  d. **telophase I**

Prophase I

- **Chromosomes** condense.
- **Synapsis** occurs: **homologous chromosomes** come together to form a **tetrad**.
- **Tetrad** is two **chromosomes** or four **chromatids** (sister and nonsister chromatids).

Prophase I - Synapsis



During Prophase I "Crossing Over" occurs.

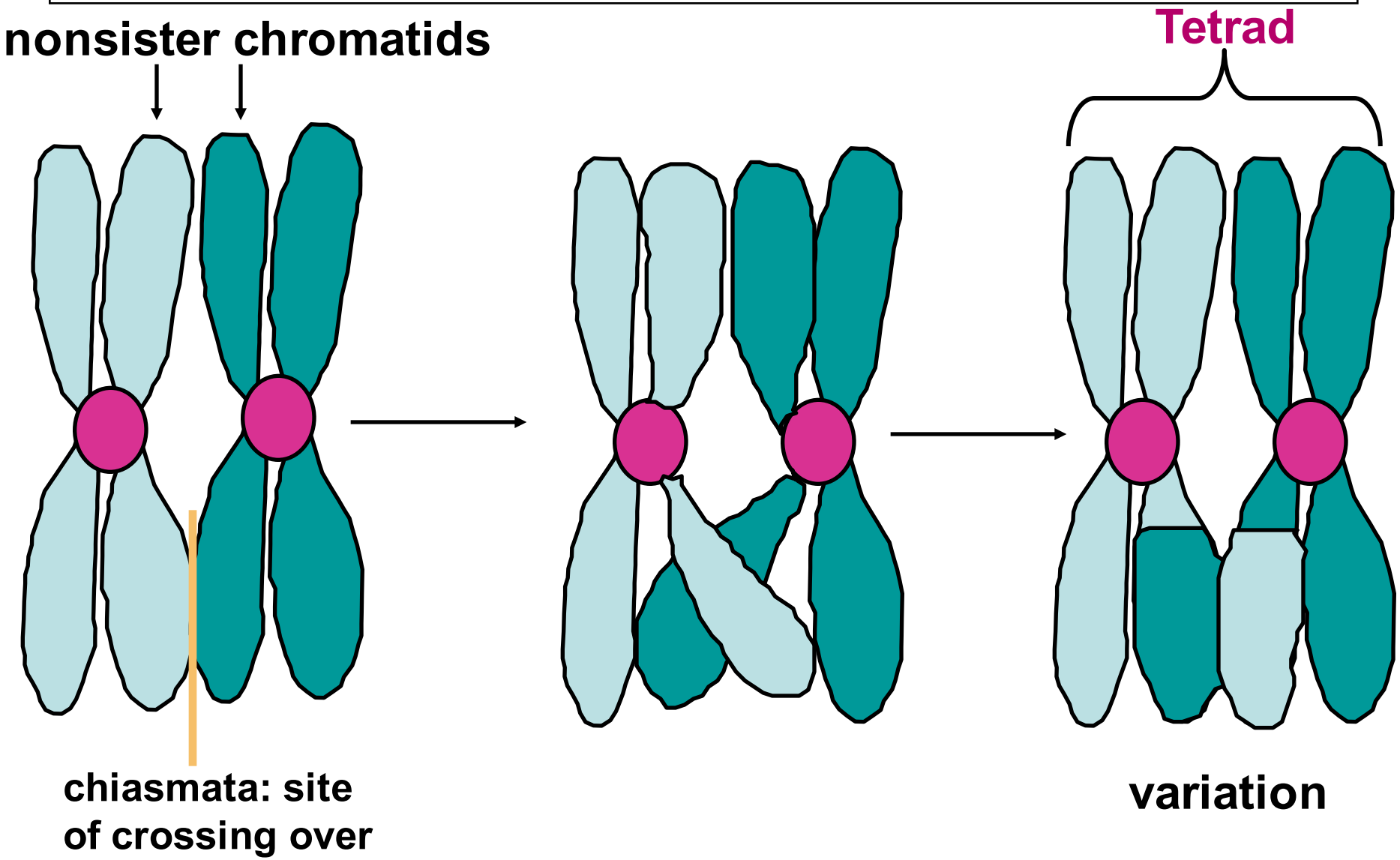
Crossing Over is one of the Two major occurrences of Meiosis

(The other is Non-disjunction)

- **During Crossing over** segments of nonsister **chromatids** break and reattach to the other **chromatid**. The **Chiasmata (chiasma)** are the sites of **crossing over**.

Crossing Over

creates variation (diversity) in the offspring's traits.



Question:

- A cell containing **20 chromosomes (diploid)** at the beginning of meiosis would, at its completion, produce cells containing how many **chromosomes**?

Answer:

- **10 chromosomes (haploid)**

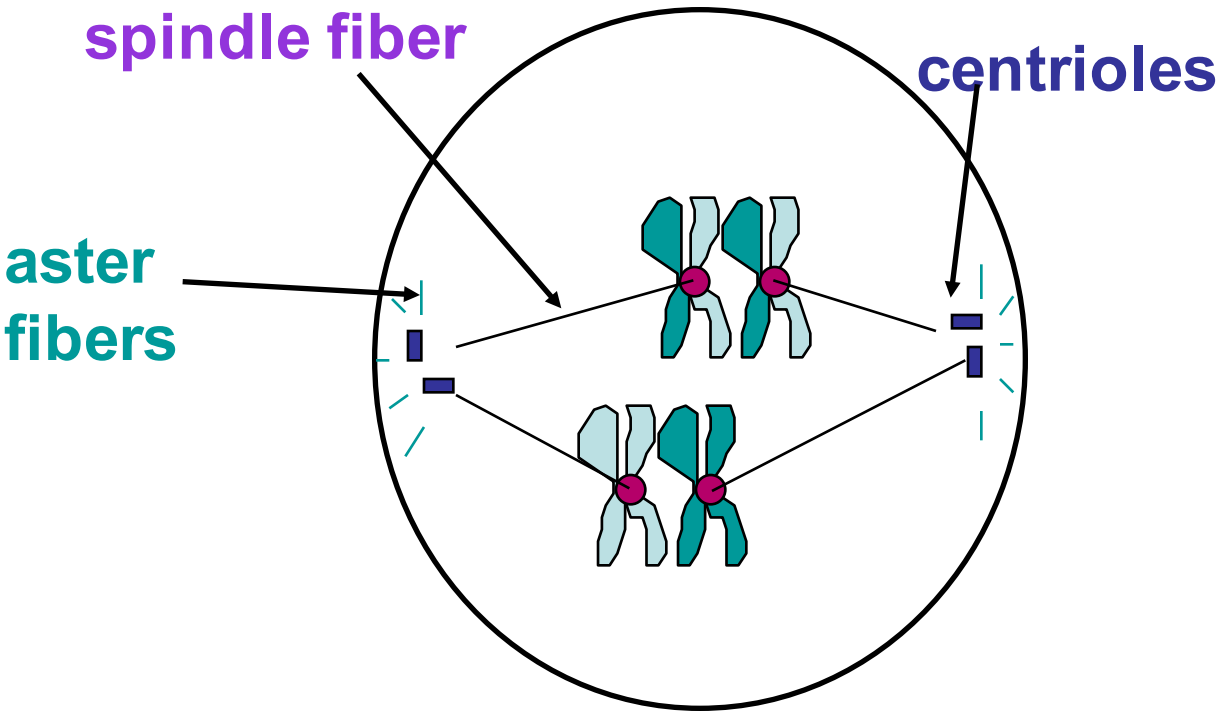
Question:

- A cell containing **40 chromatids** at the beginning of meiosis would, at its completion, produce cells containing how many **chromosomes**?

Answer:

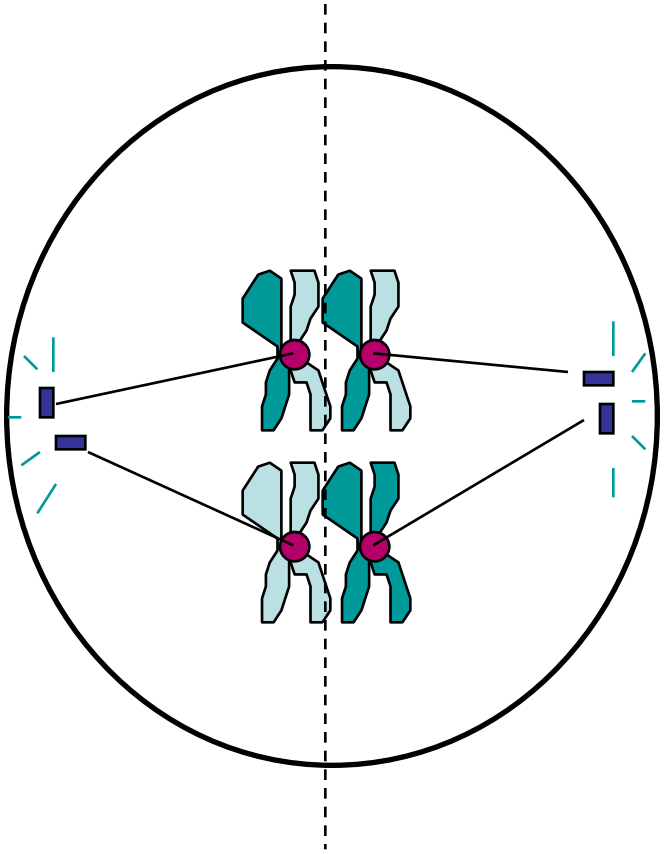
- **10 chromosomes**

Prophase I



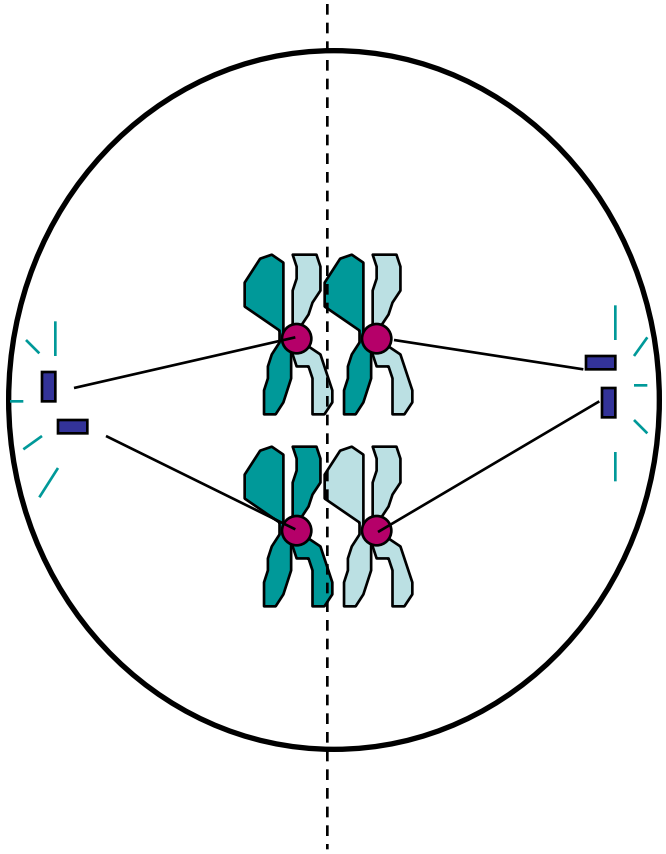
Metaphase I

Tetrads align on the **metaphase plate**.



metaphase plate

OR

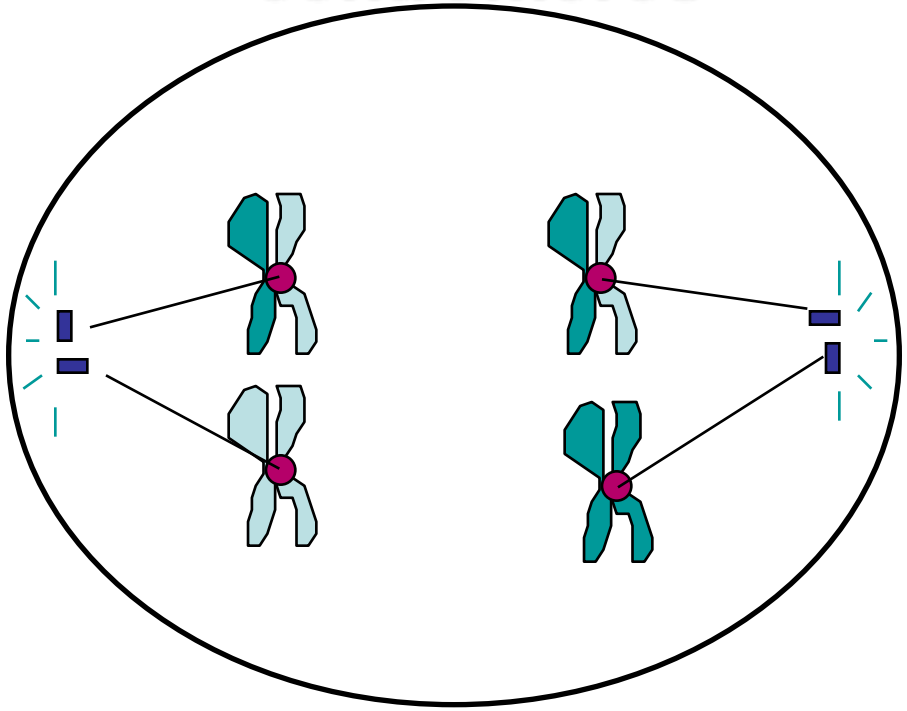


metaphase plate

Anaphase I

- **Homologous chromosomes** separate and move towards the poles.

- **Sister chromatids** remain attached at their **centromeres**.

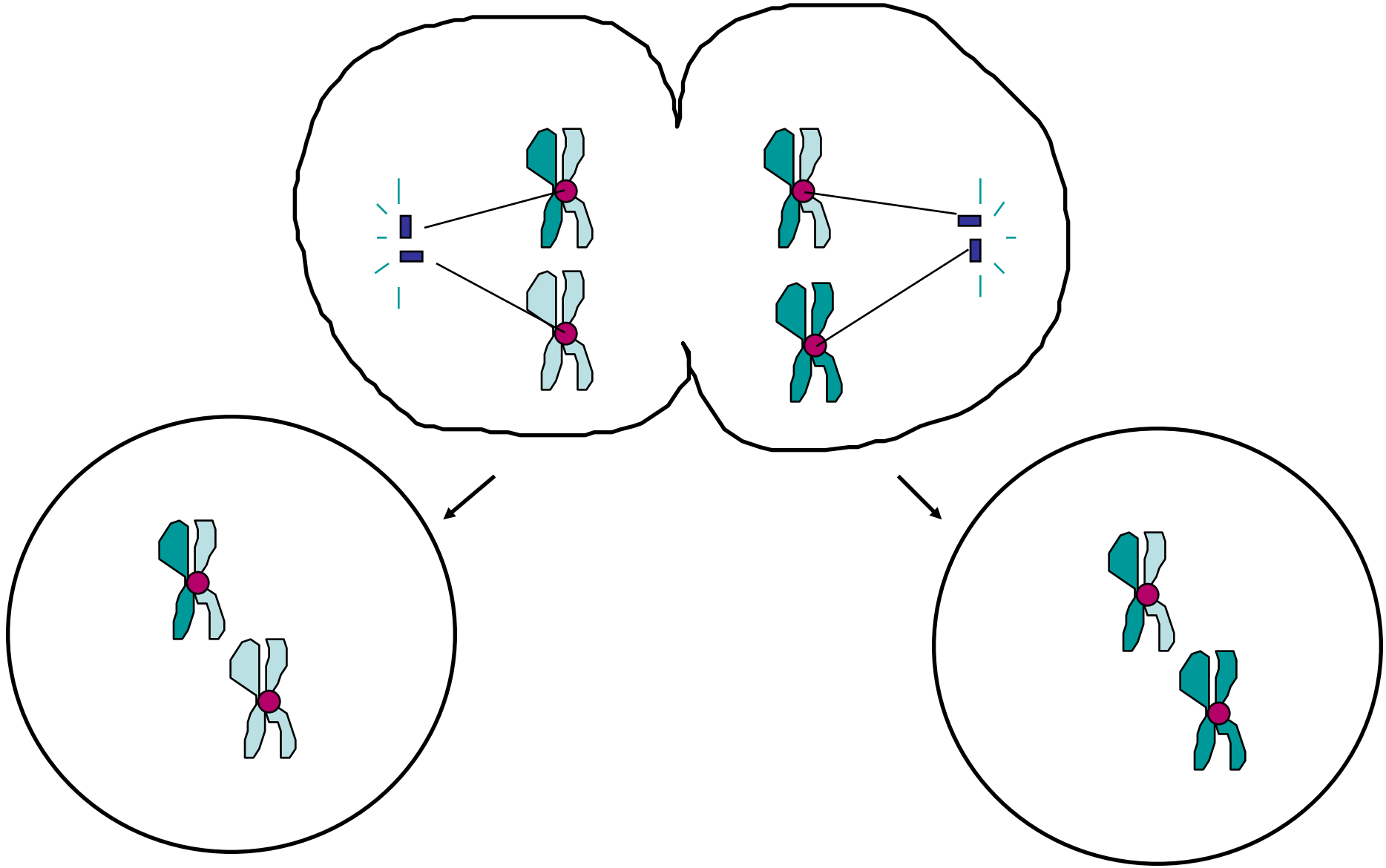


Telophase I

- Each pole now has **haploid** set of **chromosomes**.

- **Cytokinesis** occurs and two haploid daughter cells are formed.

Telophase I



Meiosis II

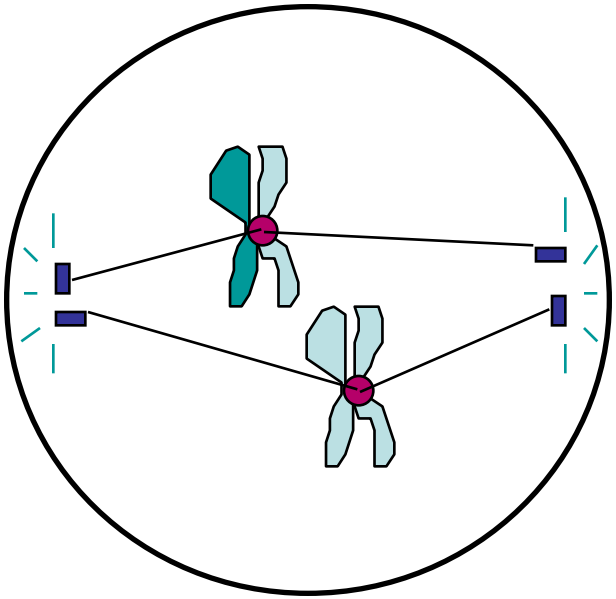
- **No interphase**

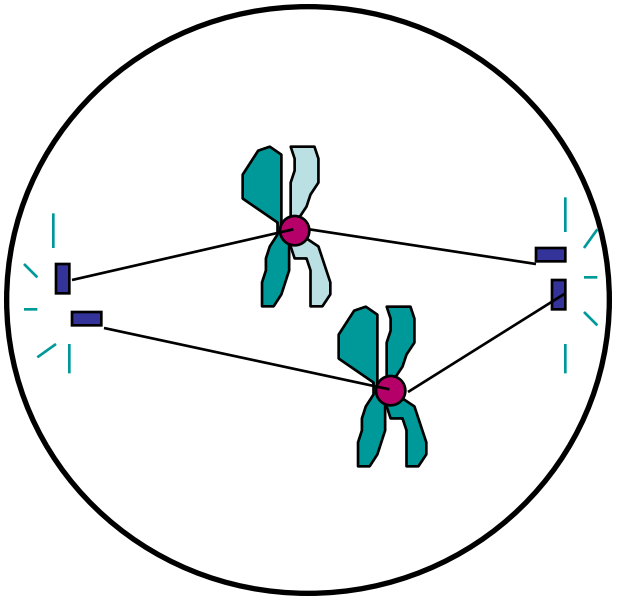
(or very short - no more **DNA replication**)

- **Remember: Meiosis II** is similar to **mitosis**

Prophase II

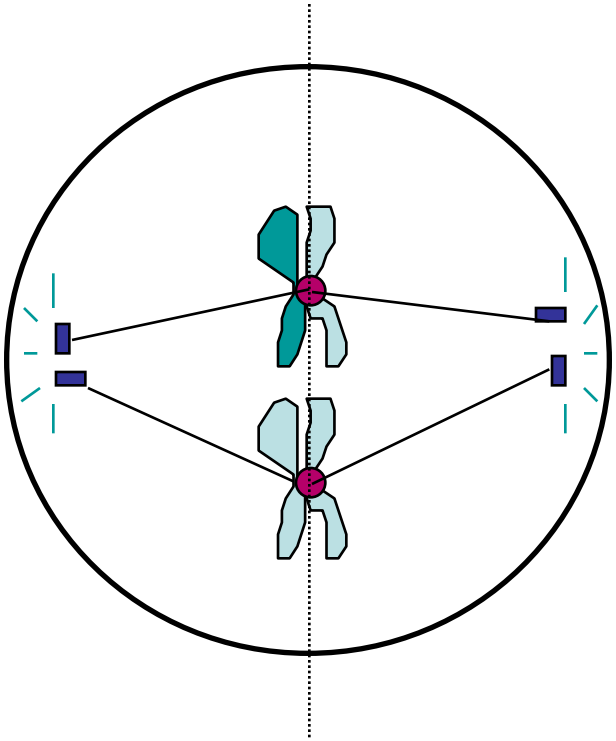
- same as **prophase** in **mitosis**



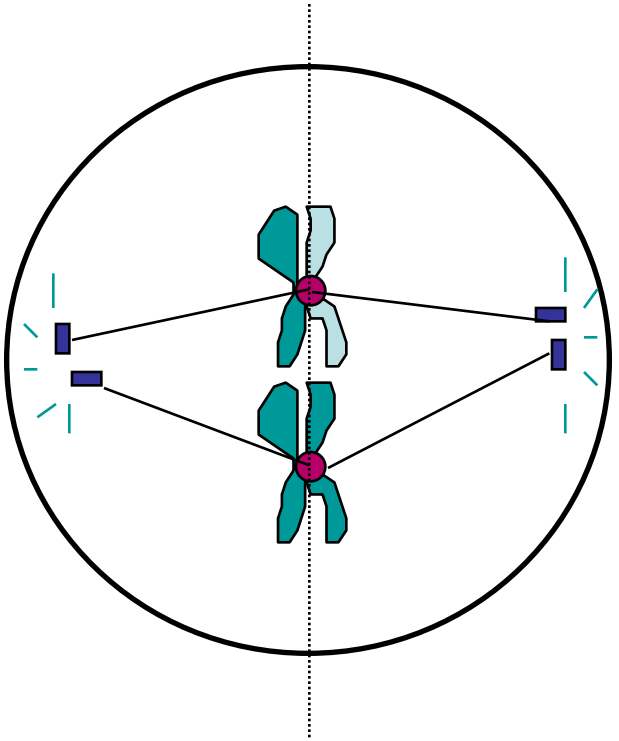


Metaphase II

- same as **metaphase** in **mitosis**



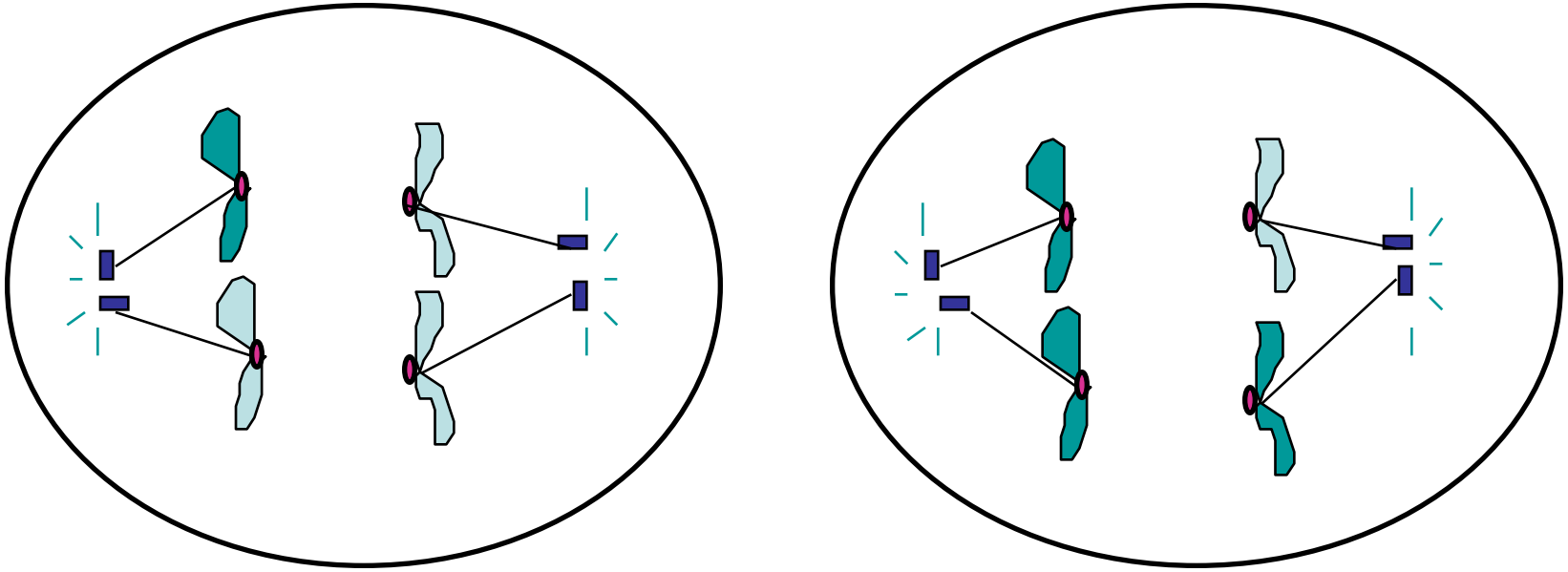
metaphase plate



metaphase plate

Anaphase II

- same as **anaphase** in **mitosis**
- **sister chromatids separate**

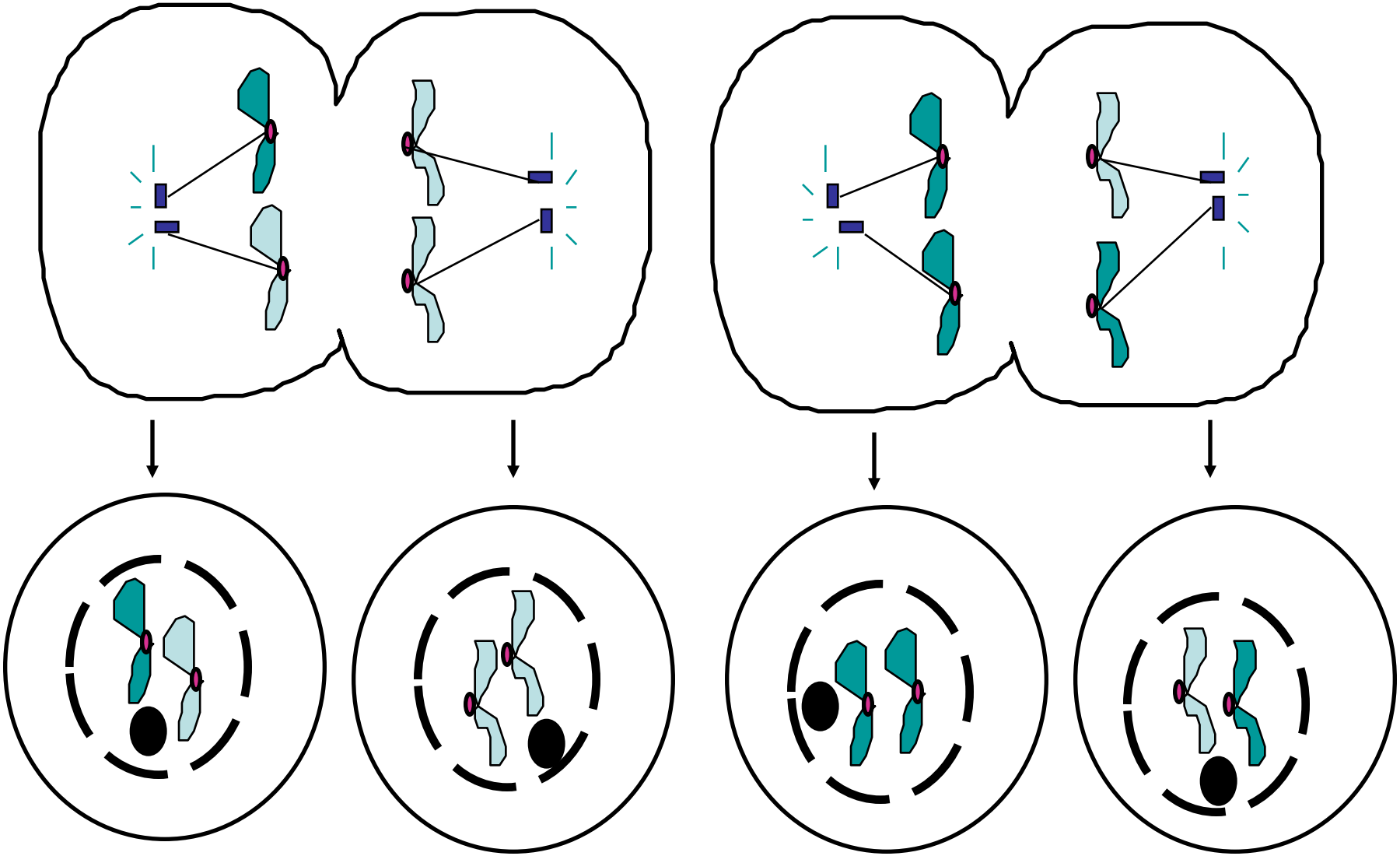


Telophase II

- Same as **telophase** in **mitosis**.
- Nuclei form.
- **Cytokinesis** occurs.
- **Remember: four haploid daughter cells produced.**

gametes = sperm or egg

Telophase II



Non-disjunction

- **Non-disjunction is the failure of homologous chromosomes, or sister chromatids, to separate during meiosis.**

- **Non-disjunction results with the production of zygotes with abnormal chromosome numbers…… remember…. An abnormal chromosome number (abnormal amount of DNA) is damaging to the offspring.**

Non-disjunctions usually occur in one of two fashions.

- The first is called **Monosomy**, the second is called **Trisomy**. If an organism has Trisomy 18 it has three chromosomes in the 18^{th} set, Trisomy 21…. Three chromosomes in the 21^{st} set. If an organism has Monosomy 23 it has only one chromosome in the 23^{rd} set.

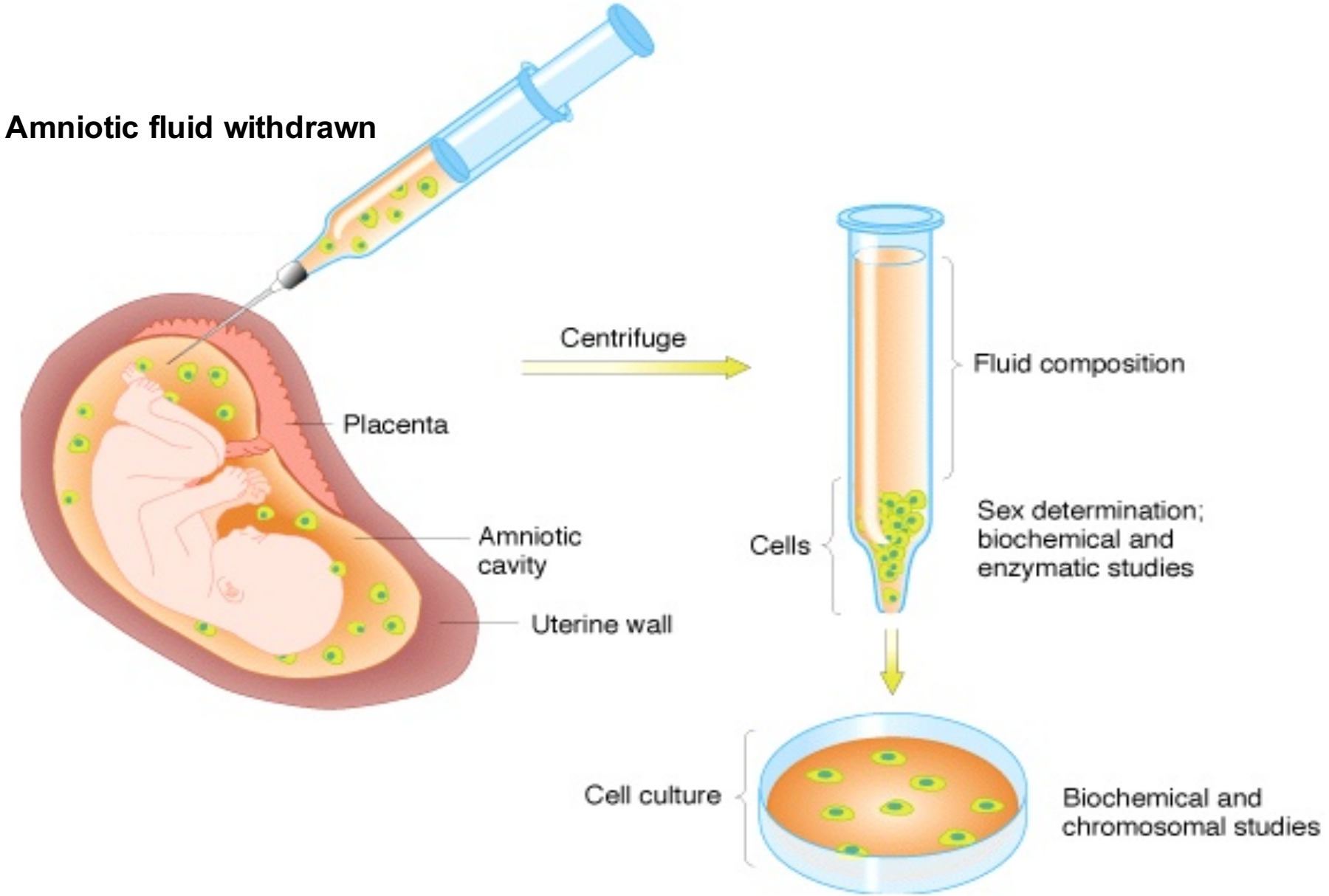
Common Non-disjunction Disorders

- **Down's Syndrome – Trisomy 21**
- **Turner's Syndrome – Monosomy 23 (X)**
- **Kleinfelter's Syndrome – Trisomy 23 (XXY)**
- **Edward's Syndrome – Trisomy 18**

Amniocentesis

- An Amniocentesis is a procedure a pregnant woman can have in order to detect some genetics disorders…..such as non-disjunction.

Amniocentesis



Karyotype

(picture of an individual's chromosomes)

One of the ways to analyze the amniocentesis is to make a Karyotype

What genetic disorder does this karyotype show?

Trisomy 21….Down's Syndrome