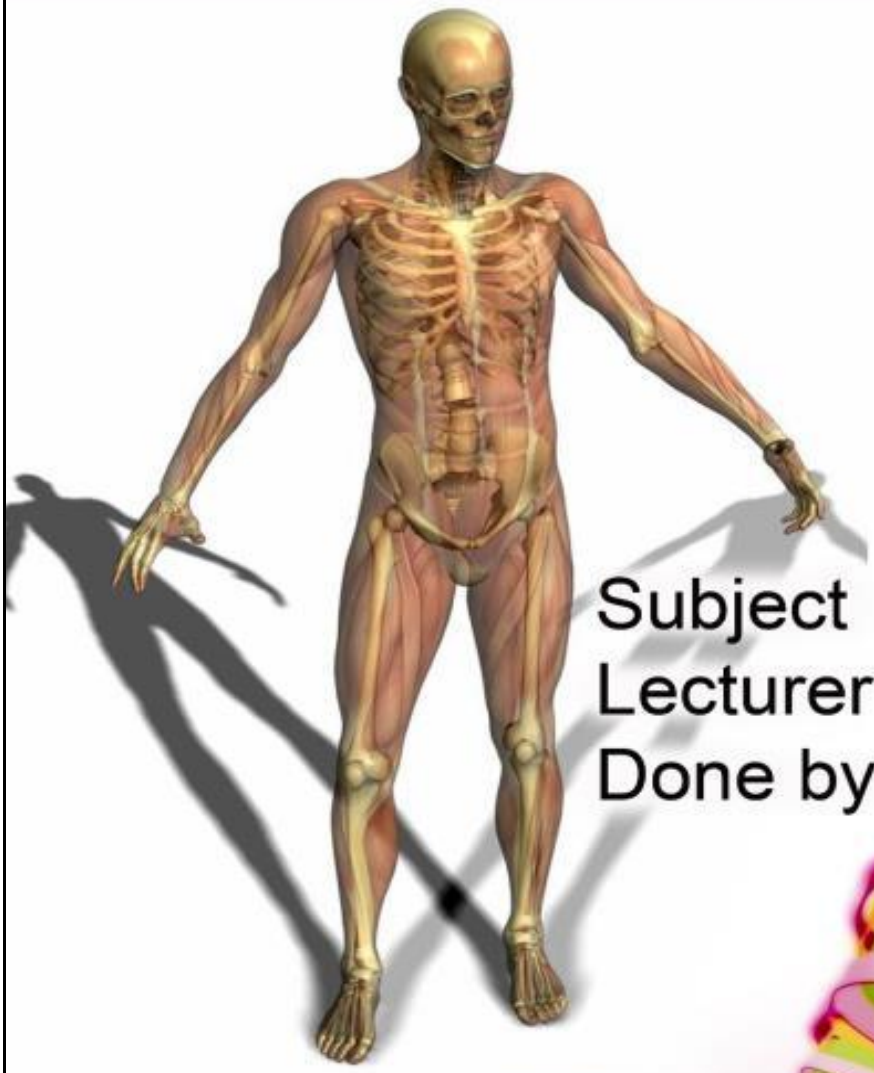
Medical Committee
The University of Jordan

ANATOMY

Sheet



Subject : *Embryology*

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Embryology – Lecture # 2

The Cell Cycle

Before moving on to what occurs in the male and female genital systems we'll talk briefly about the cell cycle.

- There are two types of cell division: Mitosis and Meiosis.

1) Mitosis:

The Cell Cycle: is a series of events within the cell that prepare the cell for dividing into two identical daughter cells. (This is here in specific in Mitosis)

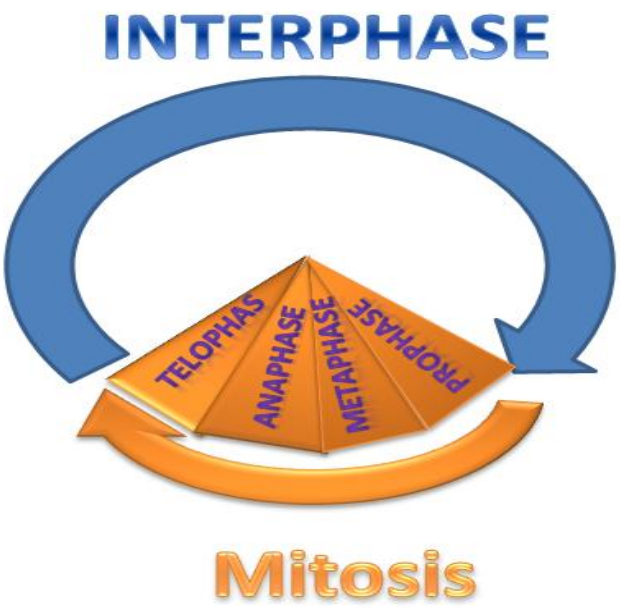
- The two major events as seen in the figure are:

1. **Mitosis.**

Which events are:

a. Prophase
b. Prometaphase
c. Metaphase
d. Anaphase
e.Telophase

2. **Interphase.**



During Mitosis, the cell divides to give **two** identical daughter cells. When cell divide mitotically, it doesn't continue directly to the next mitotic division, but instead takes a rest. This period of rest is called the **Interphase**.

Each cell in our body, specifically, Somatic cells (**cells that do not participate in the production of gametes**) contain 46 chromosomes. During the interphase, the chromosomes and the centrosomes are all doubled.

So accordingly, from mitosis to another the cell prepares itself for the next mitosis through the interphase; which is also a period of cell growth.

During the interphase:

- The cell increases its size and contents.

- It also increases its cytosolic components (Mitochondria, Golgi Apparatus, smooth and rough Endoplasmic Reticulum... etc)

- Most importantly duplication of its DNA (chromosomes and centrosomes) in preparation for mitosis.

- **Importance of the cell cycle**: Growth, renewing and wound repairing or healing.

******Wound repairing is not the same in different compartments of the body, e.g.: Healing of skin is faster than the healing of bones which is faster than healing of nerves. Also the healing of avascular tissue (**Cartilage**) takes months.

Some cells are called **reserve stem cells** those cells enters the mitotic cycle only when they are needed in high quantities, e.g**. lymphocytes**: when a foreign body enters the body they play an immune role in defending, so they enter the mitotic cycle to be increased in number. But when the body doesn't need them they stay in their **quiescent stage** (طور السكون).

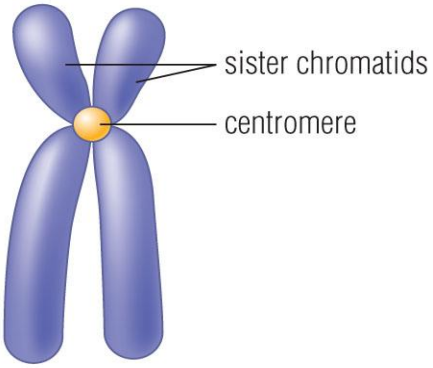
Chromosomes:

Each human somatic cell has 46 chromosomes, designed in pairs, which are called diploid cells (2n). 44 of these chromosomes are **autosomes**, the 2 left are **sex chromosomes** (XX in female, XY in male).

Cells with half number of chromosomes (23) are haploid cells (1n).

****** (1n) or (2n) are the numbers for fertilization.

A chromosome consists of two chromatids (condensed chromatin).



*Cells duplicate their DNA before entering mitosis in the interphase.

So logically, since the cell has 46 chromosomes, it has **92 chromosomes** in the **Prophase**, which equals **184 chromatids**. These 92 chromosomes are **immature** (not able to divide).

Brief review of mitosis:

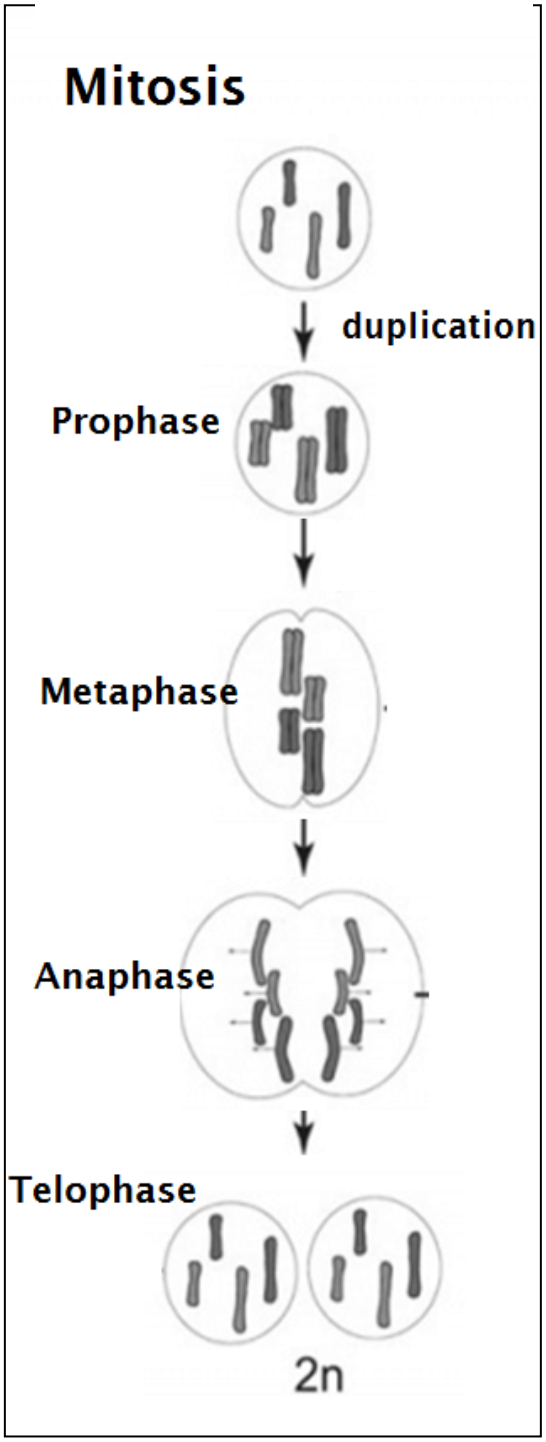
1.Prophase: Chromosomes begin to coil and condense,nucleolus disappear,centrosome starts to move to oppsite poles.

2.Prometaphase: nuclear envelope fragments,chromosome became even more condensed .

3. Metaphase: chromosomes line up at the cell equator (in the middle),centrosome at opposite poles,microtubules form centrosomes are attached to chromatids from centromere .

4. Anaphase: Centromeres and sister chromatids divide, and cleavage furrow develops.

5. Telophase: cleavage furrow deepens and Cytoplasm divides (late stage of telophase), nuclear envelope arise from fragments,nucleolus reappear.



Mitosis results in **two identical** daughter cells with **46** chromosomes (diploid).

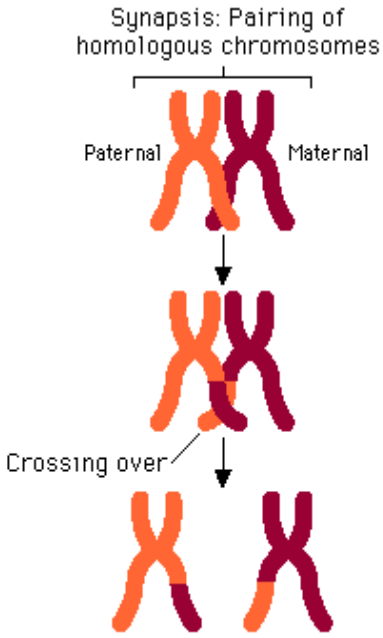
2) Meiosis:

This type of division occurs only in sex organs (ovary and testis) during the formation of gametes (sex cells: sperm and ovum), and begins after the DNA is doubled at the conclusion of the interphase.
*Gametogenesis means the formation of gametes.

▶ *Meiosis I:*

a. Prophase I

Just as in Mitosis, the chromosomes in **Prophase I** of meiosis I are **92 immature chromosomes.**



- chromosome condense and align in pairs with centromeres between sister chromatids,

-nuclear encelope fragments,nucleolus disappear.

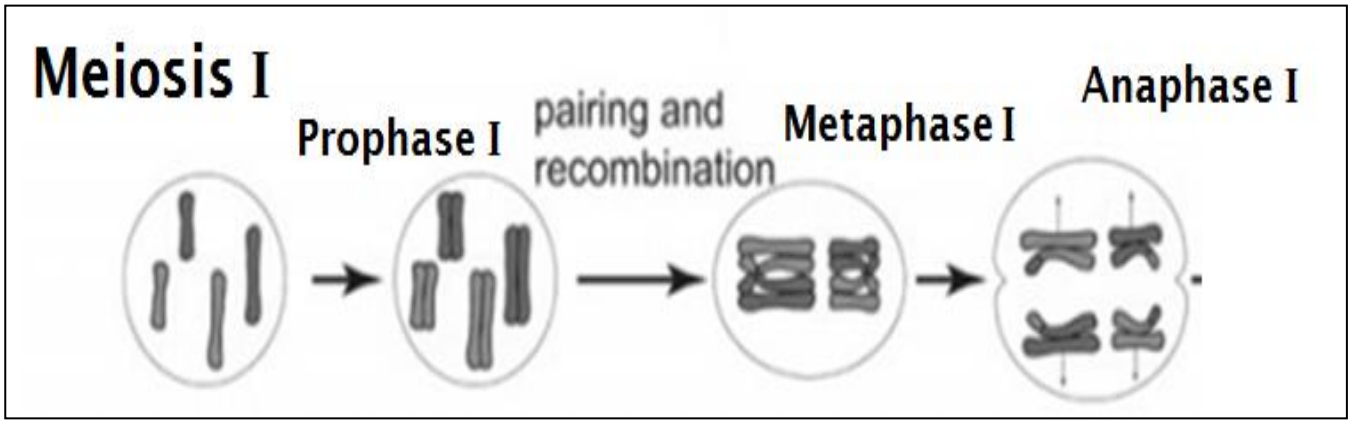
- The most important step in meiosis I is **crossing-over** between **non-sister chromatids**.

**During crossing-over genes (chromatid segments) are exchanged between maternal and paternal chromatids (see picture to the right).

b. Metaphase I: chromosomes pair and align at the equator and spindle fibres from centrosomes are attached to centromere.

c. Anaphase I: separation of the chromosomes with centrioles.

d. Telophase I: results in **two non-identical** daughter cells with **46 chromosomes (2n)**. (the daughter cells of meiosis I are shown in the figure on the next page in prophase II)



▶ ***Meiosis II*** *(Just like mitosis)*

a. Prophase II: chromosomes condense.

b. Metaphase II: chromosomes align at the equator.

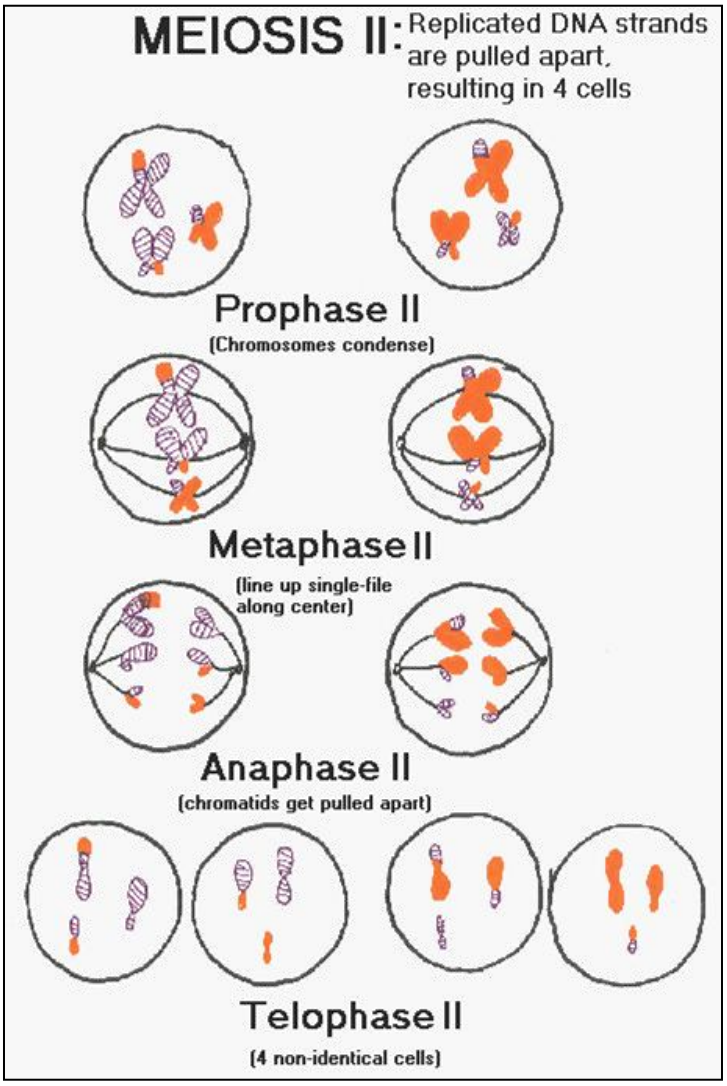
c. Anaphase II: centromere divides.

d. Telophase II: paternal and maternal chromatids connect

The resulting **<u>four non-identical</u>** daughter cells have **<u>23 chromosomes</u>** (haploid)(1n).

** The reason they are non-identical daughter cells is a result of **crossing-over** between non-sister chromatids, and because of **reshuffling.**

➔ Thus, every gamete contains its own **unique** genetic component.



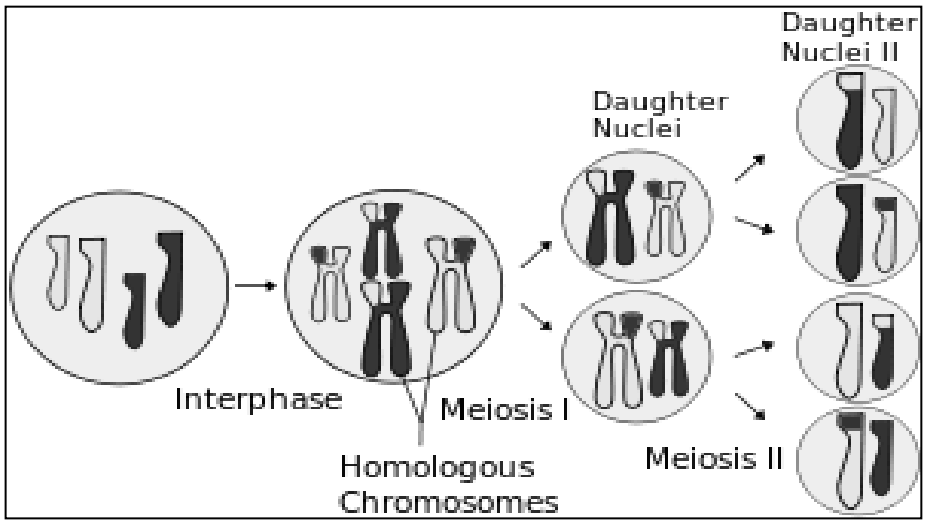
-A review for both Meiosis I and II.

(Check the slides for more details and better images).

***Remember:**

Mitosis results in **two identical** daughter cells with **46** chromosomes.

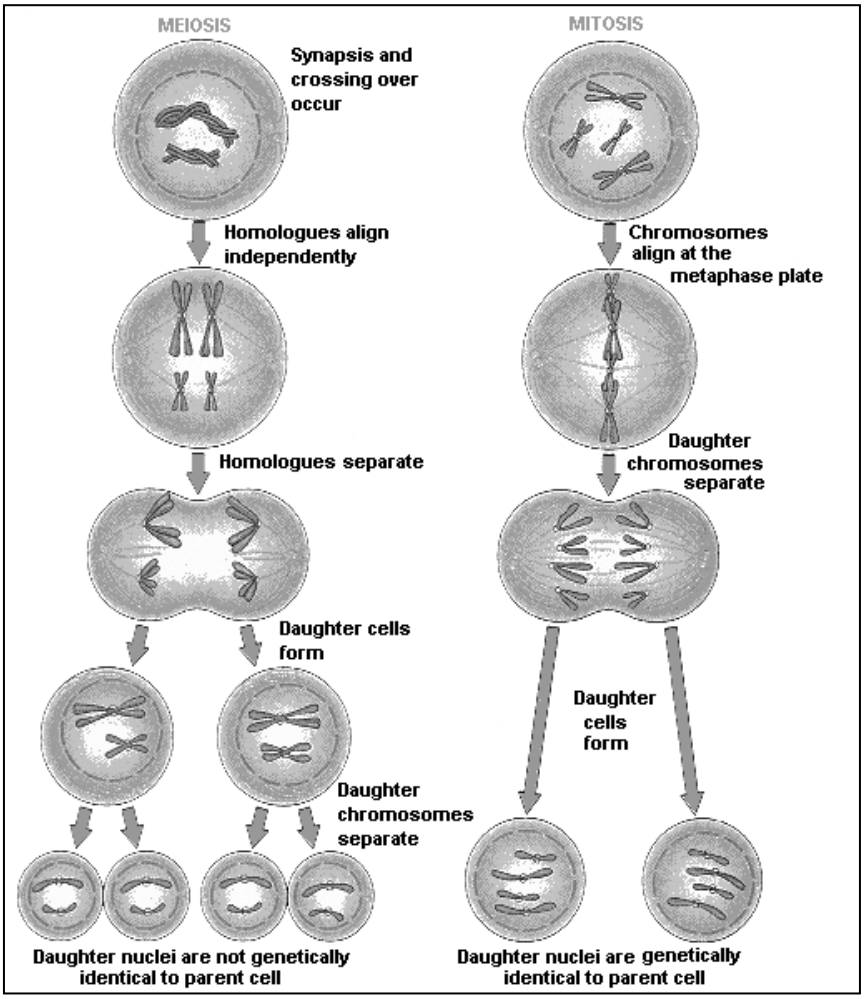
Meiosis results in **four non-identical** daughter cells with **23** chromosomes.



*the main difference between meiosis and mitosis is crossing over (may not appear in printing).

Birth Defects and abnormalities:

Some birth defects like: Cleft (hare) lip (الشفة الأرنبية), dextrocardia (القلب اليميني), Autism, congenital heart defects (ثقب في القلب)... etc. are caused by chromosomal abnormalities, either by change in their **number** or in their **structure**.



<u>Numerical abnormalities</u>:

1) An increase by one chromosome (47), which results in *Down Syndrome*, by having three chromosomes instead of 2 (**Trisomy 21**). It's the most common chromosome abnormality in humans.

2) A decrease in number of chromosomes by one (45), which results in *Turner Syndrome*, where one cell is missing a chromosome (**Monosomy**).

Best of luck ☺