



Embryology

Faculty of Medicine – JU2017

Sheet

Slides

Number

3

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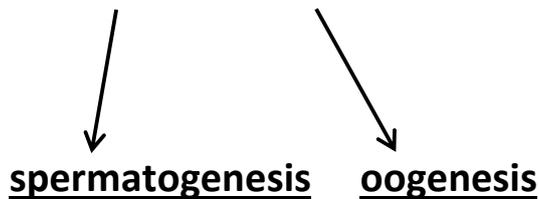
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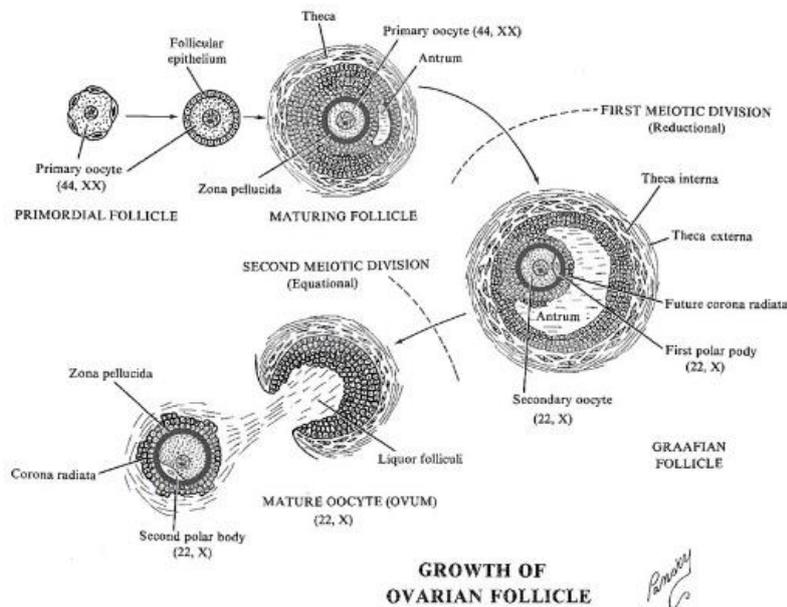
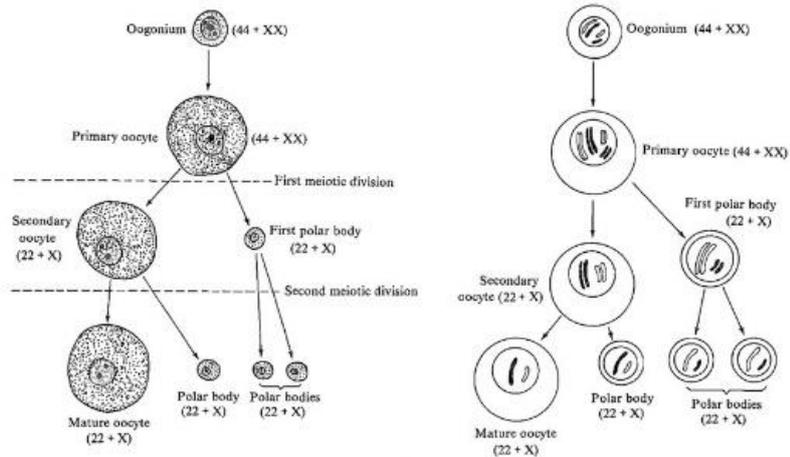
Gametogenesis: the process by which ova and sperms are formed



- Sperms and ova are **haploid (1n)** and are called gametes. When an ovum and a sperm meet they form a zygote, which is **diploid (2n)**.
- Gametes are derived from primordial (primitive) germ cells (PGC).
- Gametogenesis includes both **mitosis and meiosis**. **In mitosis there are 2 important events: duplication of DNA and centrosome division which occur in the same cell cycle. Meiosis is a reduction division and only occurs in sex organs (ovaries and testes). Unlike in mitosis, DNA duplication takes place in meiosis I, while centrosome division happens in meiosis II (two different cell cycles).**
- In mitosis, the product is 2 genetically identical cells. In meiosis we get 4 genetically non-identical cells as a result of chiasmata (crossing over).
- Ova are formed in the ovary from cells called oogonia which divide by mitosis. At **week 5 of pregnancy**, production of oogonia (baby ova) begins in females. These oogonia may take years and decades to be released for fertilization.

Oogenesis is a long process and it takes a long time for the ovum to be fertilized, however in males, spermatogenesis takes about **64 days**. Since ova are stored for years, the risk of them getting mutated is high, especially if the female is exposed to radiation/carcinogens; therefore, **the mother is responsible for chromosomal abnormalities** (mutations) in the newborn (Down's syndrome, trisomy, monosomy...etc), while **the gender is the responsibility of the father**

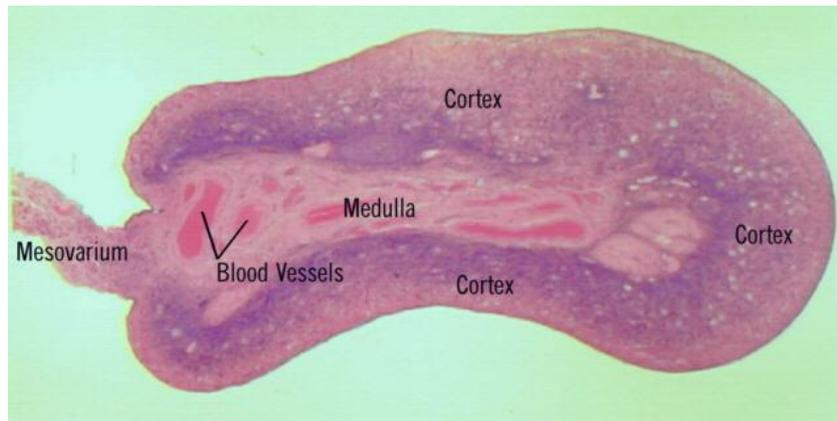
GAMETOGENESIS: OOGENESIS



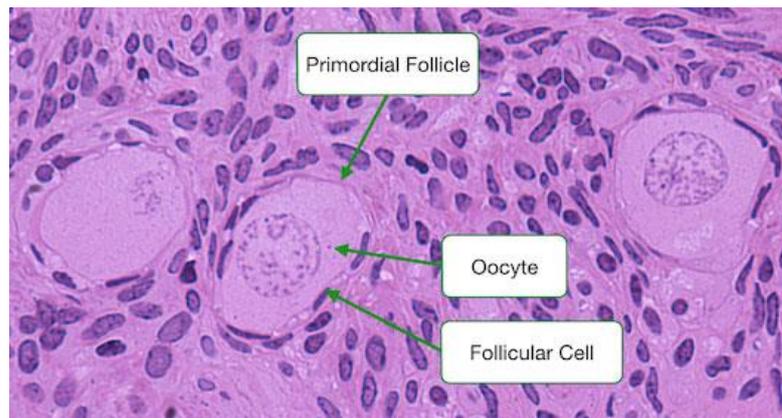
OOGENESIS

It's the sequence of events in which oogonia transform into mature ova. This maturation begins during the fetal period but isn't completed until after puberty. The ovary contains 2 layers: **cortex** (outer layer) and **medulla** (inner layer). The cortex contains oogonia/oocytes/ova at different stages of maturation. The maturation of an ovum takes place in the cortex, where it lies dormant until it's **released at day 14** of the menstrual cycle (**this ovum can stay dormant for years**). The cortex also secretes the hormones oestrogen and progesterone.

Oogenesis is a repetitive monthly ovarian cycle during the female reproductive period.



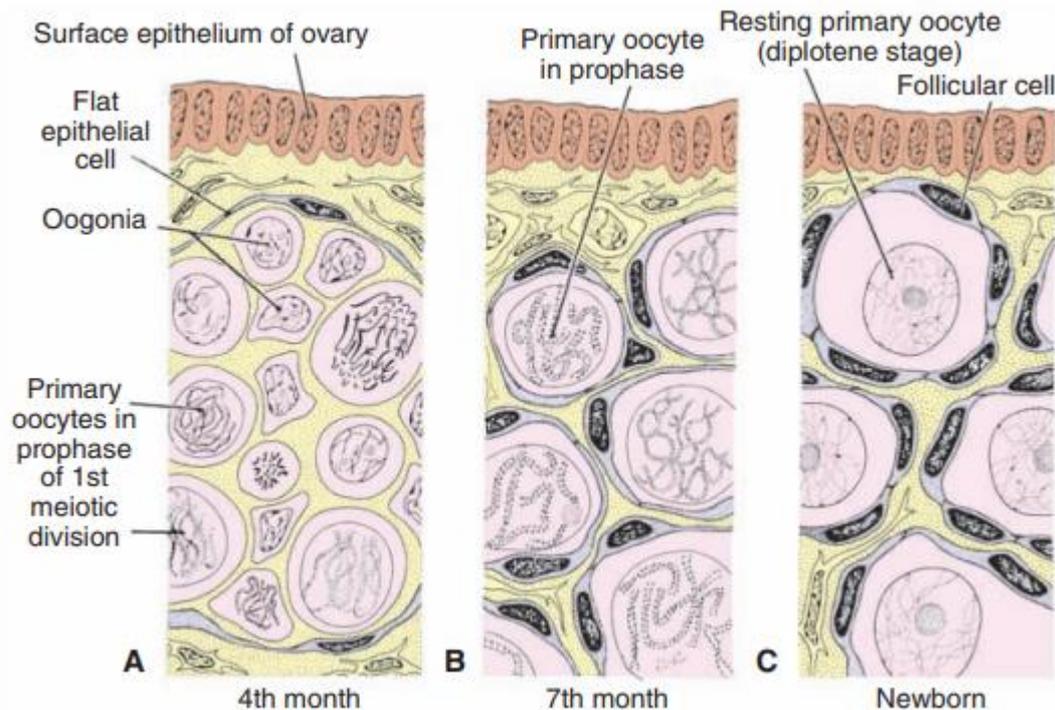
At week 5, primordial germ cells (PGC) migrate to the developing ovaries and differentiate into **oogonia** (baby ova), where they are arranged in clusters surrounded by a layer of flat follicular (epithelial) cells. By the end of the 3rd month, all oogonia have become surrounded by the follicular cells. Afterwards, they proliferate (divide) by mitosis. They begin the first meiotic division before birth but are arrested at the prophase of meiosis I (and enlarge into **primary oocytes**) until after puberty (before ovulation).



***Clinical Case:** Pregnant women should **NOT** be around X-rays during pregnancy, **ESPECIALLY** when she is in her **5th month** of pregnancy.

By the end of the 5th month, the number of germ cells (oogonia + primary oocytes) reaches the peak (7 million). Right afterwards, the germ cells begin to degenerate (cell death) and become **atretic**.

By the 7th month, the majority of oogonia have degenerated (become atretic) except for a few near the surface. The surviving primary oocytes have all entered the prophase of meiosis I and are arrested.



The primary oocytes along with the surrounding layer of flat follicular cells are called **primordial follicles**.

At birth, all primary oocytes have entered prophase I, but are arrested once more before they enter metaphase I in a stage called the **diplotene stage**. They will stay in this stage until puberty. This long stage usually lasts in females till the age of **13-15** (puberty).

Ovaries of a newborn girl contain about **2 million primary oocytes** (from the original 7 million at month 7). Most of them degenerate during childhood, until **they reach 40,000 at the age of puberty**. Out of these 40,000 **ONLY 400** will have the chance to be ovulated! We divide these 400 by the months to get the female productive period (approximately **33** years, but ranges from one woman to another).

In each ovarian cycle, **20 primary oocytes** (some books say 15) “race” to mature, but **only 1** out of these 15-20 primary oocytes will reach maturity.

Just before ovulation, the primary oocyte completes meiosis I to give a **secondary oocyte**.

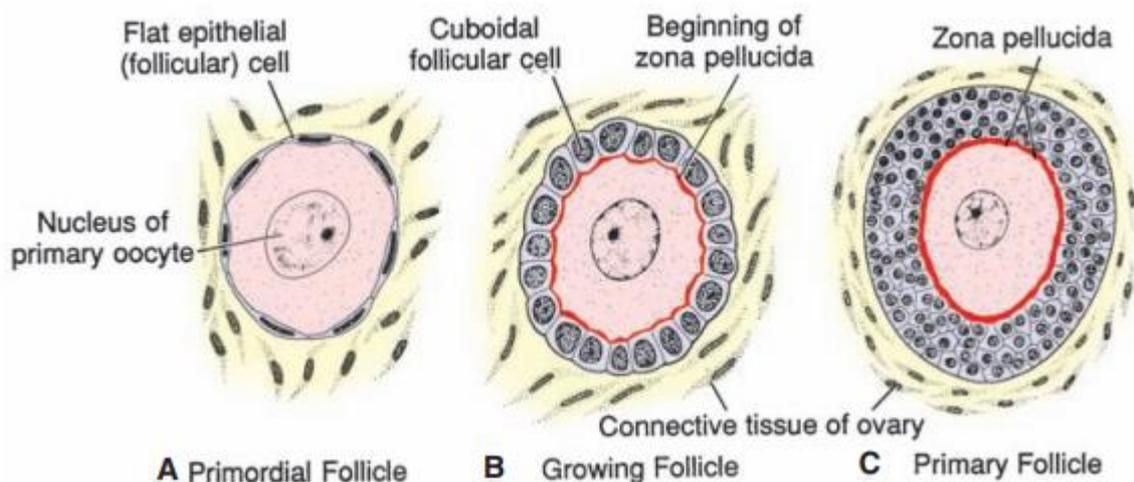
Note: a female’s menstrual cycle (period) is 3 stages:

1. Bleeding stage
2. Proliferation stage
3. Secretory stage

The secondary oocyte has 46 chromosomes (normal); it enters meiosis II but it will be arrested at metaphase II just before ovulation. In this case, **meiosis II will only be completed at fertilization**. At day 14 of the female period the secondary oocyte is ovulated under influence of **luteinizing hormone (LH)**. The ovulated secondary oocyte will enter the uterine tube to be fertilized **but stays there for only 24 hours**. The period occurs because there is **NO fertilization** (so if no bleeding occurs, then there is fertilization and the female is pregnant).

Note: Oocytes are viable for only **24** hours, while sperms are for **48** hours.

When the primordial follicles were growing at the start of the **7th month**, the layer of surrounding follicular cells starts to modify into **cuboidal cells**. These cuboidal cells proliferate by mitosis to form **granulosa cells** (stratified epithelium; many layers with prominent nuclei). The primary oocyte along with the layer of granulosa cells form the **primary follicle**. The granulosa cells secrete a layer of glycoproteins at the surface of the oocyte, called the **zona pellucida** (see-through). In the first part of the menstrual cycle, the hormone oestrogen is secreted by granulosa cells.



Good reference: <https://discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-4-gametogenesis-oogenesis>

Best of Luck 😊