Previtellogenesis and vitellogenesis

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Previtellogenesis growth period:

During this phase, no synthesis and accumulation of food reserve material, the yolk, takes place, but tremendous increase in the volume of nucleus and cytoplasm of primary oocyte occurs. There is qualitative and quantitative increase in the amount of cytoplasm. The mitochondria increase in number, the network of endoplasmic reticulum with ribosomes becomes more complicated, the Golgi bodies manufacture cortical granules, besides performing their normal function.

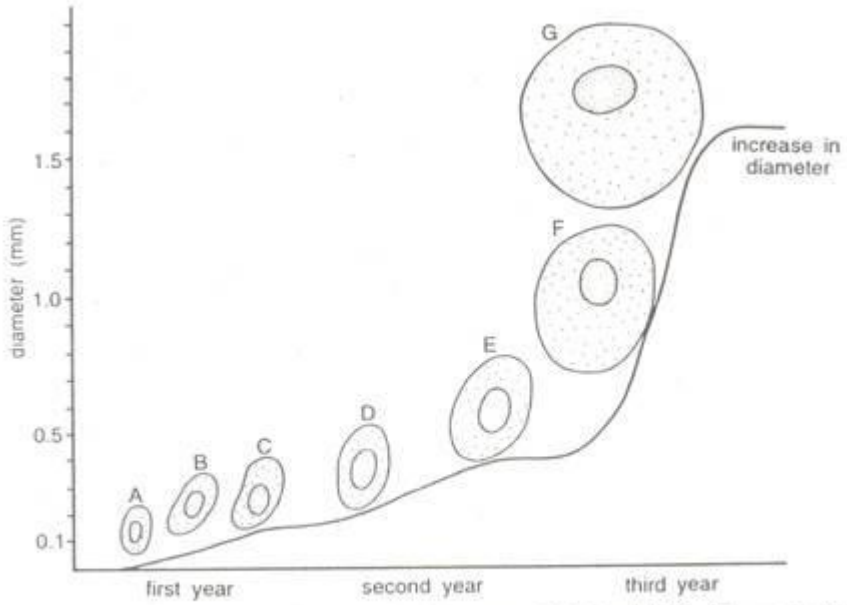

Fig. 13. Growth of frog oocytes during the first three years of the female's life. The curves show the increase in diameter of three generations of oocytes; the drawings represent the changes in size and structure of oocytes of the first generation.

(i) Growth of nuclear substances:

During this phase due to the production of the large amount of nuclear sap, the nucleus of the growing oocyte increase in size. A dark body appears at one place outside the nucleus, usually near the

Golgi complex and is known as yolk nucleus of Balbiani. This large sized oocyte inflated with the fluid is now called germinal vesicle.

The nucleus of the occyte enters the prophase of meiotic division. Synapsis occurs between homologous chromosomes but the subsequent stages of meiosis are postponed and each chromosomes increases in its length, but the amount of DNA in each choromosomes does not increase in proportion to the enlargement of the nucleus. The increased chromosomes look like bottle brush; hence they are called the lamp-brush chromosomes.

It is believed that the loop of chromosomes represent actual site for the main activity of the genes, i.e. transcription of mRNA, which in turn controls translation process in which synthesis of proteins in the cell cytoplasm takes place.

During the growth period of oocyte, all mRNA molecules are not utilized during translation but some are inactivated by the wrapping of proteins around them and stored as informosomes to be used during early cleavage of egg, when chromosomal DNA remains more actively engaged in its own transcription of mRNA (messenger RNA) r- RNA (ribosomal RNA) or t-RNA (transfer RNA).

The RNAs are transcribed by r-DNA of 'nucleolar organizer region' of chromosomes. The nucleolus has a significant role in the storage and maturation of the ribosomal RNAs. It also synthesizes all the proteins required for the biogenesis of ribosomes.

Therefore, during growth period of primary oocytes, the nucleolus increases greatly in size and becomes very conspicuous. In many animals, particularly in amphibians, instead of one large nucleolus, numerous small sized nucleoli are formed in their germinal vesicles. Most of them are localized on the periphery of the nucleus, immediately underneath the nuclear membrane.

The increased transcriptional activity (i.e. RNA synthesis) of chromosomal genes during growth period of oocytes, is called gene amplification (Ephel, 1973) or redundancy (De Robertis et al, 1982). When MRNA molecules are transcribed from DNA then it is known

as transcriptional amplification. Each MRNA molecule in turn can be translocated several times into the corresponding proteins known as translational amplification.

This high rate of gene amplification or gene activity is correlated with the fact that gene reduction (meiosis) does not take place until after the growth of the oocytes has been completed. As a result the oocytes remain tetraploid for a long time.

(ii) Growth of cytoplasmic substances:
The amount of cytoplasm of oocyte increases both quantitatively and qualitatively during the Previtellogenesis growth period of oocyte. Young oocytes, in many animals, show a very simple organisation due to poor cytoplasmic inclusions and possess none of the specialized structures found in the adult oocyte and mature egg. The cytoplasm is finely granular having granules of ribonucleo-protein and DNA.

Mitochondria, the carriers of oxidative enzymes are fairly scarce in young oocytes but may increase in number very considerably during the growth of primary oocyte because overall oxygen consumption increases during this time. In amphibians and birds, the mitochondria become aggregated in the form of large 'Mitrochondrial clouds". Mitrochondria possess its own circular DNA. So in a growing oocyte, the amount of mitrochondrial DNA far exceeds the amount of nuclear DNA.

The young oocytes have the granular endoplasmic reticulum in the form of numerous, small vesicles. Annulated lamellae are also found in the cytoplasm of growing oocyte. These membranous structures appear in the form of stakes of cisternae, either in parallel or in spiral arrangement.

Sometimes, annulated lamellae are associated with ribosomes and RNA in high concentrations, and there is also an ATPase activity in the pore complexes of these lamellae. The lamella, thus serves as a storage site of RNA in cytoplasm and they are found to break down and disappear during late oogenesis.

In young oocyte the Golgi bodies are found around the Centrosome. In mature oocytes they form a large spherical mass in some mammals, or become located in the sub-cortical cytoplasm of frog and chick, or sometimes may disappear completely. The Golgi complex of oocyte is believed to synthesize cortical granules besides performing its normal function.

In the cortical region, cortical granules are present. These are membrane bound spherical bodies of diameter from 0.8 microns (sea urchin) to 2.0 microns (frog) and contain acid mucopolysaccharides. These mucopolysaccharides are used during fertilization, in the formation of fertilization membrane.

They are present in bivalve molluscs, some annelids, fishes, frogs and some mammals (rabbit and man), but are absent in some insects, gastropods urodeles, birds and some mammals (rat and guinea pig). These granules are synthesized' by cisternae of Golgi complex in the interior of the oocyte and later they move to the periphery where they are arranged in a layer close to the plasma membrane of oocyte.