Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Zoology

Paper Code: ZOC 108

Paper Title: Developmental Biology

Unit: I - Introduction

Module Name: Oogenesis

Name of the Presenter: Dr. Suphala Pujari

Notes:

OOGENESIS

The process of oogenesis is somewhat more complicated and different than spermatogenesis. Besides, the production of four unequal sized haploid cells, there is acquisition of food reserves in the egg cytoplasm for the development of embryo. Further, before the occurrence of meiosis, enormous amount of growth and differentiation of egg-cytoplasm takes place. The oogenesis is more or less similar in all vertebrate groups. During oogenesis, the cells of germinal epithelium detach from the surface epithelium and enter the cortex of the ovary. These germinal cells are diploid and are called primordial germ cells.

They pass through the three stages to form a fully formed egg which are:

(1) Phase of multiplication: The primordial germ cells become the oogonia—the egg mother cell. The oogonial cells eventually undergo proliferation by repeated mitotic divisions, giving rise to the eggs and become primary oocytes when cell division ceases. Now they enter into a period of growth.

(2) Phase of growth: Owing to the fact that the egg contributes the greater part of the substance used in the development, growth plays a much greater role in oogenesis than in spermatogenesis. The period of growth in the female gametes is very prolonged and tremendous growth of oocyte occurs during this phase.

Most of the primordial germ cells are approx., 10 µm (0.01 mm) in diameter. The young oocyte of amphibians may be about 50 µm (0.05 mm) and the mature amphibian egg is rather

large about 1000 to 2000 µm (1.0 to 2.0 mm) in diameter. In birds the diameter of ovum is as large as 40,000 µm and in mammals it is only 200 µm.

The rate of growth of oocytes also varies; it may be slow or fast. The young oocyte starts growing after the tadpole metamorphoses into the young frog and by the third year the eggs mature and the frog spawn for the first time. In other animals, the growth of oocyte may proceed at a much higher rate and takes shorter time for completion. In hen, the last rapid growth of oocyte occurs in 10 to 14 days preceding ovulation, and during this time the volume of the oocyte increases 200 fold.

The progressive growth increase in nuclear as well as cytoplasmic substances of oocytes may be divided into two stages—(a) previtellogenesis growth period and (b) vitellogenesis growth period.

(3) Phase of maturation: during the growth phase of oogenesis, the nucleus of primary oocyte remains in a prolonged meiotic prophase. During this period various genetical events such as synapsis, duplication, chiasma formation and crossing-over take place between the homologous chromosomes. After the oocyte completes its growth and differentiation, the oocyte nucleus resumes, meiosis. The chromosomes of the oocyte reach the diakinesis stage.

Due to some type of stimulation, the nuclear membrane breaks down, the chromosomes which have become greatly contracted and concentrated toward the centre of germinal vesicle, are carried to the periphery of animal pole of the oocyte. A bulge now appears at the surface of oocyte. The outer centriole of the spindle with half of the chromosomes enters into this cytoplasmic bulge during the anaphase of first meiosis. Due to this equal nuclear division but with unequal cytoplasmic division two unequal sized cells have formed. The small cell is the haploid polar body or polocyte and the large sized cell is the secondary oocyte or the ootid. The secondary oocyte is of the same size as that of primary oocyte.

The secondary oocyte undergoes equal nuclear division by meiosis II in the same way as that of meiosis I, so that a haploid secondary polocyte and a haploid large sized fully mature ovum as functional female gamete is formed. The first polocyte may also divide by meiosis II and two secondary polocytes are formed. Thus, out of four meiotic products, only the ovum remains functional while the three polocytes later die off because they have very little

cytoplasm, with no food reserve. This second meiotic division takes place after the secondary oocyte is discharged from the ovary, and sometimes only after the sperm has fused with the egg cell.

The egg thus formed will contain most of the cytoplasm and reserve food material which may be quite sufficient for the developing embryo.