Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (First Year)

Subject: Zoology

Paper Code: ZOC 108

Paper Title: Developmental Biology

Unit: Introduction

Module Name: Parthenogenesis

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NOTES:

Parthenogenesis is a form of asexual reproduction found in certain animal groups, where growth and development of embryos occurs without fertilization by a male. It occurs naturally in Aphids, Daphnia, Rotifers, Nematodes and some other invertebrates but can also be induced efficiently in mammalian oocytes by providing appropriate stimuli in-vitro.

An organism that has developed parthenogenetically is called a parthenogenone or parthenote.

- **Partial Parthenogenesis:** the egg maybe fertilized by only a part of sperm.
- **Gynogenesis:** the sperm penetrates the egg but takes no part in development.
- **Androgenesis:** the egg is activated by the sperm and development takes place without the participation of the egg nucleus.
- **Merogony:** egg fragments devoid of nucleus develop when fertilized by a normal sperm.

Two types of Parthenogenesis:

Natural Parthenogenesis: occurs naturally in certain organisms
Artificial Parthenogenesis: can be induced in organisms which reproduce sexually.

Natural Parthenogenesis is of two types: Complete Parthenogenesis and Incomplete Parthenogenesis.

Complete Parthenogenesis

Certain insects have no sexual phase and no males and are exclusively depended on the parthenogenesis. It is also called as Obligatory parthenogenesis.

Incomplete Parthenogenesis

Certain insects have two generations that alternate between the sexual and asexual. Diploid eggs produce females and unfertilized eggs produce males. It is also called as Cyclic parthenogenesis.

The complete/incomplete form of natural parthenogenesis may be of following three types

i) Haploid or Arrhenotokous Parthenogenesis;
ii) Diploid or Thelytokous Parthenogenesis
iii) Amphitokous Parthenogenesis

Haploid or Arrhenotokous Parthenogenesis

In certain invertebrates (Hymenoptera, Coleoptera, Thysanoptera, Rotifera and Arachinida) the male arises from the unfertilized haploid egg, while females from fertilized eggs hence are diploid.

Diploid or Thelytokous Parthenogenesis

The young individuals develop from the un-fertilized diploid eggs. Only parthenogenetic females are produced. It is of two types: Ameiotic Parthenogenesis and Meiotic Parthenogenesis

Ameiotic Parthenogenesis (Apomictic Parthenogenesis)

During the oogenesis if the first meiotic division does not occur but second meiotic division occurs as usual, the eggs will contain diploid number of chromosomes and develop into new individuals without the fertilization. Occurs in *Trichoniscus* (Isopoda), *Daphnia pulex* (Crustacea), *Campelona rufum* (Mollusca), weevils and long-horned grasshoppers.

Meiotic Parthenogenesis

Certain eggs during the process of oogenesis undergo diplosis which results in the production of diploid eggs. Such eggs develop into diploid individuals.

The diplosis of the diploid thelytoky may occur by the following means:

- By Autofertilization
- By Restitution

Autofertilization

The oocyte divides meiotically up to the formation of ovum and secondary polocyte. But the ovum and the secondary polocyte fuse to form a diploid egg which develops into a new individual.

Example: *Artemia*

Restitution

In the primary oocyte, sometimes, karyokinesis forms a nucleus of the secondary oocyte and nucleus of the first polocyte; this process is not followed by cytokinesis.

The chromosomes of both daughter nuclei align at the equator and undergo second meiotic division to form a diploid ovum and a diploid polocyte. The diploid ovum develops into a parthenogenetic diploid individual.

Example: Insects of order Hymenoptera and Lepidoptera.

Amphitokous Parthenogenesis

In this type of Parthenogenesis, individuals of either sex may be produced.

Artificial Parthenogenesis

Eggs which undergo fertilization may sometimes develop parthenogenetically under certain artificial conditions. This type of parthenogenesis is called Artificial Parthenogenesis. It may be induced by various physical and chemical means.

Physical means

Treatment with physical agents such as heat or cold shocks, Electrical shocks, Ultraviolet light. Also when the eggs are pricked by the fine glass needles the development of young ones takes place parthenogenetically.

Chemical means

The following chemicals have been found to cause parthenogenesis in the normal eggs:

Alkalis; Hypertonic and Hypotonic sea waters; Chloride salts of K^+, Ca^{++}, Na^+, etc. Weak Acids such as butyric acid, lactic acid, oleic acid and other fatty acids; Fat solvents, (toluene, alcohol, benzene and acetone) and other chemicals.

Significance/Advantage

- Parthenogenesis serves as the means of reproduction and for the determination of sex in the honey bees, wasps, etc.
- It represents a scheme of high multiplication.
- It allows the formation of triploid (3n) and aneuploid races having three or more sets of chromosomes.
- It eliminates the need for mating hence energy can be invested in feeding and reproduction.

Disadvantage

Parthenogenesis eliminates variation in a population.

The offsprings developing parthenogenetically are more alike to and mostly the phenocopies of the parents, whereas, sexually developed offspring exhibits marked differences from the parents.