Unit 4: Gymnosperm

Double fertilization in Gymnosperm

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Double fertilization in Gymnosperms

It is well-known that in angiosperms the development of the ovule into a seed enclosing a diploid embryo and usually a triploid endosperm is based on the two fertilization events described in the previous paragraphs.

Robert Brown (1827) who coined the term Gymnosperms never would have thought about incidence of double fertilization in Gymnosperm.

Although gymnosperms share with angiosperms the seed habit, only sporadic reports of the occurrence of double fertilization in gymnosperms have surfaced until the end of the last century.

A far more rudimentary form of double fertilization occurs in the sexual reproduction of an order of gymnosperms commonly known as Gnetales.

Specifically, this event has been documented in both Ephedra and Gnetum, a subset of Gnetophytes.

In Ephedra nevadensis, a single binucleate sperm cell is deposited into the egg cell. Following the initial fertilization event, the second sperm nucleus is
diverted to fertilize an additional egg nucleus found in the egg cytoplasm.

In most other seed plants, this second 'ventral canal nucleus' is normally found to be functionally useless.

In Gnetum gnemon, numerous free egg nuclei exist in female cytoplasm inside the female gametophyte.

Refer to the research paper figure of cell cycle and reproduction in gnetum gnemon provided to you on your Whatsapp/e-mail group
Succeeding the penetration of the mature female gametophyte by the pollen tube, female cytoplasm and free nuclei move to surround the pollen tube.

Released from the binucleate sperm cell are two sperm nuclei which then join with free egg nuclei to produce two viable zygotes, a homologous characteristic between families Ephedra and Gnetum.

In both families, the second fertilization event produces an additional diploid embryo.

This supernumerary embryo is later aborted, leading to the synthesis of only one mature embryo.

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The additional fertilization product in Ephedra does not nourish the primary embryo, as the female gametophyte is responsible for nutrient provision.

The more primitive process of double fertilization in gymnosperms results in two diploid nuclei enclosed in the same egg cell. This differs from the angiosperm condition, which results in the separation of the egg cell and endosperm.

Refer to the research paper figure of cell cycle and reproduction in Ephedra provided to you on your Whatsapp/e-mail group.
Comparative molecular research on the genome of G. gnemon has revealed that gnetophytes are more closely related to conifers than they are to angiosperms.

The rejection of the anthophyte hypothesis, which identifies gnetales and angiosperms as sister taxa, leads to speculation that the process of double fertilization is a product of convergent evolution and arose independently among gnetophytes and angiosperms.

Refer to the research paper figure of cell cycle and reproduction in Ephedra provided to you on your Whatsapp/e-mail group.
Refer to the research paper figure of double fertilization in Ephedra trifurca provided to you on your Whatsapp/e-mail group

Schematic of the process of double fertilization in *Ephedra trifurca*. Both sperm nuclei and the egg nucleus and ventral canal nucleus begin with the 1C complement of DNA (A) Following the entry of two sperm nuclei into the egg cell, the first sperm nucleus migrates to the egg nucleus (B) and initiates contact (C). The second sperm nucleus lags behind the first sperm nucleus and converges with the ventral canal nucleus, which dislodges from its initially apical position within the egg cell. Both pairs of male and female nuclei appear to maintain their individual zones of nucleoplasm, after contact has been made, and a chalazal pattern of migration takes place. All four gamete nuclei pass through the synthesis phase of the cell cycle (B-F). This results in the production of two pairs of nuclei, each nucleus with the 2C quantity of DNA. Each pair fuses (G) to produce two nuclei with the 4C