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PLANT EMBRYOLOGY — INTRODUCTION

Modern plant embryology is a dynamically developing discipline which encompasses different levels of biological organisation, from tissues, through cells, to molecular. The last decade, due to the rapid advances in development of molecular and genetic techniques, brought particularly rapid advances in experiments conducted on plants germ line cells. Polish embryologists have actively participated in this research, continuing the outstanding work of prominent scientists, such as Professors Zygmunt Wóycicki, Anna Wałek-Czarnecka, Henryk Teleżyński and Bohdan Rodkiewicz. It is unfortunate that not all the Polish researchers with accomplishments in plant embryology chose to contribute to this issue of Kosmos. Nevertheless, we hope that the articles presented here will allow the reader to become acquainted with the research carried out at the leading Polish scientific laboratories working in this field.

All the phenomena connected with the generative reproduction of angiosperms occur in the flower. Thus, the induction of a flower, in which the female (pistils) and male (anthers) reproductive organs are differentiated, can be seen as the first stage leading to the formation of a new generation of the plant. It has long been known that such phenomena as photoperiodism, vernalization and the action of phytohormones are involved in induction of flowering. However, understanding of the molecular mechanisms that control flowering became possible only upon the discovery of the paths of cellular signalling in plants, and, especially, after decoding of the genome of such model plants as *Arabidopsis* (2000) or rice (2002). This allowed the identification of numerous genes involved in the induction of flowering and, further, of the metabolic paths leading to transformation of the vegetative meristem into a flower bud. In the article "Genetic control of the flowering of angiosperm plants", A. TRETYN and J. KOPCEWICZ present the current state of research, both world-wide and their own, on induction of flowering in angiosperms.

Two important processes take place in the developing flower. In the anther, the so-called sporogenous tissue undergoes meiosis, referred to as microsporogenesis, which initiates a cycle of events leading to the formation of pollen grains, male gametophyte. On the other hand, in the pistil, within the ovule, megaspores produced during megasporegenesis develop into the female gametophyte, the embryo sac. The production of live pollen grains is not possible without normal interaction between generative cells line and somatic tissues of the anther, mainly the tapetum. The basic function of this tissue is to nourish the generative cells during microsporogenesis and produce pollen grains. In a normally-developing anther, the fate of the tapetum is always the same; the tissue undergoes total degradation. Recent research of Maria Charzyńska's team from the University of Warsaw has provided proof that the death of the tapetum is programmed in the ontogenesis of the anther. Thus, the tapetum is one of the few known examples of plant tissue the cells of which undergo programmed death. The molecular aspect of this process is of interest not only to the plant embryologist since it concerns cellular phenomena that occur both in animals and plants. The reader can learn more about programmed plant cell death based on the example of anther tapetum from the article by J. LEŚNIEWSKA "Anther tapetum in aspect of programmed cell death".

Disturbances in the normal interaction between generative cells line and the tapetum often cause male sterility, which manifests itself in a lack of live pollen in flowers that produce fertile embryo sacs. Male sterile lines are particularly valuable in breeding work because the lack of functional pollen eliminates the necessity of anthers castration for hybrid seeds production. For this reason, not only is male sterility widely studied but also, thanks to the application of genetic engineering methods, new varieties of male sterile cultivated plants are continuously being created. In the article "Cytoplasmatic male sterility of plants — biological and molecular mechanisms", A. MAJEWSKA-SAWKA and Z. SADOCH write about genetic and molecular conditions leading to male sterility, with particular emphasis on to the mitochondrial genome, and discuss genetic engineering methods used in creation of male sterile plants.

Mature pollen grains are released and frequently land on stigma at random. Consequently, pollen from an alien species or from the same flower (self) can be found on stigma. However, in nature free cross-breeding between species or self-breeding as a result of self-pollination do not occur. The reader can learn how hermaphrodite plants, by nature unable to choose a breeding partner, protect themselves from germination of self-incompatible pollen grains in the pistil, from the article by E. BEDNARSKA and M. LENARTOWSKA "Self-incompatibility in flowering plants". Studying the genetic and molecular mechanisms of recognition between reproductive partners, i.e., the pollen grain and the pistil, is also of great value in general biology. The interaction between pollen and the pistil is a convenient, frequently used model to research the processes of reception and transduction of intercellular signals in plants.

The ultimate aim of a pollen tube germinating in a pistil is to find the micropyle of the ovule and to grow into the embryo sac. There, within the synergid, sperm cells are released, immediately preceding the act of fertilization. What is the mechanisms directing the pollen tube into the micropyle of the ovule, which represents only a small part of its surface area? Recent research, also conducted in Poland at the Maria Curie-Skłodowska University by Renata Śnieżko's team, has provided convincing proof that the ovule is not a passive partner in reproduction. As the pistil matures, and also after its pollination, both the somatic tissues surrounding the micropyle of the ovule and the embryo sac itself become the source of compounds that act as attractors for the growing pollen tubes. Thanks to this, the pollen tube can find the micropyle and direct its growth tip there. There are also indications that the pollen tube and the embryo sac can differentiate their genotypes, i.e. the pollen tube "chooses" its partner for fertilization. Only receptive, fertile ovules have the ability to attract pollen tubes. Unreceptive ovules, which lack an embryo sac, or are either too young or too old, do not attract tubes. The reader can learn how the ovules signal their receptivity to the pollen tubes in R. ŚNIEŻKO and B. CHUDZIK'S article "The ovule as the active partner in the reproductive process of flowering plants".

The sperm cells released into the synergid finally reach the space between the target cells, i.e., between the egg cell and the central cell. *In vivo*, the act of double fertilization takes place surrounded by the many layers of somatic cells of the ovule. This creates enormous technical problems in investigating this process, not only at the cytological level, but especially at the molecular one. Studies begun in the 1980s on the isolation of flowering plant gametes created hitherto unknown possibilities for studying fertilization *in vitro*. The isolation of gametes, and the capability of fusing them *in vitro* not only allow the process of fertilization to be observed, but also makes it possible to conduct research at the molecular level, and to manipulate reproductive cells and the products of their fusion. The use of *in vitro* fertilization techniques contributed to the discovery of the earliest phenomena accompanying the fusion of gametes and the processes leading to the activation of the zygote in angiosperms. The article by R. MÓL "*In vitro* fertilization (IVF) in flowering plants" discusses these matters.

The configurations of the cytosceleton in the course of the cell cycle of generative line cells and of subsequent processes during sexual plant reproduction (fertilization, endosperm development) are the subject of „The role of cytosceleton in sexual reproduction of plants" by J. BEDNARA.

Male generative cells of angiosperms, like animal oocytes, are a very convenient model for research on splicing of pre-mRNA. It is known that in all Eucaryota, both plants and animals, the original transcript contains coding sequences and non-coding ones, the later being removed before transport of the mRNA to the cytoplasm. The state of knowledge of this process in animal and plant generative line cells is compared by D. J. SMOLIŃSKI *et al.* in "Organisation of the splicing system in generative cells line".