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CONTENTS

DEVELOPMENTAL BIOLOGY

Question Bank – (Previous Year Solved Question Papers)

S.No.	*Chapterwise Reference Book*	*Page*

PLANT DEVELOPMENT-I

PLANT DEVELOPMENT-II

■ ■

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QUESTION PAPER

(June – 2019)

(Solved)

DEVELOPMENTAL BIOLOGY

Time: 2 Hours] *[Maximum Marks: 50*

Note: *Answer **Part I** and **Part II** in separate answer copies. Answer the questions as per instructions given in each part. Draw well-labelled diagrams, wherever necessary.*

PART-I

(Plant Development Biology)

Note: Answer the following as per the instructions given in each question.

Q. 1. *(a)* Fill in the blanks:

(i) **________ of ovule undergoes meiotic division.**

(ii) **Plant hormone____________is responsible for phototropism.**

Ans.*(i)* Megasporocyte, *(ii)* Auxin.

(b) **Select the correct word :**

(i) **Development of embryo without fertilization is called (parthenocarpy/ parthenogenesis)**

Ans. Parthenogenesis.

(ii) **Fruit ripening is promoted by (Abscissic acid/Ethylene).**

Ans. Ethylene.

(c) **State whether the following statements are True or False :**

(i) **Lenticels are formed by the vascular cambium.**

Ans. False.

(vi) **Endothecium is a layer of anther wall.**

Ans. True.

Q. 2. Write short notes on the following:

(a) **Synergids**

Ans. Ref.: See Chapter-2, Page No. 16, 'Synergids'.

(b) **Self-pollination**

Ans. Ref.: See Chapter-3, Page No. 22, 'Self-Pollination'.

(c) **Somatic embryogenesis**

Ans. Ref.: See Chapter-11, Page No. 99, 'Somatic Embroyogenesis'.

(d) **Abscission of leaves**

Ans. Ref.: See Chapter-8, Page No. 75, 'Abscission'.

Q. 3. Define any five of the following:

(i) **Short-day plants**

Ans. Ref.: See Chapter-7, Page No. 66, 'Short-day Plants'.

(ii) **Annual rings**

Ans. Annual rings: Each year, the tree forms new cells, arranged in concentric circles called annual rings or annual growth rings. These annual rings show the amount of wood produced during one growing season.

(iii) **Callus**

Ans. Ref.: See Chapter-11, Page No. 106, Q. No. 4 *(ii)*.

(iv) **Endothelium**

Ans. Ref.: See Chapter-1, Page No. 4, 'Endothelium'.

(v) **Geitonogamy**

Ans. Geitonogamy: Geitonogamy is a form of self-pollination, but unlike the process of autogamy where a single flower can fertilize itself, the flowers on a geitonogamy plant are fertilized by other flowers on the same plant. The single blossom of the plant is not solely self-fertile. A vector must be used to transport pollen from flower to flower on the same plant.

(vi) **Aril**

Ans. Ref.: See Chapter-6, Page No. 62, Q. No. 3 'Aril'.

Q. 4. ***(a)*** **What is apical dominance? Discuss the applications of apical dominance in horticulture and agriculture.**

Ans. Ref.: See Chapter-9, Page No. 79, 'Apical Dominance', Page No. 82, Q. No. 8.

(b) **What is Micropropagation**

Ans. Micropropagation is a method to produce genetically identical plantlets by using tissue culture techniques. In this technique, tissue is taken from a plant and grown in a laboratory to produce plantlets that are genetically identical to the parent.

Q. 5. ***(a)*** **What is Sexual Incompatibility? Discuss its biological significance. Describe one method to overcome Icompatibility.**

Ans. Ref.: See Chapter-3, Page No. 27, 'Incompatibility', Page No. 29, 'Biological Significance of Incompatibility', 'Methods to overcome Incompatibility'.

(b) **What are the functions of endosperm?**

Ans. Ref.: See Chapter-4, Page No. 43, Q. No. 12.

Q. 6. ***(a)*** **Where are the follwing located?**

(i) **Egg Cell**

Ans. Ovrule

(ii) **Caruncle**

Ans. Ref.: See Chapter-6, Page No. 54, 'Caruncle'.

(iii) **Pollenkit**

Ans. Surface of Pallengrains.

(iv) **Polar niclei**

Ans. Mid-region of the empryo sac.

(b) **What are androgenic haploids? What is their importance in agriculture?**

Ans. Ref.: See Chapter-11, Page No. 100, 'Haploid Production'.

Q. 7. Differentiate between any two of the following:

(i) **Heartwood and sap wood**

Ans. Ref.: See Chapter-10, Page No. 86, 'Heartwood and Sapwood'.

(ii) **Root apex and shoot apex**

Ans. Ref.: See Chapter-7, Page No. 69, Q. No .1 *(i)* and *(ii)*.

(iii) **Gonial apospory and somatic apospory**

Ans. Apospory is the development of 2n gametophytes, without meiosis and spores, from vegetative, or nonereproductive, cells of the sporophyte. Gonial apospory occurred rarely. When it did occur, it began early in ovule development while inner and outer integuments were initiating. The development of a diploid embryo sac in some plants by the somatic division of a nucellus or integument cell without meiosis is called somatic apospory. It is a form of agamospermy, in which a seed is produced without fertilization.

(iv) **Vegetative cell and generative cell**

Ans. Ref.: See Chapter-2, Page No. 19, Q. No. 1.

PART-II

(Animal Development Biology)

Note: Question no. 8 is compulsory. Attempt any four questions from questions no. 9. to 14.

Q. 8. Fill in the blanks:

(i) **The process of differentiation of spermatid into spermatozoa is called ________.**

(ii) **When the upper tier of blastomered lie exactly over the corresponding lower tier of blastomeres the cleavae pattern is called ____________.**

(iii) **The stimulation of population of cells to differentiate in a specific direction by another group of a cells is called ___________.**

(iv) **The blastula of mammals which implants in the uterine wall is called___________.**

(v) **The unequal first meiotic division of the primary oocyte in the process of oogenesis results in the formation of a secondary oocyte and a____________body.**

Ans. *(i)* Spermiogenesis, *(ii)* Radial Type, *(iii)* Totiopotency, *(iv)* Intersfitial Implantation, *(v)* Polar.

Q. 9. With the help of a diagram, illustrate the stages in spermatogenesis.

Ans. Ref.: See Chapter-13, Page No. 114, 'Spermatogenesis'.

Q. 10. ***(i)*** **Differentiate between holoblastic and meroblastic cleavages.**

Ans. Ref.: See Chapter-14, Page No. 136, Q. No. 2.

(ii) **What are fate maps? Write any one method of construct a fate map.**

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The Chapter

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DEVELOPMENTAL BIOLOGY

PLANT DEVELOPMENT-I

Anther and Ovule

1

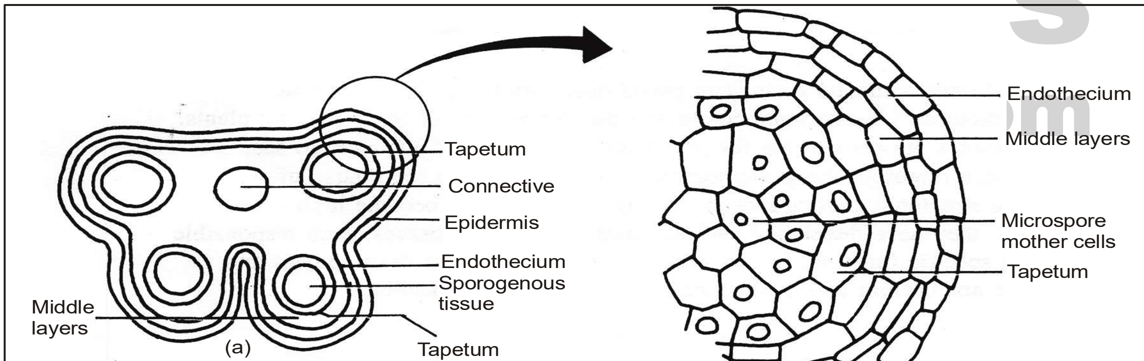
INTRODUCTION

Androecium and gynoecium are respectively the male and female reproductive structures of the flowering plant. These two reproductive structures are responsible for producing pollen and embryo sac which represent the gametophytic generation. In this chapter, we would study the development and structure of the androecium and gynoecium and their relative functions. Androecium represents the collection of stamens in a flower which consists of anther and a filament. Inside the anther lobe pollen sac is located in which pollen grains are produced. When pollen grains get mature, the anthers split, open and release pollen. Similarly gynoecium represents a collection of carpels. Carpel consists of a stigma, style and ovary and ovary encloses the ovule in which the megaspores develop. After fertilization embryo and endosperm produces and thus entire microsporangium is within enclosed structure becomes a seed.

CHAPTER AT A GLANCE

ANTHER

By cutting transverse section of the anther we see that anther has four microsporangia, two in each lobe.

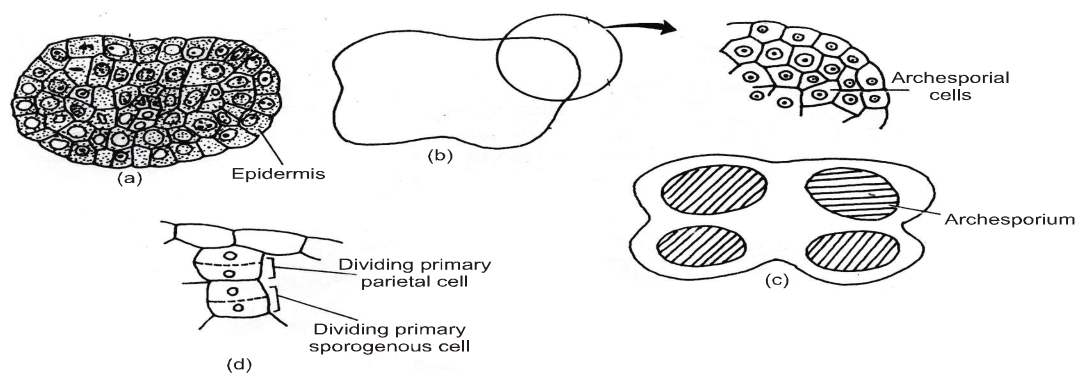


(a) Diagrammatic representation of a typical anther, cut in transverse section.
(b) A portion enlarged to show the basic cell layers/tissues.

Development

As the anther develops, it begins to assume a four-lobed appearance. In each lobe, group of two or more hypodermal cells differentiate. These cells are different from the other larger densely cytoplasmic cells and have prominent nuclei, these cells are known as archesporial cells. These cells divide in a plane parallel to the other wall of the anther lobe. These divisions are known as periclinal divisions, after which primary parietal cells (PPC) and primary sporogenous cells are formed. The

PPCs by repeated (PSC) by repeated periclinal and anticlinal divisions give rise to 2 to 5 layers of the anther wall while PSCs, either directly or after a few mitotic divisions form the microspore mother cells (MMC).



Diagrammatic representation of different stages of development of microsporangium: (a) An undifferentiated anther showing homogeneous mass of cells surrounded by epidermal layer; (b) anther that has begun to assume four lobed outline, a portion of the same enlarged to show the prominent archesporial cells; (c) an outline diagram of a four-lobed anther. The shaded areas in each lobe represent archesporial cells; (d) a portion of an anther lobe enlarged to show the two products of the archesporial cell. The one towards the epidermis is the primary parietal cell and the inner one is the primary sporogenous cell.

Anther Wall Layers

The wall of a mature anther consists of following layers–epidermis, endothecium, middle layers and tapetum. The outermost layer of the anther wall is **epidermis** which undergoes only anticlinal division. On a mature anther the epidermal cells are greatly stretched and flattened which provide a protective covering to the internal tissues The next layer from epidermis is the **endothecium** which is responsible for the dehiscence of the anther which is single layered cell. The endothecium is well differentiated in the four bulging parts of the anther. At maturity the endothecial cells can be easily recognised by the presence of fibrous bands. Thickening of endothecial cells help in the dehiscence of the anthers. The inner walls of endothecium are thickers due to the presence of more α-cellulose than the outer ones. Thus the inner walls absorb more moisture and capable to expand which is responsible in the rupturing of the anther wall. This rupture takes place at the weak points of the anther. Next inner to the endothecium lie one to three layers which are known as **middle layers**. which originate from the PPCs and have nutritive function. Cells of these layers are rich in reserve food like starch. The innermost and the most important layer of the anther wall is **tapetum** which is composed of a single layer of cells. These cells completely surround the sporogenous tissue and when the sporogenous tissues are at the tetrad stage they attain the maximum development. Sometimes the origin of tapetum is dual which is known as **dimorphic tapetum** in which the cells of the outer side originate from the derivatives of the PPCs and those of inner side from the cells of the connective. The tapetum is a nourishing tissue as well as play an important role in the formation of the exine and deposition of tryphine and pollen kit. At the time of division there is an increase in DNA content and tapetal cells becomes polyploid either due to endomitosis polyteny or by the formation of restitution nuclei. For formal development of pollen grains development of tapetum is very important otherwise pollen grains are not formed which results in pollen sterility.

In some species tapetum is of two principal types—**amoeboid** and the **secretory** e.g. in angiosperms. In the amoeboid type the cells change their position and shape during ontogeny while in secretory, the constituent cells maintain their individuality and position. **Amoeboid tapetum** is also known as invasive or **periplasmodial tapetum.** This is more prevalent in monocotyledons. There is a breakdown of the inner tangential cell wall followed by the enlargement and movement of protoplast into the anther sac, where they fuse and form periplasmodium. In the anther sac, these periplasmodia closely surround the developing microspores and play an important role in pollen development.

Secretory tapetum has some other names as parietal, cellular or glandular tapetum. This is more prevalent in dicotyledons and the cells of the tapetum remain intact in their original position, until the pollen grains get mature. The tapetal cells secrete and liberate substances to the anther sac from their inner walls.

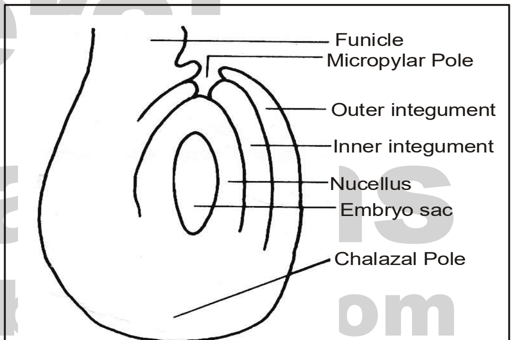
Sporogenous Tissue

Primary sporogenous cells are formed after the periclinal divisions of archesporial cells. These PSCs undergo mitotic divisions and before functioning as MMCs they increase in number and MMCs undergo meiosis division and give rise to haploid microspores. In sexual reproduction meiosis is a significant event as meiosis provides genetic variability due to recombination and crossing over of chromosomes because during meiosis diploid chromosome number get to half. Thus meiosis lead to new genotypic combination. Meiotic cycle complete in two phases—Meiosis-I which is a reduction division results in two haploid cells or nuclei while meiosis-II is mostly like normal mitosis division.

In a young anther, plasmodesmatal connections are exhibited by anther wall layers, that is, there is a flow of nutrients between different cell layers. But as meiosis is initiated the plasmodismatal connections between the cells of different wall layers get severed. As meiosis starts each sporogenous cell develops an additional wall made up of callose on the inner side of their cellulosic cell wall. Each MMC becomes enclosed in a callose wall—the cytoplasmic connections are too wide to allow the free passage of cytoplasm and organelles between meiocytes. This constitute a single functional entity called syncytium though there are hundreds of MMCs in each microsporangium. **Formation of syncytium** is to regulate synchrony amongst the meiocytes of a microsporangium. The progress of meiosis in MMCs results in the interruption of the cytoplasmic channels and so each MMC is completely enclosed by a callose wall. As meiosis division completes the formation of four microspores from each MMC takes places and callose wall works as a separating walls of microspores is associated with meiosis. At the end of meiosis, the microspores restore the synthetic activity i.e. the synthesis of RNA and proteins is initiated the ribosome population of the cell is restored and mitochondria and plastids redifferentiate to their normal structure. The outer layer of pollen, exine, is made up of sporopollenin, which is most resistant substance. Because of exine, pollen grains of prehistoric plants are well preserved as Fossils. The callose wall dissolves after the development of exine with the help of enzyme callase. The callose wall is produced by the surrounding tapetal cell periplas-modium. After the liberation of individual microspores the development of the male gametophyte begins.

OVULE

The ovule, is female reproductive organ, which is also known a megasporangium and is forerunner of the seed. Ovule consists of a central mound of tissue called the **nucellus**, which is enveloped by **integuments** is (one or two coverings). An ovule when is ready for fertilization consists of nuceller tissue and enveloped completely by integument leaving a small opening **micropyle** at the apical end which is main passage for the entry of the pollen tube into the ovule. This end is known as micropylar pole and the opposite pole is known as chalazal pole where funiculus is attached. **Funiculus** is stalk like structure with which ovule is attached to the placenta. **Female gametophyte** is present in the nucellus which is called as embryo sac.



Outline diagram of a typical ovule ovule to show its various component parts.

Development

Development of ovule takes place from a region of the ovary–the placenta which is composed of homogenous tissue. Ovules undergo different degree of curvature during development on the basis of this and the position of micropyle with respect to the funiculus.

Types of Ovules

Ovules are of basic five types–anatropous, orthotropous, hemianatropous campylotropous and amphitropous, and one another form circinotropous.

The ovule undergoes curvature in such a way that the micropylar end comes to lie parallel to the funiculus is known as *Anatropous* type of ovule. In *Orthotropous* ovule no curvature occurs and the micropyle lies in a straight line with respect to the funiculus. When the curvature of the ovule such that the micropyle comes to lie at right angles to the funiculus is known as *Hemianatropous* type of ovule. In *Campylotropous* ovule, the ovule is curved but the curvature is less than that in anatropous ovule. The *Amphitropous* ovule is much similar to campylotropous ovule but the nucellus and the embryo sac are curved like a horse shoe. Another type of an ovule is *Circinotropous* in which in early development the nucellar protuberance is more or less in line with the axis while in further development, due to unilateral growth it assumes anatropous form.

Structure

Integuments: The coverings of the ovule, integuments mature into the seed coat. Ovules may be unitegmic (one) or bitegmic (two) integuments depending on the conditions. The bitegmic condition is common in polypetalae and monocots while unitegmic condition is shown by sympetalae.

Nucellus: Nucellus is enclosed within the integuments of homogenous mass of tissue. This is the tissue in which the female gametophyte differentiates and develops. An archesporial cell or a group of cells differentiate in the hypodermal region of the nucellus, at an early stage of ovule development. The archesporial cell may function directly as the sporogenous cells. In this situation, the sporogenous cell also remain hypodermal in position and is in the micropylar and is surrounded by nucellus which is single layered. These ovules are called as tenui-nucellate which are commonly seen in sympetalae.

In some conditions the hypodermal archesporial cell divides periclinally and form an outer parietal cell and an inner sporogenous cell. These tissues divide repeatedly. The sporogenous cell becomes deeply embedded in the massive nucellus and this condition of the nucellus is known as crassinucellate.

In most of the angiosperms, the nucellus is consumed by the growing embryo sac or the endosperm. It may persists in the mature seed as the nutritive tissue. In some species which is known as perisperm, it acts as a storage tissue as in piperaceae family black pepper.

A few nucellar cells located at the base of the embryo sac and becomes sclerenchymatous and remain thin walled and secretory. These cells constitute the hypostase and associate the following functions as:

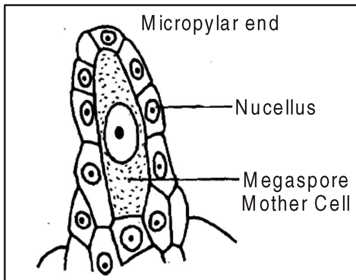
(i) Transportation of nutrients.
(ii) Acts as a barrier or boundary for the growing embryo sac and prevents it from growing into the base of the ovule.
(iii) Helps in maintaining the water balance in the seed during dormancy.
(iv) It produces certain enzymes or hormones and plays a protective role in mature seeds.

Endothelium: The nucellus degenerates during early stages of ovule development and the embryo sac comes in contact with the innermost layer of the integument in plants which bear unitegmic ovules. These cells supply nutrients to the embryo sac and cells elongate radially cytoplasm becomes dense and it store starch and lipids. This layer is known as endothelium. Plants which bear bitegmic ovule also has endothelium and their function is similar as in endothelium cells of anther that is, in storing carbohydrates, proteins, RNA, ascorbic acid and other metabolites.

Obturator: Near the micropyle, an obturator is an outgrowth of the placenta or funicle or integument or style. The cells of the obturator at the ultrastructural level, show dense cytoplasm which contain ER, dictyosomes and vesicles. Obturator provide mechanical and chemical guidance to the growing pollen tube.

Megasporogenesis: At an early stage of ovule development, one cell of the nucellus develops into megaspore mother cell (MgMC). MgMC has cellulosic walls and is connected to its neighbouring cells through plasmodesmate the MgMC also known as megasporocytes.

It divides meiotically to form a linear raw of four haploid megaspores. This is commonly known as the tetrad stage. Only one megaspore persists and the remaining three degenerate During megasporogenesis callose is deposited on the walls of MgMC and the megaspores, similar to callose deposition during microsporogenesis. After completion of megasporogenesis the callose disappears from the walls of the functional megaspore, whereas it remains present in the walls of megaspore which degenerate.



A part of a young ovule with large megaspore mother cell.