According to the Latest NCERT Syllabus

Sanjiv®

BIOLOGY

Class-12

For the Students of Rajasthan Board of Secondary Education

By

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Preface

We are extremely pleased to present this book according to latest syllabus of NCERT. The book has been written in easy and simple language so that students may assimilate the subject easily. We hope that students will get benefitted from it and teachers will appreciate our efforts. In comparison to other books available in market, this book has many such features which make it a unique book :

1. Theoretical subject-material is given in adequate and accurate description along with pictures.
2. The latest syllabus of NCERT is followed thoroughly.
3. Complete solutions of all the questions given at the end of the chapter in the textbook are given in easy language.
4. Topic wise summary is also given in each chapter for the revision of the chapter.
5. In every chapter, all types of questions that can be asked in the exam (Objective, Fill in the blanks, Very short, Short, Numerical and Long answer type questions) are given.
6. At the end of every chapter, multiple choice questions asked in various competitive exams are also given with solutions.

Valuable suggestions received from subject experts, teachers and students have also been given appropriate place in the book.

We wholeheartedly bow to the Almighty God, whose continuous inspiration and blessings have made the writing of this book possible.

We express our heartfelt gratitude to the publisher – Mr. Pradeep Mittal and Manoj Mittal of Sanjiv Prakashan, all their staff, laser type center and printer for publishing this book in an attractive format on time and making it reach the hands of the students.

Although utmost care has been taken in publishing the book, human errors are still possible, hence, valuable suggestions are always welcome to make the book more useful.

In anticipation of cooperation!

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Unit VI : Reproduction

CHAPTER 1

SEXUAL REPRODUCTION IN FLOWERING PLANTS

Chapter Overview

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1.2 Pre-fertilisation : Structures and Events
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1.4 Post-fertilization : Structures and Events
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1.5 Apomixis and Polyembryony

1.1 Flower : A Fascinating Organ of Angiosperms

Flowers are the characteristics of only angiosperms. These flowers vary in colour, shape, size and types. Human beings have an intimate relationship with flowers since time immemorial. Flowers are objects of aesthetic ornamental, social, religious and cultural value and are used to express human feelings like love, emotions, happiness, grief, mourning etc.

Flower is highly modified and condensed shoot meant for sexual reproduction. It consists of four whorls arranged as outermost calyx, corolla, androecium and gynoecium. Calyx and corolla are called non-essential whorls as they do not take part in sexual reproduction whereas androecium and gynoecium represent essential male and female reproductive organs respectively in flower (Fig. 1.1).

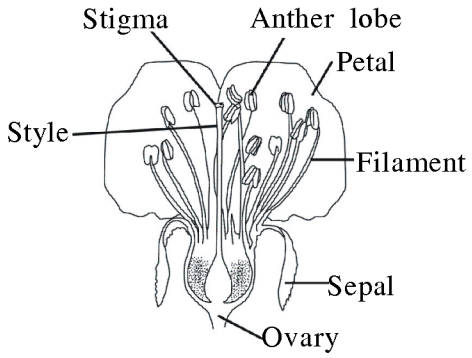

Fig. 1.1 : Diagrammatic representation of L.S. of Flower

1.2 Pre-fertilization : Structures and Events

Before flowering, angiospermic plant undergoes several hormonal and structural changes which induce the development of floral primordia that produce floral buds. These floral buds ultimately gave develop into flowers.

1.2.1 Stamen, Microsporangium and Pollen Grain

Androecium is known as male reproductive organ in flower. Its unit is stamen. Each stamen has two parts : Anther and filament.

Anther is the fertile part of stamen which may be dithecous or monothe cous. Dithecous anthers are very common in angiosperms and has two anther lobes. The two anther lobes together or with flament are united with filament by connective (Fig. 1.2).

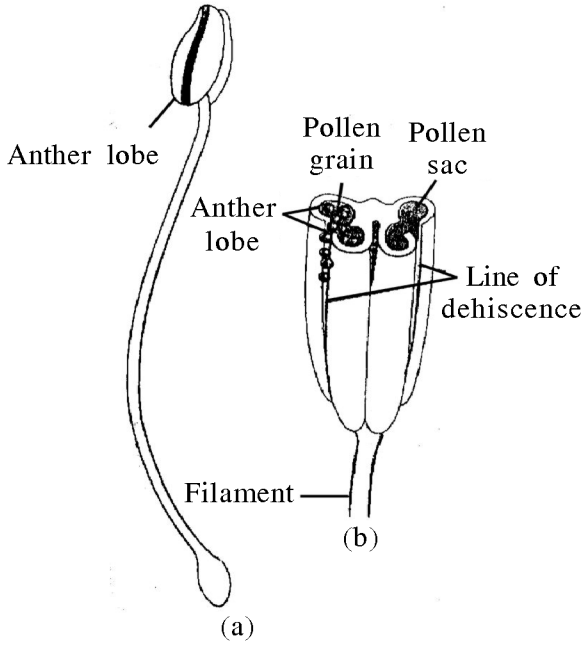

Fig. 1.2 : (a) A typical stamen (b) An anther lobe

Monothecous anther is the characteristic of members of family Malvaceae *e.g.* ladyfinger, China rose etc.

Structure of microsporangium : By studying the T.S. of mature anther of a typical stamen, it is revealed that each lobe of dithecous anther has two pollen sacs or microsporangia and dithecous anther is, therefore, tetrasporangiate and monothecous anther is bisporangiate (Fig. 1.2).

A mature anther is made of the wall and the pollen chamber.

1. Wall of Anther : The anther wall consists of four defferent layers—(i) Epidermis (ii) Endothecium, (iii) Middle layer (iv) Tapetum [Fig. 1.3 (b)].

(i) Epidermis : This is the outermost unicellular layer meant to provide protection.

(ii) Endothecium : This layer is situated just below epidermis and is formed of radially elongated cells arranged in single layer which have fibrous thickening formed by deposition of α-cellulose. It is hygroscopic and helps in dehiscence of pollen sacs. In between thick walled cells, a few cells without thickening are also present, these thin walled cells collectively form the stomium through which anther dehisces.

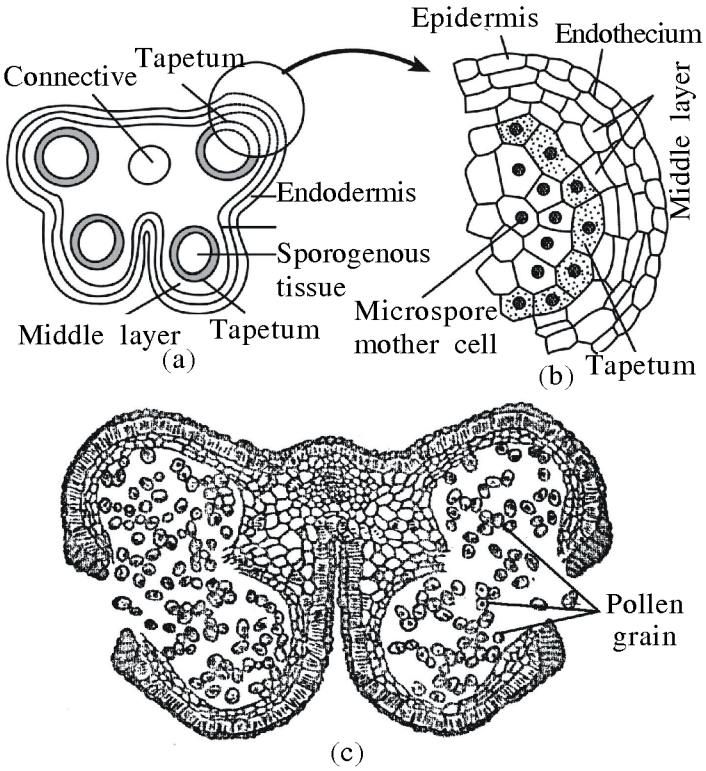

Fig. 1.3 : (a) T.S. of a typical anther (b) Enlarged view of one microsporangium showing wall layers (c) A mature dehisced anther

(iii) Middle layers : About 3-4 successive layers of this walled cells situated just below endothecium together represent middle layers which gradually degenerate in maturing anther.

(iv) Tapetum : This is the innermost layer of anther wall. Tapetal cells contain viscous protoplasm and distinct large nucleus. On maturity, tapetal cells usually becomes multinucleated and provide nutrition to the developing microspores. Tapetum, therefore, secretes both enzymes and hormones. There are two types of tapetum in angiosperms :

(a) Amoeboid or Periplasmodial : The cells of this type of tapetum separate from the wall and its protoplast move freely in pollen chamber providing nutrition to growing pollen grains *e.g.* Tradescantia, typha etc.

(b) Secretory or glandular tapetum : This is the most common type of tapetum found in most of the angiosperms in which cells remain intact and secrete nutrients, enzymes and hormones (IAA) for developing pollens.

The cells of secretory tapetum also contain spherical lipid structure called pro-ubisch bodies.

These bodies get surrounded by sporopollenin, a complex substance which forms exine or outer wall of pollen grains.

The tapetum attains maximum development at the stage of pollen grains formation and play significant role in their development by proficing nutrition. If this tapetum is lost any how prior to the development of pollen grains in anther, pollen grains becomes sterile or abortive.

2. Sporogenous cells : As already explained, that each anther has four pollen sacs. Each pollen sac or sporangium is layered with wall and has a group of homogenous cells inside innermost tapetum, together represent primary sporogenous cells. These cells form microspore or pollen mother cells (2n).

Microsporogenesis : Each active microspore mother cell, together with progressive development of anther, divides meiotically to form four haploid microspores which remain arranged in tetrad. This process of formation of microspores (n) from microspore mother cells (2n) in microsporangium is known as microsporogenesis.

Tetrads may be of following types (Fig. 1.4) depending upon the arrangement of microspores in different plants :

(i) Tetrahedral : This is the most common type of tetrad in dicots.

(ii) Isobilateral : All the microspores in tetrad lie in one plane. This is very common in monocots.

(iii) Decussate : Two microspores lies at the right angle of each other *e.g.* Magnolia.

(iv) Linear : All microspores in tetrad are arranged along a straight line.

(v) T-shaped : Out of 4, two microspores lies longitudinally and two transversely to it *e.g.* Aristolochia.

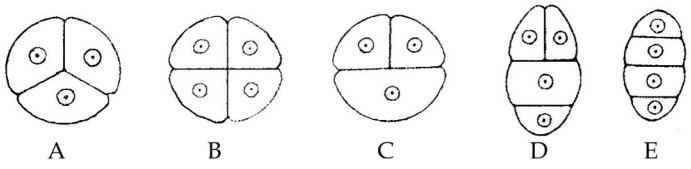

Fig. 1.4 : Tetrad of various shape—A. Tetrahedral B. Isobilateral C. Decussate D. T-shaped E. Linear

All the four microspores in a tetrad are held together by callose which on maturity of anther, degenerate and microspores become free and spherical. Now they are called pollen grains which remain scattered freely in microsporangium.

–: Some Interesting Facts :–

- In some plants like–Typha Drosera, Juncus, cryptostegia etc., all the four pollen grains or microspores do not separate but together form Compound pollen grains. In some plants *e.g.* Calotropis and orchids all the pollen grains of an anther lobe form a typical structure called pollinium (Fig. 1.5) that forms a translator apparatus.

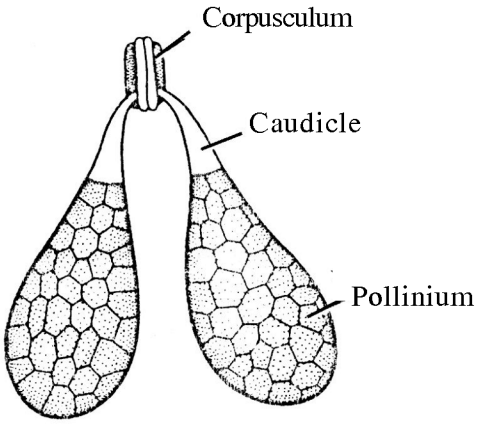

Fig. 1.5 : Pollinium

- If a tetrad has more than four spores, it is called polyspory.
- In cyperus, out of 4 pollens in a tetrad, 3 degenerate therefore one pollen is produced per meiosis.

When anther becomes mature, tapetum and middle layers degenerate and disintegrate gradually leaving only epidermis and endothecium finally. septum between two pollen sacs degenerate, allowing the pollen sacs on one side to come in contact of other side. On maturity Endothecium dehydrates creating pressure on stomium wall due to shrinkage (Fig. 1.6). So that microsporangium dehisces and pollen grains are released in external environment.

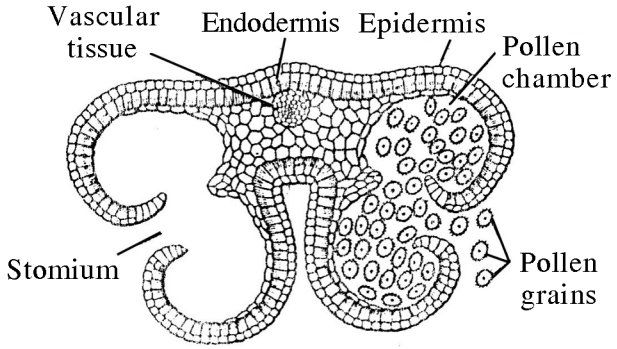

Fig. 1.6 : T.S. of mature anther

Structure of pollen grain : Microspores or pollen grains are formed in microsporangia of Anther.

Pollen grains are haploid as they are formed by meiosis in microspore mother cells. In this way, microspore or pollen grain is the first cell of male gametophytic generation.

Pollen grain is unicellular, uninucleated haploid structure which has double layered wall. Outer layer is called exine and inner layer is intine. Pollen grains are of various types depending upon shape, number and outer surface in defferent plants.

(i) Exine : It is thick, hard and ornamented Ornamentations may be reticulated, spinous or stripped etc. (Fig. 1.7). Exine is made of a highly specific chemical substance sporopollenin which is the oxidised and polymerised product of carotenoids hence pollen are dark coloured, usually of yellow colour. Spropollenin is biologically the most resistant organic substance and is not degraded by bacteria. It can also tolerate extremes of temperature and concentration of acidic and alkali solution and this is why pollen can be preserved in fossil forms for million of years. At places, exine is thin to form germ pores. In dicotyledons, pollen is tricolpate (*i.e.* containing three germ pores) whereas in monocotyledons, pollen is monocolpate (*i.e.* single germ pore).

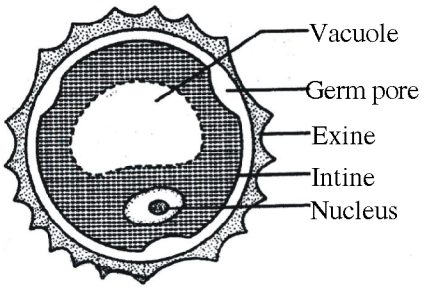

Fig. 1.7 : Pollengrain

(ii) Intine : It lies just below the exine and is thin and uniform. It is made of pectocellulose and encloses cytoplasm of pollen. At the time of germination, intine comes out of the germ pores in the form of pollen tube.

Pollen products : Pollen grains are rich in nutrients. It, therefore, has become a fashion in recent year to use pollen tablets to compensate nutrient deficiency in daily diet. In western countries, pollen products (Fig. 1.8) available in market, are consumed in huge amount as syrup and tablets and these products have been claimed to increase the stamina of athletes and race horses.

Fig. 1.8 : Pollen product

Pollen viability : As pollen grains are shed from pollen sacs during pollination, the question strikes in mind that how long is their viability. Pollen viability depends upon temperature and humidity factor. There are variations regarding pollen viability. Some species have a viability of few minutes, a few days or even months but pollen grains of defferent species can be artificially stored in liquid nitrogen (–196°C) for many years. Thus pollen stores are used for crop breeding programmes.

–: Some Interesting Fact :–

- In plants, myosotis alpestis has smallest pollen grains and that of mirabilis jalapa are of biggest in size.
- Palynology : Separate branch of botany which deals with study of pollen grains.
- In our country, major centre of Palynology are NBRI (National Botanical Research Institute), Lucknow and department of botany, Usmania University, Hyderabad and Delhi.
- In Anemophilous plants, pollen grains are indefinite tiny in size with dry and smooth surface.
- In Entomophilous plants pollen grains are comparatively large in size, less in no. and possess specific oily layer called pollenkitt that provides pollen a specific odour, stickiness and colour.
- Pollenkitt is very useful for entomophilous pollens as insects get attracted for pollination. It also protects pollen from uv-rays and helps in sticking the pollens to the insect's wings.
- Pollenkitt is formed by substances secreted by tapetal cells.
- Pollens of some plant species *e.g.* Parthenium (= carrot grass), chenopodium etc. cause allergies like hay fever and asthama in human beings.

Microgametogenesis or development of male gametophyte

The process of development of fully developed male gametophyte from pollen grain is called microgametogenesis. In fact, development of male gamete plants begins in situ (*i.e.* precocious germination within microsporangium). All the nuclear division occuring during microgametogenesis are mitotic in nature.

In the beginning, protoplasm of microspore is viscous with distinct nucleolus. As they separate from