PLUS TWO BOTANY NOTES

CHAPTER-2: SEXUAL REPRODUCTION IN FLOWERING PLANTS

Part-3: Post-Fertilization, Embryo Development and Seed

<<< Part-2 **Part-1>>>**

Flowering plants (Angiosperms) show sexual reproduction. In the previous post (part -2) we discussed about Pollination, Fertilization and Double Fertilization. This post is the Part three of Plus Two Botany Notes Sexual Reproduction in Flowering Plants. Here we briefly discuss the post-fertilization processes in plants such as development of endosperm, development of embryo, structure of dicot and monocot embryo and structure of seeds of dicots and monocots.

Development of Endosperm

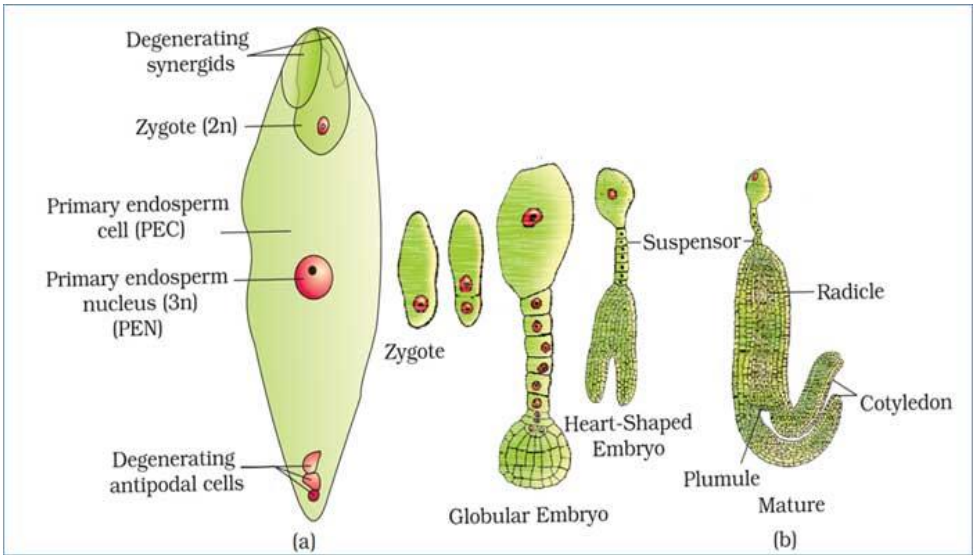
* Primary Endosperm Nucleus (PEN) develops into Endosperm.
* Stages of endosperm development:
    1) **Free nuclear endosperm**
        * Repeated nuclear divisions of PEN produce free nuclei.
        * Endosperm in this stage is called Free Nuclear Endosperm.
        * Eg. Tender Coconut water in the centre.
    2) **Cellular endosperm**
        * Free nuclei in the endosperm develops cell wall.
        * Endosperm in this stage is called Cellular Endosperm.
        * Eg. White coconut kernel.

Functions of Endosperm

1) To provide nourishment to the developing embryo.
2) Endosperm tissue consists of reserve food materials.

Development of Embryo

* Embryo develops from the zygote by cell division.
* Stages of development of embryo:
    1) Zygote
    2) Pro-embryo
    3) Globular embryo
    4) Heart shaped embryo
    5) Mature embryo

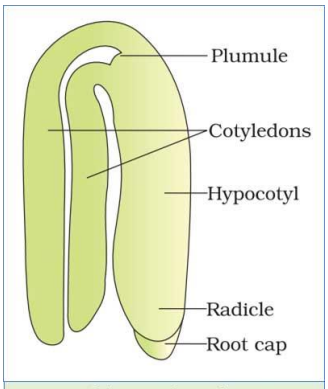


(a) Fertilized embryo sac showing zygote and Primary Endosperm Nucleus (PEN);
(b) Stages in embryo development in a dicot [shown in reduced size as compared to (a)

- **Structure of Embryo**
- **Parts of a mature embryo:**

1) Embryonal axis
    i. Plumule
    ii. Radicle
2) Cotyledons

STRUCTURE OF DICOT EMBRYO



A typical dicot embryo showing its parts

A mature dicot embryo consists of:

1) Embryonal Axis
2) Two Cotyledons

(1). Embryonal Axis

- Embryonal axis has two ends – Epicotyl and Hypocotyl
- **Epicotyle**
    * The part of embryonal axis above the level of cotyledons.
    * Epicotyle ends in plumule or stem tip.

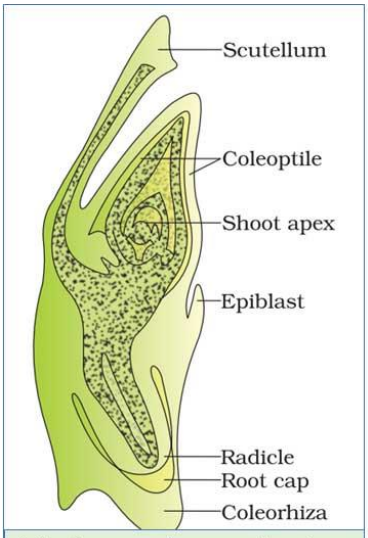
- Plumule develops into shoot system.

- **Hypocotyl**
  - The part of embryonal axis below the level of cotyledons
  - Hypocotyl ends in radicle or root tip.
  - Radicle develops into root system.
  - Radicle is covered with root cap or calyptra.
  - Root cap protects the root tip and help in downward growth of root through the soil.

(2). Cotyledons

- Cotyledons are the leaves at the embryonic stage
- A dicot embryo consists of two cotyledons.

STRUCTURE OF MONOCOT EMBRYO



L.S. of a grass (monocot) embryo showing the parts

A mature monocot embryo consists of:

1) Embryonal Axis
2) One Cotyledon

(1). Embryonal Axis

- The embryonal axis possesses radicle at the lower end.
- Radicle is covered by root cap.
- Radicle and root cap are enclosed in a sheath called **coleorhiza.**
- The portion of the embryonal axis above the level of attachment of **scutellum (cotyledons)** is the epicotyl.
- Epicotyl consists of shoot apex.
- Shoot apex is covered by protective sheath called **coleoptile.**
- Coleoptile encloses a few leaves primordia.

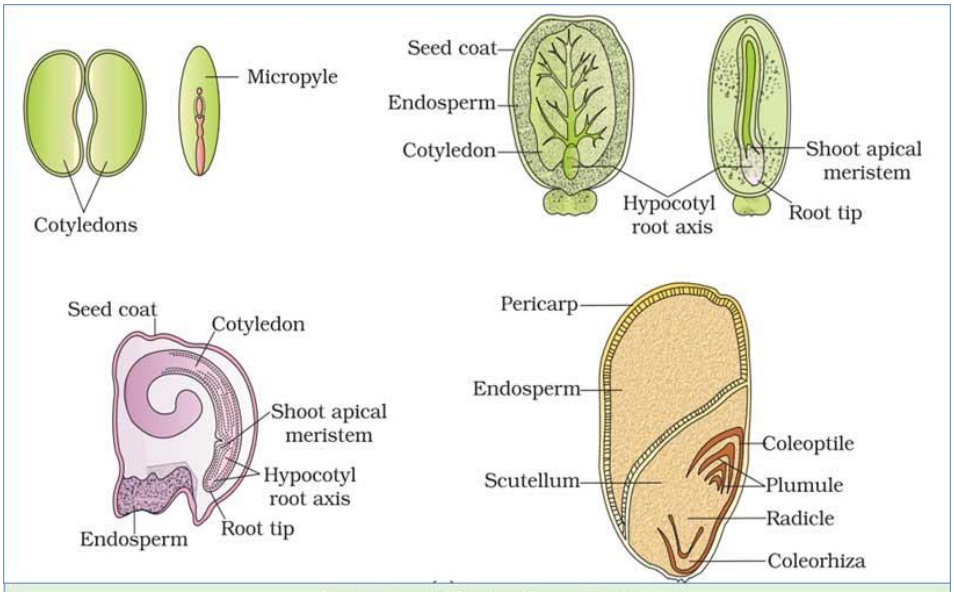
(2). Cotyledon

* Monocot embryo possess only one cotyledon
* Cotyledon in grasses is called **scutellum**
* It is placed laterally to the embryonal axis

SEED

* Fertilized mature ovule is called seed.
* It contains the embryo.
* Seeds are formed inside the fruit (fruit is mature ovary)

Structure of Dicot Seed



Structure and Parts of Some Seeds

* Dicot seed consists of:
  1) **Seed coat**
     * It is double layered
     * Outer layer is testa and inner layer is tegmen
     * It provides protection
  2) **Micropyle**
     * Micropyle is a small pore in the seed coat.
     * It is the retained micropyle of the ovule.
     * It helps in the entry of water and oxygen during germination.
  3) **Hilum**
     * A scar left by the funicle or the stalk of the ovule on the seed is called hilum
  4) **Embryo**
     * It consists of two cotyledons and embryonal axis
  1) **Endosperm**
     * The nourishment tissue of seed
     * Majority of dicot seeds do not have endosperm.

* It may get consumed during the development of the embryo.

Structure of Monocot Seed

Monocot seed – example – Maize seed

1) **Seed coat**
   * Testa is fused with pericarp (fruit wall)
   * It provides protection
2) **Embryo**
   * It consists of a shield shaped cotyledon.
   * The cotyledon is known as scutellum.
   * The embryonal axis is seen in the cotyledon.
   * The upper portion of the embryonal axis is the plumule.
   * The lower portion is the radicle.
   * The plumule is covered by a sheath called coleoptile and radicle is covered by coleorhiza.
3) **Endosperm**
   * Majority of monocot seeds possess endosperm
   * It is rich in stored food materials
   * It provides nourishment to the developing embryo
   * In maize, endosperm is surrounded by a protein rich layer called aleurone layer

TYPES OF SEEDS

Based on the presence or absence of endosperm, seeds are of two types:

1) **Endospermous seeds or Albuminous seeds**
   * Seeds with endosperm are called endospermous or albuminous seeds
   * Endosperm stores reserve food for the developing embryo
   * Eg. Maize, wheat, barley, castor
2) **Non-endospermous seeds / Non-albuminous seeds**
   * Seeds without endosperm
   * Endosperm is consumed by the developing embryo
   * Eg. Ground nut, pea, beans, cashew nut, sunflower

PERISPERM

* The residual, persistent nucellus in the seed is called perisperm.
* Eexample: Black pepper, beet

Similar Terms

1) **Endosperm**: The tissue present in seeds that provide nourishment to the developing embryo
2) **Perisperm**: The residual, persistent nucellus
3) **Pericarp**: Name of the fruit wall

Seed Dormancy

* Seed dormancy is the inability of a seed to germinate even in the presence favourable conditions.

Significance of Seeds

* Seeds contain embryo and help in propagation of plants
* Seeds are rich in reserve food for providing nourishment to the embryo
* The embryos are well protected inside the seed coat
* Seeds are produced by sexual reproduction, and thus create genetic recombination and variation
* Our agriculture is mainly based on seeds
* Seed dormancy and seed dehydration help in storage of seeds
* Seeds are rich in nutrients and are a part of our daily food

Seed Viability

* Seed viability is the ability of a seed to germinate under favourable condition
* Viability period vary from seed to seed
* Eg. *Oxalis*: a few months
* *Trifolium*: hundreds of years
* The oldest viable seed: *Lupines arcticus* (Lupine), excavated from Arctic Tundra
* Date palm seed excavated from King Herod's palace: 2000 years old

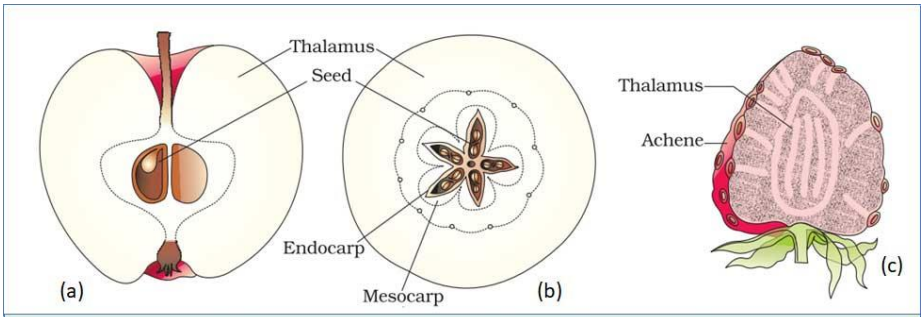
FRUITS

* The fruit is the ripened (mature) ovary.
* Fruit wall is called pericarp.
* **Types of fruits based on the nature of fruit wall:-**
  - **i. Fleshy fruits**
    - The fruit wall is soft and fleshy
    - Eg. Mango, Orange, Guava
  - **ii. Dry fruits**
    - The fruit wall is dry
    - Eg. Mustard, Ground nut
* **Types of fruits based on development:**
  - **i. True Fruit**
    - Fruits which develop only from the ovary

- Eg. Wheat, Maize, Pea

ii. False Fruit

- Fruits which develop from floral parts other than the ovary (thalamus or pedicel)
- Eg. Strawberry, cashew, apple



False fruits of apple (a) and (b) and strawberry (c)

Parthenocarpic Fruits

* These are the fruits which are developed without fertilization.
* Ovary develops in to fruits without fertilization.
* Parthenocarpic fruits are seedless fruits
* Example: Banana
* Growth hormones can be applied to produce parthenocarpic fruits in agriculture.

APOMIXIS AND POLYEMBRYONY

a) Apomixis

* Apomixis meaning: Away from mixing
* It is a method of reproduction in which seeds are formed without fertilization (fusion of gametes).
* In this method, seeds are formed asexually from the maternal tissues (diploid) of the ovule without involving meiosis and fertilization.
* The embryo thus formed is identical to the parent
* Types of Apomixis:
  - **i. Parthenogenesis**: The development of female gamete (egg) into a new organism without fertilization. Here, the egg cell is diploid which is formed without meiosis
  - **ii. Parthenocarpy**: The development of ovary into fruit without fertilization

Importance of Apomixis in Agriculture

* Apomixis does not involve mixing or sexual fusion of gametes
* So, there is no segregation of genes
* Genetic make-up remains the same
* This property can be utilized in the production of apomict seeds of hybrid plants

* If the hybrids are made into apomicts, such seeds can maintain same genetic make up
* So, there is no need to buy hybrid seeds every season

b) Polyembryony

* Formation of many (or more than one) embryos within the seed.
* Example: Onion, mango, ground nut, orange, conifers, citrus etc.
* **Reasons for polyembryony**
  1) Presence of more than one egg in the embryo sac and they all may get fertilized.
  2) Presence of more embryo sacs in the ovule.
  3) Presence of more embryos – that develop from different parts of the ovule such as synergids, antipodals, nucellus tissues, integuments, egg cell (fertilized / unfertilized) etc.

So far, we have completed the discussion of chapter-2 of Plus Two Botany (Sexual Reproduction in Flowering Plants).

Part – 2, Chick here…