Seed & Fruits :-

- Ovulary develops as the ovule/ovules and as the ovulary ripe ovules, the ovary is called fruit.
- Most ovules develop only after vascular tissue of endosperm is formed. This is an adaptation to provide assured nourishment to developing embryo.
- Though the ovule ripens slowly, the early stages of embryo development (embryogenesis) are shown to have maximum and active cell division.
- Embryogeny in plants :-
- In a typical plant the zygote elongates and then divides by a transverse wall into two unequal cells the larger cell is called haustorium cell as has a large central vacuole. The terminal cell is called as apical cell because it develops into embryo proper.
- The haustorium cell enlarges horizontally & pushes into the nucellus to produce a filamentous structure of variable length. The haustorium helps in passing the embryo to endosperm.
- The apical cell of haustorium towards the micropyle will become suspensor and develops into a haustorium.
- The last cell of the haustorium at the end adjacent to the embryo is known as hypophysis.
- Hypophysis later gives rise to one radicle and root cap.
- The embryo cell undergoes four vertical divisions (quadrant stage) and one transverse division to form eight cell arranged in two tiers (octant stage).
  - Epibasal (Cotyledonary) — organisation center for hypophysis
  - Hypobasal (Axial) — Radicle organizer
  - Tissues from the epibasal and hypobasal cells
- The octant divide periclinally to produce outer layer of protoderm and endoderm. The inner cells differentiate further into periblem (2 tiers) and ground tissues (1 portion).
  - protoderm → epidermis
  - periblem → cortex
  - Procambium → vascular tissues
  - Ground Meristem → pith
- Initially the embryo is globular and undifferentiated.
- Early embryo with radial symmetry is called Proembryo
- To transform into embryo with the development of radicle, plumule and cotyledons. Three cotyledons differentiate from the side with a future plumule in the shape as in this case the embryo becomes Heart-shaped
- The rate of growth of the cotyledons is very high so that they become elongated tremendously while the plumule remains as a dome shaped of undifferentiated tissue.

- Three types give rise to the Monocot and subsequently to the Cotyledon, Heart-shaped and Bi-lobed embryo.

Structure of Dicot embryo

Structure of monocot embryo

- A typical dicot embryo lacks a Plumule and Radicle
  - An embryonal axis
  - Two cotyledons
  - Portion of axis above the level of cotyledons is the epicotyl with terminal bud called plumule or stem tip
  - The cylindrical portion below the level of cotyledons is hypocotyl, that terminates at its lower end in the radicle or root tip
  - The root tip is covered by root cap / calyptra
- Embryo of monocot lacking an embryonal axis
  - one cotyledon called scutellum
  - In grass family the cotyledon is called Scutellum, that is situated towards one side (lateral) of the embryonal axis
  - At its lower end, the embryo axis and scutellum are covered by a sheath called Coleorhiza
  - The portion above the level of attachment of scutellum is the epicotyl
  - Epicotyl has a few leaves and a shoot tip enclosed in a hollow foliar structure called the Coleoptile
  - Epiblast represents rudiment of second cotyledon.

Seed :- (Significance of seed and fruit formation)

- In angiosperms
  - Seed is final product of sexual reproduction.
  - It is also site for Perpetual events.
  - Seeds are formed inside the fruits.
- A seed typically consists of
  - Seed coat (s)
  - Cotyledon (s)
  - An embryo axis

- Cotyledons of the embryos are actively absorbing, generally thick and fleshy due to storage of food reserves (eg in legumes)
- Occasionally in some seeds such as black pepper, castor, nymphaea and canna, remnants of nucellus are also persistent. This perisperm persistent nucellus in the perisperm (Plinth).

- Integuments → of ovule transform as tough protective seed coats
  - Outer - Testa
  - Inner - Tegmen
- micropyle → remains as small pore in the seed coat to facilitate entry of oxygen and water into the seed during germination.

- As the seed matures, it loses water & reduced and seed become relatively dry (10-15% moisture by mass). The general metabolic activity of the embryo slow down. The embryo may enter into state of inactivity called Dormancy.
- Seed germination (Germination)
- In favourable conditions are available (i.e., adequate moisture, oxygen and suitable temp. they germinate.
- Ovule → Seeds
- Ovary → Fruit
- Ovary wall → Fruit wall (Pericarp)

This transformation proceed simultaneously.

- Ovule changes as shown above, fruit and seed are formed.
- Ovary wall → Pericarp
- Integuments → Seed coat
- Zygote → Embryo
- Primary endosperm nucleus → Endosperm

- Ovule with integuments → Seed coat
- Micropyle → Micropyle
- Hilum → Hilum
- Scar of funicle → Scar of funicle
- Fruit wall → Pericarp
- Seed → Seed
- Ovule → Ovule
- Integuments → Integuments
- Primary endosperm nucleus → Endosperm
- Zygote → Embryo

- Ovule with integuments → Seed coat and micropyle → micropyle
- Hilum → Hilum
- Scar of funicle → Scar of funicle
- Fruit wall → Pericarp
- Seed → Seed
- Ovule → Ovule
- Integuments → Integuments
- Primary endosperm nucleus → Endosperm
- Zygote → Embryo

- Ovule with integuments → Seed coat and the micropyle is retained

Importance of seed :-

- Dependable means :- offer reproductive processes such as pollination and fertilization in (independent of water), seed formation is more dependable.
- Dispersal :- seeds have various adaptive strategies are dispersed to new habitats & help the species to colonize to other areas.
- Preservation :- Seed is dry (eg cereal 10-15%) with dormant embryo and thick protective seed coat. It's most suitable for preservation through unfavourable period.
- Storage :- seed can be stored for years use. This is helpful for supply of food throughout the years and to overcome drought & famine condition.
  - Adaptation & dormancy of mature seeds are crucial for storage of seeds.
  - Some seeds also use to raise crop in next season
- Agriculture :- Seed is basis of our agriculture. Agriculture originate when human learn to eat, store and sow seeds.
- Reserve food :- Seeds have reserve food for nourishing the young seedlings, till they are capable of photosynthesis on their own.
- Protection :- Seed seed coat provide protection to the young embryo.
- Variations :- Being products of sexual reproduction, they generate new genetic combinations leading to variations. → Variation → Adaptation

Viability of Seeds :-

- The ability of seeds to retain the power of germination even a period of time after dispersal is called viability of seeds. All viable seed require water.
- In fact species the seeds loose viability within a few months.
- Seeds of large number of species live for several years.
- Some seeds can remain alive for hundreds of yrs.
- Some 2000 yrs old viable seeds of Phoenix dactylifera have been discovered during archeological excavation of king Herod's palace near dead sea.
- About 1,300 yrs old seeds of lupin arcticus taken out from arctic tundra have germinated and produced plants that flowered and bore fruits.
- Loss of viability is generally due to
  - Exhaustion of food around the embryo
  - Damage to embryo
  - Denaturation of Enzymes
  - Premature exhaustion of RNAs.

Fruit :-

- True fruits are ovulary
  - In bananas fruits develop without fertilization (parthenocarpy).
  - In tomato fruits develop from ovary, it is ripened ovary with developed under the influence of ripening ovules and it's meant for protecting them. In tomato & Pumkins formed from the wall of ovary and not from ovules.
- False fruit or (Pseudocarp)
  - In the some cases, thalamus and other floral parts assist fruitformation along with development of ovary wall.
    - eg. Apple - Pericarp + Cortex + Thalamus (thalamus also contribute to fruit formation)
- Fleshy fruits :- (Pulpy fruits)
  - Fruit wall is fleshy & succulents (pulpy)
  - Fruit wall differentiated into three layers - epicarp (outermost) and endocarp eg. guava, cherry, mango
- Dry fruits :- Fruit wall is dry. Pericarp is undifferentiated. Generally, (dry pericarp) eg. Groundnut, mustard
- Natural fruits
- Seedless fruits
- (Fruit formation & not fertilization)

Parthenocarpy :- (Gk parthenos virgin, karpos fruit)

- Production and development of seedless fruits is called parthenocarpy.
- In most species, fruits are the results of fertilization.
- In few special fruits develop without fertilization. Such fruits are called parthenocarpic fruits. eg. Banana.
- Parthenocarpy is induced through the application of growth hormone and such fruits are seedless.

false fruit of apple and strawberry

- orchid flowers contain thousands of tiny seeds
- similar to the case in fruits of some parasitic root species such as Orobanche and Striga. → obligate parasite

Significance of fruit formation :-

- Protection :- Developing fruits protect the developing seeds from mechanical injury, insects and unfavourable climatic condition.
- Dispersal :- Fruits help the seeds in dispersal to distant place.
- Food to animals
- Visibility to germinating seeds

Apomixis and Polyembryony :-

- Apomixis = (Apo-without mixis-mixing)
  - Apomixis is a mode of reproduction which does not involve formation of zygote through gamete fusion.
  - Apomixis is form of asexual reproduction that mimics sexual reproduction.
  - Eg. Some species of Asteraceae and Grasses.
- There are several ways of development of apomictic seeds.
- In some species the diploid egg cell is formed without reduction division and develops into embryo sac without fertilization.

Polyembryony :- We in many citrus and mango varieties some of the nucellar cells surrounding the embryo sac start dividing, protrudes into embryo sac and develop into embryos. In such species each ovule contain many embryos. Occurrence of more than one embryo in seed is referred to as Polyembryony.

- Polyembryony discovered by Leeuwenhoek (1719) in citrus.
- Polyembryony is the phenomenon of developing more than one embryo in the same seed.

(a) Simple polyembryony → Presence of more than one embryo sac and hence zygotes. eg. Brassica

(b) Mixed polyembryony → More than one pollen tube entering an ovule and fertilizing synergids or an oosphere of cells eg. citrus

(c) cleavage polyembryony :- Splitting of one embryo in to two or more. eg. orchid, Nymphea

(d) Adventive polyembryony :- Diploid nucellar or integument cells proliferate to form embryos eg. citrus, opuntia, Mangifera.

Poly embryony

- Is true
  - If extra embryos develop from same embryo sac
- Is false
  - If extra embryos are formed elsewhere.

"Twinsterns" → (Apomixis)

- Hybrid Vars are several of rice, food and vegetable crops are being eventually cultivable.
- Cultivation of hybrids has tremendously to productivity
- One of the problems of hybrids is that hybrid seeds have to be produced every year.
- Since seed obtained from hybrids are a mix, the plants from the progeny will segregate and show maximum of hybrid characters.
- Production of hybrid seeds are costly & hence cost of hybrid seeds become too expensive for farmers.
- To make hybrids are made apomictic, there is no segregation of characters in the hybrid progeny. Then the farmers can keep using the hybrid seeds to raise new crops year after year and he does not have to buy hybrid seeds every year.
- Because of importance of apomixis in hybrid and breeding active research is going on in many laboratories around the world to understand the genetics of apomixis and to transfer apomictic gene into hybrid varieties.

- Genetic nature of apomictic embryo is similar to parents and they can be called as clone.
- In a typical flower are ovary is not in ratio depend upon no. of carpels in flower.
- One egg usually not in an embryo sac
- usually one embryo sac not in an ovule
- Number of ovule/ovary varies from plant to plant