REPRODUCTION IN ANGIOSPERMS

- The life cycle o an angiosperm has two phases 1) sporophytic phase 2) Gametophytic phase
- Sporophyte stage is the dominant stage in angiosperm life cycle
- Sporophyte starts from the development of Zygote (2n)
- The gametophytic phase starts from the formation of micro and megaspores
- Heterospory is common in angiosperms
- Production of two types of spores in the same species is called heterospory

Microsporogenesis:

- Birth of pollengrains from pollen mother cells is called Microsporogenesis
- Pollengrains represent male gametophytes which fiether forms male gametes
- A typical anther has a column of sterile tissue called connective
- Anther lobe is present on eitherside of the connective
- Each antherlobe has two pollenchambers Or pollen sacs place longitudinally
- Each pollen chamber is called a microsporangium
- A dithecous anther has 4 pollen sacs or pollen chambers and thus have 4 microsporangia
- Monothecous anthers have two pollen sacs and thus 2 microspoprangia
- Microsporangium of anther at maturity consists sporogenous tissue covered by anther wall
- It consists Epidermis, Endothecium, middle layers and tapetum
- One cell thick outer layer for protection is called epidermis
- The epidermal cells present between two pollen sacs are thin walled and constitute Stomium
- Structure useful for the dehiscence of pollen sacs is called Stomium
- Stomium degenerates by the time the spore mother cells undergoes divisions
- Hypodermal layer of anther wall having rapidly elongated hygroscopic cells with fibrous thickenings of cellulose is called Emndothecium
- Endothecium attains maximum development when the anther is ready to dehisce.
- Endothecial cells are hygroscopic when they loose water they contract and help in dehiscence of pollen sacs
- 1-5 layers of cells between endothecium and Tapetum are middle layers
- Inner most layer that encircles the sporogenous tissue is called Tapetum
- These cells are bi or multinucleate with abundant cytoplasm
- Tapetum supplies nutrition to the sporogenous tissue and is completely utilized by the time of anther dehiscence

Sporogenous tissue:

- Tissue present insidethe anther wall is called sporogenous tissue.
- Sporogenous tissue is diploid (2n). this tissue cells undego mitosis and form microspore mother cells
- The diploid microspore mother cells divide meiotically and form Microspores
- Each microspore mother cell produce a tetrad(4) of microspores. This process is called Microsporogenesis
- Microspores released from tetrad are referred as pollen grains. Pollen grains are haploid (n) unicellular and uninucleate

- Pollen grains are spherical or oval shape with two layered spore walls
- Outer layer os exosporium or exine and the inner layer is called endosporium ot intine
- Exine is formed of a material called Sporopollenin
- It is thich protective wirh a spinous ornamentation.
- Thin circular spores on exine wall are called germ spores.
- The intine is made of pecto cellulose
- Pollen grain is considered to be the first cell of male gametophyte
- It produces two unequal cells by periclinal division, larger Vegetative cell or tube cell and the smaller one is called generative cell.
- Pollen grains are liberated at **2 celled stage**
- Pollen grains germinate on the stigma with help of stigmatic secretions and produce **pollen tube**
- Intine of pollen grain comes out through germ pore and at the region of vegetative cell produce **pollen tube**
- 1 pollen tube develops from each pollen grain and are called **Monosiphonous** pollen grains.
- In Malvaceae and Cucurbitaceae **polysiphonous condition** is seen (more than one pollen tube from each pollen grain)
- Vegetative nucleus and germinative cell enter the pollen tube
- First the vegetative cell and behind it generative cell are present at the apex of the pollen tube but they change their position and the generative cell comes near to the tip and divides mitotically and forms two sperm cells or male gametes.
- Now pollen tube has 1 vegetative cell and 2 sperm cells or male gametes
- Vegetative cell degenerates and the pollen tube moves through the style and reach the ovule

Ovules and megasporogenesis:

- Integumenyted megasporangia are called Ovule
- Ovules are characteristic of phanerogams (both angiosperms and gymnosperms)
- The production of megaspore with in the ovule is called megasporogenesis.
- Megaspore further divides and forms embryosac
- Ovules attached to the placenta with the help of Funiculus
- The point of contact is called hilum
- The ovule contains a nutritive tissue called Niucellus (2n)
- 1or 2 layers of integument is present around the nucellus
- Based on the number of integuments Ovules are classified in to three types

i. Ategmic ovules: nucellus is not covered by the integument Eg: Loranthus, Balanophora
ii. Unitegmic or Monotegmic ovules: ovules covered by one integument Eg: members of Asteraceae and Solanaceae (gamopetalae members of dicots)
iii. Bitegmic ovules: the nucellus is covered by two ingteguments Eg; monocots and polypetalae members of dicots

- The place where nucellus and integument unite is called **Chalaza.** Integument do not cover the nucellus completely but leaves a apical opening called **Micropyle.**
- Hence anterior part of ovule is micropylar end and posterior region is chalazal end.
- Each ovule encloses a large **embryosac or female gametophyte.**
- Based on the position of the micropyle Ovule are classified in to 6 types

- Straight ovule with micropyle, chalaza and funicle lie in vertical plane is called orthotropous ovule. Eg. Polygonum
- Ovule body inverted (180^0) micropyle comes veryclose to funiculus but funiculus will not lie in the same straight line. The funiculus will form a ridge called raphe.
- Eg; mll most all members of gamopetalae and is also found in several families of dicots and monocots.
- If the body of the ovule is place at 90^0 to the funiculus then is called hemi antropous ovule Eg: Ranunculus and Primula
- Camphylotopous ovule:body of the ovule is place at right angles to funiculus but the body of the ovule shows a curvature (90^0 to 160^0) which brings micropyle towards the funiculus. Embryosac is straight. Eg. Fabaceae, Brasicacea
- Amphitropous ovule; the curvature of the body of ovule is more than that of campylotropous ovule and embryosac becomes horse shoe shaped. Degree of curvature is 160^0. Eg. Alismaceae and Butamaceae
- Circinitropous ovule: rare form of ovule. Funiculus is very long and coiled like watch spring around the body of the ovule.forst ovule is arthotropous then due to coiling of funiculus body rotates from orthotropous to anatropous and back to orthotropous by 360+0+. Eg. Opuntia and Plumbago

Megasporogenesis:

- Archesporial cells (2n) are developed from nucellus
- Archesporial cell divides periclinally to form outer oarietal cell and inner Sporogenous cell(2n) which develops in to megaspore mother cell.
- In some plant archisporial cell directly develops in to megaspore mother cell.
- This diploid megaspore mother cell undergoes meiosis forming a **tetrad of haploid megaspores** and the peocess is called **Megasporogenesis**
- Bout of four megaspore 3 upper megaspores near micropylar end degenerate and only onelower fourth one remains functional called functional megaspore.
- This one acts as a mother cell for the development of embryosac or female gametophyte
- This functional nucleus undergoes free nuclear divisions and first formed two nuclei are called micropylar nuclei and cahalazal nucleus.
- These nuclei undergo one more division each simultaneously and produce a two nuclei eacg which in turn undergo producing **8 nucleated stage**.
- This elongated functional megaspore is called embryosac or female gametophyte.
- One nuclei among four in micropylar end is called **upper polar nucleus** and in the same one in chalazal end is called **lower polar nuclei.**
- These two polar nucleus migrate to centre of the embryosac and fuse to form a **diploid secondary nuleus** and it is enclosed in a central cell
- The three nuclei at micropylar end form into **Egg apparatus** by the formation of the cell walls
- The three nuclei at the chalazal end develop in to **Antipodals** by developing cell walls
- This 8 nucleated 7 celled embryosac is described as female gametophyte.
- Embryosac is developed from single megaspore and hence called **Monosporic type. Eg: Polygonum**
- In Alium it develops from two megaspore called **Bisporic**
- In Fritillaria, peperomia it cdevelops from all the four megaspore mother cells and hence called **Tetrasporic**
- **Among all these types monosporic or polygonum type is most common type.**
- The female gametophyte of angiosperms is called embryosac
- Most common type of embryosac in angiosperms is 8 nucleated and 7 celled and is called polygonum type.

- 3 nuclei of embryo sac towards micropylar end develop in to **Egg apparatus**
- Among these 3 cells middle cell develops in to **Egg cell** and other two cells are **synergids.**
- Synergids contain projections called **filiform apparatus**
- Filiform apparatus help in conduction of food material from nucellus to embryosac
- Also direct the movement of pollentube towards the embryosac by secreting some chemicals
- 3 cells on the chalazal end are called ANTIPODALS. They remain ephemeral and degenerate before or after fertilization
- Antipodals are regarded as vegetative cells of the embryosac
- Largest cell of the **embryosac is Central cell** with a centrally located vacuole and two polar nuclei**.**
- **Two polar nuclei fuse to form secondary nuleus.**
- **This fusion occurs before after the pollen tube entry in to embryosac**