Reproduction in Lower & Higher Plants

Reproduction in Organisms

- The period from birth to the natural death of an organism represents its life span.
- The life cycle of an organism has 3 phases i.e., juvenile, reproductive and senescent phase.
- Reproduction enables the continuity of the species from one generation to another.

Asexual Reproduction

- In asexual reproduction offspring is produced by a single parent with or without the involvement of gamete formation.
- Morphologically and genetically similar individuals produced asexually are referred to as clones.
- Cell division is itself a mode of reproduction in unicellular organisms e.g., Amoeba, Paramecium.
- Animal and microbes can reproduce asexually through fission, budding, regeneration, etc.
- In plants, the term vegetative reproduction is used for asexual reproduction.
- In plants, roots, underground stem, creepers and leaves acts as a vegetative propagules.
- Bamboo species flower only once in their life time after 50-100 years. Strobilanthus kunthiana flowers once in 12 years, it last flowered during September-October 2006.
- In parthenogenesis female gamete develops into new organism without fertilisation.

Sexual Reproduction

- Remarkable fundamental similarity occur in process of sexual reproduction among different organisms despite different structures for reproduction.
- Reproductive processes and associated behaviours are regulated by hormones and environmental factors.
- Continuous breeders can breed throughout the year.
- Seasonal breeders can breed in specific season.
- Oestrus cycle is the main reproductive cycle of the non-primates vertebrates
- Menstrual cycle is the main reproductive cycle of the primates mammals.
- Gametogenesis and gamete transfer are the pre-fertilasation events of sexual reproduction.
- Gametogenesis involves the formation of gametes.
- Meiocytes are gamete forming diploid cells/gamete mother cells.
- Gametes are haploid in nature i.e., receive only one set of chromosomes at the end of meiosis.
- A haploid parent produces gametes by mitotic divisions (Monerans, Fungi, Algae, Bryophytes).
- A diploid parent produces haploid gametes by meiosis (Pteridophytes, Gymnosperm and Angiosperm).
- Gamete transfer enables bringing together of male and female gametes physically leading to fertilisation.
- Internal fertilisation occurs inside female reproductive tract whereas external fertilisation usually occurs in water.
- Fertilisation is the most vital event of sexual reproduction.
- In seed plants, pollen grains are the carrier of the male gametes. A specialised event called pollination facilitates the transfer of pollen grains to the stigma. Successful transfer and coming together of gametes is essential for the most critical event sexual reproduction, the fertilisation.
- Zygote is a vital connecting link ensuring continuity of species between generations.
- In oviparous animals, either of the external and internal fertilisation takes place. In these animals, parental care is very less.
- Viviparous animals shows internal fertilisation. In these animals, parental care is very high.
- Embryogenesis is the process of development of embryo from the zygote.

- In flowering plants, zygote develops into embryo, ovule into seed, ovary into fruit which has thick wall called pericarp that is protective in function.
- End of reproductive phase is a parameter of senescence, slowing of metabolism and it ultimately leads to death.

Sexual Reproduction in Flowering Plants

Parts of flower

- All flowering plants show sexual reproduction.
- A complete flower consists of calyx, corolla, androecium and gynoecium.
- Androecium is the male reproductive structure that consists of a whorl of stamens.
- Gynoecium is the female reproductive structure that consists of a whorl of carples (pistils).
- Each pistil has three parts.
- Stigma: Landing platform for pollen grains.
- Style: Elongated slender part beneath the stigma.
- Ovary: Basal bulged part of pistil, has ovarian cavity (locule). Placenta is located inside ovarian cavity.
- A typical stamen is composed of filament and anther.
- Filament: It is a long slender stalk. The proximal end of the filament is attached to the thalamus or the petal of the flower.
- Anther is terminal and generally bilobed structure and each lobe having two theca i.e., they are dithecous.
- The anther is a four-sided (tetragonal) structure consisting of four microsporangia located at the corners two in each lobe.
- The microsporangia develop further & become pollen sacs. They extend longitudinally all through the length of an anther and are packed with pollen grains.

Structure of Microsporangium

- A typical microsporangium near circular, which is generally surrounded by four wall layers.
- The outer 3 wall layers perform the function of protection and help in dehiscence of anther to release the pollen. The innermost wall layer tapetum nourishes the developing pollen grains.
- Microsporogenesis is a process of formation of microspores from PMC (Pollen Mother Cell).

Pollen Grain

- It represents the male gametophyte.
- It has prominent two layered wall-exine and intine.
- The outer layer exine is made up of sporopollenin and the intine is made up of pectin and cellulose.
- Pollen grains of many species causes severe allergies.
- Pollen grains are rich in nutrients.
- Pollen variability: depends on both temperature and humidity.
- Pollen of a large number of species can be stored for years in liquid nitrogen (–196°C) in pollen banks for crop breeding programmes.

Female Gametophyte/Embryo Sac

- Ovules generally differentiate a single megaspore mother cell (MMC) in micropylar region of nucellus.
- In majority of flowering plants, one megaspore remains functional and 3 degenerate. The functional megaspore develops in to the female gametophyte (embryo sac).
- The typical angiosperm embryo sac (female gametophyte) possess 8-nucleate and 7-celled condition at maturity.

Pollination

- Pollination is the transfer of pollen grain from anther to the stigma of the same flower (self pollination) or of different flower (cross pollination) of the same species.
- Self pollination is of two types i.e, autogamy and geitonogomy.
- Autogamy can be promoted by cleistogamy.
- Xenogomy (cross pollination) is the only type of pollination which brings genetically different types of pollen grains on the stigma.
- Geitonogamy functionally similar to cross pollination and genetically it is similar to autogamy (self pollination).
- Wind and water are common abiotic pollinating agents.
- Wind Pollination requires light, non-stickly pollen so that they can be transported by wind currents. Well exposed stamens and large often feathery stigma to trap air borne pollen, single ovule in each ovary and numerous flowers in an inflorescence.
- In majority of aquatic plants like water hyacinth and water lily, flowers emerge above water & are pollinated by insects or wind.
- In most water-pollinated species, pollen grains are protected from wetting by a mucilaginous covering.
- Insect-pollinating flowers are large, colourful, fragrant and rich in nectar.
- Nectar & pollen grains are usual floral rewards for pollinators.
- In some species, floral rewards are in providing safe places to lay eggs, eg, Amorphophallus. A species of moth and Yucca cannot complete their life cycles without each other.

Outbreeding devices

- Flowering plants have developed many out breeding devices to discourage self pollination and to encourage cross pollination. For example:
- Pollen release and stigma receptivity are not synchronised.
- Anther and stigma are placed at different positions so that pollen cannot come in contact with stigma of the same flower.
- Self-incompatibility is a genetic mechanism which prevents self-pollen from fertilizing the ovules by inhibiting pollen germination or pollen tube growth in the pistil.
- Production of unisexual flowers.

Pollen-pistil Interaction

- Pollen-pistil interaction is a chemical-mediated dynamic process.
- Following compatible pollination, pollen tube grows through the tissues of the stigma and style, the contents of pollen grain move into pollen tube.
- The growing pollen tube carrying two non-motile male gametes, reaches the ovary, enters the ovule through micropyle & then enters one of the synergids through the filiform apparatus, which guides the entry of pollen tube.
- One male gamete fuses with egg cell and other with PEN.
- In artificial hybridisation, desired pollen are used for pollination and stigma is protected from contamination from unwanted pollen by emasculation and bagging.
- If female flowers are unisexual, there is no need of emasculation.

Double Fertilisation

- Syngamy & triple fusion are together called double fertilisation, an event unique to flowering plants.
- The central cell after triple fusion becomes primary endosperm cell (PEC) and develop into endosperm.

Endosperm

- Endosperm development precedes embryo development. As it is filled with reserve food materials and used by developing embryo.

Embryo

- Embryo develops at micropylar end of embryo sac where the zygote is situated.
- Early stages of embryo development (Embryogeny) are similar in both monocotyledons and dicotyledons.
- In dicots, the stages of embryo development are: proembryo → globular → heart-shaped → mature embryo.
- Embryos of monocot has only one cotyledon called scutellum Radicle or root cap is enclosed with undifferentiated sheath called coleorhiza. Epicotyl has shoot apex & a few leaf primordia enclosed in foliar structure coleoptile.

Seed

- In angiosperms, seed (fertilised ovule) is the final product of sexual reproduction, formed inside fruits. A seed typically consists of seed coats, cotyledon(s) & an embryo axis.
- Mature seeds may be non-abuminous or ex-albuminous, having no residual endosperm, which is consumed completely during embryo development (eg. Pea, groundnut). Albuminous seeds retain a part of endosperm (eg. Wheat, maize, barley, castor, coconut).
- In black pepper & beet, remnants of nucellus are also persistent, called perisperm.
- True fruits develop from ovary.
- In apple, strawberry, cashew, etc., thalamus also contributes to form fruit called false fruit.
- Parthenocarpic fruit develop without fertilisation eg., Banana.
- Lupinus arcticusseed germinated and flowered after estimated record 10,000 years of dormancy. Phoenix dactytifera (date palm) seed remained viable for 2000 years.

Apomixis and Polyembryony

- Some species of Asteraceae & grasses have evolved a special mechanism to produce seeds without fertilisation called apomixis.
- In Citrus and mango, nucellar cells protrude into embryo sac & develops into embryos, so each ovule contains many embryos (polyembryony).