REPRODUCTION IN ORGANISMS

Life Span

The period from birth to the natural death of an organism is called its ***life span.*** Life span of organisms are not necessarily correlated with their size. The size of crows and parrots are not very different yet their life span [Crow (15 yr.), Parrot (140 yr.)] show a wide difference.

Reproduction

- Reproduction is a biological process in which an organism produces offspring similar to maintain continuity of its species, generation after generation.
- Reproduction leads to growth of population and increases the number of species.
- Major types of reproduction
  - Based on whether there is participation of one organism or two, reproduction is of two types asexual and sexual.

Asexual Reproduction

- ***Definition :*** When the offspring is produced by a single parent with or without the involvement of gamete formation, the reproduction is called asexual.
- ***Occurrence :*** Asexual reproduction is common in single celled organisms such as protozoans (*e.g., Amoeba, Paramecium, Euglena*), Sponges (*e.g., Sycon*), Coelenterates (*e.g., Hydra*), Flat worms (*e.g., Planaria*), Annelids (*e.g., Syllis*) etc.
- ***Characteristics of Asexual Reproduction :*** These are as follows :
  (i) A single parent is involved (uniparental condition).
  (ii) Gametes may or may not formed.
  (iii) No fertilization.
  (iv) There is usually mitotic cell division.
  (v) Offsprings are genetically identical to the parent and called colones.
  (vi) Multiplication occurs rapidly.
- ***Types :*** Asexual reproduction occurs in various ways :

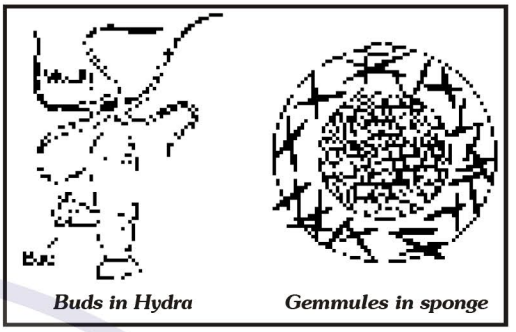
(i) ***Binary Fission :*** In this process, the parent organism divides into two equal halves, each half forming an independent daughter organism. Binary fission involves mitosis. The resultant offsprings are genetically identical to the parent and each other. Examples : *Amoeba, Euglena, Paramecium, Planaria, Ceratium etc.*

(ii) ***Multiple Fission :*** In this process, the parent body divides into many daughter organisms. Examples : *Amoeba, Plasmodium, Monocystis* (all protozoans).

(iii) ***Plasmotomy :*** In this process, the multinucleate parent divides into many multinucleate individuals Examples : *Opalina* and *Pelomyxa* (Protozoans).

(iv) ***Budding :*** In this process, a daughter organism is formed from a small projection, the bud, arising from the parent body. It is of two types :

External Budding : In this type of budding, an outgrowth or bud grows externally on the surface of the body. The bud may split away from the parent and take up an independent existence. Example : (*e.g., Spongilla)* and a few marine sponges buds are formed within the parent's body. They are called ***gemmules*** (internal buds).



(v) ***Fragmentation :*** In this process, the body of the parent breaks into pieces and then each piece develops into a whole organism. Example : It is common among certain flatworms, sponges and coelenterates.

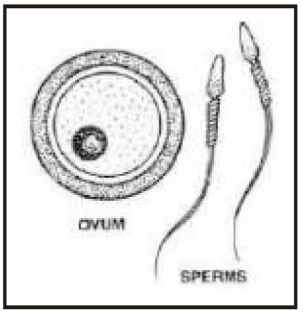
- ***Significance of Asexual Reproduction :*** Since there is no variation, it does not contribute to evolution of species. However, it involves rapid multiplication of the species.

Sexual Reproduction

- When an offspring is produced by two parents, (male and female), with the formation of gametes, it is known as sexual reproduction. It involves four processes :
  (i) Formation of haploid cells, the gametes, by gametogenesis (meiosis),
  (ii) Fusion of two gametes leads to formation of diploid cells, the zygotes (fertilization),
  (iii) Repeated mitotic divisions of the zygotes to form embryos (embryogenesis),
  (iv) Growth of embryos into new individuals (development).
- ***During sexual reproduction :*** The offspring produced are not identical to their parents or fellows because there is fusion of male and female gametes.
- ***Phases in Life :*** There are three phases in an organism's life : juvenile phase, reproductive phase and senescent phase.
  (i) ***Juvenile phase/Vegetative phase :*** All organisms have to reach a certain stage of growth and maturity in their life before they can reproduce sexually, that period of growth is called the juvenile phase. This phase is known as vegetative phase in plants. This phase is of different durations in different organisms.
  (ii) ***Reproductive phase :*** Starts after the juvenile phase and remains upto the stage when an organism is capable of reproduction. This phase is of variable duration in different organisms. Among animals, birds living in nature lays eggs seasonally while birds in poultry farms lay eggs throughout the year. In primates (monkeys, apes and humans) cyclic changes during the reproductive the year. In primates (monkeys, apes and humans) cyclical changes during the reproductive phase is called the menstrual cycle, whereas in non-primate mammals like cows, sheep, rate, deer, dogs, tiger, etc. such cyclical changes during reproduction are called oestrous cycle.
  (iii) ***Senescent phase*** is the last phase of the life span, which marks the end of the reproductive phase and the onset of the progressive deterioration in the body, ultimately leads to the death of the organism.
- Many mammals, especially those living in wild areas, exhibit oestrous/menstrual cycle only during favourable conditions in their reproductive life. Such animals are known as seasonal breeders. Many animals are reproductively active throughout their reproductive life and are known as continuous breeders.
- ***Event in Sexual Reproduction :*** These event may be grouped into three stages : Pre-fertilization, Fertilization and Post-fertilization events.

(1) Pre-fertilization Events :

- These events of sexual reproduction occur prior to the fusion (fertilization) of the male and female gametes. These events are ***gametogenesis and gamete transfer.***



- ***Gametogenesis :***
  - (i) It is the process of formation of two type of gametes–male and female. Gametes are haploid cells.
  - (ii) ***Sexuality in Organisms :*** In sexual reproduction cross fertilization or exogamy (fusion of gametes from two different individuals) occurs. Self fertilization is observed in *Taenia* (tapeworm). Self fertilization or endogamy (fusing gametes from the same individual) is common in plants.
  - (iii) Animals such as earthworm, sponge, tapeworm and leech are bisexual (hermaphrodites) and cockroach, frog, lizards, birds and mammals are unisexual.
- ***Gamete Transfer :***
  - (i) After the formation of male and female gametes, they must be brought together for fertilization. In most of organisms male gamete is motile and the female gamete is nonmotile.
  - (ii) Unisexual animals have copulatory organs to transfer the male gametes. Transfer and coming together of gametes is essential for fertilization in sexual reproduction.

(2) Fertilization :

- Fertilization is the complete and permanent fusion of two gametes from different parents or from the same parent to form a diploid zygote. The process is also called syngamy.
- Syngamy occurs either in external medium (water) or inside the body of the organism. There are two types of gametic fusion; external syngamy or external fertilization and internal syngamy or internal fertilization.
  - (i) ***External Syngamy :*** When syngamy occurs outside the body of the organism, it is called external fertilization or external syngamy. An external medium such as water is required for this type of fertilization. In most aquatic organisms such as a majority of algae, fishes, and amphibians, external fertilization occurs. A major, disadvantage of this type of fertilization is that the offsprings are not protected from predators and their survival is threatened upto adulthood.
  - (ii) ***Internal Syngamy :*** When egg is formed inside the female body, where it fuses with the male gamete, it is called internal fertilization or internal syngamy. Higher animals such as reptiles, birds and mammals, internal fertilization occurs. The number of sperms produced is very large but there is a reduction in the number of eggs produced.

(3) Post Fertilization Events :

- The events in sexual reproduction that occur after fertilization (formation of zygote) are called post-fertilization events. These events may be described under two headings : zygote formation and embryogenesis.

(i) ***Zygote formation :*** After fertilization a diploid zygote is formed in all sexually reproducing organisms. In external fertilization, zygote is formed in the external medium (usually water) whereas in internal fertilization, it is formed inside the body of the organism. Further development of the zygote depends on the type of life cycle of the organism and its environmental conditions.

(ii) ***Embryogenesis :*** The process of development of an ***embryo*** from a zygote is called ***embryogenesis.*** During embryogenesis the zygote undergoes ***mitotic cell division*** and ***cell differentiation.*** The cell division increases the number of cells while cell differentiation helps information of specialized cells and organs.

Significance of Sexual Reproduction

Since there are variations in sexual reproduction, it contributes to evolution of the species.

Parthenogenesis (Virgin Birth or virginal Reproduction)

- Development of an egg (ovum) into a complete individual without fertilization by a sperm is known as ***parthenogenesis.***
- ***Occurrence :*** Parthenogenesis occurs in many invertebrates such as Rotifers (wheel animals), Arthropods, *viz.,* Crustaceans (*e.g.*, *Apus, Cypris, Daphnia*), insects (*e.g.,* bees, wasps, beetles, ants, aphids, grasshoppers, weevils, gall flies) and Arachnids (*e.g.,* spiders, ticks, mites.).
- Parthenogenesis is of two types : ***natural*** and ***artificial.***

(I) ***Natural Parthenogenesis :*** It occurs regularly in the life cycle of certain animals. It may be complete, incomplete or paedogenetic.

(i) ***Complete (Obligatory) Parthenogenesis :*** It occurs in those animals which breed exclusively by parthenogenesis. there are no males and, therefore, such individuals are represented by females only. Example : Lacerta saxicola armaniaca (Caucassian rock Lizard).

(ii) ***Incomplete (Cyclic) Parthenogenesis :*** It is found in those animals in which both sexual reproduction and parthenogenesis occur. Example : In honey bees, fertilized eggs (zygotes) give rise to queens and workers (both are females) and unfertilized eggs (ova) develop into drones (males).

(iii) ***Paedogenetic Parthenogenesis (Paedogenesis).*** When a larva produces a new generation of larvae by parthenogenesis, it is called paedogenetic parthenogenesis or paedogenesis. Example : Sporocysts (larvae) and radiae (larvae) of liver fluke.

(II) ***Artificial Parthenogenesis :*** In this type of parthenogenesis, the egg (ovum) is induced to develop into a complete individual by artificial stimuli. Artificial parthenogenesis may be induced by physical or chemical stimuli. Example : Eggs (ova) of annelids, molluscs, echinoderms (sea urchin, star fish), frogs, salamanders, birds (turkey) and even mammals (rabbit) may be induced by physical or chemical stimuli to develop parthenogenetically into complete individuals.

Significance of Parthenogenesis

(a) ***Advantages***

(i) It is a simpler and easier means of reproduction.

(ii) It represents a method of rapid multiplication.

(iii) It permits establishment of triploid and aneuploid chromosomal combination.

(iv) It is a means of sex determination of animals such as in honey bees. Thus, it supports the chromosomal theory of sex determination.

(b) ***Disadvantages***

(i) It eliminates variation in population. So it does not play any role in organic evolution.