

- Reproduction is a biological process in which an organism gives birth to offspring similar to itself.
- Reproduction enables the retention continuity of the species, from generation to generation. The genetic variation is created and inherited during reproduction.
- When offspring is produced by a single parent without the involvement of gamete formation, the reproduction is called asexual.
- When two parents ( opposite sex) participate in the reproduction process and also involve fusion of male and female gametes, it is called sexual reproduction.

## ASEXUAL REPRODUCTION

- In asexual reproduction, a single parent is involved and is capable of producing offspring. As a result, the offsprings that are produced are not only identical to one another but are also exact copies of their parent. Asexual reproduction is common among single celled organisms, and in plants and animals with relatively simple organizations. It is also seen in multicellular organisms.

## ASEXUAL REPRODUCTION IN ANIMALS

In animals the common mode of asexual reproduction are as follows

### (1) Fission

- This method is observed in protists and monerans. In fission, the nucleus divides first and the cytoplasm next. Subsequently, the mother cell splits into two equal sized daughter cells. This division is of cell division type.
- When the cytoplasmic division passes through any direction ( e.g. amoeba) the fission is called simple binary fission.
- If the plane of cytoplasmic division coincides with the transverse axis of the individual the fission is termed transverse binary fission. E.g. paramecium and planaria.
- In Euglena and vorticells, the plane of cytoplasmic division coincides with the longitudinal axis of the individual. This kind of fission is designated as longitudinal binary fission.
- Binary fission involves mitosis only and consequently the resultant offsprings are genetically identical to the parent and to each other. It may be mentioned here that genetically identical offsprings resulting from a single parent are considered as clones.
- Sometimes, the nucleus divides several times by amitotic divisions (nuclear). Thus large number of nuclei are formed. Cytoplasm does not divide during this period. Then cytoplasm collects around each nucleus. Thus, with one material cells, innumerable unicellular and uninucleate

offspring are formed. In course of time, they live as independent, unicellular organisms. This method of reproduction is called multiple fission. Multiple fission is observed in Amoeba and Paramecium.

## (2) Sporulation

- Sporulation occurs during unfavourable conditions. Organisms like Amoeba withdraw their pseudopodia and become round in shape. They create a hard protective three layered cyst around themselves, this process is called encystation.
- When conditions become favourable, the nucleus of encysted Amoeba undergoes multiple divisions and large number of Amoeba are formed. These are called pseudo-podiospores. This process is called sporulation. When the cyst ruptures all new Amoebae are released. In plasmodium this process occurs at a specific stage in its life cycle.

## (3) Budding

- In this method, first of all, cells of some parts of the body of the animal repeatedly undergo mitotic cell divisions and the raised regions of cell masses, called bud, are formed. From such a bud a young animal develops. It separates from the parent body and lives as independent animal.
- If such a bud is produced on the outside of the body it is called exogenous budding. In Hydra, exogenous budding is observed.
- In freshwater sponge (e.g. Spongilla) and marine sponge (e.g. Sycon) specialized cell masses are produced towards the inside of the body. An envelope surrounds this cell mass. Such structures are called internal buds or gemmules. Each gemmule gives rise to a new animal. This is called endogenous budding.

## (4) Fragmentation

- In this method of reproduction, the body becomes fragmented into several distinct parts. Each part develops the remaining body parts and becomes a complete animal. This capacity is known as regeneration. Fragmentation is observed in planaria, Hydra, Starfish, etc.

## ASEXUAL REPRODUCTION IN PLANTS

- The common modes of asexual reproduction in plants is as following:

### (1) Fission

- It is the simplest method, commonly found in algal, fungi and monerans (bacteria). In this process, the unicellular mother cells divide mitotically to form two daughter cells; each eventually grows into an independent organism.

## (2) Buds

- Some algal produces adventitious branches ( e.g. dictyota, focus) or buds (e.g. protosiphon). Where as fungus like yeast produces buds. These structures are formed due to unequal division and are attached to the parental cell which eventually gets separated and matured into a new organism.

## (3) Fragmentation

- In some algal ( e.g. Ulothrium, Dedogonium, spirogyra and zygnuma) and fungi ( e.g. mucor, Rhizopus, saprolegnia), the vegetative thallus or hyphae break up into small segments due to mechanical pressure and each segments is capable of growing into a new mycelium.

## (4) Spore formation

- Asexual reproduction takes place by a variety of motile and non-motile spores / conidia.
- Ciliate motile spore, called zoospores are produced by algal and fungi, which swim in water for some time with the help of their flagella and then directly develops into new independent individuals e.g. ulothrix, chlamydomonas, oedogonium.
- Non-flagellate and non-motile spores/ conidia of various common among terrestrial fungi. Such spores are light, dry and provided with a tough coat and are well adapted for dispersal by wind. E.g. penicillium, Aspergillus.
- True spores are always born by a sporophyte. Thus, the sporophyte of mass produces asexually by spores. Similarly ferns ( Nephrolepis) bear spores and reproduce asexually by them. These plants are homosporous ( bear only one kind of spores).
- While in selaginella ( a pteridophyte) and gymnosperms are hetrosporous ( bear two types of spores)
- In flowering plants the method of vegetative propagation or reproduction are grouped into natural and artificial.
  - (i) NATURAL METHODS
    - In natural methods of propagation, the development of a new plants from some organ of the mother plant under suitable environmental conditions is very common. Such special reproductive organs develop from stem, leaf, root or even flower.
    - Vegetative reproduction occurs through roots in sweet potato, Asparagus and Dahlia.
    - In plants like Bryophyllum, buds develop in the margins of leaves. These buds produce new plants.

- In plants like Agave and Oxalis, floral buds produce new plants and in Dioscorea, axillary buds do so.
  - Among the other natural methods of vegetative propagation, runners observed in lawn grass, offsets found in Pistia, Stolons in Nephrolepis and Suckers in mint plants.
- (ii) ARTIFICIAL METHODS
- Methods are developed for artificial vegetative propagation in which some part of the plant organ is utilized for obtaining a new complete plant. Amongst them the most common methods are – cutting. Layering and grafting.
- a) Cutting
- Cut pieces of root are planted in moist soil and development of adventitious roots is artificially induced. New plants are developed in this way in lemon and tamarind.
  - In Rose, sugarcane, croton, china-rose and chrysanthemum plants, proper size of stem pieces are obtained and are planted in moist soil to develop new plants. From the underground parts of stem, adventitious roots develop and buds on the aerial parts of stems develop and buds on the aerial parts of stems sprout. The plants, so developed is called a 'cutting'. Later, these cutting are transplanted in proper places.
- b) Layering
- This method is employed in the cultivation of Rose, Lemon, Grape, Hibiscus and jasmine. The lower branches of the plant are bent and pressed under the soil in such a way that the tip of the branch remains outside the soil and the middle portion is buried inside the soil. When adventitious roots develop from this buried region of plant stem, this branch is cut and separated from the parent plant. Thus, a new plant is obtained.
- c) Grafting
- Grafting is practiced in plants which do not root easily, or have a weak root system. In this method a union is established between two plants of the same or different kinds. Such a union is established between tissues of the two plants. This process can be induced more meristematic tissue.
  - The main supporting plant is called stock plant. The plant which is being grafted on it is called scion. A plant possessing higher and desirable characters is selected as 'scion' various methods of grafting scion are practiced. Mango, Apple, Pear, Citrus, Guava, Litchi and many other fruit – yielding plants are thus obtained and maintained.

- Grafting may be of different types, namely bud grafting, side grafting, tongue grafting. Wedge grafting and crown grafting depending on the methods of uniting the two parts.

## SIGNIFICANCE OF VEGETATIVE REPRODUCTION

1. Vegetative reproduction is an ideal method of reproduction in plants in which it is desirable to maintain the same characteristic in the offspring which are present in the parents.
2. Plants showing reduced power of sexual reproduction, long dormant period of seed or poor viability can also be multiplied easily through this method.
3. Vegetative reproduction also helps in removing common infections from the parent plant.
4. In the plants raised through grafting, it is even possible to bring together the desired characters from two plants.

## SEXUAL REPRODUCTION

- Sexual reproduction involves formation of the male and female gametes, either by the same individual or by different individuals of the opposite sex. Thus gametes fuse to form the zygote which develops to form the new organism. It is a complex and slow process as compared to asexual reproduction. Because of the fusion of male and female gametes, sexual reproduction results in offspring that are not identical to the parents or amongst themselves.
- Though the plants, animal or fungi differ in external morphology, anatomy and physiology, yet their sexual mode of reproduction is similar in pattern. All organisms reach a certain stage of growth and maturity in their life before they can reproduce sexually. This period is called the juvenile phase and in plants it is known as vegetative phase.
- After attaining maturity, all sexually reproducing organisms show events and processes which have fundamental similarity, but the structures associated with sexual reproduction are quite different. In all cases, the sexual reproduction is characterized by the fusion of the male and female gametes of the species. For convenience these sequential events may be grouped into three distinct stages namely, the pre fertilization, fertilization and the post fertilization.

## PRE-FERTILIZATION EVENTS

## 1. Gametogenesis

- Gametogenesis is the process of formation of gametes. Generally gametes are of two types; male and female gametes. Gametes are haploid (n) cells. In some algal where two gametes are similar in appearance they are called isogametes or homogametes. It is morphologically and physiologically similar and usually notice and has flagellates (e.g. Cladophora, Ulothrix). However in a majority of sexually reproducing organisms the gametes produced are of two morphologically and physiologically distinct types which are known as heterogametes or anisogametes. The male gametes are smaller and more active where as the female gametes are larger and sluggish. In such cases the male gametes is called anthrozoid or sperm and the female gamete is called egg or ovum.
- Gametes are always haploids, but the parent plant body from which they arise many be either haploid or diploid. A haploid parent produces gametes by mitotic division. Several organism belonging to Monera, Fungi, Algae and Bryophyta, Gymnosperms, Angiosperms and most of the animals, the parental body is diploid. Here meiosis takes place to produce haploid gametes.
- In diploid organisms the meiocytes undergo meiosis, only one set of chromosomes (n) gets incorporated in each gamete.

## (2) Gamete transfer

After formation, the male and female gametes are brought together to facilitate fertilization. In a majority of organisms, male gamete is motile and the female gamete is stationary. There is need for a medium though which the male gametes move. In Algae, Bryophytes and Pteridophytes, water is the medium through which this gamete transfer takes place.

- A large number of the male gametes, however, fail to reach the female gametes. To compensate this loss of male gametes during transport, the number of male gametes produced is several thousand times the number of female gametes produced.
- In angiosperms pollen grains are the carriers of male gametes and ovule has the egg cells. Pollen grains are produced in anthers and are transferred to stigma, a phenomenon, which is known as pollination. This phenomenon requires the involvement of external agents such as insects, animals, wind and water pollen grains germinate on the stigma and the

pollen tubes carrying the male gametes reach the ovule and discharge two gametes near the egg cell.

- In bisexual animals, since male and female gametes are formed in different individuals, the organism must evolve a special mechanism for gamete transfer. It is essential for fertilization.

## FERTILIZATION

- The fusion of two similar or dissimilar gametes is called syngamy and in its result diploid zygote is formed. This process is known as fertilization.
- In majority of algae, fishes and amphibians syngamy occurs in the external medium i.e. water ( Outside the body of organisms). This type of gametic fusion is called external fertilization. This happens in the bony fishes and frogs where a large number of offspring are produced. A major disadvantage is that the offspring are extremely vulnerable to predators threatening their survivals up to adulthood.
- In plants group (i.e. fungi, bryophytes and pteridophytes) as well as reptiles, birds and mammals, syngamy occurs inside the body of the organism, hence the process is called internal fertilization. In this process, male gametes are motile and have to reach and fuse with egg. This takes place inside the female body.
- In seed plants, the non-motile male gametes are carried to female gamete by pollen tubes.

## POST-FERILIZATION EVENTS

### 1. Zygote

- Formation of zygote ( $2n$ ) is common in all sexually reproducing organism. In organism with external fertilization, the zygote is formed in the external medium ( water), whereas in those exhibiting internal fertilization, zygote is formed inside the body of organism. Further development of zygote depends on the type of life cycle the organism possesses and the environment to which it is exposed. In organism, such as algae and fungi, zygote develops a thick wall that is resistant to desiccation and damage commonly it undergoes a period of rest prior to germination.
- Some unicellular protist animals ( e.g. Paramecium) exhibit sexual reproduction by forming male and female gamete nuclei, which they exchange through temporary cytoplasmic bridge, later the cytoplasmic bridge appears and the gamete nucleus of one individual fuses with that of

the other to form zygote nucleus. This mode of sexual reproduction is known as conjugation.

- Zygote is the vital link that ensures continuity of species between organism of one generation and the next.

## 2. Embryogenesis

- Embryogenesis is the process of development of embryo from the zygote. During embryogenesis zygote undergoes cell division ( mitosis) and cell differentiation.
- Cell divisions increase the number of cells in the developing embryo while cell differentiation help group of cells to undergo certain modifications to form specialized tissues and organs to form organism.
- In animals, when the development of zygote takes place outside the body of the female parent, it is called viviparous.
- In oviparous animals like Reptile and Birds the fertilized eggs covered by hard calcereous shell are laid in a safe place in the environment after a period of incubation, young ones hatch out. On the other hand, in viviparous animals like mammals including human beings, the zygote develops into a young ones are delivered out of the body of the female parent. Because of proper embryonic care and protection, the chances of survival of young ones is greater in viviparous organisms.
- In Angiosperms, the zygote is formed, inside the ovule. After fertilization, the sepals, petals and stamens of the flower fall off. The pistil, however, remains attached to the plant. The zygote develops into the embryo and the ovules develop into the seed. The ovary develops into the fruit. Which develops a thick wall called pericarp that is protective in function. After dispersal seeds germinates under favourable condition to produce new plants.