

# CHAPTER :1

## REPRODUCTION IN ORGANISM

### TOPICS

. LIFE SPAN

. ASEXUAL REPRODUCTION

. SEXUAL REPRODUCTION

**Reproduction** is a biological process of formation of new offsprings from the pre-existing organism. Reproduction becomes a vital process without which species cannot survive for long. It ensures continuity of species generation after generations as older individuals undergo senescence and ultimately they die. Thus it is **a process by which an organism produces its own kind for continuity of life / for maintenance of life.**

**Life span** – • Life expectancy of an organism *i.e.* how many years an organism would live on the earth. The period from birth to the natural death of an organism represents its **life span**. Life span of organisms varies from few days (Butterfly-1 to 2 weeks) to thousands of years (Banyan tree).

Butterfly : 1—2 weeks ; Rice plant :3—4 months

Rose : 5—7 years ; Crow :15 yrs ; Cow :20—25 yrs

Dog :20—25 yrs ; Fruit fly : 30 yrs ; Horse : 60 yrs

Crocodile : 60 yrs ; Elephant : 60 yrs ;Tortoise :100-150 yrs

Parrot : 140 yrs ; Banyan tree :1000 of yrs.

Life span vary from species to species and is independent of its size.

**ASEXUAL REPRODUCTION:** Absence of sexual reproduction.

Involves one parent (Uniparental)

No fertilization

May or may not form gametes

It is quick

• **SEXUAL REPRODUCTION :**

• Involves sexual organs

• Has two parents (bi parental) or one parent (uniparental)

• Forms gametes (male gamete and female gamete)

• It shows fertilization i.e. fusion of male and female gametes.

• It is a slow process

- **Sexual reproduction is divided into:**
- **PRE FERTILIZATION** – Formation of gametes and Gamete transfer
- **FERTILIZATION (SYNGAMY)** –Fusion of male and female gamete
- **POST FERTILIZATION** --- Embryogenesis

### **ASEXUAL REPRODUCTION**

1. Usually followed by organisms with relatively simpler organizations.
  2. Offsprings is produced by single parent.
  3. With / without involvement of gamete formation.
  4. Offsprings produced are genetically and morphologically similar to each other and to the parent, i.e. they are **clones**.
- In Protista and Monera, the parent cells divides into two to give rise to new individuals. Thus, in these organisms **cell division** is the mode of reproduction itself.

### **TYPES OF ASEXUAL REPRODUCTION**

**Fission** means ‘to break’. Thus in this method an organism can divide into two or more organisms. So it can be of two types:

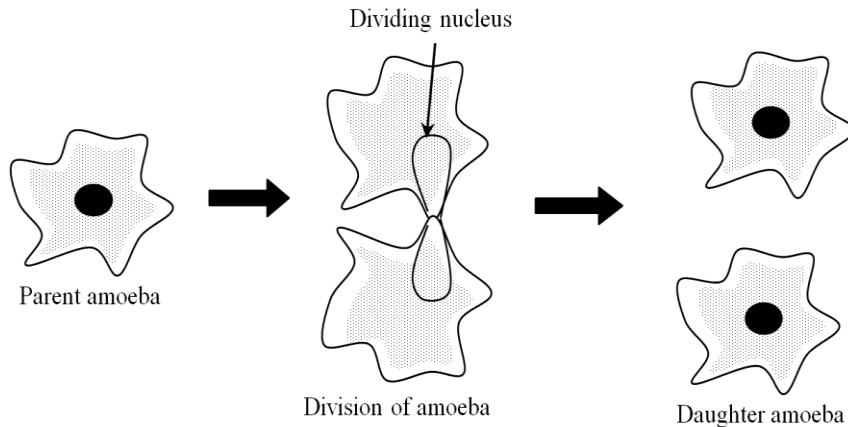
1. Binary fission
2. Multiple fission

#### **Binary Fission**

The term ‘binary fission’ consists of two words ‘binary’ and ‘fission’. The word ‘binary’ means ‘two’ and the term ‘fission’ means ‘to break’. It may be defined as the division of an organism into two offsprings or daughter organisms. in this method of asexual reproduction, a cell divides into two halves and rapidly grows into an adult. Ex- amoeba, paramecium. **ONE CELL DIVIDES INTO TWO CELLS Eg. AMOEBA**

This method of reproduction is found in protozoans like amoeba, paramecium and bacteria. In this method under favourable conditions the parent organisms grows to its full extent and then divides into two parts. Each part of the parent then separates and grows into a new organism. This

process is repeated further by the new organisms to produce a large number of organisms.



**Fig. 1** Binary fission in amoeba

### **Multiple Fission**

The term 'multiple fission' consists of two words '**multi**' and '**fission**'. The word 'multi' means 'many' and the term 'fission' means 'to break'. It may be defined as the division of a parent into many small offsprings or daughter organisms, at the same time.

This method of reproduction is also shown by protozoans such as amoeba, paramecium and plasmodium.

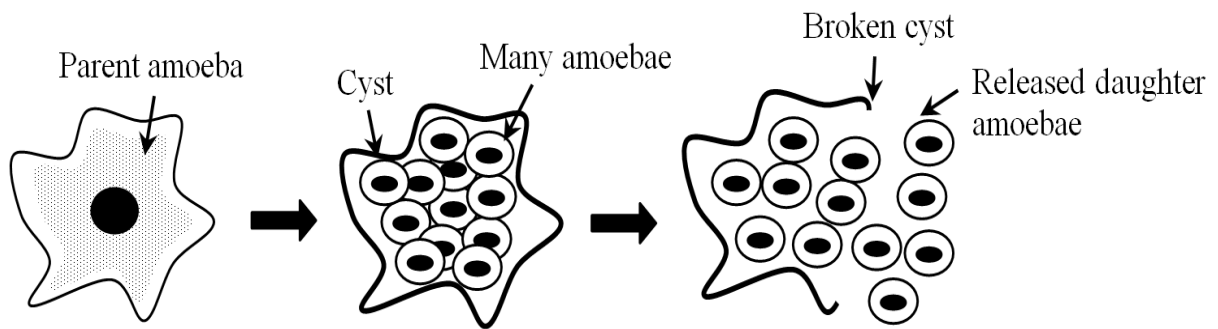
#### **Multiple Fission in Amoeba**

In this method, sometime under unfavourable or drastic conditions a very tough layer which is called as cyst is formed around the parent amoeba. Inside the cyst, the nucleus of the parent divides many times to form many nuclei. Later on, the cytoplasm of the cyst also divides

and each part of the cytoplasm encloses one nucleus. In this way many small amoebae are produced inside the cyst. On the return of favourable conditions, the cyst breaks and all the amoebae are released. These amoebae then grow into adults.

#### **Multiple fission in Plasmodium**

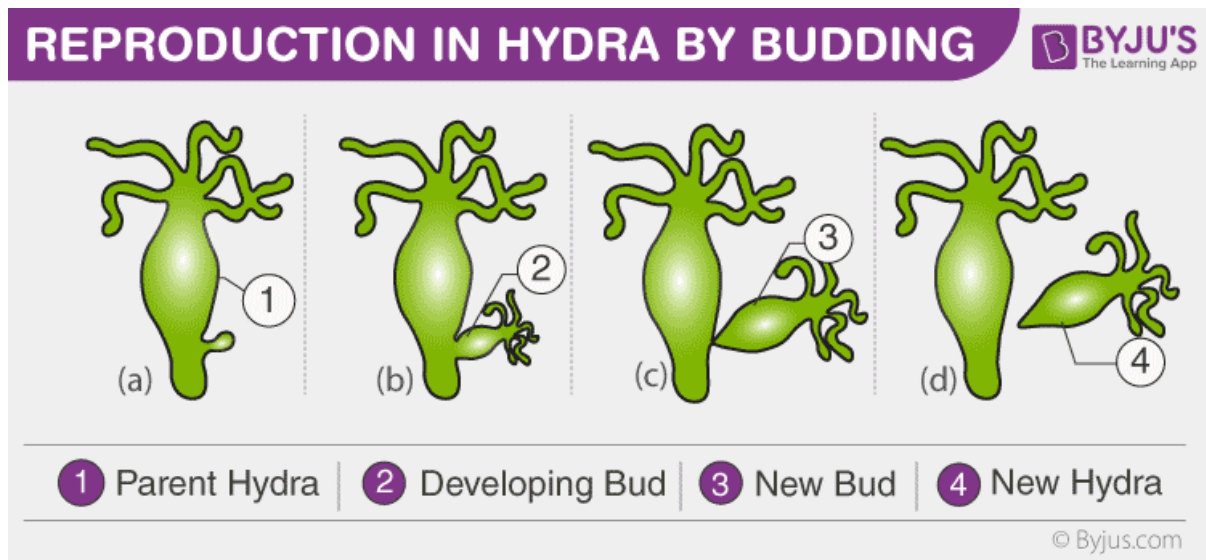
Plasmodium is the malarial parasite which produces malaria disease in human beings. The method of multiple fission in plasmodium is same as that of the amoeba.

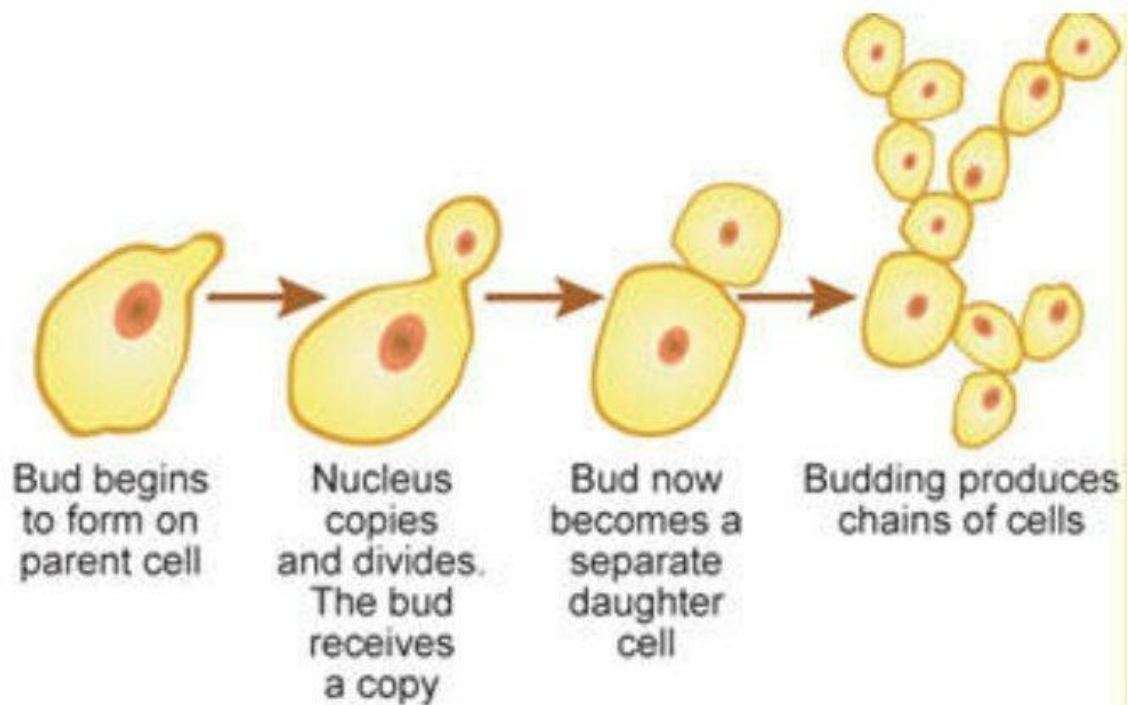


**Fig. 2** Multiple fission in amoeba

### Budding

Budding is a type of asexual reproduction in which a new organism develops from an outgrowth or bud due to cell division at one particular site. The small bulb-like projection coming out from the yeast cell is called a bud. ... In hydra, a bud develops as an outgrowth due to repeated cell division at one specific site.





#### **Fragmentation in Spirogyra - definition**

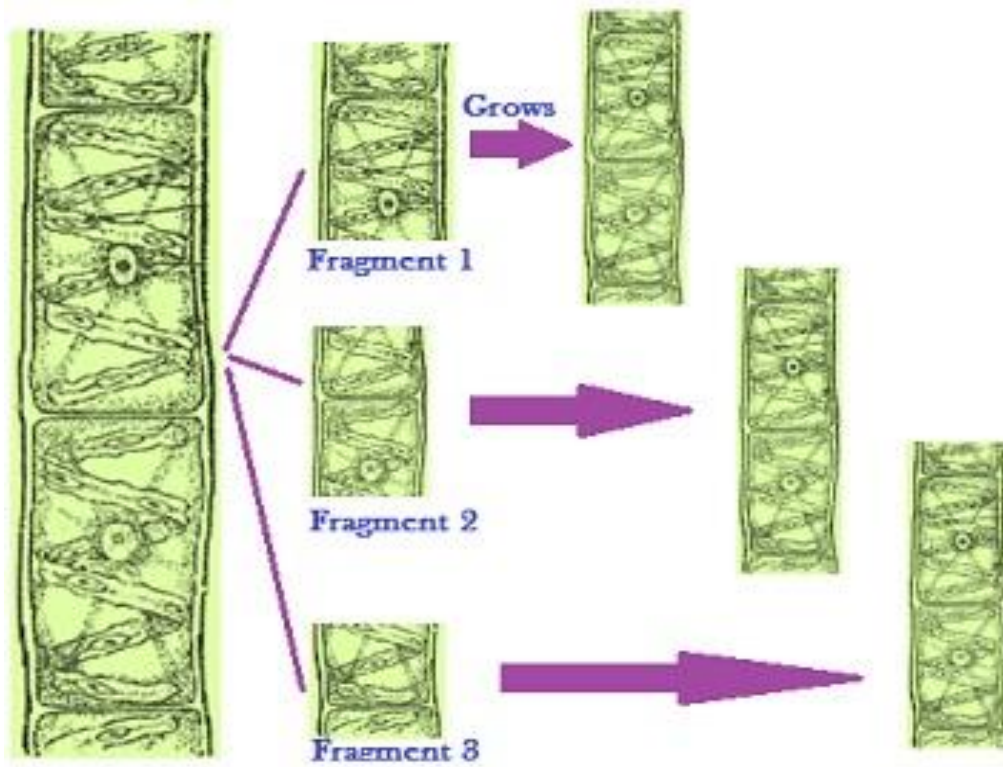
**Fragmentation** is a type of asexual reproduction in which an organism simply breaks in individual pieces at maturity. These individual small pieces then grow to form a new organism e.g., **Spirogyra**. **Spirogyra** undergoes **fragmentation**

which results in many filaments.

#### **Fragmentation**

- Parent breaks into multiple pieces on maturity, each of which gives rise to a new individual

Seen in simple multicellular organisms (Spirogyra) **REGENERATION** : IT IS THE ABILITY OF AN ORGANISM TO GENERATE THE LOST PART THUS FORMS NEW ORGANISM Eg. PLANARIA.



### Regeneration

- Parent if cut/broken into multiple pieces , each gives rise to a new individual
- This is an accidental process
- Hydra, flatworm, tapeworm

Pic. Regeneration in Planaria



**Spore formation**

ZOOSPORES Eg. CLAMYDOMONAS

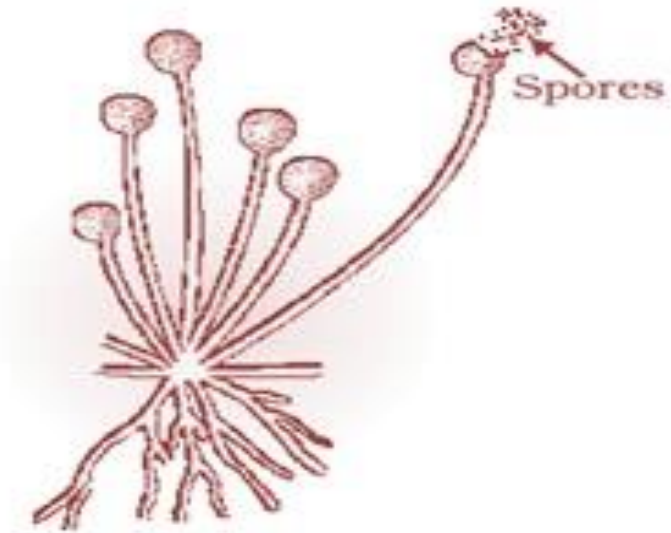
**SPORULATION** : --- CONIDIA Eg . PENCILLIUM

GEMMULES Eg. SPONGES

- Formation of new individual by germination of spores

Spores are unicellular bodies in the parent that are capable of growing into a new individual

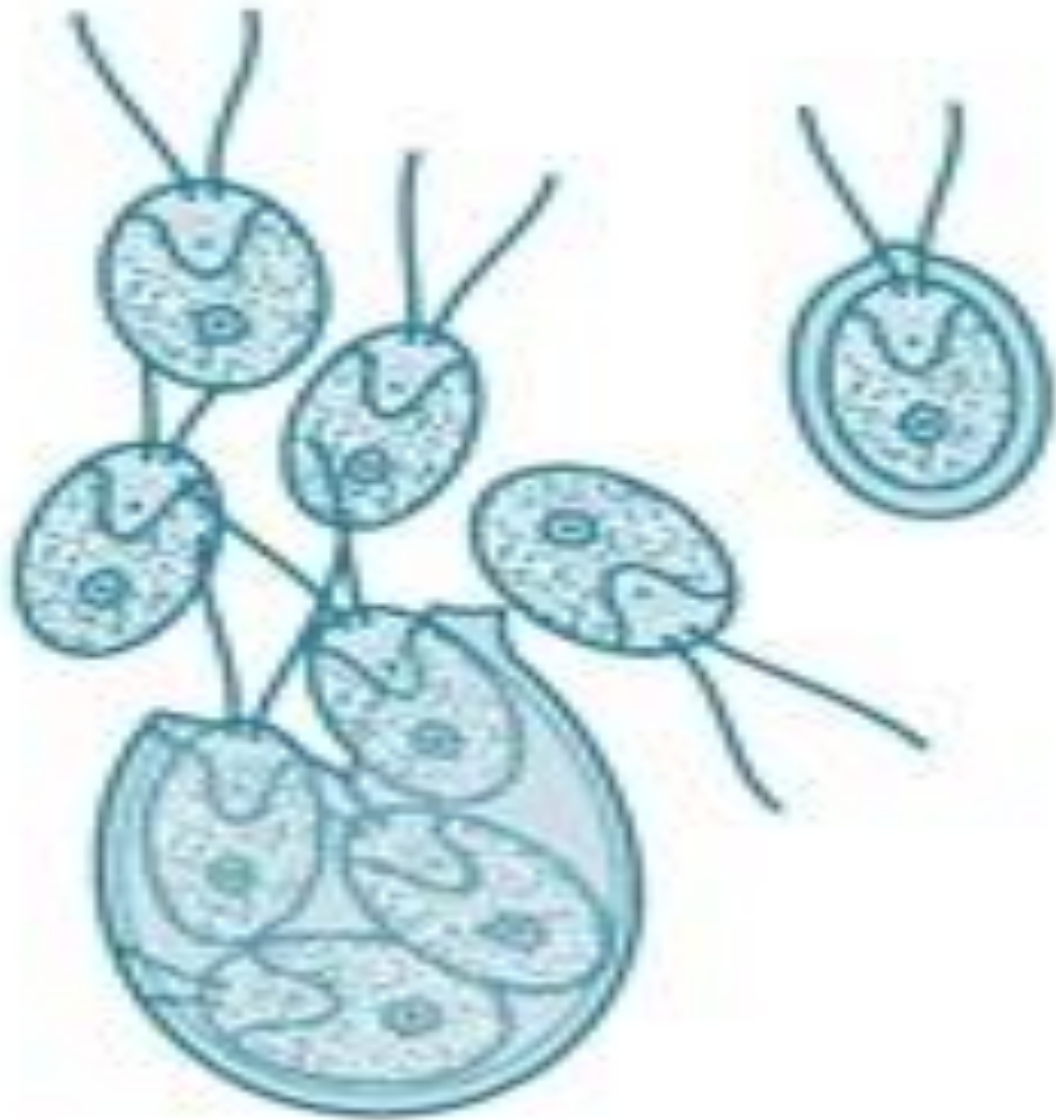
Pic. Spore formation in fungi, Rhizopus



Conidia Non-motile spores of fungus (Penicilium) Termed as Mitospores

- Zoospores
  - Motile spores
  - Uses Flagellum for locomotion
  - Used as a mode of asexual reproduction by some algae, bacteria & fungi





Pic: Zoospore formation in Chlamydomonas under favorable conditions

**VEGETATIVE PROPOGATION** ---INVOLVES PARTS OTHER THAN GERMINAL CELL *ie* SOMATIC CELLS  
HENCE DAUGHTER ORGANISM SHOW NO VARIATION.

### **WATER HYACINTH (Terror of Bengal)**

- One of the most invasive weeds
- Grows wherever there is standing water
- Drains oxygen from water- leads to death of fishes.
- Introduced in India because of its pretty flowers & shape of leaves
- Vegetative propagation occurs at a phenomenal rate

Asexual reproduction is the most common method of reproduction in organisms having simpler body like in algae and fungi but during unfavorable condition they shift to sexual reproduction

THEY ARE OF TWO TYPES

**NATURAL VEGETATIVE PROPAGATION** : .RUNNER , RHIZOME ,TUBER AND OFFSET.

**ARTIFICIAL VEGETATIVE PROPAGATION** : CUTTING ,LAYERING AND GRAFTING

THEY ALL REPRODUCE FROM NODES

Binary Fission Definition

“Binary fission is a form of asexual reproduction in which an organism divides into two, each part carrying one copy of genetic material.”

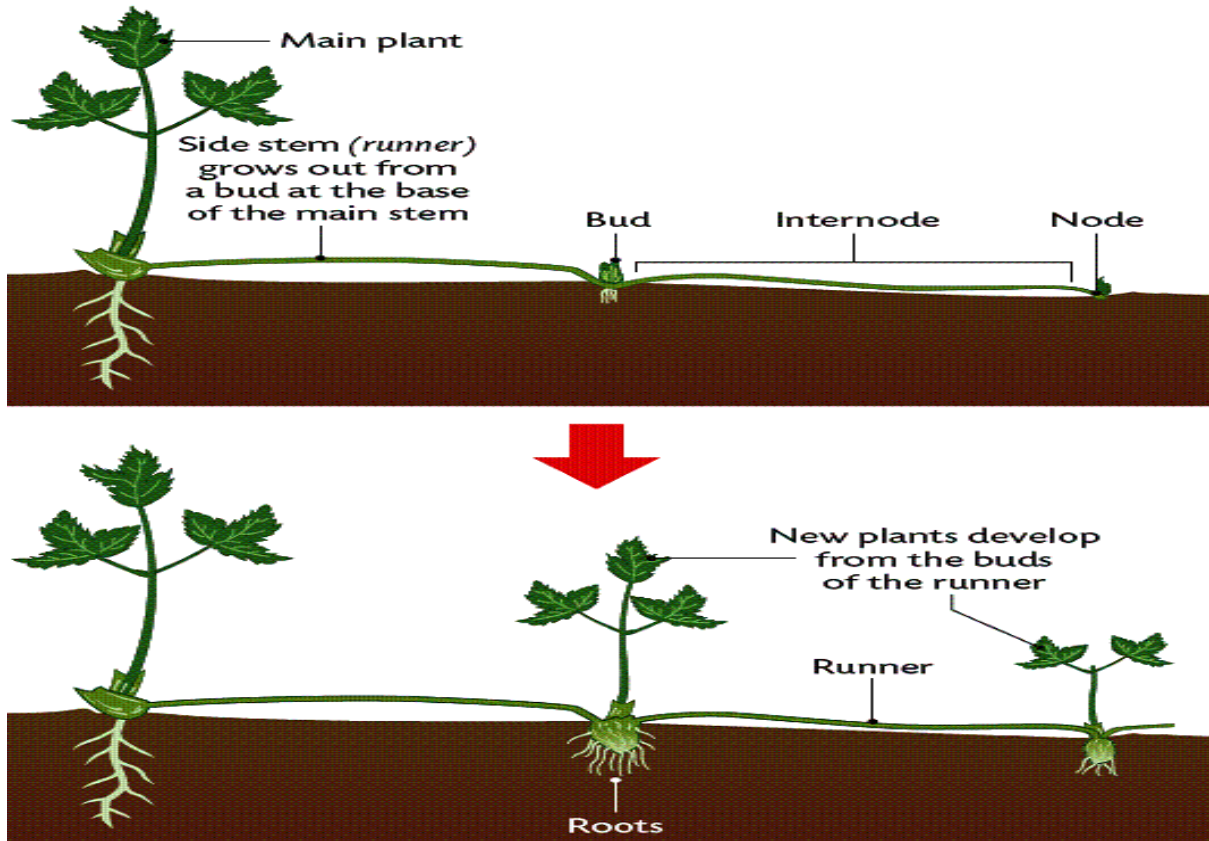
In plants, vegetative reproduction occurs by vegetative propagules like runner, rhizome, sucker, tuber, offset and bulb.

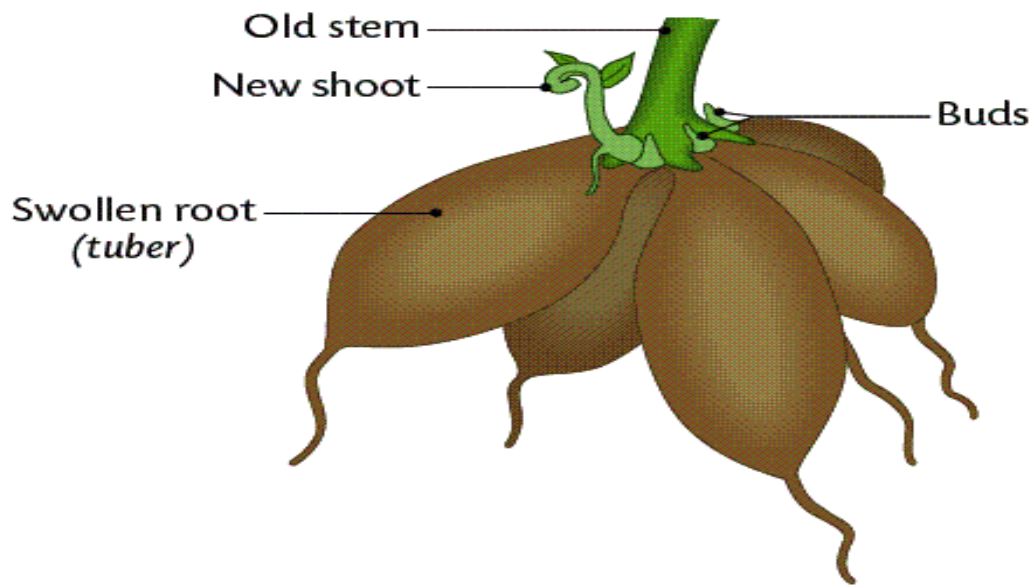
<b>Vegetative part</b>	<b>Example</b>
Roots	<i>Dahlia, Asparagus, Dalbergia, guava and tapioca</i>
Stems	
• Tubers	Potato and artichoke
• Bulbs	Garlic and onion
• Rhizome	Ginger, turmeric, banana and <i>Dryopteris</i>
• Corms	<i>Colocasia, Crocus and Amorphophallus</i>
• Suckers	Mint and <i>Chrysanthemum</i>
• Runners	<i>Oxalis and Centella</i>
• Stolons	Jasmine
• Offsets	<i>Pistia and Eichhornia</i>
Leaves	<i>Bryophyllum, Begonia, Kalanchoe</i> and walking fern
Bulbils	<i>Agave, lily and Dioscorea</i>
Turions (fleshy buds in aquatic plants)	<i>Potamogeton and Utricularia</i>

A form of asexual reproduction in plants, in which multicellular structures become detached from the parent plant and develop into new individuals that are genetically identical to the parent plant. For example, liverworts and mosses form small clumps of tissue (called gemmae) that are dispersed by splashing raindrops to form new plants. Bulbs, corms, offsets, rhizomes, runners, suckers, and tubers are all important means of vegetative reproduction and propagation in cultivated plants.

## NATURAL Vegetative Propagation

New plants grow from parts of the parent plant. They include: Stems  
Runners are stems that grow horizontally above the ground. They have nodes where buds are formed. These buds grow into a new plant.





#### Leaves

Leaves of some plants will grow into a new plant if they become detached from the parent plant. Other plants grow small plants called plantlets on the edge of their leaves.

#### Bulbs

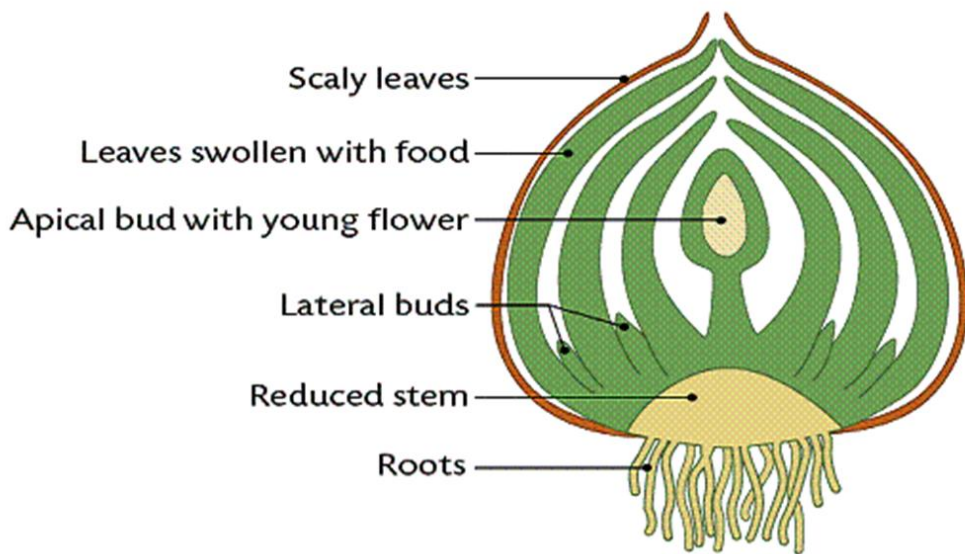
A bulb contains an underground stem. Leaves are attached to the stem. These leaves contain much stored food. At the centre of the bulb is an apical bud. Also attached are lateral buds. The apical bud will produce leaves and a flower while the lateral buds will produce new shoots. As the plant grows and develops it will form a new bulb underground.

#### **Artificial Vegetative Reproduction**

Horticulturists and farmers use artificial means to produce plants that are identical to the parent plant. Some of the methods used are:

#### Cuttings

Cuttings are part of the plant that is cut off of the parent plant. Shoots with leaves attached are usually used. New roots and leaves will grow from the cutting. The shoot is cut at an angle. A growth promoter may be used to help with the growth of the roots.

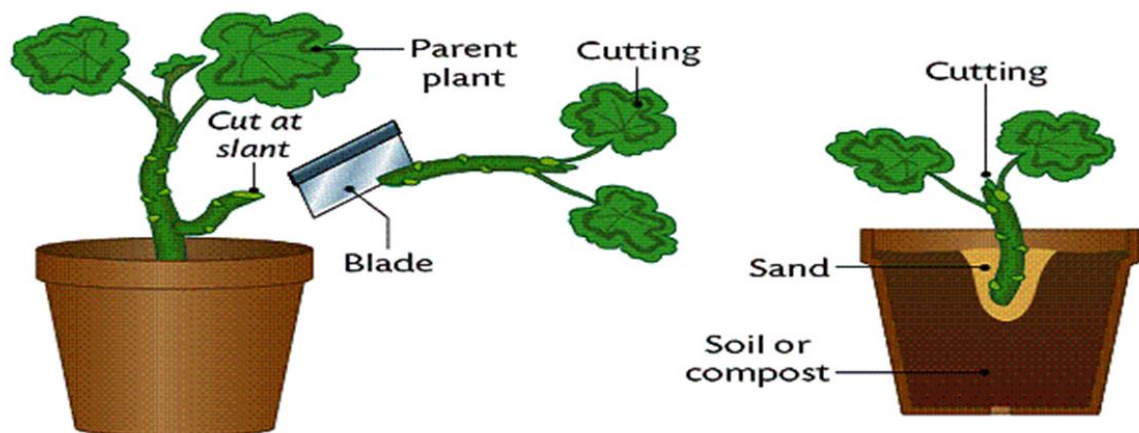


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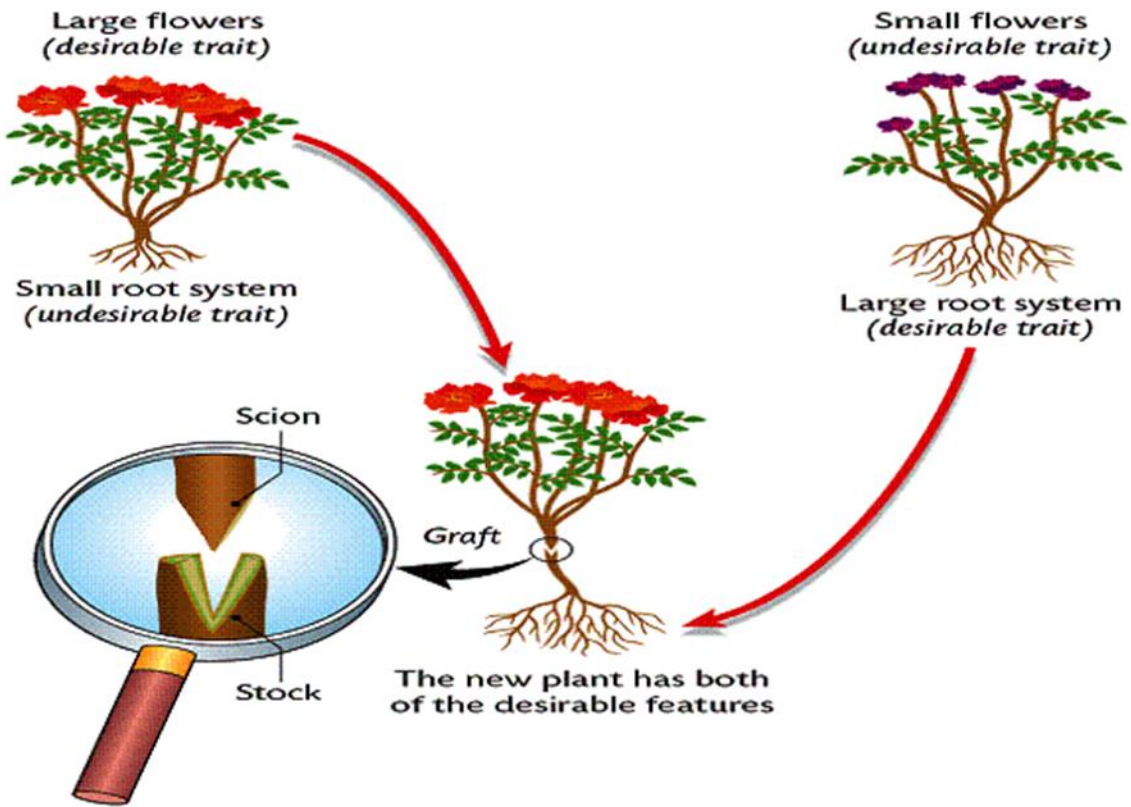
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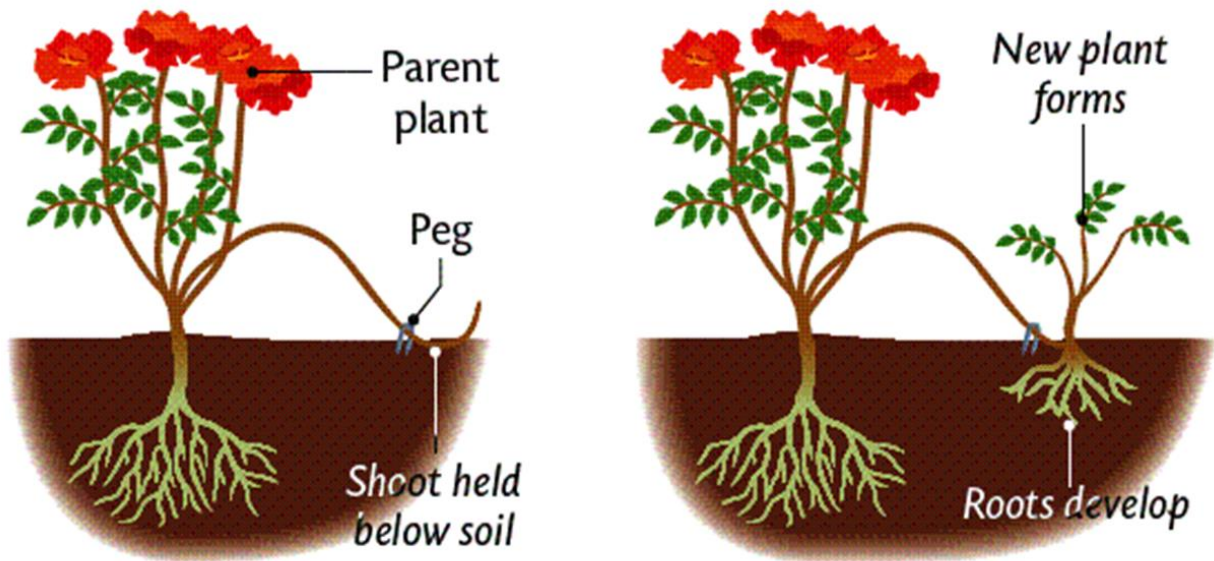
#### Grafting

In grafting 2 plants are used to develop a new plant with combined traits from the 2 parent plants. In grafting the scion is the above ground part of one plant. The scion is attached to the stock which is the rooted part of the second plant.



### Layering

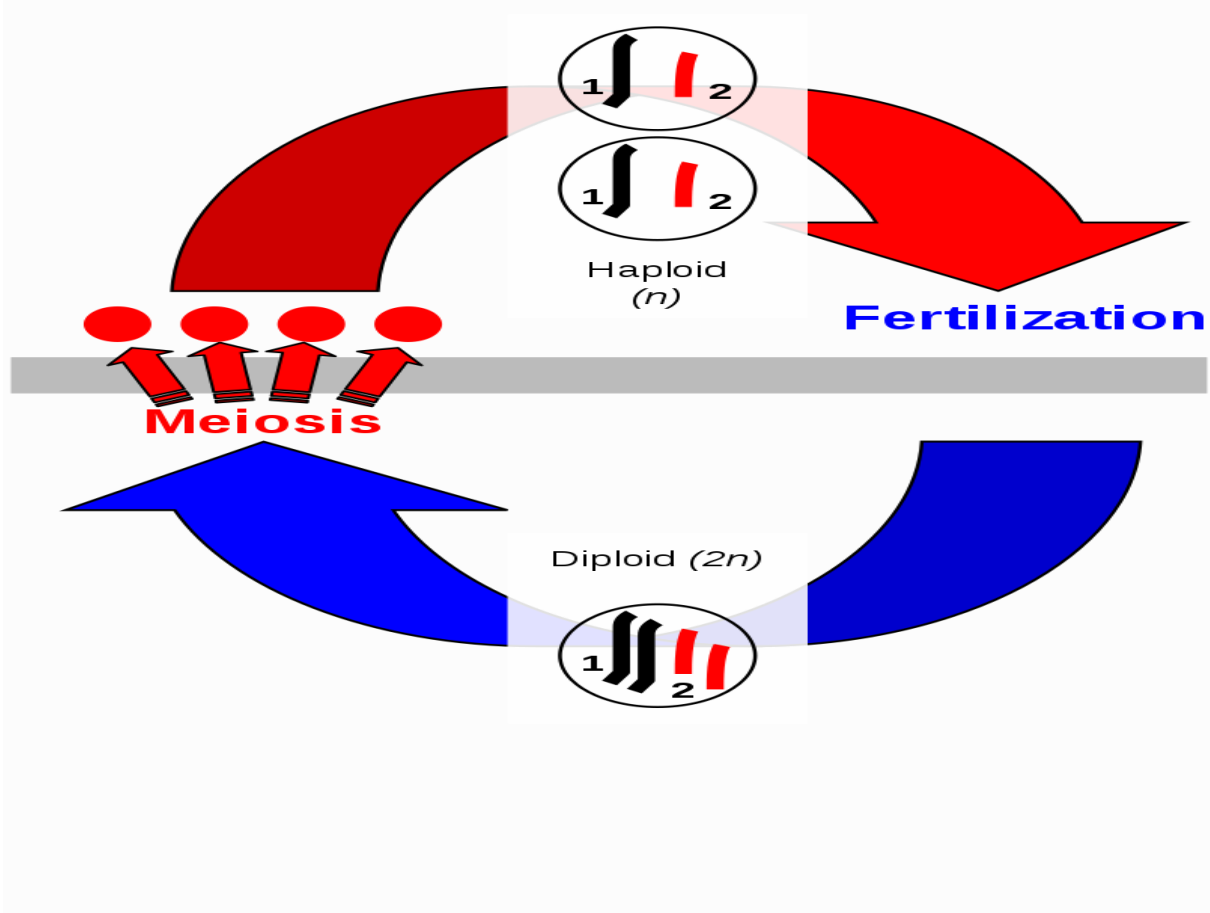
In layering a shoot of a parent plant is bent until it can be covered by soil. The tip of the shoot remains above ground. New roots and eventually a new plant will grow. These plants can then be separated.



## SEXUAL REPRODUCTION:

Sexual reproduction is a type of reproduction that involves a complex life cycle in which a gamete (such as a sperm or egg cell) with a single set of chromosomes (haploid) combines with another to produce an organism composed of cells with two sets of chromosomes (diploid).

- Involves formation of male and female gametes by two individuals of the opposite sex.
  - Offspring produced by fusion of male and female gametes not identical to each other or to the parents.
  - All sexually reproducing organisms share a similar pattern of reproduction.
- In sexual reproduction, fusion of male and female gametes results in offspring that are not identical to parents.



## DIFFERENT PHASES IN SEXUAL REPRODUCTION:

- A. Juvenile phase** – The period between birth and sexual maturity is called juvenile phase. In plants it is known as **vegetative phase**. The end of juvenile/vegetative phase marks the beginning of the reproductive phase.

### **B. Reproductive phase-**

- Some plants show flowering in particular season and some other flowers in all seasons. Some other plants like bamboo species flowers once in life time (after 50-100 years), *Strobilanthus kunthiana* (neelakuranji), flowers once in 12 years.
- The female placental animals exhibit cyclic change in activities ovaries and accessory glands as well as hormone during the reproductive phase.

Sexual reproduction is the process in which new organisms are created, by combining the genetic information from two individuals of different sexes. The genetic information is carried on *chromosomes* within the *nucleus* of specialized sex cells called *gametes*. In males, these gametes are called *sperm* and in females the gametes are called *eggs*. During sexual reproduction the two gametes join together in a fusion process known as fertilization, to create a *zygote*, which is the precursor to an embryo *offspring*, taking half of its DNA from each of its parents. In humans, a zygote contains 46 chromosomes: 23 from its mother and 23 from its father. The combination of these chromosomes produces an offspring that is similar to both its mother and father but is not identical to either

### **Menstrual cycle**

- It occurs in monkeys, apes and human beings.
- Cycle consists of 3 phases-menstrual, proliferative and secretory phase.
- Blood flows in the last few days of the cycle. The broken endometrium is passed out during menstruation.
- Female does not permit copulation during menstrual phase of the cycle.

### **Oestrous cycle**

- It occurs in non primates like cow, sheep, rat, deer, dog, tiger etc.
- It consists of a short period of oestrous or heat. it is 12-24 hours in cow followed by anoestrous or passive period.
- Blood does not flow in this cycle. The broken endometrium is reabsorbed.
- Female permits copulation only during oestrous period.
- Both in plants and animals, hormones are responsible for the transition between different phases of life cycle. Interaction between hormones and environmental factors regulate the reproductive processes.

### **C. Senescent phase –**

- It is the end of reproductive phase.
- Old age ultimately leads to death

**Events in Sexual Reproduction :** Pre-fertilisation, Fertilisation, Post-fertilisation



- a. **Pre-fertilisation**– all the events prior to fusion of gametes are included in it. It includes gametogenesis and gamete transfer.

**Gametogenesis** is the process of formation of male and female gametes. Gametes are haploid cells which may be similar or dissimilar in structure. In algae, both gametes are similar in structure called **homogametes (isogametes)**. In higher organism that reproduces sexually, two morphologically distinct gametes are formed called **heterogametes**, male gametes are called **antherozoid or sperm** and female gametes are called **ovum or egg**.

- a. **Isogametes. heterogametes**
- b. In fungi and plants, **homothallic** and **monoecious** terms are used to denote the bisexual condition and **heterothallic** and **dioecious** are used for unisexual condition. In flowering plants, the unisexual male flower is **staminate**, i.e., bearing stamens, while the female is **pistillate** or bearing pistils.
- c. • In animals, species which possess both male and female reproductive organs in same individual are called **bisexual** or **hermaphrodites** (earthworm, sponges, tapeworm etc.) and both having either male or female reproductive organs are called **unisexual** (cockroach, human).
- d. • Gametes are always **haploid**( having half set of chromosome ), although organisms may be haploid and diploid. Diploid organisms form gametes by meiotic division. The organisms belonging to algae, fungi, and bryophytes have haploid plant body and pteridophytes, gymnosperms, angiosperms and most of animals are **diploid** ( having double set of chromosome )
- e. • In diploid organisms, gamete mother cell (**meiocyte**) undergoes meiosis in which one set of chromosome is present in gametes.
- f. **Gamete Transfer** – in majority of organisms, male gametes are motile and females gametes are non-motile, except in fungi and algae in which both gametes are motile.
- g. • In simple plants like algae, fungi, bryophytes and pteridophytes water is the medium through which male and female gametes moves. The number of male gametes are much more than number of female gametes as most of male gametes fail to reach the female gametes.
- h. • Pollen grains germinate on stigma to produce pollen tube that delivers the male gametes near the ovule.
- i. **b. Fertilisation** –
- j. The fusion of male and female gamete is called **fertilization or syngamy**. It results in the formation of diploid zygote.
- k. • The process of development of new organisms without fertilisation of female gametes is called **parthenogenesis**. For example honey bee, rotifers, and lizards

**Internal Fertilization** : Internal fertilization is the fertilization of the egg by the sperm within the body of one of the parents, usually by means of [sexual intercourse](#). Internal fertilization usually takes place within the female body, after the male implants sperm. However there are exceptionally rare examples, such as seahorses (Syngnathidae), where the female implants her eggs into the male and the zygote is formed within the male's body.

The next step in internal fertilization depends on the species. Some creatures, such as birds, insects and reptiles, then lay an egg containing the cells, which are undergoing mitosis, and a reserve of yolk to feed and support growth of the embryo. After a period of time (often having been incubated) a fully formed individual will hatch from the egg. This is known as *oviparity*.

The embryos of most mammal species grow and develop within the body of their mother, resulting, resulting in the live birth of a fully formed offspring: this is called *viviparity*. Embryos are supported by the [placenta](#), which provides nutrient uptake, waste removal and thermo-regulation in placental organisms (most *mammals*). Alternatively, *marsupial* offspring (for example, koalas and kangaroos) are removed from inside the mother's body after a short *gestation* period and complete their development within an external pouch on the front of the mother's body.

A third form of development is *ovoviviparity*, in which embryos develop in eggs stored within the body of the parent until they are ready to hatch, giving the appearance of a live birth.

#### External Fertilization

External fertilization occurs when a sperm cell and an egg cell join outside of the body. Most amphibians and fish and many invertebrates use external fertilization, producing anything from hundreds to billions of gametes at a time into close proximity. The quick release of gametes into aquatic environments this is called spawning. However, sometimes females will lay eggs on a particular substrate which are subsequently fertilized by males.

The sex cells of creatures which reproduce through external fertilization often have special adaptations for movement, such as the addition of strong flagella for independent movement.

**c. Post Fertilisation Events-** events in the sexual reproduction after formation of zygote.

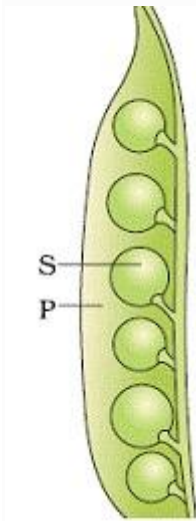
Zygote is the vital link that ensures continuity of species between organisms of one generation and the next. Every sexually reproducing organism, including human beings, begin life as a single cell—the zygote.

- In the organisms, having external fertilisation, zygote is formed in external medium (water) and those having internal fertilisation zygote is formed inside the body of female.
- In algae and fungi, zygote develops a thick wall resistant to desiccation and damage. This germinates after a period of rest.
- In the organisms having haplontic life cycle, zygote divides to form haploid spores that germinate to form haploid individual.

**Embryogenesis** – the process of development of **embryo** from the zygote. During this, zygote undergoes mitotic division and cell differentiation. Cell division increase

the number and cell differentiation help information of new group of cells and organs. **parthenogenesis**. For example honey bee, rotifers, and lizards

- In flowering plants, zygote is formed inside the ovule. After fertilisation, sepals, petals and stamens of flower fall off. The zygote develops into embryo and ovules into seeds. The **ovary** develops into **fruits** which develop a thick wall called **pericarp**, protective in function.
- After dispersal, seeds germinate under favorable condition to produce new plants.



wall called **pericarp**, protective in function.

### Development of zygote depends on:

- (a) Type of life cycle of the organism.
- (b) Environment it is exposed.

In the fungi and algae, the zygote before germination undergoes a resting period. A thick wall is developed around the zygote, which prevents it from desiccation and damage.

In organisms with haplontic life cycle, zygote divides by meiosis to form haploid spores, which grow into haploid individual.

### (ii) Embryogenesis:

The process of development of embryo from the zygote is called embryogenesis,

Embryogenesis involves the following process:

- (a) Cell division to increase in number of cells.
- (b) Cell enlargement or growth to increase in mass/volume of living matter.
- (c) Cell differentiation for the formation of different types of tissues.

### Embryogenesis in Animals:

Based on whether the development of the zygote takes place outside or inside the body of the female parent, animals are divided into two categories

#### (i) Oviparous:

Those animals, in which development of zygote takes place outside the female parent, are called oviparous. They lay fertilised eggs covered with hard calcareous shell in a safe place in the environment, e.g., reptiles and birds. After a period of incubation, the young ones hatch out from the egg.

#### (ii) Viviparous:

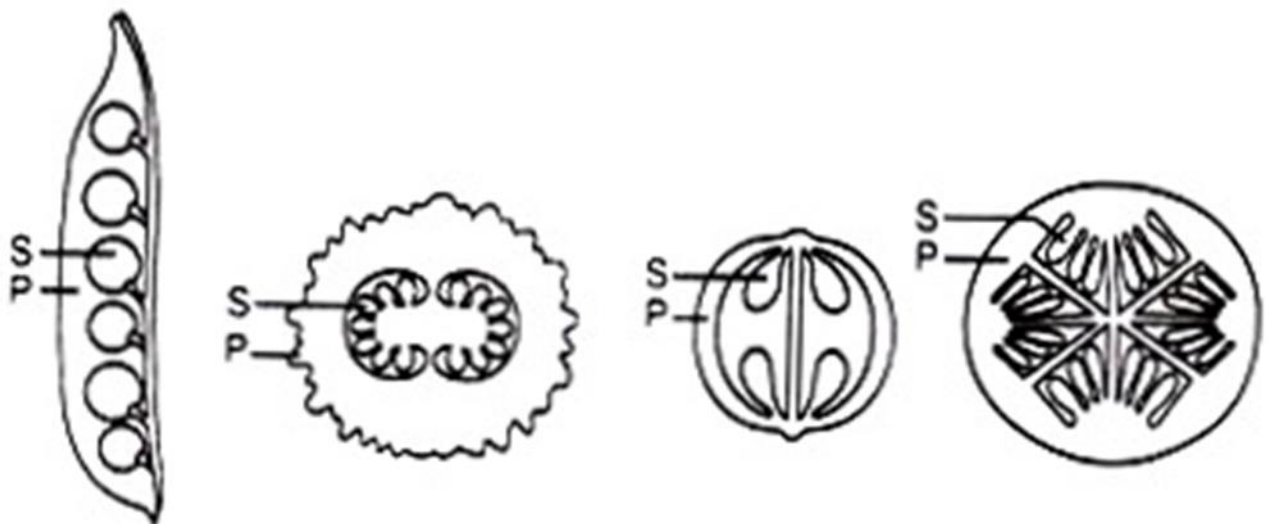
The animals in which the development of zygote takes place into a young one inside the body of the female parent, are called viviparous. After attaining a certain stage of growth, the young ones are delivered out of the body of the female organism.

The chances of survival of young ones is greater in these because of proper embryonic care and protection.

### Embryogenesis in Plants:

In all flowering plants, the zygote is formed inside the ovule. In most of the plants, with the formation of zygote, all the parts of the flower except the pistil wither and fall off. In some plants, such as tomato and brinjal, the sepals are persistent and remain attached to the developing fruit. In ovule, the zygote divides several times to form an embryo.

Meanwhile the wall of the ovule becomes hard and it develops into seed. With these developments, the wall of the ovary also starts to swell. As a result, the ovary develops into fruit. A thick wall that covers fruit is called pericarp. It is protective in function. When seeds mature, they are dispersed. Under favourable conditions, these seeds germinate to produce new plants.

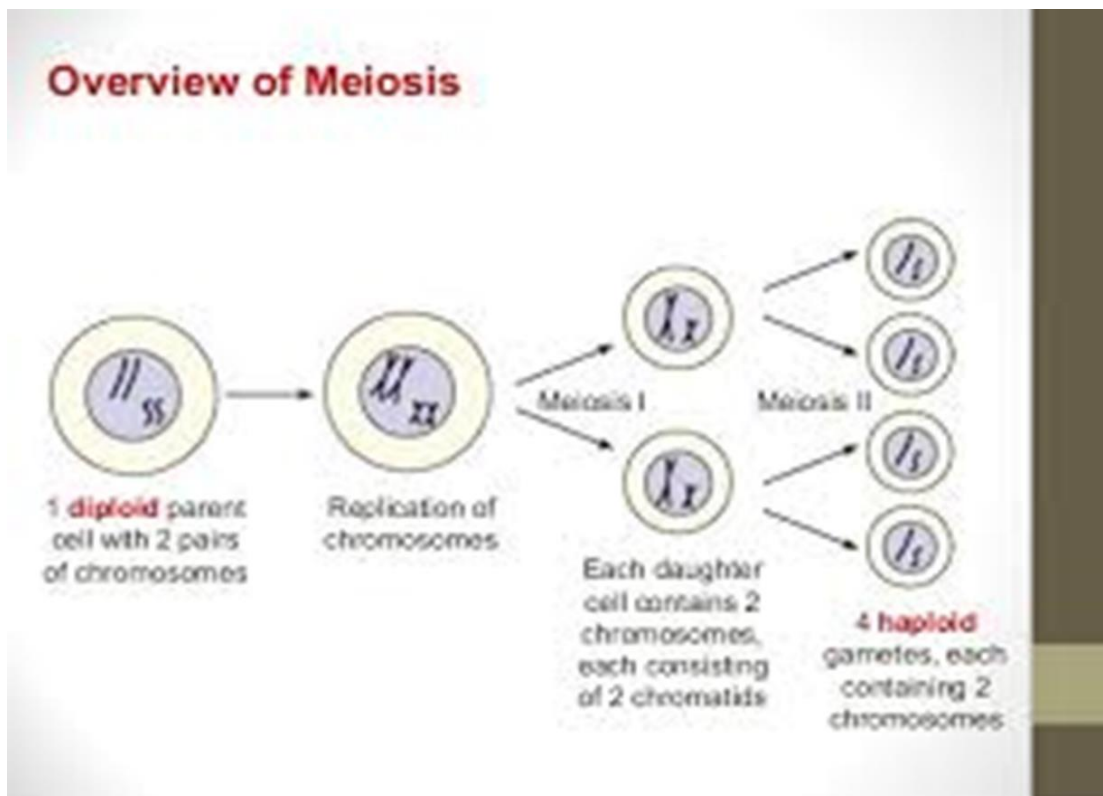
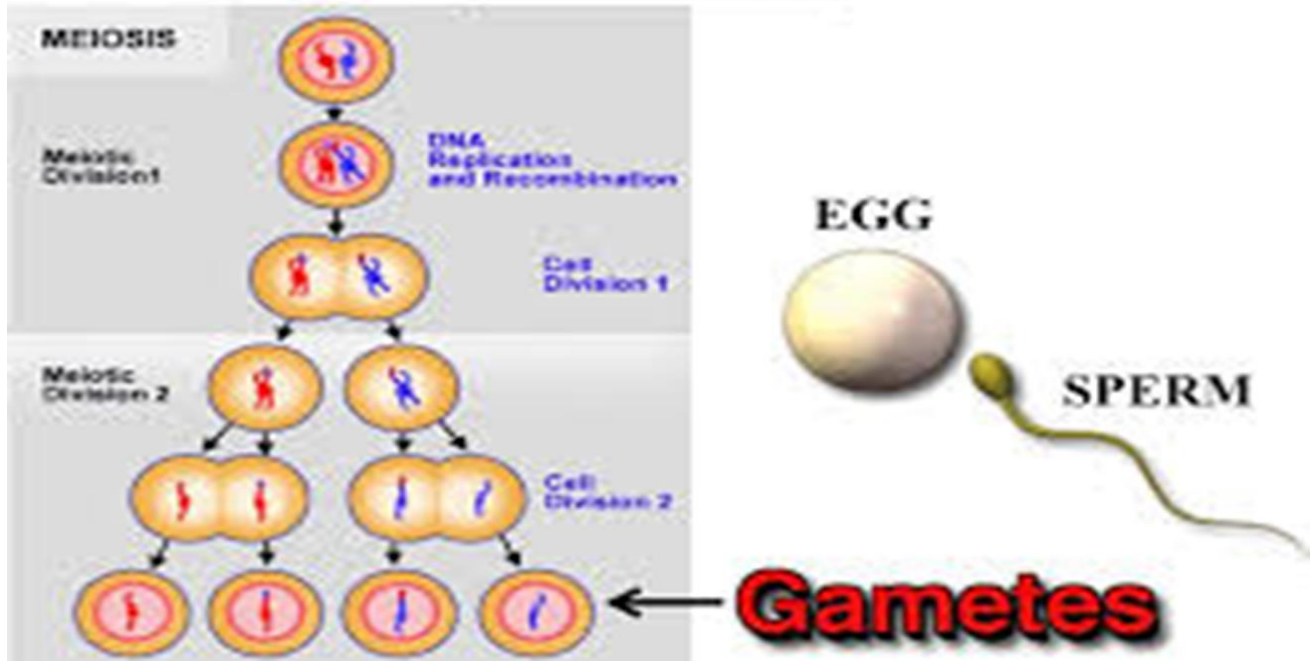


**Fig. 1.12** A few kinds of fruit showing seeds (S) and protective pericarp (P)

**Sexual reproduction** uses a type of **cell division** called meiosis, which creates gametes, such as sperm and egg cells. The process of meiosis happens in the male and female **reproductive** organs. Just like in mitosis, a **cell** starts meiosis in interphase.

## MEIOSIS: Sexual Reproduction

### Ch. 9.7 – 9.10



## Mitosis: Sexual or Asexual?

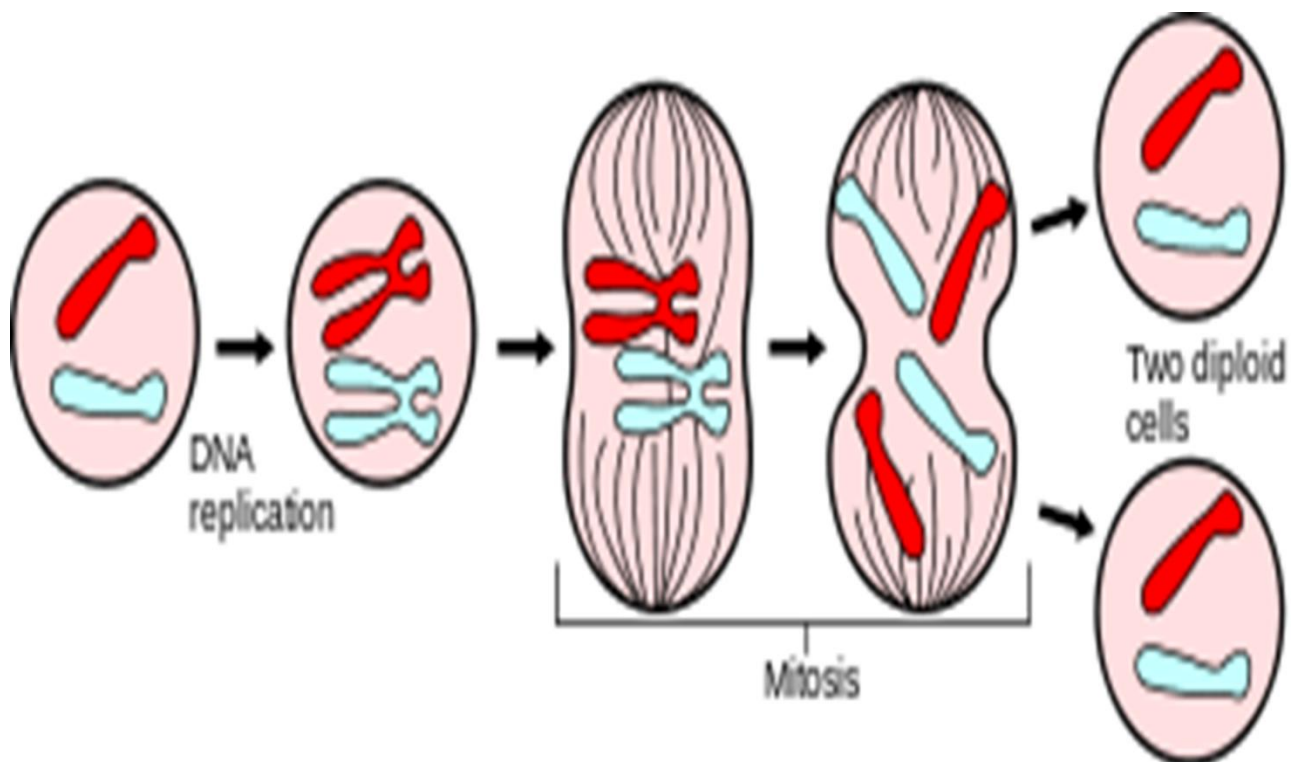
Mitosis is a form of asexual reproduction in simple living organisms. The outcome of each cell cycle is two identical cells. Mitotic checkpoints happen at certain stages of mitosis to ensure that each cell receives the same amount of DNA. Errors must be corrected or division halted because too many or too few chromosomes can harm the new cells.

Sexual reproduction happens through meiosis. In the first phase of meiosis, matching chromosomes pair up and swap gene snippets. That's why children with the same parents may or may not look alike. Errors in meiosis can result in chromosomal abnormalities and disease when gene functioning is impaired.

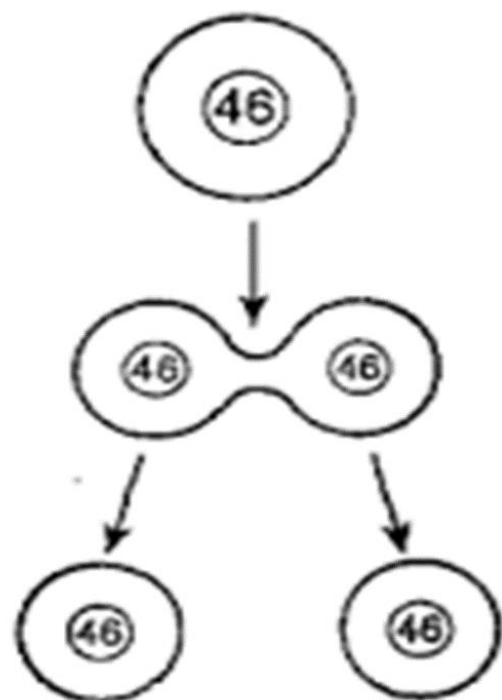
### Why Mitosis Matters for Survival

Many small organisms rely predominately on mitosis or a similar process like budding to stay alive and self-perpetuate. In larger organisms, mitosis plays a different kind of role in survival. All of the body's non-reproductive cells divide by mitosis, such as skin cells, muscle cells and blood cells. Mitosis helps organisms grow, heal wounds and replace countless cells that are shed every minute.

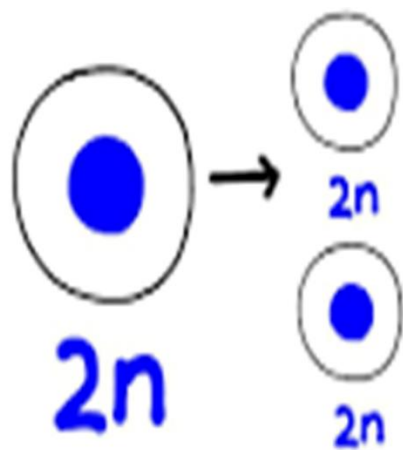
Some organisms can produce asexually or sexually depending on circumstances. For instance, diatoms predominately reproduce asexually, but they also divide through a type of meiosis. According to a 2015 article in BioMed Central Genomics, "Besides the fundamental goal of sexual reproduction to generate genetic diversity within a population, in diatoms, the sexual phase also plays a key role in cell size restitution." In other words, some organisms that normally divide asexually may switch to sexual reproduction when one organism becomes too small to divide into two organisms.



The diagram below can be used to illustrate a process directly involved in

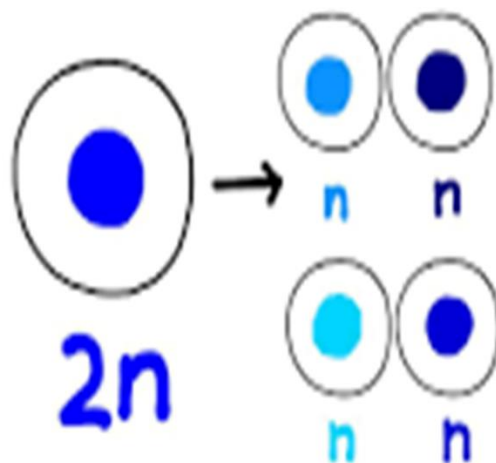


**MITOSIS**



ASEXUAL REPRODUCTION

**MEIOSIS**



SEXUAL REPRODUCTION

## Advantages Of Sexual Reproduction Over Asexual Reproduction

There is diversity in the genetic makeup of the individuals produced by sexual reproduction.

Since both the parents are involved, the newly formed individuals have the attributes of both.

Variations are more successful in sexual mode than in asexual one.

The species produced by sexual reproduction survive more than those produced by asexual reproduction. This is because genetic variations help them to adapt to different environments.

In asexual reproduction the offsprings are almost identical to their parent because they have the same genes as of their parents. Thus, genetic variation is not possible or is slow in asexual reproduction.

Sexual reproduction involves fusion of male and female gametes coming from both the parents. This is because the offsprings receive some genes from mother and some from father. The mixing of these genes of mother and father in various different combinations, results in the offsprings having genetic variation.

Thus, we conclude that sexual reproduction promotes diversity of characters in offsprings by providing genetic variation.

This genetic variation leads to continuous evolution of various species to form better and still better organisms.

### Benefits of Apomixis

It helps in hybrid seed production.

It is one of the most cost-effective methods to produce seeds.

Apomixis, derived from two Greek words "APO" (away from) and "mixed" (the act of mixing or mingling). It refers to the occurrence of an asexual reproductive process in the place of normal sexual processes involving reduction division and fertilization. Apomixis can be best described as the reference to the asexual process.

During sexual reproduction, developmental steps occurring inside the ovule produce the female gametophyte (embryo sac) and following a [double fertilization](#) event give rise to embryo and endosperm structures.

Apomixis is widely distributed among higher plants. More than 300 species belonging to 35 families are apomictic. It is most common in Gramineae, Compositae, Rosaceae, and Rutaceae. Among the major cereals maize, wheat, and pearl millet have apomictic relatives.

## QUESTIONS:

1. Name the spores in the following and state its motility. A) Rhizopus B) Clamydomonas.
2. Differentiate between A) Zoospores and zygote .B) Gametogenesis and Embryogenesis.
3. Why are unicellular organisms called Immortal ?



**4. Identify each part in a flowering plant and write whether it is haploid(n) or diploid (2n).**

a.	Ovary	
b.	Anther	
c.	Egg	
d.	Pollen	
e.	Male gamete	
f.	Zygote	

**5. What is a Unisexual and a Bisexual Flower? Give example.**

**6. Why are offspring of oviparous animals at a greater risk as compared to offspring of viviparous animals?**

**7. Higher organisms have resorted to sexual reproduction in spite of its complexity. Why?**