

- **Reproduction** is a process in which an organism gives rise to young ones (offspring) similar to itself.
- The period from birth to the natural death of an organism represents its **life span**.
- No individual is immortal, except unicellular organisms. There is no natural death in unicellular organisms.

Life spans of a few organisms

Organism	Lifespan	Organism	Lifespan
Elephant	50-70 yrs	Parrot	140 yrs
Rose		Crocodile	60 yrs
Dog	22 years	Horse	40-50 yrs
Butterfly	1-2 weeks	Fruit fly	2 weeks
Crow	15 yrs	Tortoise	100-150 yrs
Banana tree		Rice plant	
Cow	22 yrs	Banyan tree	

- Reproduction enables the continuity of the species, generation after generation.
- Based on the number of participants, reproduction is 2 types: **Asexual reproduction & Sexual reproduction**

ASEXUAL REPRODUCTION

- It is the production of offspring by a single parent.
- The offspring are identical to one another and to their parent. Such morphologically and genetically similar individuals are known as **clone**.
- Asexual reproduction is found in unicellular organisms, and in simple plants and animals.

Types of asexual reproduction

- **Fission:** In this, the parent cell divides (**cell division**) into two or more individuals. E.g. Protists and Monerans. Fission is 2 types:
 - **Binary fission:** It is the division of parent cell into two individuals. E.g., *Amoeba*, *Paramecium*.
 - **Multiple fission:** It is the division of parent cell into many individuals. E.g. *Plasmodium*, *Amoeba*.
- **Budding:** In this, a small bud appears and grows in the parent body. After maturation, it is detached from the parent body to form new individual. E.g. Hydra, Sponge, Yeast etc.
- Other asexual reproductive structures:** E.g. **zoospores** (microscopic motile structures in some algae and protists), **conidia** (*Penicillium*) and **gemmules** (*sponge*).
- **Vegetative propagation:** In plants, **vegetative propagules** (the units of **vegetative propagation** such as **runner, rhizome, sucker, tuber, offset and bulb**) are capable of giving rise to new offspring.

Examples for vegetative propagation:

- Emergence of small plants from the buds ('eyes') of the potato tuber, from the rhizomes of banana and ginger. They arise from the **nodes** of modified stems. When the nodes come in contact with damp soil or water, they produce roots and new plants.
- Adventitious buds arise from the notches present at margins of leaves of *Bryophyllum*.

Asexual reproduction is the common method in simple organisms like algae and fungi. During adverse conditions, they can shift to sexual method.

Higher plants exhibit both asexual (vegetative) and sexual modes of reproduction. But most of the animals show only sexual reproduction.

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.
- It is an elaborate, complex and slow process as compared to asexual reproduction.
- It results in offspring that are not identical to the parents or amongst themselves.
- The period of growth to reach in maturity for sexual reproduction is called the **juvenile phase**. It is known as **vegetative phase** in plants.
- In higher plants, the flowering indicates the end of vegetative phase (beginning of the reproductive phase).
- **Annual & biennial** type plants show clear cut vegetative, reproductive and senescent phases, but in **perennial** species it is very difficult to identify these phases.
- Some plants exhibit unusual flowering phenomenon. E.g. Bamboo species flower only once in their lifetime (after 50-100 years), produce large number of fruits and die. *Strobilanthus kunthiana* flowers once in 12 years.
- In animals, juvenile phase is followed by morphological and physiological changes prior to active reproductive behaviour.
- Birds living in nature lay eggs only seasonally. However, birds in captivity (e.g. poultry) can be made to lay eggs throughout the year.
- The females of placental mammals exhibit cyclical changes in the activities of ovaries, accessory ducts and hormones during the reproductive phase. It is called **oestrus cycle** in non-primates (cows, sheep, rat, deer, dog, tiger etc.) and **menstrual cycle** in primates (monkeys, apes and humans).
- **Seasonal breeders:** The mammals (living in natural conditions) exhibiting reproductive cycles only during favourable seasons.
- **Continuous breeders:** The mammals those are reproductively active throughout their reproductive phase.

Senescence (old age):

- It is the last phase of life span and end of reproductive phase.
 - During this, concomitant changes in the body (slowing of metabolism etc.) occur. It ultimately leads to death.
- In plants & animals, **hormones** are responsible for transition between **juvenile, reproductive & senescence phases**. Interaction between hormones and environmental factors regulate the reproductive processes and the associated behavioural expressions of organisms.

Events in sexual reproduction

3 stages: Pre-fertilisation, fertilisation & post-fertilisation events.

1. Pre-fertilisation Events

These are all the events prior to the fusion of gametes. They include **gametogenesis** and **gamete transfer**.

a. Gametogenesis

- It is the process of formation of male and female gametes (haploid cells).
- In some algae, all gametes are similar and cannot categorize into male and female gametes. They are called **homogametes (isogametes)**.

- In others, the male and female gametes are distinct types (**heterogametes**). Male gamete is called the **antherozoid (sperm)** and female gamete is called the **egg (ovum)**.

Sexuality in organisms:

- Plants may be **bisexual** (i.e. **monoecious**- male & female reproductive structures in the same plant) or **unisexual** (i.e. **dioecious**- male and female reproductive structures on different plants).
- In dioecious (unisexual) flowering plants, the male flower is **staminate** (bearing stamens) while the female is **pistillate** (bearing pistils). E.g. papaya and date palm.
- In monoecious flowering plants, male & female flowers are present on same individual. E.g. Cucurbits & coconuts.
- Fungi may be **homothallic** (bisexual) or **heterothallic** (unisexual).
- **Bisexual animals (hermaphrodites)**: Earthworms, leech, sponge, tapeworm, etc.
- **Unisexual animals**: Cockroach, higher animals etc.

Cell division during gamete formation:

- **Haploid** parental body (many monera, fungi, algae and bryophytes) produces haploid gametes by **mitosis**.
- **Diploid** parental body (pteridophytes, gymnosperms, angiosperms & animals) produces haploid gametes by **meiosis of meiocytes** (gamete mother cell).

Name of organism	Chromosome number	
	In meiocytes (2n)	In gametes (n)
Human being	46	23
Housefly	12	24
Rat	42	21
Dog	78	39
Cat	38	19
Fruit fly	8	4
<i>Ophioglossum</i>	1260	630
Apple	34	17
Rice	24	12
Maize	20	10
Potato	48	24
Butterfly	380	190
Onion	32	16

b. Gamete Transfer

- Male gametes need a medium to move towards female gametes for fertilisation.
- In a majority of organisms, male gamete is motile and the female gamete is stationary. In a few fungi and algae both types of gametes are motile.
- In simple plants (algae, bryophytes & pteridophytes), gamete transfer takes place through water medium. To compensate the loss of male gametes during transport, large number of male gametes is produced.
- In seed plants, pollen grains (in anthers) carry male gametes and ovule has the egg. Pollen grains are transferred to the stigma.
- In bisexual, self-fertilizing plants, (e.g. peas) transfer of pollen grains to the stigma is easy as anthers and stigma are located close to each other.
- In cross pollinating plants (including dioecious plants), **pollination** helps in transfer of pollen grains to the stigma. Pollen grains germinate on the stigma and the pollen tubes carrying the male gametes reach the ovule and discharge male gametes near the egg.
- In dioecious animals, the fertilisation helps for successful transfer and coming together of gametes.

2. Fertilisation (syngamy)

It is the fusion of gametes to form a diploid **zygote**.

Organisms like rotifers, honeybees, some lizards and birds (turkey), the female gamete develops to new organisms without fertilisation. This is called **parthenogenesis**.

Types of fertilization:

a. External fertilisation: Syngamy occurs in the external medium (water), i.e. outside the body of the organism. E.g. most aquatic organisms (many algae, bony fishes etc) and amphibians.

Such organisms show synchrony between the sexes and release a large number of gametes into the surrounding medium in order to enhance the chances of syngamy.

Disadvantage: The offspring are extremely vulnerable to predators threatening their survival up to adulthood.

b. Internal fertilisation: Syngamy occurs inside the body. E.g. terrestrial organisms, belonging to fungi, animals (reptiles, birds, mammals) & plants (bryophytes, pteridophytes, gymnosperms & angiosperms).

In this, non-motile egg is formed inside the female body to where motile male gamete reaches and fuses.

In seed plants, the non-motile male gametes are carried to female gamete by pollen tubes.

There is large number of sperms produced but the number of eggs is very low.

3. Post-fertilisation Events

These are the events after the formation of zygote.

The Zygote

- In organisms with external fertilisation, zygote is formed in the external medium. In organisms with internal fertilisation, zygote is formed inside body.
- Further development of the zygote depends on the type of life cycle of the organism and the nature of environment.
- In fungi and algae, zygote develops a thick wall that is resistant to desiccation and damage. It undergoes a period of rest before germination.
- In organisms with haplontic life cycle, zygote divides by meiosis into haploid spores that grow into haploid individuals.
- Every sexually reproducing organism begins life as a zygote. It is the vital link between organisms of one generation and the next.

Embryogenesis

- It is the 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 embryo. Cell differentiation causes the modifications of groups of cells into various tissues and organs to form an organism.

Based on place of zygote development animals are 2 types:

a. Oviparous: Here, animals lay fertilized/unfertilized eggs. E.g. In reptiles & birds, the fertilized eggs covered by hard **calcareous shell** are laid in a safe place. After incubation young ones hatch out.

b. Viviparous: Here, the zygote develops into a young one inside the female body. Later, the young ones are delivered out of the body. E.g. most of mammals.

Because of proper care and protection, the chances of survival of young ones are greater in viviparous animals.

Embryogenesis in flowering plants (see next chapter)