

1. REPRODUCTION IN ORGANISMS

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

Life spans of some organisms

Organism	Lifespan	Organism	Lifespan
Rose	5-7 years	Parrot	140 yrs
Rice plant	3-7 months	Crocodile	60 yrs
Banyan tree	400+ yrs	Horse	40-50 yrs
Banana tree	2-3 yrs	Tortoise	100-150 yrs
Dog	22 yrs	Crow	15 yrs
Butterfly	1-2 weeks	Cow	22 yrs
Fruit fly	2 weeks	Elephant	50-70 yrs

- 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.
- It is seen in unicellular organisms, simple plants & animals.
- The offspring are identical to one another and to their parent. Such morphologically and genetically similar individuals are known as **clone**.

Types of asexual reproduction

- o **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*.
- o **Budding:** In this, a bud appears and grows in the parent body. After maturation, it is detached from parent body to form new individual. E.g. Hydra, Sponge, Yeast etc.
- o **Vegetative propagation:** It is the production of offspring from **vegetative propagules** in plants. Vegetative propagules are units of vegetative propagation.

Examples for vegetative propagules:

- **Buds ('eyes')** of the potato tuber.
- **Rhizomes** of banana & ginger. Buds & Rhizomes arise from the **nodes** of modified stems. The nodes come in contact with damp soil or water and produce roots and new plants.
- **Adventitious buds** of *Bryophyllum*. They arise from the notches at margins of leaves.
- **Bulbil** of *Agave*.
- **Offset** of water hyacinth.
- **Runner, sucker, tuber, bulb etc.**

Other asexual reproductive structures: E.g. **zoospores** (microscopic motile structures in some algae and protists), **conidia** (*Penicillium*) and **gemmae** (*sponge*).

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

Higher plants reproduce asexually (vegetative) & sexually. But most of the animals show only sexual reproduction.

SEXUAL REPRODUCTION

- It is the reproduction that involves formation of male and female gametes, either by the same individual or by different individuals of the opposite sex.
- It results in offspring that are not identical to the parents or amongst themselves.
- It is an elaborate, complex and slow process as compared to asexual reproduction.
- The period of growth to reach in maturity for sexual reproduction is called the **juvenile phase**. In plants, it is known as **vegetative phase**.
- In higher plants, the flowering indicates the end of vegetative phase (beginning of **reproductive phase**).
- **Annual & biennial** plants show clear cut **vegetative, reproductive & senescent phases**. In **perennial** plants, these phases are very difficult to identify.
- Some plants exhibit unusual flowering. E.g.

- o Bamboo species flower only once in their lifetime (after 50-100 years), produce large number of fruits and die.
- o *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 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 & humans).

Based on breeding season, mammals are 2 types:

- **Seasonal breeders:** The mammals (living in natural conditions) exhibiting reproductive cycles only during favourable seasons.
- **Continuous breeders:** They are reproductively active throughout their reproductive phase.

Senescence (old age):

- It is the last phase of lifespan and end of reproductive phase.
- During this, concomitant changes occur in the body. E.g. slowing of metabolism etc. It ultimately leads to death.

In plants & animals, **hormones** cause 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 the events prior to the fusion of gametes. They include **gametogenesis** and **gamete transfer**.

a. Gametogenesis

It is the formation of male and female gametes.

Gametes (haploid cells) are 2 types:

- **Homogametes (isogametes):** Similar gametes. They cannot categorize into male & female gametes. E.g. Some algae like *Cladophora*.
- **Heterogametes:** The male and female gametes are distinct types. Male gamete is called **antherozoid (sperm)** and female gamete is called **egg (ovum)**. E.g. *Fucus* (an alga), Human beings etc.

Sexuality (bisexual or unisexual) in organisms:

- **Bisexual:** Male & female reproductive structures present in the same individual.

Bisexual plants: E.g. *Hibiscus*, *Pisum*.

In flowering plants, male flower is **staminate** (bears stamens) and female flower is **pistillate** (bears pistils).

If male & female flowers are present on same plant, it is called **monoecious**. E.g. Cucurbits & coconuts.

Bisexual animals (hermaphrodites): E.g. Earthworms, leech, sponge, tapeworm, etc.

- **Unisexual:** Male and female reproductive structures are present on different individuals.

If male and female flowers are present on different plants, it is called **dioecious**. E.g. papaya & date palm.

Unisexual animals: E.g. Cockroach, higher animals etc.

Fungi may be **homothallic** (bisexual) or **heterothallic** (unisexual).

Cell division during gamete formation:

- Many monerans, fungi, algae & bryophytes have **haploid** parental body. They produce haploid gametes by **mitosis**.
- Pteridophytes, gymnosperms, angiosperms & animals have **diploid** parental body. They produce 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	6
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 most organisms, male gamete is motile and the female gamete is stationary. In some 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** carries the egg. Pollen grains are transferred to the stigma.
- In bisexual self-fertilizing plants (e.g. peas), anthers & stigma are closely located. So transfer of pollen grains is easy.
- In cross pollinating plants (including dioecious plants), **pollination** helps in transfer of pollen grains. 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**.
- In rotifers, honeybees, some lizards, birds (turkey) etc., 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. zygote is formed outside the body. E.g. most aquatic organisms (many algae, bony fishes etc.) and amphibians.

Such organisms show synchrony between the sexes and release large number of gametes into the surrounding medium to ensure syngamy.

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

- b. Internal fertilisation:** Syngamy occurs inside the body of the organism. 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.

Zygote

- 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.
- Sexually reproducing organisms begin life as a zygote.
- Zygote 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*)

MODEL QUESTIONS

1. Write technical terms for the following:
 - (a) Morphologically different types of gametes.
 - (b) Process of formation of male and female gametes.
 - (c) Formation of new organisms without fertilization.
 - (d) Cell which undergo meiosis.
 - (e) Male and female sex organs in the same animal.
 - (f) Development of fruits without fertilization.
2. Observe the relationship of the first two and fill in the blanks.
 - (a) Sponge: gemmules Hydra:
 - (b) Homothallic Plants: Monoecious & bisexual Heterothallic Plants:
3. Differentiate between
 - (a) Asexual reproduction & Sexual reproduction
 - (b) Juvenile phase & Senescent phase
 - (c) Oviparous & Viviparous
4. Classify the following organisms, according to the nature of fertilization.
Shark, Tortoise, Tape worm, Frog, Chlamydomonas, Ficus Tree