REPRODUCTION IN ORGANISMS

SEXUAL REPRODUCTION

INTRODUCTION OF 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.
- These gametes fuse to form the **zygote** which develops to form the new organism.
- Because of the fusion of male and female gametes, sexual reproduction results in offspring that are not identical to the parents or amongst themselves.
- Different phases of life in sexual reproducing animals :

Phases of life in sexually reproducing organisms

- The life cycle of all organisms consists of three distinct stages:

(A) Juvenile phase (for animals) or **vegetative phase** (for plants),

(B) Reproductive phase,

(C) Post reproductive or **senescence phase**.

(A) Juvenile Phase :

- All organisms have to reach a certain stage of growth maturity in their life, before they can reproduce sexually.
- In animals, this period of growth is called the **Juvenile phase**, while in plants it is known as **vegetative phase**.
- This phase is of variable durations in different organisms.
  E.g. rice and wheat start flowering after 3-4 months of vegetative growth; marigold takes about 55-60 days to start flowering, Coconut and areca nut start producing flowers only when they reach an age of 6-8 years and mango takes 4-5 years of vegetative growth to flower.
- Based on the duration required for the plants to produce flowers, they have been classified into:

(a) Annuals complete their vegetative growth and flowering in one season and then they die.

(b) **Biennials** have vegetative growth in one season and flowering in the next season.

(c) **Perennials** live for many years and flower seasonally.

REPRODUCTIVE PHASE:

- The end of juvenile phase is marked by the beginning of the next phase called reproductive phase.
- It is the phase of life cycle wherein individuals have the potential to reproduce. The early period of reproductive phase is called **puberty.** Sex organs develop and mature during puberty. Growth is slowed down.
- In higher plants, appearance of flowers is indication of sexual maturity. Sexually, there are two types of flowering plants, **monocarpic** and **polycarpic**.
- Most plants exhibit multiple reproductive cycles in their life. They are called **iteroparous** or **polycarpic** e.g. mango, guava, banyan etc.
- **Semelparous** or **monocarpic** plants on other hand, show only a single reproductive episode before death e.g bamboo (exhibits flowering only once after 50-100 years), **Strobilanthus kunthiana** (flowers after 12 years).

REPRODUCTIVE PHASE IN ANIMALS

- There is an internal system to control the reproduction in animals.
- It is neuro-endocrine system.
- The hormones stimulate follicular development and ovulation (release of egg) and also prepare the uterus for pregnancy in human females.
- The female sexual cycle, called the **menstrual cycle** is carried on throughout the year with single ovulation in a month unless the woman becomes pregnant.
- In mammals such as sheep, cow, rat and dog which reproduce seasonally, cyclical changes during reproduction are referred to as the **oestrus cycle.**
- In mammals, the reproductive phase comes to an end as the organism grows old.
- This is accompanied by the decrease in the metabolic efficiency and ultimately the death.
- Both in plants and animals, hormones are responsible for the transition between three phases.

BREEDING SEASONS :-

- In most of animals do not breed throughout the year, instead they are **seasonal breeders**. For instance; birds living in nature lays eggs only seasonally.
  However, birds in captivity (as in poultry farms) can be made to lay eggs throughout the years by hormonal treatment. In this case, egg laying is not related to reproduction but is a commercial exploitation for human welfare.
- **During reproductive phase**, the females of placental mammals exhibit cyclical changes in the activities of ovaries and accessory ducts as well as secretion of hormones.
- In non-primate mammals like cows, sheeps, rats, deers. dogs, tigers, etc. such cyclical changes during reproduction are called **Oestrus cycle** where as in primates (monkeys. apes and humans) it is called menstrual cycle.
- Many mammals are reproductively active throughout their reproductive phase and hence are called continuous **breeders**.

POST REPRODUCTIVE OR SENESCENCE PHASE (AGEING).

- After reproductive maturity all organism enter into a senescent phase.
- **Senescence** may be defined as the period between reproductive maturity and death of the organism.
- In both plants and animals, hormones are responsible for the transitions between the three phases.
- Interaction between hormones and certain environmental factors regulate the reproductive processes and the associated behavioural expressions of organism.

EVENTS IN SEXUAL REPRODUCTION

The entire sexual reproduction in organisms has following events:

1. Pre-fertilization events
2. Syngamy or fertilization
3. Post-fertilization events

1. Pre-fertilisation Events :

- The two main pre-fertilisation events are gametogenesis and gamete transfer.

(a) Gametogenesis :

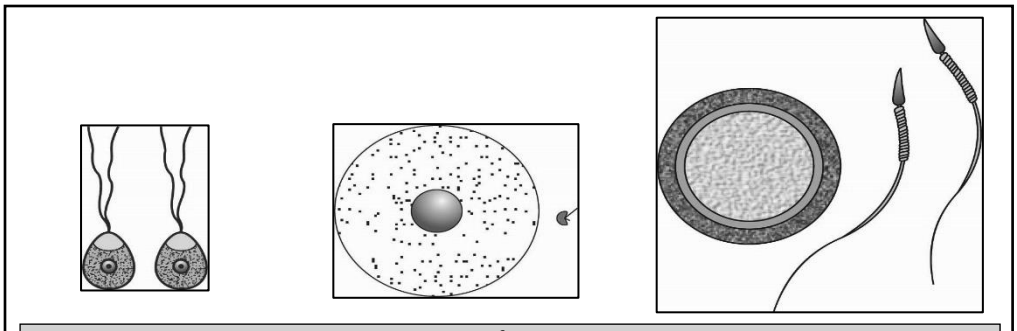
- The process of formation of the two types of gametes-male and female.
- Gametes are haploid cells.

Homogametes or isogametes :-

- In some algae, the two gametes are so similar in appearance that it is not possible to categorise them into male and female gametes, called homogamgetes or isogametes.

Heterogametes :-

- In a majority of sexually reproducing organisms the gametes produced are of two morphologically distinct types.
- In majority of animal species, the individuals are either male or female such animals are called **unisexual**.
  eg: **Human**, Monkey, **Cockroach** etc.
- Some animal species posses both male and female reproductive organs such animals are termed **bisexual** or **hermaphrodites**.
  eg : **Sponges, tapeworm, earthworm, leech.**
- In diploid organisms, specialised cells called **meiocytes** (gamete mother cell) undergo meiosis and form gamete.
- In plants, the male are called as **antherozoids** (e.g. Fucus, bryophytes) or male gametic nuclei (carried by male gametophyte formed due to the germination of **microspore** or pollen grain e.g. mango, Hibiscus) and female gametes **egg** respectively.



Types of gametes:

(a) Isogametes of Cladophora (an algal) Heterogametes: (b) Fucus (an algal): (c) Human beings

- In animals, the male gametes are called as **sperms** and female gametes as **ovum** (e.g. Man).

Cell division during gametogenesis

- Gametes are always haploid though the parent body may be haploid or diploid.
- The monerans, several algae, fungi and bryophytes have haploid plant body while pteridophytes, gymnosperms, angiosperms and most of the animals including human beings are diploid organisms.
- In **diploid organisms**, haploid gametes are produced via **meiosis** in **meiocytes** (gamete mother cells).
- In **haploid organisms**, the gametogenesis involves **mitosis**. Thus, gametogenesis via meiosis is characteristics of diploid organisms only.

(b) Gamete Transfer :

- After the formation of gametes, it is essential that male and female gametes are brought together in physical contact.
- The most primitive mechanisms for compatible gametes to come together are chemical cues.
- In a majority of organisms, male gamete is motile and the female gamete is stationary.
- Whether fertilization is external or internal, there is always a need of the medium, through which male gametes move and reach to the female gamete/s,e.g. water serves as a medium to move the male gametes in algae, bryophytes and most of the pteridophytes.
- Being motile, the male gamete has to move and to reach the female one after crossing several physical barriers.
- This is why male gametes are produced in much greater number than that of female gametes.
- In seed plants, the transfer of gametes takes place by **pollination**.
- It is the transfer of pollen grains from anthers to the stigma/s of the same flower (**self-pollination**) or different flower borne at the same or different plant/s of a species (**cross pollination**).
- The pollen grains (carriers of male gametes) reach the stigma, germinate and discharge the male gametes in the ovule (carrier of egg) through the pollen tube. This leads to fertilization.
- Animals have evolved different strategies for the transfer of gametes, e.g. many animals secrete sex pheromones to attract their partners.

- Some insects like the silkworm and moth produce pheromones and attract males to mate and release the gametes.
- Several marine invertebrates, release their gametes into water, thus there is no need for the parents to make direct physical contact.
- In others, male releases sperms into the reproductive tract of the female during the mating.
- The semen of the and secretions of the female reproductive tract provide a medium for sperms to move and fertilize the ovum.

2. Fertilisation (Syngamy) :-

- The most vital event of sexual reproduction is perhaps the fusion of gametes. This process is called syngamy results in the formation of diploid **Zygote**.

External fertilisation :-

- In most aquatic organism, such as a majority of fished as well as amphibians, syngamy occurs in the external medium (water), i.e., outside the body of organism. This type of gametic fusion is called **external fertilisation.**

Internal fertilisation :-

In many terrestrial organisms such as reptiles, birds, mammals, syngamy occurs inside the body of the organisms, hence the process is called **internal fertilisation.**

3. Post-fertilisation Events :-

- Events in sexual reproduction after the formation of zygote are called post-fertilisation events.
- 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'.

Embryogenesis :-

- Embryogenesis refers to the process of development of embryo from the zygote.
- During embryogenesis, zygote undergoes cell division (mitosis) and cell differentiation.
- While cell divisions increase the number of cells in the developing embryo, cell differentiation help groups of cells to undergo certain modifications to form specialised tissue and organs to form an organism.
- Animals are categorised into oviparous and viviparous based on whether the development of the zygote takes place outside the body of the female parent or inside, i.e. whether they lay fertilised/unfertilised eggs or give birth to young ones.
- In oviparous animals like reptiles and birds the fertilised eggs covered by hard calcareous shell are laid in a safe places in the environment; after a period of incubation young ones hatch out.
- On other hand, in viviparous animals (Majority of mammals including human beings), the zygote develops into a young one inside the body of the female organism. Because of proper embryonic care and protection, the chances of survival of young ones is greater in viviparous organisms.

S.No.	Oviparous animals	Viviparous animals
(i)	Oviparous animals lay fertilized eggs.	Viviparous animals give birth to young ones.
(ii)	The fertilized eggs have calcareous shell and young ones hatch out after a period of incubation.	The fertilized egg (zygote) has no shell and develops into a young one inside the body of the female organisms.
(iii)	Chances of survival of young one is less as the female lays egg in the environment.	Chances of survival of young one is more because of proper embryonic care and protection inside the mother's body.
(iv)	For example, reptiles, birds, etc.	For example, majority of mammals including humans.

Post fertilization events in plants:

- In the flowering plants, the zygote is formed inside the ovule. After fertilisation, the sepals, petals and stamens of the flower wither and fall off.
- The pistil however, remains attached to the plant. The zygote develops into the embryo and the ovules develops into the seed.
- The **ovary** develops into the **fruit** with a thick wall called **pericarp** that is protective in function. After dispersal, seeds germinate under favourable conditions to produce new plants.