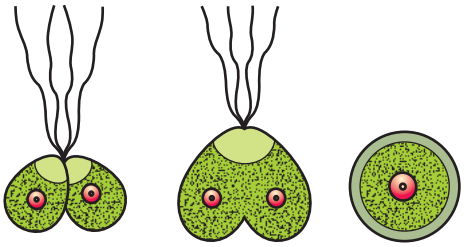
Table 1.1: Chromosome Numbers in Meiocytes (diploid, 2n) and Gametes (haploid, n) of Some Organisms. Fill in the Blank Spaces.

Name of organism	Chromosome number in meiocyte (2n)	Chromosome number in gamete (n)
Human beings	*46*	*23*
House fly	*12*	—
Rat	—	*21*
Dog	*78*	—
Cat	—	*19*
Fruit fly	*8*	—
Ophioglossum (a fern)	—	*630*
Apple	*34*	—
Rice	—	*12*
Maize	*20*	—
Potato	—	*24*
Butterfly	*380*	—
Onion	—	*8*

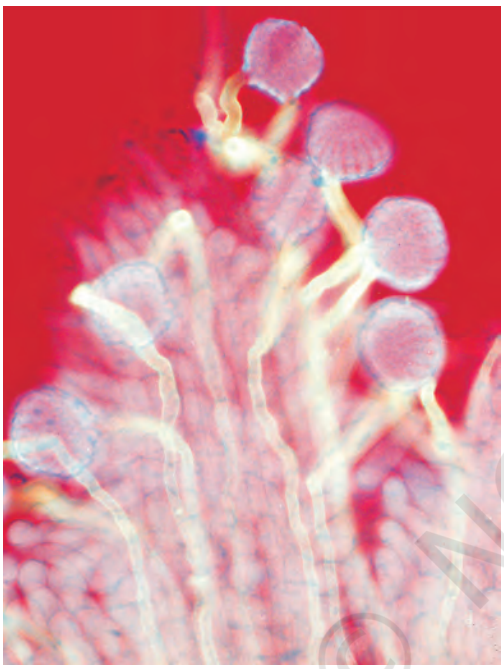
In diploid organisms, specialised cells called **meiocytes** (gamete mother cell) undergo meiosis**.** At the end of meiosis, only one set of chromosomes gets incorporated into each **gamete**. Carefully study Table 1.1 and fill in the diploid and haploid chromosome numbers of organisms. *Is there any relationship in the number of chromosomes of meiocytes and gametes?*

1.2.1.2 Gamete Transfer

After their formation, male and female gametes must be physically brought together to facilitate fusion (fertilisation). *Have you ever wondered how the gametes meet?* In a majority of organisms, male gamete is motile and the female gamete is stationary. Exceptions are a few fungi and algae in which both types of gametes are motile (Figure1.7a). There is a need for a medium through which the male gametes move. In several simple plants like 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.



(a)



(b)

Figure 1.7 (a) Homogametic contact in alga; (b) Germinating pollen grains on the stigma of a flower

In seed plants, pollen grains are the carriers of male gametes and ovule have the egg. Pollen grains produced in anthers therefore, have to be transferred to the stigma before it can lead to fertilisation (Figure 1.7b). In bisexual, self-fertilising plants, e.g., peas, transfer of pollen grains to the stigma is relatively easy as anthers and stigma are located close to each other; pollen grains soon after they are shed, come in contact with the stigma. But in cross pollinating plants (including dioecious plants), a specialised event called **pollination** facilitates 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, since male and female gametes are formed in different individuals, the organism must evolve a special mechanism for gamete transfer. Successful transfer and coming together of gametes is essential for the most critical event in sexual reproduction, the fertilisation.

1.2.2 Fertilisation

The most vital event of sexual reproduction is perhaps the fusion of gametes. This process called **syngamy** results in the formation of a diploid **zygote**. The term **fertilisation** is also often used for this process. The terms syngamy and fertilisation are frequently used though , interchangeably.

What would happen if syngamy does not occur?

However, it has to be mentioned here that in some organisms like rotifers, honeybees and even some lizards and birds (turkey), the female gamete undergoes development to form new organisms without fertilisation. This phenomenon is called **parthenogenesis.**

Where does syngamy occur? In most aquatic organisms, such as a majority of algae and fishes as well as amphibians, syngamy occurs in the external medium (water), i.e., outside the body of the organism. This type of gametic fusion is called **external fertilisation**. Organisms exhibiting external fertilisation show great synchrony between the sexes and release a large number of gametes into the surrounding medium (water) in order to enhance the chances of syngamy. 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 survival up to adulthood.

In many terrestrial organisms, belonging to fungi, higher animals such as reptiles, birds, mammals and in a majority of plants (bryophytes, pteridophytes, gymnosperms and angiosperms), syngamy occurs inside the body of the organism, hence the process is called **internal fertilisation.** In all these organisms, egg is formed inside the female body where they fuse with the male gamete. In organisms exhibiting internal fertilisation, the male gamete is motile and has to reach the egg in order to fuse with it. In these even though the number of sperms produced is very large, there is a significant reduction in the number of eggs produced. In seed plants, however, the non-motile male gametes are carried to female gamete by pollen tubes.

1.2.3 Post-fertilisation Events

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

1.2.3.1 The Zygote

Formation of the diploid zygote is universal in all sexually reproducing organisms. In organisms with external fertilisation, zygote is formed in the external medium (usually water), whereas in those exhibiting internal fertilisation, zygote is formed inside the body of the organism.

Further development of the zygote depends on the type of life cycle the organism has and the environment it is exposed to. In organisms belonging to fungi and algae, zygote develops a thick wall that is resistant to dessication and damage. It undergoes a period of rest before germination. In organisms with haplontic life cycle (As you have read in Class XI), zygote divides by meiosis to form haploid spores that grow into haploid individuals. *Consult your Class XI book and find out what kind of development takes place in the zygote in organisms with diplontic and haplo-diplontic life cycles.*

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.

1.2.3.2 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 helps groups of cells to undergo certain modifications to form specialised tissues and organs to form an organism. You have studied about the process of cell division and differentiation in the previous class.

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 place in the **environment;** after a period of incubation young ones hatch out. On the 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. After attaining a certain stage of growth, the young ones are delivered out of 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.

In flowering plants, the zygote is formed inside the ovule. After fertilisation the sepals, petals and stamens of the flower wither and fall off. *Can you name a plant in which the sepals remain attached?* 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 (Figure 1.8). After dispersal, seeds germinate under favourable conditions to produce new plants.

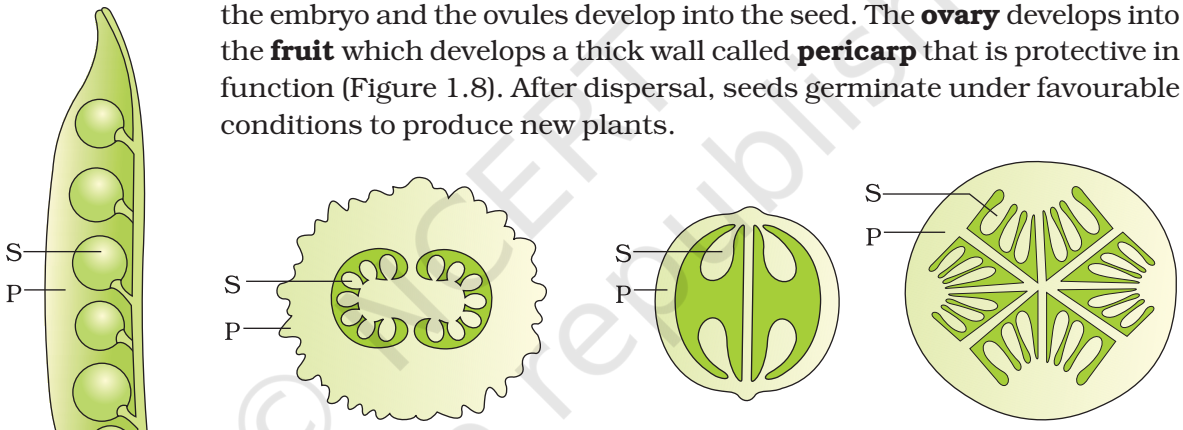


Figure 1.8 A few kinds of fruit showing seeds (S) and protective pericarp (P)

SUMMARY

Reproduction enables a species to live generation after generation. Reproduction in organisms can be broadly classified into asexual and sexual reproduction. Asexual reproduction does not involve the fusion of gametes. It is common in organisms that have a relatively simple organisation such as the fungi, algae and some invertebrate animals. The offspring formed by asexual reproduction are identical and can be referred to as clones. Zoospores, conidia, etc., are the most common asexual structures formed in several algae and fungi. Budding and gemmule formation are the common asexual methods seen in lower animals.

Prokaryotes and unicellular organisms reproduce asexually by cell division or binary fission of the parent cell. In several aquatic and

terrestrial species of angiosperms, structures such as runners, rhizomes, suckers, tubers, offsets, etc., are capable of giving rise to new offspring. This method of asexual reproduction is generally referred to as vegetative propagation.

Sexual reproduction involves the formation and fusion of gametes. It is a complex and slower process as compared to asexual reproduction. Most of the higher animals reproduce almost entirely by sexual method. Events of sexual reproduction may be categorised into pre-fertilisation, fertilisation and post-fertilisation events. Pre-fertilisation events include gametogenesis and gamete transfer while post-fertilisation events include the formation of zygote and embryogenesis.

Organisms may be bisexual or unisexual. Sexuality in plants is varied, particularly in angiosperms, due to the production of diverse types of flowers. Plants are defined as monoecious and dioecious. Flowers may be bisexual or unisexual flowers.

Gametes are haploid in nature and usually a direct product of meiotic division except in haploid organisms where gametes are formed by mitosis.

Transfer of male gametes is an essential event in sexual reproduction. It is relatively easy in bisexual organisms. In unisexual animals it occurs by copulation or simultaneous release. In angiosperms, a special process called pollination ensures transfer of pollen grains which carry the pollen grains to the stigma.

Syngamy (fertilisation) occurs between the male and female gametes. Syngamy may occur either externally, outside the body of organisms or internally, inside the body. Syngamy leads to formation of a specialised cell called zygote.

The process of development of embryo from the zygote is called embryogenesis. In animals, the zygote starts developing soon after its formation. Animals may be either oviparous or viviparous. Embryonal protection and care are better in viviparous organisms.

In flowering plants, after fertilisation, ovary develops into fruit and ovules mature into seeds. Inside the mature seed is the progenitor of the next generation, the embryo.

EXERCISES

1. Why is reproduction essential for organisms?
2. Which is a better mode of reproduction: sexual or asexual? Why?
3. Why is the offspring formed by asexual reproduction referred to as clone?
4. Offspring formed due to sexual reproduction have better chances of survival. Why? Is this statement always true?
5. How does the progeny formed from asexual reproduction differ from those formed by sexual reproduction?
6. Distinguish between asexual and sexual reproduction. Why is vegetative reproduction also considered as a type of asexual reproduction?

7. What is vegetative propagation? Give two suitable examples.
8. Define
   (a) Juvenile phase,
   (b) Reproductive phase,
   (c) Senescent phase.
9. Higher organisms have resorted to sexual reproduction in spite of its complexity. Why?
10. Explain why meiosis and gametogenesis are always interlinked?
11. 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 ——————————
12. Define external fertilisation. Mention its disadvantages.
13. Differentiate between a zoospore and a zygote.
14. Differentiate between gametogenesis from embryogenesis.
15. Describe the post-fertilisation changes in a flower.
16. What is a bisexual flower? Collect five bisexual flowers from your neighbourhood and with the help of your teacher find out their common and scientific names.
17. Examine a few flowers of any cucurbit plant and try to identify the staminate and pistillate flowers. Do you know any other plant that bears unisexual flowers?
18. Why are offspring of oviparous animals at a greater risk as compared to offspring of viviparous animals?