



Unlike the essential life processes such as nutrition, respiration or excretion, reproduction is not necessary to maintain the life of an individual. When an organism reproduces, it creates more individuals and a lot of its energy is spent in the process. Then, why do organisms reproduce? The organisms reproduce to maintain the continuity of their own race.

15.1. Reproduction in Plants

The origin of life is estimated to have happened over 3000 million years ago and has produced all living organisms of today by different methods of reproduction. One of the most important aspects of living organisms is their ability to produce copies of themselves.

Two distinct methods of producing offspring are found among living organisms.

Asexual reproduction is a rapid method of increasing the number of a species without involving a union of two cells (gametes). **Sexual reproduction** is a slower method in which the union of two cells take place for the production of a new individual. Do plants and animals have similar reproductive cycles?

15.1.1. Asexual reproduction

In asexual reproduction, the nucleus divides by mitosis, producing two daughter cells, each having the same number of chromosomes in their nuclei as the parent. **Cloning** is a term used to describe the formation of a group of organisms of the same species by asexual methods involving mitosis and vegetative or artificial propagation. The clones have identical genetic composition. This method is widely used by microorganisms, plants and lower animals.

Activity 15.1.

- ☞ Prepare a 10% sugar solution (10 g in 100 ml of water).
- ☞ Transfer 20 ml of the solution to a test tube.
- ☞ Add a pinch of yeast granules in it.
- ☞ Close the mouth of the test tube with a cotton plug.

- ☞ Keep it undisturbed for about 2 hours in a warm place.
- ☞ Take a drop of the yeast culture from the test tube on a slide and cover it with a cover slip.
- ☞ Observe the slide under a microscope.

Write down your observations.

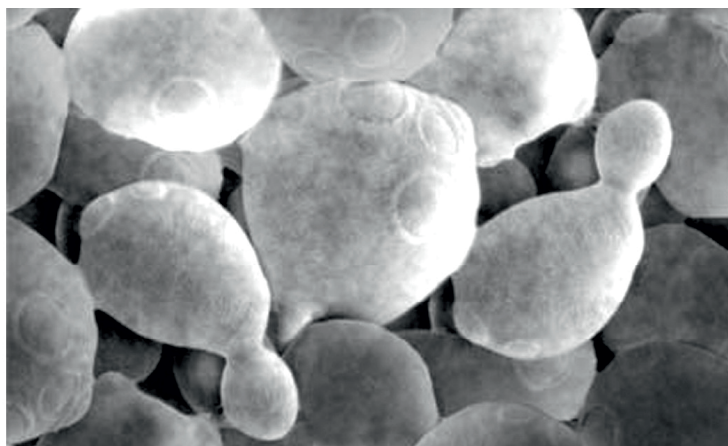


Fig . 15.1. Yeast budding

15.1.2. Budding

Yeast cell forms a small bud into which cytoplasm and a nucleus pass. The bud is much smaller than the parent cell and becomes detached (Fig. 15.1.). A multicellular organism like *Hydra* also reproduced by the formation of bud which later separates from the parent body.

15.1.3. Fragmentation

In multicellular filamentous algae like *Spirogyra*, a parent cell divides by forming a new cell wall or septum into daughter cells i.e. septation or fragmentation.

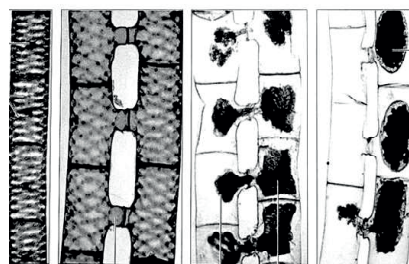


Fig. 15.2. Conjugation in *Spirogyra*

15.1.4. Sporulation (Spore formation)

Fungi, liverworts, mosses and ferns can produce enormous number of spores.

Spores are small bodies containing a nucleus and a small amount of cytoplasm. The spores of terrestrial organisms are usually very light and have a protective wall around them.

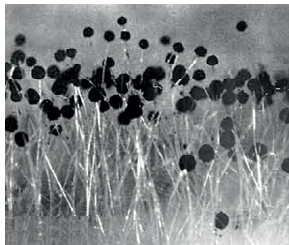
Many bacteria form a thick-walled spore inside the bacterial cell wall. This can not be considered as a reproductive mechanism for them but provides a means of survival during unfavourable conditions.

Some of the green algae and aquatic fungi form two to eight small zoospores, each with a nucleus, cytoplasm and two flagella. Swimming by means of their flagella, the spores disperse the species to new locations.

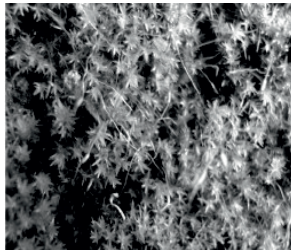
Activity 15.2.

- ☞ Keep a slice of moistened bread in a moist, warm and dark place.
- ☞ Observe the slice daily, for a week with a magnifying glass.
- ☞ Record your daily observations.

The thread like structures that developed on the bread in Activity 15.2. above are hyphae of either the bread mould (*Rhizopus*) or the pin mould (*Mucor*) from its body or mycelium. The erect hypha develops a swelling at its tip to form a sporangium. Inside the sporangium, a large number of spores are produced by mitosis and they are liberated.



(a)



(b)



(c)

Fig.15.3. (a) *Rhizopus* (b) Moss (c) Fern

The mosses, clubmosses and common ferns also produce enormous number of tiny windblown spores which serve to disperse the species to new locations.

15.1.5. Vegetative Reproduction

Vegetative reproduction is a method of asexual reproduction in which vegetative parts (root, stem, leaf and buds) can be detached from the parent plant body and developed into another complete daughter plant. This method of asexual reproduction is seen in many flowering plants like sweet potato, onion, potato, grasses, banana etc. Perennial plants which overwinter as bulbs, corms, tubers or rhizomes are vegetatively propagated plants.

This property of vegetative propagation is used artificially by the methods of layering, grafting, cutting and by artificial culture in different media. Artificial propagation is successfully performed in plants like rose, orange, grapes, sugarcane, banana, jasmine etc. Another advantage of vegetative reproduction is that the offsprings produced are genetically identical to the parent plants.

15.1.6. Micropropagation or Tissue Culture

It is a technique of propagation of plants from cells, tissues or organs by using the methods of tissue culture. Here the plant parts (roots, stem, leaf etc.) are cultured on a sterilized medium containing necessary nutrients. After some days a mass of undifferentiated cells known as callus is developed. By transferring the cells of callus to other media containing hormones the callus differentiated into plantlets. This method is successfully used in many economically important plants such as orchids, chrysanthemum, gladiolus etc. The ability of a somatic cell to produce the complete organism is called cellular totipotency. It was first observed in carrot cells.

15.1.7. Parthenogenesis

Parthenogenesis is a type of asexual reproduction in which the organism is developed from unfertilized egg. This process may be natural as well as artificial. Natural parthenogenesis is found in many plants and animals. Nonflowering plants like *Spirogyra*, *Chara*, *Marsilea* etc., and flowering plants like *Thalictrum* and certain species of *Asteraceae* (Sunflower family) and *Solanaceae* (tomato family) can reproduce by parthenogenesis. In animals the process is found in Aphids or Greenfly, but they are normally reproduce by sexual reproduction.

15.1.8. Sexual reproduction in plants

Sexual reproduction occurs widely in lower plants like *Spirogyra* (through the process of conjugation, Fig.15.2.) and *Mucor* (by gametangial contact). In mosses and ferns, there is the formation of motile male gametes in the antheridium and non-motile female ova in the archegonium. It is followed by the union of male and female gametes to form zygotes and reduction division (meiosis) to form spores. What is the significance of this sexual reproduction in non-flowering plants ?

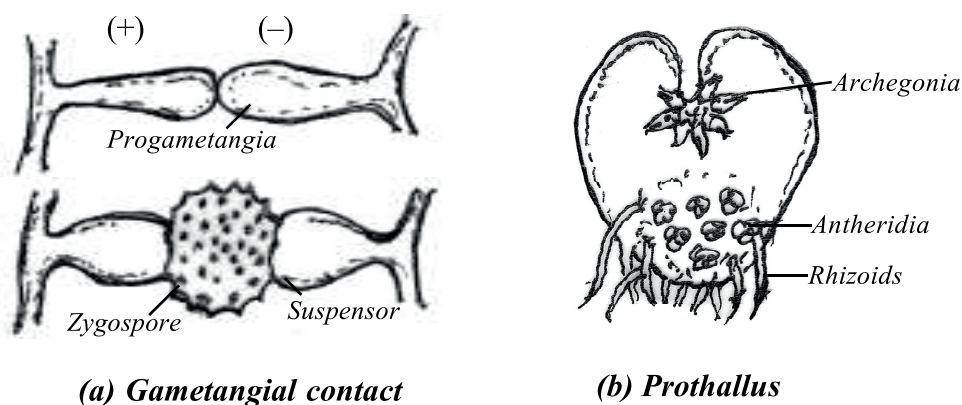


Fig.15.4. Sexual reproduction in (a) *Mucor* (b) Fern

Let us answer these .

1. Why reproduction is essential in living organisms?
2. Name the two methods of reproduction.
3. How can you differentiate budding from fragmentation ?
4. How does an organism be benefited, if it reproduce through spores?
5. Why vegetative propagation is more suitable in some types of plants?
6. What is tissue culture?

7. How will you define a callus?
8. Name two plants which can reproduce by natural parthenogenesis.
9. Give the definition of cellular totipotency.?

15.2. Sexual reproduction in flowering plants

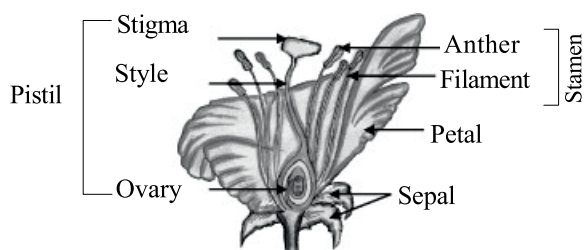


Fig. 15.5. Longitudinal section of a flower

A flower can be defined as a reproductive structure of a flowering plant. A complete flower will have four sets of floral parts. They are **Calyx** (composed of mainly green sepals), **Corolla** (composed of brightly coloured petals), **Androecium** (the male parts consisting of stamens, composed of filaments and anthers) and **Gynoecium** (the central female part consisting of a swollen bottom part called ovary, middle elongated part is the style and terminal part which may be sticky is the stigma).

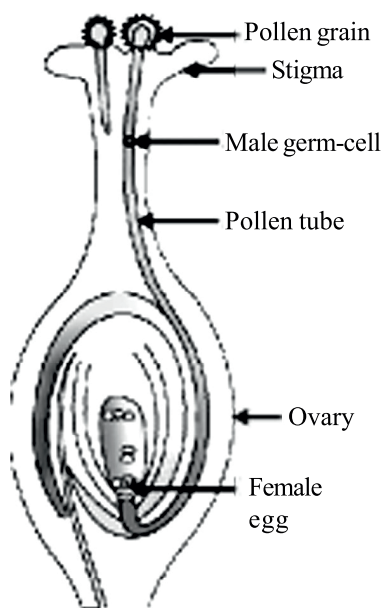


Fig.16.6. Germination of pollen on stigma

Flowers are generally bisexual in mustard, pea, china rose having both male and female floral parts. Many flowers are unisexual, (papaya, watermelon) when it contains either androecium or gynoecium. The male germ cell from the pollen, produces by the anther unites with the female gamete present in the ovule. The fusion of germ cells or fertilisation gives rise to zygote which is capable of growing into a new plant. What could be the possible functions of calyx and corolla? Their function is mainly for protection of floral sex organs and also act as flag apparatus for insect pollination.

For the process of fertilisation the pollen grains from the anther has to be

transferred to the stigma. If the pollen is transferred from the anther to the stigma of the same flower or different flowers of the same plant, it is referred to as **self pollination**. And if the transfer takes place between two different flowers of **different plants**, the process is called as **cross pollination**. Pollination is generally done in nature by wind, water, insects and animals. Artificial pollination (Pollination by human with some intention) is widely practiced in economic plants for the production of hybrids.

After the pollen lands on a suitable stigma, the male gamete from the pollen is brought by the pollen tube grows out of the pollen grain and travels through the style to reach the ovule. The zygote resulted from the union divides several times to form an embryo within the ovule. The ovule develops a tough coat and is gradually converted into a seed. The ovary grows rapidly and ripens to form a fruit. Other floral parts like sepals, petals, stamens and style fall off. The seed contains the future plant or embryo. What are the advantages of seed formation in a plant ?

Activity 15.3.

- ☞ Soak a few seeds of pea in water and keep them overnight.
- ☞ Transfer the seeds on a wet cloth and leave them for a day under cover.
- ☞ Open the wet seeds carefully and observe the different parts.
- ☞ Try to draw the parts you have seen and compare it with Fig. 15.7.

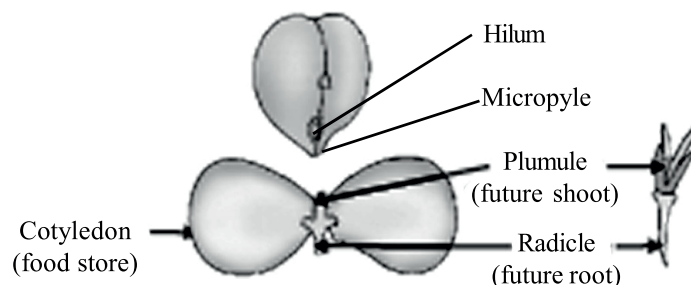


Fig.15.7. Dicotyledonous seed (gram)

15.2.1. Seed and Germination

Seed is a part of plant which contains a young plantlet in a dormant and resting condition. Can you get seeds in all the plants ? Seeds are formed within the cones of gymnosperms and inside the fruits of angiosperms, as a result of fertilization.

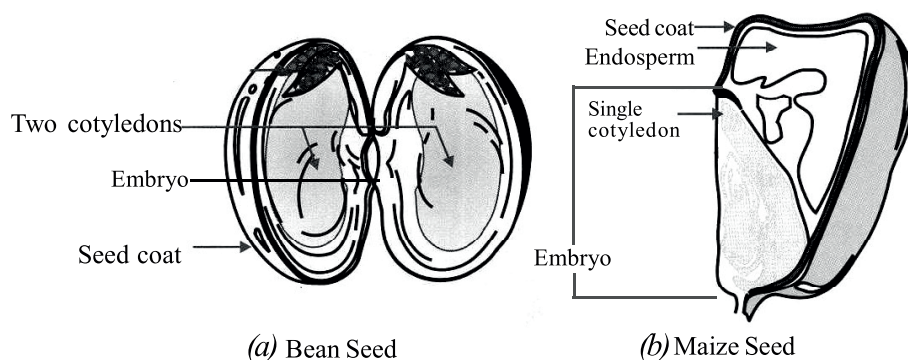


Fig. 15.8. L.S. of seeds (a) dicot and (b) monocot seeds showing embryos

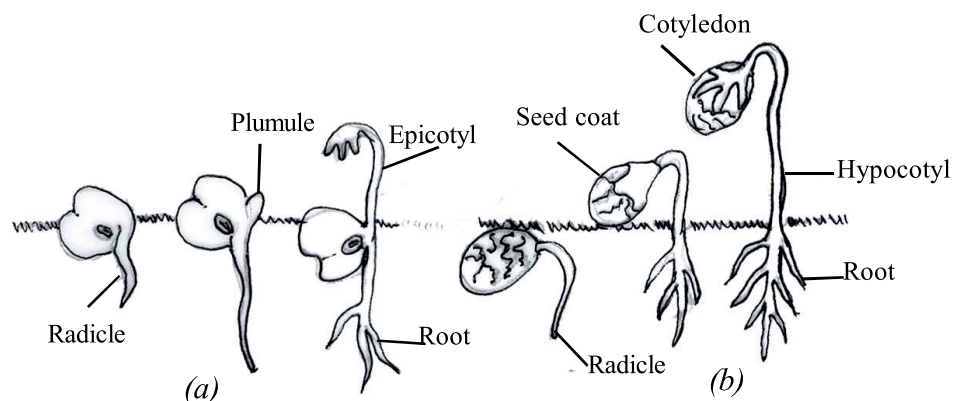
A seed is surrounded by a thick seed coat or testa providing protection against dehydration. A hilum is the scar of the seed stalk. The embryo inside the seed consists of a plumule (future shoot), radicle (future root) and seed leaves or cotyledons. Monocotyledonous plants like, grasses, rice, etc. have only one cotyledon. Dicotyledonous plants have two cotyledons, i.e. pea seeds, castor seeds, etc. Endosperm is a nutritive tissue which may surround the embryo of maize, rice, castor seed etc. or it may be absorbed into the cotyledons of non-endospermous seeds of pea, bean, etc.

Seed growth or germination commences by water entering the seed through the micropyle and the testa absorb water. The testa splits and radicle emerges.

Activity 15.4.

- ☞ Soak one healthy seed of pea and another healthy seed of castor overnight with water.
- ☞ Keep them in a petridish containing humid sand.
- ☞ Observe the seeds for a period of 5 days.
- ☞ Record your daily observations.

Compare the mode of germination in the two seeds.



**Fig. 15.9. Stages of : (a) Hypogeal germination in gram
(b) Epigeal germination in castor**

Hypogeal germination occurs in maize, gram, bean, etc. when the cotyledons remain below ground and the plumule emerges (by the elongation of epicotyl).

Epigeal germination occurs in castor, sunflower, etc. when the plumule and cotyledons emerge above ground (by the elongation of hypocotyl). The cotyledons function as leaves (Fig.15.9.).

Let us answer these.

1. How is the process of pollination different from fertilisation ?
2. Describe the parts of a dicot seed.
3. How does a seed germinate ?
4. Name the different parts of a typical flower.

15.3. Reproduction in animals

Among animals there are two types of reproduction – Asexual and sexual.

15.3.1. Asexual Reproduction

Asexual type of reproduction may be binary fission, multiple fission, regeneration and budding. **Binary fission** is seen in unicellular animals like *Amoeba*, *Leishmania*, etc. In this the single - celled body is divided into two daughter individuals (Fig.15.10).

In multiple fission, the unicellular body



Fig.15.10. Binary fission in Amoeba

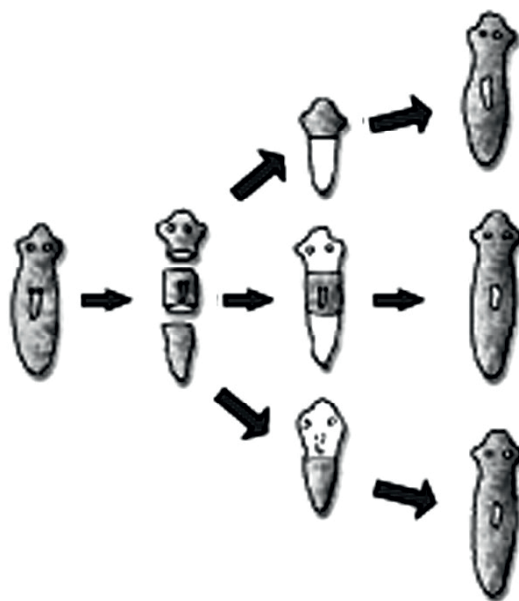


Fig.15.11. Regeneration in Planaria

is divided into a number of daughter cells. This type of reproduction is seen in *Plasmodium*, *Amoeba*, etc.. In some animals like *Hydra* and *Planaria*, if the body is cut or broken up into many pieces, many of these pieces grow into separate individuals. This is known as **regeneration** (Fig. 15.11).

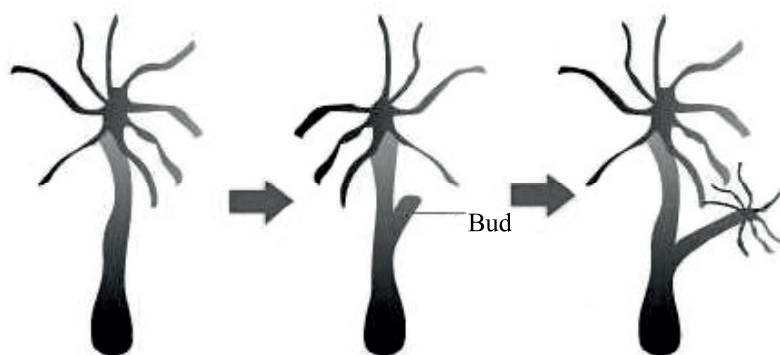


Fig.15.12. Budding in Hydra

Regeneration is carried out by specialised cells. These cells divide and make large number of cells, different cells give rise to various cell types and tissues. Finally they give rise to a complete individual. However regeneration is

not a normal process of reproduction. Most organisms would not normally depend on being cut up to be able to reproduce.

In some animals like *Hydra* some regenerative cells are used for reproduction in the process of budding. In such cases, a bud develops as an outgrowth due to repeated cell division at a specific site. Later these buds give rise to small individuals and when fully mature, detach from the parent body and become new individuals independently.

15.3.2. Sexual reproduction

This involves two individuals, male and female, followed by the fusion of two gametes one from male parent and other from female parent. Majority of the animals reproduce by this method.

In the sexual mode of reproduction, the germ-cells from two individuals have to meet and fuse together. This can happen by the external release of germ-cells from the bodies of individuals, as happens in fishes and amphibians; or it can happen by joining their bodies together by two individuals for internal transfer of germ cells for fusion as happens in many animals.

15.3.3. Sexual reproduction in invertebrates

In *Paramecium* the two partners meet with their oral grooves opposite. There is exchange of cytoplasmic and nuclear materials by breaking the surface membrane. After separation each individual divides into two by binary fission. *Hydra*, Earthworm and Tapeworm are hermaphrodite animals having gonads, ovary and testes. But these animals have different devices to perform sexual reproduction with their partners. In *Hydra* and Tapeworm the male and the female gonads mature at different time. In earthworm sperms are exchanged between two individuals by copulation. This prevent them from self fertilization.

Sexual reproduction in insect is by copulation between a male and female partner. The fertilized eggs undergo metamorphosis to become a complete young individual.

15.3.4. Sexual reproduction in vertebrate animals

The fertilization (union of gametes) is external in fishes and amphibians. The eggs are laid in great numbers into the surrounding water. These eggs are fertilized by the sperms released over the eggs from the male. In amphibians the fertilized eggs undergo metamorphosis.

Internal fertilization is the characteristic feature of birds and mammals. In birds the fertilized zygotes are converted into eggs and the eggs are laid down. Further development of embryo takes place inside the egg. Most mammal embryos develop within the mother's uterus and are protected and nourished by embryonic membranes and a placenta. Such placental mammals are called viviparous e.g. rat, rabbit, monkey and human beings.

Let us answer these.

1. Name an animal that reproduces by budding.
2. What is meant by binary fission?

POINTS TO REMEMBER

- ⇒ Reproduction, unlike other life processes, is not essential to maintain the life of an individual organism.
- ⇒ Various organisms use different modes of reproduction depending on their body design.
- ⇒ Budding, fragmentation and sporulation are examples of asexual reproduction where new generations are created from a single individual.
- ⇒ Roots, stems and leaves of some plants develop into new plants through vegetative propagation.
- ⇒ Sexual reproduction involves two individuals for the creation of a new individual.
- ⇒ Lower plants like algae, fungi, mosses and ferns etc. also can reproduce by sexual methods.
- ⇒ Reproduction in flowering plants involves transfer of pollen grains from the anther to the stigma. This process is referred to as pollination. This is followed by fertilisation.
- ⇒ Germination is the beginning of growth and development of the dormant embryo within the seed.
- ⇒ Hypogeal germination occurs in maize, pea and bean, whereas epigeal germination occurs in castor, sunflower, etc.
- ⇒ Micropropagation is a technique of propagation of plants from cells tissues or organs by using the methods of tissue culture.

- ⇒ Parthenogenesis is the development of ovum without fertilization into a new individual.
- ⇒ Metamorphosis is the period of rapid transformation from larval to adult form.
- ⇒ Viviparous is the method of development of embryo within the maternal organism and derive nutrition by close contact with maternal tissues, frequently by a placenta, without interposition of any egg membranes.
- ⇒ Cellular totipotency is the genetic potential of a plant cell to produce the entire plant.

EXERCISES

1. What type of asexual reproduction takes place in yeast ?
2. Name the plant which reproduces by the process of conjugation.
3. What are the advantages of sexual reproduction over asexual reproduction ?
4. Draw a labelled diagram of the longitudinal section of a typical flower.
5. Describe the two types of germination with labelled diagram.
6. How does binary fission differ from budding in animals.
7. How sexual reproduction takes place in Paramecium?
8. Give one similarity between the sexual reproduction of Hydra and Tapeworm.
9. In what way earthworm prevents itself from self fertilization?
10. What is metamorphosis ? Give two examples which shows metamorphosis.
11. How will you define a viviparous animal ? Give two examples.
12. What are the advantages of tissue culture in plant?
13. Why parthenogenesis is considered as asexual reproduction?

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