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OLYMPIAD

Science and Mathematics (For Beginners)

(Class 8-10)

Volume - 2

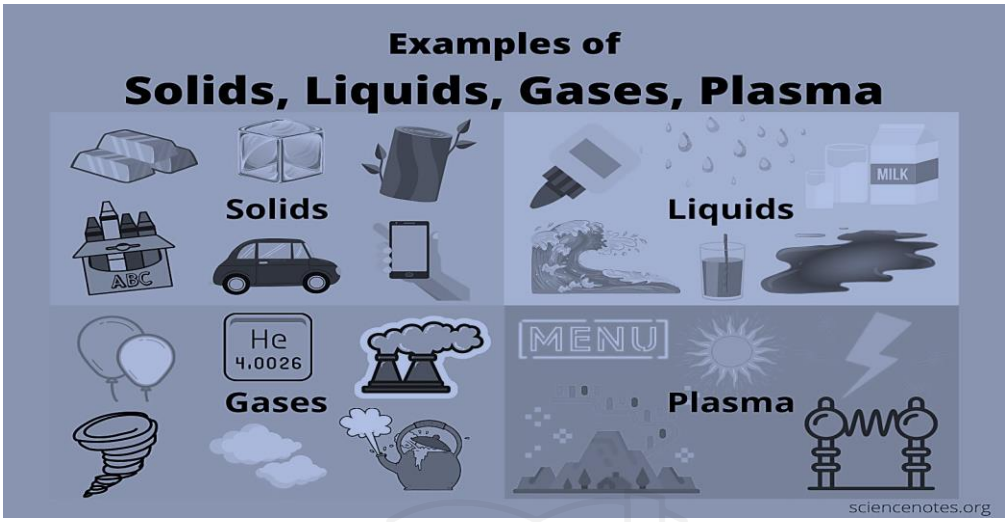
Chemistry and Biology

SIERRA INNOVATIONS

INDEX

1 CHAPTER

Matter in Our Surroundings

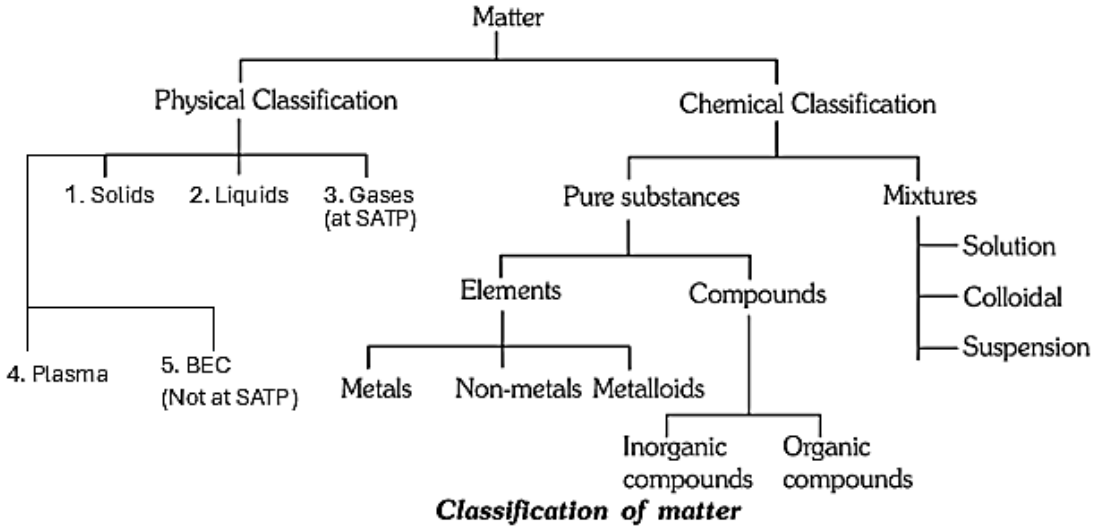


1.0 Introduction

In our surroundings, we see a large variety of things with different shapes, sizes and textures. The air we breathe, the food we eat, stones, clouds, stars, plants and animals, even a small drop of water or a particle of sand, everything is matter. We can also see, as we look around that all the things mentioned above occupy space and have mass. In other words, they have both **mass and volume.**

Matter: Anything which occupies space(or have volume) and has mass is called matter.
Some examples of matter are water, air, metals, plants, animals, etc.
The perception of joy, love, hate, thought, cold, hot, pain are not considered as matter and are different forms of energy.
The matter can be classified into different categories depending upon its physical or chemical nature.

(1) Physical classification: On the basis of physical properties, matter has been classified as solids, liquids and gases.



Classification of matter

(2) Chemical classification: On the basis of chemical properties, matter has been classified as elements, compounds and mixtures.

2.0 Physical Nature of Matter

From a long time there were two views about the physical nature of matter.

(i) Continuous nature, like a block of wood or sheet of glass.

(ii) Particulate nature, that matter is made up of particles like sand.

To understand whether the matter is continuous or particulate in nature, hold a sheet of glass in your hand, it appears continuous. Now throw it on the floor, it breaks into small or tiny particles. This shows that matter is not continuous but is made up of small particles. In fact, all matter in this universe is made up of small particles. These particles which make up all the matter around us are either atoms or molecules however these particles differ from one kind of matter to the other.

Matter is made up of particles

Active Chemistry

Aim

To show the particle nature of matter.

Materials required

Beaker(100 mL), water, glass rod, salt.

Method

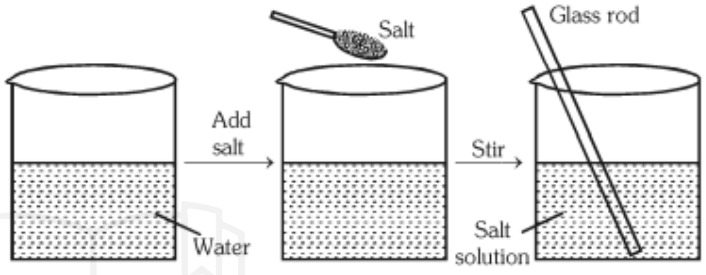
(a) Take about 50 mL water in 100 mL beaker.

(b) Mark the level of water.

(c) Add some salt to the beaker

(d) Stir with the help of a glass rod.

(In solution particles of salt get into the spaces between particles of water)



Dissolution of salt in water

Now answer

(a) What happened to the common salt initially?

(b) What happened to the common salt on stirring?

(c) What happened to the level of water in the beaker after the activity isover?

(d) Where does the common salt disappear?

Observation and conclusion

(a) The common salt settled at the base of the beaker, as it is a continuous form of matter.

(b) On stirring, the common salt disappeared i.e. it get dissolved in water. This dissolving or disappearance of common salt in water suggests that common salt is not a continuous state of matter. Instead, it is made of extremely small particles. The water breaks down the common salt into small particles that they are no longer visible to the eye.

(c) The level of water in the beaker does not rise or fall. This suggests that particles of common salt got dispersed in water. This also suggests that there must be some hollow spaces in water. This implies that water by itself is not continuous, but is made of extremely small particles, which are not visible to the eye.

(d) The extremely small particles of common salt positioned themselves in the small spaces between the particles of water. This also accounts for the fact that level of water does not rise, because the particles of common salt do not displace it but occupy the small spaces in between the particles of water.

3.0 Characteristics of Particles of Matter

(i) Size of the particles

Particles of matter are very small. The following activity demonstrates that the constituent particles of matter are very small.

Active Chemistry

Aim

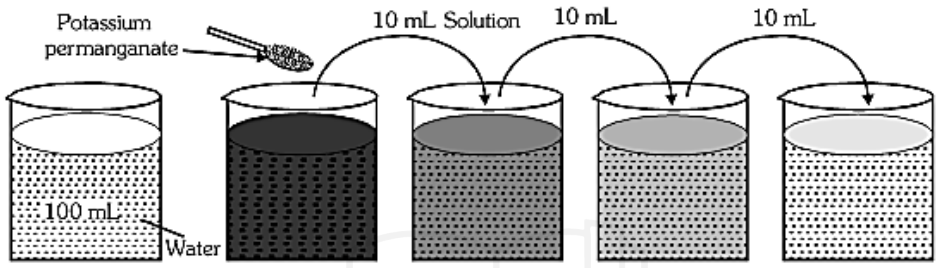
To show that the constituent particle of matter are very small.

Materials required

Beakers (250 mL), water, glass rod, potassium permanganate.

Method

(a) Take a 250 mL beaker and add 100 mL water to it.
(b) Now add 2-3 crystals of potassium permanganate ($KMnO_4$) and stir with a glass rod in order to dissolve the crystals.
(c) Take 10 mL of this solution and add to 90 mL of water taken in another beaker.
(d) Take 10 mL of this diluted solution and put into 90 mL of water taken in another beaker.
(e) Repeat this process two more times. Observe the colour of the solution in the last beaker.



Potassium permanganate colour fades on dilution with water

Observation

This experiment shows that just a few crystals of potassium permanganate can colour a large volume of water. So, we conclude that there must be millions of tiny particles in just one crystal of potassium permanganate which keep on dividing themselves into smaller and smaller particles with each dilution there by making the colour lighter and lighter. The same activity can be done using 2 mL of Dettol instead of potassium permanganate. The smell can be detected even on repeated dilution.

The particles of matter are very small, they are small beyond our imagination!!

Conclusion

The matter is made up of extremely small particles which cannot be seen even with a powerful microscope what we actually see is an aggregate of tiny particles.

(ii) Particles of matter have space between them

When sugar is dissolved in water, the volume of the liquid remains unchanged because during dissolution, the particles of sugar get into the spaces between the particles of water.

As a result, they get evenly distributed and there is no noticeable change in volume. Similarly, when potassium permanganate is dissolved in water, its particles, get evenly distributed throughout the bulk of water. This is indicated by uniform colour of the solution.

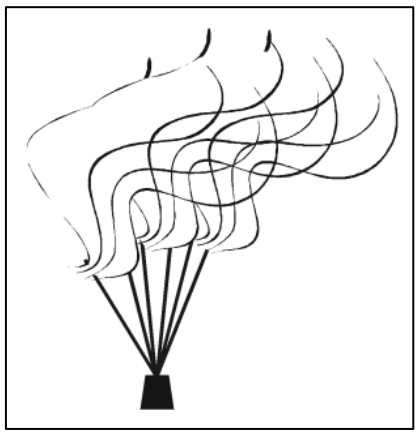
This indicates that there are spaces between particles of matter. The particles of potassium permanganate get uniformly distributed in the spaces between water molecules.

Similarly, when we prepare tea, coffee or lemonade(nimbu pani) we observe that particles of one type of matter get into the spaces between particles of other.

(iii) Particles of matter are continuously moving

We have so far concluded from our discussion that matter is made up of very small particles and these are separated from one another by empty spaces or voids also called interparticle spaces.

A question will immediately come to our mind. Are these particles stationary or in a state of motion? The following activity will illustrate that particles are continuously moving. These are not stationary.



Diffusion of particles of burned incense stick shows that particles of matter are in a state of continuous motion.

Aim

To prove that the particles of matter are in a state of continuous motion.

Materials required

A fresh agarbatti(incense stick), a stand to hold agarbatti, a matchstick.

Method

(a) Take out a fresh incense stick and hold it in a stand.

(b) Place the stand in the corner of a room. You will be able to smell its perfume. Now slowly move away from the incense stick. You will notice that you cannot smell the perfume.

(c) Now light the incense stick and leave the room for a few minutes. On entering the room, you will be able to smell the perfume everywhere in the room.

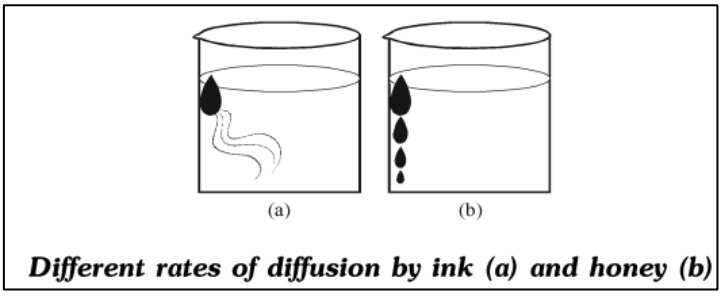
Conclusion

a. Particles of matter are in continuous state of motion and hence have some energy.

b. When the temperature of matter rises, the particles of matter move faster. i.e. K.E. T

3.1 Diffusion

"This spontaneous intermixing of particles of two or more different substances is called diffusion." The rate of diffusion becomes faster with increase in temperature because at higher temperature, the particles have more energy and hence move faster.



Different rates of diffusion by ink (a) and honey (b)

Diffusion is,

(i) Fastest between two different gases.

(ii) Slower between two different liquids or a solid and a liquid.

(iii) Slowest (or almost negligible) in case of two different solids.

Diffusion of gas through small holes is called effusion. For example,

(a) Slowly escaping of air from a tyre pinhole.

(b) Deflating of balloon over time due to mini holes on the balloon.

Active Chemistry

Aim

To understand different rates of diffusion by different substances.

Materials required

Glasses, blue or red ink, honey, water.

Method

(a) Take two glasses filled with water.
(b) Put a drop of blue or red ink slowly and carefully along the sides of the first glass and honey in the same way in the second glass.
(c) Leave them undisturbed. Record your observations.

Now answer

a. What do you observe immediately after adding the ink drop?
b. What do you observe immediately after adding a drop of honey?
c. How many hours or days does it take for the colour of ink to spread evenly throughout the water?

Observation

a. As the drop of ink trickles along the sides of the beaker, the blue colour of the ink starts diffusing in water, which appears like wavy blue streaks in water.
b. The honey drop continues travelling along the side of beaker and there is no visible diffusion of it in water.
c. The ink spreads evenly in the water in about two hours.

Conclusion

a. Rate of diffusion depends upon the nature of substances (density). i.e. Rate of diffisation $\propto \frac{1}{\sqrt{d}}$
b. More viscous substances which have particles with less kinetic energy, takes more time to get diffused.
c. Rate of diffusion $\propto$ T.
The following activity may be carried out to demonstrate the attractive forces between particles of matter.

Active Chemistry

Aim

To show that particles of matter attract each other.

Method

Open a water tap, try breaking the stream of water with your fingers.

Nowanswer

(a) Were you able to cut the stream of water?
(b) What could be the reason behind the stream of water remaining together?

Observations

(a) Yes, stream of water can be cut.
(b) Water molecules exerts a force of attraction on each other, therefore as soon as we remove fingers, they will try to unite again and will remain together forming a continuous stream again.

Conclusion

Since energy is required to break crystals of matter into particles. It indicates that particles in matter are held together by some attractive forces, the strength of these attractive forces varies from one matter to another.

From these activities it is observed that when two different forms of matter are brought in contact, they intermix spontaneously. This intermixing is possible due to motion of the particles of matter and also due to the spaces between them. The intermixing takes place due to movement of particles of one form into the spaces between the particles of the other form of matter.

Illustrations

Illustration 1. The diver is able to cut through water in a swimming pool. Why?

Solution The diver is able to cut through water in the swimming pool because matter is not continuous, but it is made up of particles which have vacant spaces between them. Moreover, the attractive forces between molecules of water are not very strong. The diver can easily cut through water by applying force to displace water and occupy its place.

Illustration 2. We can get the smell of perfume sitting several meters away. Why?

Solution This is because perfumes contain volatile solvent which carries pleasant smelling vapours. They diffuse quite fast and can reach to people sitting several meters away.

Illustration 3. We can easily move our hand in the air but to do the same through a solid block of wood we need a karate expert. Why?

Solution In air the interparticle attractive forces are negligible and hence, it is easy to separate the particles in air and we can easily move our hand through it. In a solid block of wood, the interparticle forces are very strong and hence, it is not easy to separate the particles. Therefore, it is not easy to move our hand through a solid block of wood (only akarate expert can do it).

Check Your Concepts -1

1. Which of the following are matter?
2. Give reason for the following

(i) It is commonly observed that if a bottle of ammonia is opened in one corner of the laboratory, its smell can be felt in the other corner of the laboratory after some time.

(ii) The smell of hot sizzling food reaches you several meters away, but to get the smell from cold food you have to go close.

4.0 States of Matter

On the basis of interparticle spaces and forces of attraction, matter can be classified into three states: Solids, liquids and gases.

$$\text{Interparticle space} \propto \frac{1}{\text{Interparticle force of attraction}}$$

4.1 The Solid State

Solids are known for their hardness and rigid nature.

Characteristics of the solid state:

(1) Solids have fixed shapes: Solids generally have fixed shapes. They do not change their shapes even when put in different containers. For example, blue crystals of copper sulphate have needle like shape which they retain whether kept in a beaker or in a china dish or placep on the palm of our hand.

(2) Some solids can change their shape under force but regain the same when the applied force is removed. For example, a sponge on pressing changes its shape, but regains it after force is removed.

(3) Solids keep their volume which mean that they have fixed volume. For example, a sponge on pressing changes its shape, but regains it, after force is removed. Volume is the space occupied by a substance. The solids have fixed volume. Actually in the solid state, the constituents are very closely packed in space and interparticle forces are strong. As a result, the solids keep their volume.

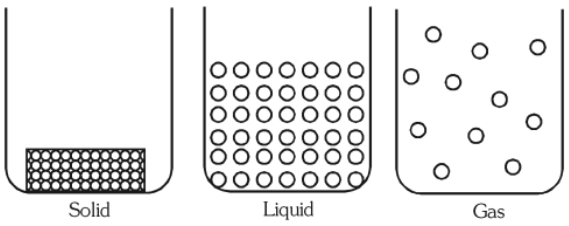
(4) Solids can be hardly compressed on applying pressure. It is very difficult to compress a solid on applying pressure. For example, we cannot compress a piece of stone by applying pressure with our hands. Actually, the constituent particles are so closely packed in a solid that they either do not come closer or do so only slightly when a high pressure is applied. However, there are some exceptions.

(5) Solids have negligible kinetic energy of the particles. The kinetic energy is linked with movement of the particles from one place to the other. Since the constituents in the solid state are very closely packed, they have negligible kinetic energy. That is why solids do not flow.

(6) Solids do not have the property of diffusion. Due to the absence of kinetic energy in the particles of a solid, there is hardly any diffusion. For example, let us keep pieces of metals like copper and silver side by side. They may touch each other but will not mix.

For example, Table, chair, common salt, silver, ice, diamond, stone, sugar, etc.

Important points: In certain cases of solids, diffusion is noticed when the two solids are kept in contact for a long time. For example, if we try to rub something written on the black board by a chalk after a gap of about a week or so, it becomes rather difficult to rub the same. Probably some particles of chalk in the form of dust have diffused in the pores of the black board which is normally made from some wooden material.



Matter have spaces between the particles

4.2 The Liquid State

The liquids are less rigid than the solids and the molecular motion is also comparatively more. Both these characteristics in the liquid state are because of the presence of weaker interparticle forces.

Characteristics of the liquid state:

(1) Liquids do not have fixed shapes.

Liquids do not have fixed shapes and take up the shape of any container in which these are put.

(2) Liquids occupy definite volume or keep their volume.

Though the liquids do not have definite shape, but they do have definite volume. This means that like a solid, a liquid cannot be compressed on applying pressure. Actually, the intermolecular forces in the liquids are so strong that the pressure which is applied, is not in a position to overcome these. The liquids therefore keep their volume.

(3) Liquids have fluidity and not rigidity.

Unlike solids, the liquids have fluidity and not rigidity i.e. they have tendency to flow. This is due to lesser interparticle or intermolecular forces that are present in the liquid state as compared to the solid state. However, the liquids differ in their relative fluidity. For example, water flows at a faster rate than honey because in honey, the particles are heavier and also more closely packed.

(4) Liquids have lesser density as compared to solids.

As compared to solids, liquids are generally light. This is on account of greater number of interparticle spaces in the liquid state as compared to the solid state of the same substance but in case of H_2O, ice floats on water. Because, the structure of ice is more porous as compared to that of water. Therefore, for a given mass, the volume of ice is more than that of water and its density is comparatively less. As a result, ice floats over water.

(5) The kinetic energy of the particles in the liquid state is more than in the solid state.

The particles in the liquid state are less closely packed as compared to the solid state. As a result, the interparticle forces are weaker. Therefore, the kinetic energy of the particles in the liquid state of a substance is more than in solid state. It further increases with the rise in temperature.

(6) Particles in the liquid state can easily diffuse.

Due to lesser interparticle forces of attraction, the particles in a liquid state can diffuse more readily than the solid state of a substance. This also helps in the intermixing of certain liquids. For example, water and alcohol are both liquids and can easily mix to form a liquid mixture or solution.

For example, Water, alcohol, milk, diesel, petrol, kerosene oil, vegetable oil, fruit juices, etc.

4.3 The Gaseous State

Out of the three states of matter, the interparticle spaces are the maximum in the gaseous state. The interparticle forces which hold the different particles in the gaseous state together are the minimum. As a result, rigidity is the minimum while fluidity is the maximum.

Characteristics of gaseous state:

(1) Gases do not have fixed shape.
Gases do not have any shape of their own. They acquire the shape of the container in which they are filled or kept.

(2) Gases have maximum fluidity and least rigidity.
Since the interparticle spaces are the maximum in the gaseous state, the attractive forces are the least. As a result, the fluidity is very large while rigidity is negligible.

(3) Gases do not have fixed volume and are highly compressible.
Since the interparticle distances in the gaseous state are very large, they can be changed (increased or decreased) by altering the pressure. Thus, a gas can be compressed to a large extent on applying pressure. This means that change in pressure can bring a change in volume or we can say that gases do not keep their volume.

(4) Density of gases is very less.
Due to large interparticle spaces, particles of gas are far separated and volume of a given mass of a gas is quite large. Therefore, density becomes less and gases are thus, light.

(5) The kinetic energy of the particles in the gaseous state is very high.
The interparticle forces are very weak. As a result, the particles or the molecules of a gas can move quite freely from one place to the other. This means that their translation motion is large and kinetic energy is quite high. It can further increase when the temperature of the gas is increased.

(6) Gases exert pressure.
Since particles in a gas have high kinetic energy, they strike the walls of the container with force. As a result, they exert pressure. Please note that greater the number of hits recorded per unit area of the wall of the container, more will be the pressure of the gas, which depends on the energy of particles.

(7) Gases diffuse very rapidly.
Since the interparticle spaces are very large and interparticle forces are quite weak, the particles of one gas readily diffuses into empty spaces of another gas.

Active Chemistry

Aim

To study the compressibility of solids, liquids and gases.

Materials required

100 mL syringes, chalk pieces, water, rubber corks.

Method

(a) Take three 100 mL syringes and close their nozzles by inserting them in a rubber cork. Remove the pistons from all the syringes.
(b) Fill chalk pieces in the first, water in the second and leave third syringe as such. It already contains air.
(c) Insert the pistons back into the syringes.
(d) Compress all the syringes by pushing the pistons.

Observation

It is observed that when the syringe containing air, is compressed by applying pressure, the piston can move downward easily and it can be compressed to a larger extent. But when the second syringe containing water is compressed, it is compressed not easily and it can be compressed to much lesser extent than that of air. The first syringe containing chalk pieces (solid) is compressed with most difficulty.

5

CHAPTER

Reproduction in Plants

1.0 Introduction

All living organisms reproduce. What it means in simple terms is that living organisms produce young ones of their own kind. For example, a cat produces kittens which grow into adult cats. In plants too, seeds grow into young seedlings. The seedlings in due course of time develop into mature plants, as in a mango tree.

Reproduction is one of the most important properties of living organisms. It means creating new life, producing young ones of their own kind.

Why living organisms need to reproduce?

All living organisms have a fixed life span. During their life span, the organisms perform various life functions including reproduction. In an annual plant the life span is about one year, and in a perennial plant, it goes up to many years. Then the organisms die leaving behind individuals of their own kind. Thus they ensure by reproducing during their life span. If they would not reproduce, then after their death, there would be no organisms left. The species would thus perish.

Reproduction is, thus, the means of perpetuation of species.

2.0 Significance of Reproduction

For maintenance of continuity of a species: Since every organism dies after a certain age, by reproduction new individuals are born which replace them.

For adding variation for evolution: By reproduction new variations are added as you can see the members of a family having variation in color, shape, size, intelligence, body capacity etc, some are better suitable than other which are selected by nature and others die and are removed.

For maintenance of population size: By reproduction new members are added which maintains the population size.

Illustrations

Illustration 1. Why is variation beneficial to the species but not necessary for the individual?

Solution Variation is necessary for the survival of species as variation make species more adapted to survive with the changing conditions. A particular variation in an individual may not be suitable for any given condition but when condition changes such variation may save it from being dead and leads to formation of a new population with suitable character.

3.0 Modes of Reproduction

Flowers produce seeds which are formed by the fusion of a male gamete with a female gamete. We sow these seeds and grow more plants of the same type. This is the most common method of growing new plants. This type of reproduction is called sexual reproduction.

Can we grow new plants without seeds?

Yes. There are some plants which do grow without seeds. These plants give rise to new plants from a part of stem, root or leaf. These parts of the plant are called vegetative parts.

For example, a new plant of rose is produced by growing a cutting from one of its branches.

This type of reproduction, which takes place without seeds, is called asexual reproduction.

Sexual reproduction is characterised by the fusion of two cells (gametes) usually coming from two parents. New plants are produced from seeds.

Asexual reproduction, on the other hand, is any type of reproduction that does not involve the union of gametes. New individual is produced from a single parent.

3.1 Methods of asexual reproduction

(i) Fission
(ii) Budding
(iii) Regeneration
(iv) Fragmentation
(v) Spore formation
(vi) Vegetative propagation

(i) Fission: It is a kind of asexual reproduction in which unicellular organisms create two or more new individuals. It can be of two types.

(a) Binary fission: One cell splits into two equal halves, e.g., many bacteria and protozoa like Amoeba, Paramecium and Leishmania. In Amoeba fission can take place in any plane. (Fig.1)

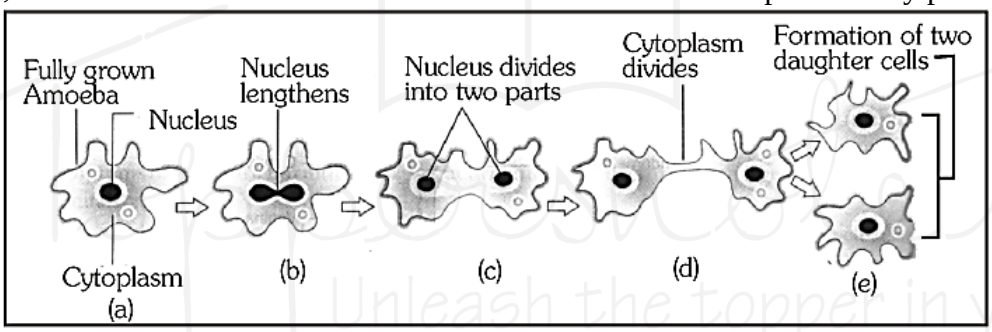


Fig.1 Binary fission in *Amoeba*

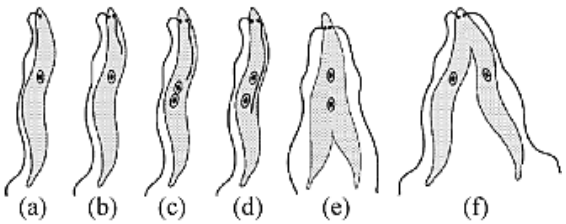


Fig.2 Binary fission in *Leishmania*

(b) Multiple fission: One cell divides in repeated fashion into many daughter cells simultaneously. e.g., Plasmodium (Malarial parasite) and Amoeba in unfavourable conditions. (Fig.3)

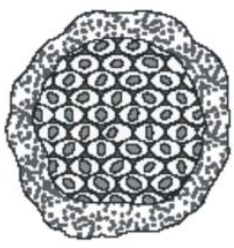


Fig.3 Multiple fission in *Plasmodium*

(ii) Budding: Asexual mode of reproduction in which a small outgrowth (bud) appears on the body of the organism. Budding is commonly observed in yeast. A bulb-like projection, called the bud, is formed on the body. The nucleus of the body divides into two. Then, one of the two nuclei passes into the bud. The bud detaches itself from the parent body. It grows to full size and becomes a new individual. (Fig.4)

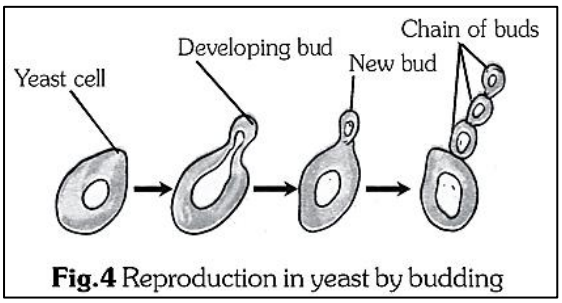


Fig.4 Reproduction in yeast by budding

Aim

To observe budding in yeast.

Method

Take about 10 gram of yeast powder and put it in a glass beaker containing warm water in which a spoonful of sugar has been dissolved, Yeast powder can be obtained from a bakery or a chemist shop. Keep the beaker in a warm place (at about 35° to 40°C). After an hour, take a drop of solution from the beaker on a glass slide, and observe the slide under the microscope. Make a sketch of what you observe.

Observation

You will observe budding in yeast.

(iii) Regeneration: The process of getting back a full organism from the body parts of the parent individual is called regeneration. Regeneration is carried out by specialised cells. These cells proliferate and make large number of cells. These changes in organised sequence is called as development. Hydra and Planaria can be cut into any number of pieces and each piece grows the missing parts and form into a complete organism. (Fig.5)

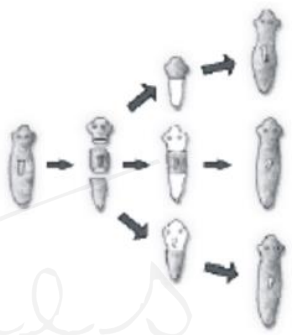


Fig.5 Regeneration in *Planaria*

(iv) Fragmentation: In some filamentous organisms such as Spirogyra (an algae), the filaments break up into two or more fragments. Each fragment or piece grows into a new individual. (Fig.6)

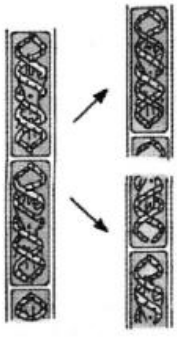


Fig.6 Fragmentation in Spirogyra

(v) Spore formation: In non-flowering plants (the plants which do not produce seeds), like fungi (Mucor), bacteria, ferns or mosses, formation of spores is a common method of reproduction. (Fig. 7) Spores are very small in size. They have thick walls. The thick walls help the spores to survive adverse conditions in the environment, like high temperature, scarcity of water and lack of food. The spores give rise to new organisms under favourable conditions.

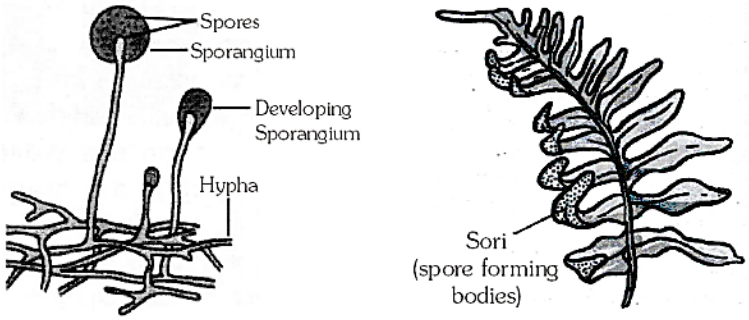


Fig.7 Spore formation in Mucor (a fungus)

Active Biology

Aim

To grow your own fungi like bread mould.

Materials required

Take a small piece of bread, a paper napkin, a small jar or bottle with cap and water.

Method

(a) Cut a piece of the napkin to fit in the bottom of the jar.
(b) Pour a small amount of water into the jar just enough to wet the paper napkin completely.
(c) Place a piece of bread on the moist paper napkin.
(d) Cap the jar loosely. This is very important.
(e) Place the jar in a dark place where it is not cold.
(f) Look at it everyday for a week and draw pictures showing how the mould looked during its growth stages.

Check Your Concepts #1

1. How does binary fission differ from multiple fission?
2. Can you think of a reason why more complex organisms do not reproduce by means of simple reproductive methods like fragmentation?
3. Write two advantages of reproduction by spore formation.

(vi) Vegetative propagation: This is an asexual method of reproduction in plants where vegetative parts namely root, stem and leaves give rise to new plants in appropriate conditions.
Vegetative propagation is of two types:
(a) Natural vegetative propagation (b) Artificial vegetative propagation.

(a) Natural vegetative propagation: Plant reproduce without the help of human being.
By leaves: Leaves of some plants produce adventitious buds with adventitious roots on their margin, which get detached and develop into new plants e.g. Bryophyllum, Kalanchoe (Fig.8).

Fig.8 Natural vegetative propagation by leaf (*Bryophyllum*)

By stem: Underground modified stems possess buds that produce aerial shoots annually under favourable conditions when planted in soil. e.g. Potato, Ginger, Onion. (Fig.9)

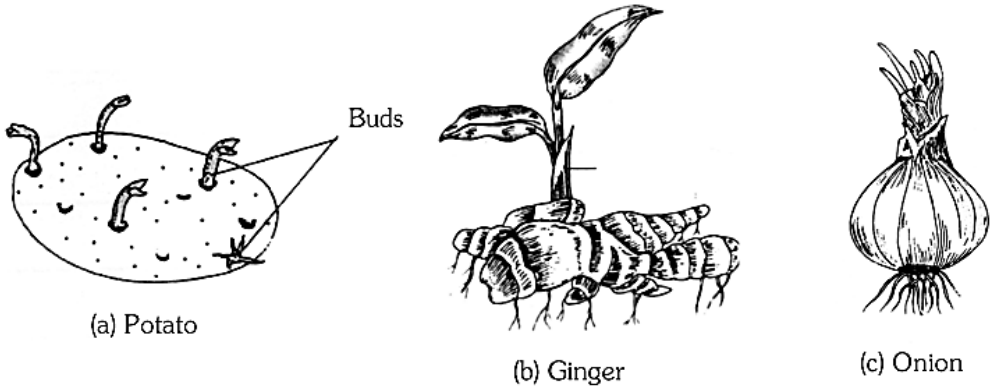


Fig.9 Natural vegetative propagation by stems

By roots: Modified tuberous roots when planted in soil, the buds present on the roots grow into leafy shoots above ground and adventitious roots at their bases. e.g. Sweet potato, Dahlia. (Fig.10)

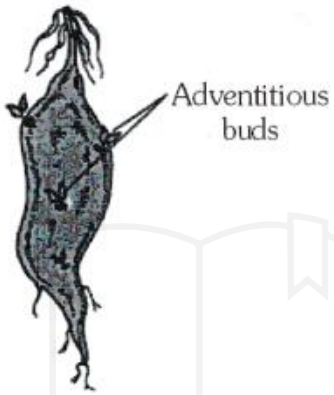


Fig. 10 Natural vegetative propagation by root (sweet potato)

Check Your Answers #1

1. In binary fission, one nucleus divides only once and results into the formation of two daughter nuclei but in multiple fission, the nucleus undergo repeated division resulting in many nuclei. So, in binary fission only two daughter cells are produced but in multiple fission many cells are produced.

2. The reason is that many multi-cellular organisms, as we have seen, are not simply a random collection of cells. Specialised cells are organised as tissues, and tissues are organised into organs, which then have to be placed at definite positions in the body. In such a carefully organised situation, cell-by-cell division would be impractical. Multi-cellular organisms, therefore, need to use more complex ways of reproduction.

3. (i) Spores are protected by hard covering which can tolerate harsh environmental conditions.
(ii) Being light weight they can be carried away by air and water currents to new locations where on germination give rise to new individuals.

(b) Artificial vegetative propagation: These methods are man made and developed by plant growers to prepare plants with desirable characters. These are of four types:

Cutting: In this method small part of plant (stem, root or leaf) is cut and buried partly in the moist soil then cutting develops roots and grows into a new plant. Stem cuttings are most commonly used for artificial vegetative propagation. e.g. Rose, Sugarcane, Potato, Cactus. (Fig.11)

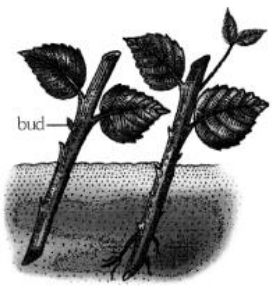


Fig.11 Cutting

Grafting: Two dicotyledonous plants of closely related varieties are joined together so that they live as one plant. The plant of which roots remain in the soil is called as stock. Cutting part of a plant that is grafted on the other rooted plant is called scion. e.g. Mango, Apple, Lemon (Fig.12).

Grafting is not possible in monocot plants. Cambium activity is essential for the union of stock and scion.

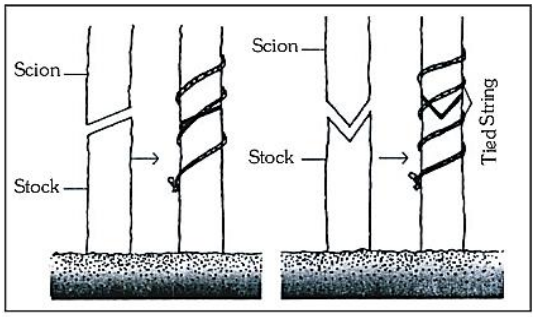


Fig.12 Grafting

Layering: This is the most common method of propagating herbaceous plants. In this method the lower branch of the parent plant is bent and buried in the moist soil with the growing tip of the branch remains above the soil surface. The portion of the branch which is in contact with the soil develops adventitious roots and this rooted branch is called layer.

Layer is then detached from the parent plant and grows into a new plant. e.g. Jasmine, Hibiscus.

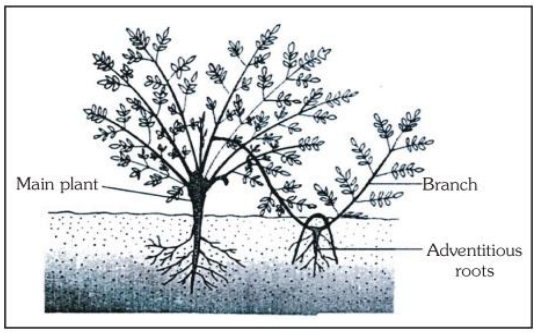


Fig.13 Vegetative propagation by layering

Tissue culture or Micropropagation: Cells or tissue is isolated from the growing tip of plant called explant. The explant develops into undifferentiated mass of cells called callus in the proper culture medium. The callus is transferred to another medium containing hormones for growth and differentiation, that forms plantlet. The plantlets are transplanted into pot or soil to form mature plant. This technique is known as micropropagation. e.g. Orchids, Chrysanthemum.

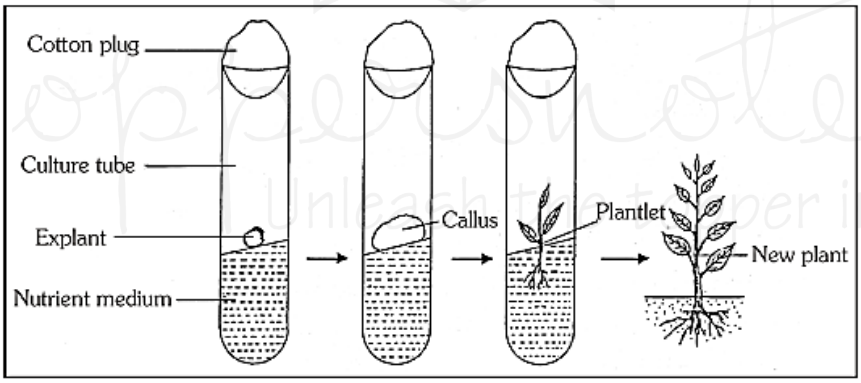


Fig.14 Artificial vegetative propagation by tissue culture

Check Your Concepts #2

1. What happens when a leaf of bryophyllum (sprout leaf plant) falls on a moist soil?
2. Write two examples of plants whose roots can also give rise to new plants.
3. What are algae?
4. What is bread mould?
5. Potato plants produce flowers, fruits and seeds. Yet, they are never grow from seeds. Why?
6. What are the differences between asexual and sexual reproduction?

Advantages of vegetative propagation

(i) It is an easier, rapid and less expensive method of propagation. Plants can be grown in much less time.

(ii) Seedless plants can be raised.

(iii) Plants produced by this method are identical copies of the parent plant and show no variations.

(iv) Plants like banana, sugarcane, sweet potato, rose and jasmine do not produce viable seeds. Such plants can be easily grown by this method.
(v) Disease free plants can be produced.
(vi) Superior quality fruits or flowers can be produced by grafting.
(vii) Propagation is also possible for plants that have lost the capacity to produce seeds. e.g. orange.

Advantages of asexual reproduction

1. It is only method of reproduction in most unicellular organisms.
2. The parental properties are preserved.
3. It is rapid method as it does not require any sexual maturation, production of gametes, transfer of gamete and their fusion.

3.2 Sexual reproduction

In nature, sexual reproduction occurs in plants as well as animals. It is the most common method of reproduction.

As stated earlier, two parents, one male and the other female, are required for sexual reproduction.

Two types of reproductive cells, called gametes are produced from the reproductive organs of two parents. Male parent produces the male gamete and the female parent produces the female gamete.

The fusion of the two gametes is called fertilisation. The product of fusion of the two gametes is called the zygote.

The male gamete in a flowering plant is formed by the pollen grain where as in animals, it is the sperm. The female gamete in plants is a large egg-cell in the ovule, while in animals, it is the ovum. After fertilisation, the zygote undergoes cell division and growth. Ultimately, it forms the new individual.

Embryo: A ball-like structure formed after divisions in the fertilised egg (zygote).

Sexual reproduction involves following steps -

a. Formation of gametes (by meiotic cell division).
b. Fusion of gametes (Formation of zygote).
c. Development of zygote to new individual.

Check Your Answers #2

1. When a leaf of bryophyllum falls on a moist soil, each bud can give rise to a new plant.
2. Sweet potato and dahlia are two examples of plants whose roots can also give rise to new plants.
3. Slimy green patches in ponds or in other stagnant water bodies are called algae.
4. Bread mould is a type of fungi which reproduce by producing spores.
5. Potato seeds are weak. They rarely grow into plants.
6. Differences between asexual and sexual reproduction

Features	Asexual Reproduction	Sexual reproduction
Number of parents involved	One	Two
Resemblance with parents	Organisms produced resemble exactly with the parent.	Organisms do not resemble exactly with the parent but resemble in certain features with both the parents.
Type of cell divisions	Amitotic / mitotic.	Mitotic and meiotic both are present.
Adaptability	Organisms produced have less adaptability.	Organisms produced have more adaptability.
Examples	Fission in Amoeba, budding in Yeast,	Higher Plants and Animals

Illustrations

Illustration 2 Why do we need sexual reproduction?

Solution. Sexual reproduction brings about the fusion of gametes from both the parents. The zygote so formed thus possesses characters of both parents.
This also helps to bring variations among new individuals. You can now understand why children of the same parents show variations

3.3 Sexual reproduction in flowering plants

Sexual reproduction takes place within specialized reproductive organs, called flowers in angiosperms (flowering plants).
Flower is a modified condensed reproductive shoot on which all the floral appendages are inserted.
A typical flower has four whorls arranged on thalamus.

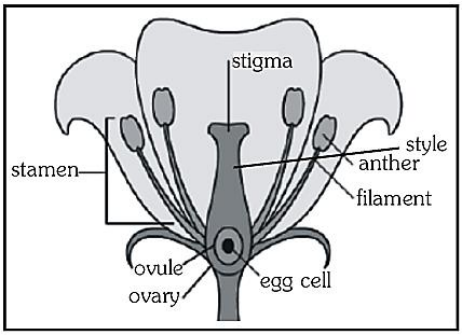


Fig.15 L.S. of flower

1. Calyx
2. Corolla

— Non-essential organs or acessory organs

3. Androecium
4. Gynoecium

— Essential organs or reproductive organs

1. **Calyx:** It is the outermost whorl consisting of sepals. Sepals are green and leaf like structure. Calyx protect the flower bud before it opens.
2. **Corolla:** It is the second whorl, inner to calyx, consisting of petals. Petals are generally large, coloured and showy. Corolla attract insects for pollination.
3. **Androecium:** It is the third whorl, inner to corolla, consisting of male reproductive parts called stamens.
Each stamen has two parts, filament and anther. Anther is bilobed structure present at the tip of filament. Each anther produces pollen grains that are yellowish in colour. Each pollen grain produces two male gametes/germ cells.

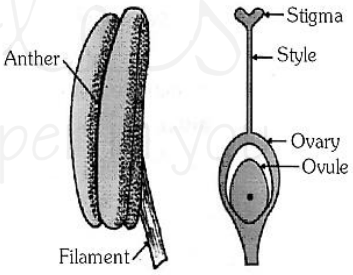


Fig.16 (a) A stamen, (b) A pistil

4. **Gynoecium:** It is the fourth and innermost whorl consisting of carpels. Carpel is present in the centre of flower.
Each carpel has three parts that is Ovary, Style and Stigma.
Ovary is a swollen basal part of carpel that contains one or several ovules.
Each ovule contains an embryosac that bears an egg (female gamete). Style is the middle elongated part of the carpel and has sticky part called stigma above it which receives pollen grains.

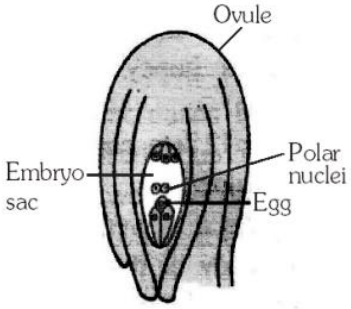


Fig.17 Female gamete inside the ovule.

Bisexual Flower: In many plants, the male and the female parts are present in the same flower. Examples: rose, mustard and petunia.

Unisexual Flower: In some, the male and the female parts are born in different flowers. Examples papaya, corn and cucumber.

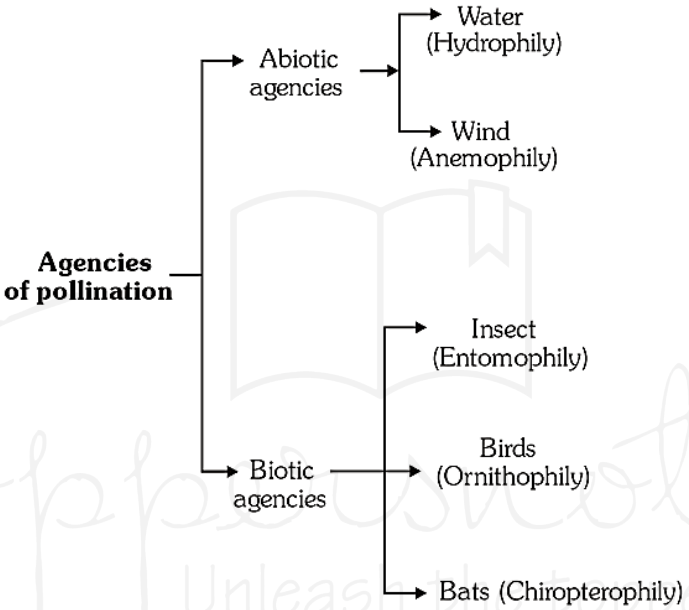
3.4 Pollination

Process in which pollen grains are transferred from the ripe anther to the stigma. It is of two types

(i) Self pollination: It is the transfer of pollen grains from an anther to the stigma of the same plant. If it is in the same flower it is called autogamy (e.g. Pea) and if it is between flowers of the same plant then it is called geitonogamy (e.g. Oxalis).

(ii) Cross pollination: It is the transfer of pollen grains from anther to the stigma of different plants of the same species, it is also called xenogamy. (e.g. Mango).

Agencies of pollination: Transfer of pollen from one flower to another is achieved by agents like wind, water or animals.



3.5 Fertilization

Fertilization is the process of fusion of the male and female gametes to form a diploid zygote which takes place in the embryo sac present in the ovule.

After pollination, pollen grains germinate on the stigma by producing pollen tube. It then penetrates the stigma and passes through the style. The nucleus in the pollen tube divides into two male gametes/germ cells. Pollen tube enters the ovule through a narrow pore called micropyle. It releases two male gametes in embryo sac.

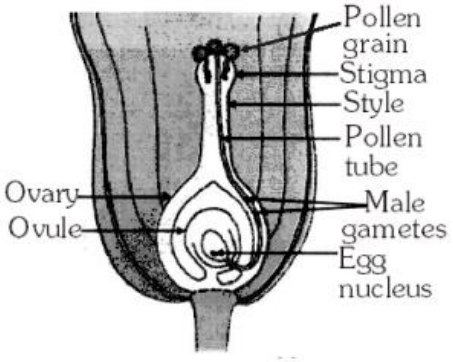


Fig.18 Process of fertilization

A fully developed typical angiospermic embryosac consists of seven cells and eight nucleus stage. 3 antipodal cells, 2 synergids, central cell containing 2 polar nuclei (which fuse to form diploid secondary nucleus) and 1 egg cell.

One male gamete fuses with egg cell and second male gamete fuses with the two polar nuclei.

One male gamete + Egg cell $\xrightarrow{\text{Syngamy}}$ Zygote.

Second male gamete + Two polar nuclei $\xrightarrow{\text{Triple fusion}}$ Triploid nucleus (Primary Endosperm Nucleus)

Syngamy + Triple fusion = Double fertilization.

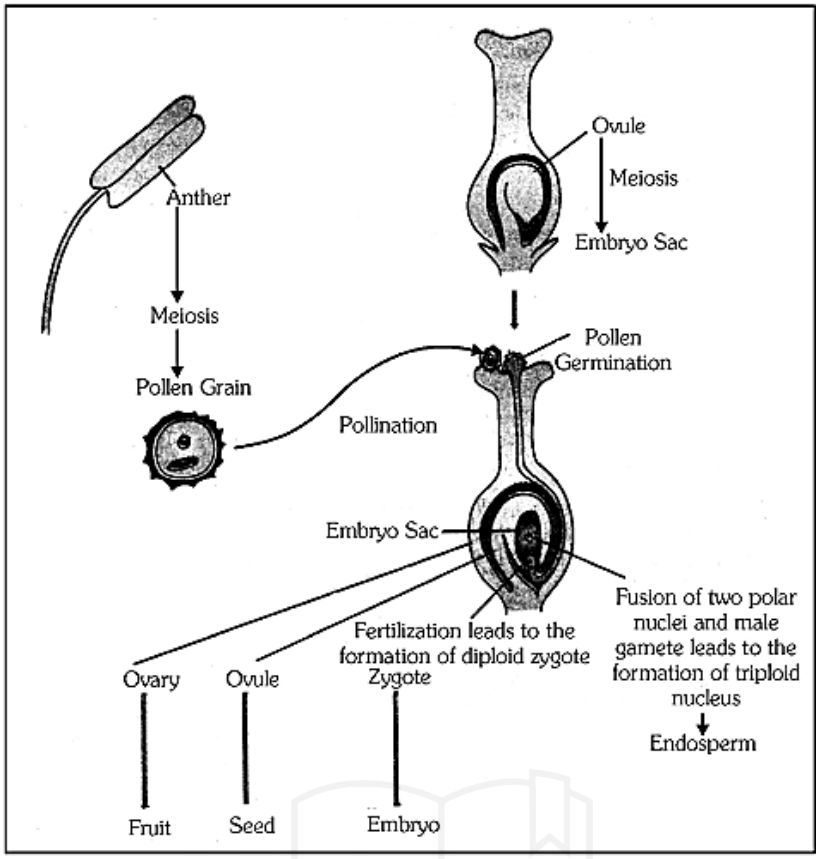


Fig.19 Sexual reproduction in plants

Check Your Concepts #3

1. How does a bisexual flower, inspite of the young stamens being removed artificially, produces fruit?
2. Why can not fertilization take place in flowers if pollination does not occur?
3. Where is the zygote located in the flower after fertilization?

Differences between pollination and fertilization

Pollination	Fertilization
Transfer of pollen grains from anther to stigma.	Fusion of male and female gametes.
It does not ensure formation of zygote.	It ensures formation of zygote and further development.
It does not initiate fruit formation.	After fertilization ovary develops into fruits.
There are many agents of pollination.	Fertilization is always same in all plants.

3.6 Post fertilization changes in the flower

The petals and stamen withers off, however the calyx may be present in some cases. Style and stigma degenerates. Ovary develops into fruit and ovule grows into seed. The seed contains the future plant or embryo which develops into a seedling under appropriate conditions. This process is called as germination.