



Reproduction - The generating system

In plants and animals reproduction is necessary life process for continuation of life by the production of offsprings .

- *Do you think reproduction occurs only for continuation of life?*
- *How does an organism grow? How does repair of worn out parts take place? Is there any form of reproduction involved in the process?*

Organisms are capable of giving rise to offsprings by the process of reproduction. Some organisms may reproduce differently in different situations. For example, in favorable conditions paramoecium give rise to more of its kind from a single parent by simply splitting into two. This happens rapidly and several of them are formed. During unfavourable conditions two paramoecia come in contact exchange certain materials of their bodies and produce forms that are more to tolerant.

The time required to reproduce also varies from organism to organism. Even within the organism there could be certain environmental conditions that would make faster the process of reproduction.

Let us do an activity to find out how fast an organism might be reproducing

Activity-1

Formation of bacterial colony in milk

We are aware that Lactobacillus bacteria is responsible for formation of curd. Take a tea spoon full of curd and mix it throughly with around 30 tea spoon full of (half of the glass) luke warm milk in a bowl. Take another tea spoon full of curd and mix it with 30 tea spoon full of cold milk in

another bowl. Cover both the bowls and note the initial time. Keep observing every hour to see whether curd has formed. Curdling indicates that the increase in number of bacteria.

Note the time taken for formation of curd in both the bowls.

- *Does it take the same time to form curd in both the bowls?*
- *What is the time taken to form nearly 30 times the size of the bacterial colony indicate?*

Think, how fast they are growing. During rainy season you may have wondered how swarms of insects suddenly appear. Most insects have life cycles spanning a few days to a few months. You may find great variations in period of reproduction in yeasts, bacteria, rat, cow, elephant and man.

Asexual mode of reproduction

Let us study modes of reproduction involving a single parent, without involving gametes. These are known as asexual modes of reproduction.

Organisms can reproduce asexually in many ways. Some of them are given here.

Fission

Single celled organisms, such as Paramecium and bacteria, reproduce by splitting into two or more offsprings. This usually occurs in a symmetrical manner. They split into two by binary fission. When more cells are formed it is called multiple fission. This is often the only mode of reproduction in these organisms.

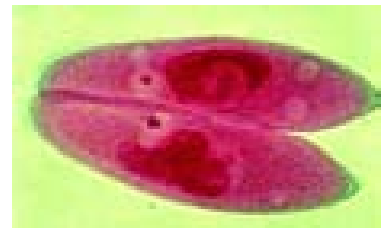
- *How do you think bacteria were dividing to form curd?*

Budding

A growth on the body as a bud that grows to form nearly identical copy of parent. When the bud totally grows then it separates from the parent and survives independently. Ex: Yeast.

Fragmentation

Some can grow from a separate piece of parent organism. This can be from any part of the body. This happens only in the simplest, such as some flatworms, moulds, lichens, Spirogyra etc. grow in this manner. These may also reproduce sexually. Fragmentation is a common mode of reproduction in algae, fungi and many land plants.



*fig-1:
Fission in paramecium*



fig-2: Budding in yeast



fig-3: Fragmentation

Parthenogenesis

Now a days we are able to develop seedless fruits like watermelon, grapes etc. This is a process of reproduction where there is a shift from sexual to asexual mode of reproduction.

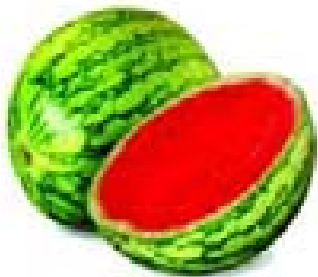


fig-4: Seedless fruit

- *How do you think this happens?*

This process also occurs in nature. An organism which reproduce sexually sometimes asexually. We have utilised this process of reproduction in growing organisms of our choice with more desirable characters. In this process generally the female gametes develops into zygote without fertilization.

- *Would it involve two parents?*

This strange kind of reproduction occur in bees, ants and wasps. The zygote might develop from fertilized egg or by parthenogenesis. When meiosis does occur. The parthenocarpic zygote develop into male (Monoploid). While the fertilized one developed into female (Diploid).

Discuss with your teacher about plants and animals that show Parthenogenesis and prepare a bulletin.

Regeneration

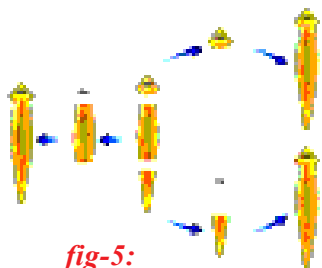


fig-5:
Regeneration in
planaria

Many organisms have the ability to give rise to new individual organisms from their body parts. That is, if the individual is somehow cut or broken up into many pieces, these pieces grow into separate individuals. This is similar to fragmentation.

- *Regeneration could be kown as a type of fragmentaion? Do you agree? Why? Why not?*
- *Which type of fission would produce larger colonies in less period of time. Why?*
- *Which mode of asexual reproduction provides maximum scope of choice of desirable characters?*

Vegetative propagation

In higher plants vegetative propagation. may be natural or artificial.

Natural propagation

Leaves: In Bryophyllum small plants grow at the edge of leaves.

Stems: Aerial weak stems like runners and stolons, when they touch the ground, give off adventitious roots. When the connection with the parent plant is broken, the stem portion with the adventitious roots develops into



fig-6:
Bryophyllum

an independent plant. Some examples for propagation by stem are from stolons, bulbs, corms, tuber, etc.

Stolons - Vallisneria, strawberry, Bulbs - Allium cepa or onion, Corms - Colocasia, tuber - potato,

Roots: Roots of Dahlia, radish, carrot etc., grow as new plants.

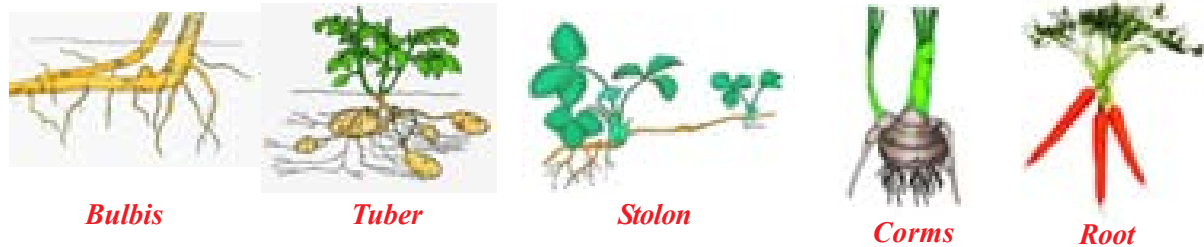


fig-7

Artificial propagation

Cutting:

Some plants grow individually when a piece of a parent plant having bud is cut from the existing plant. The lower part of this cutting is buried in moist cell. After few days the cut parts having buds grow as an individual plant after developing roots. Ex: Rose

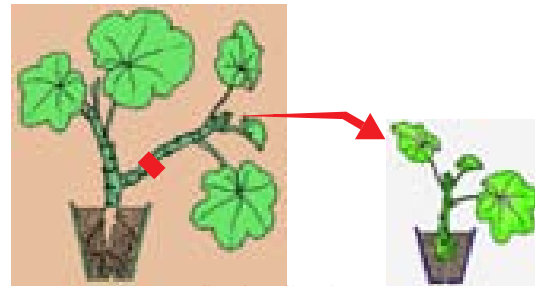


fig-8: Cutting

Layering:

A branch of the plant with at least one node is bent towards the ground and a part of it is covered with moist soil leaving the tip of the branch exposed above the ground. After some time, new roots develop from the part of the branch buried in the soil. The branch is then cut off from the parent plant, the part which has developed roots grows to become a new plant. Ex: Nerium.

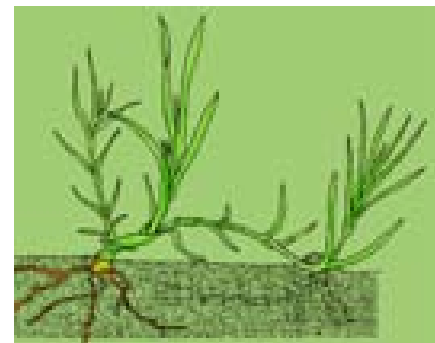


fig-9: Layering

Grafting:

Two plants are joined together in such a way that two stems join and grow as a single plant. One which is attached to soil is called stock and the cut stem of another plant without roots is called scion. Both stock and scion are tied with help of a twine thread and covered by a polythene cover. Grafting is used to obtain a plant with desirable characters. This technique is very useful in propagating improved varieties of various flower and fruits (ex: Mango, citrus, apple, rose).

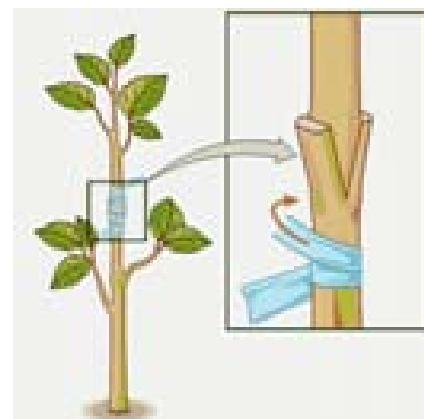


fig-10: Grafting

If you have two varieties of fruit yielding trees in your garden. One tree has the character of giving big sized fruits but less in number. The taste of the fruit is pretty good. The other one produce more number of fruits but they are neither big in size nor tasty.

- *What are the characters that would like to select?*
- *What mode of propagation would help you to produce the plants with selected characters?*
- *Whether they reproduce by budding or fission or fragmentation, organisms formed are copies of their parents. Is it true? Why?*



Do you know?

The cutting, layering and grafting are the traditional methods for the artificial propagation of plants. Examples of plants produced in this manner are Banana, Pineapple, Orange, Grape, Rose, etc. For commercial purposes; they are being replaced by the modern technology of artificial propagation of plants involving tissue culture. In tissue culture, few plant cells or plant tissue are placed in a growth medium with plant hormones in it and it grows into new plants. Thousands of plants can be grown in very short interval of time.



By grafting a very young scion (shoot part of a plant) can be made to flower and produce fruits quite fast.

Collect information from your school library or internet about advantages and disadvantages of artificial vegetative propagation and discuss in your class room.

Spore formation:

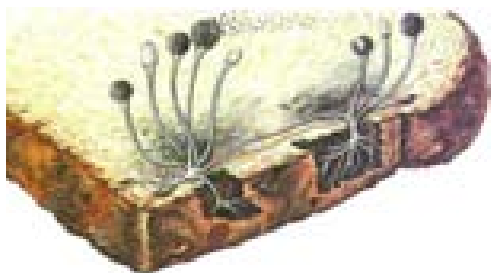
Generally we may notice whitish threads and blackish powdery like substance on rotten fruits, bread slices and other food materials. When you touch it, the blackish powder sticks on your fingers. These are the reproductive spores produced by a fungi. Ex: Rhizopus. You have already learnt about this in the chapter ‘The story of micro organisms’ in class VIII.

Rhizopus produces hundreds of microscopic reproductive units called spores. When the spore case (also called sporangium) bursts, the spores spreads into air. These air-borne spores land on food or soil, under favourable conditions like damp and warm conditions, they germinate and produce new individuals. Most of the fungi like Rhizopus, Mucor etc., Bacteria and non-flowering plants such as ferns and mosses reproduce by the method of spore formation.

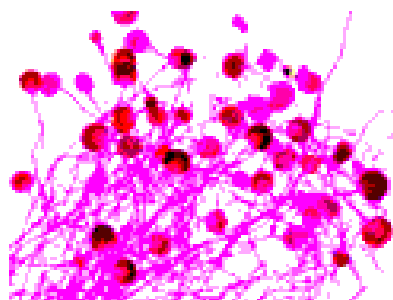


Lab Activity

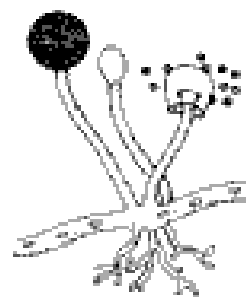
To examine *Rhizopus* or common mould under the microscope, it is best to grow your own in a controlled environment. Use a soft bread that is preservative free or a roti, fruits or vegetables such as potatoes or oranges. A good sample of mould may require 4-10 days to form spores so be sure to plan ahead for this project. (Please note: this should not be done by those with allergies to mould or with severe asthma.)



Rhizopus growing on bread



Rhizopus under microscope



Rhizopus sporangium

fig-11

Leave the bread in the open air for about an hour, so it is exposed to contaminants in the air. Place the bread in a plastic bag, sprinkle water over it to have dampness then seal the bag, leaving some air inside. Place the bag in a dark, warm place. A kitchen cupboard close to the stove may be one option. Or you could place it next to a window, with a bowl or plate covering it from the light. Mould will grow best in a moist environment. Mould would start growing in 2-3 days, but will take a week or more to form spores depending upon the weather.

Check the piece of bread every few days, and add some water if it is drying. Avoid opening the plastic bag as much as you can. If you touch the bread, be sure to thoroughly wash your hands afterwards. When sufficient mould has formed, you can prepare a slide and examine it under the microscope. You would find whitish thread like growth with masses of black, grey and green fine dotted structures (See fig-11). The black dotted structure is that of bread mould. Take a part of the bread or roti to school in a matchbox and ask your teacher to help you to make a slide and observe under the microscope.

Material required: Mould sample, plain glass slide, coverslip, water, disposable gloves.

Procedure:

1. Place a drop of water in the centre of the slide.

- Using a toothpick, scrape very little of the mould and place it on the drop of water.
- Take the cover slip and set it at an angle to the slide so that one edge of it touches the water drop, then carefully lower it over the drop so that the cover slip covers the specimen without trapping air bubbles underneath.
- Use the corner of a tissue paper or blotting paper to blot up any excess water at the edges of the cover slip.
- View the slide with a compound microscope first observe under low power.

The common bread mould consists of fine thread like projections called hyphae and thin knob like structures called Sporangia (sporangium in singular). Each sporangium contains hundreds of minute spores. When the sporangium bursts, the tiny spores are dispersed in air.

Try to give some more examples of organisms which reproduce through spore formation.

Sporophyll:

Ferns also produce spores. Collect a fern leaf which is called sporophyll. Observe the leaf carefully. On the lower surface of the leaf you find clusters of dot like structures called sporangia. These contain spores. Gently rupture the sporangia with a needle and observe spores by using magnifying lens.

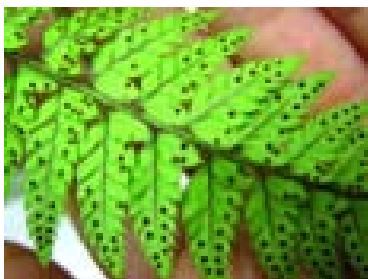


fig-12: Fern sporophyll

- Do you find any similarities between rhizopus and fern spores and sporangia?
- What about mushrooms, how do they grow? Discuss in your class.

Sexual reproduction

As you have studied earlier, sexual reproduction is a way of reproduction where fusion of gametes takes place, by a process called fertilisation. Fertilisation may occur either outside the body of the mother (external fertilisation) or inside the mother's body (internal fertilisation). As a matter of fact, the eggs of land animals are fertilised inside the body of the mother. The fertilized eggs start dividing and growing into the embryo.

External fertilisation is common in aquatic animals like most of the fishes and amphibians. The female lays a vast number of eggs in water and male release some millions of sperms on them in water. As the chance of fertilisation is controlled by nature which occurs externally, hence it is inevitable to give rise to vast number of eggs and sperms (gamete).

Reproduction in a placental mammal - Man

While talking about mammals especially human beings special reproductive organs have developed in males and females to carry out reproduction. Let us study them in detail.

Male reproductive system

In human males, the two testes are located in pocket like structure outside the body wall called the scrotum. The male reproductive cells, the sperms, are produced in very large numbers (hundreds of millions). Observe the fig-13 of male reproductive system and find out parts essential for the transport of the sperm cells. Each testes has several lobules and each lobule contain several seminiferous tubules. They are small, highly coiled tubes and 80cm in length. Vasefferentia collect spermatozoa from the tubules. Vasefferentia forms epididymis. Here sperms are stored temporarily and moved into vasdeference then to uretra of penis and expels out of the body. One prostate, two cowper glands which are accessory glands in male reproducing system secretes a fluied called semen. This provide nutrients for sperm to keep alive and helps as a medium for the movement of sperms.

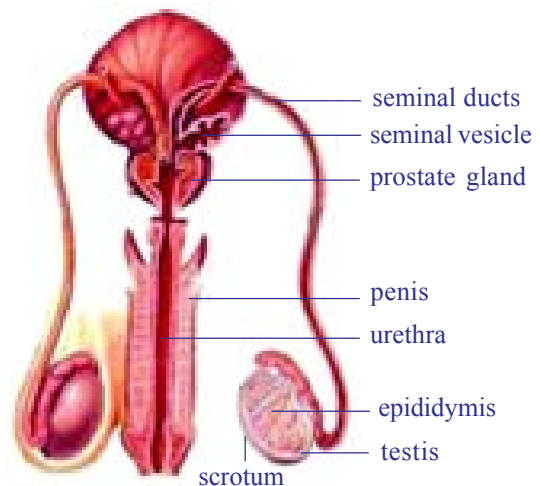


fig-13: Male reproductory system

The sperm cell is a flagellated structure with long tail. This helps them to move towards the ovum.

The development of the male reproductive organs is regulated by the male sex hormone called testosterone.

You know that secondary sexual characters are also controlled by the male sex hormones, which are secreted by the testes. The production of sperms by the testes will begin when these events occur.

Men produce sperm, from the age of about 13 or 14 years, and can go on doing so most of their lives, although their power to do so decreases as they grow older.



Do you know?

Some bacteria and other micro organisms have been found that are capable of changing the sex of the organism in which they grow. A species of wasp has lost its sexual ability to reproduce and has reverted to asexual mode.

Female reproductive system

The two ovaries, where ova are formed, are located deep in the abdomen of female's body. Observe the fig-14 of female reproductive system to know how it works.

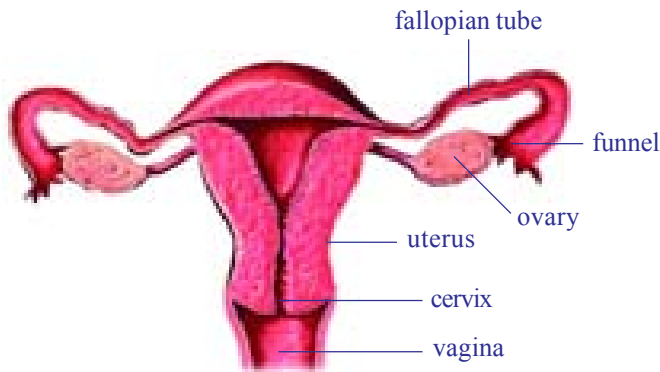


fig-14: Female reproductory system

The ova develop in tiny cellular structures called follicles, which at first look like cellular bubbles in the ovary. They are called graffian follicles. As a follicle grows, it develops a cavity filled with fluid. Each follicle contains a single ovum which is formed after the process of cell division (meiosis). When an ovum is mature, the follicle ruptures at the surface of the ovary and the tiny ovum is flushed out. This release of the egg or ovum is called ovulation.

Generally the ovum enters the widened funnel of an oviduct (fallopian tube), a tube that extends from the neighbourhood of an ovary to the muscular, thick-walled uterus. Fertilization occurs as the ovum passes through the oviduct thus begins a new life, fertilization with sperm would lead to for,ation of a mass that might grow to form a baby.

As the egg passes from the oviduct to the uterus, we encounter one of the most marvelous control mechanisms that man and other mammals possess. The uterus at the time of fertilization is beautifully adapted to receiving the developing embryo, providing it with food, and disposing of its wastes. A few days prior to this time, the uterus is in normal condition. Then it was small, its tissues were thin, and its supply of blood vessels was poor. Now that the fertilized egg, or zygote, is about to enter, the uterus enlarges and become much larger. Its inner wall is thick, soft, and moist with fluid; its blood supply is greatly increased. It is, so to speak, just waiting for an embryonic occupant.

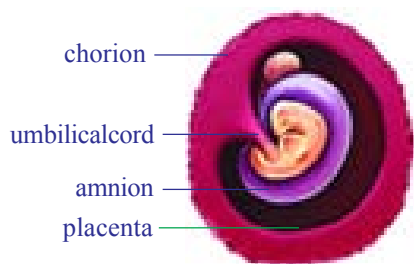


fig-15: Human embryo

Shortly we shall return to this transformation and see how it occurs and how it is timed for the arrival of the fertilized ovum. But now let us see what the transformation does for the developing embryo.

The fertilized ovum undergoes division. As it moves down the oviduct and finally attaches to the soft tissues of the uterus. Once attached, the embryo

sinks into the soft inner uterine wall. Then certain cells of the embryo develop into membranous structures that help to nourish, protect, and support the developing embryo.

During the development of the embryo, tiny finger like projections grow from the surface of the outer membrane called chorion into the soft tissues of the uterus. Gradually, small pools of rapidly moving blood around these finger like projections in the uterine wall. These tissues of the chorion and the adjacent part of the uterine tissue make up the placenta.

Placenta is a tissue formed by the cells from the embryo and the mother. It is formed at around 12 weeks of pregnancy and becomes an important structure for nourishment of the embryo. Under normal conditions there is no direct flow of blood from mother to the young. The blood systems of the two are separated by thin membranes made up of cells that allow an exchange mainly by diffusion, of oxygen, carbon dioxide, nutrients, and waste materials.

Another embryonic membrane, the amnion, grows around the embryo itself. The cavity within the amnion becomes filled with fluid called amniotic fluid. The embryo develops in this fluid-filled cavity, which keeps it moist and protects it from minor mechanical injury.

Another membrane called allantois, which originates from the digestive canal of the embryo forms the major part of a tube like structure called umbilical cord. It contains the very important blood vessels that connect the embryo with the placenta.

Thus the embryo develops until it is ready to be born. From the third month of pregnancy the embryo is called foetus. Pregnancy lasts, on an average, 9 months, or 280 days. This period is called gestation period.

Let us observe the chart showing monthwise developmental stages of human embryo.



fig-16: Developmental stages of human embryo

? Do you know?

The average length of pregnancy varies by species: it is about 63 days for the domestic cat and dog, 330 days for the horse, 280 days for the cow, and 20-22 days for the rat and mouse.

Child birth

As pregnancy progress, the foetus of an embryo with certain characters grows and the uterus increases in diameter. Usually, at about the ninth month after fertilization. The head of the foetus is turned down towards the opening of the uterus. At birth, the head usually comes out first. Sometimes the feet come first; this makes the delivery more difficult. We still do not know much about the mechanism of child birth and how it is triggered.

Childbirth begins when the muscle layers of the uterus starts to a rhythmic contract and relax, these actions are felt as labour pains. At first, muscular activity of the uterus is just strong enough to move the baby slowly toward the vagina the outer canal of the female reproductive tract. Generally, at this stage, the sac (amnion) around the baby breaks, and its fluid contents are released. This is a good sign that labour is well on its way. Then the contractions of the muscles become stronger and more frequent, and the baby is pushed through the vagina and into the outer world.

The umbilical cord leading from the baby to the placenta, is tied off and cut by the doctor. (The small piece of cord remaining attached to the baby shrivels and falls off within a few days. The navel marks the place where it once entered the body.) After the birth of the baby, the muscular

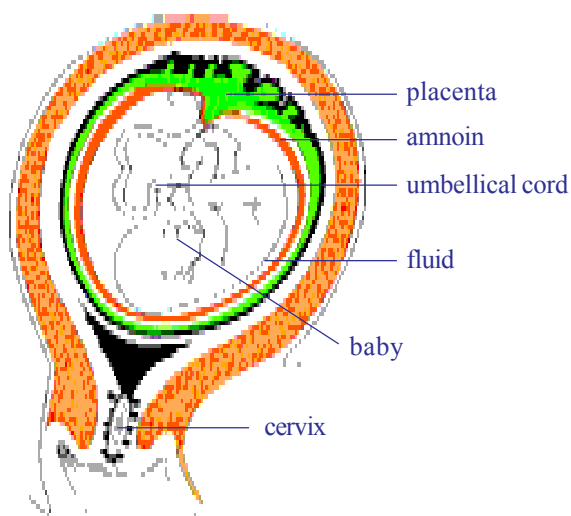


fig-17: Shortly before birth

contractions of the uterus continue until they push out the tissues of the placenta, which are commonly called the “afterbirth.” During the last part of pregnancy, a watery lymph like fluid called ‘colostrum’ accumulates in the mammary glands, which have gradually been enlarging and undergoing a transformation. For the first few days after the baby is born, the mammary glands secrete only colostrum. It is very important to feed this to the new born baby. It helps in developing the immune system of the child.

? Do you know?

Need for sexual reproduction

Asexual reproduction as we have studied produce organisms which are normally copies of the single parent. Sexual reproduction would require two parents and organism produced would have a combination of characters of both parents. Asexual reproduction appears to be more efficient as only one parent is required and no time or energy is spent in finding a mate. But sexual reproduction helps organisms to develop characters that would be help them to adapt better to their surroundings. Think of the paramoecium mentioned in the begining of the chapter.

When compare with animals sexual reproduction is less complex in most flowering plants. Let us study how it happens in them.

Sexual reproduction in plants

So far we know about nearly 275,000 species of flowering plants. With a few exceptions, all of them give rise to seeds enclosed in fruits. Most of the plants you are familiar with are mostly flowering plants. Their characters are quite remarkable. The plant size range from trees weighing many tonns to tiny water plants about the size of a rice grain. A sal tree growing in the Himalyan moutains, a giant cactus in the Sahara desert, an orchid plant on the branch of a jungle tree-all are flowering plants. Now let us examine the essentials parts of sexual reproduction in flowering plants.

Flower - The reproductive part

The reproductive parts of flowering plants are located in the flower. You have already studied the different parts of the flower- sepals, petals, stamens and carpels. The reproductive parts of the flower which possess the sex cells or germ cells called stamens and carpels.

- *What function do you think is served by petals and sepals?*
- *Draw the diagram of the flower that you collect and label the parts shown and write their functions.*

Flowers having either stamens or carpels are called unisexual like that of

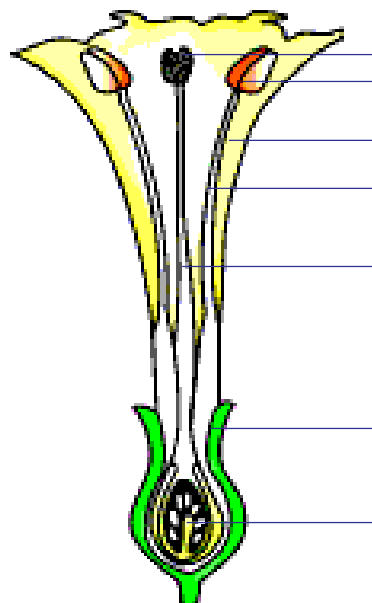


fig-18: Structure of flower

bottle gourd and papaya. Flowers having both the stamen and carpel are bisexual like *Datura*. Stamens (male portion called androecium) produce male sex cells in the pollen grain. Carpels (female portions called Gynoecium) produce female sex cells in ovules inside ovaries. Carpels have three main parts, one to receive the pollen called as stigma, one for passage of compatible male sex cells called the style and the part where fusion of male and female sex cells occur to form zygote, is the ovary.

The plants having flowers where male reproductive cells of stamen of the flower fertilise the female reproductive cell of the carpel of the same flower is called self-pollination. We can see this type of pollination in plants like those of the pea family.

Try to find out some other plants that are self-pollinating types.

Are there any observable characters that help you to find out whether a plant is self-pollinating type or not? The illustrations given here will help you. If anthers are present below the stigma of the carpel.

- *How does the male reproductive cells fertilise the female reproductive cells in flowers of such plants?*

You have studied in earlier classes how birds and insects help plants as agents of pollination.

What happens in plants that carry the female reproductive structure or the male reproductive structure borne in separate flowers? Remember the flowers of bottle gourd you studied in earlier classes.

? Do you know?

Darwin in 1876 showed that plants when isolated had the greatest tendency to self-fertilize while when surrounded by varieties of the same flower, they readily cross fertilize.

In cases where male cells of flower of a plant fertilise the other female flower on the same or different plant of the same group, this type of pollination is called cross pollination. Observe fig-21 showing plant carpel with pollen on stigma and pollen tube running down.

Do you know what is self-pollination?

Let us now observe some smaller parts that are involved in the process of reproduction in plants. The male reproductive part or the stamen consists of some sac like structures at its head bearing small ball like structures. We can easily observe these structures called pollen with the help of hand lens. The pollen grain reach the female reproductive part and fertilize the egg to form a zygote.

Activity-2

Observation of pollen grain

Take a slide and put a few drops of water on it. Now take any flower like hibiscus, tridax, marrigold, etc. Tap the anther over the drop of water. You will see small dot like structures in water. These are pollen grains. Observe these first under hand lens then under a compound microscope.

You may also see a permanent slide of pollen grain from your lab. Observe under microscope. Make a drawing of what you observe and compare with the given diagram.

- How many cells are present in the pollen grain?

The given diagram shows two nuclei. Do you think they may have formed if we assume that pollen grain may have started as a single cell stage? The pollen grain germinates only on the stigma.

What happens then? In order to find out the remaining process we must look into the structure of the ovule.

Structure of the ovule

An ovule is an egg-shaped structure attached by a stalk to the inner side of the ovary. Depending upon the species of plant involved, an ovary may have one, two, several, or even hundreds of ovules. At the center of each ovule is a microscopic embryo sac filled with food and water. The embryo sac is composed of gametophyte cells.

The majority of flowering plants have an embryo sac consisting of seven cells and eight nuclei. Two of which are important to our discussion. One is a large central cell containing two nuclei. These are called polar nuclei. The other cell is the egg. It is located at the end of the embryo sac closest to the opening through which the pollen tube enters. Cells on the surface of the stigma secrete a sticky nutrient fluid contains sugars and other substances. This will help the pollengrain to germinate. Then it forms pollen tube. It bears two nuclei. Soon after the tip of the pollen tube enters the embryo sac, the end of the tube ruptures and releases the two sperms into the embryo sac.

One of the two sperms fuses with the egg to form a zygote. By the time the egg cell has been fertilized, the two polar nuclei combine to form a single fusion nucleus. Now the second sperm deposited in the embryo

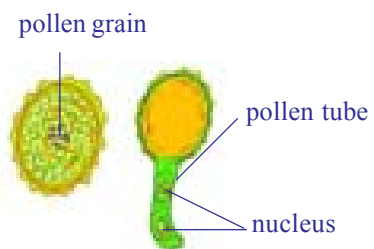


fig-19: Pollen grain

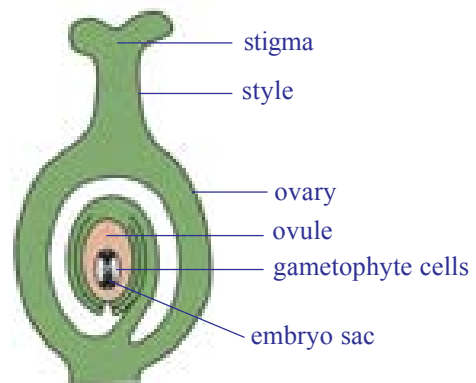


fig-20: Structure of ovule

sac by the pollen tube moves to the center and unites with the fusion nucleus. The zygote will develop into an embryonic plant within the ovule. Fertilization of the fusion nucleus stimulates the formation of a new tissue the endosperm. In which, food materials are stored as development of the ovule proceeds.

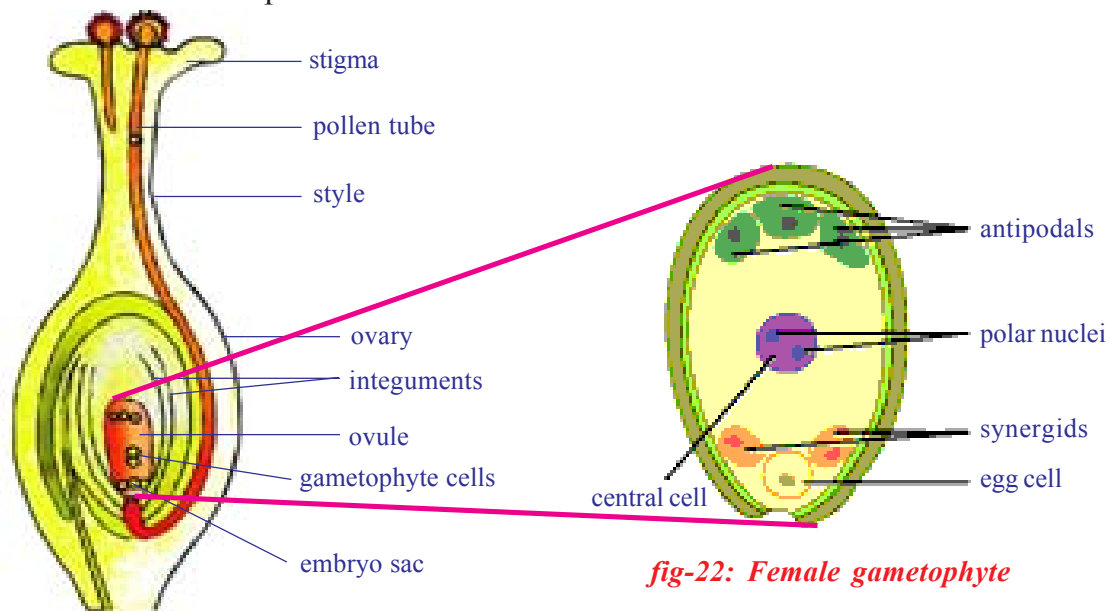


fig-22: Female gametophyte

fig-21: Fertilisation

Union of one sperm with the egg, and the second sperm with the fusion nucleus is called double fertilization. As far as we know, double fertilization occurs only in flowering plants. After double fertilization, the ovule increases in size rapidly as a result of the formation of endosperm tissue by mitosis and the development of the new embryo. The embryo consists of one or more cotyledons an epicotyl and a hypocotyl. Both the epicotyl and hypocotyl are parts of a rod like axis attached to the cotyledons.

The cotyledons digest and absorb the endosperm and make the stored food available for the growth of the epicotyl and hypocotyl. The cotyledons of some flowering plants, beans for example, digest, absorb, and store the foods from the endosperm as the ovule is maturing into a seed. As a consequence, the cotyledons become greatly enlarged because of stored food and the endosperm disappears more or less completely. Many other flowering plants (such as corn or castor bean), the endosperm tissue continues to grow as the ovule matures into a seed.

After fertilisation, the zygote divides several times to form an embryo within the ovule. The ovule develops a tough coat and is generally converted into a seed. The ovary grows rapidly and ripens to form the fruit. Meanwhile the other floral parts may shrivel and fall off.

- Which floral parts is may be seen in a fruit?

The seed produced after fertilisation contains the future plant or embryo that develops into a seedling under appropriate conditions. The process is called germination.

Activity-3

Seed germination

Soak few groundnut or bengal gram (chana) seeds overnight.

Drain the excess water and cover the seeds with wet cloth. Leave them for a day. Keep sprinkling water at regular intervals so that they do not dry up. Open the seeds carefully and observe the parts, compare with figure to identify the parts.

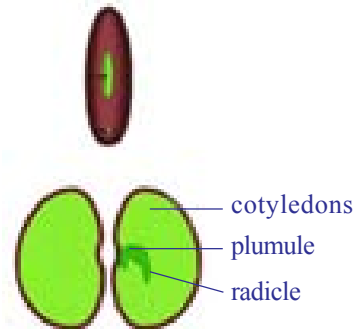


Fig-23: Seed germination

- How cotyledons are usefull for the plant?

Observe the life cycle of plant as a whole in the following diagram.

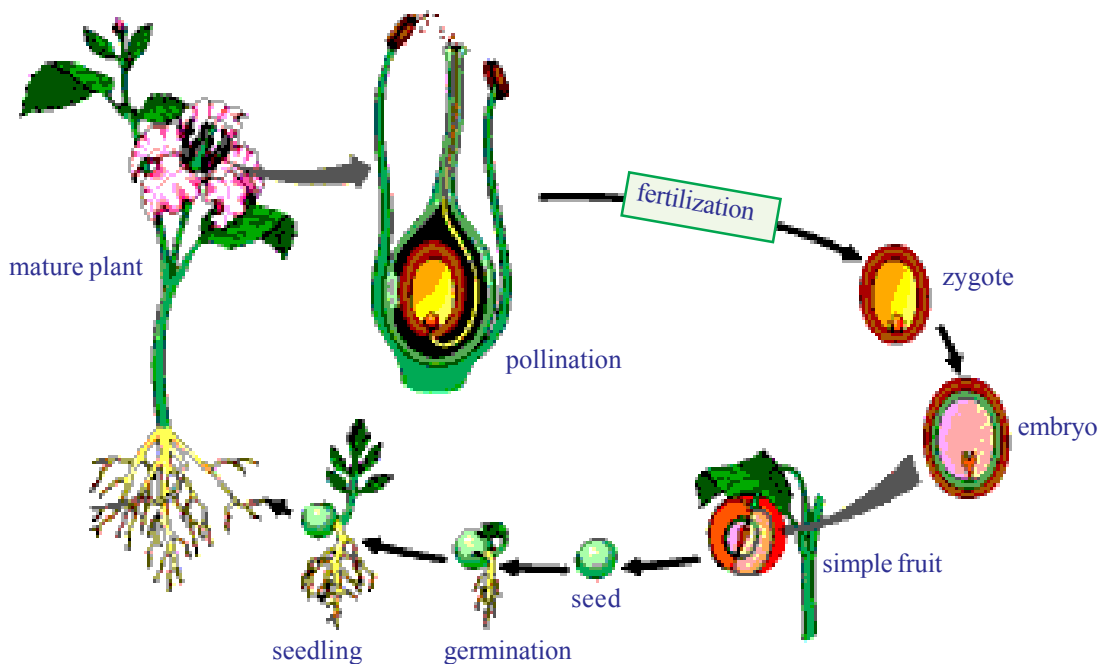


fig-24: Life cycle of flowering plant



Do you know?

In sexually reproducing organisms useually single fertilization gives rise to zygote. In plants there occurs a second fertilization giving rise to a nutritive tissue that provides nutrition to the baby plant which develops from the zygote. The pollen grain has two cells. In one of its cells called a tube cell, there are two nuclei. They travel down

through the stigma and style to the ovary. One of the nuclei fertilizes the egg to form zygote and the other nucleus fertilizes fusion nucleus to form an endosperm which provides food to the baby plant. This is called double fertilization.

Cell division and continuation of life

Continuation of life starts from cells either those of the general body or the sex cells (gametes).

Virchow (1821–1902) a proponent of cell theory is given the credit for the phrase *Omnis cellula de cellula*, or cells arise from pre-existing cells, indicates the importance of cell division in the creation of new cells.



fig-25:
Walther Flemming

In 1852 a German scientist, Robert Remak, published his observations on cell division, based on his observations of embryos. This was one of the first attempts to understand the mechanism of cell division. He stated that binary fission of cells was the means of reproduction of animal cells. What happens during cell division could only be understood better when scientists came to know what is present inside the nucleus of the cell.

In 1879 Walther Flemming (1843–1905) examined many kinds of animal and plant cells and selected those that showed division. He reported from his observations of such cells that there were string like structures in the nucleus which split longitudinally during cell division. He named such a process of division as mitosis (mitos- means fine threads) as the dividing structures resembled threads. He made a meticulous observation and made sketches and observed that there were a sequence of events in the process of division. A decade later these thread like structures were named as chromosome (coloured bodies) as repeatedly in efforts to see them scientists were trying to use dyes to stain the nucleus and found that these structures were stained most often. His most important discovery was chromosomes appear double in nature.

Wilhelm Roux (1850-1924) proposed that chromosomes carried a different set of heritable elements and longitudinal splitting observed by Flemming, ensured the equal division of these elements. Combined with the rediscovery of Gregor Mendel's 1866 paper on heritable elements in peas, these results highlighted the central role of the chromosomes in carrying heritable material (or genetic material). In cell division the cell divides into two halves with equal number of chromosomes which are similar to parent cell and are diploid in nature.

But the chromosomes number always remained the same. Biologists

also began to wonder about this. When cells divide, the daughter always have the same number of chromosomes as the parent cell. Let us assume that cell division is always preceded by mitosis. In case of man egg cells and sperm cells like other cells, must contain 46 chromosomes. But if this were so, then the union of egg nucleus and sperm nucleus, which takes place during fertilization would produce a total of 92 chromosomes in zygote. If it continues this would be 184, 368 and so on. But the situation is not like that.

August Weiseman (1834-1914) a biologist hypothesised that

1. In successive generations, individuals of the same species have the same number of chromosomes.
2. In successive cell division the number of chromosomes always remain constant.

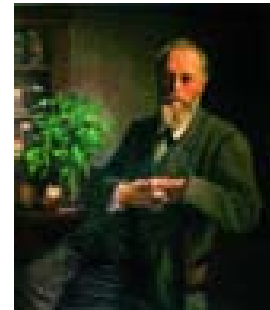
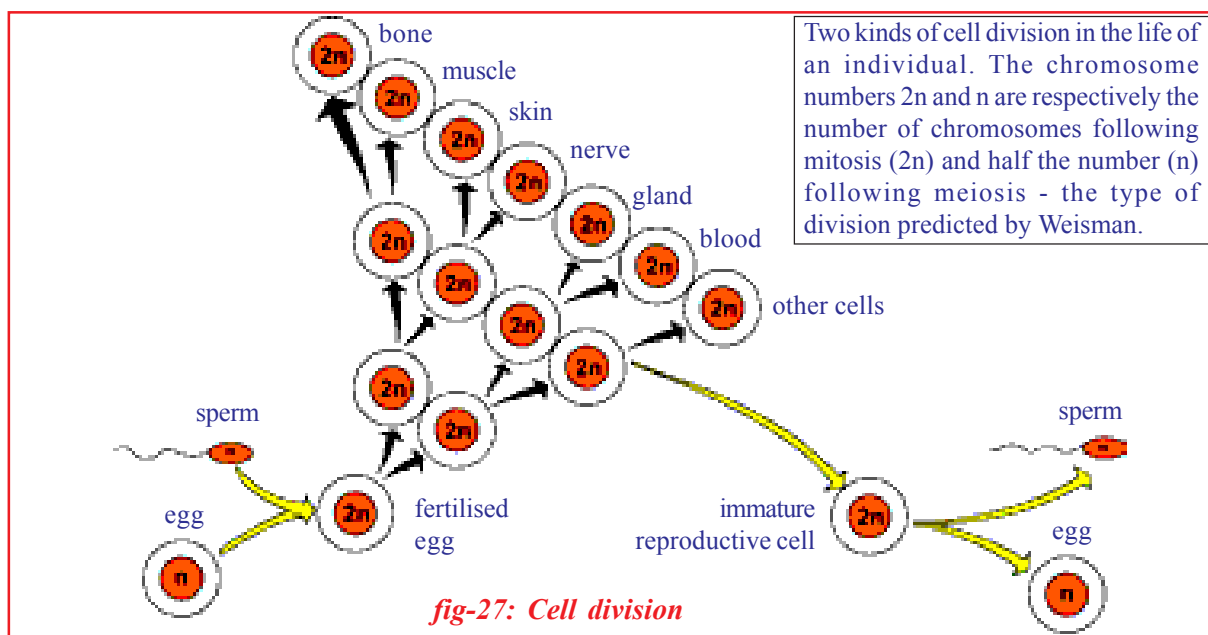


fig-26:
August weiseman

? Do you know?

August Weiseman was a scientist with poor eye sight, it was difficult for him to use a microscope to study cells. But there were other things that he could do. Advancement of science is not only possible by mere collection of data. Someone must think, analyse and interpret the data. August Weiseman's poor eyesight forced him to spend time thinking. Think how great he was!

The scheme of mitotic division was confirmed in 1904 by Theodor Boveri (1862–1915). The chemical nature of the genetic material was determined after a series of experiments over the next fifty years,



culminating in the determination of its structure the deoxy ribonucleic acid (DNA) in 1953 by James Watson (DNA) and Francis Crick. Scientists proved that mitosis takes place in all body cells which retains same number of chromosomes. Meiotic division takes place in sex cells where the chromosome number is halved. Observe the following flow chart.

Cell division in Human beings

We know that cell as the structural and functional units of life of any organism. In all organisms the cell divide and form new cells. The process of cell division is same in unicellular organisms and highly evolved multicellular organisms like human being.

Cell division is the process that transforms a human fertilized egg into a baby in nine months and into an adult in the next 20 years. Cell division and function in a multicellular organism is highly regulated. It occurs only when there is a need for it.

Cells in some organs, such as heart and brain of an individual never divide. On the other hand bone marrow cells actively divide to produce red blood cells, which have a short life span in the body. For example, if you cut your finger and bleed, soon a blood clot forms to stop the bleeding. This brings in various chemicals to the site that stimulate skin cells to divide and heal the wound. Cell division ceases as the wound is completely healed. In contrast, cancer cells do not respond to such growth regulating factors and continual dividing at the expense of normal cells, thus ultimately killing the host. So it becomes important to understand the processes involved in cell division. The cell cycle will help us understand this better.

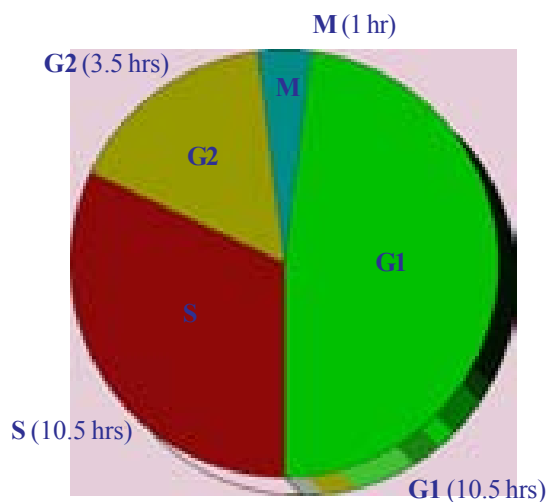


fig-28: Interphase

Cell cycle

The process of cell division is called 'Mitosis', which is completed in 40 to 60 minutes (this is the time of active division). The period between two cell divisions is called 'Interphase'. This is actually the period when the genetic material makes its copy so that it is equally distributed to the daughter cells during mitosis. Interphase can be divided into three phases.

G1 phase: This is the linking period between the completion of mitosis and

the beginning of DNA replication (Gap 1 phase). The cell size increase during this period.

S phase: This is the period of DNA synthesis (Synthesis phase) leading duplication of chromosomes.

G2 phase: This is the time between the end of DNA replication and the beginning of mitosis.(Gap 2 phase). Cell organelles divide and prepare chromosome for mitosis.

M phase: This is mitotic cell division phase.

To understand the functional relationship between these phases, Potu Rao and Johnson (see annexure) conducted some experiments using the cell fusion technique. That is combining two cells in experimental conditions. With this cell fusion technique Johnson and Potu Rao revealed for the first time the structure of interphase(G1, S and G2) chromosomes that are not ordinarily visible under the microscope. They provided evidence on progression of cells through the cell cycle in sequential unidirectional and controlled way by a series of chemical signals that can diffuse freely between nucleus and cytoplasm. These experiments are considered to be a ‘mile stone’ in the cell cycle studies.

Activity-4

Observe different stages of mitotic cell division

Take permanent slides which shows different stages of mitotic cell division from your lab kit. Observe carefully under microscope. Draw diagrams what you observe, and compare your observations with the following chart.

Division of cytoplasm is called Cytokinesis which finally brings about formation of two daughter cells. While observing cells in tissues undergoing division, it is not easy to differentiate different stages of division.



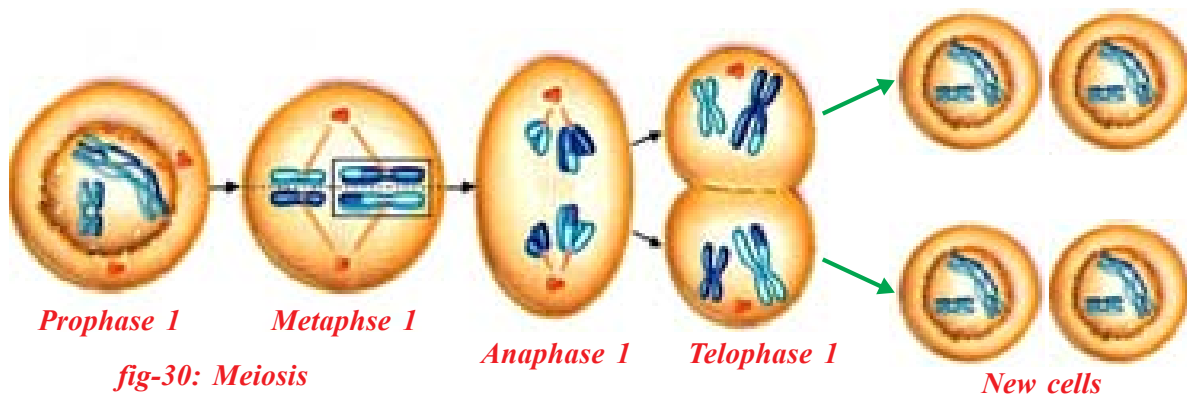
fig-29: Mitosis

Table-1: Mitosis

Stage	Description
1. Prophase	<ol style="list-style-type: none">1. Chromosomes contract, spiral and become visible even in light microscope and nucleoli become smaller (material to chromosomes).2. Chromosomes split lengthwise to form chromatids, connected by centromeres.3. Nuclear membrane breaks down.4. Centrosome, containing rod-like centrioles, divide and form ends of spindle (probably animal cells only). (Note: No pairing of chromosomes as in meiosis).
2. Metaphase	<ol style="list-style-type: none">1. Chromosomes move to spindle equator, centromeres attached to spindle fibres.2. Centromeres split, separating the chromatids.
3. Anaphase	<ol style="list-style-type: none">1. Spindle fibres attached to centromeres contract, pulling chromatids towards poles
4. Telophase	<ol style="list-style-type: none">1. Chromatids elongate, become invisible, (replication at this stage to become chromosomes).2. Nuclear membranes form round daughter nuclei.3. Cell membrane pinches in to form daughter cells (animals) or new cell wall material becomes laid down across spindle equator (plants)4. Nucleus divides into two and division of cytoplasm starts.

Process of meiosis

Unlike mitosis which is a continuous process for division in most cells. Meiosis occurs only during the formation of gametes in sexual reproduction. Meiosis has two phases. During the first phase of meiosis the parent cell (containing two sets of chromosomes) divides twice, though the chromosomes divide only once. The second phase of meiosis is similar to normal mitosis, but chromosomes do not duplicate, more over the



chromosomes are distributed equally to each cell. Thus the four daughter cells have just half the number of chromosomes of the parent cell. These are haploid (containing only one set of chromosome). Thus this division is also called reduction division. You will learn more about this in further classes.

- *What differences do you find in mitosis and meiosis? Write in a tabular form.*
- *What would happen if the gametes do not have half the chromosome number as the skin parent?*
- *How would it affect the progeny formed by sexual reproduction?*

Reproductive health

- *Why did the government of India fixed the legal marriage age of boys (21 years) and girls (18 years)?*
- *Do you feel that it is a social responsibility to control birth after having one or two children?*
- *What do you understand by the term 'Healthy Society'?*
- *Will you encourage child marriage? Why?*

As we have seen, the process of sexual maturation is gradual, and takes place while general body growth is still going on. Therefore, some degree of sexual maturation does not necessarily mean that the body or the mind is ready for sexual acts. Further, it is not fit for having and bringing up children. How do we decide if the body or the mind is ready for this major responsibility? All of us are under many different kinds of pressures about these issues. There can be pressure from our friends for participating in many activities, whether we really want or not. There can be pressure from families to get married and start having children. There can be pressure from government and voluntary organisations to avoid having children. In these situations, making right choices is important.

In the lesson why do we fall ill, we learnt that the diseases can be transmitted from person to person in a variety of ways. Since the sexual act is a very intimate connection of bodies, it is not surprising that many diseases can be sexually transmitted. These include bacterial infections such as Gonorrhoea and syphilis, and viral infections such as AIDS (Acquired Immuno Deficiency Syndrome).

- *What is the virus which causes AIDS?*

These diseases spread by unsafe sexual contacts, using infected devices, infected blood transfusion, from an infected mother to child.



*fig-31:
Red ribbon
1st December
AIDS Day*

It is very sad to say Andhra Pradesh has the highest number of HIV positive patients in the country. According to official statistics, the state had 24 lakh HIV positive patients in the country during 2011-12.

Maharashtra, Karnataka are followed by Andhra Pradesh. Officials said that one in every 300 adults is suffering from HIV elsewhere.

The prevalence of HIV is 1.07 percent among males and 0.73 among female in the state, which again is higher than other states. Its prevalence among adults (15-49 years) 0.90 percent, pregnant women 1.22 percent in Andhra Pradesh.

Illiteracy, poor health, unemployment, migration, non-traditional sex practise, unethical contacts and trafficking are some of the factors contributing to the spread of HIV in the state, according to experts.

The government established Anti Retroviral Therapy (ART centres) to supply medicine to HIV patients. Medical and health, family health departments AIDS control projects implementing various programmes like ASHA (Accredited Social Health Activist), Red Ribbon Express, etc., to create awareness in society on the risks and symptoms of AIDS.

- *Invite local health worker to your school and discuss about HIV and its impact on society.*
- *Social discrimination against AIDS patients is also a social evil. Can you support this? Why?*

If we follow the simple life styles as cited below one could avoid many sexually transmitted diseases.

- Avoid sex with unknown partners/multiple partners
- Even though contraceptives are available it is better follow ethical and healthy life practices.
- In case of doubt, go to a qualified doctor for early detection and get complete treatment if diagnosed with disease.

Birth control methods

The sexual act always has potential to lead to pregnancy. Pregnancy will make major demands on the body and the mind of the woman, and if she is not ready for it, her health will be adversely affected. Therefore, many ways have been devised to avoid pregnancy.

The prevention of pregnancy in women by preventing fertilisation is called contraception. Any device or chemical (drug) which prevents pregnancy in woman is called a contraceptive. The birth control methods can be of various types and can be used by any of the partners as preferable. Physical devices such as condoms and diaphragm (cap) are used. This

prevents reaching of sperms to ova for fertilisation. This device not only prevents fertilisation but also transmitting some sexually transmitted diseases (STD) like gonorrhoea, syphilis and AIDS. No other method of contraception provides protection against sexually transmitted diseases. Chemicals in the forms of pills are induced either orally or inserting into female reproductive organ vagina. It contains hormones which stop the ovaries from releasing ovum into the oviducts. Now a days pills for males are also available. These pills kill the sperms and hence are called spermicides.

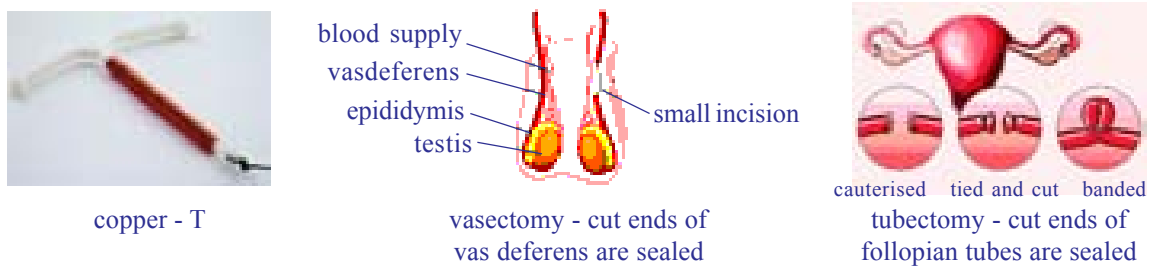


fig-32: Birth control methods

The use of intra-uterine device called copper-T, loop etc. are also very effective in preventing pregnancy. If a woman uses a copper-T as a method of contraception for avoiding unwanted pregnancies, they cannot protect her from acquiring sexually transmitted diseases. Surgical methods of birth control are available for males as well as females. In males a small portion of vas deferens (sperm ducts) is removed by surgical operation and both ends are tied properly. This method is called vasectomy. In females a small portion of oviducts (fallopian tube) is removed by surgical operation and the cut ends are tied. This prevents the ovum from entering into the oviducts. This method is called tubectomy.

Fighting against social ills

Teenage motherhood

We have studied how complicated the process of reproduction is. Child birth is even more complicated. Understanding it and getting prepared for it needs maturity of the mind and body. Thus a girl only after 18 years of age can be said to be prepared for the same. Most of the times this age is also dangerous to the girl. According to the department of family welfare 21% of teenage mothers die during delivery. So girls below 18 years of age should not be marry.

Stop female foeticide

Who knows today's girl child may become a great scientist, a famous doctor, a top class engineer, a dedicated administrative officer, a world

renowned economist, a wonderful teacher of an unmatched world leader of tomorrow. Stop female foeticide! Save the girl child.

Due to reckless female foeticide the male female child sex ratio is declining at an alarming rate in some sections of our society. Our government has already enacted laws to ban on determination of sex of foetuses. In spite of laws it's a social responsibility of us to prevent female foeticide.

- *Why doctors are prohibited to do sex determination through ultrasound scanning for pregnant women?*

We know that if health is lost, everything is lost. It's our responsibility to be healthy and to make others realise the importance of health. Sound body is to sound mind. To be an ideal citizen of India we should have knowledge of reproductive health not only to control high population growth but to create a healthy society.



Key words

Progeny, cyst, fragmentation, regeneration, vegetative propagation, artificial propagation, parthenogenesis, cutting, layering, grafting, stock, scion, desirable characters, tissue culture, amniotic fluid, placenta, umbilical cord, mitosis, meiosis, chromatid, chromosome, foeticide, HIV-AIDS, vasectomy, tubectomy.



What we have learnt

- Reproduction is necessary for perpetuation and continuation of life.
- Reproduction is of two types keeping in view of fusion of gametes- Sexual and Asexual.
- In sexual reproduction only half of each parent's chromosomes are passed to the next generation.
- Fission, budding, fragmentation, regeneration, spore formation are the ways of asexual reproduction.
- Several plants may be grown from vegetative parts like stems, roots, leaves etc and is called vegetative propagation.
- Vegetative propagation may be natural or man made. It has got some economic importance.
- In grafting we can acquire desirable characters of plants.
- Tissue culture is a modern technique of growing plants. It helps to grow more plants in less time and place.
- Sexual reproduction in higher animals is through specialised organs, distinctively male and female reproductive systems.
- Cells divide for growth of the individual to repair and replace the worn out cells and also for the formation of gametes.

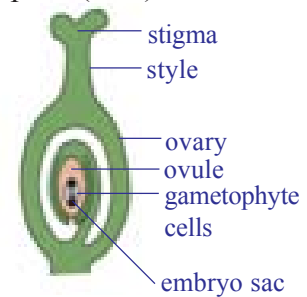
- Cell division is of two types-a) Mitosis-or somatic cell division B) meiosis-or reproductive cell division.
- The cell of the body may either be somatic cells that constitute the general body of the organism or germ cells that take part in formation of gametes.
- G-1, G-2, S and M are the stages in a cell cyclic which occur in a manner.
- The longest phase is the synthesis phase in cell cycle where duplication of genetic material takes place.
- At the end of mitosis two daughter cells are formed with the number of chromosomes same as that of their parents. It runs through Prophase, Anaphase Metaphase and Telophase.
- Division of cytoplasm is called Cytokinesis.
- During meiosis the parent cell divides twice and four daughter cells are formed.
- Reproductive health is important to possess sound mind in a sound body.
- One should be aware of the facts related to transmission of sexually transmitted diseases.
- There is no cure for AIDS. Prevention is the only way to avoid it.
- Now a days various methods of contraception are available to control child birth.
- It is our responsibility to build a healthy society.
- Determination of sex before birth is illegal.
- Stop female foeticide.



Improve your learning

1. Why do fish and frog produce a huge number of eggs each year?(AS1)
2. Give examples and explain what is meant by external fertilisation?(AS1)
3. Write differences between.(AS1)
 - a) asexual reproduction - sexual reproduction
 - b) stamen-carple
4. Explain the process of fertilisation in plants.(AS1)
5. What are the different modes of asexual reproduction? Cite them with examples.(AS1)
6. In what ways does sexual reproduction differs from asexual one? State at least three reasons.(AS1)
7. How are sperm cells adapted for their function?(AS1)
8. The menstrual cycle prepares the uterus for a fertilised egg. How long is an average menstrual cycle from start to finish?(AS1)
9. When the foetus is growing inside the uterus it needs nutrients. What provides these nutrients?(AS1)
10. What does the mother's blood take away from the baby and into the placenta?(AS1)
11. What is the job of the amniotic sac?(AS1)
12. What are the advantages of sexual reproduction?(AS1)
13. How does reproduction help in providing stability to population of species?(AS1)
14. Write the differences between mitosis and meiosis.(AS1)
15. What happens to the wall of the uterus during menstruation?(AS2)
16. "All unicellular organisms undergo only mitotic cell division during favourable conditions" - Do you support this statement? Why?(AS2)

17. Vicky's father wants to grow a single plant having two desirable characters colourful flowers and big fruits What method will you suggest him and why?(AS3)
18. Uproot an onion plant and take a thin section of its root tip. Stain it and observe under microscope. Draw as you see and identify the stages of the cell division.(AS3)
19. Visit a nearby village and collect information how farmers grow sugarcane, flowering plants like chrysanthamum, primrose and vegetables like stem tubers, plump gourd (dondakaya) etc. Make a report and submit in class.(AS4)
20. Collect information from school library or using internet what vegetative methods are followed in your district as well as in your state to propagate various plants of economic importance. Represent it in a graph.(AS4)
21. Make a flow chart to show the cell cycle and explain cell division describing different stages of mitosis.(AS4)
22. Draw neat labelled diagrams of male and female reproductive system of plant.(AS4)
23. Observe the following part of a flowering plant prepare a note.(AS5)
24. Prepare a flow chart to explain the process of sexual reproduction in plants.(AS5)
25. Draw a neatly labled diagram to explain plant fertilisation. Write few points on pollen grain.(AS5)
26. What would be the consequences if there is no meiosis in organisms that reproduce sexually?(AS6)
27. How will you appreciate cell division that helps in perpetuation of life? (AS6)
28. What precautions will you take to keep away from various sexually transmitted diseases?(AS7)



Q.No.23

Choose the correct answer

1. The part of the female reproductive system that produces the eggs? ()
 a) Ovary b) Epididymis c) Cervix d) Fallopian tube
2. The term that we use to describe a sperm cell fusing with an egg cell? ()
 a) Fragmentation b) Fermentation c) Fertilisation d) Fusion
3. Which part of the male reproductive system produces (human) the sperm cells? ()
 a) Vasdiference b) Epididymis c) Bladder d) Scrotum
4. How does the sperm break through the egg cell membrane? Choose the option you think is right.
 a) Tears a hole in the membrane b) Dissolves the membrane with chemicals ()
 c) Bites through the membrane with teeth d) Squeezes through gaps in the membrane
5. Why are egg cells larger than sperm cells? Choose the option you think is right. ()
 a) Egg cells have more cells in them b) Have food store to help growth after fertilisation
 c) Have thicker cell membranes d) Have larger nuclei

6. Which of these things will affect the way a foetus grows? Choose the option you think is right. ()
- a) Chemicals in cigarette smoke b) Alcohol c) Drugs d) All of the above
7. Which of the following is the correct sequence of steps in the human life cycle? Choose the right option. ()
- a) Babyhood, childhood, adolescence, adulthood b) Childhood, babyhood, adulthood, adolescence
c) Adolescence, babyhood, adulthood, childhood d) None of these



Annexure

Dr. Potu Narasimha Rao, a renowned scholar and an eminent cytologist came from a poor family in Muppalla village of Guntur district. He completed his graduation in Agriculture and did his MS at IARI, New Delhi. Later, he went to USA for research. He worked on the cytogenetics of tobacco plant. During his research, a cell line called Hela, isolated from a human tumour was established in 1952 and received his PhD in 1963. He switched his attention from plant cytogenetic to the field of cancer cells. He conducted research in cell kinematics and studied extensively on the ‘triggering factor’ of cell division i.e mitosis.



*Dr. Potu
Narasimha Rao*



He La Cell

He found that human cells either normal or cancer cells in culture media usually divide every 20 to 24 hours. But actually normal mitosis is completed in 40 to 60 minutes. The period in between two cell divisions is called interphase. The interphase further consists of 3 phases G1, S and G2 phases.

To understand the functional relationship between these phases of cell cycle. Dr.N.Rao and his research associate Dr.Johnson conducted experiments on cell fusion technique. His researches revealed that the cell cycle is sequential Unidirectional and controlled by a series of chemical signals. His experiments are considered to be a milestone in the cell cycle studies. This study threw a new hope of ray for the budding scientists to carry out researches on cell division. If you want to talk to this great scientist log in with email poturao@yahoo.com

Read the poem ‘Ma Mughe Ane Do’ in your Hindi book.

Collect information about Rashtriya Kishore Swasthya Karakram (RKSK)