

EV SSC BIOLOGY

Chapter-14: Biotechnology

Ques. ► 1 Bangladesh agricultural scientists discovered a new variety of rice by crossing a Bangladeshi rice variety with an African rice variety which is high yielding and drought tolerance. Now a days this method is becoming popular in Bangladesh for the development of agriculture. [D.B.-17]

- What is dominant character? 1
- Survival of the fittest. — Explain the statement. 2
- Describe the stem's mentioned process by which living being of expectable characteristics will be obtained. 3
- Evaluate the possibilities of the mentioned method in case of Bangladesh. 4

Answer to the question no. 1

a The characteristics that expressed among the first-generation organisms from their parents are called dominant characters.

b Place, shelter and food are limited in this world. So, the more an organism naturally reproduces, the more struggle is created among them to survive. The species which triumphs in this struggle of existence are considered to be worthy of survival. Darwin coined the term 'Survival of the fittest' based on this capability of survival.

c The process mentioned in the stem is recombinant DNA technology. By recombinant DNA technology organisms with expected characteristics can be possibly obtained. Some steps of this process have been explained below-

- DNA of desired characteristics are chosen.
- A carrier is selected by which the DNA of desired characteristics can be transmitted.
- The necessary restriction enzyme required for cutting the specific parts of the desired DNA and carrier's DNA are chosen.
- Ligase enzyme required for connecting the specific parts of the desired DNA and carrier's DNA are chosen.
- The DNA of the carrier with parts of the desired DNA is the recombinant DNA.
- Transgenic cells are made by inserting the recombinant DNA in the cells of the desired organism by a carrier.
- An organism with desired characteristics can be made from the transgenic cells through tissue culture.

d The process mentioned in the stem is recombinant DNA technology. There are limitless possibilities for this technology in Bangladesh. By this technology DNA of desired characteristics can be transmitted inside animal body. Recombinant DNA technology is successful for creating new breed of crops. By this technology, it has been possible to create a new insect resistant breed of eggplant. This technology has been used in many organizations of our country to increase the nutritional value of crops. For example- researches are being done to transmit the gene of vitamin 'A' beta-carotene in rice. Researches are being done to bring genetical changes in crops by transmitting salt and base tolerating gene. By using the insulin producing genes of human body commercially insulin is being produced from genetically modified *E.coli* bacteria and yeast, which is being used for treating diabetes.

Besides, scientists are trying to make different kinds of crops are by using recombinant DNA technology.

So, there are endless possibilities for the technology mentioned in the stem.

Ques. ► 2 Habiba learnt about a special technology while reading her text book. With this technology, many plants of same characteristics can be grown from plant part. [C.B.-17]

- What is locus? 1
- What is food web, explain. 2
- Explain the steps in the technology mentioned in the stimulus above. 3
- Analyse the role of this technology in Bangladesh's economy. 4

Answer to the question no. 2

a Locus is a specific location of chromosome where genes are located.

b The web formed by interconnection of multiple food chains in an ecosystem is called food web. For example: a food web is formed with different elements (algae, fish etc.) of a pond.

c The technology mentioned in the stimulus above is tissue culture. The steps in this technology is explained below—

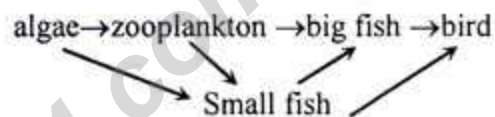


Fig: Food web

i. Selecting mother plant: High quality tree part is selected for explant.

ii. Preparation of culture medium: Culture medium is prepared by mixing the essential mineral nutrients, vitamin, phytohormone, sucrose and agar in appropriate amount.

iii. Preparing sterilized culture: Culture medium is sterilized in autoclave machine. Later explants are placed in the consolidated culture medium and kept in a controlled room. Thus calluses and plantlets are formed.

iv. Transferring in root growing medium: Plantlets are transferred in the root growing culture medium.

v. Transferring in natural environment i.e. field level: Plantlets with roots are first planted in soiled filled pots inside laboratory and later planted in natural environment.

d The role of the above technology i.e. tissue culture in Bangladesh's economy is extremely important. As numerous plants can be grown by tissue culture in tissue culture lab, this process is naturally very lucrative. Also there are these following advantages of tissue culture which make it economically profitable—

- Production of numerous saplings of same characteristics.
- Production of disease-free saplings.
- Avoiding the limitation of producing seasonal saplings.
- Storing relatively more saplings in less place.
- Production of saplings of those plants for which saplings cannot be grown by seed or by normal method.
- Production and conservation of nearly extinct tree's saplings.
- Inventing new type of plants and fast reproduction.

Substantial economic growth can be achieved by applying these features of tissue culture technology. Bangladesh also already has earned much success in agriculture field using this technology. Disease resistant and more productive crop, flower plant, wood producing tree etc. are produced which is already playing a significant role in economic growth.

So it can be said, tissue culture can have a significant effect on Bangladesh's economy.

Ques. ▶ 3

Fig : X

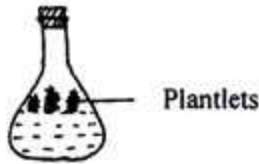


Fig : Y

- [Ctg.B.-17]
- What is producer? 1
 - What is the cause of Bacteria's involvement into Kingdom Monera? Explain. 2
 - Describe the procedure of Figure-X. 3
 - Analyse the importance of the technology of the mentioned Figure-Y. 4

Answer to the question no. 3

a Producers of an ecosystem are the ones who prepare food on their own. Usually producers are green plants.

b Bacteria is included in the Monera kingdom because-

- Bacteria is prokaryotic
 - They contain no membrane bound organelles
 - They have ribosomes
 - Usually undergoes reproduction by amitosis cell division
- These characteristics match the requirements of Monera kingdom, hence bacteria has been included into this particular kingdom.

c The figure X represents a recombinant DNA, which can be made following the steps-

1. Selecting the DNA of interest
2. Choosing the best carrier, in which it is possible to transfer the DNA of interest
3. Selecting the suitable restriction enzyme to cut the DNA at the desired place
4. Selecting a suitable ligase enzyme to perform the joining of carrier and the DNA of interest
5. Choosing a suitable host in which the recombinant DNA can replicate
6. Evaluating the expression of the recombinant DNA

d Figure Y of the stem shows tissue culture technology. It is possible to prepare plant seedlings in the laboratory throughout the year using tissue culture technology. As aseptic conditions are maintain in the lab, so the seedlings remain germ and disease free which keeps them healthy.

The yield of plants is greater in this technique and requires minimum labor and time. There are a variety of plants which do not produce offspring via seeds. Tissue culture helps save those species. Besides, one can earn huge foreign currency by producing medicinal plant seedlings, orchid seedlings etc. and importing them to abroad. It is also possible to save extinct species via tissue culture.

So tissue culture has immense possibilities and importance.

Ques. ▶ 4 Rahima has a rare species palm tree which does not produce flower and fruit now in her farm. Besides, the growth of cows and goat reducing day by day in her farm. One day she was watching an agriculture related programme on TV and learns that, she can solve her problem by using the technology of changing the material of heredity. [D.B.-16]

- What is evolution? 1
- Explain natural selection. 2
- Explain which Biotechnology is possible to save Rahima's farm plant from extinct. 3
- To solve last problem of stem indicate which technology – Analyze it. 4

Answer to the question no. 4

a Evolution is the development of an organism in the course of time through a gradual sequence of changes from simple to a more complex and adaptive form.

b Every organism needs food, shelter and scope of reproduction. In this circle, changes of in structure and their function take place the modified characters are inherited from generation to generation and the organism become adapted in the changed condition in modified form by their excellence in modification. It makes the organism to survives in the struggle for existence and naturally selected. On the other hand, those organisms can not change themselves adaptive in the new environment. Thus the selection by the nature for existence of the species, the organism is the natural selection. By the natural selection new species are created. Dinosaurs could not change themselves in on adaptive way in the changing environment and it has become extinct.

c The plant grown in Rahima's farm is a rare palm tree. Currently the tree has stopped producing flowers and fruits and as such seed is not produced. As a result, without reproduction, the plant is going to be extinct. In this situation, tissue culture technique can save the palm tree from extinction. In tissue culture, a part of the meristematic tissue, such as shoot tip, root tip etc. is used as the explant and the explant is cultured on artificial nutrient medium in aseptic condition and controlled light and temperature suitable for cell division. From the explant thus cultured several new plantlets can be grown within a short period of time. For the development of root and shoot combination of hormones should be changed. Thus complete plantlets with root and shoot will be produced. Individual plantlets are then cultured in separate test tubes or conical flasks. When the plantlets are developed enough, they are transferred from the culture vessel to the pot and quarantined for a few day. Finally the plantlets are transferred to the field.

So, taking explant from the root tip of the endangered palm tree in Rahima's garden, plantlets could be produced in tissue culture method and the plant could be saved from extinction.

d Second problem in the stem was that the cattle heads in this farm are not growing properly. She also observed in the T.V. programme that this problem could be solved by changing the genetic material or DNA. In this case change in genetic material indicated the recombinant DNA technology. DNA contains all the genes controlling different features of the living organism even the growth controlling genes of the cattle-heads. Recombinant DNA technology can change the undesired gene and replace it with a desired gene.

The gene controlling the production of the growth hormone here should be replaced so that proper growth hormone is produced and the cows and goats in her farm grows rapidly. In case of recombinant DNA technology the following steps should be followed to replace the desired gene.

1st step: Selection of desired gene or the DNA part and also a suitable vector.

2nd step: A suitable enzyme should be selected to cut the both DNA in specific points.

3rd step: The part of the DNA containing the desired gene for growth hormone is then joined in the gap of the vector DNA by an enzyme- ligase.

In the next steps recombinant DNA thus prepared will be introduced into the egg cells of the cows and goats of Rahima's farm. Thus changed egg cells when fertilized will produce calves that will grow fast.

So, the above analytical discussion makes it clear that the second problem in the stem can be solved by recombinant DNA technology.

Ques. ▶ 5 Mr. Tamim used the lateral bud instead of seed for rapidly seedlines. Then after he successfully produced the new varieties seedlings by changing the gene sequence in the cell. [Dj.B.-16]

- What is heterocious plant? 1
- What is meant by the essential parts of the flower? 2

- c. Explain the seedling production process by Mr. Tamim. 3
 d. What do you think about the implement of the second technology for quality development of the living being? Analyze it. 4

Answer to the question no. 5

a Those plants in which the male and female flowers grow on two separate plants, they are known as Dioecious plants.

b There are four whorls of a flower— e.g.- Calyx, Corolla, androecium and the gynoecium. Among these 4 whorls, calyx and corolla helps to protect the internal parts and pollination of the flower. Androecium and the gynaecium are directly associated with the sexual reproduction and without these two whorls sexual reproduction is impossible. So the androecium and the gynoecium are known as essential whorls.

c Mr. Tamim used lateral buds instead of seed for rapid production of plantlets. The production of plantlets from the lateral buds in the laboratory instead of seed is done in the process of tissue culture. So, the technique used by Mr. Tamim is producing plantlets from lateral buds was tissue culture. The process of tissue culture used by Mr. Tamimis explained below—

1. First, one mother plant is selected to use its parts as explant. This mother plant should be fresh, healthy and disease free.
2. The culture medium is prepared by mixing essential minerals, vitamins, phytohormones and an energy source sucrose in proper proportion and then to this medium agar is added to make the medium semisolid. It is dispensed in equisete amount in suitable vessels.
3. The medium is autoclaved to make it free from all germs. The explant is then cut into small segments, made germ free and placed in the culture vessels (tubes or conical flasks). This process is called in culation.
4. Inoculated culture vessels are kept in growth chamber at controlled temperature and light condition. In this condition, the tissue of the explant divide rapidly and form an undifferentiated mass known as the callus.
5. The callus is then subcultured in a modified medium to shoot and root development and differentiation. All the operations are done in aseptic condition.
6. When shoot develops, seperated from each other and placed on another modified medium for rooting. Roots develop quickly and complete plantlets are produced.
7. After attaining a proper size the plantlets are taken out of culture vessel and quarantined in pots.
8. Finally the plantlets are transferred to cultivation field. Mr. Tamim produced plantlets using the lateral buds as explant in tissue culture.

d The second technique used by Mr. Tamim for the production of plantlets with new characteristic features by changing the gene structure of the nucleus. Genes are present in the DNA. A specific DNA part is known as the gene which regulates a particular character. So, the second technique is recombinant DNA technology. By this recombinant DNA technology we can achieve several types of benefits. By using recombinant DNA technology, it is possible to produce plants with more productivity or high yielding, insects and pest resistant, herbicide resistant, stress toleranance etc. developed characteristics. By this technology creating change in DNA level or genetic level, crops with more nutrient value have been produced. For example, super rice Varity rich in vitamin 'A' and iron has been developed. Similarly the cows has been developed producing more protein in their milk. Recombinant DNA technology has important achievement in the field of medicine also. Following recombinant DNA technology, transferring gene to the yeast cell, vaccine of hepatitis 'B' has been produces. The hormone insulin used to cure diabetes of man is also being producing commercially by Bacteria *E. coli*, by transferring human insulin gene to the Bacteria. Besides

that, recombinant technology has also developed fishes with 60% enlarged size which helps to metigate animal protein demand of man.

Similarly hundreds and thousands of beneficial activities are being done by this new technology.

So, from the above discussion, I can assume that this technology will be able to do a lot of benefits in crop production, vetenary and animal husbandy, fisheries and medicine etc.

Ques. ▶ 6 Mr. Jamal is a Biotechnologist. He can able to produce huge number of seedlings to use a specific part of a plant. Besides this, he usually transferred or added the DNA to produce the new variety of plants of desired characters. Nowadays both the process are very popular and playing an important role in the economic development of human kind.

[S.B.-16]

1. What is decomposer?
2. What do you understand by mutualism?
3. Present a labelled diagram of the first process mentioned in the stem.
4. The second technology used by Mr. Jamal plays an important role in the economic development— Explain the statement with logic.

Answer to the question no. 6

a Decomposers one saprophytic micro organisms which live on the dead and decaying organic substances and thereby decompose the dead bodies and complex organic substances into simpler components.

b Mutualism is the association between two different organisms in which both the partners become benefited and no one is harmed. Lichen is an example of mutualism in which fungi and algal components live together in close association. The algal component of the lichen manufacture carbohydrate food by photosynthesis and the fungal component hold water and nutrients and supply it to the algae. Water is used by the algae in photosynthesis and the food produced in photosynthesis is used by both the partners. Here both the partners are equally benefited without any harm.

c The 1st process indicated in the stem is the tissue culture. The different steps followed in tissue culture are diagrametically given below:

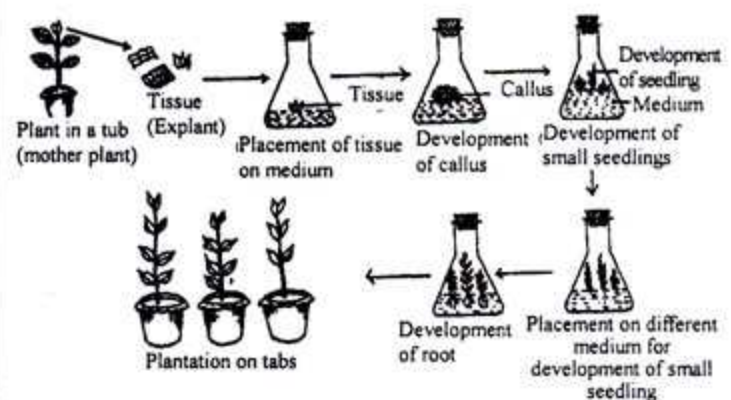


Fig: Consecutive steps of tissue culture.

d Mr. Jamal used to subtract or add some parts to change DNA for the production of new variety plants with desired characteristics. So, the technique practiced by Mr. Jamal in the second process is the recombinant DNA technology. This new technology might play an important role in the economic development of the country. The various success of this technology in crop improvement, in medical field, in fisheries development, even in animal development and environment consensation etc. It may play vital role in the economic development of the country.

Recombinant DNA technology has developed harmful insect and pest resistant crop varieties. For example, Bt-maize, Bt-cotton, Bt-Brinjal have been developed which one resistant to insects and pests, thus giving relief to the farmer cutting the

cost of insecticides and enhancing production. These crops play an important part in the economy of the country. Following recombinant DNA technology high yielding crop varieties have been developed. Crops with increased nutrient value have also been produced in this technique. Disease resistant crops like tomato, tobacco etc. have also been produced in this technique. All these crops are playing an important role in the economic development of our country. Rice varieties enriched in bitacarotin and iron may play an important role in solving the vitamin-A and iron deficiency for the low income group of people of the country. Following recombinant DNA technology Protein-C gene has been transferred to cows so that their milk become protein enriched. Several medicinal components in cow's milk have also been added following this technique. Transferring viral resistant gene to yeast cells, hepatitis-B vaccines have been produced in the technique. Insulin, growth hormone, somatostatin etc. are now being producing by the transferring human insulin, somatostatin gene to the bacterial cells. Thus this technology play role in the field of medicine and play an important role in economic development of the country. In fisheries, human growth hormone gene has been transferred to fish varieties which increases the size of the fish 60% increased, busting fish production and thus matigating animal protein demand of the people. In the field of conservation of environment, recombinant DNA technology helps us in various ways, such as clearing oil spills in the sea by the oil-tankers, decomposing debris etc

From the above discussion, it appears that the recombinant DNA has an important role in agriculture medical field, veterinary, fisheries development and thus the technology play an important part in the economic development of the country.

- Ques. ▶ 7** Razib was an unemployed young man. He takes a training how to improve quality of plant tissue from the nearest agriculture developing center. For this reason now he is an economically solvent and self-dependent young man. *[J.B.-16]*
- What is tissue? 1
 - What do you mean by biotechnology? 2
 - Explain the steps of the process of Razib's training. 3
 - Mentioned process is very much useful to develop our country Analyse it with logic. 4

Answer to the question no. 7

a A collection of cells of similar or dissimilar in structure but originating from the same source and performing the same function are known as the tissue.

b The word Biotechnology is derived from two words-biology and technology. Biology means the specific knowledge about living organisms and technology means the manner of accomplishing a task specially using technical processes, machines or knowledge. Thus the relation between biology and technology is the biotechnology. Hungarians engineer Karl Ere key in 1919 first introduced the term Biotechnology. At present the technology as the process of using organisms, organs, cells or organelles for the benefit of human society is known as biotechnology. It is the modern branch of Biological science.

c By means of recombinant DNA technology the quality of plant tissue can be improved. So the Rajib's training was in recombinant DNA technology. The different steps of this technicque is described below—

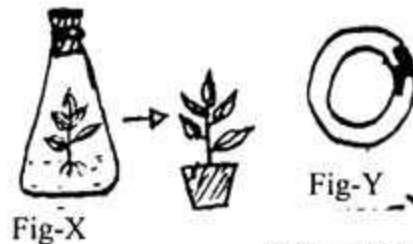
For Description see-the answer 2(d) of creative questions.

d In my opinion, the technique mentioned in the stem is the recombinant DNA technology, might play an effective role in the development of our country. This new technology has tremendous development of our country. This new technology has tremendous development for crop improvement both in productivity and quality, in health care and medicine, in the improvement of domestic animals in various ways, in improvement of fisheries and in environment conservation.

Thus the technology can help in the development of the country by booting agricultural production and minimizing production cost, developing improved quality of crops, fisheries and animal products and keeping environment pollution free etc.

By practicing recombinant DNA technology pest and insect resistant crop varieties have been developed. Bt-maize Bt-soyabean, Bt-cotton, Bt-Brinjal are a few examples of this type of crop. For the development of these type of insect-pest and disease resistant crop varieties production cost in minimised and production has increased in many folds. Rice vereties have also been developed which are enriched in B-carotene and iron. This improved variety of rice may be beneficial for the low income group of people in solving vitamin-'A' and iron deficiency, which are the main problems of the 3rd world people. Several hormones like insulin, somatostatin, somatomorphin, enterferon which are used for the remand of different diseases of human are now being produced by the microbes like bacteria, yeast etc. trans ferring human genes to that organisms. Thus the technique an important in solving medical quality of cows milk has also been improved in this technology by transferring vitamin-C genes to cows. Fish production has also been increased in this technique by transferring human growth hormone gene to fish varieties. Thus the size of the fish has been increased in 60% producing more animal proteins to metigate the protein demand of the people. Recombinant DNA technology may assist in environments conservation in various ways— as clearing oil spills, decomposing domestic debris, clearing sewerage system etc. So, from the above discussion. It is concluded that the process mentioned in the stem, can play vital and aeffective role in the development of the country.

Ques. ▶ 8



[Mirzapur Cadet College, Tangail]

- What is biological clock? 1
- Why variation is seen in the new plant produced by cross pollination? 2
- How rare and threatened plant species can be conserved by the 'X' process shown on the stem? Explain. 3
- Among 'X' and 'Y' which process is more suitable to develop a new variety? Give your opinion after a comparative discussion. 4

Answer to the question no. 8

a Sleep-wake and other daily patterns are part of our circadian rhythms, (circum means "around" and dies, "day") which are governed by the biological clock, housed deep within the brain.

b Cross pollinating with another plant (and not even necessarily of the same species!) means that another plants genes can make new combination. That is why variation is seen in cross pollination.

c Fig: "X" mentioned in the stem states the tissue culture process. Through tissue culture rare and threatened plant species can be conserved. The tissue culture process is explained below —

Steps of tissue culture:

- Selection of mother plant: The healthy, disease resistant plant with high quality is selected for plant tissue culture.
- Preparation of culture medium: For the growth of the plant culture, culture media are made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semisolid state.

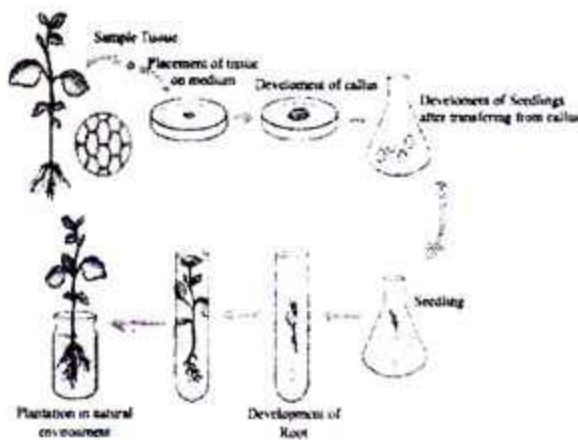


Fig: Steps of tissue culture.

- iii. Establishment of sterilized medium: In an autoclave machine, keeping it at the temperature of 121°C under 15 – 1b/sq. inch pressure for 20 minutes, the medium is sterilized. Then again after closing the mouth or opening the glass container, it is kept in a room with the controlling of light and temperature (25+2° C) for the growth of the explants. After the turning of the medium into a cold and semisolid state, explants are inoculated on it.
- iv. Transfer in root developing medium: If no root is developed in the plantlets by this time, then after attaining a definite height, shoots are cut and again placed in the root developing medium.
- v. Transfer to natural environment or to field level: After washing with water and putting them outside the room on the tubs, the plantlets are allowed to adapt with the external environment. When the grown-up plantlets become fresh and strong, they are once planted in soil in natural environment.

d. “X” and “Y” mentioned in the stem is tissue culture and genetic engineering or recombinant DNA technology respectively. To develop a new variety recombinant DNA technology is more suitable. My opinion is described below — Genetic engineering techniques are used only when all other techniques have been exhausted, i.e. when the trait to be introduced is not present in the germplasm of the crop; the trait is very difficult to improve by conventional breeding methods; and when it will take a very long time to introduce and/or improve such trait in the crop by conventional breeding methods (see Figure 2). Crops developed through genetic engineering are commonly known as transgenic crops or genetically modified (GM) crops. Modern plant breeding is a multi-disciplinary and coordinated process where a large number of tools and elements of conventional breeding techniques, bioinformatics, molecular genetics, molecular biology, and genetic engineering are utilized and integrated.

Ques. ► 9

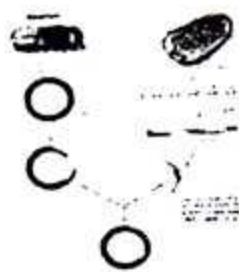


Fig-A

[Rajshahi Cadet College, Rajshahi]

- a. What is centrosome? 1
- b. Colour blindness is a genetic disease. Explain it. 2
- c. Describe the different steps of the technology mentioned in Figure-A. 3
- d. How can the technology mentioned above be utilized to produce better crops? Explain. 4

Answer to the question no. 9

a Centrosomes are structures found inside of cells. They are made from two centrioles.

b The two genes that produce red and green light-sensitive proteins are located on the X chromosome. Mutations in these genes can cause color blindness. Color blindness is a common inherited sex-linked disorder that affects a person's ability to see or recognize certain colors.

c The technology mentioned in the stem is genetic engineering or recombinant DNA technology. The steps of this technology are described below —

1. DNA with desired gene is separated from donor organism. Then plasmid DNA is separated from a bacteria to use it as a carrier of the gene. Plasmid is an individual DNA besides the chromosome in bacteria cell, which is able to divide or able in self-division.
2. In this step plasmid DNA and donor DNA are divided by a special enzyme. Desired gene is present in any of the part (location) of the donor DNA.
3. Then donor DNA is placed in between the two terminal parts of a plasmid by lipase enzyme. Lipase here act as adhesive. As a result DNA recombinant forms with the specific desired gene. This recombinant plasmid now carries the desired part of donor DNA.

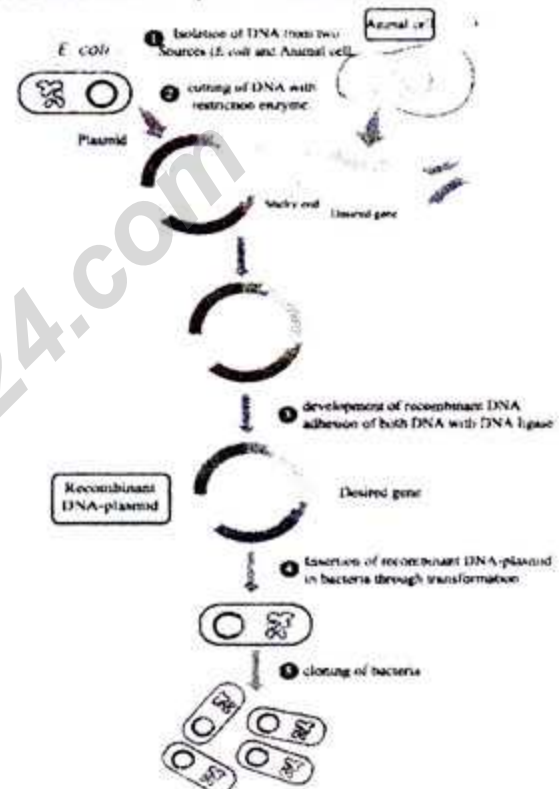


Fig: Recombinant DNA technology

4. In this stage the bacteria recombinant DNA emerges into receiver bacteria. The method of emergence of donor's chopped DNA part into bacteria is called transgenic organism. A new species of bacteria or organism created due to transformation is called transgenic organism.
5. In this stage bacteria with recombinant plasmid are identified and then separated. Bacteria with desired genes are then made reproduce rapidly. Now each of these reproduced bacteria contain the desired gene. The process by which gene is reproduced is called gene cloning. To use the gene, plasmid is separated again.

d The technology mentioned in the stem is genetic engineering or recombinant DNA technology which plays an important role in developing crops. This is explained below — Genetic engineering or recombinant DNA technology is the most modern biotechnology. The main objective of the technology is to develop organisms with new and advanced characteristics and by which human beings can be benefited. By this time, notable successes have already been achieved through this technology. Insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton. Bt rice (developed in China). These crops are resistant to harmful insects under Lepidoptera and Coleoptera orders. Using this technology, virus-resistant varieties of crop have been developed, for instance by transferring the genes, tomato mosaic virus

(ToMV), tobacco mosaic Virus (TMV) and tobacco mild green mosaic virus (TMGMV), resistant varieties of crop have been developed. Through genetic change, the nutrition value of some crops has been improved. For example, vitamin A i.e. beta-carotene gene has been transferred into rice. Efforts to add iron to rice are being continued. Attempts are also made to develop salinity and drought-resistant varieties of crops through genetic modification.

Ques. ► 10 Teacher informed in class ten that in 22 January 2014. The government of Bangladesh introduced the Bt brinjal for cultivation. Bt brinjal is an insect resistant variety.

[Cumilla Cadet College, Cumilla]

- What is tissue culture? 1
- What is meant by GMO? 2
- Explain the procedure of production of above crop. 3
- "Crop given in stem is harmful for insects, not for human beings" -Analyze with logics. 4

Answer to the question no. 10

a The process of growing a tissue on a nourishing and sterilized medium is called tissue culture.

b GMO is genetically modified organism.

c The procedure mentioned in the stem is genetic engineering or recombinant DNA technology. The process is described below —

- DNA with desired gene is separated from donor organism. Then plasmid DNA is separated from a bacteria to use it as a carrier of the gene. Plasmid is an individual DNA besides the chromosome in bacteria cell, which is able to divide or able in self—division.
- In this step plasmid DNA and donor DNA are divided by a special enzyme. Desired gene is present in any of the part (location) of the donor DNA.
- Then donor DNA is placed in between the two terminal parts of a plasmid by lipase enzyme. Lipase here act as adhesive. As a result DNA recombinant forms with the specific desired gene. This recombinant plasmid now carries the desired part of donor DNA.
- In this stage the bacteria recombinant DNA emerges into receiver bacteria.

The method of emergence of donor's chopped DNA part into bacteria is called transgenic organism. A new species of bacteria or organism created due to transformation is called transgenic organism.

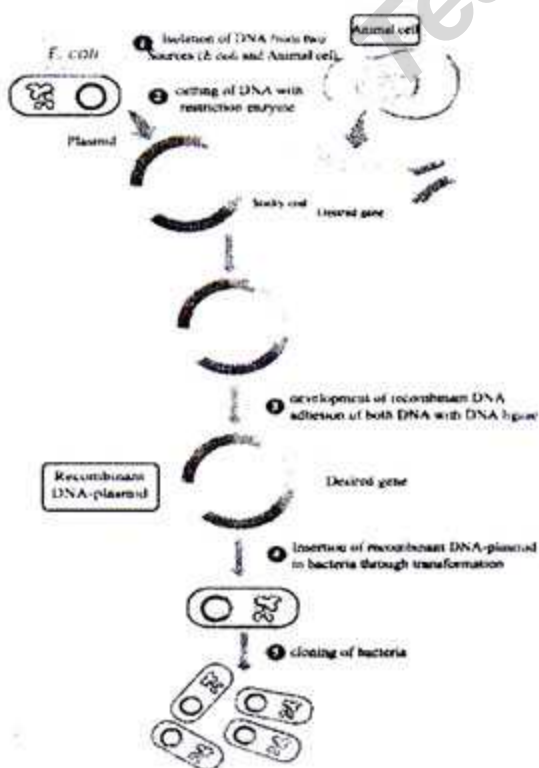


Fig: Recombinant DNA technology

5. In this stage bacteria with recombinant plasmid are identified and then separated.

Bacteria with desired genes are then made reproduce rapidly. Now each of these reproduced bacteria contain the desired gene. The process by which gene is reproduced is called gene cloning. To use the gene, plasmid is separated again.

d "Bt brinjal is harmful for insects, not for human beings"—the statement is analyzed below —

The Bt brinjal is a suite of transgenic brinjals (also known as an eggplant) created by inserting a crystal protein gene (*CryIAc*) from the soil bacterium *Bacillus thuringiensis* into the genome of various brinjal cultivars. The insertion of the gene, along with other genetic elements such as promoters, terminators and an antibiotic resistance marker gene into the brinjal plant is accomplished using *Agrobacterium*-mediated genetic transformation. The Bt brinjal has been developed to give resistance against lepidopteron insects, in particular the Brinjal Fruit and Shoot Borer. So, Bt brinjal is harmful for insects, not for human beings.

Ques. ► 11



[Feni Girls' Cadet College, Feni]

- What is transgenic? 1
- What do you mean by tissue culture? 2
- Describe the process of duplication of figure 'P'? 3
- What are the roles of figure 'P' in genetic engineering? Analyze it. 4

Answer to the question no. 11

a Transgenic means containing a gene or genes transferred from another species.

b The process of growing a tissue on a nourishing and sterilized medium is called tissue culture.

c Fig: "P" mentioned in the stem is DNA. The process of duplication or replication of DNA is described below —

Through the process, a new DNA molecule is synthesized from an existing molecule of DNA. DNA replicates in a half—conservative way. Through this process, the double-stranded DNA becomes single stranded by breaking hydrogen bonds. Then the floating nucleotide in a cell creates new complementary strands by combining "A" (adenine) with 'T'(Thymine), 'T' with A, 'C' with 'G' and 'G' with 'C'. Thus one of the old strands remains and combines with a new strand to make a complete DNA. In the end, a new strand, combining with another old strand forms the structure of a molecule of DNA. As the new DNA emerges, it has a new and an old strand. This principle is known as the semi-conservative method.



Fig: DNA replication

d Fig: "P" mentioned in the stem is DNA. The roles of DNA in genetic engineering are given below —

- Recombinant DNA
- Working with DNA fragments
- DNA fingerprints and Forensics
- Genetically engineered bacteria, animals, and plants
- Cloning animals
- Human gene therapy

- Genetics: The ethical implications of genetic engineering
- Genetically modified crops
- Environmentally protection

Ques. ► 12 During teaching in the class the teacher said, biotechnology and genetic engineering has opened up many exciting possibilities in agriculture, industries, medicine and food industry. Agricultural institutes have made many plantlets from a vegetative part of plant by using biotechnology.

[Faujdarhat Cadet College, Chattogram]

- What is Heredity? 1
- Why is a chromosome called the physical basis of heredity? 2
- Describe the technology which indicates in last sentence of above stem. 3
- Evaluate the possibilities of biotechnology mentioned in above stem. 4

Answer to the question no. 12

- Heredity is the passing of traits from parent to offspring.
- The function of chromosomes is to carry genes (which control the characteristics of organisms) to the offspring from the parents. Colors of human eyes, nature of hair, compositions of skin etc. continue intact through the flow of heredity carried by chromosomes. This is why chromosomes are designated as the physical basis of heredity.
- The technology mentioned in the stem is genetic engineering or recombinant DNA technology. This is described below —

- DNA with desired gene is separated from donor organism. Then plasmid DNA is separated from a bacteria to use it as a carrier of the gene. Plasmid is an individual DNA besides the chromosome in bacteria cell, which is able to divide or able in self-division.
- In this step plasmid DNA and donor DNA are divided by a special enzyme. The desired gene is present in any of the part (location) of the donor DNA.
- The donor DNA is placed in between the two terminal parts of a plasmid by lipase enzyme. Lipase here act as adhesive. As a result DNA recombinant forms with the specific desired gene. This recombinant plasmid now carries the desired part of donor DNA.
- In this stage the bacteria recombinant DNA emerges into receiver bacteria.

The method of emergence of donor's chopped DNA part into bacteria is called transgenic organism. A new species of bacteria or organism created due to transformation is called transgenic organism.

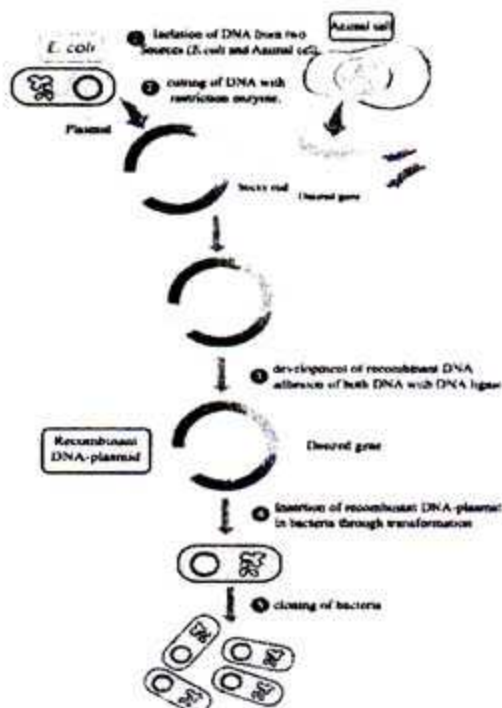


Fig: Recombinant DNA technology

- In this stage bacteria with recombinant plasmid are identified and then separated.

Bacteria with desired genes are then made reproduce rapidly. Now each of these reproduced bacteria contain the desired gene. The process by which gene is reproduced is called gene cloning. To use the gene, plasmid is separated again.

Q The possibilities of genetic engineering or recombinant DNA technology are evaluated below —

- In developing Crops:** Insect resistant varieties of crops have been developed. These crops are resistant to harmful insects under Lepidoptera and Coleoptera orders. Using this technology, virus-resistant varieties of crop have been developed, for instance by transferring the genes, tomato mosaic virus (ToMV), tobacco mosaic Virus (TMV) and tobacco mild green mosaic virus (TMGMV), resistant varieties of crop have been developed.
- In animals:** In livestock, for example, transfer of the protein C gene has been done to increase the protein in cow-milk, though this is still in research level. Through genetic modification, genetic changes have been accomplished with sheep by transferring the growth hormone producing gene from human beings to it with the view of increasing its size and meat production.
- In improvement of fishing:** Transfer of the growth hormone gene of Salmon fish, through genetic modification, to catfish, common carp, loitta fish, nilotica can increase the growth rate of the fishes by 60 percent.
- In healthcare:** Hepatitis b-virus vaccine is being produced from yeast through genetic modification. From genetically modified E. coli bacteria and yeast, insulin is being commercially produced for the treatment of diabetes by using the gene, which produces insulin in the human body.

Ques. ► 13 Observe the following figure and write the answer —

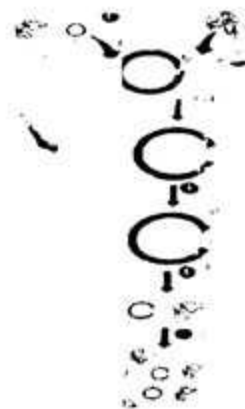


Figure-X

[Sylhet Cadet College, Sylhet]

- What is GMO? 1
- How is culture medium prepared? 2
- Describe the above process with figure that indicated in figure-X. 3
- Figure "X" create a great revolution in human civilization —Analyze. 4

Answer to the question no. 13

- GMO is genetically modified organism.
- For the growth of the plant culture, culture media are made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semisolid state.
- Fig- "X" mentioned in the stem is genetic engineering or recombinant DNA technology. The process is described below —
 - DNA with desired gene is separated from donor organism. Then plasmid DNA is separated from a bacteria to use it as a carrier of the gene. Plasmid is an individual DNA besides the chromosome in bacteria cell, which is able to divide or able in self-division.

- In this step plasmid DNA and donor DNA are divided by a special enzyme. Desired gene is present in any of the part (location) of the donor DNA.
- Then donor DNA is placed in between the two terminal parts of a plasmid by lipase enzyme. Lipase here act as adhesive. As a result DNA recombinant forms with the specific desired gene. This recombinant plasmid now carries the desired part of donor DNA.
- In this stage the bacteria recombinant DNA emerges into receiver bacteria.

The method of emergence of donor's chopped DNA part into bacteria is called transgenic organism. A new species of bacteria or organism created due to transformation is called transgenic organism.

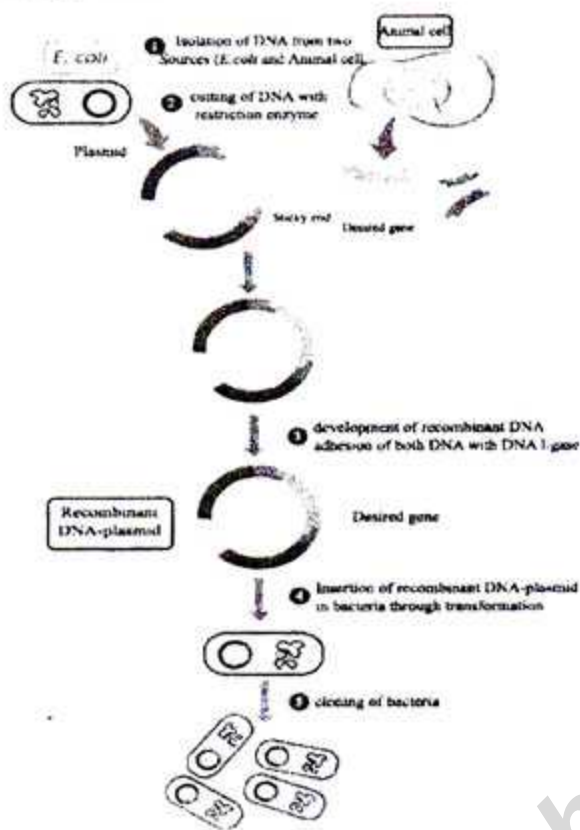


Fig: Recombinant DNA technology

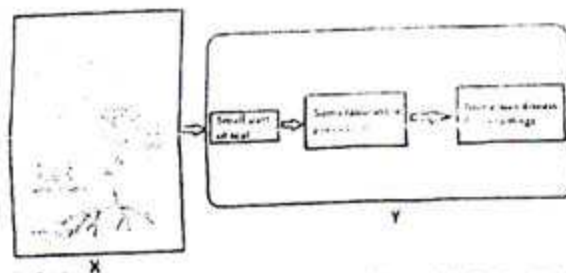
- In this stage bacteria with recombinant plasmid are identified and then separated. Bacteria with desired genes are then made reproduce rapidly. Now each of these reproduced bacteria contains the desired gene. The process by which gene is reproduced is called gene cloning. To use the gene, plasmid is separated again.

d Fig- "X" mentioned in the stem is genetic engineering or recombinant DNA technology which has created a great revolution in human civilization. This is analyzed below-

- In developing crops: Insect resistant varieties of crops have been developed. These crops are resistant to harmful insects under Lepidoptera and Coleoptera orders. Using this technology, virus-resistant varieties of crop have been developed, for instance by transferring the genes, tomato mosaic virus (ToMV), tobacco mosaic Virus (TMV) and tobacco mild green mosaic virus (TMGMV), resistant varieties of crop have been developed.
- In animals: In livestock, for example, transfer of the protein C gene has been done to increase the protein in cow-milk, though this is still in research level. Through genetic modification, genetic changes have been accomplished with sheep by transferring the growth hormone producing gene from human beings to it with the view of increasing its size and meat production.
- In improvement of fishing: Transfer of the growth hormone gene of Salmon fish, through genetic modification, to catfish, common carp, loitta fish, nilotica can increase the growth rate of the fishes by 60 percent.

- In healthcare: Hepatitis b-virus vaccine is being produced from yeast through genetic modification. From genetically modified *E. coli* bacteria and yeast, insulin is being commercially produced for the treatment of diabetes by using the gene, which produces insulin in the human body.

Ques. ► 14 Observe the figures carefully-



[Jhenidah Cadet College, Jhenidah]

- What is GMO?
- What do you mean by anaerobic respiration?
- With diagram describe the procedure of Y mentioned in stem.
- Why X is necessary for living world? Explain.

Answer to the question no. 14

- GMO means genetically modified organism.
- Respiration, which occurs in absence of oxygen, is called anaerobic respiration.
- "Y" mentioned in the stem is tissue culture technology. The process is described below —

The process of separating a tissue from a plant and allow it to grow in a nutrient medium is called tissue culture. Tissue culture is comparatively a new branch of botany. In plant tissue culture, any detached part of a plant or any part (pollen grain, terminal or lateral bud, part of root) is cultured in any nourishing and sterilized medium. The part of a plant being separated for tissue culture is called 'explants'.

Steps of tissue culture:

- Selection of mother plant:** The healthy, disease resistant plant with high quality is selected for plant tissue culture.
- Preparation of culture medium:** For the growth of the plant culture, culture media are made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semisolid state.

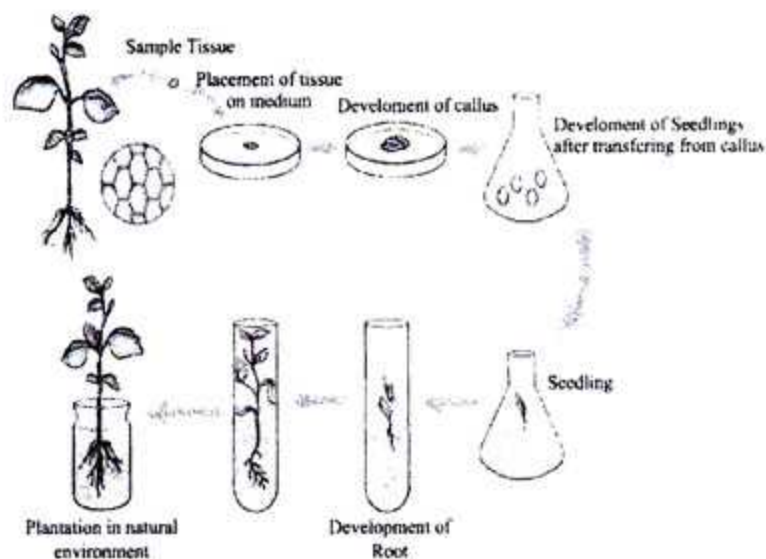


Fig: Steps of tissue culture

- Establishment of sterilized medium:** Taking the culture medium in a glass container (test tube, conical flask), its opening is usually closed with a cotton plaque. Later in an autoclave machine, keeping it at the temperature of 121°C under 15-1lb/sq. inch pressure for 20 minutes, the medium is sterilized. Then again after closing the mouth or opening the

glass container, it is kept in a room with the controlling of light and temperature (25+2° C) for the growth of the explants. After the turning of the medium into a cold and semisolid state, explants are inoculated on it. In this stage, the tissue placed on the medium through repeated cell division turns directly into a plantlet or callus or a cluster of cells without differentiation.

4. Transfer in root developing medium: If no root is developed in the plantlets by this time, then after attaining a definite height, shoots are cut and again placed in the root developing medium.

5. Transfer to natural environment or to field level: After washing with water and putting them outside the room on the tubs, the plantlets are allowed to adapt with the external environment. When the grown up plantlets become fresh and strong, they are once planted in soil in natural environment.

d "X" mentioned in the stem is photosynthesis which is necessary for living world. This is explained below —

Photosynthesis is the most important biochemical process in the world. Through the process, a bridge is developed between living things and sunlight. Only green plants can transform solar energy into chemical energy and store as food through photosynthesis. No animal can produce its food itself. The foods we eat such as rice, bread, fruits, vegetables, fish, meat, milk, egg etc., are directly or indirectly derived from green plants. So, all animals are completely dependent on green plants for their food, and the green plants produce food through the process of photosynthesis. The progress of human civilization is dependent on photosynthesis directly and indirectly. Foods, clothes, industrial materials (such as nylon, rayon, paper, cellulose, timber, rubber), medicine (such as quinine, morphine), and fuel coal, petrol, gas are produced from plants. So, if photosynthesis does not occur, human civilization would be ruined, and the living world would be destroyed. This is why photosynthesis is the most important biochemical process in the living world.

Ques. ▶ 15 'M' is a biotechnological process by which new characteristics are developed in living organism.

[RAJUK Uttara Model College, Dhaka]

- What is biodiversity? 1
- What does it mean by antibiosis? 2
- Describe the process 'M'. 3
- Explain how this process (M) play role in developing crops. 4

Answer to the question no. 15

a Biodiversity is the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.

b If the growth and development of any organism is partly or wholly interrupted by the biochemical substance produced by other organism or even the organism may die, then this process is called antibiosis.

c Process "M" mentioned in the stem is genetic engineering or recombinant DNA technology. The process is described below —

- DNA with desired gene is separated from donor organism. Then plasmid DNA is separated from a bacteria to use it as a carrier of the gene. Plasmid is an individual DNA besides the chromosome in bacteria cell, which is able to divide or able to self-replicate.

- In this step plasmid DNA and donor DNA are divided by a special enzyme. Desired gene is present in any of the part (location) of the donor DNA.
- Then donor DNA is placed in between the two terminal parts of a plasmid by lipase enzyme. Lipase here act as adhesive. As a result DNA recombinant forms with the specific desired gene. This recombinant plasmid now carries the desired part of donor DNA.
- In this stage the bacteria recombinant DNA emerges into receiver bacteria.

The method of emergence of donor's chopped DNA part into bacteria is called transgenic organism. A new species of bacteria or organism created due to transformation is called transgenic organism.

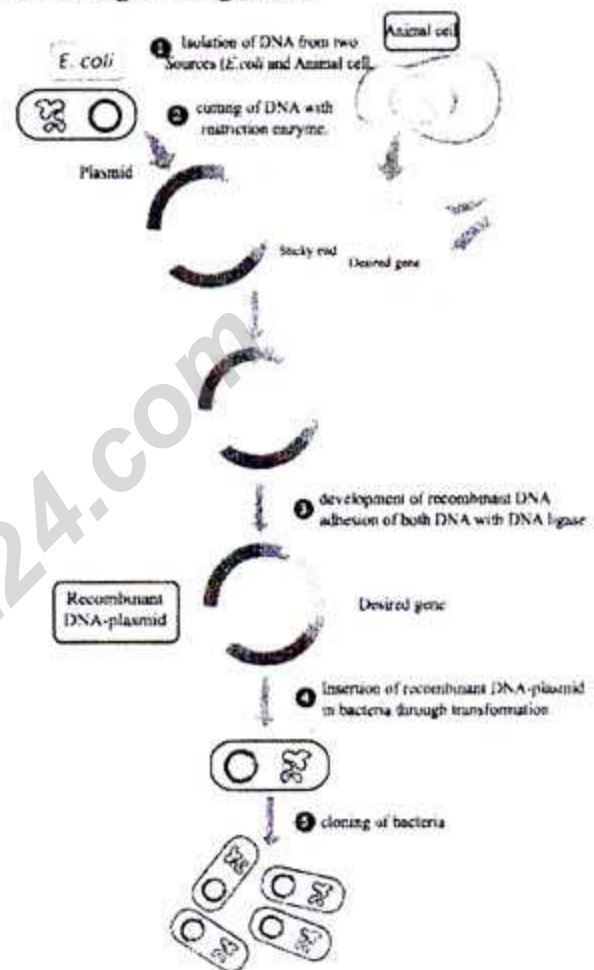


Fig: Recombinant DNA Technology

- In this stage bacteria with recombinant plasmid are identified and then separated.

Bacteria with desired genes are then made reproduce rapidly. Now each of these reproduced bacteria contain the desired gene. The process by which gene is reproduced is called gene cloning. To use the gene, plasmid is separated again.

d Process "M" mentioned in the stem is genetic engineering or recombinant DNA technology which plays an important role in developing crops. This is explained below —

Genetic engineering or recombinant DNA technology is the most modern biotechnology. The main objective of the technology is to develop organisms with new and advanced characteristics and by which human beings can be benefited. By this time, notable successes have already been achieved through this technology. Insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China). These crops are resistant to harmful insects under Lepidoptera and Coleoptera orders. Using this technology, virus-resistant varieties of crop have been developed, for instance by transferring the genes, tomato mosaic virus (ToMV), tobacco mosaic Virus (TMV) and tobacco mild green mosaic virus (TMGMV), resistant varieties of crop have been developed. The variety of papaya that is resistant to ring spot

virus (PRSV) has also been developed. Research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene. Varieties of corn and cotton tolerant to herbicides have been produced by genetic modification. Scientists have become able to develop herbicide tolerant tomatoes by transferring herbicide tolerant genes into the tomato from bacteria. This way herbicide tolerant varieties of soybean, corn, cotton, canola etc. have been produced. Through genetic engineering, more than one trait can be inserted into the same plant. Nowadays, this type of transgenic plants is commercially available. For instance, side by side both herbicide tolerant and insect-resistant characteristics have been inserted in corn and cotton. Through genetic change, the nutrition value of some crops has been improved. For example, vitamin A i.e. beta-carotene gene has been transferred into rice. Efforts to add iron to rice are being continued. Attempts are also made to develop salinity and drought-resistant varieties of crops through genetic modification.

Ques. ► 16 Look at the figures below and answer to the questions:

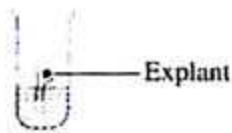


Fig. P



Fig. Q

[Milestone College, Dhaka]

- What is traction fiber? 1
- What is meant by synovial joint? 2
- Explain the technological steps related to Fig. P of the stem. 3
- 'The technology related to Fig. Q plays significant role in developing crops and animals'-Analyze. 4

Answer to the question no. 16

a Traction fiber is defined as a spindle fiber of a dividing cell that extends from a pole to the chromosomal centromere and along which a daughter chromosome moves to the pole of the spindle.

b A synovial joint is a connection between two bones consisting of a cartilage lined cavity filled with fluid. Synovial joints are the most flexible type of joint between bones, because the bones are not physically connected and can move more freely in relation to each other.

c Fig-P mentioned in the stem is tissue culture process. The technological steps of tissue culture are explained below —
Steps of tissue culture—

1. Selection of mother plant: The healthy, disease resistant plant with high quality is selected for plant tissue culture.

2. Preparation of culture medium: For the growth of the plant culture, culture media is made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semisolid state.

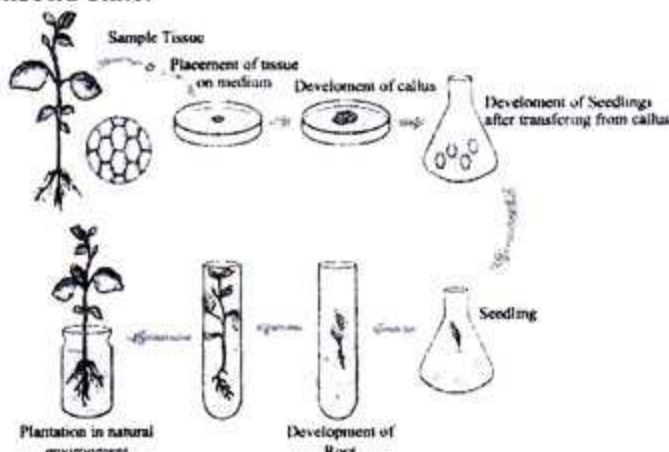


Fig: Steps of tissue culture.

3. Establishment of sterilized medium: Taking the culture medium in a glass container (test tube, conical flask), its opening is usually closed with a cotton plaque. Later in an autoclave machine, keeping it at the temperature of 121°C under 15—1b/sq. inch pressure for 20 minutes, the medium is sterilized. Then again after closing the mouth or opening the glass container, it is kept in a room with the controlling of light and temperature (25+2° C) for the growth of the explants. After the turning of the medium into a cold and semisolid state, explants are inoculated on it. In this stage, the tissue placed on the medium through repeated cell division turns directly into a plantlet or callus or a cluster of cells without differentiation.

4. Transfer in root developing medium: If no root is developed in the

plantlets by this time, then after attaining a definite height, shoots are cut and again placed in the root developing medium.

5. Transfer to natural environment or to field level: After washing with water and putting them outside the room on the tubs, the plantlets are allowed to adapt with the external environment. When the grown up plantlets become fresh and strong, they are once planted in soil in natural environment.

d Fig- Q mentioned in the stem is genetic engineering or recombinant DNA technology. This technology plays significant roles in developing crops and animals. This analysed below —
Genetic engineering or recombinant DNA technology is the most modern biotechnology. The main objective of the technology is to develop organisms with new and advanced characteristics and by which human beings can be benefited. By this time, notable successes have already been achieved through this technology.

a. In developing crops: Insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China). These crops are resistant to harmful insects under Lepidoptera and Coleoptera orders. Using this technology, virus resistant varieties of crop have been developed, for instance by transferring the genes, tomato mosaic virus (ToMV), tobacco mosaic Virus (TMV) and tobacco mild green mosaic virus (TMGMV), resistant varieties of crop have been developed. The variety of papaya that is resistant to ring spot virus (PRSV) has also been developed. Research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene. Varieties of corn and cotton tolerant to herbicides have been produced by genetic modification. Scientists have become able to develop herbicide tolerant tomatoes by transferring herbicide tolerant genes into the tomato from bacteria.

This way, herbicide tolerant varieties of soybean, corn, cotton, canola etc. have been produced. Through genetic engineering more than one trait can be inserted into the same plant. Nowadays, this type of transgenic plants is commercially available. For instance, side by side both herbicide tolerant and insect-resistant characteristics have been inserted in corn and cotton. Through genetic change, the nutrition value of some crops has been improved. For example, vitamin A i.e. beta-carotene gene has been transferred into rice. Efforts to add iron to rice are being continued. Attempts are also made to develop salinity and drought resistant varieties of crops through genetic modification.

b. In animals: In livestock, for example, transfer of the protein C gene has been done to increase the protein in cow-milk, though this is still in research level. Through genetic modification, genetic changes have been accomplished with sheep by transferring the growth hormone producing gene from human beings to it with the view of increasing its size and meat production. To improve the amount and quality of the sheep's fur, two bacterial genes, CysE and CysM, have been transferred to the genomes of sheep.

Ques. ► 17 In Jaidebpur BARI is working to develop a drought resistance variety. For that purpose the scientists have collected a drought resistance gene from a local rice variety of Satkhira.
[St. Joseph Higher Secondary School, Dhaka]

- What is assimilation? 1
- How light play important role in photosynthesis? 2
- Explain the structure of the main component of the stem mentioned collected part. 3
- Analyze with figure how scientists will do the stem indicated work. 4

Answer to the question no. 17

a Digested food substances are converted into the constituent of protoplasm is assimilation.

b The importance of light in photosynthesis is immense. For the production of carbohydrates from H_2O and CO_2 , the source of required energy is light. Sunlight takes part in the development of chlorophyll. With the effects of sunlight and stomata being opened, CO_2 can enter leaves, and take part in the production of food carbohydrates. The rate of photosynthesis increases with the increase of light up to a definite limit.

c The collected part in the stem is gene and it is a main component of chromosome in nucleus. A well-structured nucleus has the following parts:

- Nuclear membrane:** The membrane that encloses the nucleus is called nuclear membrane. It is a double-layered membrane, and composed of lipids and proteins.
- Nucleoplasm:** The jell-like fluid enveloped by nuclear membrane is called nucleoplasm.
- Nucleolus:** In a nucleus round shaped structure attached with a chromosome is called nucleolus. Its main function is to assemble ribosomes in a eukaryotic cell.
- Chromatin reticulum:** A mass of genetic material, composed of thread-like coiled structures, is called chromatin reticulum. Chromatin fibers get supercoiled during nuclear division and become more condensed, and then they are called chromosomes. Chromosomes contain genes and thus carry hereditary trait from generation to generation.

d The scientists will develop a drought-resistant variety of rice by collecting a drought-resistant gene from local rice variety. The process mentioned in the stem is recombinant DNA technology. By recombinant DNA technology organisms with expected characteristics can be possibly obtained. Some steps of this process have been explained below —

- DNA of desired characteristics is chosen.
- A carrier is selected by which the DNA of desired characteristics can be transmitted.
- The necessary restriction enzyme required for cutting the specific parts of the desired DNA and carrier's DNA are chosen.
- Ligase enzyme required for connecting the specific parts of the desired DNA and carrier's DNA are chosen.
- The DNA of the carrier with parts of the desired DNA is the recombinant DNA.
- Transgenic cells are made by inserting the recombinant DNA in the cells of the desired organism by a carrier.
- An organism with desired characteristics can be made from the transgenic cells through tissue culture.

Ques. ► 18 Maksudul Alam is a geneticist. He combines the genes of Jute of our local variety with that of developed variety. [Shaheed Bir Uttam Lt. Anwar Girls' College, Dhaka]

- What is plasmid? 1
- What do you mean by mutuallsm? 2
- Explain the work technique of Mr. Maqsdul with fig. 3
- "The technique of Mr. Maqsdul has contributed a lot in the agriculture and medical sector". Evaluate. 4

Answer to the question no. 18

a A plasmid is a small, circular, double-stranded DNA molecule that is distinct from a cell's chromosomal DNA.

b Mutualisms are defined as interactions between organisms of two different species, in which each organism benefits from

the interaction in some way. Sometimes mutualisms are symbiotic relationships. In such cases, the two species live in close proximity to each other for part or all of their lives; however, not all symbiotic relationships are mutualistic.

c The work technique of Mr. Maqsdul stated in the stem is genetic engineering. The technique is explained below — Genetic engineering or Recombinant DNA technology refers to the process of joining DNA molecules from two different sources and inserting them into a host organism, to generate products for human use. The steps of Recombinant DNA technology —

- DNA with desired gene is separated from donor organism. Then plasmid DNA is separated from a bacteria to use it as a carrier of the gene. Plasmid is an individual DNA besides the chromosome in bacteria cell, which is able to divide or able in self—division.
- In this step plasmid DNA and donor DNA are divided by a special enzyme. Desired gene is present in any of the part (location) of the donor DNA.
- Then donor DNA is placed in between the two terminal parts of a plasmid by lipase enzyme. Lipase here act as adhesive. As a result DNA recombinant forms with the specific desired gene. This recombinant plasmid now carries the desired part of donor DNA.
- In this stage the bacteria recombinant DNA emerges into receiver bacteria. The method of emergence of donor's chopped DNA part into bacteria is called transgenic organism. A new species of bacteria or organism created due to transformation is called transgenic organism.
- In this stage bacteria with recombinant plasmid are identified and then separated.

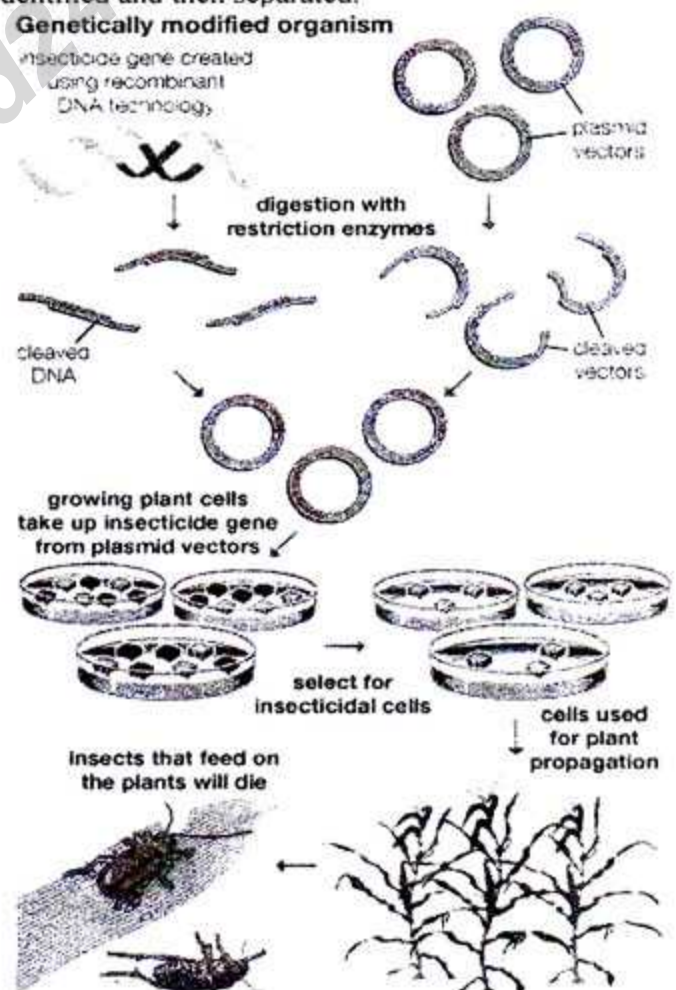


Fig: Recombinant DNA technology

Bacteria with desired genes are then made reproduce rapidly. Now each of these reproduced bacteria contain the desired gene. The process by which gene is reproduced is called gene cloning. To use the gene, plasmid is separated again.

d The work technique of Mr. Maqsdul stated in the stem is genetic engineering or recombinant DNA technology which has contributed a lot in the agriculture and medical sector. This is evaluated below —

Contribute in agriculture sector: Insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China). These crops are resistant to harmful insects under Lepidoptera and Coleoptera orders. Using this technology, virus resistant varieties of crop have been developed, for instance by transferring the genes, tomato mosaic virus (ToMV), tobacco mosaic virus (TMV) and tobacco mild green mosaic virus (TMGMV), resistant varieties of crop have been developed. The variety of papaya that is resistant to ring spot virus (PRSV) has also been developed. Research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene. Varieties of corn and cotton tolerant to herbicides have been produced by genetic modification. Scientists have become able to develop herbicide tolerant tomatoes by transferring herbicide tolerant genes into the tomato from bacteria. This way herbicide tolerant varieties of soybean, corn, cotton, canola etc. have been produced. Through genetic engineering more than one trait can be inserted into the same plant. Nowadays, this type of transgenic plants is commercially available. For instance, side by side both herbicide tolerant and insect-resistant characteristics have been inserted in corn and cotton. Through genetic change, the nutrition value of some crops has been improved. For example, vitamin A i.e. beta-carotene gene has been transferred into rice. Efforts to add iron to rice are being continued. Attempts are also made to develop salinity and drought resistant varieties of crops through genetic modification. In livestock, for example, transfer of the protein C gene has been done to increase the protein in cow-milk, though this is still in research level. Through genetic modification, genetic changes have been accomplished with sheep by transferring the growth hormone producing gene from human beings to it with the view of increasing its size and meat production. To improve the amount and quality of the sheep's fur, two bacterial genes, CysE and CysM, have been transferred to the genomes of sheep. Transfer of the growth hormone gene of Salmon fish, through genetic modification, to catfish, common carp, loitta fish, nilotica can increase the growth rate of the fishes by 60 percent.

Contribute in medical sector: Hepatitis b-virus vaccine is being produced from yeast through genetic modification. From genetically modified *E. coli* bacteria and yeast, insulin is being commercially produced for the treatment of diabetes by using the gene, which produces insulin in human body. Human growth hormone and components of the stimulant for accelerated growth of granulocytes macrophage colony are being produced from genetically modified *E. coli* bacteria and yeast, and these are respectively being used for dwarfism, viral disease, cancer, AIDS etc.

Ques. ► 19 Mahmud is a plant breeder. He produced the variety Z from the varieties X and Y of the following:

X → A disease resistant wild variety

Y → A disease susceptible cultivable variety

Z → A disease resistant cultivable variety

[Birshreshtha Noor Mohammad Public College, Dhaka]

- What is vernalization? 1
- Why is plastid called pigment forming organ? 2
- How can Z be produced form X and Y of the stem? Explain. 3
- 'The method adopted by Mahmud has added a new dimension in our agriculture' -Analyze the statement. 4

Answer to the question no. 19

a The acceleration of flowering of plants by applying chilling on them is called vernalization.

b Plastid is called pigment forming organ in plants because they are of different colors and found in plants. Green colored

plastids are called chloroplast. They are found in the cells of leaves, young stems and other green parts of a plant. Though the chloroplasts are colored, they are not green. The photosynthetic pigment xanthophyll, carotene, phycoerythrin, phycocyanin etc. are present in them, and so some of them are yellow, some others are blue and red.

c In the stem, X is disease resistant wild variety, Y is disease susceptible cultivable variety and Z is disease resistant cultivable variety. Z can be produced from X and Y in the following way:

- Selection of targeted DNA.
- Selection of a carrier so that transfer of the desired segment of DNA becomes possible.
- Selection of necessary restriction enzyme to chop the DNA molecule at a particular locus.
- Selection of DNA ligase enzyme to join the segments of DNA chopped.
- Selection of a host for the replication of carrier DNA with the segment of desired DNA.
- Evaluation of the expression of recombinant DNA prepared with the desired DNA segment.

d The method adopted by Mahmud is the method of genetic engineering. It has added a new dimension in our agriculture in the following way:

Harmful insects resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China) etc. For the insertion of bacterial genes named *Bacillus thuringiensis* into the crops, these genetically modified crops are designated as Bt corn. Using this technology, virus resistant varieties of crop have been developed, for instance by transferring gene, tomato mosaic virus (TOMV), tobacco mosaic virus (TMV) and tobacco mild green virus (TMGMV) resistant varieties of crop have been developed. The variety of papaya resistant to ringspot virus (PRSV) has also been developed. The research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene. Through genetic engineering, more than one trait can be inserted in the same plant. Nowadays, with no trouble this type of transgenic plants is commercially available. For instance, side by side both herbicides tolerant and insect resistant characters have been inserted in corn and cotton. Through genetic change, nutrition value of some crops has been improved. For example, vitamin i.e. beta-carotene gene has been transferred into rice. Taking efforts to add iron in rice is being continued. The attempts are also being made to develop salinity and drought-resistant varieties of different crops through genetic modification.

Ques. ► 20



Figure : M



Figure : N

[BAF Shaheen College, Kurmitola, Dhaka]

- What is Explant? 1
- Write the differences between traditional and genetic engineering method in reproduction. 2
- Mention significance of the process of Fig: N in getting new improved breed of plants. 3
- "Using process of Fig: M both plants and animals can be developed" justify the statement with examples. 4

Answer to the question no. 20

a The part of a plant, being separate with the view of using it in tissue culture, is called explant.

b Differences between traditional and genetic method in reproduction are given below-

It requires a long time to achieve desired results through the traditional way of reproduction. It is possible to obtain plants or animals or microorganisms with desired characteristics in a very short period of time with genetic engineering. In case of traditional reproduction, unexpected genes may be transferred with the desired gene and the successful transfer of the desired gene remains uncertain. In genetic engineering, there is no possibility of transferring unexpected genes and the transfer of the desired gene is certain.

c Fig- "N" mentioned in the stem is tissue culture. The significance of tissue culture in getting new improved breed of plants is given below —

Tissue culture technology is being used for the development of the plants of new characters. French scientist George Morel (1964) proved that it is possible to obtain 40 thousand plantlets from a meristem of the orchid plant named Cymbidium in a year. In natural way, only a limited number of Cymbidium plantlets are produced in a year. Nowadays, it has become a regular practice to make some plants free from viral diseases by culturing their meristems, such as potato tubers. In Malaysia the reproduction of palm oil is done through tissue culture. It is possible to obtain 44 crores of plantlets of Garland Chrysanthemum from a vegetative part of it through tissue culture. Plantlets of different types of pulses, groundnut, jute have also been produced. It has become possible to produce disease free plantlets and seed microtuber of potato applying tissue culture.

d Fig- "M" mentioned in the stem is recombinant DNA technology or genetic engineering. By using this process both plants and animals can be developed. This is analyzed below —

Insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice. These crops are resistant to harmful insects under Lepidoptera and Coleoptera orders. Using this technology, virus resistant varieties of crop have been developed, for instance by transferring the genes, tomato mosaic virus (ToMV), tobacco mosaic virus (TMV) and tobacco mild green mosaic virus (TMGMV), resistant varieties of crop have been developed. Scientists have become able to develop herbicide tolerant tomatoes by transferring herbicide tolerant genes into the tomato from bacteria. This way herbicide tolerant varieties of soybean, corn, cotton, canola etc. have been produced. Through genetic engineering, more than one trait can be inserted into the same plant. Nowadays, this type of transgenic plants is commercially available.

In livestock, for example, transfer of the protein C gene has been done to increase the protein in cow-milk, though this is still in research level. Through genetic modification, genetic changes have been accomplished with sheep by transferring the growth hormone producing gene from human beings to it with the view of increasing its size and meat production. To improve the amount and quality of the sheep's fur, two bacterial genes, CysE and CysM, have been transferred to the genomes of sheep.

Ques. ► 21 Abiba's father is a genetic engineer. One day Adiba wants to know about recombinant DNA to her father. Her father described in details about recombinant DNA and its contribution. *[BIAM Model School and College, Dhaka]*

- What is karyokinesis? 1
- Why mitochondria are called the power house of the cell? 2
- Describe the stages of process to transfer targeted characteristics by the above mentioned technology. 3
- Evaluate the contribution of stem mentioned technology in case of agriculture and health care. 4

Answer to the question no. 21

a Karyokinesis and cytokinesis represent the division of nucleus during cell division.

b A series of biochemical reactions of Kreb's cycle occur in mitochondria of a cell. In the process, energy is, ultimately, produced. This is why a mitochondrion is called 'the power house of a cell.'

c The stages of process to transfer targeted characteristics by 'Recombinant DNA' technology is given below,

- Selection of targeted DNA.
- Selection of a carrier so that the transfer of desired segment of DNA becomes possible.
- Selection of necessary restriction enzyme (special type of enzyme to cut DNA) to chop the DNA molecule at a particular locus.
- Selection of DNA ligase enzyme to join the segments of DNA chopped.
- Selection of a host for the replication of the carrier DNA with the segment of desired DNA.
- Evaluation of the expression of recombinant DNA prepared with the desired DNA segment.

d Importance of genetic engineering in agriculture and healthcare: Harmful insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton. Again, Tomato mosaic virus (ToMV), tobacco mosaic virus (TMV), variety of papaya resistant to ring spot varieties of crop have been developed. The research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene.

Hepatitis b-virus vaccine is being produced from yeast through genetic modification. From genetically modified *E. coli* bacteria and yeast, insulin is being commercially produced for the treatment of the diabetes disease by using the gene, which produces insulin in human body. Again, *E. Coli* being used for dwarfism, viral disease, cancer, AIDS etc.

Ques. ► 22 Grass → Grasshopper → Frog → Snake → Hawk *[BIAM Model School And College, Dhaka]*

- What is osteoblast? 1
- Why transpiration is called necessary evil? 2
- How energy flow in the above mentioned stem? 3
- Eco system will be changed due to absent of first organism of the stem. Explain it. 4

Answer to the question no. 22

a Bone forming cells are called osteoblast

b Transpiration is essential for plants. But high rate of transpiration is harmful for the plant. Thus, transpiration is said to be 'necessary evil'

c The sun is the main source of energy in any ecosystem. Only 2% of the received energy is stored through the photosynthesis done by grass primarily in the ecosystem. This energy, reaches grasshopper through the food chain. Then frog, snake, hawk receives a decreased amount of the energy successively through the food chain. Lastly, the energy again comes back to the environment by the terminal acts of the decomposers.

d Ecosystem means any unit of landscape where there are non-living substances, food producing green plants, animals dependent on plants and many more microorganisms for the disintegration

of the dead bodies of organisms, and a proper interrelation between these elements exists. **Producers (grass)** in presence of sunlight obtaining carbon dioxide from the air and absorbing water from the soil, produce their chief food carbohydrates. At this time oxygen is produced as a by-product. The whole living world directly or indirectly depends on this photosynthesis process and production of carbohydrate.

Moreover, the non-green plants in many way depend on green plants for the maintenance of their life. Thus, in absence of grass the total ecosystem will fall.

Ques. ▶ 23

Fig- P

[Rajshahi Cantonment Public School and College, Rajshahi]

- What is transformation? 1
- What do you mean by unidirectional energy flow of eco system? 2
- Explain the steps of preparation of 'P' through figure? 3
- Analyze the importance of 'P' in agriculture. 4

Answer to the question no. 23

a Microorganisms are called transformers. Transformation is the process of decomposition of plants and animals waste, dead bodies into food components.

b Energy flow can never be turned opposite. About 80% to 90% energy is reduced in every stage of food chain. The more a food chain is long the more energy would be reduced in higher tropic level and at one stage there would be no remaining energy. Thus, energy flow is unidirectional.

c The stages of process to transfer targeted characteristics by 'Recombinant DNA' technology is given below,

- Selection of targetted DNA.
- Selection of a carrier so that the transfer of desired segment of DNA becomes possible.
- Selection of necessary restriction enzyme (special type of enzyme to cut DNA) to chop the DNA molecule at a particular locus.
- Selection of DNA ligase enzyme to join the segments of DNA chopped.
- Selection of a host for the replication of the carrier DNA with the segment of desired DNA.
- Evaluation of the expression of recombinant DNA prepared with the desired DNA segment.

d **Importance of Genetic engineering (P) in agriculture:**

Harmful insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China) etc. These fruits are resistant to the harmful insects under Lepidoptera and Coleoptera orders. For the insertion of bacterial genes named *Bacillus thuringiensis* into the crops, these genetically modified crops are designated as Bt corn. Tomato mosaic virus (ToMV), tobacco mosaic virus (TMV) and tobacco mild green virus (TMGMV) resistant varieties of crop have been developed. Scientists have become able to develop herbicides tolerant variety of tomato. The variety of papaya resistant to ring spot virus (PRSV) has also been developed. The research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene.

Ques. ▶ 24 Rahim is a biotechnologist. In laboratory he put an explain on nutrient media and observe a mass of cell growing from it.

[BIAM Laboratory School and College, Bogura]

- What is plasmid? 1
- What do you mean by genetic engineering? 2
- Describe the cell division process that occurred in the explants. 3
- The occurrence mentioned in stem is part of a procedure. Explain the achievements of the procedure with example. 4

Answer to the question no. 24

a A plasmid is a small, circular, double-stranded DNA molecule that is distinct from a cell's chromosomal DNA.

b Genetic engineering, also called genetic modification, is the direct manipulation of an organism's genome using biotechnology. With this technology, the transfer of the desired

part of DNA from bacteria to human being, from plant to animal and from animal to plant have become possible. The organism with the new characters is called GMO (genetically modified organism).

c The cell division that occurred in the stem is called mitosis cell division.

Mitosis is a type of cell division that results in formation of two daughter cells each having the same number and kind of chromosomes as the parent nucleus. Mitosis contains the following stages —

- Prophase:** At the onset of the stage, the nucleus becomes little larger and chromatin fibers start condensing into short, thick and tightly coiled structures called chromosomes.
- Pro-metaphase:** At the very early time of the stage, spindle apparatus having two poles is developed. The middle plane of the spindle apparatus is called equator. Kinetochores are protein structures assembled on centromeres and link the chromosomes with mitotic spindles. The nuclear membrane and nucleolus being disintegrated begin to disappear. In animal cells, aster rays are seen.
- Metaphase:** The centromere of each chromosome remains on the equator but the two arms take position towards the poles. In this stage, chromosomes look the shortest and thick. At the late of the stage, division of centromere starts. Nuclear membrane and nucleolus disappear completely.
- Anaphase:** Each chromosome splitting into two moves to two poles, and so the number of chromosome remains unchanged. On the position of the centromere in the chromosome, chromosomes look V, L, J or I shaped.
- Telophase:** Chromosomes being de-condensed and surrounded by new nuclei elongate back into thin and long structures called chromatin fibers. Nucleolus also reappears. So, ultimately, two new nuclei are formed in two poles. The spindle apparatus is disintegrated and so, spindle fibers gradually disappear.

d The experiment conducted in the laboratory by Rahim is named as tissue culture.

The process of growing a tissue on a nourishing and sterilized medium is tissue culture. Plant tissue culture is a collection of techniques used to maintain or grow plant cells, tissues or organs (like pollen, apical or lateral bud, node, root) under sterile conditions on a nutrient culture medium of the known composition.

The achievements of tissue culture are-

- Innumerable plantlets can be produced with the same characters from one single plant,
- Disease-free plants are produced
- Rare species can be preserved and be saved from extinction.
- New characters in plants can be developed.
- The plants, which do not produce endosperm, can be developed directly by culturing their embryo.
- Different products like oil, perfume etc. can be made using tissue culture.
- Plants can be adapted to any environment using tissue culture rather than growing them in their native area.
- Disease and pest resistant plantlets are being developed i.e. potato, banana.
- Rapid afforestation is done by producing a large number of saplings of different plants through tissue culture.

Thus tissue culture has helped us achieve a lot of success.

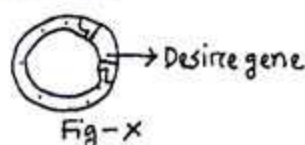
Ques. ▶ 25

Fig-X

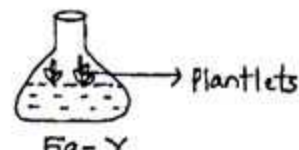


Fig-Y

[Sirajganj Collectorate School and College, Sirajganj]

- What is producer? 1
- What is the cause of Bacteria's involvement into Kingdom Monera? Explain. 2
- Describe the procedure of Figure X. 3
- Analyse the importance of the technology of the mentioned figure Y. 4

Answer to the question no. 25

a Producers of an ecosystem are the ones who prepare food on their own:

b Bacteria is included in the Monera kingdom because —

- Bacteria is prokaryotic
- They contain no membrane-bound organelles
- They have ribosomes
- Usually undergoes reproduction by amitosis cell division.

c The figure X represents a recombinant DNA, which can be made following the steps —

- Selecting the DNA of interest
- Choosing the best carrier, in which it is possible to transfer the DNA of interest
- Selecting the suitable restriction enzyme to cut the DNA at the desired place
- Selecting a suitable ligase enzyme to perform the joining of carrier and the DNA of interest
- Choosing a suitable host in which the recombinant DNA can replicate
- Evaluating the expression of the recombinant DNA

d Figure Y of the stem shows tissue culture technology.

It is possible to prepare plant seedlings in the laboratory throughout the year using tissue culture technology. As aseptic conditions are maintained in the lab, so the seedlings remain germ and disease free which keeps them healthy.

The yield of plants is greater in this technique and requires minimum labor and time. There are a variety of plants which do not produce offspring via seeds. Tissue culture helps save those species. Besides, one can earn huge foreign currency by producing medicinal plant seedlings, orchid seedlings etc. and importing them to abroad. It is also possible to save extinct species via tissue culture.

So tissue culture has immense possibilities and importance.

Ques. ▶ 26 Titir found a very good variety of wood apple visiting her friend's house. To produce the plantlets of exact characters, she brought some lateral buds of the plant and produce them in her university lab of botany department.

[Dinajpur Laboratory School and College, Dinajpur]

- What is callus? 1
- What do you mean by Tissue culture? 2
- Explain which Biotechnology can possible to save Titir's farm plant from extinct. 3
- Briefly discuss the consecutive steps of stem mention culture. 4

Answer to the question no. 26

a Callus is an unorganized cluster of cells that is developed during tissue culture technique, through cell division and without any kind of cell differentiation.

b Tissue culture is a process of growing a tissue on a nourishing and sterilized medium. For plant tissue culture pollen, apical or lateral bud, node, root etc. parts of explant are cultured on or in any nourishing and sterilized medium where all the elements for the nutrition and growth of tissue are already supplemented.

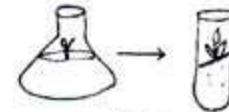
c **Biotechnology to save plants from extinction:** In the whole tissue culture technique, plantlets with identical characteristics can be developed within a reduced timeframe, this technique helps to address the issue of near extinction plants. Some available plants in nature, which are now facing the threat of extinction, are unable to produce endosperm. This problem can be solved directly by culturing their embryo. The rapid multiplication of the plants, which do not reproduce

through sexual reproduction or of which rate of natural reproduction is low, can be done by culturing their embryo.

d **Steps of tissue culture**

- Selection of mother plant:** The healthy, disease resistant plant with high quality is selected for plant tissue culture.
- Preparation of culture medium:** For the growth of the plant culture, culture media are made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semisolid state.
- Establishment of sterilized medium:** Taking the culture medium in a glass container (test tube, conical flask), its opening is usually closed with a cotton plaque. Later in an autoclave machine, keeping it at the temperature of 121°C under 15-lb/sq.-inch pressure for 20 minutes, the medium is sterilized. After the turning of the medium into a cold and semi-solid state, explants are inoculated on it. Then again after closing the mouth or opening the glass container, it is kept in a room with the controlling of light and temperature (25+2°C) for the growth of the explants. In this stage, the tissue placed on the medium through repeated cell division turns directly into a plantlet or callus or a cluster of cells without differentiation.
- Transfer in root developing medium:** If no root is developed in the plantlets by this time, then after attaining a definite height, shoots are cut and again placed in the root developing medium.
- Transfer to natural environment or to field level:** After washing with water and putting them outside the room on the tubs, the plantlets are allowed to adapt with the external environment. When the grown up plantlets become fresh and strong, they are once planted in soil in natural environment.

Ques. ▶ 27



[Mainamati International School, Cumilla]

- What is recombinant DNA technology? 1
- What do you mean by commensalism? 2
- Explain the consecutive steps of above mentioned figure. 3
- Analyze the significance of the above process in agriculture sector. 4

Answer to the question no. 27

a **Recombinant DNA technology:** To acquire certain desired characteristics, when DNA or genes from different organisms are joined together, is known as recombinant DNA technology.

b **Commensalism:** Commensalism is an ecological interaction where only one gets benefited. Though the other associate is not benefited, it does not lose anything. Such as creeper plant with its root is anchored in the soil and creeps up around a big tree. This way it collects sufficient amount of light by spreading on another plant. Woody creeper does not depend on the plant that is providing shelter for it for food and does not do any harm to it. Epiphytic plants collect food from the air but do not do any harm to the plant providing shelter. Some algae dwell in bodies of other plants but do not do any harm to them.

c The figures in the stem indicate the tissue culture process. Steps of tissue culture process are given below:

- Selection of mother plant:** The healthy, disease resistant plant with high quality is selected for plant tissue culture.
- Preparation of culture medium:** For the growth of the plant culture, culture media are made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semisolid state.

3. **Establishment of sterilized medium:** Taking the culture medium in a glass container (test tube, conical flask), its opening is usually closed with a cotton plaque. Later in an autoclave machine, keeping it at the temperature of 121°C under 15-lb/sq.-inch pressure for 20 minutes, the medium is sterilized. After the turning of the medium into a cold and semi-solid state, explants are inoculated on it. Then again after closing the mouth or opening the glass container, it is kept in a room with the controlling of light and temperature (25+2°C) for the growth of the explants. In this stage, the tissue placed on the medium through repeated cell division turns directly into a plantlet or callus or a cluster of cells without differentiation.
4. **Transfer in root developing medium:** If no root is developed in the plantlets by this time, then after attaining a definite height, shoots are cut and again placed in the root developing medium.
5. **Transfer to natural environment or to field level:** After washing with water and putting them outside the room on the tubs, the plantlets are allowed to adapt with the external environment. When the grown-up plantlets become fresh and strong, they are once planted in soil in natural environment.

d Significance of tissue culture in agriculture:

1. By utilizing the tissue culture, nowadays in the reproduction of plants and in the field of developing a new variety.
2. From the plant part in a short period of time, innumerable plantlets can be produced with the same characters. Easily disease free and especially free from viruses, plantlets can be produced. It can be free from the limitation of producing plantlets in the specific season. As the facility of producing plantlets in a short period of time in a very conspicuous place, a sufficient number of plantlets can be produced and the problem of storing of seeds can be avoided. The attainment of plantlets of those plants which do not reproduce by seeds and they can be speedily transferred in a short period of time in fresh condition.
3. Tissue culture technology is well accredited for the production and conservation of the species about to be extinct. The plants, which do not produce endosperm, can be developed directly by culturing their embryo. The rapid multiplication of the plants, which do not reproduce through sexual reproduction or of which rate of natural reproduction is low, can be done by culturing their embryo.
4. Tissue culture technology is being used for the development of the plants of new characters. French scientist George Morel (1964) proved that it is possible to obtain 40 thousand plantlets from a meristem of the orchid plant named *Cymbidium* in a year. In 1952 the scientist named Martin obtained disease free Dalia and Potato plant by culturing meristems of them. Nowadays, it has become a regular practice to make some plants free from viral diseases by culturing their meristems, such as potato tubers.
5. In Malaysia, the reproduction of palm oil is done through tissue culture. It is possible to obtain 88 crores of plantlets of Garland of Chrysanthemum from a vegetative part of it through tissue culture. By the hybridization in between different species and varieties of Iris, it has become possible to grow more plantlets of it in a year instead of 2/3 years. Commercially the perfume atar is being produced from the suspension of *Jasminum* using this technology in many different countries
6. Through tissue culture, not only the reproduction of this plant has become possible but also it has been changed to a level to adapt to the climate of India. In Bangladesh by this time much more successes have been made through tissue culture, such as it has become possible to produce the

plantlets of different orchids grown in the country and in other countries. Disease resistant and high yielding plantlets of banana, wood apple, jackfruit have been produced. Garland chrysanthemum, gladiolus, lily, garden carnation etc. flower producing plantlets also have been produced.

Ques. ▶ 28 Micropropagation is used to produce improved quality of plants. This has developed the agricultural fields of Bangladesh. [Cantonment English School and College, Chattogram]

- a. What is explant? 1
- b. What do you mean by recombinant DNA? 2
- c. Show the stages of the above. 3
- d. The process is significant for the agricultural fields-explain. 4

Answer to the question no. 28

a The healthy part of a plant which is separated from the plant with the view of using it in tissue culture, is called explant.

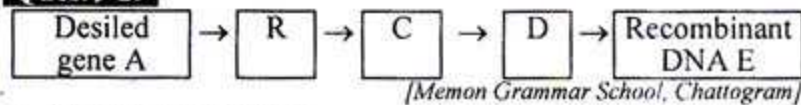
b Recombinant DNA technology refers to the joining of two DNA molecules from different species that are inserted into a host organism to produce new genetic combinations that are of value to science, medicine, agriculture, and industry. Recombinant DNA is a very important tool in genetic engineering.

c Micropropagation is the laboratory technique for rapid propagation of plants using tissue culture. This process saves the time requires to grow a plantlet in conventional ways. Steps of micropropagation is described below —

1. One healthy disease-free mother plant is selected to use its parts as explant.
2. The culture medium is prepared by mixing essential minerals, vitamins, phytohormones and an energy source sucrose in proper proportion and then to this medium agar is added to make the medium semisolid so that the plantlets can grow on it.
3. The medium is autoclaved to make it free from all germs. The explant is then cut into small segments, made germ free and placed in the culture vessels (tubes or conical flasks). This process is called inoculation.
4. Inoculated culture vessels are kept in growth chamber at controlled temperature and light condition. In this condition, the tissue of the explant divide rapidly and form an undifferentiated mass known as the callus.
5. The callus is then sub-cultured in a modified medium for shoot and root development and differentiation. All these steps are done in aseptic condition.
6. When shoot develops, the growing plantlets are separated from each other and placed on another modified medium for rooting. Roots develop quickly and complete plantlets are produced.
7. After attaining a proper size the plantlets are taken out of culture vessel and quarantined in pots.
8. Finally the plantlets are transferred to cultivation field.

d Plant tissue in small amounts is sufficient for the production of millions of clones in a year using micropropagation. It would take a great deal of time to produce an equal number of plants using conventional methods.

- The technique of micropropagation provides a good alternative for those plant species that show resistance to practices of conventional bulk propagation.
- Plants in large numbers can be produced in a short period.
- Large amounts of plants can be maintained in small spaces. This helps to save endangered species.
- Disease-free plant varieties are obtained through this technique.
- There is no more seasonal fruits or crops, any fruit or crop can be grown at any time of the year.
- Yield of crops is improved.
- The micropropagation technique is also useful for seed production in certain crops

Ques. ► 29

- What is imbibition? 1
- Why meiosis important in maintaining genetic stability? 2
- Describe the process from A to E in brief as mentioned at the stem. 3
- The process mentioned above has great influence in crop development and agriculture – analyse. 4

Answer to the question no. 29

a The special process of absorbing liquid by dry or half-dry colloidal substance is known as imbibition.

b Because of meiosis, the chromosome number in organisms remains constant. So generation after generation, the number of chromosomes remains the same in the cells of the body of offspring. Besides, genetic diversity is also found in species of organisms as the exchange of genes occurs during meiosis. Thus genetic stability is maintained.

c The process mentioned in the stem is genetic engineering. The process is described stepwise below:

- Desired gene A is chosen.
- A carrier is selected by which the DNA of desired characteristics can be transmitted. It is the step R.
- The necessary restriction enzyme required for cutting the specific parts of the desired DNA and carrier's DNA are chosen. It is the step C.
- Ligase enzyme required for connecting the specific parts of the desired DNA and carrier's DNA are chosen. It is the step D.
- The DNA of the carrier with parts of the desired DNA is the recombinant DNA E.

d The above process which is genetic engineering has great influence in crop development and agriculture.

Genetic engineering has played significant role in agriculture. Harmful insects resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China) etc. Using this technology, virus resistant varieties of crop have been developed, for instance by transferring gene, tomato mosaic virus (ToMV), tobacco mosaic virus (TMV) and tobacco mild green virus (TMGMV) resistant varieties of crop have been developed. The variety of papaya resistant to ring spot virus (PRSV) has also been developed. The research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene. Varieties of corn and cotton tolerant to herbicides have been produced by genetic modification.

Ques. ► 30 Arman is a biotechnologist. In laboratory he pull an explants in nutrient media and observed a mass of cell grow in from it. [Jalalabad Cantonment Public School and College, Sylhet]

- What is GMO? 1
- Why Bacterial DNA is known as plasmid DNA? 2
- Explain the cell division process that occurred in explants. 3
- Analyze the achievement of the procedure with example which is mentioned in above stem. 4

Answer to the Question no. 30

a GMO is genetically modified organism.

b Bacterial DNA is called plasmid DNA. Plasmids are short, circular extra chromosomal DNA. These plasmids are capable of replicating themselves inside a bacterial cell. A plasmid DNA is selected to be used as a vector or carrier for multiplication of the gene in genetic engineering.

c The cell division that occurred in the explants is called mitosis cell division.

Mitosis is a type of cell division that results in formation of two daughter cells each having the same number and kind of chromosomes as the parent nucleus. Mitosis contains the following stages —

i. Prophase: At the onset of the stage, the nucleus becomes little larger and chromatin fibers start condensing into short, thick and tightly coiled structures called chromosomes.

ii. Pro-metaphase: At the very early time of the stage, spindle apparatus having two poles is developed. The middle plane of the spindle apparatus is called equator. Kinetochores are protein structures assembled on centromeres and link the chromosomes with mitotic spindles. The nuclear membrane and nucleolus being disintegrated begin to disappear. In animal cells, aster rays are seen.

iii. Metaphase: The centromere of each chromosome remains on the equator but the two arms take position towards the poles. In this stage, chromosomes look the shortest and thick. At the late of the stage, division of centromere starts. Nuclear membrane and nucleolus disappear completely.

iv. Anaphase: Each chromosome splitting into two moves to two poles, and so the number of chromosome remains unchanged. On the position of the centromere in the chromosome, chromosomes look V, L, J or I shaped.

v. Telophase: Chromosomes being de-condensed and surrounded by new nuclei elongate back into thin and long structures called chromatin fibers. Nucleolus also reappears. So, ultimately, two new nuclei are formed in two poles. The spindle apparatus is disintegrated and so, spindle fibers gradually disappear.

d The experiment conducted in the laboratory by Arman is named as tissue culture.

The process of growing a tissue on a nourishing and sterilized medium is tissue culture. Plant tissue culture is a collection of techniques used to maintain or grow plant cells, tissues or organs (like pollen, apical or lateral bud, node, root) under sterile conditions on a nutrient culture medium of the known composition.

The achievements of tissue culture are

- Innumerable plantlets can be produced with the same characters from one single plant,
- Disease-free plants are produced
- Rare species can be preserved and be saved from extinction.
- New characters in plants can be developed.
- The plants, which do not produce endosperm, can be developed directly by culturing their embryo.
- Different products like oil, perfume etc. can be made using tissue culture.
- Plants can be adapted to any environment using tissue culture rather than growing them in their native area.
- Disease and pest resistant plantlets are being developed i.e. potato, banana.
- Rapid afforestation is done by producing a large number of saplings of different plants through tissue culture.

Thus tissue culture has helped us achieve a lot of success.

Ques. ► 31 Lily has palm trees of rare species in her farm that do not produce flower and fruit nowadays. She noticed that the growth of cows and goats has been reduced in her farm. One day in an agriculture related T.V programme Lily found that her problem can be solved by changing hereditary elements.

[SCHOLARSHOME, Sylhet]

- What is evolution? 1
- Explain natural selection. 2
- Explain which Biotechnology can be applied to save the plants in Lily's farm from being extinct. 3
- To solve the last problem indicated in the stem, which technology is useful?— Analyze your answer. 4

Answer to the question no. 31

a Evolution is the gradual development of life and organisms over successive generations on earth.

b Natural selection is the process where organisms with favorable traits are more likely to reproduce. In doing so, they pass on these traits to the next generation. Over time this process allows organisms to adapt to their environment.

c Tissue culture can be applied to save the plants in Lily's farm from being extinct. This analyzed below —

Tissue culture is a collection of techniques used to maintain or grow plant cells, tissues or organs under sterile conditions on a nutrient culture medium of known composition. Plant tissue culture is widely used to produce clones of a plant in a method known as micro propagation. Different techniques in plant tissue culture may offer certain advantages over traditional methods of propagation, including:

- The production of exact copies of plants that produce particularly good flowers, fruits, or have other desirable traits.
- To quickly produce mature plants.
- The production of multiples of plants in the absence of seeds or necessary pollinators to produce seeds.
- The regeneration of whole plants from plant cells that have been genetically modified.
- The production of plants in sterile containers that allows them to be moved with greatly reduced chances of transmitting diseases, pests, and pathogens.
- The production of plants from seeds that otherwise have very low chances of germinating and growing, i.e.: *orchids* and *Nepenthes*.
- To clear particular plants of viral and other infections and to quickly multiply these plants as 'cleaned stock' for horticulture and agriculture.

Plant tissue culture relies on the fact that many plant cells have the ability to regenerate a whole plant (totipotency). Single cells, plant cells without cell walls (protoplasts), pieces of leaves, stems or roots can often be used to generate a new plant on culture media given the required nutrients and plant hormones.

d To solve the last problem indicated in the stem, recombinant DNA technology is useful. This analyzed below —

Recombinant DNA technology is a area of biotechnology that will have significant impact on animal agriculture. Applications to animal agriculture can be expected in animal health management, improved crops and feeds, manipulation of animal physiology, and genetic improvement of livestock species. Improved diagnostic reagents and vaccines that will improve herd health are currently under development. Yield of crop plants such as corn will be increased and the nutritional value of these feeds improved through applications of recombinant DNA technology. Administration of exogenous hormones synthesized by bacteria holds great promise for increasing the yield of milk and possibly meat. Research on the transfer of cloned genes into animals has progressed rapidly and has recently been accomplished in sheep and swine. Tissue-specific and developmentally regulated expression of transferred genes now seems possible with defined gene promoter sequences. In livestock, for example, transfer of the protein C gene has been done to increase the protein in cow-milk, though this is still in research level. Through genetic modification, genetic changes have been accomplished with sheep by transferring the growth hormone producing gene from human beings to it with the view of increasing its size and meat production. To improve the amount and quality of the sheep's fur, two bacterial genes, CysE and CysM, have been transferred to the genomes of sheep.

Ques. ▶ 32 Pay heed to the figure and answer the following questions:

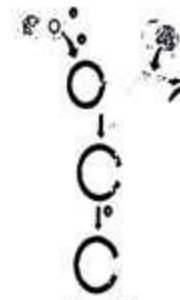


Fig : X

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- a. What is explant? 1
- b. Write the process to prepare a culture medium for tissue culture. 2
- c. Discuss of the preparation of DNA of GMO by the above process. 3
- d. Discuss the roles of genetic engineering in improving crops. 4

Answer to the question no. 32

a The part of a plant, being separate with the view of using it in tissue culture, is called explants.

b **Preparation of culture medium:** For the growth of the plant culture, culture media are made by mixing proper amount of essential mineral nutrients, vitamins, phytohormones, sucrose and condensing substance agar to bring the medium to a semisolid state.

c **Stages of the preparation of DNA of genetically Modified Organism (GMO):**

1. Selection of targetted DNA.
2. Selection of a carrier so that the transfer of desired segment of DNA becomes possible.
3. Selection of necessary restriction enzyme (special type of enzyme to cut DNA) to chop the DNA molecule at a particular locus.
4. Selection of DNA ligase enzyme to join the segments of DNA chopped.
5. Selection of a host for the replication of the carrier DNA with the segment of desired DNA.
6. Evaluation of the expression of recombinant DNA prepared with the desired DNA segment.

d **Genetic engineering in developing crops:**

1. Harmful insect resistant varieties of crops have been developed, such as Bt corn, Bt cotton, Bt rice (developed in China) etc. These fruits are resistant to the harmful insects under Lepidoptera and Coleoptera orders. For the insertion of bacterial genes named *Bacillus thuringiensis* into the crops, these genetically modified crops are designated as Bt corn.
2. Tomato mosaic virus (ToMV), tobacco mosaic virus (TMV) and tobacco mild green virus (TMGMV) resistant varieties of crop have been developed. Scientists have become able to develop herbicides tolerant variety of tomato.
3. The variety of papaya resistant to ring spot virus (PRSV) has also been developed.
4. The research is being carried out for the development of late blight resistant variety of potato by transferring late blight fungus resistant gene.
5. Varieties of corn and cotton tolerant to herbicides have been produced by genetic modification.
6. Herbicides tolerant varieties of soybean, corn, cotton, canola etc. have been produced.