4. Enhancement in Food Production

4.0 : Introduction

Q.1. How has plant breeding helped India to fulfill the national requirement of food ?

Ans: Plant breeding technology has helped in bringing about green revolution in India to fulfill the national requirement of food production.

Q.2. Name the branches of biology that are used in plant breeding methods.

Ans: Plant breeding methods involve use of genetics, molecular biology and tissue culture techniques for developing plants with desired traits.

4.1 : Plant Breeding

Q.3. Define plant breeding. What are the objectives of plant breeding ?

Ans: Plant breeding is an applied branch of Botany which involves collective use of art and science for changing and improving the heredity of plants in order to create desired types.

Objectives/Need of plant breeding :

i) To develop desired plants that are better suited for cultivation, give better yield and are disease resistant.

ii) To develop plants with improved quality.

iii) To produce plants that have increased tolerance limits to environmental stresses like drought, salinity, etc.

iv) To develop plants which are resistant to pathogens and pests.

Q.4. What is plant breeding? Describe various steps involved in classical breeding of plants.

Ans: Plant breeding : Plant breeding is an applied branch of Botany which involves collective use of art and science for changing and improving the heredity of plants in order to create desired types.

The main steps in breeding a new genetic variety of a crop are :

i) Collection of variability :

Variations are the differences seen among individuals of a species or population, for a particular character. Genetic variation is the source of raw material for selection. Collection and preservation of all the different wild varieties, species and relatives of cultivated species is done for the exploitation of natural genes available in the population. All such collected genes are effectively exploited for the plant breeding programmes. Genetic variations can be created by germplasm collection which is an entire collection of plants and seeds having all the diverse alleles for all genes in a particular crop.

ii) Evaluation and selection of parents :

The germplasm is evaluated for identifying plants with desirable combination of characters. Such identified plants are selected and then used in the process of hybridisation. Purelines are created whenever desirable and possible.

iii) Hybridization among the selected parents :

Hybridization is the crossing of two plants differing from each other genotypically in one or more traits. Selection cannot bring out anything which is not already in genes. It only helps to isolate the good genes, but fails to make the genes better. Useful characters are usually present scattered in different races, varieties, etc. Only by hybridization, it is possible to combine all the characters in a single variety. Its main objectives are:

a. To produce a single variety having combination of good characters.

b. To exploit and utilize the hybrid vigour.

c. To increase and generate the genetic variations through recombinations.

iv) Selection and selting of superior recombinants :

This step involves selection of only those plants from the progeny of hybrids, that have the desired combinations of characters. The plants which are superior to both the parents and exhibit hybrid vigour are collected. These plants are self-pollinated for a number of generations till they become homozygous for the trait. Due to this, plants attain a state of uniformity and characters do not segregate in the progeny. Such plants are called pure lines.

v) Testing and release of a new variety :

The newly developed variety undergoes critical evaluation for yield, quality, resistance to diseases and insect pests, etc. before it is released as a new variety for cultivation. This step of evaluation is carried out by Indian Council of Agricultural Research (ICAR), New Delhi. The varieties developed by different breeders are evaluated together at several locations in different agroclimatic zones of the country. The performance of the new varieties is compared with that of the existing varieties and also with one another. The variety that is superior to the existing varieties and also to the other new varieties under testing is chosen for release as a new variety under a new name with the permission of the government.

Q.5. What is domestication ?

Ans: Domestication is the process of bringing a species under human management. All our major food crops represent domesticated varieties.

Additional information

Q.6. What is hybridization? Explain the steps involved in hybridization.

Ans: Hybridization: It is the process of crossing two plants differing from each other genotypically in one or more traits.

Hybridization involves the following steps:

i) Selection and isolation of parents :

Here, two healthy plants with desirable characters are selected.

Then, parent plants are grown separately on isolated plots to avoid cross pollination. Self pollination is carried out in both the parents to produce inbreds. Self pollination is done for 6-8 generations till the majority of plants become homozygous and true breeding. The last generation of both the parents are used for further steps of hybridisation.

ii) Emasculation : It is the removal of stamens from one of the parents (if bisexual) before they release their pollen grains. It is done by the following methods :

a) Hand method b) Hot water or alcohol method

Importance of emasculation: It prevents self-pollination.

iii) Bagging: Soon after emasculation, the flowers are covered by polythene bags to prevent crosspollination by undesired pollen grains. The bags are tied at the base of the flower or inflorescence.

iv) Collection of pollen grains: At maturity, pollens from other non-emasculated selected parent plants are collected in dry bags.

v) Crossing: Fresh pollen should be used for crossing. In wheat and oats, the pollen viability is only of few minutes. When the stigma of emasculated flower matures, the polythene bag is removed and stigma is dusted with stored pollen grains. It is advisable to perform crossing early in the morning as in most of the crops, stigma becomes receptive at different times in the morning.

vi) Tagging : A tag with relevant information is attached with plants. A tag carries information like :

a) date of emasculation b) field record number

c) date of pollination and crossing d) details of male and female parents

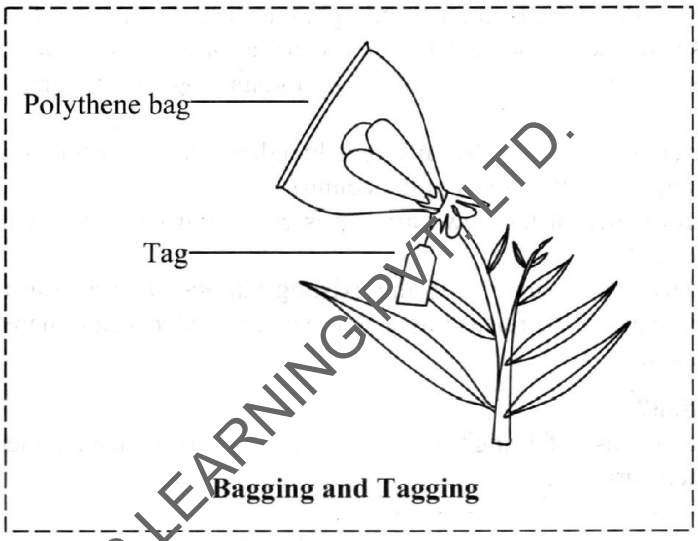
Q.7. With the help of suitable diagram, define 'bagging' and 'tagging' of flower. [Oct 2013]

Ans: Bagging :

During hybridization, emasculated flowers are covered with butter paper or polythene bag of suitable size to prevent pollination by pollen grains of unwanted source. This is known as bagging.

Tagging :

After dusting the pollen grains on stigma of the emasculated flower, it is rebagged and a tag with relevant information such as date of emasculation, date of pollination, details of male and female parents, etc. is attached with plants. This is known as tagging.

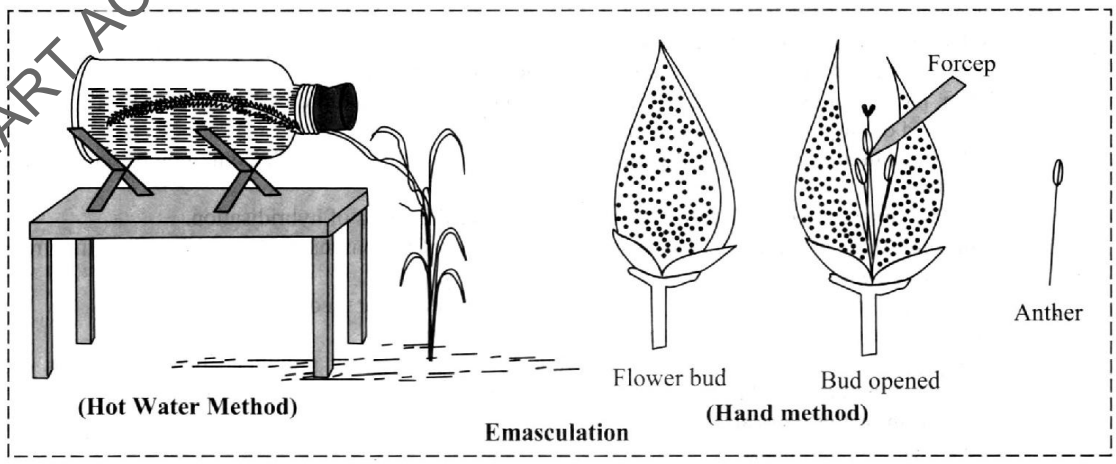


Bagging and Tagging

Q.8. With the help of diagrams, describe emasculation and bagging. [Mar 2014]

Ans: i) Emasculation :

It is the removal of stamens from one of the parents (if bisexual) before they release their pollen grains. It is done to prevent self pollination. It is done by hand method, hot water or alcohol method.



Emasculation

ii) Bagging :

Emasculated flowers are covered by polythene or butter paper bags to prevent cross-pollination by undesired pollen grains. The bags are tied at the base of the flower or inflorescence. [*For diagram: Refer Q.7.*]

Q.9. What is hybrid vigour ?

Ans: Hybrid vigour (heterosis) is the superiority of the hybrid over either parent in one or more characters.

Q.10. Write a note on Green Revolution.

Ans:i) India has an agriculture based economy, with agriculture accounting for 33% of India's GDP (Gross Domestic Product) and employing more than 60% of the total population .

ii) In the post-independence era, the crisis and challenge of supplying enough food to the increasing population with a limited suitable agricultural land was a difficult task.

iii) The development of many improved high yielding varieties of rice and wheat in the decade from 1960 to 1970 through the techniques of plant breeding helped the farming community to attain record agriculture production in our country.

iv) This achievement was popularly called "Green Revolution". The Green Revolution ensured unprecedented surge in the Indian economy and has provided numerous employment opportunities to improve the quality of life.

v) Basic elements considered in green revolution were use of genetically improved varieties for cultivation, expansion of usable farmland, cultivation of double crops in the same farmland, optimum use of fertilizers, etc.

Q.11. How is plant breeding useful in improving food quality ?

Ans:i) Increase in quantity is of less importance if it is not accompanied by better quality. Qualitative characters differ from crop to crop and also vary with the use of plant produce. e.g. shape, size, colour, milling, baking, malting and cooking in foodgrains; size, colour, taste, flavour and nutrition in fruits.

ii) Breeding is done with the objective of improving :
   a) Protein content and quality
   b) Oil content and quality
   c) Vitamin content
   d) Micronutrient and mineral content

iii) Thus, breeding crops with higher levels of vitamins and minerals or higher protein and healthier fats is possible due to plant breeding programmes.

Q.12. What are the advantages of high yielding varieties of crops?

Ans: Advantages of high-yielding varieties of crops :

i) High yield : The improved varieties of crops give us more production per hectare as compared to traditional varieties.

ii) Dwarfness : The high-yielding varieties of crops are not very tall, they are dwarf (of short height). Due to dwarfness, they are stronger and therefore, they can withstand strong winds and heavy rain.

iii) Better response to fertilizers: The high yielding varieties of crops give better response to fertilizers than the traditional crop varieties. Therefore, they give better crop yields.

iv) Early maturation (early ripening): The high yielding varieties of crops take less time for maturing than the traditional varieties of crops. Therefore, these varieties save a lot of time for raising some other crop in the same field.

Q.13.Write examples of high yielding varieties of rice and wheat.

Ans: High yielding varieties of wheat :

i) Sonalika and Kalyansona (High yielding and disease resistant 'semi dwarf varieties)
ii) Sharbati-Sonora
iii) Sonora-64
iv) Lerma Rojo 64-A
v) Safed Lerma

High yielding varieties of rice :

i) IR-8 (Semi dwarf rice variety formed at International Rice Research Institute (IRRI), Philippines).
ii) Jaya and Ratna: Developed in India
iii) Vijaya
iv) Kanti
v) Jayanti
vi) Padma

Q.14.Name any five hybrid varieties of crop plants, which have been developed in India.

Ans: Some hybrid varieties of crop plants developed in India are :

No.	crop	Hybrid variety	Resistant to disease
i)	Wheat	Himgiri	Leaf and strip rust
ii)	Cauliflower	Pusa shubhra and Pusa snowball K -1	Black rot
iii)	Cow pea	Pusa komal	Bacterial blight
iv)	Chilli	Pusa sadabahar	Chilli mosaic and leaf curl
v)	Okra	Pusa sawani, Pusa A–4	Shoot and fruit borer

Q.15. Explain, how plant breeding helped farmers to develop a sugarcane crop with high sugar content?

Ans:i) *Saccharum barberi* was commonly cultivated in North India but had poor yield and sugar content with resistance to most crop diseases.

ii) *Saccharum officinarum,* a tropical species grown in South India had high sugar content and better yield, but it did not grow successfully in North 'India because of its susceptible nature to all serious crop diseases.

iii) The hybrid varieties formed after crossing these two species have the desirable combination of characters like high yield, greater sugar content and resistance to most of the crop diseases.

iv) These hybrid varieties are successfully growing in North India.

Q.16. Give an account of breeding of crop plants for disease resistance and high yield.

Ans: i) A number of pathogens like fungi, bacteria and viruses causes different diseases to the crop plants which results in significant decrease in crop yield.

ii) The breeding of crop plants to produce high yielding and disease resistant varieties is the most effective, cheapest and convenient method.

iii) It not only helps in enhancing the food production, but also reduces the dependency on the use of chemical fertilizers.

iv) It has been studied that the resistance to diseases caused by different pests is a genetically controlled character.

v) By plant breeding technique, it is possible to transfer the genes for disease resistance to the susceptible and desirable varieties.

Q.17.Name the disease resistant varieties of crop plants for the different pathogens like fungus, bacteria and virus.

Ans:

No.	Name of crop	Resistant to disease	Pathogen
i)	Himgiri of wheat	Hill bunt leaf and Strips rust	Fungs
ii)	Pusa shubhra, Pusa Snowball K-I of cauliflower	Curl blight black rot; Black rot	Bacteria
iii)	Pusa sadabahar of Chilli	Leaf curl	Chilli mosaic virus

Q.18. What is mutation ?

Ans: Mutation can be defined as sudden and heritable variation which appears in an organism due to permanent change in their genotype. It is a phenomenon in which alteration of base sequences in DNA is caused and it results in changes in the genotype and phenotype of an organism.

Q.19.Define mutation breeding.

Ans: The induction and utilization of mutation for the development of new crop varieties having desirable traits is known as mutation breeding.

Q.20.Give application of mutation breeding. **[Mar 2013)**

Ans: Mutation breeding is used to develop desirable traits in an organism.

Q.21.What is a mutagen ?

Ans: Any physical or chemical agent which is used in the artificial induction of mutations is called mutagen. Mutagen can be divided into two types :

i) Chemical mutagens: e.g. Methylating agent, Acridine dyes, Deamination of bases.

ii) Physical mutagens: e.g. X-rays, alpha rays, gamma rays, beta rays, cosmic rays.

Many varieties of barley contain artificially mutated genes due to which there is increase in yield, insensitivity to day length, resistance to mildew and reduction in height. Somatic mutations are of much importance in vegetatively propagated plants like potato, sugarcane, mango, etc.

Q.22.How do some plants posses insect resistance quality naturally ?

Ans: In some crop plants, insect resistance may be found due to morphological, biochemical or physiological character. Hairy leaves in some plants are associated with resistance to insect pests. e.g. resistance to jassids in cotton. Smooth leaved and nectar-less cotton varieties are not attacked by the bollworms. Maize variety with high aspartic acid, low nitrogen and sugar content, is not affected by maize stem borers.

Q.23. Give the names of two insect resistant varieties of crop.

Ans:

No.	Crop	Hybrid variety	Resistant to
i)	Brassica (Rapeseed mustard)	Pusa Gaurav	Aphids
ii)	Okra (Bhindi)	Pusa Sawni; Pusa A-4	Shoot and fruit borer

Q.24.Explain Biofortification.

Ans: Biofortification is the method of breeding of crops to produce varieties which have increased nutritional value. This can be done either through conventional selective breeding or through genetic engineering. It is the most practical means to improve public health. The objectives ofbiofortification are improving;

i) the protein content (quantity and quality).

ii) vitamin content.

iii) oil content (quantity) and quality (unsaturated fats)
iv) micronutrients and mineral content.

Q.25. Explain selective breeding with example.

Ans: i) In selective breeding method, plant breeders search seed or germplasm banks for existing varieties of crops which are naturally high in nutrients. .
ii) Then, they crossbreed these high-nutrient varieties with high-yielding varieties of crops, to provide a seeds with high yields and increased nutritional value.
iii) Crops with sufficient amounts of nutrients must be bred to have a measurable positive impact on human health.
iv) Such crops must be developed with the involvement of nutritionists and should have extra nutrients, as storage, processing and cooking of the food affects their available nutrient levels.

Examples :

a) Hybrid maize with almost double the quantity of amino acids like lysine and tryptophan.
b) Wheat variety, Atlas-66 with high protein content.
c) Rice variety with five times more iron.
d) Vitamin A enriched bitter gourd, bathua, mustard, tomato.
e) Iron and calcium enriched spinach.
f) Protein enriched beans and garden peas, etc.

Q.26.What is Golden rice?

Ans: Golden rice is a genetically modified crop developed for its nutritional value. Golden rice contains genes from the soil bacterium Erwinia and either maize or daffodil plants, and contains increased levels of beta-carotene which can be converted by the body into vitamin A. This can help to overcome disorders due to vitamin A deficiency.

4.2 : Tissue Culture

Concept of Cellular Totipotency

Q.27.Explain the term 'Totipotency'.

Ans: The ability of a single cell to divide and differentiate into a mature plant if placed in the appropriate environment is called cellular totipotency. In 1902, Haberlandt was the first to demonstrate totipotency and introduced plant tissue culture.

Q.28.Define plant tissue culture technique.

Ans: The culturing or growing isolated protoplasts or cells or tissue or organ on nutrient medium under controlled aseptic conditions to produce a complete plant or plant parts is called tissue culture technique.

Q.29. Define the following terms:

i) Explant **ii) Callus**
iii) Morphogenesis **iv) Clones**

Ans: i. Explant :
Plant part that is excised from the original plant and used for the initiation of tissue culture is known as explant.

ii) Callus :
Callus is an unorganized and undifferentiated mass of loosely arranged parenchymatous cells which develop from the parent tissue due to proliferation of cells.

iii) Morphogenesis :
The process of development of different organs such as root, stem, leaves, etc. from the callus is called morphogenesis.

iv) Clones :
The genetically identical organisms produced from the original parent organism are described as clones of each other.

Q.30.List out the things required for plant tissue culture technique.

Ans: The basic and essential requirements for tissue culture technique are as follows :
i) Plant material from which explant is taken.
ii) Specialized nutrient or culture medium as per the requirement.
iii) Aseptic laboratory conditions.

iv) Facility to control different factors such as temperature, light, humidity, etc.
v) Different growth factors such as auxins, cytokinins, etc.

Q.31. What are the various components of medium used for propagation of an explant in vitro ?
Ans: The following ingredients are required in the nutrient media used for plant tissue culture:

i) Inorganic salts :
Inorganic macronutrients e.g. N, P, K, Ca, Mg and Sand micronutrients, e.g Cu, Zn are added in the form of their salts.

ii) Growth hormones :
Cytokinins such as BAP (Benzylaminopurine) promote cell division and regulate growth and development; Auxins like 2,4-D, IAA stimulate root formation and shoot elongation.

iii) Organic constituents :
Sucrose and D-glucose are commonly used organic compounds, which serve as source of carbon and energy.

iv) Vitamins :
Vitamins catalyze the enzymatic activities of cells and are required in trace amounts. Vitamin BI is most commonly used for plant tissue cultures. Other vitamins used are vitamin B2, vitamin B6, etc.

v) Amino acids :
To promote the growth, amino acids and arnides are used in media. The commonly used amino acids are glycine, L-glutamic acid, etc.

vi) Water :
Double distilled or demineralized and sterile distilled water is used for preparation of media.

vii) Solidifying agent :
For preparation of solid or semisolid media, 0.5 - 1% Agar is used as a solidifying agent. Agar is a polysaccharide obtained from red algae.

viii) pH :
Optimum pH between 5.0 to 5.8 is adjusted by adding NaOH or HCl.

Q.32. Which medium is commonly used for plant tissue culture technique ?
Ans: MS medium (Murashige and Skoog) is commonly used for plant tissue culture technique.

Q.33. Write a note on methods for sterilization of tools and culture media.
Ans: Sterilization Methods:

i) Sterilization of plant materials (explants): The plant materials and explants are sterilized by disinfectants like 1% sodium hypochlorite or 10% hydrogen peroxide or 70% ethanol or 0.1% HgCh.
ii. Sterilization of nutrient media: Culture medium is taken in a conical flask and plugged with cotton. It is sterilized by autoclaving at 15 lbs psi for 30 min. at 121°C.
iii) Sterilization of glassware and instruments: Glasswares like petriplates, flasks, pipettes, etc. and metallic instruments are sterilized in a hot air oven at 160°-180° C for 2 - 4 hours.
iv) Sterilization of inoculation chamber: Inoculation chamber is sterilized by V.V. light.

Q.34. Describe different steps involved in tissue culture technique.
Ans: The different steps involved in tissue culture technique are :

i) Explant :
Plant part that is excised from the original plant and is used for initiation of a culture is known as explant. e.g. root apex, shoot apex, pollen grains, etc. The explants are sterilized properly and placed on solid nutrient medium. The cells from explants absorb nutrients and start multiplying.

ii) Callus formation and its culture :
Callus is an unorganized mass of loosely arranged parenchymatous cells which develop from parent tissue due to proliferation of cells. All the cells of callus are identical because they are produced by mitosis only.

iii) Organogenesis :
Growth hormones like auxins and cytokinins in proper proportion are provided to the callus to induce formation of organs. If auxins are more, roots are formed (rhizogenesis) and if the cytokinins are in more quantity, then the shoot system begins to develop (caulogenesis).

iv) Sub-culturing :
The callus is transferred to fresh medium to form subculture. It permits rapid multiplication of culture material.

v) Plant regeneration :

Each callus is transferred to regeneration medium containing growth hormones. Plantlets can be obtained from cultured cell by transplanting.

vi) Transplanting :

The healthy plantlets are transferred to soil in pots. They are kept in growth chambers and then in glass houses. Gradual exposure of plantlets to the environment is called hardening. The hardened plants are transferred to the field.

Q.35.Describe suspension culture.

Ans: Suspension culture :

i) A fragment of callus is transferred to a liquid culture medium.
ii) It is agitated constantly at 100-250 rpm aseptically for aeration, mixing of medium and to prevent aggregation of cells.
iii) The callus breaks into isolated single cells as well as small groups of cells.
iv) This cell suspension culture contains a few single cells, cell clumps and dead cells.
v) Cell suspension cultures are homogenous in size and can grow on a large scale like cultures of micro-orgamsms.
vi) Isolated cells can be used for protoplast culture and somatic hybridisation.

Q.36.Enlist the applications of tissue culture.

Ans: Tissue culture technique has wide applications. They are :

i) It is useful for production of protoplast culture and formation of somatic hybrids.
ii) It is used for production of virus free plants.
iii) It is a rapid method of multiplication of many plants.
iv) Many economically important plants like Orchids, Dahlia, Grapes, Pineapple, etc. have been made disease resistant.
v) Somaclonal variants are used in crop breeding for development of improved varieties which are resistant to herbicides, salts, toxins, etc.
vi) Large scale production of seeds from any part of the plant is possible.
vii) Production of disease resistant plants.
viii) Production .of secondary metabolites by cell or suspension culture. Secondary metabolites include alkaloids, anti-tumor agents, enzymes, hormones, etc.
ix) Plants regenerated from cell culture often show genetic variation.
x) Transgenic plants can be created through tissue culture.

Q.37. Describe any 'two' applications of tissue culture technique.

Ans: Applications of tissue culture technique :

i) Micropropagation :

a. It is a type of tissue culture technique by which large number of genetically identical plants are produced within a short time period.
b. Due to this technique, multiplication of plants becomes season independent, also rare plants can be conserved by micropropagation technique.
c. Storage becomes easy as micropropagules require little space.

ii) Production of disease free plants :

a. Tissue culture technique is useful to recover the healthy plants from diseased plants.
b. Generally, apical meristems are used as explant as they are free from infection.
c. Good variety of banana, potato and sugarcane is successfully recovered by culturing apical meristem. **[Mar 2014]**

Q.38.Explain micropropagation technique and its advantages.

Ans: Micropropagation :

It is a type of tissue culture technique by which large number of plants propagules are produced. In this technique, shoot apical meristem is used as explants. Using the proper proportion of growth hormones, many shoot apices can be produced. These shoot apices are called Micropropagules. These are genetically identical and from them, individual plants can be obtained.

Advantages :

i) Micropropagation technique is useful for obtaining large number of genetically identical plants (clones) within a short period of time.

ii) Due to micropropagation, multiplication of plants becomes season independent.
iii) Rare plants can be conserved by this technique.
iv) Storage becomes easy as micropropagules require little space.
v) Commercial production of potato, banana, orchids is possible.

Q.39. Which part of the plant is best suited for making virus free plants and why ?

Ans: Healthy plants can be recovered from diseased plant by using tissue culture technique. In this, apical meristems are used as explant, which produce disease-free plants. This is because, in plants, the apical meristem is generally free from infection, i.e. without pathogens like viruses.

Q.40.What is the major advantage of producing plants by micropropagation ?

Ans: Rapid clonal multiplication and production of virus-free plants is the major advantage of producing plants by micropropagation.

Q.41. Give the name of a secondary metabolite with its plant source.

Ans:

Plant source	Secondary metabolite
Catharanthus roseus	Vincristin, Vinblastin
Dacus carota	Anthocyanin
Datura stramoneum	Tropane
Mentha piperata	Menthol
Nicotiana tabacum	Nicotine

Q.42.What is somatic hybridization?Give its applications.

Ans:Somatic hybridization :

The protoplast from two different plants can be made to fuse by using fusogenic agent as polyethylene glycol (PEG). From the resultant combined protoplast by tissue culture, a new plant variety can be produced.

e.g. Pomato = Potato + Tomato
Raphanobrassica = Raphanus + Brassica

Applications of somatic hybridization :

i) It helps to develop new hybrid varieties in a short period and limited space.
ii) It is useful in those plants which cannot be hybridized sexually due to incompatibility.
iii) It produces genetic variability even in vegetatively propagated plants.
iv) It produces rare hybrids which are rich in quality food and economic products.

4.3 : Single Cell Protein

Q.43.What is SCP? What are the advantages SCP ?

Ans:Single cell protein (SCP) :

Single cell protein (SCP) refers to any microbial biomass produced by uni and multicellular microorganisms and can be used as food or feed additives.

Microbes like *Chiarella* (green algae), *Spirulina* (BGA), *Methylophilus* bacterium are grown on large scale as source of good protein.

Advantages :

i) Spirulina serves as a good source of proteins (SCP).
ii) It can be produced throughout the year.
iii) Large quantities of SCP from very small land area can be obtained due to rapid growth of microbes.
iv) Cheap substrates or even wastes can be used for production.
v) Some SCPs are good sources of B-complex vitamins.
vi) So, SCP is expected to solve the problem of protein deficiency in the children of developing countries. (But, SCP may contain toxic compounds produced by some microbes and may lead to indigestion and allergic reactions.)
vii) It can be an ideal supplement to conventional food.

Q.44.Give the scientific name of bacterium cultivated as a source of SCP.

Ans: *Methylophilus methylotrophus* is cultivated as a source of SCPo

Additional Theory Questions

Q.1. Give objectives of plant breeding. ***Refer Q.3.***

Q.2. Briefly describe various steps involved in plant breeding. ***Refer Q.4.***

Q.3. What is plant breeding? Describe the breeding of crop plant for disease resistance and high yielding. ***Refer Q.3 and 16.***

Q.4. Explain what is meant by Biofortification. ***Refer Q.24.***

Q.5. Explain selective breeding. Give any 'two' examples and their nutrients obtained by selective breeding. [Oct 2014] ***Refer Q.25.***

Q.6. What is cellular totipotency? ***Refer Q.27.***

Q.7. Enlist the basic and essential requirements for plant tissue culture experiments. ***Refer Q.30.***

Q.8. What are the ingredients of nutrient media used for plant tissue culture? ***Refer Q.31.***

Q.9. Explain how suspension culture is prepared from callus. [Mar 2013] ***Refer Q.35.***

Q.10. Explain any two applications oftissue culture. [Mar 2013 Old Course] ***Refer Q.37.***

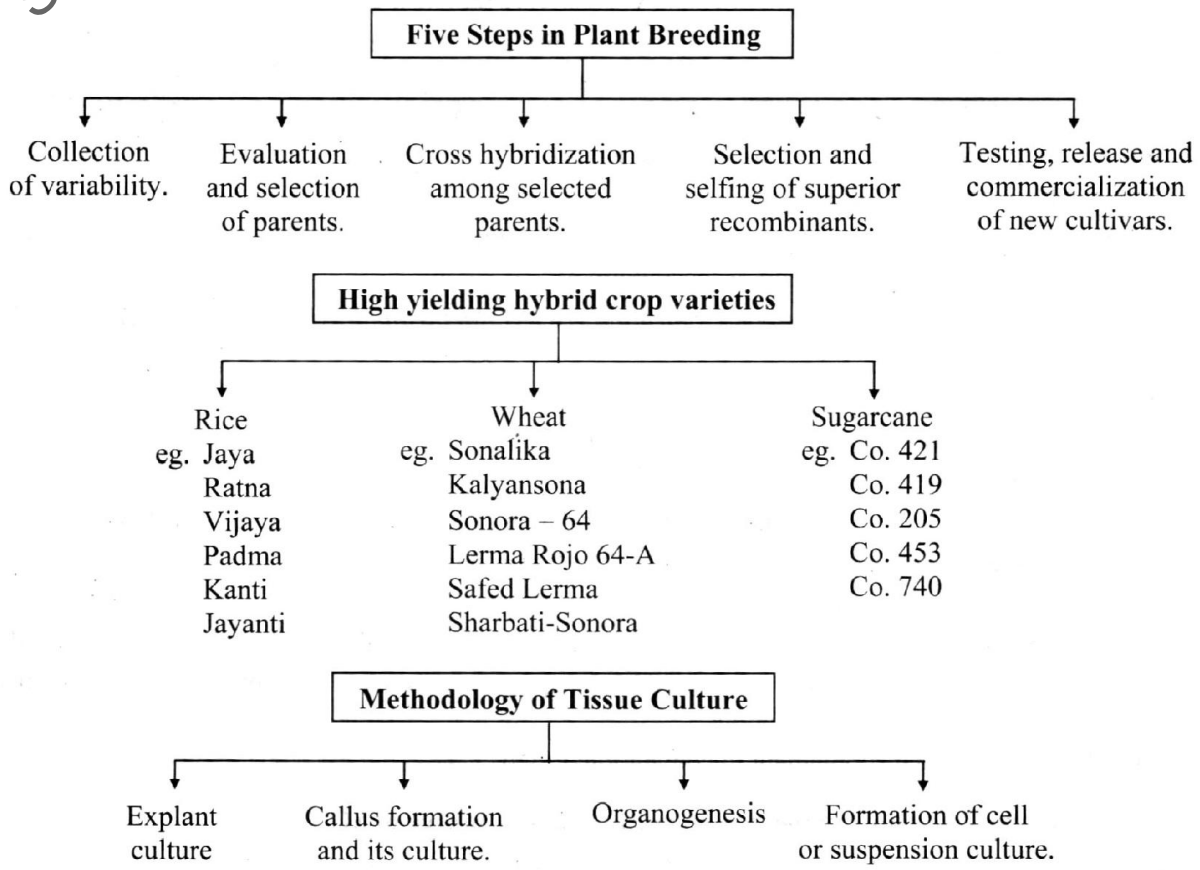
Q.11. Explain how healthy plants are recovered from diseased plant. ***Refer Q.39.***

Q.12. Explain the importance of micro propagation and somatic hybridization. ***Refer Q.38 and 42.***

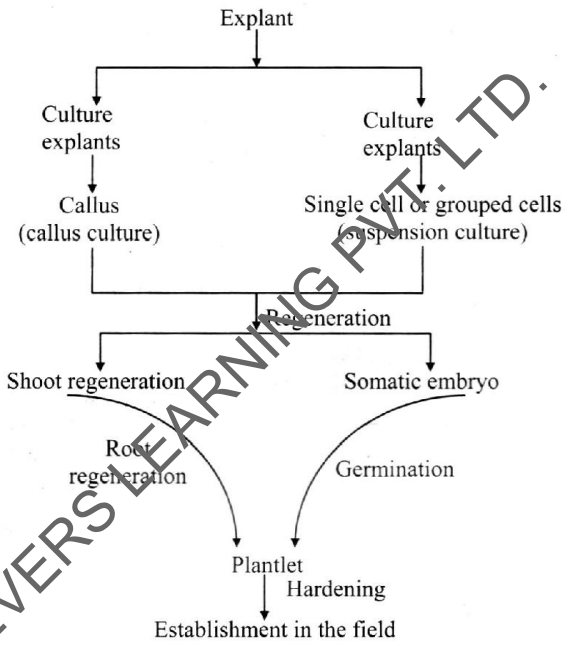
Q.13. Define SCPoRefer Q.43.

Q.14. Give advantages of single cell protein (SCP). [Oct 2013] ***Refer Q.43.***

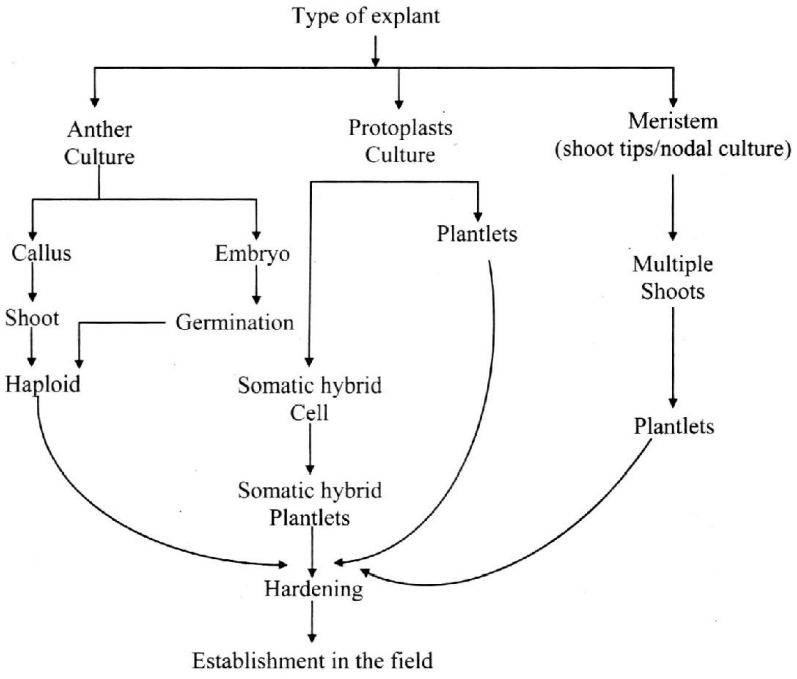
Quick Review



- **Schematic representation indicating thecallus and suspension culture.**

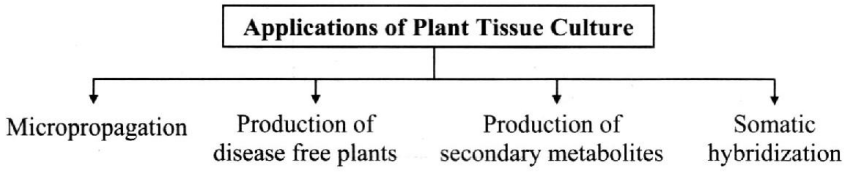


- **Schematic representation indicating the anther, protoplast, embryo and shoot tip culture.**



- **Scientists and their contribution:**

No.	Scientists	Contribution	Year
i.	Dr. Norman E.Borlaug	Father of green revolution. Developed semi dwarf varieties of wheat.	–
ii.	Haberlandt	Showed totipotency in plants for the first time.	1902



Multiple Choice Question

1. Crop improvement is also termed as
   a) evolution
   b) mutation breeding
   c) plant breeding
   d) crop rotation
2. Process of bringing wild species of plant under human management is called
   a) Selection
   b) Introduction
   c) Domestication
   d) Hybridization
3. The green revolution is related to
   a) revolution in industries.
   b) revolution in agricultural output.
   c) revolution in 1857.
   d) revolution in fodder output.
4. The classical method of plant breeding is
   a) hybridization
   b) mutation breeding
   c) genetic engineering
   d) tissue culture
5. Germplasm includes
   a) only improved varieties of crop.
   b) all cultivated varieties and wild relatives of a particular crop.
   c) all hybridized varieties only.
   d) only mutant varieties of a crop.
6. In hybridization, tagging is done on
   a) male parent
   b) female parent
   c) both a) and b) d) hybrids
7. Hybrid vigour is due to
   a) Homozygosity
   b) Linkage
   c) Emasculation
   d) Heterozygosity
8. Emasculation is required for
   a) selective hybridization
   b) pure lines
   c) self pollination
   d) natural hybridization
9. The new varieties of plants are produced by
   a) selection and hybridization.
   b) mutation and selection.
   c) introduction and mutation.
   d) selection and introduction.
10. The technique of removal of stamens from the flowers of female parent is
    a) selection b) harvesting
    c) bagging d) emasculation
11. Emasculation in large flowers is done by
    a) hand method
    b) hot water or alcohol method
    c) suction pressure method
    d) all of these
12. The physical mutagens include
    a) 5-bromouracil
    b) colchicine
    c) nitrous acid
    d) X-rays
13. Genetic variability can be created by
    a) Clone selection
    b) Mass selection
    c) Mutation
    d) Hybridization
14. Apart from high yield, other main objective of plant breeding is
    a) improvement of quality.
    b) development of resistance to pathogen.
    c) reduction in dormancy period
    d) all the above
15. An improved insect resistant variety "Pusa Gaurav" is variety of
    a) Brassica b) Flat bean
    c) Cowpea d) Bhindi
16. A wheat variety resistant to hill bunt disease is
    a) Pusa Shubhra b) Himgiri
    c) Pusa Gaurav d) Pusa Sawani
17. Wheat variety 'Atlas 66' is improved for
    a) high proteins
    b) high carbohydrates
    c) high fats
    d) high vitamins
18. Somatic hybridisation of potato and tomato forms
    a) *Triticale* b) Pomato
    c) *Secale* d) *Altonia*
19. Cellular totipotency is demonstrated by
    a) only gymnosperm cells.
    b) all plant cells.
    c) all eukaryotic cells.
    d) only bacterial cells.
20. Unorganized mass of cells developed from parenchymatous cells is called
    a) callus b) explant
    c) clone d) tissue
21. In tissue culture, which one of the following pairs of substances are used to induce shoot and root formation respectively in the callus ?
    a) Cytokinin and auxin
    b) auxin and cytokinin
    c) PEG and IAA
    d) ethylene and ABA
22. Fusogenic agent used for somatic hybridization is
    a) PEG b) Auxin
    c) Cytokinin d) Agar

23. Micropropagation refers to
a) raising new plants by cell or tissue culture.
b) seed germination in test tubes.
c) entry of pollen tubes through micropyle.
d) syngamy and triple fusion in angiosperm.

24. An ability of a plant cell by virtue of which it can generate whole plant under suitable conditions is called
a) micropropagation
b) totipotency
c) somatic hybridization
d) organogenesis

25. Hybridization involves
a) removal of stamens
b) removal of stigma
c) male sterility
d) female sterility

26. Murashige and Skoog's medium is used for
a) bacterial cultures.
b) raising plants through micropropagation.
c) culture of Spirulina.
d) isolation of fungal strains.

27. Somatic hybridisation is carried out by
a) pollen culture
b) cell culture
c) protoplast fusion
d) haploid culture

28. Characteristic/s of suspension culture is/are
a) liquid medium.
b) agitation of liquid medium.
c) single cells or small group of cells.
d) all of these

29. In most of the plants, a part which is free from infections/diseases is
a) apical bud b) flower
c) root d) stem

30. For the production of disease free plant, the explant is taken from meristem. **[Mar 2013 Old Course]**
a) lateral b) apical
c) intercalary d) secondary

31. Explant is
a) plant collected after harvesting.
b) exploited part of a plant.
c) small part of the plant meant for tissue culture.
d) uprooted plant for transplantation.

32. In tissuelbacterial culture, glasswares and nutrients are sterilized through
a) water bath at 200°C
b) dry air oven at 200°C
c) dehumidifier
d) autoclave

33. "Golden rice" or Miracle nee IS transgenic rice, rich in
a) Vitamin B and iron
b) Vitamin A and iron
c) Vitamin A and vitamin B
d) Iron

34. Transgenic plants are also called
a) TGP crops b) GMO crops
c) GM crops d) TP crops

35. Agitation of liquid tissue culture serves the purpose of
a) aeration.
b) constant mixing.
c) breaking cell aggregates.
d) all of these.

36. The better yielding semi-dwarf rice varieties developed in India are
a) Jaya and Ratna
b) Kalyan sona and Sonalika
c) Sharbati sonora and Sonalika
d) Pusa and Lerma

37. "Vincristin", a secondary metabolite is obtained from the plant
a) Catharanthus roseus
b) Asparagus racemosus
c) Daucus carota
d) Datura stramoneum

38. Single cell protein can be obtained from
a) yeast culture b) Asparagus
c) Spirulina d) Fungi

Answer Keys

1.	c)	**2.**	c)	**3.**	b)	**4.**	a)	**5.**	b)	**6.**	b)	**7.**	d)	**8.**	a)	**9.**	a)	**10.**	d)
11.	a)	**12.**	d)	**13.**	c)	**14.**	d)	**15.**	a)	**16.**	b)	**17.**	a)	**18.**	b)	**19.**	b)	**20.**	a)
21.	a)	**22.**	a)	**23.**	a)	**24.**	b)	**25.**	a)	**26.**	b)	**27.**	c)	**28.**	d)	**29.**	a)	**30.**	b)
31.	c)	**32.**	d)	**33.**	b)	**34.**	c)	**35.**	d)	**36.**	a)	**37.**	a)	**38.**	c)				