

# 9

## Strategies for Enhancement in Food Production

### Multiple Choice Questions (MCQs)

**Q. 1** The chances of contacting bird flu from a properly cooked (above 100° C) chicken and egg are

- (a) very high (b) high  
(c) moderate (d) None of these

**Ans. (d)** The chances of contacting bird flu from a properly cooked (above 100°C) chicken and egg are negligible.

Highly pathogenic strains of avian influenza can be found inside and on the surface of eggs. In an infected bird, it may spread to all the parts including the meat.

However, proper cooking at or above 70°C, prior to eating, will inactivate the virus in the egg as well as in the meat.

**Q. 2** A group of animals which are related by descent and share many similarities are referred to as

- (a) breed (b) race (c) variety (d) species

**Ans. (a)** A group of animals that are related by descent and are similar in most characters like general appearance, features, size, configuration, etc., are said to belong to a breed.

The other three options are incorrect because race is a classification system used to categorize humans into large and distinct populations or groups based on anatomical, cultural, ethnic or geographical differences.

While a variety is a genetically and morphologically distinct subset of a species that is geographically isolated from other populations within that species.

A species is defined as a group of individuals that potentially interbreed in nature.

**Q. 3** Inbreeding is carried out in animal husbandry because it

- (a) increases vigour
- (b) improves the breed
- (c) increases heterozygosity
- (d) increases homozygosity

**💡 Thinking Process**

*Inbreeding refers to the mating of more closely related individuals within the same breed for 4-6 generations.*

**Ans. (d)** Inbreeding increases homozygosity, i.e., state of possessing two identical alleles, one inherited from each parent. It is necessary if we want to evolve a pureline in any animal.

Inbreeding exposes harmful recessive genes that are eliminated by selection. It also helps in accumulation of superior genes and elimination of less desirable genes.

**Q. 4** Sonalika and Kalyan Sona are varieties of

- (a) wheat
- (b) rice
- (c) millet
- (d) tobacco

**Ans. (a)** Sonalika and Kalyan Sona are outstanding semi-dwarf varieties of wheat possessing amber grains and good yield potential. They were developed in 1963 at Indian Agriculture Research Institute, as a part of systematic programme for breeding semi-dwarf wheat varieties.

**Q. 5** Which one of the following is not a fungal disease?

- (a) Rust of wheat
- (b) Smut of bajra
- (c) Black rot of crucifers
- (d) Red rot of sugarcane

**Ans. (c)** Black rot of crucifers is not a fungal disease. It is caused by a bacteria, *Xanthomonas campestris*. Other three diseases are caused by fungal infection.

Rust of wheat is caused by a fungus, *Puccinia*, red rot of sugarcane is caused by *Colletotrichum falcatum* and smut of bajra is caused by *Tolyposporium penicillariae*.

**Q. 6** In virus-infected plants the meristematic tissues in both apical and axillary buds are free of virus because

- (a) the dividing cells are virus resistant
- (b) meristems have antiviral compounds
- (c) the cell division of meristems are faster than the rate of viral multiplication
- (d) viruses cannot multiply within meristem cell(s)

**Ans. (c)** In virus infected plants the meristematic tissues in both apical and axillary buds are free of virus because the multiplication of meristematic cells is faster than replication of viruses.

The main reason behind it is the gene silencing. Neither dividing cells are virus resistant nor the meristems have antiviral compounds.

**Q. 7** Several South Indian states raise 2-3 crops of rice annually. The agronomic feature that makes this possible is because of

- (a) shorter rice plant
- (b) better irrigation facilities
- (c) early yielding rice variety
- (d) disease resistant rice variety

**Ans. (c)** Several South Indian states raise 2-3 crops of rice annually. The agronomic feature that makes this possible is early yielding rice variety. These varieties are a group of crops created intentionally during the green revolution to increase global food production.

**Q. 8** Which one of the following combination would a sugarcane farmer look for in the sugarcane crop?

- (a) Thick stem, long internodes, high sugar content and disease resistant
- (b) Thick stem, high sugar content and profuse flowering
- (c) Thick stem, short internodes, high sugar content, disease resistant
- (d) Thick stem, low sugar content and disease resistant

**Ans. (a)** In the sugarcane crop, a sugarcane farmer looks for thick stem, long internodes, high sugar content and disease resistance. In practice, *Saccharum barberi* and *Saccharum officinarum* are being used to develop such combination.

*Saccharum barberi* was originally grown in north India, but had poor sugar content and yield. Tropical canes grown in South India, *Saccharum officinarum* had thicker stems and higher sugar content but did not grow well in North India.

Now, these two species are successfully crossed to get sugarcane varieties combining the desirable qualities of high yield, thick stems, high sugar and ability to grow in the sugarcane areas of North India.

**Q. 9** Fungicides and antibiotics are chemicals that

- (a) enhance yield and disease resistance
- (b) kill pathogenic fungi and bacteria, respectively
- (c) kill all pathogenic microbes
- (d) kill pathogenic bacteria and fungi respectively

**Ans. (b)** A wide range of fungal, bacterial and viral pathogens, affect the yield of cultivated crop species. Fungicides and antibiotics are chemicals that kill pathogenic fungi and bacteria, respectively.

**Q. 10** Use of certain chemicals and radiation to change the base sequences of genes of crop plants is termed

- (a) recombinant DNA technology
- (b) transgenic mechanism
- (c) mutation breeding
- (d) gene therapy

**🔦 Thinking Process**

*Mutation is a phenomenon by which genetic variation is achieved through changes in the base sequences within genes that creates a new character or trait absent in parental generation.*

**Ans. (c)** It is possible to induce mutations artificially in crop plants through the use of chemicals or radiations (like gamma radiations), and then selecting and using those plants that have the desirable character as a source in breeding. This process is called mutation breeding.

Use of radiations is not involved in other three options. Recombinant DNA technology involves transferring of a desired gene (*trans* gene) from an organism and incorporating it to host organism by genetic engineering to produce a recombinant to gene therapy is performed mainly in humans. It involves replacing a defective gene with a normal one.

**Q. 11** The scientific process by which crop plants are enriched with certain desirable nutrients is called

- (a) crop protection
- (b) breeding
- (c) biofortification
- (d) bioremediation

**Ans. (c)** **Biofortification** is breeding crops with higher levels of vitamins and minerals, or higher protein and healthier fats. It is the most practical means to improve public health.

*Breeding for improved nutritional quality is undertaken with the objectives of improving*

- I. Protein content and quality
- II. Oil content and quality
- III. Vitamin content
- IV. Micronutrient and mineral content

The other options are incorrect because crop protection includes many ways for protecting crops against a number of pests and pathogens.

Breeding involves artificial mating of two plants with desirable characteristics to produce a progeny with features of both the parents. Bioremediation is a waste management technique that involves the use of organisms to remove or neutralise pollutants from a contaminated site.

**Q. 12** The term 'Totipotency' refers to the capacity of a

- (a) cell to generate whole plant
- (b) bud to generate whole plant
- (c) seed to germinate
- (d) cell to enlarge in size

**Ans. (a)** The capacity of a cell or an explant (any part of plant taken out and grown in test tube) to grow into a whole plant is called 'totipotency'.

**Q. 13** Given below are a few statements regarding somatic hybridisation. Choose the correct statements.

- I. Protoplasts of different cells of the same plant are fused .
- II. Protoplasts from cells of different species can be fused.
- III. Treatment of cells with cellulase and pectinase is mandatory.
- IV. The hybrid protoplast contains characters of only one parental protoplast.

- |              |                |
|--------------|----------------|
| (a) I and II | (b) I and II   |
| (c) I and IV | (d) IV and III |

**💡 Thinking Process**

*The process of fusion of protoplast of somatic cells obtained from different varieties or species of plant and growing on a suitable nutrient medium in vitro to develop a somatic hybrid is called somatic hybridisation.*

**Ans. (d)** The process of producing somatic hybrids involves the following steps

- I. Single cells from selected plants are isolated.
- II. The cell walls of cells are digested by enzymes like pectinase and cellulase to expose the naked protoplasts.
- III. Naked protoplasts surrounded only by plasma membranes are isolated.
- IV. The isolated protoplasts are fused to obtain hybrid protoplasts under sterile conditions in special nutrient media.
- V. The hybrid protoplasts are cultured in a suitable media to form new plant. The hybrid protoplast contains characters of both parental protoplasts.

**Q. 14** An explant is

- (a) dead plant
- (b) part of the plant
- (c) part of the plant used in tissue culture
- (d) part of the plant that expresses a specific gene

**Ans. (c)** Any part of a plant taken out and grown in a test tube under sterile conditions in a special nutrient media is called an explant. A whole plant can be generated from an explant.

**Q. 15** The biggest constraint of plant breeding is

- (a) availability of desirable gene in the crop and its wild relatives
- (b) infrastructure
- (c) trained manpower
- (d) transfer of genes from unrelated sources

**Ans. (a)** Breeding (conventional) is often constrained by the availability of limited number of disease resistance genes that are present and identified in various crop varieties or wild relatives.

**Q. 16** Lysine and tryptophan are

- (a) proteins
- (b) non-essential amino acids
- (c) essential amino acids
- (d) aromatic amino acids

**Ans. (c)** Lysine and tryptophan are essential amino acids.

**Q. 17** Micro-propagation is

- (a) propagation of microbes *in vitro*
- (b) propagation of plants *in vitro*
- (c) propagation of cells *in vitro*
- (d) growing plants on smaller scale

**Ans. (b)** Micro-propagation is propagation of plants *in vitro* to achieve a large number of plants in very short durations. This results in genetically identical plants and is widely used in forestry and floriculture.

**Q. 18** Protoplast is

- (a) another name for protoplasm
- (b) an animal cell
- (c) a plant cell without a cell wall
- (d) a plant cell

**Ans. (c)** A protoplast is a plant, bacterial or fungal cell whose cell wall is completely or partially removed using either mechanical or enzymatic means.

**Q. 19** To isolate protoplast, one needs

- (a) pectinase
- (b) cellulase
- (c) both pectinase and cellulase
- (d) chitinase

**Ans. (c)** The cell wall of plant cells consists of pectin and cellulose which can be removed by digestion with a combination of pectinase and cellulase to isolate the protoplast.

**Q. 20** Which one of the following is a marine fish?

- (a) Rohu                      (b) *Hilsa*                      (c) *Catla*                      (d) Common carp

**Ans. (b)** *Hilsa*, sardines, mackerel and pomfrets are some of the marine fishes.

*Catla*, rohu and common carp are freshwater fishes.

**Q. 21** Which one of the following products of apiculture is used in cosmetics and polishes

- (a) Honey                      (b) Oil                      (c) Wax                      (d) Royal jelly

**Ans. (c)** *The most common products of apiculture include*

- (i) Bees wax which finds many uses in industry, such as in the preparation of cosmetics and polishes of various kinds.
- (ii) Honey, is a food of high nutritive value and also finds use in the indigenous systems of medicine.
- (iii) Royal jelly, is the queenbees extraordinary source of food. It is rich in nutrition values and is believed to be a potent antioxidant.

**Note** *Oil is not considered as a product of apiculture.*

**Q. 22** More than 70% of livestock population is in

- (a) Denmark                      (b) India                      (c) China                      (d) India and China

**Ans. (d)** It is estimated that more than 70% of the world livestock population is in India and China.

**Q. 23** The agriculture sector of India employs

- (a) 50% of the population                      (b) 70% of the population  
(c) 30% of the population                      (d) 60% of the population

**Ans. (d)** India is mainly an agricultural country. Agriculture employs nearly 60% of the population.

**Q. 24** 33% of India's Gross Domestic Product comes from

- (a) Industry                      (b) Agriculture  
(c) Export                      (d) Small-scale cottage industries

**Ans. (b)** Agriculture accounts for approximately 33% of India's GDP (Gross Domestic Products).

**Q. 25** A collection of all the alleles of all the genes of a crop plant is called

- (a) germplasm collection                      (b) protoplasm collection  
(c) herbarium                      (d) somaclonal collection

**Ans. (a)** Germplasm collection is the entire collection of plants/seeds having all the diverse alleles for all genes in a given crop. The given definition does not fit in other options because protoplasm collection deals mainly with collection of protoplast, *i.e.* plant cell without cell wall.

A herbarium is a museum of preserved plants that are used for botanical research, mainly in identification and classification of plants.

Somaclonal collection involves plants produced from a single cell which are genetically variable from their parents.

## Very Short Answer Types Questions

**Q. 1** Millions of chicken were killed in West Bengal, Asom, Odisha and Maharashtra recently. What was the reason?

**Ans.** Millions of chicken were killed or rejected in West Bengal, Asom, Odisha and Maharashtra because they were found to be infected with H<sub>5</sub>N<sub>1</sub> virus, which is the causal organism of bird flu.

**Q. 2** Can gamma rays used for crop improvement programmes prove to be harmful for health? Discuss.

**Ans.** No radiation treatment has been used to create thousands of new plant varieties. These varieties are cultivated as food and feed. Radiation is known to be much more disruptive for chromosomal structure than the manipulations used to make transgenic plants.

Such radiation treatment of crop plants has caused no documented instances of ill-health among consumers despite having been used commercially for several decades.

For rice crops alone, hundreds of different mutant varieties have been developed mostly made by using ionising radiations, like gamma rays.

**Q. 3** In animal husbandry, if two closely related animals are mated for a few generations, it results in loss of fertility and vigour. Why is this so?

**💡 Thinking Process**

*The phenomenon being referred to is called 'Inbreeding Depression' and results in loss of fertility and vigour.*

**Ans.** The loss in fertility and vigour occurs after inbreeding because the recessive alleles tend to get together and express harmful effects in the progeny.

**Q. 4** In the area of plant breeding, it is important not only to preserve the seeds of the variety being cultivated, but also to preserve all its wild relatives. Explain with a suitable example.

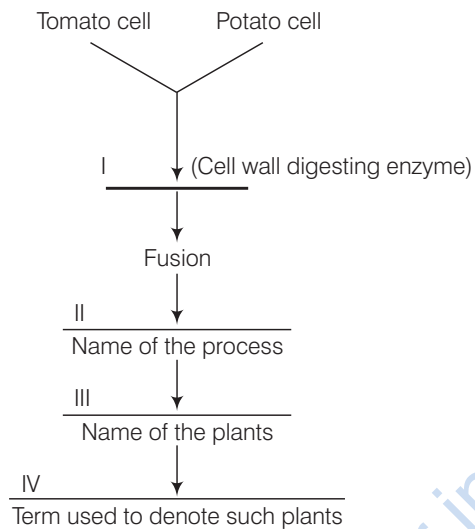
**Ans.** Collection and preservation of all the different wild varieties, species and relatives of the cultivated species is a important for effective exploitation of natural genes available in the population. e.g., sources of resistance genes may be cultivated varieties, germplasm collections of the crop or wild relatives.

**Q. 5** Name a man-made cereal. Trace how it was developed and where is it used?

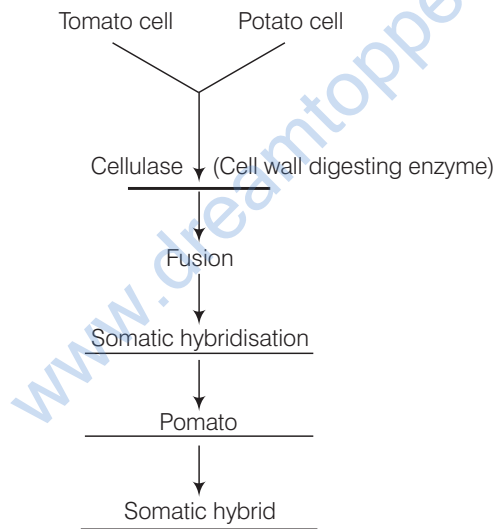
**Ans.** *Triticale* is a man-made cereal. It was developed by crossing *Triticum aestivum* (common wheat) and *Secale cereale* (European rye).

*Triticale* seed grain is being used in some parts of the world as a wheat substituted.

**Q. 6** Fill in the blanks.



**Ans.**



**Q. 7** A few statements are given below followed by a set of terms in a box. Pick the correct term and write it against the appropriate statement

(a) Mating of closely related individuals within the same breed.	(i) Cross breeding
(b) Mating of animals of same breed but having no common ancestors on either side for 4-6 generations.	(ii) Inter-specific hybridisation
(c) Mating of animals of two different species.	(iii) Outbreeding
(d) Breeding of animals belonging to different breeds.	(iv) Outcrossing
	(v) Inbreeding



- Ans.** (a) Mating of closely related individuals within the same breed is called inbreeding.  
(b) Mating of animals of same breed but having no common ancestors on either side for 4-6 generations is called outbreeding.  
(c) Mating of animals of two different species is called interspecific hybridisation.  
(d) Breeding of animals belonging to different breeds is called cross-breeding.

**Q. 8** What is meant by 'hidden hunger'?

**Ans.** Consumption of food deficient in nutrients particularly, micronutrients, proteins and vitamins is called 'hidden hunger'.

**Q. 9** Why are plants obtained by protoplast culture called somatic hybrids?

**Ans.** Plants obtained by protoplast culture are called somatic hybrids because they are formed by the fusion of isolated protoplasts from two different varieties of plants, each having a desirable character, to obtain a hybrid protoplast which can be further grown to form a plant.

**Q. 10** What is protoplast fusion?

**Ans.** The ability of protoplasts obtained from two different cells to fuse and form a hybrid protoplast is called protoplast fusion.

**Q. 11** Why is it easier to culture meristems compared to permanent tissues?

**Ans.** Meristems have the capacity to divide continuously throughout their life. Their walls are thin and elastic to facilitate the division, hence are suitable for tissue culture.

Permanent cells lose their ability to divide and their walls are thick. They have to differentiate to divide, hence are not easier to culture.

**Q. 12** Why are proteins synthesised from *Spirulina* called single cell proteins?

**Ans.** Single cell proteins are proteins obtained from unicellular organisms/microorganisms. *Spirulina* is one such unicellular microbe. So, the proteins synthesised by *Spirulina* are called single cell proteins.

**Q. 13** A person who is allergic to pulses was advised to take a capsule of *Spirulina* daily. Give the reasons for the advise.

**Ans.** The person with allergies to pulses is advised to take *Spirulina* daily due to the following reasons

- (i) It could be a substitute for protein rich pulses.
- (ii) *Spirulina* is rich in beta-carotene and anti-oxidants besides all essential amino acids that help in improving the allergic symptoms appeared due to consumption of pulses.

**Q. 14** What is aquaculture? Give example of an animal that can be multiplied by aquaculture.

**Ans.** When culturing of aquatic plants and animals is done in freshwater bodies, it is called aquaculture.

*Examples of animals that can be multiplied by aquaculture are*

- Finfish — Tilapia, Carp, Catfish, etc.
- Shellfish — Shrimps, Oysters, etc.

**Q. 15** What are the duties of a veterinary doctor in management of a poultry farm?

**Ans.** A veterinary doctor has to ensure proper and safe farm conditions to keep the animals disease-free and treat them appropriately if diseased.

**Q. 16** Would it be wrong to call plants obtained through micro-propagation as 'clones'? Comment.

**Ans.** No, it is not wrong to call plants obtained through micro-propagation as clones because each of these plants will be genetically identical to each other and the parent plant.

**Q. 17** How is a somatic hybrid different from a hybrid?

**Ans.** Somatic hybrids are obtained by uniting protoplasts from two different varieties of plants and then further cultured to form a novel plant. Compatibility between two plants is not a limitation. Any two protoplasts can be united.

Whereas, hybrids are obtained by crossing two selected parent plants of opposite sex. Many times compatibility is a limitation for breeding.

**Q. 18** What is emasculation? Why and when is it done?

**Ans.** Removal of stamens from the bisexual flower that is used as a female parent in plant hybridisation is called emasculation. This is done to avoid unwanted self-pollination. This has to be done at bud condition before the anthers dehisce.

**Q. 19** Discuss the two main limitations of plant hybridisation programme.

**Ans.** *The limitations of plant hybridisation programme include*

- (i) Availability of a limited number of identified disease resistant genes that are present in various crop varieties or wild relatives.
- (ii) Compatibility of parents.
- (iii) Time consuming and tedious process.

**Q. 20** Interspecific crosses are rare in nature and intergeneric crosses almost unknown. Why?

**Ans.** In interspecific crosses, male and female animals of two different related species are mated. In some cases, the progeny may combine desirable features of both the parents, and may be of considerable economic value, e.g., the mule.

An interspecific hybrid's fertility varies. Many of *Panthera* (ligers, tigons leopons etc.) hybrid males are infertile, while the female counterparts can breed with the species she contains (female ligers can breed with a lion or a tiger to produce li-ligers or ti-tigers). These are rare in nature.

Intergeneric hybridisation is the crossing of two different animals/plants of different genus. It is almost unknown in nature. Intergeneric hybrids more or less never form complete zygotes/embryos. These are sterile/infertile.

**Q. 21** Differentiate between pisciculture and aquaculture.

**Ans.** Fish farming in isolated water bodies is called pisciculture.

Similarly, when culturing of aquatic plants and animals is done in freshwater bodies, it is called aquaculture.

**Q. 22** Give two important contribution of Dr. MS Swaminathan.

**💡 Thinking Process**

*Green revolution which was responsible for not merely meeting the national requirement in food production but also helped us to export it. It was due to the initiative taken by **Dr. MS Swaminathan** in collaboration with **Dr. N. Borlaug**.*

**Ans.** Contributions of Dr. MS Swaminathan are as follows

- (i) Introduction of short, high yielding varieties of wheat in India.
- (ii) Development of short duration, high yielding varieties of rice.

**Q. 23** The term 'desirable trait' can mean different things for different plants. Justify the statement with suitable examples.

**💡 Thinking Process**

*Plant breeding is the purposeful manipulation of plant species in order to create plants with desirable traits.*

**Ans.** The desirable trait can be different for different for different plants. The breeders have tried to incorporate these into crop plants. *The list may be as follows*

- (i) Increased tolerance to environmental stress (salinity, extreme temperature, drought) e.g., hybrid maize, jowar and bajra which are resistant to water stress.
- (ii) Resistance to pathogens (viruses, fungi and bacteria) e.g., moong bean (resistance to yellow mosaic virus and powdery mildew).
- (iii) Increased tolerance to insect pests. e.g., a new variety of *Brassica* (rapeseed mustard) is resistant to aphids.
- (iv) High-yielding and improved quality of crop plant. e.g., Atlas 66 used as a donor for developing wheat varieties with improved protein content.

## Short Answer Type Questions

**Q. 1** You are planning to set up a dairy farm. Describe the various aspects you would consider before you start the venture.

**Ans.** *The following aspects are required to be considered*

- (i) Good breeds with high-yielding potential should be kept.
- (ii) Cattle should be fed in scientific manner with good quality and quantity of fodder.
- (iii) Animal shed should be kept clean, away from dirt and pollution.
- (iv) Cattle and handler should be kept in hygienic condition.
- (v) Regular visit by veterinary doctors with proper record is needed.
- (vi) Cattle should be housed well with adequate water and conditions should be disease-free.

**Q. 2** It is said, that diseases are spreading faster due to globalisation and increased movement of people. Justify the statement taking the example of H<sub>5</sub>N<sub>1</sub> virus.

**Ans.** The avian flu (bird flu) is a current and significant issue involving the global environment as well as the health of millions of people around the world. The H<sub>5</sub>N<sub>1</sub> virus (influenza-A) occurs mainly in birds, is highly contagious among them and can be deadly.

The major global environmental issue that plays a large role in the advancement of the H<sub>5</sub>N<sub>1</sub> avian influenza virus is globalisation. *i.e.*, increasing integration of countries.

Through globalisation, the progression of the H<sub>5</sub>N<sub>1</sub> avian influenza virus occur through the world at a pace faster than scientists can anticipate, and also technology and research cannot possibly keep up. Globalisation will give the H<sub>5</sub>N<sub>1</sub> avian influenza virus an opportunity to travel to various parts of the world without impediment.

Once, it has developed the ability to spread easily from human to human, the major concern becomes the travel of individuals around the world, particularly air travel. Through air travel, an infected individual could infect dozens of people during their movement, those newly infected individuals would in turn, infect dozens more, and so on and so forth.

**Q. 3** Explain the concept of the blue revolution.

**Ans.** The term 'Blue Revolution' refers to the remarkable emergence of aquaculture as an important and highly productive agricultural activity.

Aquaculture refers to all forms of active culturing of aquatic animals (including fish) and plants, occurring in marine, brackish or freshwater.

**Q. 4** A farmer was facing the problem of low yield from his farm. He was advised to keep a beehive in the vicinity. Why? How would the beehive help in enhancing yield?

**Ans.** Bee keeping or apiculture is an important enterprise of agriculture concerned with the maintenance of hives of honeybees for the commercial production of honey and wax. Bee keeping is a low investment, less problematic and highly profitable cottage industry.

The beehives when kept in the fields of sunflower, *Brassica*, apple and pear, increase the pollination efficiency of flowering plants and improve the yields.

**Q. 5** Life style diseases are increasing alarmingly in India. We are also dealing with large scale malnutrition in the population. Is there any method by which we can address both of these problems together?

**Ans.** To address both these problems biofortification can be done. This area focuses at improving food quality with respect to protein, oil, vitamin, micronutrient and mineral content. The oils need to be rich in omega 3 fatty acids which are good for heart.

Similarly, proteins should have more of lysine and tryptophan (essential amino acids). Many varieties of maize, carrots and spinach have been released which fulfill the above criteria.

**Q. 6** How can we improve the success rate of fertilisation during artificial insemination in animal husbandry programmes?

**Ans.** To improve chances of successful production of hybrids many means are used. One such programme is called MOET or Multiple Ovulation Embryo Transfer. During this procedure, a cow is given hormonal treatment so that more than one ovule (6-8 eggs) is produced per cycle.

After mating or artificial insemination, the embryos at 8-32 celled state are transferred to different surrogate mothers. The method has been successfully used for cattle, sheep, buffalo, etc.

**Q. 7** What is meant by germplasm collection? What are its benefits?

**Ans.** The collection of all the diverse alleles of all the genes of a crop plant is called germplasm collection. It is of great benefits in plant breeding programmes as it offers, to the breeders, the entire of genes and alleles and the characteristics which a plant expresses.

The breeder selects the most favourable characters of a particular gene, manipulates it and transfers to a desirable parent.

**Q. 8** Name the improved characteristics of wheat that helped India to achieve green revolution.

**Ans.** *Improved characteristics of wheat that helped India to achieve green revolution are*

- (i) Semi-dwarf nature
- (ii) Quick yielding feature
- (iii) High yielding feature
- (iv) Disease resistance

**Q. 9** Suggest some of the features of plants that will prevent insect and pest infestation.

**Ans.** *Features of plants that will prevent insect and pest infestation are*

- (i) Increasing hair growth on aerial parts of plants.
- (ii) Rendering the flowers nectarless.
- (iii) Enabling plants to secrete insect killing chemicals (toxins).

**Q. 10** It is easier to culture plant cells *in vitro* as compared to animal cells. Why?

**Ans.** It is easier to culture the plant cells *in vitro* as compared to animal cells because, the plant cells have the property to grow into a new plant. This property of plant cell is termed as totipotency. This ability is limited in animal cells.

**Q. 11** The culture medium (nutrient medium) can be referred to as a 'highly enriched laboratory soil'. Justify the statement.

**Ans.** Culture medium is a highly enriched laboratory soil as it provides all the necessary requirements, e.g., carbon source such as sucrose and inorganic salts, vitamins, amino acids and growth regulators like auxins and cytokinins, etc., to the growing plant.

**Q. 12** Is there any relationship between dedifferentiation and the higher degree of success achieved in plant tissue culture experiments?

**Ans.** Yes, When a cell dedifferentiates once, it gets regressed back to its embryonic stage and then can again differentiate into any form of tissue. So, the plant tissue culture can be more successful as any kind of tissue can be produced even from differentiated cells.

**Q. 13** Give me a living cell of any plant and I will give you a thousand plants of the same type", Is this only a slogan or is it scientifically possible? Write your comments and justify them.

**Ans.** It is scientifically possible to grow thousand plants from a living cell of any plant and this process is called micropropagation. The property of plant cells that helped them to grow into a new plant is totipotency.

Micropropagation is the use of plant cell culture to regenerate large number of plants. This results in genetically identical plants and is also called clonal propagation.

Hence, the desirable characters are kept constant for many generations. Micropropagation is widely used in forestry and in floriculture. Plants can be obtained throughout the year under controlled conditions.

**Q. 14** What is the difference between a breed and a species? Give an example for each category.

**Ans.** A breed is a specific group of animals or plants having homogenous appearance, behaviour and other characteristics that distinguish it from other animals or plants of the same species, e.g., Afghan shepherd, American bulldog are breeds of dog.

Species is one of the basic units of biological classification and a taxonomic rank. It can be defined as the largest group of organisms capable of interbreeding and producing fertile offspring. e.g., lion, cow, dog are species.

**Q. 15** Plants raised through tissue cultures are clones of the 'parent' plant. Discuss the utility of these plants.

**Ans.** Plants raised through tissue culture are very useful because they are identical copy of the parent plant. This is of great use when desirable traits of the parent plant have to be maintained.

**Q. 16** Discuss the importance of testing of new plant varieties in a geographically vast country like India.

**Ans.** Before the new plants are generated through plant breeding programs, they need to be evaluated for their yield and other agronomic traits of quality, disease resistance, etc.

The testing is done on the farmers' field for at least three growing seasons, at different locations in the country representing all the agroclimatic zones, where the crop is usually grown. The material is evaluated in comparison to the best available local crop cultivar known as a check or reference cultivar.

**Q. 17** Define the term 'stress' for plants. Discuss briefly the two types of stress encountered by plants.

**Ans.** Stress for plants can be defined as any external factor that negatively influences plant growth, productivity, reproductive capacity or survival. This includes a wide range of factors which can be broadly divided into abiotic or environmental stress factors like salinity, extreme temperatures, drought, etc., and biotic or biological stress factors.

**Q. 18** Discuss natural selection and artificial selection. What are the implications of the latter on the process of evolution?

**Ans.** Natural selection is a gradual, non-random process by which biological traits become either more or less common in a population as a function of differential reproduction of their bearers. It is a key mechanism to evolution.

In natural selection the environment acts as a sieve through which only certain variations can pass.

Artificial selection is a process in which animals and plants with desirable traits are considered by human breeders and favoured for reproduction. It is an artificial mechanism by which evolution can occur.

It is also called selective breeding as it promotes traits that suit human preferences. In contrast to natural selection, here the evolution is intentional or guided.

**Q. 19** Discuss briefly how pure lines are created in animal husbandry.

**💡 Thinking Process**

*Inbreeding increases homozygosity.*

**Ans.** When breeding is between animals of the same breed, it is called inbreeding. If we want to evolve a pureline in any animal, inbreeding (for 4-6 generation) is necessary. It also helps in accumulation of superior genes and elimination of less desirable genes by increasing homozygosity.

**Q. 20** What are the physical barriers of a cell in the protoplast fusion experiment? How are the barriers overcome?

**Ans.** Cell wall is the most important physical barrier in protoplast fusion experiments. This can be overcome by treatment with enzymes like cellulase and pectinase which have the ability to digest the cell wall and liberate the naked protoplast surrounded only by the cell membrane.

**Q. 21** Give few examples of biofortified crops. What benefits do they offer to the society?

**Ans.** Maize, wheat, rice, bathua, spinach, pulses have biofortified varieties. Maize hybrids have twice the amount of amino acids, fortified wheat variety has high protein content, fortified rice has high quantity of iron.

Consumption of such biofortified foods will enrich the nutritive value of our common foods and will vastly improve public health.

Instead of consuming different food items for obtaining different nutrients, if 2 or 3 nutrients can be incorporated into a single crop, it would offer enormous benefits to human beings and may even help to overcome several nutrient deficiency disorders latent in our country.

## Long Answer Type Questions

**Q. 1** You are a Botanist working in the area of plant breeding. Describe the various steps that you will undertake to release a new variety.

**Ans.** Plant breeding programmes are carried out in a systematic way world wide-in government institutions and commercial companies.

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

(i) **Collection of Variability** Genetic variability is the root of any breeding programme. In many crops pre-existing genetic variability is available from wild relatives of the crop.

Collection and preservation of all the different wild varieties, species and relatives of the cultivated species (followed by their evaluation for their characteristics) is a pre-requisite for effective exploitation of natural genes available in the populations.

The entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called germplasm collection.

(ii) **Evaluation and Selection of Parents** The germplasm is evaluated so as to identify plants with desirable combination of characters. The selected plants are multiplied and used in the process of hybridisation. Purelines are created wherever desirable and possible.

(iii) **Cross Hybridisation Among the Selected Parents** The desired characters have very often to be combined from two different plants (parents), e.g., high protein quality of one parent may need to be combined with disease resistance from another parent.

This is possible by cross hybridising the two parents to produce hybrids that genetically combine the desired characters in one plant. This is a very time-consuming and tedious process since the pollen grains from the desirable plant chosen as male parent have to be collected and placed on the stigma of the flowers selected as female parent.

Also, it is not necessary that the hybrids do combine the desirable characters, usually only one in few hundred to a thousand crosses shows the desirable combination.

(iv) **Selection and Testing of Superior Recombinants** This step consists of selecting, among the progeny of the hybrids, those plants that have the desired character combination. The selection process is crucial to the success of the breeding objective and requires careful scientific evaluation of the progeny.

This step yields plants that are superior to both of the parents (very often more than one superior progeny plant may become available). These are self-pollinated for several generations till they reach a state of uniformity (homozygosity), so that the characters will not segregate in the progeny.

(v) **Testing, Release and Commercialisation of New Cultivars** The newly selected lines are evaluated for their yield and other agronomic traits of quality, disease resistance, etc.

This evaluation is done by growing these in the research fields and recording their performance under ideal fertiliser application, irrigation and other crop management practices.

The evaluation in research fields is followed by testing the materials in farmers' fields, for at least three growing seasons at several locations in the country, representing all the agroclimatic zones when the crop is usually grown.

The material is evaluated in comparison to the best available local crop. After evaluation the variety can be released for the farmers.



**Q. 2** (a) The shift from grain to meat diets creates more demands for cereals. Why?

(b) A 250 kg cow produces 200 g of protein per day but 250 g of *Methylophilus methylotrophus* can produce 25 tonnes of protein. Name this emerging area of research. Explain its benefits.

**Ans. (a)** The shift from grain to meat diets creates more demand for cereals as it takes 3-10 kg of grain to produce 1 kg of meat by animal farming.

(b) This research is related to single cell protein.

Microbes are being grown on an industrial scale as a source of good protein. Microbes like *Spirulina* can be grown easily on materials like wastewater from potato processing plants (containing starch), straw, molasses, animal manure and even sewage, to produce large quantities and can serve as food rich in protein, minerals, fats, carbohydrate and vitamins.

Such utilisation also reduces the environmental pollution.

**Q. 3** What are the advantages of tissue culture methods over conventional method of plant breeding in crop improvement programmes?

**Ans.** As traditional (conventional) breeding methods failed to keep pace with demand and to sufficiently provide fast and efficient systems for crop improvement, another technology called tissue culture developed.

*The advantages of tissue culture over conventional breeding are as follows*

- (i) It can be used to produce large number of plantlets within a short period by micropropagation.
- (ii) All cells in the culture are derived from a single explant by mitotic division, therefore all have the similar genotype and constitute a clone.
- (iii) Tolerance to stress can be obtained by providing pollutants, toxins, salts, etc., in culture medium in increasing dosage. The surviving healthy cells are selected for raising resistant plants.
- (iv) Virus free plantlets can be obtained by meristem culture.
- (v) Embryos which do not survive inside seeds can be grown by tissue culture to form new plants.

**Q. 4** 'Modern methods of breeding animals and plants can alleviate the global food shortage'. Comment on the statement and give suitable examples.

**Ans.** With ever increasing population of the world, enhancement of food production is a major necessity. Modern biological principles as applied to animal husbandry and plant breeding have a major role in our efforts to increase food production. These modern techniques include embryo transfer technology and tissue culture techniques.

Multiple Ovulation Embryo Transfer Technology (MOET) is a programme for herd improvement in animals like cattle, sheep, rabbits, buffaloes, mares, etc.

High milk-yielding breeds of female are bred with high quality meat-yielding (meat with less lipid) bulls to increase herd size. It ensures good quality of progeny. It is also economic and time saving process to obtain the desirable progeny.

The procedure for MOET is as follows

- (i) A cow is administered hormones with FSH-like activity to induce follicular maturation and super-ovulation.
- (ii) The cow produces 6-8 eggs instead of one egg produced normally.
- (iii) It is now, either mated with an elite bull or artificial insemination is carried out.
- (iv) When the fertilised eggs attain 8-32 cells stage, they are non-surgically removed and transferred to a surrogate mother.
- (v) The genetic mother can now be again super ovulated.

Modern methods in plant breeding involves following

- (i) Tissue culture is an *in vitro* technique of regeneration of a whole plant from any part of a plant (explant) by growing it on culture medium under aseptic conditions.
- (ii) Biofortification is the method for developing crops with higher levels of vitamins, minerals, proteins and healthier fats to improve public health.
- (iii) Single cell protein is an alternative protein source for animal and human nutrition from certain beneficial microorganisms like *Spirulina*.

**Q. 5** Does apiculture offer multiple advantages to farmers? List its advantages if it is located near a place of commercial flower cultivation.

**Ans.** Yes, apiculture offers many advantages to farmers such as

- (i) Honey produced by honeybees is a food of high nutritive value.
- (ii) It is used in the indigenous system of medicine.
- (iii) Honeybee also produces beeswax, which is used in the preparation of cosmetics and polishes of various kinds.

If apiculture is done near a place of commercial flower cultivation it offers several advantages. Bees are the pollinators of many crop species such as sunflower, *Brassica*, apple and pear. *Keeping beehives in crop fields during flowering period*

- (i) Increases pollination efficiency.
- (ii) Improves the yield which is beneficial both from the point of view of crop yield and honey yield.

**Q. 6** (a) Mutations are beneficial for plant breeding. Taking an example, justify the statement.  
(b) Discuss briefly the technology that made us self-sufficient in food production.

**💡 Thinking Process**

*Mutation is the process by which genetic variations are created through changes in the base sequence within genes resulting in the creation of a new character or trait not found in the parental type.*

**Ans. (a)** It is possible to induce mutations artificially in plants through use of chemicals or radiations (like gamma radiations), and then selecting and using those plants that have the desirable character as a source in breeding.

This process is called mutation breeding. In mung bean, resistance to yellow mosaic virus and powdery mildew was induced by mutations.

- (b) Traditional farming can only yield a limited biomass, as food for humans and animals. Better management practices and increase in agricultural land area can increase yield, but only to a limited extent. Plant breeding as a technology has helped increase production to a very large extent.

Plant breeding is the purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.

This technology has given support to green revolution, which was responsible for not merely meeting the national requirements in food production, but also helped us to export it.

**Q. 7** Discuss how the property of plant cell totipotency has been utilised for plant propagation and improvement.

**💡 Thinking Process**

*The property of plant cells that helped them to grow into a new plant is totipotency. The production of healthy plantlet by rapid vegetative multiplication is done under aseptic and controlled conditions.*

**Ans.** Plant cell totipotency can be utilised for plant propagation and improvement

- (i) By application of these methods it is possible to achieve propagation of a large number of plants in very short time. Plants like tomato, banana, apple, etc., have been produced on commercial scale.
- (ii) Healthy plants can be recovered from diseased plants (by micropropagation). This is done by removing the meristem, which is disease-free and growing it *in vitro*. This has been done in banana, sugarcane potato, etc.

**Q. 8** What are three options to increase food production? Discuss each giving the salient features, merits and demerits.

**Ans.** Traditional farming can only yield a limited biomass as food for humans and animals. Better management practices and increase in agricultural land can increase yield, but only to a limited extent.

*Following are the three options to increase food production*

(a) **Single Cell Protein**

The biomass obtained from microorganisms can be treated or processed in industry to be used as food and is called single cell protein.

**Merits of Single Cell Proteins**

- (i) Its production reduces pollution as it uses organic wastes and industrial effluents.
- (ii) It provides a protein-rich diet.
- (iii) It fulfills the demand of protein for human diet and takes off the pressure on agriculture system.

**Demerits of Single Cell Protein**

- (i) Sometimes the microbial biomass when taken as diet supplement may lead to allergic reactions.
- (ii) Many types of microorganisms produce substances which are toxic to the humans and also to the animals.

(b) **Biofortification**

It is the method for developing crops with higher levels of vitamins, minerals proteins and healthier fats to improve public health.

**Merits of Biofortification**

- (i) It can increase yields grown on the same or less acreage.
- (ii) It can potentially improve nutritional value or other health benefits.

**Demerits of Biofortification**

- (i) Its successful implementation into society requires safe delivery systems, stable policies, appropriate social infrastructures.
- (ii) It continued by financial support also.

(c) **Tissue-Culture**

It is an *in vitro* technique for regeneration of a whole plant from any part of a plant by growing it on culture medium under aseptic conditions.

**Merits of Tissue Culture**

- (i) A large number of plants can be grown in short time.
- (ii) Disease-free plants can be multiplied.
- (iii) Seedless plants can be multiplied
- (iv) The plants where sexual reproduction is absent may undergo somatic hybridisation.

**Demerits of Tissue Culture**

- (i) It requires great expense because it needs latest techniques in the laboratory.
- (ii) It requires acclimatisation of plants grown by tissue culture to the external environment.
- (iii) It requires special expertise.