CHAPTER

9 STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

Syllabus

➢ ***Improvement in food production :*** *Plant breeding, tissue culture, single cell protein, Biofortification, Apiculture and Animal husbandry.*

Chapter Analysis

List of Topics		2016		2017		2018
		D	OD	D	OD	D/OD
Animal husbandry	• Animal breeding (inbreeding/out breeding) • Inbreeding depression • Controlled breeding experiments- MOET	1 Q (1 M)	1 Q (1 M)	1 Q (3 M)	1 Q (1 M)	1 Q (2 M) 1 Q (3 M)
Plant Breeding	• Fill in the table type on crop variety • Resistant crop variety • Indian hybrid crops- Sugarcane • Plant breeding technique	1 Q (2 M) 1 Q (3 M)		1 Q (2 M)	1 Q (3 M)	
Tissue Culture	• Tissue culture • Micro-propagation		1 Q (3 M)			

- *On the above analysis, it can be concluded that topics like methods of animal breeding (inbreeding/ outcrossing/ MOET), Indian hybrid crops like sugarcane, Fill in the table type on crop variety, Tissue culture and micropropagation are important topics from this chapter.*

TOPIC-1
Animal Husbandry

Revision Notes

➢ With ever-increasing population of the world, enhancement of food production is a major necessity. Biological principles as applied to animal husbandry and plant breeding have a major role in our efforts to increase food production. Several new techniques like embryo transfer technology and tissue culture techniques are going to play a pivotal role in further enhancing food production.

Animal Husbandry

➢ It is the agricultural practice of breeding and raising livestock by applying scientific principles.

➢ It deals with the care and breeding of livestock such as buffaloes, cows, pigs, horses, cattle, sheep, camels, goats, bees, silkworms, etc. and poultry farming and fisheries, which are useful to humans.

- More than 70% of the world's livestock population is in India and China.
- However, the contribution to the world's farm produce is only 25% *i.e.* the productivity per unit is very low. Hence, the new technologies have to be applied to achieve improvement in quality and productivity.

Dairy Farm Management (Dairying)

- It is the management of animals for increasing yield and quality of milk and its products for human consumption.
- It deals with the processes and systems to improve quality and quantity of milk.
- Milk yield depends on the quality of breeds in the farm.
- The selection of good breeds having high yielding potential and resistance to diseases is important.
- For the yield potential :
  - The cattle have to be well looked after i.e. they have to be housed well, should have adequate water and maintained disease free.
  - The feeding of cattle should be carried out in a scientific manner i.e. with special emphasis on the quality and quantity of fodder.
  - Stringent cleanliness, hygiene of cattle and handlers while milking, storage and transport of the milk.
- Now-a-days, these processes have mechanized and so the chance of direct contact of the produce with the handler has been reduced.
- **To ensure stringent measures there should be :**
  (i) Regular inspections with proper record keeping which helps to identify and rectify the problems.
  (ii) Regular visits by a veterinary doctor.

Poultry Farm Management

- Poultry is the domesticated fowls (birds) used for food or eggs. Examples – chicken, ducks, turkey and geese.
- **Important Parameters of poultry farm management :**
  - Selection of disease free and suitable breeds.
  - Proper feed and water.
  - Proper and safe farm conditions.
  - Hygiene and health care of birds.

Animal Breeding

- A breed is a group of animals related by descent and similar in general appearance, features, size etc.
- Breeding is the modification of genotype of an organism to make that organism more useful to humans.
- The objective of animal breeding is to increase the animal yield and to improve the desirable qualities of the produce.

Types of Breeding

- Breeding is of two types namely inbreeding and out-breeding.

(a) Inbreeding

- It is the mating of more closely related individuals within the same breed for 4-6 generations.
- The procedure of inbreeding is as follows :
- Superior males and superior females of the same breed are identified and mated in pairs.
- The progeny obtained are evaluated and superior males and females among them are identified for further mating.
- In cattle, a superior female is the cow that produces more milk per lactation.
- A superior male (bull) gives rise to superior progenies.

Advantages of Inbreeding

- It increases homozygosity to evolve a pure line animal.
- It exposes harmful recessive genes that are eliminated by selection.
- It helps in accumulation of superior genes and elimination of less desirable genes. This approach increases the productivity of inbred population.

Disadvantages of Inbreeding

- Continued inbreeding especially close inbreeding may reduce fertility and productivity. This is called inbreeding **depression.** To solve this problem, selected animals should be mated with unrelated superior animals of the same breed.

(b) Out-breeding

- It is the breeding of the unrelated animals.
- It is of three types namely out-crossing, cross-breeding and inter-specific hybridization.

(i) Out-crossing

- It involves mating the animals of different breeds or same breed that have no common ancestors on either side of their pedigree up to 4-6 generations.
- The offspring of such a mating is known as out-cross.
- It is the best method to increase milk production in animals having low milk productivity growth rate in cattle etc.

- It helps to overcome inbreeding depression.
- The objective of out-crossing is to enhance genetic diversity.

(ii) Cross-breeding

- In this method, superior males of one breed are mated with superior females of another breed.
- The desirable qualities of 2 different breeds are combined into a progeny.
- The hybrid progeny animals may be used for commercial production or may be subjected to inbreeding and selection to develop new stable superior breeds *e.g.* Hisardale (sheep) developed in Punjab by crossing *Bikaneri ewes* and *Marino rams*.

(iii) Interspecific hybridization

- It involves the mating of male and female animals of two different species, which produces interspecific hybrids.
- In some cases, the progeny may combine desirable features of both the parents and may be of considerable economic value *e.g.* Mule, a cross between male ass with female horse.

Artificial insemination

- In this method, the semen collected from selected male parent is injected into the reproductive tract of selected female by the breeder.
- The semen may be used immediately or can be frozen and used later.
- It can also be transported in a frozen form to where the female is housed.
- The success rate of crossing mature male and female animals is low even though artificial insemination is carried out.

Multiple Ovulation Embryo Transfer (MOET) Technology

- It is a programme for herd improvement in animals like cattle, sheep, buffaloes etc.
- In this a cow is administered hormones with FSH-like activity, to induce follicular maturation and super ovulation *i.e.* production of 6-8 eggs instead of one egg per cycle.
- The animal is either mated with an elite bull or artificially inseminated.
- Fertilised eggs at 8–32 cells stages are recovered non surgically and transferred to surrogate mothers.
- This technology has been demonstrated for cattle, sheep, rabbits, buffaloes, mares, etc.
- High milk yielding breeds of females and high quality, meat-yielding bulls have been bred successfully to increase herd size in a short time.

Bee-keeping (Apiculture)

- It is the maintenance of hives of honeybees for the production of honey and beeswax.
- Honey is a miracle food of high nutritive and medicinal value.
- Beeswax is used for preparation of cosmetics, polishes, etc.
- Bee-keeping can be practiced in any area where there are sufficient bee pastures of some wild shrubs, fruit orchards and cultivated crops.
- Most common species that can be reared is *Apis indica*.
- Bees are the pollinators of many of our crop species such as sunflower, *Brassica,* apple and pear.
- Keeping beehives in crop fields during flowering period increases pollination. It improves both crop yield and honey yield.
- **A successful bee keeping requires :**
  - **(i)** Knowledge of the nature and habits of bees.
  - **(ii)** Selection of suitable location for keeping beehives.
  - **(iii)** Catching and hiving of swarms (group of bees).
  - **(iv)** Management of beehives during different seasons
  - **(v)** Handling and collection of honey and beeswax.

Fisheries

- Fishery is an industry of catching, processing or selling of fish, shellfish or other aquatic animals such as prawn, crab, lobster, edible oyster, etc.
- The freshwater fishes include *Catla, Rohu*, common carp, etc.
- The edible marine fishes include *Hilsa*, Sardines, Mackerel, Pomfrets, etc.
- Fisheries provide income and employment to millions of fishermen and farmers particularly of coastal region.

Techniques to Increase the Production of Aquatic Plants and Animals

- **(a) Aquaculture :** Rearing and management of useful aquatic plants and animals like fish, oysters and prawn etc. is called aquaculture.
- **(b) Pisciculture :** It is the rearing, catching and management of fish. It has led to the development of fishery industry.
- **Blue Revolution :** It is the increased production of fish and fish produce which has led to the development and flourishing of the fishery industry. It was started in our country India during about 1960 along with the Green revolution and white revolution.

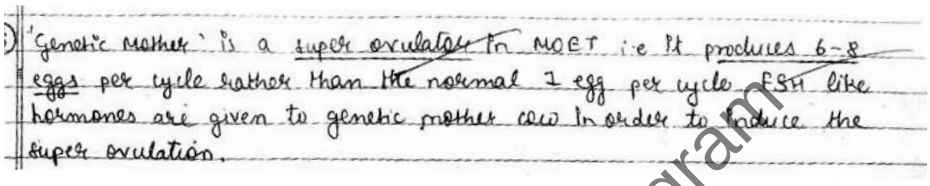
Very Short Answer Type Questions (1 mark each)

Q. 1. Mention the role of 'genetic mother' in MOET. A [Outside Delhi Set-I, 2016]

Ans. The MOET (Multiple Ovulation Embryo Transfer) is the programme used to enhance the herd size in a short time. In this programme the genetic mother is administrated hormones with FSH like activity, to induce follicular maturation and super ovulation. As a result 6-8 eggs are produced instead of one per cycle. After fertilisation, the eggs are transferred to surrogate mothers at 8-32 cell stage for further development. The genetic mother can be then used for another round of super ovulation. **1**

[CBSE Marking Scheme, 2016]

OR


'Genetic mother' is a super ovulator in MOET i.e it produces 6-8 eggs per cycle rather than the normal 1 egg per cycle. FSH like hormones are given to genetic mother cow in order to induce the super ovulation.

[Topper's Answer, 2016]

Commonly Made Error

- Instead of MOET, which is used in cattle, many student explains about GIFT and ZIFT in humans. Many of them confuse MOET with artificial insemination.

Answering Tip

- Revise the concept of MOET in detail. Abbreviations when elaborated should have correct spellings.

AI **Q. 2. Suggest the breeding method most suitable for animals that are below average in milk productivity.** A **[Delhi Set-I, 2016]**

OR

Write professional approach at genetic level that can help the farmer to improve the milk yield of low milk producing cows on his farm.

[Delhi Comptt., 2013]

Ans. Outcrossing or outbreeding or cross breeding is the most suitable breeding method for animal, that are below average in milk productivity. **1**

[CBSE Marking Scheme, 2016]

Q. 3. Mention the economic value of *Apis indica*. R **[Delhi Set-I, Comptt. 2015]**

Ans. *Apis indica* is a common species of honey bee used in apiculture. It is also useful in agriculture yield / honey / bee wax / pollination. **1**

Q. 4. Write the name of the following :

(i) The most common species of bees suitable for apiculture.

(ii) An improved breed of chicken

R **[Outside Delhi Set-I, 2012]**

Ans. **(i)** *Apis indica / Apis mellifera / Apis dorsata* ½

(ii) *White Leghorn / Rhode Island Red / Minorca* ½

Q. 5. Write the importance of MOET.

R **[Delhi Set-I, 2013]**

Ans. MOET (Multiple Ovulation Embryo Transfer) technology is a programme which is used (i) to increase the herd size within a short time (ii) to improve the chances of successful production of hybrids and (iii) to obtain higher milk yielding cattle. **(Any one) 1**

Commonly Made Error

- Students instead of writing about importance, they start explaining the procedure.

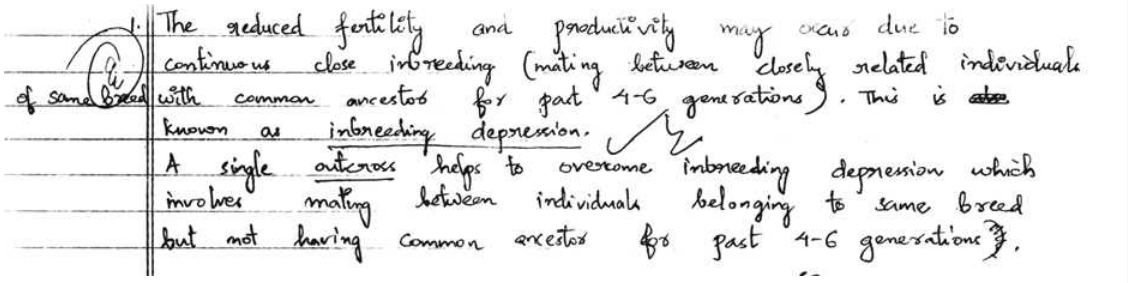
Q. 6. A herd of cattle is showing reduced fertility and productivity. Provide one reason and one suggestion to overcome this problem. R **[Outside Delhi 2017, Set - I, II, III]**

Ans. **Reason :** Inbreeding depression or continuous inbreeding. ½

Suggestion : Should be mated with unrelated superior cattle of the same breed or out - breeding or out - crossing ½

[CBSE Marking Scheme, 2017]

OR


The reduced fertility and productivity may occur due to continuous close inbreeding (mating between closely related individuals of same breed with common ancestor for past 4-6 generations). This is known as inbreeding depression.
A single outcross helps to overcome inbreeding depression which involves mating between individuals belonging to same breed but not having common ancestor for past 4-6 generations.

[Topper's Answer, 2017]

Commonly Made Error

- Students write irrelevant stories. Be specific. Read question carefully and write only what is asked.

Q. 7. Name any interspecific hybrid mammal.

R **[Delhi Set-I, 2012]**

Ans. Mule is an interspecific hybrid mammal. It is obtained by following cross : Female horse (Mare) × Male donkey. 1

AI **Q. 8. Which one of the following is used in apiculture : Hilsa, *Apis indica*, Sonalika.** R **[Foreign 2009]**

Ans. *Apis indica*. 1

Q. 9. Mention the strategy used to increase homozygosity in cattle for desired traits.

A **[Outside Delhi 2009]**

Ans. Inbreeding increases homozygosity. It is the mating of related individuals of the same breed for 4-6 generations. **1**

Q. 10. List any two economically important products for humans obtained from *Apis indica.*

R **[Delhi 2008]**

Ans. **(i)** Honey **(ii)** Bee wax. ½+½

Short Answer Type Questions-I **(2 marks each)**

Q. 1. (i) Why is inbreeding necessary ? Give two reason. (ii) What does continued inbreeding lead to ?

R **[Outside Delhi Set-II, Compt. 2016]**

Ans. **(i)** Inbreeding is necessary if we want to evolve a pure line in any animal / plant.
(ii) Inbreeding exposes harmful recessive genes that are eliminated by selection leading to accumulation of superior genes. Continued inbreeding reduces fertility and productivity (Inbreeding depression).
[CBSE Marking Scheme, 2016] 2

Q. 2. What kind of areas are suitable for practicing apiculture? Write the scientific name of the variety commonly reared for the purpose.

U **[Foreign Set-I, 2016]**

Ans. Bee pastures of wild shrub, fruit orchards, cultivated crop. *Apis indica*
[CBSE Marking Scheme, 2016] 2

Detailed Answer :

Apiculture (Bee Keeping) can be practised in any area where there are sufficient bee pastures of some wild shrubs, fruits orchards and cultivated crops. Most common variety that is reared for this purpose is *Apis indica.*

Q. 3. Success rate of artificial insemination in cattle is fairly low. Identify any other technique to improve the successful production of hybrids. State two advantages of this technique. A **[SQP, 2016-17]**

Ans. Multiple Ovulation Embryo Transfer Technology increases herd size, in a short time. **1+1**
[CBSE Marking Scheme, 2016]

Detailed Answer :

Controlled breeding of cattle is carried out by artificial insemination but the success rate is low. This can be overcome by MOET (Multiple Ovulation Embryo Transfer) technique.

This techniques helps to improve the successful production of hybrids and also to increase the herd size.

Answering Tip

- Carefully understand the concept of controlled breeding in cattles. Students often get confused between artificial insemination and MOET. Learn the differences point wise in a tabular form for better retention and understanding.

AI **Q. 4. State the disadvantage of inbreeding among cattle. How it can be overcome ?**

U **[Delhi Set-I, II, 2014, 2011]**

Ans. It leads to reduction in the fertility and productivity of an organism due to continuous inbreeding. This is also known as inbreeding depression. **1**

It can be overcome by outbreeding or out-crossing, in which mating is done between different selected unrelated superiors or individuals of the same breed having no common ancestors. **1**

Answering Tip

- Charts and interactive boards can be used to understand the concept of inbreeding. Emphasize upon their advantages and disadvantages.

Q. 5. Explain inbreeding depression and how it can be overcome. U **[Delhi Set-III, 2013]**

OR

How does inbreeding depression set in ? Mention the procedure you would suggest to reverse this. [Outside Delhi Comptt. 2011]

Ans. Continuous inbreeding among cattle causes inbreeding depression. It decreases the fertility and productivity of an animal. It can be overcome by applying outbreeding, in which mating is done between different breeds or individuals of the same breed but having no common ancestors. Outbreeding includes out-crossing, cross-breeding and interspecific hybridisation. **1 + 1 = 2**

Q. 6. In MOET technology, two 'mothers' are needed to produce one calf. Justify. U **[Foreign, Set - II, 2017]**

Ans. One mother contributes fertilised eggs (8-32 cell stage), the other is surrogate. **1 × 2 = 2**

[CBSE Marking Scheme, 2017]

Detailed Answer.

In MOET, the genetic mother produces 6 - 8 eggs per cycle. After fertilisation, the eggs are transferred to surrogate mother at 8 - 32 cell stage for further development.

Q. 7. What is outbreeding ? Mention any two ways it can be carried out. R **[Foreign, Set - I, 2017]**

Ans. Breeding of unrelated animals from the same breed having no common ancestors for 4 – 6 generations. ½ +½

Outcrossing or cross breeding or interspecific hybridisation. **(Any two)** ½ +½

[CBSE Marking Scheme, 2017]

Detailed Answer :

Outbreeding is the breeding of the unrelated animals. It is of three types namely,

(i) Outcrossing

(ii) Cross - breeding

(iii) Inter - specific hybridization.

AI **Q. 8. A farmer maintained beehives in his *Brassica* field during its flowering season. How will he be benefitted?** A **[CBSE SQP, 2018]**

OR

Keeping beehives in crop fields has several advantages. List any two. [CBSE SQP, 2015]

OR

Why are beehives kept in crop field during flowering period ? [Delhi Set-I, 2011]

Ans. Keeping beehives in crop fields during flowering period increases pollination efficiency and improves the yield– crop yield and honey yield. **1 +1**

[CBSE Marking Scheme, 2018]

Detailed Answer:

(i) Keeping bee hives in crop field increases the pollination efficiency and improves the crop yield.

(ii) Bees collect nectar from the flowers of crop plants to make honey and thus honey yield is also increased.

Answering Tip

- Understand the advantages of keeping beehives in crop field during flowering plant.

Q. 9. How is pure line in an animal raised ? Explain.

R **[Delhi Comptt. 2011]**

Ans. Pure line :

(i) A pure line animal is raised through inbreeding. It is a progeny of single, self-fertilized homozygous individuals.

(ii) A similar strategy is used for developing pure lines in cattle as was used in case of peas. Inbreeding increases homozygosity. Thus, inbreeding exposes harmful recessive genes that are eliminated by selection.

(iii) It also helps in accumulation of superior genes and elimination of less desirable genes. The selection increases the productivity of inbred population. **2**

Q. 10. (i) List two advantages of keeping beehives in a crop field during flowering season.

(ii) Name one annual and one perennial crop species favourable to beeswax collection.

R **[Foreign Set-III, 2016]**

Ans. (i) Bees help in increasing pollination efficiency, leading to improved yield. ½ + ½

(ii) Annual : Sunflower/*Brassica* or any other correct example. ½

Perennial : Apple / pear or any other correct example. ½

[CBSE Marking Scheme, 2016]

Q. 11. Differentiate between out-crossing and cross-breeding.

U **[Delhi/Outside Delhi, Comptt, Set 1, 2018]**

Ans.

Out-crossing	Cross breeding
Mating of animals of same breed.	Superior males of one breed are mated with superior females of another breed.
No common ancestors on either side upto 4 – 6 generations	Progeny may have desirable characters of both parent
Helps to overcome inbreeding depression	Used for commercial production / obtaining improved characters

Any two differences [1 + 1= 2 marks]

Answering Tip

- Learn the differences between out crossing and cross breeding in tabular form for better retention and understanding.

Short Answer Type Questions-II (3 marks each)

Q. 1. (i) Name any two fowls other than chicken reared in a poultry farm.

(ii) Enlist four important components of poultry farm management. R **[Delhi Set-III, 2016]**

Ans.(i) Ducks, Geese and turkey.

(ii) Four important components of poultry farm management are :

(a) Selection of disease free and suitable breeds.

(b) Provision of proper and safe farm conditions.

(c) Provision of proper feed and water.

(d) Hygiene and health care. **1+2=3**

[CBSE Marking Scheme, 2016]

Answering Tip

- Write your answer in points. This will save your time.

Q. 2. Explain how and why controlled breeding experiment is carried out in cattle.

U **[Delhi Set-I, II, III, Comptt., 2016]**

Ans. Controlled breeding experiments are carried out using artificial insemination. Semen is collected from the male-chosen as parent, injected into the reproductive tract of the selected female (cow), stored semen may be used later to conduct desirable matings. ½×4=**2**

Helps overcome several problems of normal mating, improve the quality and quantity of desired yield. **1**

[CBSE Marking Scheme, 2016]

Commonly Made Error

- Many student while explaining artificial insemination forgets to mention about 'part of female body where semen is transferred'. They just write 'transfer of semen in female body'.

AI **Q. 3. As a biologist explain the technique to a dairy farmer for increasing the yield of herd size of cattle in a short time.** A **[CBSE SQP, 2018]**

OR

High yielding cattle is a good solution for food enhancement. How does the MOET technology help to increase the herd size ?

[Outside Delhi Set-I, Comptt. 2015]

OR

MOET programme has helped in increasing the herd size of the desired variety of cattle. List the steps involved in conducting the programme.

[Outside Delhi 2009]

Ans. Multiple Ovulation Embryo Transfer Technology (MOET) has helped the dairy farmer for increasing the yield of herd size of cattle in a short time. **1**

In this method, a cow is administered hormones with FSH-like activity, to induce follicular maturation and super ovulation – instead of one egg, which they normally yield per cycle, they produce 6-8 eggs. **1**

The animal is either mated with an elite bull or artificially inseminated. ½

The fertilized eggs at 8–32 cells stages are recovered non-surgically and transferred to surrogate mothers. ½

[CBSE Marking Scheme, 2018]

Detailed Answer:

Steps of MOET (Multiple Ovulation Embryo Transfer) are as follows :

(i) The cattle (Cow- the genetic mother) is given hormones with FSH like activity which induces follicular maturation and super ovulation.

(ii) The cow produces 6-8 eggs instead of only one per cycle.

(iii) The cow is then mated or artificially inseminated to achieve fertilization.

(iv) When the eggs attain 8-32 celled stage of development they are non surgically removed and transferred to surrogate mother for further development.

(v) The genetic mother can again be used for another round of superovulation.

Answering Tip

- Important points like, superovulation by FSH injection, embryo transplantation into a surrogate mother, super milch cows / high quality meat producing bulls, etc. should be stressed upon.

Q. 4. Enlist the steps involved in inbreeding of cattle. Suggest two disadvantages of this practice.

R **[Delhi Set-III, 2015]**

Ans. Inbreeding involves mating of closely related individuals within the same breed for 4-6 generations. **1**

Superior males and superior females of the same breed are identified and mated in pairs, the progeny are evaluated, superior males and females among them are selected for further mating. **1**

Disadvantages : Continued inbreeding causes inbreeding depression, reduction in fertility, reduction in productivity. **(Any two)** ½ × 2 = **1**

[CBSE Marking Scheme, 2015]

Commonly Made Error

- Students instead of inbreeding, they write about out-breeding. They get confused between the two.

Answering Tip

- Understand the differences between the two (inbreeding and outbreeding). Practice writing all definitions emphasizing on operative terms.

Q. 5. Enumerate any six essentials of good, effective dairy farm management practices.

U **[Outside Delhi Set-I, 2015]**

Ans. Selection of high yielding and disease resistant breeds, well housed, adequate and clean water supply, maintain disease free feeding in a scientific manner with special emphasis on quality and quantity of fodder, regular visits by veterinary doctors, regular inspection and record keeping, cleanliness and hygiene of both the cattle and handlers while milking and transport.

(Any six) ½ × 6=3

[CBSE Marking Scheme, 2015]

Q. 6. (i) State the objective of animal breeding.

(ii) List the importance and limitation of inbreeding. How can the limitations be overcome ?

(iii) Give an example of new breed each of cattle and poultry.

A **[Delhi Set-III, 2014; Outside Delhi Set-I, 2014]**

Ans. **(i)** Increases the yield of animal and improves the desirable qualities of the produce. 1

(ii) Importance :

(a) Increases homozygosity which is necessary to evolve pure line in any organism.

(b) helps to expose harmful recessive genes.

(c) helps in accumulation of superior genes.

Limitation :

Continuous inbreeding among cattle causes inbreeding depression. It decreases the fertility and even productivity of an animal. It can be overcome by applying outbreeding, in which mating is done between different breeds or individuals of the same breed but having no common ancestors. Outbreeding includes out-crossing, cross-breeding and interspecific hybridisation. **1**

(iii) Jersey / Hisardale - a new breed by crossing *Bikaneri ewes* and *Miranio rams* (cattle) and white Leghorn (poultry). **1**

Commonly Made Error

- Students instead of mentioning about objective, they start explaining animal breeding. Sometimes they forget to answer further sub parts.

Answering Tips

- Do not overlook any part of a question and avoid being in a hurry to conclude an answer.
- Comprehend what is being asked before beginning to write your answers.

AI **Q. 7. Differentiate between inbreeding and outbreeding in cattle. State one advantage and one disadvantage for each one of them.**

U **[Delhi Set-I, 2013, KVS]**

OR

Differentiate between inbreeding and outbreeding. Mention two advantages of inbreeding programme in cattle.

[Delhi Set-III, 2013]

Ans. **Inbreeding :** Inbreeding refers to the mating between closely related individuals within the same breed for 4-6 generations.

Outbreeding : It refers to the breeding of unrelated animals either of the same breed but do not have common ancestor or of different breeds.

Advantage : Inbreeding brings the homozygosity in the population and helps in accumulation of superior genes and elimination of less desirable or harmful genes. Outbreeding is the best method of breeding for animals that have average productivity and growth.

Disadvantage : Continued inbreeding causes inbreeding depression *i.e.* reducing productivity and fertility. Outbreeding leads to loss of recessive characters. **3**

[CBSE Marking Scheme, 2013]

Q. 8. (i) What is the programme called that is involved in improving success rate of production of desired hybrid and herd size of cattle ?

(ii) Explain the method used for carrying this programme for cows.

R **[Outside Delhi Set-II, 2012]**

Ans. **(i)** Multiple ovulation embryo transfer method / (MOET) is involved in improving success rate of production of desired hybrid and herd size of cattle. ½

(ii) High milk yielding cow administered hormone (with FSH like activity) → 6 to 8 eggs produced → inseminated artificially → fertilised eggs recovered non-surgically at 32 cell stage → transferred to surrogate mother for further growth. **½ × 5=2½**

[CBSE Marking Scheme, 2017]

Q. 9. Mention and describe any three methods to overcome inbreeding depression in animal husbandry. R **[Delhi Set-I, Comptt., 2012]**

Ans. Three methods of overcoming inbreeding depression in animal husbandry are outcrossing, cross breeding and interspecific hybridization. **(i)** Outcrossing is the mating between unrelated members of the different breed or same breed with common ancestors on either side of progeny upto 4-6 generations. **(ii)** In cross breeding the superior males and females of two different breeds are mated to obtain better progenies. **(iii)** The interspecific hybridization involves mating between members of two different species. This results in the formation of interspecific hybrids. **3**

Answering Tip

- Learn the three methods of outbreeding- outcrossing, cross breeding and interspecific hybridization by comparison.

Q. 10. (i) Write the scientific name of the most common species of honey bee reared.

(ii) Mention the kind of areas that are suitable for bee keeping practices.

(iii) Mention any two uses of bee wax.

R [Delhi Comptt. 2011]

Ans. (i) *Apis indica* is the most common species.

(ii) Bee keeping can be practiced in any area where there are sufficient bee pastures of some wild shrubs, fruit orchards and cultivated crops.

(iii) Bee wax is used in cosmetics and medicines.

1 × 3 = 3

Q. 11. What is 'Blue Revolution' ? Name two fresh water and two marine edible fish.

R [Delhi Comptt. 2011]

Ans. Rearing of aquatic animals (like fish and prawn), on large scale is called Blue Revolution. It has brought a lot of income to the farmers in particular and the country in general. Blue revolution is being implemented along the same lines as 'Green Revolution'.

Fisheries have an important place in Indian economy. They provide income and employment to millions of fishermen and farmers. It is the only source of their livelihood.

Freshwater fish : *Catla, Rohu* and Common Carp.

Marine fish : *Hilsa*, Sardines, Mackerel and Pomphrets. **1 + 2 = 3**

Commonly Made Error

- Students get confused between blue and green revolution. Make sure you understand the difference between the two.

Q. 12. Write the aim with which animal breeding programmes are carried. Describe the essential steps be followed in poultry management.

R [Outside Delhi Comptt. 2017, Set - I, II, III]

Ans. Aims - increasing the yield of animals, improving the desirable qualities of the produce. ½ + ½

Steps to be followed in Poultry Management :

(i) Selection of disease free and suitable breeds.

(ii) Proper and safe farm conditions.

(iii) Proper feed and water.

(iv) Hygiene and health care of birds. ½ × 4

[CBSE Marking Scheme, 2017]

Detailed Answer :

The aim of the animal breeding programmes are to increase the animal yield and to improve the desirable qualities of the produce.

Essential steps to be followed in poultry Management are :

(i) Selection of disease free and suitable breeds.

(ii) Proper and safe farm conditions.

(iii) Proper feed and water.

(iv) Hygiene and health care of birds.

Q. 13. (i) What is inbreeding depression ?

(ii) Explain the importance of "selection" during inbreeding in cattle. R [Delhi 2017, Set - I, II, III]

Ans. (i) Continuous inbreeding especially close inbreeding usually reduces fertility and even productivity / yield. ½ + ½

(ii) Helps in accumulation of superior genes / elimination of less desirable genes, increases homozygosity, pure lines, true breeding, helps to restore fertility, helps to increase yield / productivity, produces more milk per lactation, produces superior progeny, produces disease resistant breeds.

(Any two) 1 + 1

[CBSE Marking Scheme, 2017]

Detailed Answer :

Continued inbreeding, leads to reduce fertility and productivity. This is called inbreeding depression.

Importance of selection during inbreeding in cattle :

(i) Helps in accumulation of superior genes.

(ii) Helps in elimination of less desirable genes.

(iii) Helps in increasing homozygosity.

(iv) Helps in increasing the productivity of inbred population.

(v) Helps to increase yield or more milk per lactation.

(vi) Helps to produce disease resistant breeds.

Q. 14. State the objective with which a dairy farm is set up. Describe the essential steps to be followed for dairy farm management.

U [Delhi Comptt. 2017, Set - I, II, III]

Ans. Processes and systems that increase yield and improve quality of milk

- Selection of good breeds having high yielding potential and resistance to diseases
- House to have adequate water and kept disease free
- Feeding in a scientific manner with quality fodder
- Storage and transport of milk and products
- Regular inspection with proper record keeping / Regular visits of veterinary doctor.

(Any six) ½ × 6 = 3

[CBSE Marking Scheme, 2017]

Q.15. Explain out-breeding, out-crossing, and cross breeding practices in animal husbandry?

U [Outside Delhi/ Delhi, 2018]

Ans. Out breeding : Breeding of unrelated animals (which may be between individual of same breed or between individuals of different species).

Out crossing : (a type of out breeding) mating of animals within the same breed but having no common ancestors on either side of their pedigree upto 4 – 6 generations.

Cross breeding : (another type of out breeding) superior males of one breed are mated with superior females of another breed. **[1 + 1 + 1]**
[CBSE Marking Scheme, 2018]

Answering Tip

- Practice writing all definitions emphasizing on operative terms.

Long Answer Type Question (5 marks)

Q. 1. Explain the efforts which must be put in to improve health, hygiene and milk yield of cattle in dairy farm. C **[Delhi, 2010]**

Ans. Following efforts must be put in mainly to improve health, hygiene and milk yield of cattle in dairy farm:

(i) The cattle should be housed well in well ventilated sheds with adequate water supply.

(ii) There must be cleanliness and hygiene of both the cattle as well as the handlers while milking and transport.

(iii) Regular visit by veterinary doctors must be ascertained so as to keep the cattle healthy and disease free.

(iv) Feeding should be carried out in a most scientific manner with special emphasis on quality and quantity of fodder and the hygienic conditions.

(v) Breeding is necessary for improving the milk yield.

(vi) Selection of high yielding and disease resistant breed should be arranged.

(vii) Regular inspection and keeping updated record of all the activities of dairy is necessary. **5**

TOPIC-2
Plant Breeding

Revision Notes

- It 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.

Green Revolution

- During mid 1960s, several high yielding varieties of wheat and rice were developed as a result of various types of breeding techniques. This has resulted in the dramatic increase in food production not only in our country but in the whole world. This phase of enhanced food production is referred to as **Green revolution.**
- It is dependent on plant breeding.
- Norman E. Borlaug is the father of Green revolution.
- Dr. M.S. Swaminathan is known as the father of green revolution in India.

Classical Plant Breeding

- It involves hybridization of pure lines and artificial selection of progeny plants to produce desirable traits of higher yield nutrition and disease resistance.
- The plant breeding is carried out by using molecular genetic tools.

Desirable Traits Need to be Incorporated

- Increased crop yield.
- Improved quality.
- Increased tolerance to environmental stresses such as salinity, extreme temperature and drought, resistance to pathogens.
- Increased tolerance to insect pests.

Steps of Breeding

(i) Collection of Genetic Variability

- 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 is a prerequisite for effective exploitation of natural genes.
- The entire collection of plants / seeds having all the alleles for all genes in a given crop is called germ plasm collection.

(ii) Evaluation and Selection of Parents

- The germ plasm is evaluated so as to identify plants with desirable combination of characters.
- The selected plants are multiplied and used for hybridisation.
- The pure lines are created wherever desirable and possible.

(iii) Cross Hybridisation among the Selected Parents

- Cross hybridization is done when the objective is to incorporate the desired characters of two different plants in the hybrid.
- For example: High protein quality of one parent and disease resistance quality of another parent can be genetically incorporated in one plant by cross hybridization.
- This is possible by cross hybridizing the two parents to produce hybrids that genetically combine the desired characters in one plant.
- **Limitations**
  - **(a)** This is a very time-consuming and tedious process.
  - **(b)** The hybrids may not combine the desirable characters.
  - **(c)** Usually only one in a few hundred to a thousand crosses shows the desirable combination.

(iv) Selection and Testing of Superior Recombinants

- It is crucial to the success of the breeding objective and requires careful scientific evaluation of the progeny.
- It yields plants that are superior to both of the parents. This is called hybrid vigour or heterosis.
- These are self-pollinated for several generations till they reach a state of uniformity (homozygosity), so that the characters will not segregate in the future progeny.

(v) Testing, Release and Commercialization of new cultivars.

- The newly selected lines are evaluated for their yield and other agronomic traits of quality, disease resistance etc.
- This is done by growing them in the research fields and recording their performance under ideal fertiliser application, irrigation and other crop management practices.
- The evaluation is followed by testing the materials in farmer's fields, for at least three growing seasons at several locations in the country, representing all the agro-climatic zones.
- The material is evaluated in comparison to the best available local crop cultivar (a check or reference cultivar).
- The variety tested is selected, certified and is released as a new variety.

Wheat and Rice

- The development of high yielding varieties of wheat and rice in the mid-1960s, through plant breeding techniques has increased food production in our country. This phase is known as the Green Revolution.
- During the period 1960-2000, wheat production increased from 11 million tons to 75 million tons. The rice production went up from 35 million tons to 89.5 million tons.
- Nobel laureate Norman E. Borlaug (International Centre for Wheat and Maize Improvement, Mexico) developed semi-dwarf wheat. In 1963, high yielding and disease resistant varieties such as *Sonalika* and *Kalyan Sona* were introduced all over the wheat-growing belt of India.
- Semi-dwarf rice varieties were derived from IR-8, developed at International Rice Research Institute (IRRI, Philippines and Taichung Native-1 (from Taiwan).
- Better-yielding semi dwarf varieties, *Jaya* and *Ratna* were developed in India.

Sugarcane

- *Saccharum barberi* which is grown in north India has poor sugar content and yield.
- It was crossed with *Saccharum officinarum* which grows in south India.
- The hybrid developed possess thicker stems and higher sugar content grows well in north India.

Millets

- Hybrid maize, jowar and bajra developed in India.
- It includes high yielding varieties resistant to water stress.

Plant Breeding for Disease Resistance

- It enhances food production and helps to reduce the use of fungicides and bacteriocides.
- Resistance of the host plant is the genetic ability to prevent the pathogens from disease.

Plant Diseases : Plant diseases may be caused by fungi, bacteria or viruses.

- **Fungal diseases :** Rusts **(***e.g.* brown rust of wheat and black rust of wheat), Red rot (Red rot of sugarcane and late blight of potato).

- **Bacterial diseases :** Black rot of crucifers, blight of rice and citrus canker etc.
- **Viral :** Tobacco mosaic, turnip mosaic etc.

Methods of Breeding for Disease Resistance

(a) Conventional Method

- The steps are :
  - **(a)** Screening germ plasm for disease resistance.
  - **(b)** Hybridisation of selected parents.
  - **(c)** Selection and evaluation of the hybrids.
  - **(d)** Testing and release of new varieties.
- **Demerits of conventional method :**
  - **(i)** Conventional breeding is constrained by the availability of limited number of disease resistance genes.
  - **(ii)** Only a limited number of genes resistant to diseases have been identified in crop variation or their wild relatives.

(b) Mutation Breeding

- Mutation is the creation of genetic variations through changes in the base sequences within the genes *i.e.* which can create new desirable characters not found in the parental type.
- Plants having these desirable characters can be multiplied directly or can be used in breeding.
- Mutation breeding is the breeding by artificially inducing mutation through the use of chemicals or radiations like gamma radiations, selecting and using the plants that have desirable character as a source in breeding.

  Example - In mung bean, resistance to yellow mosaic virus and powdery mildew were induced by mutations.
- Resistant genes from wild species are introduced into the high-yielding cultivated varieties.

  Example - Resistance to yellow mosaic virus in bhindi **(***Abelmoschus esculentus***)** was introduced from a wild species and resulted in a new variety called *Parbhani kranti***.**
- Transfer of resistant genes is achieved by sexual hybridisation between the target and the source plant.
- **Mutation breeding is carried out in following steps.**
  - **(i)** Inducing mutation in plants artificially by chemicals or radiations.
  - **(ii)** Screening plants for desired variations.
  - **(iii)** Selecting plants with desired traits for multiplication and further breeding.

Plant Breeding for Developing Resistance to Insect Pests

- Insect resistance in host crop plants may be due to morphological, biochemical or physiological characteristics.
- **Some important characteristics that lead to insect pest resistance are :**
  - **(i)** Hairy leaves : *e.g.* resistance to jassids in cotton and cereal leaf beetle in wheat.
  - **(ii)** Solid stems in wheat : lead to non-preference by the stem sawfly.
  - **(iii)** Smooth leaved and nectar-less cotton varieties do not attract bollworms.
  - **(iv)** High aspartic acid, low nitrogen and sugar content in maize leads to resistance to maize stem borers.
- The steps of breeding methods are the same as for other agronomic traits.

Plant Breeding for Improved Food Quality

- More than 840 million people in the world do not have adequate food. 3 billion people suffer from micronutrient, protein and vitamin deficiencies *i.e.* 'hidden hunger'.
- Therefore, breeding of crops for improvement in quality of food produced is essential and a most important aspect.
- Biofortification is the method of breeding crops with higher levels of nutrients, which help to improve public health.

Objectives of Biofortification or Breeding for Improved Nutritional Quality

- To improve protein content and quality.
- To improve oil content and quality.
- To improve vitamin content.
- To improve micronutrient and mineral content.

Examples for Hybrids with Improved Nutritional Quality

- Maize hybrids having twice the amount of amino acids, lysine and tryptophan compared to existing maize hybrids.
- Wheat variety, Atlas 66, having high protein content.
- Iron-fortified rice variety containing over five times as much iron as in common varieties.

Vegetable Crops Rich in Vitamins and Minerals

- Indian Agricultural Research Institute, New Delhi has produced variety of vegetable crops rich in vitamin and minerals such as vitamin A enriched carrots, spinach, pumpkin, vitamin C enriched bitter gourd, *bathua*, mustard, tomato, iron and calcium enriched spinach and *bathua*; and protein enriched beans (broad, lablab, French and garden peas).

Single Cell Protein

- It is an alternative source of proteins for animal and human nutrition derived from certain beneficial microorganisms like *Spirulina*.
- *Spirulina* is rich in protein, minerals, fats, carbohydrate and vitamins.
- It is grown on materials like waste water from potato processing plants, straw, molasses, animal manure and sewage. This also reduces environmental pollution.
- A 250 kg cow produces 200 g of protein / day.
- In the same period, 250g of a micro-organism like *Methylophilus methylotrophus* produce 25 tonnes of protein.
- Microbes are being grown commercially as a source of SCP. They are :
  - **(i)** *Spirulina*—a cyanobacterium or blue green alga.
  - **(ii)** *Chlorella*—a green alga.
  - **(iii)** *Yeast—Saccharomyces cerevisiae*—a fungus.
  - **(iv)** *Methylophilus methylotrophus*—a bacterium.
  - **(v)** *Fusarium graminearum*—a fungus.

Tissue Culture

- It is a technique of growing plant cells / tissues / organs in sterile culture medium under controlled aseptic conditions.
- The ability to generate a whole plant from any cell / explant is called totipotency.
- An explant is any part of a plant that is grown in a test-tube under sterile nutrient media.
- The nutrient medium must provide a carbon source such as sucrose, inorganic salts, vitamins, amino acids and growth regulators like auxins, cytokinins etc.
- The method of producing thousands of plants in very short time through tissue culture is called micropropagation.
- These plants will be genetically identical to original plant from which they were grown *i.e.* they are somaclones.
- Tomato, banana, apple etc. are produced using this method.
- Tissue culture is also used for recovering healthy plants from diseased plants.
- The meristem which is free of virus from infected plant is removed and grown *in vitro* to obtain virus-free plants.
- Scientists have cultured meristems of banana, sugarcane, potato etc.

Somatic Hybridization

- Protoplasts from two different varieties of plants with desirable characters are fused to get hybrid protoplasts.
- It can be grown to form a new plant called somatic hybrids. This process is called somatic hybridization.
- Protoplasts can be isolated after digesting the cell walls of single cells of plants.
- A protoplast of tomato has been fused with that of potato, to form new hybrid plants with the characteristics of tomato and potato.
- But it does not have all the desired characteristics for its commercial utilization.

Very Short Answer Type Questions (1 mark each)

Q. 1. A certain tissue, of a plant, infected with TMV was used to obtain a new plant using tissue culture technique. Identify the technique used and reason out the possibility of obtaining a new healthy plant. U **[SQP 2016-17]**

Ans. Tissue culture using meristematic tissue as it is virus free.
[CBSE Marking Scheme, 2016] ½+½=1

Q. 2. State the economic value of *Saccharum officinarum* in comparison to *S. barberi*.
U **[Outside Delhi Comptt. 2015]**

Ans. *Saccharum officinarum* has higher sugar content and thicker stem, whereas *Saccharum barberi* is inferior in sugar content and yield. 1

Commonly Made Error

- Students often write opposite answers for each. Learn the economic value of each in tabular form for better retention and understanding.

AI **Q. 3. Write an alternate source of protein for animal and human nutrition.** R **[Outside Delhi Set-III 2014]**

Ans. Single cell protein / *Spirulina*. **1**

AI **Q. 4. State the importance of biofortification.**

R **[Outside Delhi Set-I, 2014]**

Ans. Biofortification is the breeding of crops for improvement of nutritional quality. ½

It is used to improve protein content and quality, to improve oil content and quality, to improve vitamins, etc. **(Any one)** ½

Q. 5. Why are living plant cell, said to be totipotent ?

U **[Outside Delhi Set-I, Comptt., 2013]**

Ans. The living plant cell are said to be totipotent because a whole plant can be generated from any living cell of the plant. They possess all the hereditary information and potentialities which enable them to differentiate into all type of cells which are present in the plant body. **1**

Q. 6. Name any two diseases the '*Himgiri*' variety of wheat is resistant to.

R **[Outside Delhi Set-I, II, 2013]**

Ans. **(i)** Leaf and stripe rust. ½

(ii) Hill bunt. ½

Q. 7. Name the following :

(i) The semi-dwarf variety of wheat which is high-yielding and disease-resistant.

(ii) Any one inter-specific hybrid mammal.

R **[Delhi Set-I, 2012]**

Ans. **(i)** *Kalyan Sona / Sonalika* ½

(ii) Mule / Hinny / Liger / Tigon. ½

Q. 8. Name the semi-dwarf variety of wheat which is high yielding and disease resistant.

R **[Delhi Set-I, 2012]**

Ans. *Sonalika* and *Kalyan-sona* are the high yielding and disease resistant varieties of wheat. **1**

Q. 9. How are the following two varieties of sugarcane different from each other ?

(i) *Saccharum barberi*

(ii) *Saccharum officinarum.* U **[Delhi Comptt. 2010]**

Ans. *Saccharum barberi* has poor sugar content and yield, while *Saccharum officinarum* has higher sugar content and a thicker stem. **1**

Answering Tip

- Learn the differences between the two varieties of sugarcane carefully.

Short Answer Type Questions-I **(2 marks each)**

Q. 1. Suggest four important steps to produce a disease resistant plant through conventional plant breeding technology.

U **[Outside Delhi Set-I, 2016]**

Ans. Steps for producing disease resistant plants are :

(i) Screening of germplasm (for resistance source).

(ii) Hybridization of selected parents.

(iii) Selection and evaluation of hybrids.

(iv) Testing and release of new varieties.

[CBSE Marking Scheme, 2016] 2

Detailed Answer :

The important steps involved in conventional plant breeding technology are :

(i) Selection of parent plants with desired combination of characters.

(ii) Cross hybridisation among the selected parents.

(iii) Selection of superior hybrids.

(iv) Testing, release and commercialisation of new cultivars. ½ × 4 = 2

Q. 2. Identify 'A', 'B', 'C' and 'D' in the given table :

Crop	Variety	Resistance of disease
A	*Himgiri*	Leaf rust
Cauliflower	*Pusa Shubhra*	B
Brassica	*Pusa Swarnim*	C
Cowpea	D	Bacterial blight

R **[Delhi Set-I, 2016]**

Ans. **A** → Wheat
B → Black rot and curl blight
C → White rust
D → Pusa Komal ½+½+½+½

AI **Q. 3. How has mutation breeding helped in improving the production of mung bean crop ?**

U **[Delhi Set-I, 2015]**

Ans. Mutation breeding has helped in improving the moong bean crop by producing its disease resistant varieties against yellow mosaic virus /powdery mildew. In mutation breeding, the mutations are induced artificially through the use of chemicals or radiations (like gamma rays) followed by selecting and using the plants that have desirable characters as a source in breeding. **1+1=2**

AI **Q. 4.Why are microbes like *Spirulina* being produced on a commercial scale ? Mention its two advantages.**

U **[Delhi/Outside Delhi, Comptt, Set 1, 2018]**

OR

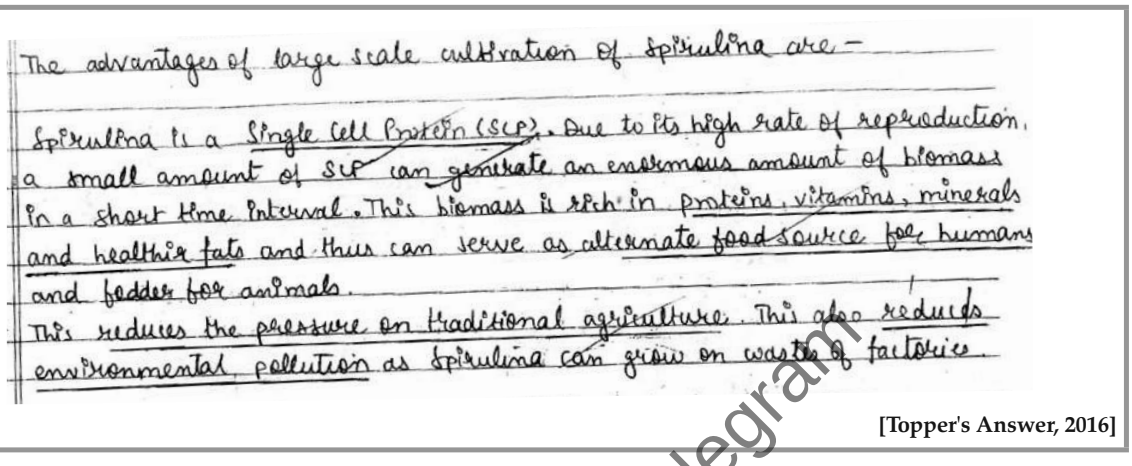
"Large scale cultivation of *Spirulina* is highly advantageous for human population." Explain giving two reasons. **[Outside Delhi Set-II, 2016]**

OR

"Growing *Spirulina* on a large scale is beneficial both environmentally and nutritionally for humans." Justify. **[Delhi, Set - II, 2017]**

Ans. As source of food protein. **1**
Reduces environmental pollution / solves problem of hunger and malnutrition / rich source of protein / low cost production. **(Any two) 1**
[CBSE Marking Scheme, 2018]

OR


The advantages of large scale cultivation of Spirulina are –

Spirulina is a Single Cell Protein (SCP). Due to its high rate of reproduction, a small amount of SCP can generate an enormous amount of biomass in a short time interval. This biomass is rich in proteins, vitamins, minerals and healthier fats and thus can serve as alternate food source for humans and fodder for animals.

This reduces the pressure on traditional agriculture. This also reduces environmental pollution as Spirulina can grow on wastes of factories.

[Topper's Answer, 2016]

Q. 5. Enumerate four objectives for improving the nutritional quality of different crops for the health benefits of the human population by the process of "Biofortification". U **[Delhi Set-III, 2015]**

Ans. Biofortification involves the breeding of crops to increase their nutritional value. **The objective for biofortification are as follows :**

(i) To improve protein content and quality.

(ii) To improve oil content and quality.

(iii) To improve vitamin content.

(iv) To improve micronutrients and mineral contents. ½+½+½+½

Q. 6. In an agricultural field there is a prevalence of the following organisms and crop disease which are affecting the crop yield badly :

(i) White rust

(ii) Leaf and stripe rust

(iii) Black rot

(iv) Jassids

Recommend the varieties of crops the farmers should grow to get rid of the existing problem and thus improve the crop yield.

R **[Delhi - 2017, Set - I]**

Ans. **(i)** Pusa Swarnim / Karan rai ½
(ii) Himgiri ½
(iii) Pusa Shubhra / Pusa Snowball K - 1 ½
(iv) Pusa Sem 2 / Pusa Sem 3 ½
[CBSE Marking Scheme, 2017]

Q. 7. To reduce the percentage of population suffering from hunger and malnutrition, microbes are grown on a large scale to act as food supplements. Mention any two microbes used as food supplement and suggest their role. A **[SQP, 2016-17]**

Ans. The two microbes used as food supplement are *Spirulina* and *Methylophilus.*
Spirulina **:** Produces large quantities of food rich in protein, minerals, fats, carbohydrates and vitamins. ***Methylophilus methylotrophus*—** 250 gm of this microorganism produces 25 tonnes of protein per day. ½ × 4 = 2
[CBSE Marking Scheme, 2016]

Q. 8. By taking two examples, explain how has bio-fortification helped in improving food quality.

R **[Delhi 2017, Set - I]**

Ans. A maize hybrid was developed that had twice the amount of amino acid / lysine and tryptophan / Atlas 66 wheat variety having high protein content used as donor for improving cultivated wheat / Iron fortified rice / (IARI has released)
Vitamin A enriched carrots / spinach / pumpkin
Vitamin C enriched bitter gourd / bathua / mustard / tomato.
Iron & calcium enriched spinach / bathua
Protein enriched beans - broad / french peas / garden peas **(Any two examples) 1 + 1**
[CBSE Marking Scheme, 2017]

Detailed Answer :

(i) Maize hybrids having twice the amount of amino acids, lysine and tryptophan.

(ii) Wheat variety, Atlas 66, having high protein content.

(iii) Iron fortified rice variety containing over five times as much as iron as in common varieties.

(iv) Indian agricultural Research institute, New Delhi has produced variety of vegetable crops rich in vitamins and minerals such as vitamin A enriched carrots, spinach, pumpkin, vitamin C enriched bitter gourd, bathua, mustard, tomato, iron and calcium enriched spinach and bathua, protein enriched beans. **(Any two)**

Q. 9. (i) "Fortification of crops is the need of the hour." Give two reasons.

(ii) Select one fresh-water and one marine fish from the following : Prawn; Catla; Mackerel; Lobster.

A **[Foreign Set-I, 2016]**

Ans. (i) To improve the nutritional quality in order to improve public health / to prevent malnutrition. ½+½

(ii) Fresh water : Catla, **Marine Fish :** Mackerel. ½+½

[CBSE Marking Scheme, 2016]

Detailed Answer :

(i) With the ever increasing population of the world, the enhancement of food production by fortification of crops has become a major necessity. Further, keeping in view the present public health and hygiene and also the problem of malnutrition it is necessary to improve the nutritional quality which can be achieved by fortification of crops.

Q. 10. What is biofortification ? Mention the contribution of Indian Agricultural Research Institute towards it with the help of any two examples.

R **[Delhi/Outside Delhi, Comptt, Set 1, 2018]**

Ans. Breeding crops with higher level of vitamins and minerals or higher protein and healthier fats. ½ × 2

(i) Vitamin A enriched carrots / spinach / pumpkin.

(ii) Vitamins C enriched bitter gourd / bathua / mustard / tomato.

(iii) Iron and calcium enriched spinach / bathua.

(iv) Protein enriched broad lablab / french & garden peas. **(Any two) 1 + 1**

AI **Q. 11. Life style diseases are increasing alarmingly in India. We are also dealing with large scale malnutrition in the population. Suggest a process by which we can address both these problems. Give any three examples to support your answer.** C **[CBSE SQP, 2018]**

Ans. Biofortification ½

a) Enhancing food quality with respect to protein- Maize hybrids that had twice the amount of the amino acids, lysine and tryptophan, compared to existing maize hybrids were developed. Or Wheat variety, Atlas 66, having a high protein content has been used as a donor for improving cultivated wheat.

Or Protein enriched beans- broad, lablab, French and garden peas. (Any one) ½

b) Vitamin enriched- Vitamin A enriched Carrots, Spinach, Pumpkin Or Vitamin C enriched bitter gourd, bathua, mustard, tomato. **(Any one)** ½

c) Enrichment of Micro Nutrient and Mineral content- Iron and calcium enriched spinach and bathua. ½

[CBSE Marking Scheme, 2018]

Answering Tips

- Express main concepts pointwise wherever it is possible.
- Be specific about the key word in the statements.

Q. 12. Name any two common Indian millet crops. State one characteristic of millets that has been improved as a result of hybrid breeding so as to produce high yielding millet crops.

R **[Delhi Set-II, 2015]**

Ans. Two common Indian millet crops are Maize and Jowar. Hybrid breeding has resulted in the production of high yielding millet varieties that are resistant to pest attack and water stress. **2**

Q. 13. (i) Why are the plants raised through micropropagation termed as somaclones ?

(ii) Mention two advantages of this technique.

R **[Outside Delhi Set-I, 2015]**

Ans. (i) Genetically identical.

(ii) Large number of plants in short duration, virus free plants.

[CBSE Marking Scheme, 2015] 2

Detailed Answer :

(i) The plants obtained by micropropagation are called somaclones because they are genetically identical to each other as well as to parent plant.

(ii) Advantages :

(a) It helps in the propagation of a large number of plants in a short span of life.

(b) It helps in the production of healthier plants that are disease and pest resistant.

1+½+½=2

Q. 14. How can healthy potato plants be obtained from a desired potato variety which is viral infected ? Explain. A **[Delhi Set-II, 2014]**

Ans. Healthy potato plants can be obtained from a desired potato variety which is viral infected by the method of tissue culture. The apical and axillary meristems of the infected plant is virus free. Hence, they can be removed and grown in vitro to obtain healthy potato plants. This is one of the applications of tissue culture. **2**

Q. 15. You have obtained a high yielding variety of tomato. Name and explain the procedure that ensures retention of the desired characteristics repeatedly in large populations of future generations of the tomato crop. 2

A **[Outside Delhi/Delhi, 2018]**

Ans. Tissue culture / micropropagation / somaclonal propagation / apomixis.

(a) Explant / any part of plant taken out and grown (in a test tube / vessel).

(b) under sterile condition.

(c) in special nutrient medium (containing carbon source / sucrose, inorganic salt / vitamins / amino acids and growth regulator).

[½ + 1½ = 2 marks]

[CBSE Marking Scheme, 2018]

Q. 16. List the two steps that are essential for carrying out artificial hybridization in crop plants and why ? R **[Delhi Set-II, 2014]**

Ans. **Step 1 :** Hybridization of pure lines

Step 2 : Artificial selection

These steps help to produce plants with desirable traits such as high yield, nutrition and resistance to diseases. **2**

Q. 17. How are biofortified maize and wheat considered nutritionally improved ? A **[Foreign 2012]**

Ans. Biofortified maize and rice are quite rich in amino acids and proteins. Biofortified maize contains twice the amount of amino acids like lysine and tryptophan as compared to existing varieties and biofortified wheat, which has increased amount of protein. **2**

Short Answer Type Questions-II (3 marks each)

AI **Q. 1. (i) Mention two advantages of micropropagation. (ii) Give two examples where it is commercially adopted.** R **[Outside Delhi, Set-II, 2016]**

Ans. **(i) Advantages of micropropagation are :**

(a) A large number of plant can be produced in a short duration.

(b) The plants produced are genetically identical.

(c) Healthy plants can be obtained from the diseased plants.

(ii) Micropropagation is commercially adopted in case of :

(a) Tomato **(b)** Banana **(c)** Apple. **3**

[CBSE Marking Scheme, 2016]

Q. 2. A sugarcane has been affected by virus. How can a virus free cane developed from it ? U **[Delhi Set-I, Comptt. 2015]**

Ans. Virus free sugarcane can be developed by tissue culture technique. The meristematic regions of a plant are generally free from virus. Healthy and virus free sugarcane plants can by developed by this technique using meristems as explants.

Procedure : Explants obtained from the meristem apical or young axillary buds or from nodes near the stem apex are taken and surface sterilized by 0.5% sodium hypochlorite and then seeded over the nutrient agar medium enriched with cytokinin under aseptic conditions. After incubation for a few days under optimal conditions the explants give rise to shoots. These shoots are cut into nodal segments of 2-3 cm which are then transferred into a medium containing extra auxin for promoting root formation. This results in the development of a number of plantlets, which are then transferred to fields. **3**

[CBSE Marking Scheme, 2016]

Q. 3. How are somaclones cultured from explants in vitro conditions? Why are somaclones so called ? R **[Foreign 2010]**

Ans. Explant is a part of a plant used in tissue culture. For developing the somaclones, the explants is grown in nutrient medium under aseptic conditions. This results in the formation of an undifferentiated mass of tissue called callus from which a large number of plantlets are produced by micropropagation.

These plants so produced by tissue culture are called somaclones because they are genetically identical to the original plant from which the explant is taken. **3**

[CBSE Marking Scheme, 2016]

Q. 4. (i) Write two limitations of traditional breeding technique that led to promotion of micro-propagation.

(ii) Mention two advantages of micro-propagation.

(iii) Give two examples where it is commercially adopted. R **[Outside Dehil Set-I, 2016]**

Ans. **(i)** Failed to keep pace with demand, failed to provide fast and efficient system of crop improvement. **1**

(ii) Large number of plants can be developed in a short duration / production of genetically identical plants / somaclones / healthy plants can be recovered from diseased plants. **1**

(iii) Tomato / banana / apple. **1**

[CBSE Marking Scheme, 2016]

Detailed Answer :

(i) Two limitations of traditional breeding that led to promotion of micro-propagation are :

(a) It failed to fulfil the demand.

(b) It failed to provide an efficient and fast crop improvement system.

(ii) Two advantages of micro-propagation are :

(a) It helps in the propagation of a large number of plants in a short span of time.

(b) It leads to the production of healthier plantlets, which exhibit better disease resistant powers.

(iii) Micro-propagation technology is adapted in the commercial production of many important food plants such as tomato, apple and banana.

Q. 5. Plant breeding technique has helped sugar industry in North India. Explain how. A **[Delhi Set-I, 2016]**

Ans. Two species (*Saccharum barberi* and *Saccharum officinarum*) were crossed to get sugarcane varieties with high yield / thick stem / high sugar content / ability to grow in North India. **3**

[CBSE Marking Scheme, 2016]

Detailed Answer :

(i) *Saccharum barberi* was originally grown in north India, but had poor sugar content and yield.

(ii) *Saccharum officinarum,* which was used to be grown in South India, had thicker stems and higher sugar contents. However, it did not grow well in North India.

(iii) These two species were crossed to get sugar cane varieties with the desirable qualities of high yield, thick stems, high sugar and ability to grow in the sugar cane areas of north India.

(iv) This breeding experiment helped in the growth of the sugar industry in north India.

Q. 6. (i) Name the tropical sugar cane variety grown in South India. How has it helped in improving the sugar cane quality grown in North India ?

(ii) Identify 'a', 'b' and 'c' in the following table :

S. No.	Crop	Variety	Insect Pests
(i)	*Brassica*	Pusa Gaurav	(a)
(ii)	Flat bean	Pusa Sem 2 Pusa Sem 3	(b)
(iii)	(c)	Pusa Sawani Pusa A-4	Shoot and fruit borer

A **[Outside Delhi Set-III, 2014; Delhi Set-I, 2011, KVS]**

Ans. (i) *Saccharum officinarum*, crossed with, North Indian variety (*Saccharum barberi*) to increase quality. ½ × 3=1½

(ii) (a) Aphids

(b) Jassids / aphids / fruit borer

(c) Okra (Bhindi) ½ × 3=1½

Q. 7. What is "biofortification" ? Write its importance. Mention the contribution of Indian Agricultural Research Institute towards it with the help of two examples. U **[Foreign 2014] [NCERT]**

Ans. The process of breeding crops for higher level of vitamins and minerals, higher proteins, healthier fats, to improve public health is known as biofortification.

It helps to improve :

(i) Protein content and quality.

(ii) Oil content and quality.

(iii) Vitamin content and

(iv) Micronutrient and mineral content. ½ × 4=2

IARI has released several vegetable crops that are rich in vitamins and minerals *e.g.* Vitamin A enriched carrots, spinach, pumpkin, vitamin C enriched bitter gourd, *bathua*, mustard, tomato, iron and calcium enriched spinach and bathua, protein enriched beans–lablab, broad, French and garden pea. **1**

Q. 8. How can crop varieties be made disease resistant to overcome food crisis in India ? Explain. Name one disease resistant variety in India of :

(i) Wheat to leaf and stripe rust.

(ii) *Brassica* to white rust. U **[Delhi Set-I, 2011]**

Ans. The crop varieties can be made disease resistant so as to overcome food crisis in India by usual and conventional methods of breeding or mutation breeding for disease resistance by hybridization and selection. The various sequential steps of this programme are screening germplasm for resistance sources, hybridization of selected parents, selection and evaluation of the hybrids and testing and release of new varieties // mutation breeding. It is possible to induce mutations artificially through use of chemicals or radiations (like gamma radiations) and selecting and using the plants of desirable character as a source in breeding. Selection amongst somaclonal variants / Genetic engineering.

(Any one explanation)

(i) Variety of wheat resistant to leaf and stripe rust is Himgiri.

(ii) Variety of *Brassica* resistant to white rust disease is Pusa swarnim / Karan rai.

2 + ½ + ½ = 3

[CBSE Marking Scheme, 2011]

Detailed Answer :

A wide range of fungal, bacterial and viral pathogens affect the yield of cultivated crops. Disease resistant can be provided by conventional breeding, mutational breeding or genetic engineering.

(i) Conventional breeding: It includes the basic steps of screening, germplasm, hybridisation, selection, testing and release.

(ii) Mutational breeding: In this method, genetic variations are created, which then result in the creation of traits not found in the parental type.

(iii) Genetic engineering: Certain wild varieties have disease- resistant characteristics but they are low yielding, Disease- resistant genes from such varieties are introduce in high- yielding varieties through recombinant DNA technology.

One disease resistant variety in India is:

(a) Himgiri **(b)** Pusa swarnim

AI **Q. 9. Scientists have succeeded in recovering healthy sugarcane plants from a diseased one.**

(i) Name the part of the plant used as explant by the scientists.

(ii) Describe the procedure the scientists followed to recover the healthy plants.

(iii) Name this technology used for crop improvement. U **[Outside Delhi Set-I, 2011]**

Ans. (i) Meristem (apical, axillary) or shoot tip or nodal segment. ½

(ii) Procedure, the scientists followed to recover healthy plants is :

Explant / Virus free meristem is grown in nutrient medium, under aseptic conditions, tissue proliferates to form undifferentiated mass called callus, transferred to a medium containing auxins and cytokinins, regeneration of plants from callus, Hardening of plantlets, transfer of regenerated plantlets to field conditions. ½ × 4 = 2

(iii) Tissue culture / micropropagation. ½

Q. 10. IARI has released several varieties of crop plants that are biofortified. Give three examples of such crops and their biofortifications.

A **[Foreign 2011, NCERT]**

Ans. The biofortified crops released by IARI are :

(i) Carrots enriched with Vitamin A.

(ii) Bittergourd-rich with Vitamin C.

(iii) Spinach enriched with calcium and iron. **3**

[CBSE Marking Scheme, 2016]

Q. 11. How can pollen grains of wheat and rice which tend to lose viability within 30 minutes of their release be made available months later for breeding programmes ? [Delhi 2009]

Ans. The pollen grains can be preserved at low temperature preferably in liquid nitrogen (temperature-196°C). Such stored pollen remain viable for years together and therefore can be used in breeding programmes. **3**

[CBSE Marking Scheme, 2016]

Q. 12. (i) Write the desirable character a farmer looks for in his sugarcane crop.

(ii) How did plant breeding techniques help north Indian farmers to develop cane with desired characters ?

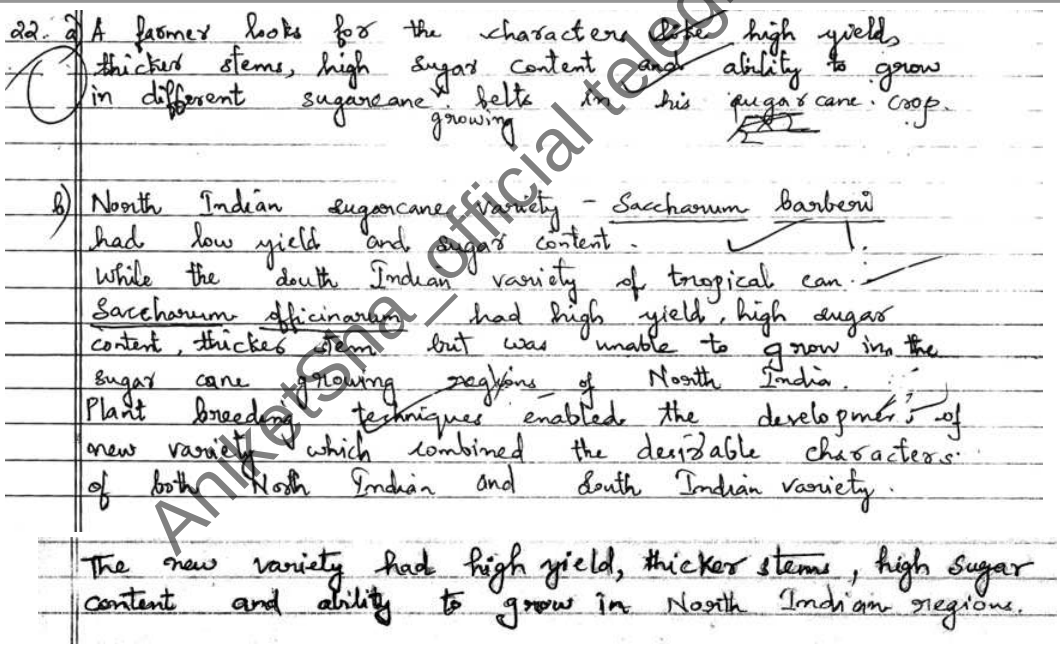
A **[Outside Delhi - 2017, Set - I, II, III]**

Ans. (i) High yield, thick stem, high sugar content, ability to grow in their areas. **½ × 4**

(ii) By crossing *Saccharum officinarum* / South Indian variety having desired characteristics with *Saccharum barberi* / north Indian low yield variety. **[CBSE Marking Scheme, 2017] 1**

OR

Ans.



[Topper's Answer, 2017]

Q. 13. (i) What is green revolution ? Mention the steps that led to it.

(ii) Name the scientist whose contribution led to development of semi-dwarf wheat varieties in India. U **[Delhi 2017, Comptt. Set - I, II, III]**

Ans. (i) Dramatic increase in food production (wheat and rice) during the mid 1960's is termed as Green Revolution by various plant breeding techniques / better management practices / use of agrochemicals (fertilizers and pesticides).

(Any two) ½ + ½

(ii) Norman E. Borlaug

[CBSE Marking Scheme, 2017] 1

Q. 14. GM plants are useful in many ways. How would you convince farmers to grow GM plants on their field ? Explain giving three reasons.

C **[Delhi Comptt. 2017, Set - I, II, III]**

Ans. Make crop more tolerant to abiotic stresses / Reduce reliance on chemical pesticides / Help to reduce post harvest loses / Increase efficiency of mineral usage / Enhance nutritional value of food.

(Any three) 1 × 3 = 3

[CBSE Marking Scheme, 2017]

Detailed answer:

GM plants refers to genetically modified plants, plants in which foreign genes have been introduced through genetic engineering methods.

Growing plants GM plants (approved by government) has various benefits

i. the GM cotton, is not only pest resistant but also requires less water. Such Bt Cotton crop farming gives very good produce.
ii. Post harvest losses are reduced, examples in flavr savour tomato, where the plant is introduced with delayed ripening gene.
iii. Crops with increased nutritional value like golden rice will have high vitamin A content.
iv. Crops are more resistant to abiotic stress such as, cold, drought, salt and heat.
v. Increased efficiency of mineral usage by plant prevents early exhaustion of soil fertility.
vi. herbicide resistance and disease resistance

(Any three)

Q. 15. The Indian Agricultural Research Institute has introduced several cereal and vegetable crops that are nutritionally rich in vitamins and minerals. What is this kind of breeding called? Write the main objectives with which such breeding programme is carried.

[A] [Outside Delhi Comptt. 2017, Set - I]

Ans. Biofortification **1**

Objectives : Improving –

(i) Protein content and quality.
(ii) Oil content and quality.
(iii) Micronutrient and mineral content.
(iv) Vitamin content. ½ × 4

[CBSE Marking Scheme, 2017]

Detailed Answer :

(i) Biofortification is the method of breeding crops with higher levels of nutrients which help to improve public health.

Objectives of Biofortification or Breeding for Improved Nutritional Quality :

(ii) To improve protein content and quality.
(iii) To improve oil content and quality.
(iv) To improve vitamin content.
(v) To improve micronutrient and mineral content.

[AI] Q. 16. What is single cell protein ? Give its importance and two examples of SCP. [U] [Imp]

Ans. Single cell protein is the large quantities of biomass produced by culturing single type of cells or microorganisms, which serve as food specially rich in protein, fats, carbohydrates, minerals and vitamins.

Importance :

(i) It serves as rich source of protein in human diet.
(ii) It reduces pressure on agricultural production system for the supply of protein requirement.
(iii) It helps in reducing environmental pollution.

Examples :

(a) *Spirulina*–a cyanobacterium or blue green algae.
(b) *Methylophilus methylotrophus–a bacterium.*

1+1+1

Commonly Made Error

- The question has three parts- definition, importance and examples. Many students write about only definition and example. They forget to mention about its importance.

Long Answer Type Questions

(5 marks each)

Q. 1. With advancement in genetics, molecular biology and tissue culture, new traits have been incorporated into crop plants.
Explain the main steps in breeding a new genetic variety of crop. [A] [Outside Delhi Set-I, 2014]

Ans. Main steps involved in breeding a new genetic variety of a crop are :

(i) Collection of variability / germplasm collection and preservation of all different wild varieties, species and relatives of cultivated species / entire collection of plants. ½ + ½
(ii) Evaluation and selection of parents to identify plant with desirable combination of character / purelines are created. ½ + ½
(iii) Cross hybridization among selected parents: cross hybridizing the two parents to produce hybrids with genetically combine desired characters in one plant. ½ + ½
(iv) Selection and testing of superior recombinants: selection among the progeny of the hybrids that have desired character combinations, superior to both the parents / self pollinated for several generations till they reach the state of uniformity and they do not segregate in the progenies. ½ + ½
(v) Testing, release and commercialisation of new cultivars, newly selected lines are evaluated for yield / other agronomic traits of quality / disease resistance by growing them in research fields followed by testing the material in farmers fields for atleast three growing seasons at different agroclimatic zones.
(vi) Release of new variety : The variety evaluated is selected, certified and released as new variety. ½ + ½

[CBSE Marking Scheme, 2014]

Q. 2. (i)Name the technology that has helped the scientists to propagate on large scale the desired crops in short duration. List the steps carried out to propagate the crops by the said technique.

(ii) How are somatic hybrids obtained ?

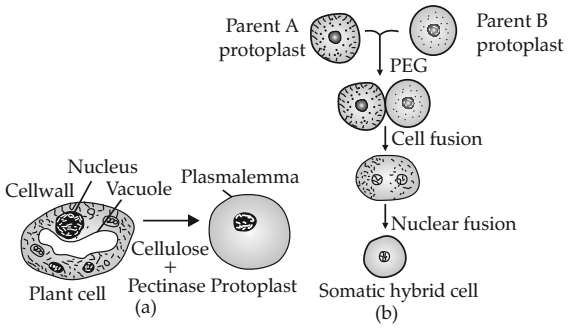
[A] [Outside Delhi Set-II, 2014]

Ans. (i) Tissue culture / micro propagation. **1**

Explants are grown in a test-tube, under sterile condition, in special nutrient medium / culture medium. **½ × 4 = 2**

(ii) Isolated single cells, digests cell walls, to obtain naked protoplast from two different varieties, fusion of protoplast.

Hybrid protoplasts thus, obtained are cultured in a suitable medium to form new plants.



Somatic hybridisation: (i) Isolation of protoplasts using enzymes pectinase and cellulase (ii) Protoplasts fusion induced by PEG.

½ × 4 = 2

AI **Q. 3. (i) What is plant breeding ? List the two steps the classical plant breeding involves.**

(ii) How has the mutation breeding helped in improving crop varieties ? Give one example where this technique has helped.

(iii) How has the breeding programme helped in improving the public nutritional health ? State two examples in support of your answer.

A **[Delhi Set-I, III, 2013]**

Ans. (i) Plant breeding is the science of changing the genetics of plants in order to produce desired characteristics. Plant breeding can be done through many different techniques ranging from simply selecting plants with desirable characteristics for propagation.

Classical plant breeding uses : (a) Deliberate interbreeding (crossing) of closely or distantly related individuals to produce new crop varieties with desirable properties.

(b) *In-vitro* techniques such as protoplast fusion, mutagenic agents.

(ii) Mutagenic agents such as radiation and certain chemicals are used to induce mutations and generate genetic variations from which desired mutants may be selected.

Treatment with mutagens alters genes or breaks chromosomes. Gene mutation occurs naturally as errors in DNA replication *e.g.* a mutant of paddy rice.

(iii) Plant breeding helps in increased food production by :

(a) Development of high-yielding crops.

(b) Improved management practices.

(c) Provisions of genetically derived better seed germplasm. Breeding crops with higher levels of vitamins and minerals or higher protein and healthier fats is the most practical means to improve public health.

Examples of crop plants with enhanced nutritional qualities and which have been developed by IARI New Delhi are :

(i) Golden maize : This is a hybrid variety which is rich in amino acids lysine and tryptophan.

(ii) Wheat variety Atlas-60 : It is protein rich variety.

(iii) Golden rice : It is iron rich fortified variety of rice. **5**

Q. 4. What is somatic hybridization? Explain the various steps involved in the process. Mention any two uses of somatic hybridization.

R **[Delhi Set - 2007]**

Ans. The process of fusion of protoplast of somatic cells derived from different varieties or species of plants on a suitable nutrient medium to produce the somatic hybrids is called somatic hybridization. For example pomato is the somatic hybrid obtained by the protoplast fusion of tomato and potato.

The steps involved in somatic hybridization are :

(i) Single cells isolated from the selected plants.

(ii) Removal of cell wall of the fusing cell with the help of the enzymes like pectinase and cellulase. These enzymes digest the cell wall to expose the naked protoplast.

(iii) The isolated protoplasts of selected parents are fused to obtain hybrid protoplast on special nutrient medium under aseptic conditions. This fusion is induced in the presence of polyethylene glycol (PEG) or by a brief high voltage electric current.

(iv) The hybrid protoplast are cultured on suitable nutrient medium, where they regenerate cell wall and begin to undergo division to form new plantlets. These plantlets are the somatic hybrids.

Use of somatic hybridization :

(a) Species of plants in which sexual hybridization or breeding is not possible can be hybridized by somatic hybridization.

(b) Somatic hybridization produces hybrids between those lines or species where it is not possible through sexual hybridization.

(c) This technique is useful in raising allopolyploids. **5**

Know the Terms

- **Breed** : It is a group of animals related by descent and similar general appearance, features, size etc.
- **Classical Plant Breeding** : It involves hybridization of pure lines and artificial selection to produce desirable traits.
- **Animal husbandry :** It is the agricultural practice of breeding and raising livestock by applying scientific principles.
- **Breeding :** It is the modification of genotype of an organism to make that organism more useful to humans.
- **Inbreeding :** It is the mating of more closely related individuals within the same breed for 4-6 generations.
- **Out-breeding :** Breeding between animals of different breeds is known as out-breeding.
- **Apiculture :** It is the practice of bee-keeping for production of various products such as honey and beeswax.
- **Pisciculture :** It refers to the breeding, hatching and rearing of fish under controlled conditions.
- **Aquaculture :** It is the cultivation of aquatic organisms.
- **Mariculture :** It refers to aquaculture practiced in marine environments.
- **Green Revolution :** It is the development and flourishing of the agriculture.
- **Mutation breeding :** It 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.
- **Biofortification:** It is the process of breeding crops with higher levels of vitamins, minerals, proteins and fat content.
- **Tissue culture :** It is the process of developing a complete plant from a part of a plant. The plant part is called an explant.
- **Micro propagation :** It is a method of producing new plants in a short duration through tissue culture.

❐❐❐