CHAPTER

09

Strategies for Enhancement in Food Production

Due to the rapid growth of the world population, there is an increasing demand for food. Consequently, it has become essential to enhance food production from animal and plant sources to meet this demand. This is achieved by implementing various biological principles such as animal husbandry and plant breeding. Through these methods, animal and plant production can be increased sustainably and efficiently to cater to the growing population's food requirements.

Animal Husbandry

Animal husbandry is the practice of rearing economically important livestock, including dairy, industry, poultry, fish rearing, and more. This involves providing animals with food, shelter, and working to control diseases and improve breeding. It is a crucial component of agriculture and food production, given the growing demand for animal-based products.

Dairy farm management is an essential part of animal husbandry, focused on improving the quality and quantity of milk production. The quality of milk largely depends on the breed of animals being raised, making the selection of high-quality breeds critical. Other important aspects of dairy farm management include maintaining disease-free conditions for the animals, regular veterinary check-ups, feeding high-quality and appropriate amounts of fodder, and maintaining the cleanliness and hygiene of the animals and their handlers.

Poultry farm management is another critical aspect of animal husbandry, focused on raising birds for meat and eggs. This involves selecting disease-free breeds, providing proper food and water, and maintaining the health and hygiene of the birds.

Animal breeding is also an essential part of animal husbandry. This practice aims to increase animal yield and improve desirable qualities of the produce. A **breed** is a group of animals related by descent and similar in most characters such as general appearance, features, size, configuration, etc. By selectively breeding animals with desirable traits, such as increased milk or meat production, farmers can improve their overall yields and the quality of their products.

To obtain the desired characteristics in livestock, various breeding methods can be used. **Inbreeding** refers to mating of closely related individuals for 4-6 generations, which increases homozygosity, degrading the reproductivity and productivity. This condition is called *inbreeding depression* and is done to develop homozygous pure lines.

Outbreeding is the breeding of unrelated animals. The offspring resulting from such mating is known as outcross, and a single outcross may help to overcome inbreeding depression.

Outcrossing refers to the practice of mating animals within the same breed but not having common ancestors on either side of their pedigree up to 4-6 generations.

Crossbreeding involves mating the superior male of one breed with the superior female of another breed to combine the desirable qualities of two breeds into a single individual. **Interspecific hybridization** is the mating between male and female animals of two different species. For example, the interspecific hybridization between female horse and male donkey species results in the formation of a 'mule.' These breeding methods help to improve the overall productivity and quality of livestock.

Controlled breeding techniques are an important method for animal breeding. One such technique is **Artificial Insemination (AI)**, which involves injecting semen collected from a superior male parent into the reproductive tract of a selected female parent. This method overcomes several challenges of natural mating and enables breeders to fertilize cows at distant locations.

Another important controlled breeding technique is **Multiple Ovulation Embryo Transfer (MOET)**, which produces a larger number of offspring from milk-producing cattle such as cows and buffaloes. This technique involves injecting hormones with FSH-like activity into milk-producing animals to stimulate the production of more than one egg. These eggs are then fertilized with sperm carrying desirable genes from an elite bull. If successful, the fertilized eggs at the 8-32 cell stage are implanted into the uterus of a surrogate mother.

Beekeeping, also known as Apiculture or Bee culture, involves maintaining hives of honeybees to produce honey and beeswax. This age-old practice has traditionally been a cottage industry, with large places called apiaries or beehives used for bee culture. In India, the most common species reared by beekeepers are Api's indica and Api's dorsata.

Fisheries, on the other hand, focus on rearing fish, molluscs (shell-fish), and crustaceans (crabs, prawns, etc.) to meet the growing demand for fish products. Techniques such as aquaculture and pisciculture are used to increase the production of aquatic plants and animals in both fresh and marine water. In India, the common ***freshwater fishes*** are catla, rohu, and common carp, while the ***marine fishes*** include hilsa, sardines, mackerel, and pomfret. Fish are an excellent source of natural vitamin-A, protein, and iodine.

It Is worth noting that the *Blue Revolution* is a movement aimed at increasing fish rearing.

Plant breeding

Plant breeding is a powerful technique used to manipulate plant species in order to create desired plant types that are more suitable for cultivation, provide higher yields, and are resistant to diseases. This process involves incorporating specific traits and characters into crop plants such as increased tolerance to environmental stresses, resistance to pathogens, and improved quality.

The steps Involved in plant breeding include the collection of variability,

1. evaluation and selection of parents
2. cross hybridization among selected parents
3. selection and testing of superior recombinants
4. the testing, release, and commercialization of new cultivars.

By utilizing this method, scientists were able to bring about the green revolution by enhancing the yield of cereal produce.

Dr. Norman E Borlaug is recognized as the Father of the Green Revolution worldwide for his contributions in obtaining the wheat variety possessing the **Norin-10** dwarfing gene. Dr. MS Swaminathan is regarded as the Father of the Indian Green Revolution. Indian hybrid crops of high yielding varieties produced during the Green Revolution include **wheat** (Sonalika, Kalyan Sona), **rice** (Jaya, Ratna, IR-8), **sugarcane** (a hybrid of Saccharum barberi and Saccharum officinarum).

Developing Disease-Resistant Plants through Breeding

The resistance of a host plant to diseases is determined by its genetic makeup, which allows it to resist pathogen attacks.

This resistance can be achieved through two breeding methods:

(i) **Conventional Breeding**: This is a traditional technique that involves producing hybrid varieties. Some notable examples of plants developed through conventional breeding are Himgiri (wheat), Pusa Swarnim (mustard), Pusa Shubhra (cauliflower), Pusa Komal (Cowpea), and Pusa Sadabahar (chilli).

(ii) **Mutation Breeding**: This technique induces genetic variations in crops by changing the base sequences within genes. Mutation breeding has been used to improve crops, such as mung beans that are resistant to yellow mosaic virus and powdery mildew.

Developing Insect-Resistant Plants through Breeding

Insect resistance in host crop plants can be achieved through various characteristics such as morphological, biochemical, or physiological. Breeding techniques, such as hybridization and selection, have been used to develop crop varieties that are resistant to insect pests like aphids. Some examples of such plants are Pusa Gaurav (rapeseed mustard), Pusa Sem 2 (flat bean), etc.

Developing Plants with Improved Food Quality through Breeding

Improving the quality of food produced by crops is a crucial aspect due to various reasons, such as the lack of adequate food with essential nutrients, hidden hunger, and the absence of essential micronutrients in the diet.

To meet these requirements, two different breeding methods are used:

(i) **Conventional Breeding**: This technique involves producing hybrid varieties that are capable of producing nutrient-rich foods.

(ii) **Genetic Engineering**: This technique modifies the genetic makeup of plants to produce food with improved nutritional quality.

Biofortification involves the selective breeding of crops that possess elevated levels of essential nutrients such as vitamins, fiber, protein, and carbohydrates. This process aims to enhance the nutritional value of crops to help address malnutrition and nutrient deficiencies.

Single Cell Protein (SCP) refers to a type of edible microorganism that is composed of unicellular organisms such as algae, yeasts, fungi, or bacteria. The biomass or protein extract derived from these microorganisms can serve as a substitute for protein-rich foods and can be used in human or animal consumption. Examples of SCPs include **Spirulina** and **Chlorella**.

Other Techniques for Food Production

There are a few other techniques besides traditional plant breeding that are used for food production. These techniques include **tissue culture** and **somatic hybridisation**.

Tissue culture is a method where a whole plant is produced from a small plant tissue sample called an explant. The ***explant*** is grown in an artificial culture medium, and the ability of a plant cell to produce a whole plant is known as **totipotency**. One application of tissue culture is ***micropropagation***, which is the rapid multiplication of plants vegetatively. This method is fast and efficient and can produce a large number of plantlets.

Somatic hybridisation is another technique used for food production. This process involves fusing protoplasts (cells without cell walls) from different varieties or species of a plant using **Polyethylene Glycol (PEG)** on a suitable nutrient medium in vitro. The resulting hybrid is called a somatic hybrid. One example of a somatic hybrid is **Pomato**, which is produced by fusing tomato and potato protoplasts. However, Pomato does not possess all the desirable characteristics for commercial utilisation.

These techniques offer alternative methods for plant propagation and hybridisation that can lead to new and useful plant varieties.

Strategies for enhancement in food production

Animal husbandry

- Farm and farm animals
  - Dairy farm Management
  - Poultry farm Management
  - Fisheries
    - Freshwater fishes- Catla, Rohu, common carp, etc.
    - Marine fishes - Hilsa, Sardines, Mackerel, etc.
  - Bee Keeping (Apiculture)
    - Practice of bee-keeping for honey and beeswax.
    - ***Apis indica*** is most common species used.

Animal Breeding

- Inbreeding
  - Mating of more closely related individuals with in the same breed for 4-6 generations.
  - Continued inbreeding, leads to inbreeding depression.
- Out-breeding
  - Out-Crossing
    - Mating of animals within the same breed.
    - Must have no common ancestors on either side of their pedigree up to 4-6 generations.
    - Helps in improving milk production, growth rate in beef cattle, etc. and to overcome inbreeding depression.
  - Cross-breeding
    - Superior males of one breed are mated with superior females of another breed E.g.,Hisardale (sheep)
  - Inter-specific hybridization
    - The mating of male and female animals of two different species E.g.,Mule
- Controlled breeding techniques
  - Artificial insemination
    - MOET
      - The semen collected from male parent is injected into the reproductive tract of selected female by the breeder.
      - Multiple Ovulation Embryo Transfer technology is a programme for herd improvement.

Tissue culture

- Meristem culture
  - This method is used to recover healthy plants from diseased plant.
  - Meristem (apical and axillary) is the only virus free part of a virus infected plant.
  - E.g., Banana, sugarcane, potato, etc.
- Somatic hybridization
  - Process of fusion of protoplast of different varieties on a suitable nutrient medium in vitro to develop somatic hybrid.
  - E.g. Pomato= tomato + potato protoplasts.

Plant Breeding

- Steps
  - Collection of genetic variability
  - Evaluation of germplasm and selection of parents
  - Cross hybridisation among the selected parents
  - Selection of superior hybrids
  - Testing, release and commercialization of new cultivars.
- Reasons
  - For disease resistance varieties
    - Conventional Breeding Technique
      - Crossing or hybridisation of pure lines, followed by artificial selection to producing plants with desirable traits.
    - Mutation Breeding
      - The genetic variations are created through changes in the base sequence within genes to create a new trait. Example: In mung bean, the resistance to yellow mosaic virus and powdery mildew
  - For Developing resistance to pest

Crop	Variety	Insect pests
Brassica (rape seed mustard)	Pusa Gaurav	Aphids
Flat bean	Pusa Sem 2, Pusa Sem 3	Jassids, aphids and fruit borer.
Okra (Bhindi)	PusaSawani, Pusa A-4	Shoot and Fruit borer.

For improving food quality

- Single Cell protein
  - *Spirulina* is used for SCP, so as to provide alternate source of nutrition.
  - It is rich in protein, minerals, fats, carbohydrate and vitamins.
- Objectives of Biofortification
  - To improve protein content and quality.
  - To improve oil content and quality.
  - To improve vitamin content.
  - To improve micronutrient and mineral content.
- Example
  - Hybrid maize
  - Wheat variety: Atlas 66
  - Iron fortified rice

Trace the Mind Map

First Level · Second Level · Third Level

Practice Questions

1.What is the term used for rearing and breeding of fish in ponds, tanks, and artificial reservoirs?

a) Aquaculture b) Fishing c) Pisciculture d) Apiculture

2.Bee wax is a product of great significance in which of the following areas?

a) Industrial b) Domestic c) Medicinal d) All of the above

3.Which factor was responsible for the significant increase in wheat crop production during the Green Revolution in 1963?

a) Semi-dwarf varieties of wheat b) Jaya and Ratna wheat varieties

c) Both (a) and (b) d) Sonalika and Kalyan Sona wheat varieties

4.Which plant's seeds are used for obtaining safflower oil?

a) Saffron b) Sunflower c) Sesame d) None of the above

5.What is the primary purpose of evaluating germplasm in a plant breeding program?

a) To identify plants with a desirable combination of characters

b) For effective exploitation of natural genes

c) Both (a) and (b)

d) For the collection of variability

6.What hormone(s) can be used to induce spawning in fishes?

a) TSH b) Thyroxine c) FSH and LH d) STH

7.Which of the following is an old breeding technique?

a) Introduction b) Selection c) Mutation breeding d) Hybridization

8.Which of the following strategies is commonly used for enhancement in food production?

A) Crop rotation B) Deforestation C) Overfishing D) Urbanization

9.What is the reason for breeding plants to improve food quality?

I. Inadequate food with essential nutrients in the world

II. Majority of people unable to afford enough fruits, vegetables, legumes, fish, and meat, resulting in deficiencies or hidden hunger.

III. Essential micronutrients are missing from the diet.

Choose the correct option:

a) I and II b) I and III c) II and III d) I, II, and III

10.What is the term for the mating of two individuals with different genotypes to produce genetic variation?

a) Domestication b) Incubation c) Hybridization d) Mutation

11.From which part of the cotton plant is cotton fiber obtained?

a) Roots b) Stems c) Seeds d) Leaves

12.Which is the cheapest high-energy crop in India?

a) Apple b) Guava c) Mango d) Banana

13.What part of the flower is removed during emasculation?

a) Stigma b) Sepals and petals c) Anthers d) The entire organism

14.Which enzymes are required for protoplast fusion?

a) Cellulose, hemicellulose, pectinase b) Pectinase

c) Ligase, hemicellulose d) Hemicellulose

15.How long do cows and buffaloes stay in heat?

a) 24-36 hours b) 36-48 days c) 7-10 days d) 15-20 days

16.Which of the following sequences correctly shows the chronological order of events during callus culture?

a) Callus → Cell division → Addition of cytokinin → Cells acquire meristematic property → Explant

b) Explant → Cell division → Callus → Addition of cytokinin → Cells acquire meristematic property

c) Explant → Cell division → Addition of cytokinin → Callus → Cells acquire meristematic property

d) Explant → Callus → Cell division → Addition of cytokinin → Cells acquire meristematic property

17.The part of the grain in cereals where much of the protein lies is:

a) Aleurone b) Endosperm c) Pericarp d) Embryo

18.Haploids are important in crop improvement programmed because they:

a) Require half the amount of nutrients

b) Are helpful in studying meiosis

c) Grow better under adverse conditions

d) Form perfect homozygous individuals upon diploidisation

19.Honey bees use a specific type of dance to communicate the location of food, known as the:

a) Tap dance b) Round dance and waggling dance

c) Break dance d) Waggle dance

20.The plant cell without the cell wall is called:

a) Protoplast b) Cytoplast c) Nucleoplast d) None of these

21.The capacity of a cell explant to grow into a whole plant is called:

a) Plant culture b) Tissue culture c) Cellular totipotency d) All of these

22.Close inbreeding usually results in a reduction of fertility and productivity. This is called:

a) Homozygosity b) Outbreeding c) Inbreeding depression d) Outbreeding depression

23.Read the following statement about outcrossing:

I. It is the breeding between animals within the same breed but do not have common ancestors on either side of their pedigree up to 4-6 generations.

II. It is done to increase milk production and growth rate in animals.

Which of the statements given above is incorrect?

a) Only I b) Only II c) Both I and II d) None of these

24. …… is a phenomenon by which genetic variation is achieved through changes in the base sequences within genes, creating a new character or trait absent in the parental generation.

a) Apomixis b) Mutation c) Mutation breeding d) Heterosis

25.Which of the following statements best describes the main objectives of animal breeding?

a) Improving growth rate

b) Increasing production of milk, meat, eggs, wool, etc.

c) Achieving superior quality of milk, meat, eggs, wool, etc.

d) Improving resistance to various diseases

e) All of the above

26.Which of the following animals is a beast of burden that requires little care?

a) Pig b) Donkey c) Mule d) Yak

27.What is isinglass, a byproduct of the fish industry, primarily used for?

a) Feeding cattle, pigs, and poultry
b) Preparation of paints and varnishes
c) Clarification of vinegar, wines, and beer
d) Production of insulin

28.What is the enzyme used for isolating single cells from explants/cells?

a) Pectinase
b) Catalase
c) Ligninase
d) Maltase

29.Which of the following is a new breed of animal developed in Punjab by crossing Bikaneri ewes and Marino rams?

a) Sheep
b) Chicken
c) Cow
d) None of the above

30.Which of the following are economic importance of fish?

a) Fish as food
b) Source of income
c) Aesthetic value
d) All of the above.

31.What are lysine and tryptophan?

a) Proteins
b) Non-essential amino acids
c) Essential amino acids
d) Aromatic and no acids

32.Which of the following diseases can be controlled by enhancing resistance through mutation in moong bean?

a) Yellow mosaic virus
b) Powdery mildew
c) Black rust
d) All of the above

33.What is the conventional method of breeding for resistance?

a) Screening the germplasm for resistant sources
b) Hybridization of selected parents
c) Selection and evaluation of the hybrids
d) Testing and release of new varieties

34.What is the primary aim of animal breeding?

a) Qualitative increase in the product

b) Quantitative increase in the product

c) Marketing of animal product

d) Both a and b

35.What is the scientific name of maize?

a) Zingiber

b) Raphanus

c) Daucas

d) Zea mays

36.Which of the following methods have been used to develop improved wheat varieties suitable for Indian environment?

A) Euploidy and cloning

b) Hybridization and mutation

c) Polyploidy and hybridization

d) Cloning and polyploidy

37.Which word is most appropriate to fill in the blank to complete the following sentence? "_____ is used in the manufacture of many items including cosmetics, shaving creams and polishes of various kinds."

a) Bee wax

b) Honey

c) Latex

d) Resin

37.Which breed of cow is considered a milch breed?

a) Haryana

b) Malvi

c) Kankrej

d) Halliker

38.What is the name of the embryo that develops from a somatic cell?

a) Somatic embryo

b) Reproductive embryo

c) Clone embryo

d) None of these

39.What is a hinny?

a) A cross breed between a male donkey and a female horse

b) A cross breed between a female donkey and a male horse

c) A cross breed between a male mule and a female horse

d) None of these

40.What is the science of altering the genetic pattern of plants to increase their value and utility for human welfare called?

a) Plant breeding b) Agriculture c) Plant genetics d) All of these

41.Which term refers to the cultivation of aquatic animals or plants for food?

a) Aquaculture b) Pisciculture c) Sericulture d) Apiculture

42.What is the process associated with the differentiation of organs and tissues in a developing organism?

a) Developmental mutations b) Differential expression of genes

c) Lethal mutations d) Deletion of genes

43.Which cereal crop is obtained by crossing wheat with another crop?

a) Oat b) Barley c) Maize d) Rye

44.What are essential oils composed of?

a) Vitamins b) Auxins c) Trace elements d) Aromatic volatile organic substances

45.What is the method used to produce a mule?

a) Inbreeding b) Artificial insemination

c) Interspecific hybridization d) Intraspecific hybridization

46.Which of the following crop varieties were developed for the green revolution in India?

a) Maize b) Rice c) Wheat d) Bajra

47.Which of the following statements about animal husbandry is correct?

I. Breeding of livestock buffaloes, cows, sheep, camels, etc., that are useful to humans

II. Rearing, catching, selling, etc., of fish, molluscs and crustaceans

III. Breeding of fowls for human use

a) I and II b) I and III c) II and II d) I, II and III

48.Which of the following agents induce mutations?

a) Mutagens b) Carcinogens c) Oncogenes d) None of these

49.Which of the following statements is correct about the center of origin of a plant?

a) More diversity in improved variety b) Frequency of dominant gene is more

c) Climatic conditions are more favorable d) None of the above

50.Which of the following statements are true and which are false?

I. Breeding of animals is very important for animal husbandry

II. Both the male and female animals selected for breeding should be of superior quality

III. The word 'husbandry' means the management of domestic affairs

IV. In our country, poultry mainly means chickens, domesticated for eggs

V. Cows and buffaloes generally give more milk than goats and sheep

VI. The yellow color of buffalo milk is due to carotene

a) F F T T F F

b) T T F F T F

c) T T T F T F

d) F T F T T F

Answers

1.The correct answer is c) Pisciculture. Pisciculture is the practice of rearing and breeding of fish in ponds, tanks, and artificial reservoirs. It involves the cultivation of aquatic organisms like fish, crustaceans, mollusks, and aquatic plants for commercial, recreational, or scientific purposes. Aquaculture is a broader term that encompasses the cultivation of all aquatic organisms, including fish, shellfish, and aquatic plants.

2.The correct answer is d) All of the above. Bee wax is a versatile product that has various uses in industrial, domestic, and medicinal fields. It is used to make candles, cosmetics, soaps, polishes, and pharmaceuticals. It is also used in food processing as a coating or packaging material.

3.The correct answer is a) Semi-dwarf varieties of wheat. The Green Revolution was a period of intensive research and technological development in agriculture that led to significant increases in crop production in developing countries. One of the key factors that contributed to the success of the Green Revolution was the development of semi-dwarf varieties of wheat, which had shorter stems and higher yield potential than traditional tall varieties. The semi-dwarf varieties were able to support the weight of their heavier grain heads without falling over, allowing for higher yields.

4.The correct answer is d) None of the above. Safflower (Carthamus tinctorius) is a plant whose seeds are used for obtaining safflower oil. Saffron is a spice derived from the Crocus sativus flower. Sunflower (Helianthus annuus) seeds are used for obtaining sunflower oil, and sesame (Sesamum indicum) seeds are used for obtaining sesame oil.

5.The correct answer is c) Both (a) and (b). Evaluating germplasm is an essential step in a plant breeding program. Germplasm refers to the genetic material of a plant, including seeds, tissues, and other plant parts. The primary purpose of evaluating germplasm is to identify plants with a desirable combination of characters, such as high yield, disease resistance, and quality traits. Effective exploitation of natural genes is also important for developing new varieties of crops.

6.The correct answer is c) FSH and LH. Fish can be induced to spawn by injecting them with hormones such as follicle-stimulating hormone (FSH) and luteinizing hormone (LH). These hormones stimulate the ovaries and testes to release eggs and sperm, respectively, which can be fertilized to produce offspring.

7.The correct answer is a) Introduction. Introduction is an old breeding technique that involves bringing a plant or animal species from one region or country to another for breeding or cultivation. This technique has been used for centuries to introduce new crop varieties and livestock breeds into different regions to improve productivity and adapt to local conditions. However, the introduction of non-native species can also have negative ecological and economic impacts.

8.The correct answer Is A) Crop rotation.

Crop rotation is a widely employed strategy for enhancing food production. It involves the systematic planting of different crops in a specific sequence on the same piece of land over time. This practice helps in replenishing soil fertility, reducing pest and disease pressure, and preventing the buildup of specific crop pathogens. By alternating the types of crops grown, the soil's nutrient levels are better maintained, ensuring optimal conditions for plant growth.

9.The correct answer is d) I, II, and III. Breeding plants to improve food quality is important because there is inadequate food with essential nutrients in the world, and a majority of people cannot afford enough fruits, vegetables, legumes, fish, and meat, resulting in deficiencies or hidden hunger. Essential micronutrients are missing from the diet, and breeding plants with improved nutrient content can help address these issues.

10.The correct answer is c) Hybridization. Hybridization is the process of mating two individuals with different genotypes to produce offspring with new combinations of genetic traits. This process is commonly used in plant breeding to develop new crop varieties with desirable traits.

11.Answer: c) Seeds

Explanation: Cotton fiber is obtained from the seeds of the cotton plant. The seeds are surrounded by a fluffy layer of cotton fibers called the lint, which is used to make cotton fabric.

12.Answer: d) Banana

Explanation: Banana is the cheapest high-energy crop in India, as it is widely cultivated in the country and has a high yield per acre.

13.Answer: c) Anthers

Explanation: Emasculation is the process of removing the anthers from the flower, which is done to prevent self-pollination and to facilitate controlled pollination in plant breeding.

14.Answer: b) Pectinase

Explanation: Pectinase is the enzyme required for protoplast fusion, which is the process of fusing two plant cells together to create a single cell with a new genetic makeup.

15.Answer: c) 7-10 days

Explanation: Cows and buffaloes stay in heat, or estrus, for 7-10 days on average. This is the period when they are receptive to mating and can become pregnant.

16.Answer: b) Explant → Cell division → Callus → Addition of cytokinin → Cells acquire meristematic property

Explanation: Callus culture is a technique used in plant tissue culture to produce a mass of undifferentiated cells, called a callus, from an explant. The correct chronological order of events during callus culture is: Explant → Cell division → Callus → Addition of cytokinin → Cells acquire meristematic property.

17.Answer: a) Aleurone

Explanation: The aleurone is the layer of cells in the outermost part of the endosperm of cereal grains such as wheat, rice, and corn. It is rich in protein and other nutrients.

18.Answer: b) Are helpful in studying meiosis

Explanation: Haploids are important in crop improvement programs because they allow for the study of meiosis and the creation of genetically diverse populations through the creation of homozygous lines.

19.Answer: d) Waggle dance

Explanation: Honey bees use a waggle dance to communicate the location of food to other bees in the colony. The dance consists of a series of figure-eight movements that indicate the direction and distance to the food source.

20.Answer: a) Protoplast

Explanation: A protoplast is a plant cell that has had its cell wall removed. It consists of the plasma membrane, cytoplasm, and nucleus of the original cell.

21.c) Cellular totipotency. This refers to the ability of a single cell to regenerate an entire organism.

22.c) Inbreeding depression. This occurs when the offspring of closely related individuals have reduced fitness due to an increase in homozygosity for deleterious recessive alleles.

23.b) Only II. Outcrossing is the breeding of two unrelated individuals within the same breed to increase genetic diversity and improve traits. It is not always done to increase milk production and growth rate specifically.

24.b) Mutation. This can occur spontaneously or be induced through various methods such as radiation or chemical mutagens.

25.d) All of the above. Animal breeding aims to improve various traits in animals including growth rate, production of milk, meat, eggs, wool, etc., superior quality of these products, and resistance to diseases.

26.b) Donkey. Donkeys are known for their strength and endurance and are often used as pack animals.

27.c) Clarification of vinegar, wines, and beer. Isinglass is a collagen obtained from fish bladders and is commonly used as a fining agent in the clarification process of alcoholic beverages.

28.a) Pectinase. This enzyme is commonly used in plant tissue culture to break down the cell walls of the explants and release the single cells.

29.a) Sheep. The new breed is called Barmar.

30.d) All of the above. Fish are an important source of food and income for many people around the world. They also have aesthetic value and contribute to recreational activities such as fishing and aquarium keeping

31.c) Essential amino acids. Lysine and tryptophan are both essential amino acids, which means that they cannot be synthesized by the human body and must be obtained through diet.

32.a) Yellow mosaic virus. Yellow mosaic virus is a disease that can be controlled by enhancing resistance through mutation in moong bean. Powdery mildew and black rust are not controlled by mutation in moong bean.

33.b) Hybridization of selected parents. The conventional method of breeding for resistance involves selecting and hybridizing plants with desirable traits, such as resistance to certain diseases or pests.

34.b) Quantitative increase in the product. The primary aim of animal breeding is to achieve a quantitative increase in the product, such as meat, milk, or eggs. Qualitative improvements may also be sought, but are secondary to quantitative goals.

35.d) Zea mays. Maize is scientifically known as Zea mays. Zingiber, Raphanus, and Daucas are all different plant genera.

36.c) Polyploidy and hybridization. Improved wheat varieties suitable for Indian environment have been developed through polyploidy and hybridization.

37.a) Bee wax. Bee wax is used in the manufacture of many items, including cosmetics, shaving creams, and polishes of various kinds. Honey, latex, and resin may be used in some products, but are not as versatile as bee wax.

38.a) Somatic embryo. A somatic cell can be induced to develop into an embryo through a process called somatic embryogenesis, resulting in a somatic embryo.

39.b) A cross breed between a female donkey and a male horse. A hinny is a hybrid offspring of a female donkey and a male horse. The reverse cross, a male donkey and a female horse, produces a mule.

40.a) Plant breeding. The science of altering the genetic pattern of plants to increase their value and utility for human welfare is called plant breeding. Agriculture and plant genetics are broader fields that encompass many aspects of plant science beyond breeding.

41.a) Aquaculture refers to the cultivation of aquatic animals or plants for food. Pisciculture refers specifically to the cultivation of fish, while sericulture refers to the production of silk and apiculture refers to beekeeping.

42.b) The process associated with the differentiation of organs and tissues in a developing organism is the differential expression of genes. Developmental mutations refer to mutations that affect the development of an organism, while lethal mutations result in death or impaired function of an organism. Deletion of genes can also affect an organism's development, but it is not specifically related to differentiation.

43.c) Maize is a cereal crop that is obtained by crossing wheat with another crop. Oat, barley, and rye are all cereal crops, but they are not obtained by crossing with wheat.

44.d) Essential oils are composed of aromatic volatile organic substances. They are not composed of vitamins, auxins, or trace elements.

45.c) The method used to produce a mule is interspecific hybridization, which involves mating a male donkey with a female horse. Inbreeding involves mating closely related individuals, while artificial insemination involves the introduction of semen into a female's reproductive system to achieve fertilization. Intraspecific hybridization involves mating between individuals of the same species.

46.b) Rice is a crop variety that was developed for the green revolution in India. Maize, wheat, and bajra are all cereal crops, but they were not specifically developed for the green revolution in India.

47.b) The correct statement about animal husbandry is I and III, which refer to the breeding of livestock and fowls for human use. Rearing, catching, and selling of fish, molluscs, and crustaceans is aquaculture, not animal husbandry.

48.a) Mutagens are agents that induce mutations. Carcinogens are agents that can cause cancer, while oncogenes are genes that can cause normal cells to become cancerous.

49.c) The correct statement about the center of origin of a plant is that climatic conditions are more favorable. The center of origin of a plant is the geographic region where it first evolved and developed its characteristic properties. This region typically has favorable climatic conditions and other environmental factors that are conducive to the plant's growth and development.

50.b) The true statements are II, IV, and V. Breeding of animals is indeed important for animal husbandry, but the word “husbandry” does not specifically refer to the management of domestic affairs (statement III is false). Poultry does indeed mainly refer to chickens domesticated for eggs (statement IV is true). Cows and buffaloes do generally give more milk than goats and sheep (statement V is true). The yellow color of buffalo milk is not due to carotene (statement VI is false).