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STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

SYLLABUS

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

KEY CONCEPTS

ANIMAL HUSBANDRY

* Science of rearing, improvement and caring of domesticated animals is called Animal Husbandry.
* Domesticated animals, especially the farm animals, kept for profit are collectively called live stock. eg. Cow (*Bos indicus*), Buffaloes (*Bos bubalus*), sheep, goat, pigs, horses, camel.

Management of Farms and Farm Animals

(i) Dairy Farm Management:

* Dairying is the management of animals for milk and its products for human consumption.
  In dairy farm management, we deal with processes and systems that increase yield and improve quality of milk.
* Selection of good breeds having high yielding potential, combined with resistance to diseases is very important.
* Cattle have to be housed well, should have adequate water and be maintained disease free.
* The feeding of cattle should be carried out in a scientific manner (quality and quantity of fodder).
* Stringent cleanliness and hygiene are importance while milking, storage and transport of the milk and its products.

(ii) Poultry farm management:

* Poultry is the class of domesticated fowl (birds) used for food and eggs.
* Selection of disease free and suitable breeds.
* The improved breed of poultry is Leghorn.
* Proper and safe farm conditions
* Proper feed and water
* Hygiene and health care.
* Poultry birds exclusively grown for meat are called broilers (e.g., Plymouth rock).
* **Layers** are female fowls raised for egg production (e.g., White leghorn).
* Bird flu is an avian influenza which can also attack human beings. It was caused by (H_5N_1) influenza virus in 2003 (Thailand).
  Infected birds pass on virus through their saliva, nasal secretions and faeces. In 1918, it attacked human beings and killed about 50 million humans. The reservoir of bird flu seems to be migratory birds. The virus attacks and kills monocytes. The raw meat and eggs may contain virus. Once an outbreak is detected, the infected chicken are culled to prevent spread of the disease.
* The chicken is commonly classified on the basis of its origin.

(a) American breeds : Plymouth rock, Rhode Island Red, New Hampshire.

(b) **English breeds :** Australorp, Cornish (dark)
(c) **Asiatic breeds :** Brahma (light), Cochin, Langshan (black).
(d) **Mediterranean breeds :** Leghorn.
* **Indigenous breeds :** Aseel, Busra, Chittagon. Karaknath, Ghagus.
* Aseel fowls are used in cock fighting.

Breeds of cattle :
* The most important breeds of milk cows in the United States of America are Holstein, Friesian, Jersey, Quernsery, Ayrshire & Brown Swiss, Red Dane.
* In India the most important breeds of buffaloes are: Surti, Niliravi, Nagpuri (ellichpuri), Jaffrabandi, Bandawari, murrah, mehsana.
* Depending upon the utility, the cattle are classified into the following groups
  (i) Milch breeds (Milk producing animal).
  (ii) Draught breeds (Used for working).
  (iii) General utility breeds (Used for safety).

Important breeds of Indian Cattle

1. Milch Breeds

(i) Gir	(ii) Sahiwal
(iii) Red Sindhi	(iv) Deoni

2. Draught Breeds

(i) Malvi	(ii) Hallikar
(iii) Nageri	(iv) Kangyam

3. General utility Breeds

(i) Haryana	(ii) Ongole
(iii) Kankerj	(iv) Tharparkar

Breeding of Cattle :
* Gestaion period of cows is about 9 months & buffaloes is about 10 months.
* Cows give 8-10 calves in complete life span.
* The breeding of cattle is done by two methods
  (i) Natural Breeding (ii) Artificial breeding

(i) **Natural breeding :** It is further of two types –
(a) **Random Breeding :**
* Some pedigree bulls are kept along with the grazing cows.
* Bulls not selected for breeding are castrated and changed to bullocks.

(b) **Controlled breeding :**
* In this type of breeding native cows are crossed with superior quality of imported bulls in natural breeding.
* Foreign dairy breeds like Jersey (England), Holstein. Freisian (Holland), Brown Swiss (Switzerland), Ayrshire (Scotland) have been important to give better results.
* Hybrid cows require special environment & yield more milk.
* Hybrid oxen is also comparatively more active & energetic.
* Some improved hybrids are – Jersey, Sindhi ; Brown Swiss, Sahiwal ; Ayrshire, Sahiwal, etc.

(ii) **Artificial Breeding :** The introduction of semen (sperm) in the body (vagina) of females by artificial means is called artificial Insemination.
* Several cows can be inseminated by semen of a single bull.

Animal Breeding:
* When breeding is between animals of the same breed it is called **inbreeding**, while crosses between different breeds are called **outbreeding**.

(I) **Inbreeding :**
* Inbreeding refers to the mating of more closely related individuals within the same breed for 4-6 generations.
* The breeding strategy is as follows – superior males and superior females of the same breed are identified and mated in pairs.
* The progeny obtained from such matings are evaluated and superior males and females among them are identified for further mating.
* A superior female, in the case of cattle, is the cow or buffalo that produces more milk per lactation.
* On the other hand, a superior male is the bull, which gives rise to superior progeny as compared to those of other males.
* Inbreeding increases **homozygosity**. Thus inbreeding is necessary if we want to evolve a pureline in any animal.
* Inbreeding exposes harmful recessive genes that are eliminated by selection.

* It also helps in accumulation of superior genes and elimination of less desirable genes. Therefore, this approach, where there is selection at each step, increases the productivity of inbred population.
* Continued inbreeding, especially close inbreeding, usually reduces fertility and even productivity. This is called **inbreeding depression**. Whenever this becomes a problem, selected animals of the breeding population should be mated with unrelated superior animals of the same breed. This usually helps restore fertility and yield.

(II) Out-breeding :

* Out-breeding is the breeding of the unrelated animals, which may be between individuals of the same breed but having no common ancestors for 4-6 generations (out-crossing) or between different breeds (cross-breeding) or different species (inter-specific hybridisation).

(i) Out-crossing: This is the practice of mating of animals within the same breed, but having no common ancestors on either side of their pedigree up to 4-6 generations. The offspring of such a mating is known as an out-cross. It is the best breeding method for animals that are below average in productivity in milk production, growth rate in beef cattle, etc. A single outcross often helps to overcome inbreeding depression.

(ii) Cross-breeding: Superior males of one breed are mated with superior females of another breed. Cross-breeding allows the desirable qualities of two different breeds to be combined. The progeny hybrid animals may themselves be used for commercial production. Alternatively, they may be subjected to some form of inbreeding and selection to develop new stable breeds that may be superior to the existing breeds. Many new animal breeds have been developed by this approach. *Hisardale* is a new breed of sheep developed in Punjab by crossing Bikaneri ewes and Marino rams.

(iii) Interspecific hybridisation: Male and female animals of two different related species are mated. In some cases, the progeny may combine desirable features of both the parents, and may be of considerable economic value, e.g., the mule (a cross between male donkey and female horse).

Controlled breeding experiments

(i) Artificial insemination :

* The semen is collected from the male that is chosen as a parent and injected into the reproductive tract of the selected female by the breeder.
* The semen may be used immediately or can be frozen and used at a later date.
* It can also be transported in a frozen form to where the female is housed. In this way desirable matings are carried.
* Artificial insemination helps us overcome several problems of normal matings.

(ii) Multiple Ovulation Embryo Transfer Technology (MOET)

* It is for herd improvement.
* 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.
* The animal is either mated with an elite bull or artificially inseminated.
* The fertilised eggs at 8–32 cells stages, are recovered non-surgically and transferred to surrogate mothers.
* The genetic mother is available for another round of super ovulation.
* This technology has been demonstrated for cattle, sheep, rabbits, buffaloes, mares, etc. High milk-yielding breeds of females and high quality (lean meat with less lipid) meat-yielding bulls have been bred successfully to increase herd size in a short time.

APICULTURE

* The scientific method of care & management of honey bees is called Apiculture.
* Honey is a food of high nutritive value and also used in the indigenous systems of medicine.

* Honeybee also produces beewax, which finds many uses in industry,such as in the preparation of cosmetics and polishes of various kinds.
* Honey is near neutral sugary syrup with 6.8 pH, having 17-25% water, 3.3% minerals, abundant vitamins (B1, B6, C, D), L-fructose (Laevulose, 41%), glucose (35%), sucrose (1.9%) and dextrin (1.5%). It is tonic, laxative and sweetening agent.
* Bee wax is secreted by abdominal wax glands of the worker bees. It possesses a hardening substance from cephalic gland and a resin called **propolis** from pollen grains.
* Although bees are very active throughout the year but in winter they become sluggish & are very active in spring.
* They show polymorphism & good division of work.
* The diameter of a normal bee hive is about 30-90 cm. In it the number of bees is about 50-60 thousands.
* Bees are pollinators for sunflower, Brassica, apple & pear.

Social Organisation :

* A highly organised division of labour is found in the colony of honey bee,
* Each colony has 40,000 to 50,000 individual consisting of 3 casts : Queens, Drones and Workers.

Important species of Honey-bees:

(i) ***Apis dorsata*** **(Rock bee) :** It is also named as sarang bee. It is of largest size and produces highest yield of honey. However, ut is of highly aggressive nature and migratory species, which is not suitable for rearing by man.

(ii) ***Apis indica*** **(Indian Mona-bee) :** It lives across the whole country of India and is smaller in size than saarang-bee. It is mild in nature, so that it is easily manageable during rearing. Mona-bee yields about 3-4 kg. of honey per hive.

(iii) ***Apis florea*** **(Bhringa-bee) :** This bee is smallest in size and of timid nature. It only yields about 250gms. of honey every hive. Hence is not suitable for commercial purpose.

(iv) ***Apis mellifera*** **(European bee) :** This bee is of mild nature. It yields more honey than mona-bee. It is the most useful bee for commercial purpose. The Italian variety of this species is by far the most important variety.

FISHERIES

* Fishes & other aquatic animals are reared and caught for food which is rich in protein vitamin A & D.
* "Aquaculture" involves production of useful aquatic plants and animals such as fishes, prawns, shrimps, lobsters, crabs, molluscs (edible and pearl oysters) by the proper utilisation of small and large bodies of water.
* Pisciculture is rearing catching & management of fishes.
* Culture fishery is the raising of fishes in tanks & ponds.
* Capture fishery is management of catching of fish without actually raising them.
* Blue Revolution is effort to increase fish yield in India.
* Fresh water fishes.

Indogenous sps :

1. *Labeo rohito* (Rohu)
2. *Labeo calbasu* (Calbasu)
3. *Catla catla* (Catla)
4. *Clarias betrachus* (Magur)
5. *Mystus singhala* (Singhara)
6. *Heteropneustes heteropneusts* (Singhi)

Exotic sps.

1. Cyprinus carpio (Common carp)
2. Ctenopharyngodon idella (grass carp)
3. Hypopthalmicthys molitrix (chinese carp/silver carp)

Marine fishes

1. Hilsa (Hilsa) - Coastal India
2. Aluitheronema (Salmon) - East & west coast
3. Sardinella (Sardine) - West & south coast
4. Harpodon (bombay duck) -Coastal Maharashtra
5. Stromateus (pomphret) - Indopacific coast
6. Anguilla (Eel), Mackerel

IMPROVEMENT IN CROP PLANTS

* The branch of botany, which is related with the studies about genetical improvement of crop plants is known as plant breeding. Improved varieties of crop plants are developed by its application. Improvement of crop plants is made to obtain following characters

(1) Increased yield of seeds, oil & fibres.
(2) To develop insect, disease & frost resistance.
(3) To acclimatize in adverse conditions
(4) To change maturation period

Eminent plant breeder

1. **N.J. Vavilov :** The famous plant breeder of Russia proposed centres of origin.
2. **Norman borlaug :** He was famous plant breeder of Mexico, who proposed dwarf varieties of wheat eg. Sonora-64, and Lerma Rojo-64. These are high yielding varieties.
   He was awarded Nobel prize for peace on the basis of this substantial contribution in resolving food problem of world. He is also known as father of green revolution.

Indian plant breeders :

1. **Sir T.S. Venkatraman :** He developed improved varieties of sugarcane.
2. **Chaudhary Ramdhan :** Developed C-591 variety of wheat.
3. **Dr. B.P. Pal:** Developed NP variety of wheat.
4. **Dr. Puskarnath :** Famous potato breeder.
5. **Dr. Boshi Sen :** The famous maize breeder.
6. **Dr. M.S. Swaminathan :** Mainly contributed in mutation breeding. He developed "Sharbati sonora" variety of wheat by mutation breeding. He is also known as "Father of Indian green revolution".

Steps in plant breeding techniques:

(a) **Collection of variability-**Collection and preservation of all the different wild varieties, species and relatives of the cultivated species.

(b) **Evaluation and selection of parents-** Evaluation is done to identify plants with desirable characters. The selected plants are multiplied and used in the process of hybridization.

(c) **Cross hybridization among the selected parents -** By cross hybridizing the two parents to produce hybrids that genetically combine the desired characters in one plant.

Types of hybridisation :

(i) **Intravarietal :** Between two plants belonging to same variety (useful for self-pollinated crops).

(ii) **Intervarietal (intraspecific) :** Between two varieties of same species e.g., Ganga and Ranjit varieties of maize.

(iii) **Interspecific :** Between different species of same genus e.g., Rice variety ADT-37 (*Oryza japonica* × *O. indices*).

(iv) **Intergeneric :** Between two different genera e.g., *Triticale* (wheat × rye), *Raphanobrassica* (radish × cabbage).

(d) **Selection and testing of superior recombinants -** The selection process is crucial to the success of the breeding objective and requires careful scientific evaluation of the progeny. These are self pollinated for several generations till they reach a state of uniformity, so that the characters will not segregate in the progeny.

(e) **Testing, release and commercialization of new cultivars -** This evaluation is done by growing these plants in the research fields and recording their performance under ideal fertilizer application irrigation, and other crop management practices. It will be followed by testing the materials in farmers' fields, for at least three growing at several locations in the country.

Green Revolution :

Indian father - M.S. Swaminathan

Green revolution was dependent to a large extent on plant breeding techniques for development of high - yielding and disease resistant varieties in wheat, rice, maize, etc.

(i) **Wheat and Rice:**

* Production of wheat and rice increased in many folds due to **semi-dwarf variety** during the period of 1960-2000.

* Nobel laureate Norman E.Borlaug, at international centre for wheat and Maize improvement in Mexico, developed semi-dwarf variety of wheat.
* In 1963 several varieties such *Sonalika* and *Kalyan Sona* high yielding variety was introduced in India.
* Semi-dwarf rice was derived from IR-8 (developed at International Rice Research Institute (IRRI) Philippines) and Taichung Native -I (from Taiwan).
* *Jaya* and *Ratna*, semi dwarf rice variety developed in India.

(ii) Sugarcane:

* *Saccharum barberi* of north India with poor sugar content and yield crossed with *Saccharum officinarum* with thick stems and higher sugar content to produce sugar cane of high yield, thick stems, and high sugar.

(iii) Millets:

* Hyrbid maize, jowar and bajra have been developed in India, which are high yielding and resistant to water stress.

Plant breeding for Disease Resistance:

* Resistance is defined as the genetic ability of a plant to prevent pathogen from causing disease.
* Development of resistance in crops enchances production and reduces the dependence on fungicides and bacteriocides.

Plant A × Plant B ⟶ Desired variety
(Good Seeded) (Disease resistant) (Good quality) + Disease resistant

Pathogen causing different diseases in plants:

* Fungi: brown rust of wheat, red rot of sugarcane, late blight of potato.
* Bacteria: black rot of crucifer,
* Virus: tobacco mosaic, turnip mosaic etc.

Method of breeding for disease resistant:

(i) Conventional breeding method:

* Screening of germplasm for resistance sources.
* Hybridization of selected parent.
* Selection and evaluation of hybrids
* Testing and release of new varieties.
* Some crop varieties breed by hybridisation and selection, for disease resistance to fungi, bacteria and viral diseases are :

Crop	Variety	Resistance to diseases
Wheat	*Himgiri*	Leaf and stripe rust, hill bunt
Brassica	*Pusa swarnim (Karan rai)*	White rust
Cauliflower	*Pusa Shubhra, Pusa Snowball K-1*	Black rot and Curl blight black rot
Cowpea	*Pusa Komal*	Bacterial blight
Chilli	*Pusa Sadabahar*	Chilly mosaic virus, Tobacco mosaic virus and Leaf curl

Disadvantages :

(a) Limited number of disease resistance genes are present.
(b) Limited number of disease resistance genes have been identified in crop varities or wild relatives.

(ii) 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.
* It is possible to induce mutations artificially through use of chemicals or radiations, and selecting and using the plants that have the desirable character as a source in breeding.
* A number of new varieties have been developed *e.g.,*

(i) Sharbati Sonora and Pusa Lerma varieties of **wheat** (formed basis of green revolution in India).
(ii) Reimei, Atomita-2 and Jagannath varieties of **rice.**
(iii) Erectiferum and Erectoids varieties of **barley.**
(iv) Aruna variety of **castor.**
(v) Thick shell in **ground nut** (TGI)
(vi) **Wheat -** NP 836
(vii) **Cotton -** Indore-2
(viii) In **mung bean,** resistance to yellow mosaic virus and powdery mildew.
(ix) **Peppermint** *(Mentha iciperata)*-Todd's Mitcham variety, (high oil content and disease resistant).

(x) Resistance to yellow mosaic virus in bhindi (*Abelmoschus esculentus*) was transferred from a wild species and resulted in a new variety of *A. esculentus* called *Parbhani kranti*.

Plant breeding for developing resistant to insect pest:

* Insect resistance in host crop plants may be due to morphological, biochemical or physiological characteristics.

Characters that make the plant resistance to insect pest:

* Hairy leaves in several plants make them resistant to insect pest.
* Solid stem in wheat lead to non-preference by stem sawfly.
* Smooth leaves and nectar-less cotton variety do not attract bollworms.
* High aspartic acid, low nitrogen and sugar content in maize make them resistant to stem borers.
* Steps for developing insect pest resistant variety of crop are same as others.
* The resistant variety is selected either form the wild variety or from other available cultivars.
* Some released crop varieties breed by hybridisation and selection, for insect pest resistance are :

Crop	Variety	Insect Pests
Brassica (rapeseed mustard)	*Pusa Gaurav*	Aphids
Flat bean	*Pusa Sem 2, Pusa Sem 3*	Jassids, aphids and fruit borer
Okra (Bhindi)	*Pusa Sawani Pusa A-4*	Shoot and Fruit borer

Plant breeding for Improved Food quality:

* Around three billion people suffer from micronutrient, protein and vitamin deficiencies called Hidden hunger.
* Diets lacking essential micronutrients particularly iron, vitamin A, iodine or zinc- increase the risk of diseases; reduce life span, reduce mental ability.
* **Biofortification:**-breeding crops with higher levels of vitamins and minerals or higher protein and healthier fats - is the most practical means to improve public health.

Objectives of biofortification: is to improve

* Protein content and quality.
* Oil content and quality
* Vitamin content
* Micronutrient and mineral content.

List of crop with improved nutrient content :

* Hybrid maize developed with twice the amount of amino acids lysine and tryptophan, compared with existing maize.
* Wheat variety **Atlas 66**, having high protein content has been used as donor for improving cultivated wheat.
* **Iron fortified rice** developed with five times more iron than existing variety.

IARI New Delhi developed:

* Vitamin A enriched carrots, spinach pumpkin.
* Vitamin C enriched bitter gourd, bathua mustard tomato.
* Iron and Calcium enriched spinach and bathua
* Protein enriched beans- broad, lablab, French and garden peas.

SINGLE CELL PROTEIN

* It is a microbial biomass. This biomass is obtained from both mono and multicellular microorganism.
* Single cell protein can be produced using algae, fungi, yeast and bacteria. Commercial production of S.C.P. is mostly based on yeasts and some other fungi e.g. fusarium graminearum.

(i) SCP may be used directly as human food supplement, or else.

(ii) It may be used in animal feed to at least partially replace the currently used protein-rich soyabean meal and fish proteins, and even cereals, which can be diverted for human consumption.

* Microorganisms which can be explored for obtaining SCP are:

(i) **Algae :** *Spirulina, Scenedesmus, Chlorella*

(ii) **Fungi :** *Fusarium graminearum, Candida utilis, Trichoderma viride*

(iii) **Bacteria :** *Achromobacter, Cellulomonas, Methylophilus methylotrophus* (Source of Pruteen).

Certain bacterial species like *Methylophilus* methylotrophus, because of its high rate of biomass production and growth, can be expected to produce 25 tonnes of protein.

Advantages of SCP :

1. The SCP is rich in high quality protein and is rather poor in fats, which is rather desirable.
2. They can be produced all the year round and are not dependent of the climate (except the algal processes).
3. The microbes are very fast growing and produce large quantities of SCP from relatively small area of land.
4. They use low cost substrates and in some cases, such substrates which are being wasted and causing pollution to the environment.
5. When the substrate used for SCP process is a source of pollution, SCP production helps reduce pollution.
6. Strains having high biomass yields and a desirable amino acid composition can be easily selected or produced by genetic engineering.
7. Some SCPs are good sources of vitamins, particularly B-group of vitamins, e.g., yeasts and mushrooms.
8. Mushrooms are considered as delicacy in the human diet.
9. At present, SCP appears to be the only feasible approach to bridge the gap between requirement and supply of proteins.
10. Production of SCP require carbon source and other nitrogen, phosphorus and other nutrients needed to support optimal growth of the selected microorganism. SCP process are highly aerobic (except those using algae). Therefore aeration must be provided.

TISSUE CULTURE

* This is a modern method of crop improvement. It is based on totipotent nature of plant cell.
* Every plant cell has got the capability to develop into a new plant, this is known as **totipotency**.
* The principle of totipotency was put forward by Haberlandt, but elaborated by Steward through his experiments.
* He developed a completely natural wild carrot plant by tissue culture of a single cell from root apex.
* A single cell or a group of cells is used in tissue culture method, it is known as **explant**. As a result of explant culture in culture medium, an irregular group of cells is formed which is known as **callus.**
* Later on necessary concentrations of Auxins and cytokinens are added in culture media and root and shoot formation is stimulated. This process is known as **organogenesis**. In this manner a complete plantlet is developed by single cell culture. Later on it is grown in soil or flower pots for further growth.

Practical applications of tissue culture for crop improvement:

(a) Micro propagation:

* Rapid multiplication of a plant by tissue culture method is known as micropropagation.
* By this method numerous plantlets are developed in a limited space, which can be later on utilized for Agriculture or horticulture, or forestry.
* Each of these plants will be genetically identical to the original plant from which they were grown, i.e., they are **somaclones**. Many important food plants like tomato, banana, apple, etc., have been produced on commercial scale using this method.

(b) Production of disease free plants :

The recovery of healthy plants from diseased plants. Although the plant is infected with a virus, the **meristem** (apical and axillary) is free of virus. Hence, one can removethe meristem and grow it in vitro to obtain virus-free plants. Scientists have succeeded in culturing meristems of banana, sugarcane, potato, etc.

(c) Culture of rare hybrids : The hybrid plants obtained by interspecific or Inter generic cross are mostly sterile. Because their embryo becomes abortive in earlier or later stages. These rare hybrids can be preserved by embryo culture.

(d) **Somatic or protoplast hybridization:** In this method protoplasts from cells of two genetically different species are fused. With the help of cellulose or pectinase enzymes cell wall of the cells is separated as a result of which wall less cells or protoplasts are formed. Fusion of protoplasts is done Pomato & Bromato hybrids have been developed by this method.

Potato × Tomato → Pomato

Brinjal × Tomato → Bromato

CONCEPT REVIEW

* **Apiary :** An apiary is a place where beehived are kept in wooden chambers (artificial) to get honey and other products of bee.
* **Apiculture :** Rearing of honey bees for increased production of honey, bee's wax, propolis, royal jelly and bee venom. *Apis mellifera* is commonly used for production of honey on commercial basis.
* **Artificial Insemination :** Introduction of semen of good quality of male into the vagina of another female.
* **Aquaculture :** It pertains to the production of useful aquatic plants and animals such as fishes, prawns, crayfish, mussels, oysters and seaweeds by proper utilization of available water.
* **Allele :** It refers to one of the alternative forms of a gene. In most organisms there are two alleles- Dominant and Recessive.
* **Biofortification** is a process of breeding crops with higher levels of vitamins, minerals, proteins, and fat content.
* **Blue Revolution :** Increased production of fisheries based on scientific management.
* **Callus :** Unorganised mass of cells produced after growth of explant.
* **Concentrate :** Mineral rich food components *e.g.,* Cereal grains, bran, maize and oil cake etc.
* **Culture Fishery :** Rearing of fishes in artificial fresh water bodies such as pond, lake reservoir using scientific methods of feeding, breeding etc. as to enhance the output production of fish.
* **Exotic Breeds :** Good quality breeds introduced in an area from an outside country.
* **Explant :** A part of plant excised from its original location and used for tissue culture.
* **Fry :** Young ones of fishes about 3-14 days old.
* **Germplasm Collection :** The entire collection (of plants/ seeds) having all the diverse alleles for all the genes in a given crop.
* **Green Revolution :** Increased production of food due to scientific management.
* **Horticulture :** It is a branch of agriculture and deals with act of growing vegetables, fruits and ornamental plants.
* **Heterosis or Hybrid Vigour :** The superiority of F1 hybrids over either of the parents in terms of yield, growth or any other function.
* **Inbreeding :** Breeding by self pollination or selfing or between the members of same population, variety or species.
* **Inbreeding Depression :** Continued close inbreeding decreases the fertility and productivity.
* **Micropropagation** is a method of producing new plants in a short duration using plant tissue culture.
* **Out Breeding:**Crosses between different breeds.
* **Plant Breeding :** An applied branch of Botany which deals with improvement of economically important plants.
* **Pisciculture :** Rearing of fishes to increase meat yield.
* **Poultry :** Rearing of birds to increase meat yield and egg.
* **Pureline :** It is a progeny of single self fertilized homozygous individuals.
* **SCP :** The biomass obtained from micro-organisms, where the cells are treated/processed in various ways and used as food or feed.
* **Somatic Hybridisation :** The process of fusing protoplasts of somatic cells derived from different varieties or species of plants, to produce a hybrid.
* **Super Ovulation :** Stimulation of good female animal to release more eggs.
* **Totipotency :** Ability of a cell to give rise to complete organism when cultured in a suitable medium at appropriate temperature and aeration conditions.

GREEN MANURE

* It is a manure prepared from young, green crop plants by ploughing them back into soil.
* Usually, young leguminous crops are used for green manuring because they also increase the nitrogen fertility of the soil.
* The plants commonly used for green manuring in India are : Sunn Hemp *(Crotolaria juncea),* Dhaincha *(Sesbania aculeata),* Cluster Bean *(Cyamopsis tetragonoloba),* Sweet Clover *(Melilotus parviflora),* Cowpea *(Vigna sinensis),* Horse Gram *(Dolichos uniflorus),* Egyptian clover (Berseem, *Trifolium alexandrinum),* Lentil *(Lens esculenta).*
* The plants are rich in nitrogenous compounds because of the presence of nodules on the roots. *Sesbania rostrata* possesses such nodules on the stem (caulinary nodules) as well.
* The plants are slowly converted into manure through the activity of microorganisms. Green manures have all the benefits of farmyard manure.

IMPORTANT POINTS

* Hybrid varieties of crop plants :

(i) Cauliflower varieties- *Pusa Shubhra and Pusa Snowball K-1*
(ii) Brassica varieties - *Pusa Swarnim (Karan rai)*
(iii) Wheat varieties - *Himgiri*
(iv) Rice varieties - *Jaya and Ratna*
(v) Chilli varieties - *Pusa Sadabahar*

* Marine animals are richer in Iodine
* Shark Liver oil and cod liver oil are very good source of vitamin A and D.
* Angoora wool: It is obtained from Angoora rabbit.
* NDRI (National Dairy Research Institute) was established during first five year plan at Karnal (Haryana).
* Pinctada vulgaris is a common oyster for pearl culture industry in India.
* Jaffarbandi, Murrah and Mehsana are breeds of buffalo.
* Exotic breeds of poultry are White Leghorn and Rhode Island Red.
* Blue revolution is related to fish production.
* Virus free plants can be obtained by shoot tip culture.
* Haploid plant cultures are got from pollen grain.
* Hybrid of potato and tomato is pomato.
* Inherent capacity of a cell to regenerate the whole organism is called totipotency.
* Embryo Culture involves excision of young embryo from seeds and their cultivation through tissue culture.
* Root knot disease of Brinjal is due to *Meloidogyne incognita*.
* Bacterial leaf blight of Rice is caused by *Xanthomonas*.
* Plant piece used in tissue culture is called explant.
* Krishna/Ratna and 'Jaya' are variest of Rice.
* Pusa Komal variety of Cow Pea is resistant to Bacterial blight.
* Breeding crops for improved nutritional quality is referred to as bioremediation.
* A petroleum plant is *Euphorbia*.
* *Methanobacterium* is used in biogas generation.
* *Zea mays* should be used for production of bioethanol.
* **FAO :** Food and Agricultural Organisation of U.N.O.
* **IRRI:** International Rice Research Institute, Los Banos, Philippines.
* **ICRISAT :** International Crops Research Institute for Semi Arid Tropics, Hyderabad, India.
* First natural hybridization was reported in corn (maize) by Cotton Mather (1716).
* First artificial hybrid was obtained by crossing sweet william and carnation by Thomas Fairchild (1717) and was known as Fairchild's mule.
* Hybridization was first of all practically utilized in crop improvement by Kolreuter (1760).
* Norman Borlaugh, 1970 developed two wheat varieties - Sonora 64 and Lerma Roja 64 A. Both varieties were red coloured and rejected by Indian population. When exposed to gamma radiation, they mutated into amber coloured, Sharbati sonora and Pusa Lerma.

Sonora 64 $\xrightarrow{\text{Gamma radiation}}$ Sharabati sonora

Lerma Roja 64 A $\xrightarrow[\text{Radiation}]{\text{Gamma}}$ Pusa Lerma.

* Dr. Kurein is called the architect of India's modern dairy industry and the father of white revolution. Amul is the brain child of Dr. V. Kurein.

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.4

Match the column I with column II.

Q.1

	Column I	Column II
a.	MOET	i. It is done to increase milk production and growth rate in animals.
b.	Interspecific hybridisation	ii. For herd improvement
c.	Cross breeding	iii. The progeny may or may not be of economic value.
d.	Outcrossing	iv. The progency may be used for commericial production.

Codes

(A) (a) – (ii), (b) – (iv), (c) – (iii), (d) – (i)
(B) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)
(C) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)
(D) (a) – (iv), (b) – (i), (c) – (ii), (d) – (iii)

Q.2

	Column I (Causative Organism)	Column II (Diseases)
a.	Fungi	i. Brown rust of wheat
b.	Bacteria	ii. Red rot of sugar cane
c.	Virus	iii. Late blight of potato
		iv. Black rot of crucifers
		v. Blight of rice
		vi. Citrus canker
		vii. Tobacco mosaic
		viii. Turnip mosaic

(A) a-iv, v, vi ; b-vii, viii ; c-i, ii, iii
(B) a-i, ii, iii ; b-iv, v, vi ; c-vii, viii
(C) a-v, vi, vii ; b-iv, viii ; c-i, ii, iii
(D) a-vii, viii ; b-iv, v, vi ; c-i, ii, iii

Q.3

	Column I	Column II
a.	Follicle stimulating hormone	i. Crop plants
b.	*Jassids*	ii. Fish
c.	*Spirulina*	iii. SCP
d.	*In vitro clonal* propagation	iv. Micropropagation
e.	Blue revolution	v. Cotton
f.	Green revolution	vi. Super ovulation

Codes

(A) (a)-(vi), (b)-(v), (c)-(iii), (d)-(iv), (e)-(ii), f-(i)
(B) (a)-(v), (b)-(iii), (c)-(iv), (d)-(ii), (e)-(i), f-(vi)
(C) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i), (e)-(vi), f-(v)
(D) (a)-(ii), (b)-(i), (c)-(vi), (d)-(v), (e)-(iii), f-(iv)

Q.4

	Column I	Column II
a.	Himgiri variety	i. White rust
b.	Pusa swarnim	ii. Hill bunt
c.	Pusa shubhra	iii. Leaf curl
d.	Pusa sadabahar	iv. Black rot

(A) a-ii, b-i, c-iii, d-iv (B) a-i, b-ii, c-iv, d-iii
(C) a-ii, b-i, c-iv, d-iii (D) a-i, b-ii, c-iii, d-iv

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.5 to Q.15 :

Choose one word for the given statement from the list.

Cellular totipotency, Mutagens, Inbreeding, Outbreeding, Rice, Vermiculture, Protein, Fats, Mutation breeding, Plant breeding.

Q.5 The process which results in the identification of superior males and superior females of the same breed _____.

Q.6 Rate of mutations is induced by means of certain agents called _____.

Q.7 Jaya and Ratna are varieties of _____.

Q.8 SCP is rich in high quality ____ and is poor in _____.

Q.9 Cultivation of fishes in artificially prepared ponds or water bodies is called _____.

Q.10 Science of altering the genetic pattern of plants in order to increase their value and utility for human welfare is called _____.

Q.11 The process of breeding by artificially inducing mutations using chemical or radiation is called _____.

Q.12 In tissue culture method, the embryoids formed from pollen grain is due to _____.

Q.13 When breeding is between different breeds, it is called _____.

Q.14 Controlled breeding experiments are carried out using artificial insemination. **[True / False]**

Q.15 Multiple Ovulation Embryo Transfer Technology (MOET) is used for herd improvement. **[True / False]**

SECTION - 3 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : ANIMAL HUSBANDRY

Q.16 Crustacean fishery is connected with exploitation of –
(A) oysters and crabs (B) mussels and squids
(C) shell and cuttle fish (D) lobster and prawn

Q.17 Which of the following is not a marine fish?
(A) Hilsa (B) Catla
(C) Pomfret (D) Mackeral

Q.18 MOET stands for
(A) Multiple Ovulation Embryo Transfer technology.
(B) More Ovulation Embryo Transfer technology.
(C) Multiple Ovulation Embryo Test technology
(D) None of the above

Q.19 Which one of the following is a viral disease of poultry?
(A) Bird flu (B) Swine flu
(C) Fowl cholera (D) Spirochaetosis

Q.20 Examples of crustaceans are
(A) prawns (B) crabs
(C) Both (A) and (B) (D) None of these

Q.21 When breeding is between animals of the same breed for 4-6 generation, it is called
(A) cross breeding (B) outbreeding
(C) outcrossing (D) inbreeding

Q.22 Inbreeding is carried out in animal husbandry because it:
(A) increases vigour
(B) improves the breed
(C) increases heterozygosity
(D) increases homozygosity

Q.23 Some common marine fishes are
(A) Hilsa (B) Mackerel
(C) Pomfrets (D) All of these

Q.24 Apiculture means
(A) rearing of honey bees
(B) rearing of silkworm
(C) rearing of lac insect
(D) None of these

Q.25 Close inbreeding usually results in reduction of fertility and productivity. This is called
(A) homozygosity
(B) outbreeding
(C) inbreeding depression
(D) outbreeding depression

Q.26 Real product of apiculture is
(A) honey (B) bee wax
(C) Both (A) and (B) (D) sugar

Q.27 Father of white revolution in India is
(A) Verghese Kurein
(B) Dr MS Swaminathan
(C) Alexzander Flemming
(D) William Harvey

Q.28 Which of the following is correctly matched?
(A) Apiculture - Honey bee
(B) Pisciculture - Silk moth
(C) Sericuiture - Fish
(D) Aquaculture - Mosquitoes

Q.29 The yellow colour of cow milk is due to the presence of –
(A) carotene (B) albumin
(C) casein (D) lactose

Q.30 Most common honey bee species in India
(A) *Apis indica* (B) *Apis flarea*
(C) *Apis mellifera* (D) *Apis darsata*

Q.31 The most common egg-type variety used for commercial production through out the world is
(A) leghorn (B) plymoth rock
(C) cornish (D) new hampshire

Q.32 Molluscs are also called as
(A) ray fish (B) golden fish
(C) electric fish (D) shell fish

Q.33 Some common fresh water fishes are
(A) catla (B) rohu
(C) common carp (D) All of these

Q.34 Bird flu is caused by
(A) fungus (B) bacteria
(C) protozoan (D) virus

PART - 2 : PLANT BREEDING

Q.35 Sonalika and Kalyan Sona are the varieties of
(A) wheat (B) rice
(C) millet (D) tobacco

Q.36 The scientific process by which crop plants are enriched with certain desirable nutrients is called
(A) crop protection (B) plant breeding
(C) biofortification (D) bioremediation

Q.37 Improved rice variety IR - 8 has been introduced in India from
(A) Taiwan (B) Bangladesh
(C) Phillippines (D) China

Q.38 Semi-dwarf wheat was developed at
(A) International Centre for Wheat and Maize Improvement Brazil.
(B) International Center for Wheat and Maize Improvement Mexico.
(C) International Center for Wheat and Rice Improvement Japan.
(D) International Center for Wheat and Gram Improvement Mexico.

Q.39 The quickest method of plant breeding is–
(A) introduction (B) selection
(C) hybridisation (D) mutation breeding

Q.40 Wonder wheat is new wheat variety developed by –
(A) Mexico's International Wheat and Maize Improvement Centre.
(B) Indian National Botanical Research Institute
(C) Australian Crop Improvement Centre.
(D) African Crop Improvement Centre.

Q.41 India's wheat yield revolution in the 1960s was possible primarily due to –
(A) hybrid seeds
(B) increased chlorophyll content
(C) mutations resulting in plant height reduction
(D) quantitative trait mutations

Q.42 In maize, presence of high aspartic acid, low nitrogen and sugar content protect them from
(A) aphids (B) fruit borer
(C) jassids (D) stem borer

Q.43 Semi-dwarf varieties of rice were developed from
(A) IR-8 (B) Taichung Native-1
(C) Both (A) and (B) (D) Jaya and Ratna

Q.44 Semi-dwarf wheat was developed by
(A) Norman E Borlaug (B) MS Swaminathan
(C) Wi Cheung (D) Fontana

Q.45 Which one is correct about Atlas 66?
(A) It has high protein content.
(B) It has been used as a donor for improving cultivated wheat.
(C) Both (A) and (B)
(D) None of the above

Q.46 Several South Indian states raise 2-3 crops of rice annually. The agronomic feature that makes this possible is because of
(A) shorter rice plant
(B) better irrigation facilities
(C) early yielding rice variety
(D) disease resistant rice variety.

Q.47 International Rice Research Institute (IRRI) is situated at
(A) New York (USA)
(B) Tokyo (Japan)
(C) Manilla (Philippines)
(D) Hydrabad (India)

Q.48 Fungicides and antibiotics are chemicals that:
(A) enhance yield and disease resistance
(B) kill pathogenic fungi and bacteria, respectively
(C) kill all pathogenic microbes
(D) kill pathogenic bacteria and fungi respectively.

Q.49 Lysine and tryptophan are
(A) proteins
(B) non-essential amino acids
(C) essential amino acids
(D) aromatic and no acids

Q.50 The entire collection having all the diverse alleles for all genes in a given crop is called
(A) gene collection
(B) germ collection
(C) germplasm collection
(D) plasma collection

Q.51 The biggest constraint of plant breeding is:
(A) availability of desirable gene in the crop and its wild relatives.
(B) infrastructure
(C) trained manpower
(D) transfer of genes from unrelated sources.

Q.52 *Saccharum barberi* and *Saccharum officinarum* are varieties of
(A) sugar cane (B) maize
(C) wheat (D) rice

Q.53 Which one of the following combination would a sugarcane farmer look for in the sugarcane crop?
(A) Thick stem, long internodes, high sugar content and disease resistant.
(B) Thick stem, high sugar content and profuse flowering.
(C) Thick stem, short internodes, high sugar content, disease resistant.
(D) Thick stem, low sugar, conten, disease resistant.

Q.54 High content of lysine is present in
(A) wheat (B) apple
(C) maize (D) banana

PART - 3 : SCP AND TISSUE CULTURE

Q.55 *Spirulina* is a
(A) cyanobacteria (B) fungi
(C) protozoan (D) brown algae

Q.56 Somaclones are obtained by –
(A) tissue culture (B) plant breeding
(C) irradiation (D) genetic engineering

Q.57 The term 'totipotency' refers to the capacity of a:
(A) cell to generate whole plant
(B) bud to generate whole plant
(C) seed to germinate
(D) cell to enlarge in size.

Q.58 In crop improvement programmes, virus-free clones can be obtained through –
(A) grafting (B) hybridisation
(C) embryo culture (D) shoot apex culture

Q.59 Which of the following terms is used to describe the component isolated from a plant, for in vitro culturing in the specific medium?
(A) Callus (B) Embryoid
(C) Synthetic seeds (D) Explant

Q.60 An explant is –
(A) dead plant
(B) part of the plant
(C) part of the plant used in tissue culture
(D) part of the plant that expresses a specific gene.

Q.61 The inherent capacity of a cell to regenerate a new whole organism is called –
(A) ontogeny (B) totipotency
(C) phylogeny (D) proliferation

Q.62 To isolate protoplast, one needs –
(A) pectinase (B) cellulase
(C) Both (A) and (B) (D) chitinase

Q.63 SCP reduces the pressure on agricultural production systems for the supply of the required
(A) vitamins (B) carbohydrate
(C) minerals (D) proteins

Q.64 Meristem culture is practised in horticulture to get –
(A) sornaclonal variation
(B) haploids
(C) virus·free plants
(D) slow growing callus

Q.65 A collection of all the alleles of all the genes of a crop plant is called:
(A) germplasm collection
(B) protoplasm collection
(C) herbarium
(D) somaclonal collection

Q.66 Some plants developed by meristem culture are
(A) banana (B) sugarcane
(C) potato (D) All of these

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 'P-1542' is a hybrid variety of which plant?
(A) Wheat (B) Rice
(C) Maize (D) Pea

Q.2 The entire collection of plants / seeds having all the diverse alleles for all genes in a given crop is known as –
(A) Genetic erosion (B) Germplasm collection
(C) Gene pool (D) Genetic drift

Q.3 Inter generic crosses are rarely successful through usual breeding techniques which of the following may be used to achieve success in this regard –
(A) Embryo culture
(B) Hybridoma technology
(C) Somatic hybridization
(D) None of these

Q.4 The quickest method of plant breeding is –
(A) Introduction (B) Selection
(C) Hybridization (D) Mutation breeding

Q.5 Which one of the following is not a fungal disease?
(A) Rust of wheat
(B) Smut of Bajra
(C) Black rot of crucifers
(D) Red rot of sugarcane

Q.6 *Saccharum barberry* had poor sugar content and yield. This veriety of sugar cane mainly grown in which part of india ?
(A) South India (B) East India
(C) North India (D) West India

Q.7 The conventional method of breeding for disease resistance in plants is :
(A) Hybridisation (B) Selection
(C) Mutation (D) Both (A) and (B)

Q.8 Parbhani kranti variety of *Ablemoschus esculentus* was created for resistance against which of the following disease
(A) Yellow mosaic virus
(B) Curl blight black rot
(C) White rust
(D) Powdery mildew

Q.9 Resistance to jassids in cotton and cereal leaf beetles in wheat is due to which of the following morphological/physiological/Biochemical characteristic
(A) Solid stem (B) Nectorlessness
(C) High aspartic acid (D) Hairy leaves

Q.10 In mung bean, resistance to yellow mosaic virus and powdery mildew were induced by :
(A) Plant introduction (B) Plant tissue culture
(C) Hybridisation (D) Mutation

Q.11 Parbhani Kranti, which has resistance to yellow mosaic virus is a variety of –
(A) Wheat (B) Cow pea
(C) Bhindi (D) Chilli

Q.12 Production of thousands of plants through tissue culture method is called :
(A) Macropropagation (B) Micropropagation
(C) Somatic embryo (D) Totipotency

Q.13 Root of any plant breeding programme is :
(A) Mutation (B) Genetic variability
(C) Hybridisation (D) Selection

Q.14 Plants produced by tissue culture method are called –
(A) Explant
(B) Somaclones
(C) Micropropagation
(D) SCP (Single cell protein)

Q.15 Lac is a product of –
(A) Faecal matter
(B) Secretion from body
(C) Excretion from body
(D) Excess food oozing out of the body

Q.16 Sonalika is variety of :
(A) Wheat (B) Rice
(C) Maize (D) Pea

Q.17 "International center for wheat and maize improvement" is situated at :
(A) Phillipins (B) India
(C) Mexico (D) Brazil

Q.18 Biological principles as applied to animal husbandry and food production. Which of the following technique is not going to play a pivotal role in further enhancing food production –
(A) Embryo transfer (B) Tissue culture
(C) Mutations (D) Biomining

Q.19 Green revolution was dependent to a large extent on plant breeding techniques for development of
(A) High yielding (B) Disease resistant
(C) Wild varieties (D) Both A and B

Q.20 Purposeful manipulation of plant species in order to create desired plant type that are better suited for cultivation, give better yields and disease resistant is –
(A) Plant systematics (B) Plant breeding
(C) Plant monitoring (D) Biofortification

Q.21 Classical plant breeding involves
(A) Hybridisation of pure lines exclusively.
(B) Hybridisation of pure lines followed by artificial selection.
(C) Artificial selection exclusively.
(D) Mutation breeding.

Q.22 Which can be used for cultivation of SCP
(A) Waste water from potato processing plants
(B) Straw
(C) Sewage
(D) All above

Q.23 250gm *Methylophilus methylotrophus* can produce how much amount of proteins in a day
(A) 2.5 tonnes (B) 25 tonnes
(C) 250 tonnes (D) 25 Kg

Q.24 Which is not a step of plant breeding
(A) Collection of variability
(B) Evalution and selection of parents
(C) Cross hybridisation within a pure line
(D) Selection & testing of superior recombinants

Q.25 Which variety of Bhindi is resistance to shoot and fruit borer ?
(A) Pusa Gaurav (B) Pusa sem-2
(C) Pusa komal (D) Pusa sawani

Q.26 Which of the following is root of any plant breeding programme
(A) Genetic variability.
(B) Evaluation and selection of parents.
(C) Cross hybridisation among selectied parents.
(D) Selection of superior recombinants.

Q.27 Himgiri variety of wheat, which developed by hybridisation and selection is mainly resistance for –
(A) Leaf and stripe rust (B) White rust
(C) Bacterial blight (D) Chilly mosaic virus

Q.28 Which of the following rice variety were developed in India
(A) IR - 8 (B) IR - 36
(C) TN - 1 (D) Jaya

Q.29 In India, how many varieties of rice are present?
(A) 200000 (B) 50000
(C) 10000 (D) 1000

Q.30 Pomato is an example of :
(A) Somatic hybrid (B) Somatic embryo
(C) Androgenic haploid (D) SCP

Q.31 Vanilla is obtained from –
(A) Flowers (B) Stems
(C) Roots (D) Fruits

Q.32 In protoplast fusion, the enzymes required are
(A) cellulase, hemicellulase, pectinase
(B) pectinase
(C) ligase, hemicellulase
(D) hemicellulase

Q.33 About disease resistant varieties of plant select out the incorrect match
(A) Wheat – Himgiri
(B) Brassica – Pusa swarnim
(C) Cauliflower – Pusa shubhra
(D) Cowpea – Pusa snowball K1

Q.34 Which character of maize leads to resistance to maize stem borers naturally?
(A) High aspartic acid
(B) Low nitrogen content
(C) Low sugar content
(D) All of the above

Q.35 "Atlas 66" is high protein contained variety of :
(A) Wheat (B) Maize
(C) Rice (D) Bhindi

Q.36 In maize resistance to maize stem borer is due to
(A) High aspartic acid
(B) Low nitrogen and sugar content
(C) High nitrogen and sugar content
(D) Both A and B

Q.37 India has maximum genetic diversity of :
(A) Wheat (B) Rice
(C) Mango (D) Apple

Q.38 Which chemical is used in somatic hybridisation?
(A) Polyethyline glycole (B) Acredine
(C) HNO_2 (D) Ethenol

Q.39 Select the incorrect match
(A) Pusa gaurav – Aphids
(B) Pusa sem 2 – Shoot borers
(C) Pusa sem 3 – Jassids &Aphids
(D) Pusa sawani – Fruit borers

Q.40 Hidden hunger is associated with deficiency of
(A) Proteins (B) Vitamins
(C) Micronutrients (D) All the above

Q.41 Which one of the following products of apiculture is used in cosmetics and polishes:
(A) honey (B) oil
(C) wax (D) Royal jelly

Q.42 In honey, the percentage of maltose and other sugar is
(A) 9.2 (B) 8.81
(C) 10.5 (D) 11.2

Q.43 In poultry birds, nasal and eye discharge with foul smell, acute respiratory problem and inflammed and swollen eyes are the symptoms of –
(A) chronic respiratory disease
(B) infectious coryza disease
(C) brooder pneumonia disease
(D) Marck's disease

Q.44 Use of certain chemicals and radiation to change the base sequences of genes of crop plants is –
(A) recombinant DNA technology
(B) transgenic mechanism
(C) mutation breeding
(D) gene therapy.

Q.45 In virus-infected plants the meristematic tissues in both apical and axillary buds are free of virus because:
(A) the dividing cells are virus resistant
(B) meristems have anti viral compounds
(C) the cell division of meristems are faster than the rate of viral multiplication
(D) Viruses cannot multiply within meristem cell(s).

Q.46 Choose the correct statement regarding somatic hybridization.
(i) protoplasts of different cells of the same plant are fused
(ii) protoplasts from cells of different species can be fused
(iii) treatment of cells with cellulase and pectinase is mandatory.
(iv) the hybrid protoplast contains characters of only one parental protoplast.
(A) (ii) and (iii) (B) (i) and (ii)
(C) (iii) and (ii) (D) (ii) and (iii)

Q.47 What will you conclude, when a cow is crossed to a bull and the female progeny is yielding more milk than its mother?
(A) More numberof genes for high yielding milk are inherited, only from the female parent.
(B) More number of genes for high yielding milk are inherited only, from the male parent.
(C) More number of genes for high yielding milk are inherited from both the parents.
(D) The progeny through mutation achieved more number of genes for high yielding milk.

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 Which of the following is not a consequence of hidden hunger
(A) Increased the risk of disease.
(B) Reduced life span.
(C) Reduced mental abilities.
(D) Reduced skin pigmentation.

Q.2 Breeding crops with higher levels of vitamins and minerals, higher proteins and healthier fats is known as –
(A) Bioremediation (B) Biomagnification
(C) Biofortification (D) Biotransformation

Q.3 Which of the following is not an objective of plant breeding for improved nutritional quality
(A) Protein content and quality
(B) Oil content and quality
(C) Vitamin content
(D) Carbohydrate content

Q.4 Which of the following nutrient was enhanced in hybrid maize developed in the year 2000
(A) Lysine (B) Tryptophane
(C) Threonine (D) Both A and B

Q.5 Which wheat variety have high protein content
(A) Kalyansona (B) Sharbati sonara
(C) Atlas 66 (D) IR - 8

Q.6 Match the following

a.	Vitamin A rich	i. Lablab
b.	Vitamin C rich	ii Spinach
c.	Fe and Ca Rich	iii Bitter guard
d.	Protein Rich	iv Carrot

(A) a-iv, b-iii, c-ii, d-i (B) a-iv, b-iii, c-i, d-ii
(C) a-iii, b-iv, c-ii, d-i (D) a-iii, b-iv, c-i, d-ii

Q.7 Which sugarcane species were crossed to combine desirable qualities of high yield, thick stem, high sugar content and ability to grow in sugarcane areas of North India –
(A) Saccharum officinale × Saccharum barberi
(B) S. officinarum × S. baberi
(C) S. barberi × S.indica
(D) S. officinarum × S. officinale

Q.8 Which cell property is the basis of plant tissue culture –
(A) Homeostasis (B) Thermoperiodicity
(C) Meristematic (D) Totipotency

Q.9 Each of the plant obtained through tissue culture are genetically identical to the original plant from which they were grown are known as –
(A) Genocopies (B)Somaclonal variants
(C) Somaclones (D) Phenocopies

Q.10 Fusion between two naked protoplasts is known as –
(A) Somatic hybridisation
(B) Germinal hybridisation
(C) Parasexual hybridisation
(D) Both A and C

Q.11 Groundnut oil is obtained from the plant –
(A) *Brassica juncea*
(B) *Artabotrys odoratissimus*
(C) *Arachis hypogaea*
(D) *Acacia arabica*

Q.12 *Triticum aestivum*; the common breed of wheat is –
(A) triploid with 21 chromosomes
(B) tetraploid with 28 chromosomes
(C) hexaploid with 42 chromosomes
(D) diploid with 14 chromosomes

Q.13 Biofortified rice are enriched in which of the nutrient
(A) Iron (B) Amino acids
(C) Fatty acids (D) Essential amino acids

Q.14 A queen Honey Bee lays eggs of –
(A) One type from which all castes develop.
(B) Two types, one forming queen and workers and second forming drones.
(C) Three types forming queen, drone and workers.
(D) Unfertilized eggs die while fertilised ones form all castes.

Q.15 The part of papaver sominiferum from which opium is obtained is –
(A) Seed (B) Mature fruit
(C) Unripe fruit (D) Stem and leaf

Q.16 The new varieties of plants are produced by –
(A) Introduction & mutation
(B) Selection & introduction
(C) Selection & hybridization
(D) Mutation & selection

Q.17 "Jaya" and "Ratna" are better yielding semi dwarf varieties of rice. These varieties are developed in which country ?
(A) Japan (B) India
(C) Phillipins (D) Mexico

Q.18 Which of the plant tissue culture shows totipotency –
(A) Meristem (B) Sieve tube
(C) Collenchyma (D) Xylem vessel

Q.19 Integrated pest management (IPM) stand for –
(A) Chemical control
(B) Biological control
(C) Host plant resistance
(D) Integration of above

Q.20 Silk is produce by –
(A) Larva (B) Cocoon
(C) Larva & adult moth (D) Adult moth

For Q.21-Q.23
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(C) Statement - 1 is True, Statement- 2 is False
(D) Statement -1 is False, Statement -2 is False.

Q.21 **Statement 1 :** Cattle breeds can be improved by superovulaton and embryo transplantaion.
Statement 2 : Superovulation in high milk-yielding cows is induced by hormonal injection.

Q.22 **Statement 1 :** Fish meal is a rich source of protein for cattle and poultry.
Statement 2 : Fish meal is produced from the non-edible parts of fishes like fins and tail.

Q.23 **Statement 1 :** Virus-free plants can be produced from virus infected plants by means of meristem tissue culture.
Statement 2 : The virus fails to grow during the growth of the host tissue in the artificial medium.

Q.24 Which of the following shows correct chronological order of the events occurring during callus culture?
(A) Callus → Cell division → Explant → Addition of cytokinin → Cells acquire meristematic property
(B) Explant → Cell division → Addition of cytokinin → Cells acquire meristematic property
(C) Explant → Cell division → Callus → Addition of cytokinin → Cells acquire meristematic property
(D) Callus → Explant → Cell division → Addition of cytokinin → Cells acquire meristematic property

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 In plant breeding programmes, the entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called – **[NEET 2013]**
(A) Evaluation and selection of parents.
(B) Germplasm collection.
(C) Selection of superior recombinants.
(D) Cross-hybridisation among the selected parents.

Q.2 An alga which can be employed as food for human being is – **[AIPMT 2014]**
(A) *Ulothrix* (B) *Chlorella*
(C) *Spirogyra* (D) *Polysiphonia*

Q.3 To obtain virus-free healthy plants from a diseased one by tissue culture technique, which part/parts of the diseased plant will be taken – **[AIPMT 2014]**
(A) Apical meristem only.
(B) Palisade parenchyma.
(C) Both apical and axillary meristems.
(D) Epidermis only.

Q.4 A technique of micropropagation is –
(A) Protoplast fusion **[AIPMT 2015]**
(B) Embryo rescue
(C) Somatic hybridisation
(D) Somatic embryogenesis

Q.5 A protoplast is a cell **[RE-AIPMT 2015]**
(A) Undergoing division
(B) Without cell wall
(C) Without plasma membrane
(D) Without nucleus.

Q.6 Outbreeding is an important strategy of animal husbandry because it – **[RE-AIPMT 2015]**
(A) Is useful in overcoming inbreeding depression.
(B) Exposes harmful recessive genes that are eliminated by selection.
(C) Helps in accumulation of superior genes.
(D) Is useful in producing purelines of animals.

Q.7 A cell at telophase stage is observed by a student in a plant brought from the field. He tells his teacher that this cell is not like other cells at telophase stage. There is no formation of cell plate and thus the cell is containing more number of chromosomes as compared to other dividing cells. This would result in **[NEET 2016 PHASE 1]**
(A) Aneuploidy (B) Polyploidy
(C) Somaclonal variation (D) Polyteny

Q.8 A true breeding plant is **[NEET 2016 PHASE 2]**
(A) One that is able to breed on its own.
(B) Produced due to cross-pollination among unrelated plants.
(C) Near homozygous and produces offspring of its own kind.
(D) Always homozygous recessive in its genetic constitution.

Q.9 Interspecific hybridization is the mating of **[NEET 2016 PHASE 2]**
(A) Animals within same breed without having common ancestors.
(B) Two different related species.
(C) Superior males and females of different breeds.
(D) More closely related individuals within same breed for 4–6 generations.

Q.10 Among the following edible fishes, which one is a marine fish having rich source of omega-3 fatty acids? **[NEET 2016 PHASE 2]**
(A) Mystus (B) Mangur
(C) Mrigala (D) Mackerel

Q.11 Homozygous purelines in cattle can be obtained by: **[NEET 2017]**
(A) mating of related individuals of same breed.
(B) mating of unrelated individuals of same breed.
(C) mating of individuals of different breed.
(D) mating of individuals of different species.

Q.12 A 'new' variety of rice was patented by a foreign company, though such varieties have been present in India for a long time. This is related to **[NEET 2018]**

(A) Lerma Rojo (B) Sharbati Sonora
(C) Co-667 (D) Basmati

Q.13 Select the **INCORRECT** statement. **[NEET 2019]**

(A) Inbreeding increases homozygosity.
(B) Inbreeding is essential to evolve purelines in any animal.
(C) Inbreeding selects harmful recessive genes that reduce fertility and productivity.
(D) Inbreeding helps in accumulation of superior genes and elimination of undesirable genes.

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (B) **(2)** (B) **(3)** (A) **(4)** (C)
(5) Inbreeding **(6)** Mutagens **(7)** Rice
(8) Protein; fats **(9)** Pisciculture
(10) Plant breeding **(11)** Mutation breeding
(12) Cellular totipotency **(13)** Outbreeding
(14) True **(15)** True

EXERCISE - 1

Q	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
A	D	B	A	A	C	D	D	D	A	C	C	A	A	A	A	A	D	D	D	A
Q	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
A	C	C	B	C	A	C	D	C	A	C	C	C	B	C	C	A	A	A	C	A
Q	56	57	58	59	60	61	62	63	64	65	66									
A	A	A	D	D	C	B	C	D	C	A	D									

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	D	B	A	D	C	C	D	A	D	D	C	B	B	B	B	A	C	D	D	B
Q	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
A	B	D	B	C	D	A	A	D	A	A	D	A	D	D	A	D	B	A	B	D
Q	41	42	43	44	45	46	47													
A	C	B	B	C	C	D	C													

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A	D	C	D	D	C	A	B	D	C	D	C	C	A	B	C	C	B	A	C	A	B	C	C	C

EXERCISE - 4

Q	1	2	3	4	5	6	7	8	9	10	11	12	13
A	B	B	C	D	B	A	B	C	B	D	A	D	C

SOLUTIONS

EXERCISE-1

(1) (B) **(2)** (B) **(3)** (A) **(4)** (C)
(5) Inbreeding **(6)** Mutagens **(7)** Rice
(8) Protein; fats **(9)** Pisciculture
(10) Plant breeding **(11)** Mutation breeding
(12) Cellular totipotency **(13)** Outbreeding
(14) True **(15)** True **(16)** (D) **(17)** (B)
(18) (A)
(19) **(A).** Bird flu resembles influenza and is caused by a virus H5N1. The virus enters the man through chicken.
(20) **(C).** Crustaceans form very large group of arthopods, which include crabs, lobsters prawns, etc.
(21) (D) **(22)** (D) **(23)** (D) **(24)** (A)
(25) (C) **(26)** (C) **(27)** **(A)** **(28)** (A)
(29) (A)
(30) **(A).** The most common species of honey bee is *Apis indica*. The exotic varieties are *Apis mellifera* (An Italian variety) and *Apis adamsoni*. At present, the Italian variety *Apis mellifera* is used in apiarise for large scale production of honey and wax.
(31) **(A).** The most common egg-type variety used for commercial production through out the world is leghorn.
(32) **(D).** Molluscs has a shell-like exoskelecton. So, molluscs are also called as shell fish.
(33) **(D).** Some of the fresh water fishes, which are very common include rohu, catla, calbasu, mrigal, chital, common carp, etc.
(34) **(D).**
(35) **(A).** High yielding and disease resistant wheat varieties were introduced in India in 1963, e.g., Sonalika and Kalyan Sona.
(36) **(C).** Biofortification differs from ordinary fortification because it focusses on making plant foods more nutritious as the plants are growing rather than nutrients added to the foods when they are being processed.
(37) **(C).** Semi-dwarf varieties of rice were developed from IR-8 (developed at International Research Institute or IRRI, Phillippines) and Taichung Native-1 (developed in Taiwan).
(38) **(B).**
(39) **(C).** Hybridisation involves simple process of emasculation and transfer of pollens from one flower to the stigma of other flower.
(40) **(A).** Wonder wheat is a new wheat variety with a yield of 18 tonnes per hectare. It has some 200 grains per stalk and has developed by Mexico's International Wheat and Maize Improvement Centre.
(41) **(C).** In 1963, ICAR introduced many dwarf selections from CIMMYT, including those developed by Norman Borlaug using Norin-10 as the source of dwarfing genes.
(42) **(D).** Low nitrogen, sugar and high aspartic acid in maize develops resistance to maize stem borers.
(43) (C) **(44)** (A)
(45) **(C).** Atlas-66, soft wheat, has been used since 1953 as a genetic source of higher protein in wheat. It has been used as a donor for improving cultivated wheat.
(46) **(C).**
(47) **(C).** International rice Research Institute is situated at Manila (Phillippines) and Indian Rice Research Institute is situated at Cuttack.
(48) (B)
(49) **(C).** Lysine and tryptophan are essential amino acid. Our body can not synthesise atleast 8 amino acid (10 in children) which must be provided in the diet from outside. These eight amino acids are called essential amino acids. Thus, these essential amino acids, when present in the protein of our diet in sufficient amount, constitute protein quality.
(50) (C) **(51)** (A)
(52) **(A).** *Saccharum barberi* and *Saccharum officinarum* are varieties of sugar cane. *S. barberi* and *S. officinarum* were crossed to obtain sugar cane varieties having desirable qualities.
(53) (A) **(54)** (C) **(55)** (A)
(56) **(A).** Somaclones are obtained by tissue culture. The plant regenerated from cell and tissue

cultures shows heritable variation for both qualitative and quantitative traits. Plant breeding is the branch of biology, which is concerned with developing varieties superior to existing one. Irradiation means exposure to any form of radiation. Genetic engineering is the technique by which genetically modified organisms are obtained.

(57) **(A).** The capacity to generate a whole plant from any cell/ explant is called cellular totipotency. Infact, a whole plant can be regenerated from any plant part (referred to as explant) or cell.

(58) (D) **(59)** (D) **(60)** (C) **(61)** (B)

(62) (C) **(63)** (D) **(64)** (C)

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

(66) **(D).** Some plants developed by meristem culture are banana, sugarcane and potato, etc. Healthy plants can be recovered from diseased plants by meristem culture.

EXERCISE-2

(1) (D)

(2) **(B).** Germplasm is the living genetic resources such as seeds or tissue that is maintained for the purpose of animal and plant breeding, preservation, and other research uses.

(3) (A) **(4)** (D) **(5)** (C)

(6) **(C).** Saccharum barberi is a strong-growing species of grass in the genus Saccharum, the sugarcanes. It originates from northern India and has been exported to other countries and grown for the production of sugar.

(7) (D)

(8) **(A).** Okra or Lady's Finger or Bhendi (Abelmoschus esculentus) Improved Varieties: Pusa Makhamali, Pusa sawani, Vaishali, Vagmi, pb. Padmini, Selection 2-2, Pusa sawani is fairly mosaic tolerant Parbhani Kranti (Resistant to virus disease). Okra (Abelntoschus esculentus).

(9) (D) **(10)** (D) **(11)** (C)

(12) **(B).** Micropropagation is the practice of rapidly multiplying stock plant material to produce a large number of progeny plants, using modern plant tissue culture methods.

(13) (B)

(14) **(B).** Somaclonal variation is the variation seen in plants that have been produced by plant tissue culture.Chromosomal rearrangements are an important source of this variation.

(15) (B) **(16)** (A) **(17)** (C) **(18)** (D)

(19) (D)

(20) **(B).** Plant breeding is the purposeful manipulation of plant species in order to create desired genotypes and phenotypes for specific purposes. This manipulation involves either controlled pollination, genetic engineering, or both, followed by artificial selection of progeny.

(21) (B) **(22)** (D) **(23)** (B) **(24)** (C)

(25) (D) **(26)** (A) **(27)** (A) **(28)** (D)

(29) (A)

(30) **(A).** The pomato (or tomtato) is a chimera produced by grafting a tomato plant and a potato plant, both of which are members of the Solanaceae (nightshade) family. Cherry tomatoes grow on the vine, while white potatoes grow in the soil from the same plant.

(31) (D)

(32) **(A).** In protoplasm fusion the enzyme required are cellulose, hemicellulase and pectinase.

(33) (D) **(34)** (D)

(35) **(A).** Atlas 66 variety of wheat was developed for High protein content ; Scented grains ; Checking grassy stunt virus ; Vitamin C

(36) (D) **(37)** (B) **(38)** (A) **(39** (B)

(40) (D) **(41)** (C)

(42) **(B).** Honey is a natural sweet syrup extracted from the hives of honey bees. The chemical composition of honey is ash 01.00%, enzyme and pigments 02.21 %, maltose and other sugar 08.81 %, water 17.20%, dextrose 21.28% and levulose 88.90%.

(43) **(B).** All the given symptoms are infectious coryza disease of poultry birds.

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

found in the parental type. It is possible to induce mutations artificially through use of chemicals or radiations (like gamma radiations), and selecting and using the plants that have desirable characters as a source in breeding - this process is called mutation breeding.

(45) (C) **(46)** (D) **(47)** (C)

EXERCISE-3

(1) (D)

(2) **(C).** Biofortification is the idea of breeding crops to increase their nutritional value. This can be done either through conventional selective breeding, or through genetic engineering.

(3) (D) **(4)** (D) **(5)** (C) **(6)** (A)

(7) (B) **(8)** (D) **(9)** (C) **(10)** (D)

(11) **(C).** Arachis hypogaea, the peanut or groundnut, is an annual herbaceous plant in the Fabaceae (legume or bean family).

(12) **(C).** A natural mutant of *T. turgidum* is represented by tetraploid *T. durum* (4n=28) which was crossed with diploid wild grass, *Aegilops squarrosa* (2n = 14) under natural conditions. The resultant triploid hybrid was sterile which on doubling of chromosomes produced the hexaploid bread wheat, *Triticum aestivum* (6n = 42).

(13) (A) **(14)** (B) **(15)** (C) **(16)** (C)

(17) (B) **(18)** (A) **(19)** (C) **(20)** (A)

(21) **(B).** Superovulation is induced by hormone injection. Superovulation and embryo transplantation techniques have been used in India for cattle improvement.

(22) **(C).** Fish meal is a good source of protein for cattle and poultry. It is obtained from the non-edible (waste) parts of fishes like tails and fins.

(23) **(C).** Virus free plants can be produced from the virus infected plants by means of meristems tissue culture. By removing the meristem and growing in vitro, virus free plants can be obtained. Some plants developed by meristem culture are banana, sugarcane, potato, etc.

(24) **(C).** In callus culture, cell division in explant forms a callus. Callus is irregular unorganised and undifferentiated mass of actively dividing cells. Darkness and solid medium gelled by agar stimulates callus formation. The culture medium contains growth regulators auxin 2, 4-D and often a cytokinin like BAP. Both of these growth regulators stimulate meristematic property in callus.

EXERCISE-4

(1) **(B).** Germplasm collection/collection of variability.

(2) **(B).** *Chlorella* is rich in proteins and are used as food supplements even by space travellers.

(3) **(C).** Apical and axillary meristems are free of virus.

(4) **(D).** Somatic embryogenesis is technique of micro-propagation. Micropropagation is the growing of plants from meristematic tissue or somatic cells of plants on suitable nutrient media, under controlled conditions.

(5) **(B).** Plant cell — Cell wall = Protoplast

(6) **(A).** A single outcross (a type of outbreeding) is useful in overcoming inbreeding depression.

(7) **(B).** Polyploidy cells have a chromosome number that is more than double the haploid number.

(8) **(C).** True breeding line is one that, having undergone continuous self pollination, shows the stable trait inheritance and expression for several generations. It is both homozygous recessive as well as dominant in genetic constitution.

(9) **(B).** Interspecific hybridization is mating of animals of two different related species.

(10) **(D).** Mackerel is a marine fish having rich source of omega-3 fatty acids.

(11) **(A).** Inbreeding results in increase in the homozygosity. Therefore, mating of the related individuals of same breed will increase homozygosity.

(12) **(D).** In 1997, an American company got patent rights on Basmati rice through the US patent and trademark office that was actually been derived from Indian farmer's varieties. The diversity of rice in India is one of the richest in the world, 27 documented varieties of Basmati are grown in India.
Indian basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty. Sharbati Sonora and Lerma Rojo are varieties of wheat.

(13) **(C).** Inbreeding exposes harmful recessive genes that are eliminated by selection. It also helps in accumulation of superior genes and elimination of less desirable genes. Therefore this is selection at each step, increase the productivity of inbred population. Close and continued inbreeding usually reduces fertility and even productivity.