**Poultry Science**

**Chapter 5: Poultry Breeding and Genetics**

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**POULTRY GENETICS AND BREEEDING**

* **Zoological Classification of Poultry:**

|  |  |
| --- | --- |
| Kingdom | Animalia |
| Phylum | Chordata |
| Subphylum | Vertebrata |
| Class | Aves |
| Subclass | Neornithes |
| Superorder | Carinatae |
| Order | Galliforms |
| Suborder | Galli |
| Family | Phasianidae |
| Subfamily | Phasianinae |
| Genus | *Gallus* |
| **Species:** |  |
| Red jungle fowl | *Gallus gallus* |
| Ceylon jungle fowl | *Gallus lafayettei* |
| Grey jungle fowl | *Gallus sonnerati* |
| Java or Green jungle fowl | *Gallus varius* |

* **Different poultry species, their scientific names and chromosome number:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Poultry** | **Scientific Name** | **Chromosome No.** |
| 1. | Ducks | *Anas platyrhynchos* | 80 |
| 2. | Muscovy ducks | *Cairina moschata* | 80 |
| 3. | Geese | *Anser anser* | 80 |
| 4. | Guinea fowl | *Numida meleagris* | 78 |
| 5. | Pea fowl | *Pavo cristatus* | 80 |
| 6. | Japanese quail | *Cotunix coturnix japonica* | 78 |
| 7. | Bobwhite quail | *Colinus virginianus viginianus* | 78 |
| 8. | Pigeon | *Columba livia* | 80 |
| 9. | Ostrich | *Struthio camelus* | 80 |
| 10. | Emu | *Dromaius novaehollandiae* | 80 |
| 11. | Chicken | *Gallus gallus domesticus* | 78 |
| 12. | Turkey | *Meleagris gallopavo* | 80 |
| 13. | Pheasant | *Phasianus colchicus* | 82 |
| 14. | Dove | *Columba oneas* | 80 |

* **Characteristics of poultry breeds:**

|  |  |
| --- | --- |
| **Class** | **Breed** |
| **American Class:**   * Single comb * Clean shank * Yellow skin * Red ear lobe * Dual purpose * Medium size * Brown shelled eggs | Chanteclers (Pea comb)  Wyandotte (Rose comb) |
| Lamona (White egg)  Jersey giant (Black shank) |
| 1. Plymouth Rock 2. New Hampshire 3. Rhode Island Red |
| **Asiatic Class:**   * Single comb * Feathered shank * Yellow skin * Red ear lobe * Meat purpose * Massive size * Loose plumage * Brown shelled eggs | 1. Brahma (pea comb) 2. Langshan (white skin) |
| 1. Langshan (Bluish black shank) |
| **English Class:**   * Clean shank * White skin * Red ear lobes * Dual purpose * Medium size * Single comb (common) * Brown shelled eggs | 1. Cornish (Pea comb, yellow skin) 2. Redcaps (Rose comb) |
| Australorps (Blue-black shank) |
| Redcap and Dorking (White egg) |
| Sussex  Orpington |
| **Mediterranean Class:**   * Clean shank * Yellow or white skin * White ear lobes * Egg purpose * Small size * Tight feathering * White shelled eggs | 1. Leghorn and Minorca (Single comb and rose comb both) |
| 1. Minorca and Andalusian (White skin) |
| 1. Minorca (Black shank) 2. Andalusion (Blue shank) |
| 1. Anconas 2. Araucanas 3. Sicilian |

* **Class**: A class is a group of standard breeds that have developed in certain geographical regions of the world.
* **Breed**: Breed refers to an established group of fowls within a class possessing a distinctive shape and the same general weight.
* **Variety**: A variety is a subdivision of a breed, distinguished either by colour, colour and pattern, or comb.
* **Strain**: Strain is a family of birds from any breed or variety carefully bred over several years, at least five generations of closed flock breeding for specific purposes.
* **Classification of chicken on the bases of their utility:**

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Type** | **Breeds** |
| 1. | Egg Type | White Leghorn, Minorca, Ancona. |
| 2. | Meat Type | Cornish, Plymouth Rock, Brahma. |
| 3. | Dual Purpose | Rhode Island Red, New Hampshire. |
| 4. | Game Bird | Aseel. |
| 5. | Pet Type | Andalusian, Hamburgh. |

* **Indian breeds of chicken:**

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Desi fowl** | **Characteristics** |
| 1. | Aseel  (Lucknow ka murga) | Home tract: Andhra Pradesh.  World famous game bird, known for pugnacity, high stamina, majestic gait and dogged fighting qualities.  Biggest bird among Indian breeds.  Males: 4-5kg, Females: 2-3kg. |
| 2. | Kadaknath  (Kalamasi) | Home tract: Madhya Pradesh.  Black pigment is due to the deposition of melanin.  Adaptable to tropical environment and disease. |
| 3. | Chittagong  (Malay) | Home tract: Meghalaya and Tripura.  Dual purpose breed. |
| 4.. | Bursa | Home tract: Gujrat and Maharashtra.  Medium sized bird, deep bodied, light feathered and alert and Poor layer. |
| 5. | Nicobari | Home tract: Andaman and Nicobar  Best egg producer among Indian breeds.  Adapted to humid climate and resistant to most of the disease. |

* **Breeds of Ducks:**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Type** | **Breeds** |
| 1. | Meat-Type | Aylesbury, Muscovy, Pekin, Rouen, Cayuga, Swedish and Call Duck. |
| 2. | Egg-Type | Indian Runner and Campbell. |

* **Notes:**
* Mule ducks: Produced by mating female muscovies to mallard-type drakes. Mule ducks produce satisfactory meat yields, but they are sterile.
* Indian Runner ducks characteristically stand erect and their carriage is almost

perpendicular.

* Khaki Campbell ducks are prolific egg layers and can lay around 365 eggs in a laying year.
* **Breeds of Turkey:**

American Poultry Association recognized breeds of turkey are Bronze, White Holland, Bourbon Red, Narragansett, Black, Slate and Beltsville small white. Among these Broad-breasted bronze, Broad-breasted white and Beltsville small white turkeys are popular in commercial point of view.

* **Breeds of Geese:**

Important breeds of geese are Toulouse, Embden, African, Chinese, Canada, Buff, Pilgrim, Sebastopol and Egyptian.

* **Breeds of Guinea Fowl:**

Popular breeds of Guinea fowl are Pearl, White, and Lavender.

* **Breeds of Japanese Quail:**

Manchurian Golden, British Range, English White, and Tuxedo

* **Mendel's Laws of Inheritance:**

**Law of Segregation:** This law states that each individual has two alleles for each gene, one inherited from each parent, and these alleles segregate (separate) during the formation of gametes. As a result, each gamete carries only one allele for each gene.

**Law of Independent Assortment**: This law states that genes located on different chromosomes assort independently during the formation of gametes. This means that the inheritance of one gene does not influence the inheritance of another gene.

* **Qualitative versus quantitative traits:**

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| **S. No.** | **Qualitative traits** | **Quantitative traits** |
| 1. | Mono-factorial inheritance. | Polygenic/multifactorial inheritance. |
| 2. | Variations observed are discrete. | Variations are continuous. |
| 3. | Single gene effect can be detected. | Individual gene effect can’t be detected. |
| 4. | Not affected by environmental variations. | Influenced by environmental variance. |
| 5. | Not much economic importance. | Economically important. |
| 6. | Effect Is larger or nil. | Effect is small and additive. |
| 7. | Analysis by counting numbers or ratios. | Analysis in terms of population parameters. |

* **Additive gene action:** The combined effect of multiple alleles at different loci contributing to the phenotype. In poultry, traits like body weight, where multiple genes contribute additively to the overall weight of the bird.
* **Non-additive gene action**: Include dominance and epistasis, where the interaction between alleles at the same locus (dominance) or between alleles at different loci (epistasis) influences the phenotype. Non-additive effects can play a role in traits like plumage color, comb type, and disease resistance.
* **Dominance:** The relationship between alleles at the same locus, where one allele (dominant) masks the effect of the other allele (recessive).
* **Incomplete Dominance:** When neither allele is completely dominant, and the heterozygous phenotype is an intermediate blend of the homozygous phenotypes.
* **Epistasis**: The interaction between genes at different loci, where the expression of one gene mask the effect of another gene.
* **Complementary Gene Action:** When two or more genes are required together to produce a particular phenotype.
* **Lethal Alleles**: Alleles that, when present in a homozygous state, result in the death of the organism.
* **Mutation:** A heritable change in the DNA sequence. Mutations can introduce new traits or variations.
* **Genetics of fowl:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Conditions** | **Genetics** | **Remarks** |
| 1. | Crooked beak | Autosomal recessive | Tip of upper beak curl downward |
| 2. | Crooked neck dwarf | Autosomal recessive | Lethal |
| 3. | Diplopodia | Autosomal recessive | Partial doubling of structure of feet |
| 4. | Micromelia | Autosomal recessive | Limb of effected embryo is small (Lethal) |
| 5. | Wingless | Autosomal recessive | Embryo lack wing completely |
| 6. | Rumplessness | Dominance autosomal | Tail absents |
| 7. | Feathered shank | Dominant | Feather on the shank (Asiatic breeds) |
| 8. | Apterolosis | Dominant autosomal | Lethal |
| 9. | Creeper | Dominant autosomal | Short leg condition (Lethal) |
| 10. | Polydactyly | Dominant autosomal | 5th toes |
| 11. | Duplex Comb | Incomplete dominance | V shaped comb (Polish, Buttercups, Houdans) |
| 12. | Pea Comb | Incomplete dominance | Triple comb (Aseel, Cornish) |
| 13. | Frizzling | Incomplete dominant | Homozygous are lethal |
| 14. | Naked neck | Incomplete dominant | No feather in neck region, increase tolerance in heat |
| 15. | Blue plumage | Incomplete dominant | Andalusians breed |
| 16. | Spangling | Incomplete dominant | Feather has black tip (V shaped) |
| 17. | Brachydactyly | Incomplete dominant autosomal | Digit 4 is shorter than 2 |
| 18. | Silkiness | Recessive | Barbules lack hamuli and scrolls, lack of interlocking, wooly |
| 19. | Necked | Sex linked recessive | Lethal |

* **Some dominant and recessive characters in chicken:**

|  |  |
| --- | --- |
| **Dominant Character** | **Recessive Character** |
| Barred plumage | Non barred plumage |
| Rose comb | Single comb |
| Silver plumage | Golden plumage |
| Slow feathering | Fast feathering |
| Broodiness | Non broodiness |
| White skin | Yellow skin |
| Feathered shanks | Non feathered shanks |

* **Economic traits of Layers:**

1. Egg production:
   1. Hen Housed Egg Production (HHEP) {Flock average 80% is optimum or 295 eggs per year}
   2. Hen Day Egg Production (HDEP) {Flock average 85% is optimum or 310 eggs per year}
   3. Survivor’s Egg Production
2. Age at sexual maturity
3. Persistency:

Measured in terms of moulting performance. Annual egg production is best to improve persistency.

1. Clutch size:

Total number of eggs laid by hen without a break.

1. Broodiness:

More common in RIR, Australorp etc. Interbreed crosses show more broodiness than parent breeds.

1. Pause:

When interclutch period exceeds 7 days or more. Also includes pause due to broodiness.

1. Feed efficiency:

FCR, per kg egg mass ≤ 2.2.

FCR, per dozen of egg ≤ 1.5.

1. Egg weight:

Highly heritable. First egg of clutch is larger. Birds which mature early produce smaller eggs. Egg weight increases after moulting.

1. Quality of albumen:

Haugh index

1. Yolk index
2. Fertility and hatchability
3. Intensity of lay

* **Economic traits of Broilers:**

1. Body size and conformation
2. Body weight
3. Dressing percentage.
4. Growth rate
5. Feed conversion efficiency (FCR = Kg of feed consumed up to market age/ Body weight gain at market age)
6. Hatch weight
7. Liveability

* **Sex linked traits:**

Sex-linked traits are determined by genes located on the sex chromosomes.

**Example:**

1. Silver and golden plumage
2. Barring and non-barring
3. Slow and fast feathering
4. Sex linked dwarfism
5. Sex linked feather colour
6. Brown shell colour inhibitor
7. Foot colour
8. Dwarf- sex linked recessive

* **Sex limited trait:**

Sex-limited traits are those that are expressed only in one sex, even though both sexes may carry the genes responsible (present on autosomes). The expression of the trait is limited to either males or females.

**Example:**

1. Cock feathering is autosomal recessive trait that is sex limited to males.
2. Blue egg production.
3. Egg production in chicken.

* **Sex influenced trait:**

Sex-influenced traits are influenced by the sex of the individual, but they are not limited to one sex. The expression of these traits is influenced by the hormonal and physiological differences between males and females.

* **Important epistatic gene actions:**

|  |  |
| --- | --- |
| Recessive epistatic gene action | 9:3:4 |
| Duplicate Recessive/complimentary gene action | 9:7 |
| Dominant epistatic gene action | 13:3 |
| Duplicate dominant epistatic gene action | 15:1 |
| Inhibitory gene with partial dominance at inhibitory locus | 7:6:3 |

* **Heritability**:

Heritability defined as ratio of genetic variance to phenotypic variance.

Heritability in **broad sense**, h2 =

Heritability in **narrow sense**, h2 =

Mathematically, heritability is the regression of breeding value on phenotypic value (h2 = bAP).

* Heritability ranges from 0 to 1.
* Structural, anatomical and growth traits are highly heritable.
* Production traits are medium heritable.
* Reproduction traits are low heritable.
* **Breeding value:**

Genetic worth of an animal as a parent, indicating its additive effect on offspring traits.

The value of an individual, as measured by the average value of its progeny.

Breeding value = 2 (Average progeny - Population mean)

* **Selection:**

Selection in the context of poultry breeding refers to the process of choosing specific individuals (males and females) from a population to become parents of the next generation.

* **Types of natural selection:**

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| --- | --- | --- |
| 1. | **Directional selection** | Individuals with more extreme form of trait have higher fitness.  Shifts normal distribution to right or left. |
| 2. | **Stabilizing selection** | Having average form of trait has highest fitness.  Normal distribution becomes narrower, see less individuals at extremes. |
| 3. | **Disruptive selection** | Individuals with any extreme trait have a higher fitness. |

* + **Single Trait Selection (Basis of selection)**
  1. Individual or mass selection:
     1. For highly heritable traits
     2. Not for sex limited traits

Demerits

* + 1. Least effective aid
  1. Pedigree selection:
     1. More accurate and cheap
     2. For qualitative and quantitative traits
     3. For sex limited traits
     4. For low and medium heritable traits
     5. Unintentional mistakes are made --- Demerits
  2. Selection by progeny testing:
     1. Most accurate (Best method)
     2. Low heritability traits
     3. Sex limited traits
     4. Carcass traits
     5. More commonly used for males
     6. Time consuming and expensive --- Demerits
  3. Family selection:
     1. More frequently used in poultry since progeny is more
     2. Sex limited traits
     3. Carcass traits
     4. Low heritable traits
     5. Increase in inbreeding

Demerits

* + 1. Expensive

* + **Multi Trait Selection (Methods of selection):**
  1. Tandem method:
     1. One trait at a time is selected until improvement has occurred.
     2. Low efficiency.
  2. Independent culling method:
     1. Two or more traits are considered at a time.
     2. Every bird is required to meet a predefined minimum standard for each trait.
     3. Superior to tandem method and easier to perform.
  3. Selection index or total score method:
     1. Most effective.
     2. All traits are given weightage according to their economic values.
  4. BLUP (Best Linear Unbiased Prediction).
  + **Response to Selection (R or Genetic gain):** Difference between mean phenotypic value of the offspring of the selected parents and whole the parent population before selection.
  + **Selection Differential (S):** Superiority of selected parent over population mean. It is also defined as the difference between mean phenotypic value of the selected parents and whole the parent population before selection.
  + **Intensity of Selection (i):** Ratio of selection differential and phenotypic standard deviation of trait.
  + **Breeding systems:**

1. **Random mating** (panmixia)**:** Mating of individuals without any selection and all potential parents may contribute equally to the next generation.
2. Breeding for increased homozygosity
3. **Inbreeding**: Mating between individuals which are more closely related.
4. **Close inbreeding:** Mating between sibs or parents and progeny.
5. **Line breeding:** Inbreeding within an ancestral line.
6. **Outbreeding:** mating of less closely related individuals.
7. **Outcrossing**: Two lines or flocks within a same breed are separated for 4 or 5 generations and the sire from one flock is used to mate with the dams of another flock.
8. **Line crossing:** Crossing of inbred lines within a specific breed.
9. **Top crossing:** Mating of inbred males with females of non- inbred populations.
10. **Grading up:** Back crossing to same superior breed for several generations.
11. **Cross breeding:** Mating of different breeds to obtain progeny that show hybrid vigor or heterosis.

* **Two way cross/ single cross**: Two different breeds are crossed with each other to produce F1, which is useful for production purposes and not for breeding purposes.
* **Three ways cross:** The first-generation crossbred males are crossed with females of third breed by using the hybrid vigor of dam.
* **Four ways cross:** Four different breeds are used to produce two separate F1 crossbreds which will be mated together to produce F2 progeny.
* **Back cross:** In this system, F1 offspring are back crossed to one of the parental breeds especially with sire.
* **Rotational cross:** Two or three breeds are used for crossing purpose in rotational manner. It is used to maintain a high degree of heterozygosity. Three breeds are generally used rather than two breeds for rotational purposes.
* **Species hybridization:** The success of species hybridization in poultry is very less. When chicken is crossed with quail, a new offspring is developed which is called as ‘Quicken”, but the fertility and hatchability of interspecies crossed eggs are very low.
* **Co-efficient of Inbreeding(F)** Inbreeding coefficient is a probability that two genes at a locus are identical by descent. Value varies between 0 and 1.
* **Methods of mating:**

1. **Individual mating/ stud mating:**

Male always confined to a small individual pen.

Different females allowed to the males one after another.

1. **Pen mating:**

Usual method of pedigree breeding of chicken.

1-2 males are allowed to 6-12 females in each pen.

1. **Flock mating/ mass mating:**

Group of males (10-20) will be allowed to mate 100-200 females in large flock.

10 to 15 hens per cock in light breed and 8 females in heavy breed per cock.

1. **Artificial Insemination:**

Commonly used in Turkey flocks.

AI dose = 0.05 ml of semen.

Performed usually in afternoon.

Done once in 5days in hens.

* + **Broiler breeding centres:**
* CARI, Izatnagar
* QUAT, Bhuwaneshwar
* KVAFSU, Bangalore
* GADVASU, Ludhiana
* **Layer breeding centres:**
* CARI, Izatnagar
* AAU, Anand
* KAU, Mannuthy
* SVVU, Hyderabad
* **Rural poultry breeding centres**
* ICAR- research complex, NE Region Agartala
* JNKVV, Jabalpur
* **Commercial poultry breeding:**

The commercial poultry breeding programme are aimed at developing hybrids, capable of fast growth and high rate of egg production.

|  |  |
| --- | --- |
| White shelled egg production | Strain cross or inbred hybrid of White Leghorn origin are used |
| Brown shelled egg production | Cross breeding involving (White Leghorn) as male parent and (RIR or New Hampshire or Black Australorp) as female parent is employed |
| Evolving meat type strains | Cross-breeding of Cornish, White Rock and New Hampshire breeds are used. |

* **Different breeder flocks of broilers and layers:** 
  1. Pure lines (maintained by foundation /principal breeder)

Pure lines are highly inbred lines where full-sibs or parent x half-sib crosses are followed for nearly 3 generations

* 1. Grandparent stock (maintained by franchise hatcheries)

Three or four pure lines are maintained as grandparent stock to perform 3-way or 4-way crosses.

* 1. Parent stock (maintained by associate hatcheries)
  2. Commercials (maintained by poultry farmer)
* Male lines are usually selected based on the growth rate, feed efficiency and carcass traits whereas female lines are usually selected for reproductive traits as well as growth rate.

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Broiler strains** | **Layer strains** |
| 1. | Arbre: Acres (most popular strain in world [30% world shares]; failure in India) | Babcock/ BV- 300: 70% Indian share |
| 2. | Anak 2000: [White Broiler (Israel strain)] | H& N nick chick |
| 3. | Anak 40: Coloured Broiler | Hy-Line: popular strain in world egg size is very small |
| 4. | Cobb 40: 50% Indian market | Shaver star cross-288: Both brown egg and white egg layers are available. |
| 5. | Ross: UK bird; less uniformity | LSL Lohmann: Both brown and white egg varieties are available. |
| 6. | Hypeco: 10% Indian market | Bovans: 20% market share in India |
| 7. | Peterson: Available in North India | DeKalp: USA bird; Largest selling white egg bird in world. |

* **Artificial insemination in poultry:**
* In natural mating one male can be used for every 8 to 10 females. But on AI the semen collected from an individual male can be used to fertilize 150 to 200 females.
* AI in poultry is a three-step procedure involving semen collection, semen dilution and insemination. The second step may be omitted if 'neat' semen (undiluted) is to be used for inseminations within 30 minutes after collection.

1. Fowl semen is generally highly concentrated (3 to 8 billion spermatozoa per ml) for broiler fowl.
2. The cocks from 22 or 24 weeks of age are used for semen collection.
3. The natural colour of poultry semen is white or pearly white.
4. Heavy breed male can produce 0.75 to 1 ml semen and light breed male can produce 0.4 to 0.6 ml of semen.
5. A male can be used thrice in a week for semen collection with a gap of one day.
6. In practice, inseminating chicken after 3 p.m. obtained better results. In turkey flocks much better results are obtained if insemination is done after 5 pm.
7. Insemination apparatus is introduced into the vagina about 1 inch and semen is deposited at the junction of vagina and uterus.
8. Dose and frequency of insemination: Chicken: 0.03 ml, every 5 days.
9. It has been observed that the males produce more semen of good quality during morning and females produce more fertile eggs when inseminated around 9 p.m.

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| --- | --- | --- | --- |
| Species | Volume | Sperm concentration | Sperm concentration needed per insemination |
| Broiler type chicken | 0.7 ml | 3500 million/ml | 200 million/ml |
| Layer type chicken | 0.5 ml | 4000 million/ml | 200 million/ml |

* **Auto-sexing:**

The principle of sex linkage has been used for commercial use in the poultry industry especially auto-sexing at day-old and for dwarf chicken development. Some of the sex-linked characters used for auto-sexing or feather sexing are:

1. Barring and non-barring
2. Silver plumage and Golden plumage
3. Slow feathering and fast feathering.

* **Genomic selection in poultry:**

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| --- | --- | --- |
| **S. No.** | **Genomic selection** | **Remarks** |
| 1. | Restriction Fragment Length Polymorphisms (RFLP) | Botstein et al. (1980) introduced RFLP as a DNA marker based on hybridization. The initial DNA marker maps utilized genetic variations identified through the digestion of DNA with restriction enzymes and the use of probes targeting either genomic dispersed repetitive elements or specific genes. This technique is capable of detecting significant insertions and deletions in DNA, as well as single-base changes occurring within the restriction enzyme digestion site. |
| 2. | Microsatellites | Microsatellites, also known as short tandem repeats (STRs), are short repetitive DNA segments typically consisting of less than 100 base pairs. They are composed of tandem repeats of 1-6 base pair fragments. |
| 3. | Quantitative trait locus (QTL) | A quantitative trait locus (QTL) refers to a specific region of DNA (locus) that shows a correlation with variations observed in a particular phenotype, specifically a quantitative trait. Typically, the QTL is associated with or includes the genes responsible for regulating that phenotype. |
| 4. | Marker-assisted selection (MAS) | Marker-assisted selection (MAS) is a method of directly selecting those regions of the genome that influenced traits of commercial importance. |
| 5. | SNPs | SNPs, or single nucleotide polymorphisms, refer to variations in the DNA sequence that arise when a single nucleotide within the genome undergoes a change. |

* **Conservation of poultry genetic resources:**

Conservation of poultry genetic resources is essential to maintain biodiversity, preserve valuable genetic traits, and ensure the long-term sustainability of poultry production.

* Documentation and Characterization:

Identification and documentation of different poultry breeds and populations.

Characterization of genetic traits, such as growth rate, disease resistance, reproductive performance, and adaptability.

* Risk Assessment:

Evaluation of the risk status of different poultry breeds based on factors such as population size, geographical distribution, and the level of threat to their existence.

* Establishment of Conservation Programs:

Creation of conservation programs to safeguard endangered or rare poultry breeds.

Establishment of dedicated breeding programs to maintain genetic diversity within populations.

* In situ Conservation:

Encouraging and supporting local farmers to continue traditional and sustainable breeding practices.

Promoting community-based conservation initiatives to protect indigenous poultry breeds within their natural habitats.

* Ex situ Conservation:

Establishment of gene banks or repositories to store genetic material, such as semen, embryos, or DNA samples, for future use.

Collaborative efforts among poultry breeders, research institutions, and conservation organizations to maintain live populations in controlled environments.

* Education and Awareness:

Educating farmers, breeders, and the general public about the importance of poultry genetic resource conservation.

Raising awareness about the unique characteristics and benefits associated with different poultry breeds.

* Research and Technology:

Conducting research to understand the genetic basis of desirable traits in poultry.

Utilizing modern biotechnological tools, such as molecular markers and genomics, to enhance the efficiency of conservation efforts.

* Policy and Regulation:

Implementing policies and regulations that support the conservation of poultry genetic resources.

Integrating genetic conservation considerations into national and international agricultural policies.

* Economic Incentives:

Providing economic incentives for farmers and breeders who actively participate in the conservation of rare or endangered poultry breeds.

Promoting the utilization of unique traits in indigenous breeds for specific market niches, contributing to sustainable agriculture.

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**Fill in the blanks:**

1. A …...…..……. is a group of standard breeds that have developed in certain geographical regions of the world.
2. ………….….. refers to an established group of fowls within a class possessing a distinctive shape and the same general weight.
3. A …….………. is a subdivision of a breed, distinguished either by colour, colour and pattern, or comb.
4. …………….. is a family of birds from any breed or variety carefully bred over a number of years, at least five generations of closed flock breeding for specific purposes.
5. ……………. is an American breed which lays blue or green coloured eggs.
6. ………… is an Indigenous game fowl with fighting temperament.
7. …………. is an Asian breed which is notable for its quaint feather formation.
8. Chicken and Japanese quail have …… pairs of chromosomes.
9. In chickens, …... pairs of macro-chromosomes and …… pairs of micro-chromosomes are present.
10. In poultry, …….……... is heterogametic sex (ZW) and ………..…... is homogametic sex (ZZ).
11. The presence of a gene at one locus masks or influences the expression of another gene at different locus, the situation is described by a term, …………………….
12. Dwarfism means subnormal in size, which is produced by the ……………... recessive gene.
13. Some of the characters are determined by many pairs of genes, each with a small effect and are influenced by environment to a varying degree. These are known as ……………… traits.
14. Peak production is reached about ……………. weeks after the first egg is laid.
15. The number of eggs continuously laid by a hen without a break is called …….………….
16. Broodiness is determined by complementary genes and it has a ……………….. inheritance.
17. Most of the egg quality traits whether exterior or interior are ……………. heritable.
18. Breeding Value is twice the difference of the expected progeny mean from the ………………….
19. …………………………….. is a source of error that reduces precision in genetic studies.
20. ……………………….. is removal of inferior bird and retaining best bird in the flock.
21. In ………………………………………. method birds are selected for breeding purpose on the basis of their own phenotype.
22. Individual selection is not efficient when ………………….. of a character is low.
23. ……………………………. is a method of assessing the breeding value of a sire for any specific trait from the expression of the trait in its offspring.
24. If the records of individual are included in the family average and used as a criterion for selection, it is known as ………………………….
25. If the records of individual are not included in the family average, it is known as …………………………….
26. ……………………………….. methods are useful for sex limited and carcass traits.
27. In …………………………… of selection is practiced for only one trait at a time until improvement has been made in the trait.
28. Birds failing to meet the minimum standard even for a less important trait are likely to be culled in ……………………………………….
29. The response to the method of selection depends on …………………. variance available in the population.
30. In recurrent selection only one of the two population is purebred and is improved in reference to the other population called ………………………….. population.
31. RRS increases the frequency of both ……………………. and ………………………. genes.
32. Heritability is defined as the proportion of the …………………… variance which can be assigned to ………………… variance.
33. The only one which can be readily selected for in a breeding programme is the ……………. variance.
34. The average superiority of the selected parents is called as …………………………..
35. The …………………………. is the mean deviation of the selected individuals in units of standard deviation.
36. ……………………………… is defined as the difference between the mean phenotypic value of the individuals selected as parents and the mean phenotypic value of all the individuals in the parental generation before selection.
37. When the response to selection has stopped, the population is said to be at ………………………………………………….
38. ………………………. accuracy in selection can be obtained by comparing the animals in controlled environmental conditions.
39. In Outcrossing, two lines or flocks within a same breed are separated for …..……… generations and the sire from one flock is used to mate with the dams of another flock.
40. The gene for …………..……. comb is recessing to the gene for Rose and Pea comb.
41. When rose comb and pea comb are crossed, all the progeny will have walnut comb due to the ………………………… effect of 'R' and 'P' genes.
42. Neat semen (undiluted) is to be used for inseminations within …………. minutes after collection.
43. Fowl semen have high concentration of ………………… spermatozoa per ml for broiler fowl.
44. Cock start producing semen from the age of …………………
45. In India, RSTs are being carried out by the Government of India at its Central Poultry Breeding farms at ……………………., Bombay, ……………………… and Gugaon.
46. …………………. breed of India has high stamina, majestic gait and dogged fighting qualities.
47. Astralorp is a breed of ………………. class.
48. ………………………… is a commercial white egg laying chicken breed developed by CARI.
49. CARIBRODhanraja is a commercial cross produced by crossing ……………………… and female line.
50. Kadambri has black plumage with white and uniformly distributed spot is a variety of ……………………………………..

**MCQs:**

1. Which one of the following is no the breeds of geese:
2. White Holland
3. Toulouse
4. Embden
5. Pilgrim
6. Age at sexual maturity in poultry can be measured at
7. age at first egg
8. age at 5% per cent production
9. both
10. none
11. Broodiness is
    1. Sex-limited character
    2. Sex-linked character
    3. Sex influenced character
    4. None of these
12. Which lethal gene of fowl is not Autosomal Recessive?
13. Micromelia
14. Diplopodia
15. Crooked neck dwarf
16. Creeper
17. Frizzling is due to
18. Autosomal recessive
19. Autosomal dominant
20. Sex- linked dominant
21. Sex- linked recessive
22. Which of the following chicken breeds developed by CARI is dual-purpose?
23. UPCARI
24. CARIDEBENDRA
25. CARIBROVISHAL
26. CARIPRIYA
27. Which chicken breed developed by CARI is known for commercial white egg laying?
28. CARINIRBHEEK
29. UPCARI
30. CARISONALI
31. CARIPRIYA
32. Which poultry breed developed by CARI is known as a white egg-laying quail?
33. CARIUTTAM
34. CARIPEARL
35. CARIUJJAWAL
36. CARISWETA
37. American Class breeds:
    * + 1. Plymouth Rock and Langshan
        2. Australorp and New Hampshire
        3. New Hampshire and Rhode Island Red
        4. Rhode Island Red and Australorp
38. What is the required volume of semen for inseminating a single hen?
39. 0.05 ml to 0.10 ml
40. 0.10 ml to 0.15 ml
41. 0.01ml to 0.05 ml
42. 0.15 ml to 0.20 ml
43. What is the primary outcome of inbreeding according to the given information?
44. Increased fertility and hatchability
45. Enhanced growth and maturity
46. Reduction in mean phenotypic values
47. Decrease in the frequency of defects
48. Which of the following best defines inbreeding in poultry?
49. Mating between unrelated birds in a population
50. Mating between birds with no ancestral relation
51. Mating between birds with diverse genetic backgrounds
52. Mating between birds more closely related than the average in the population
53. Which of the following statements about heritability is true?
54. Heritability for a particular character is consistent within a species or strain.
55. Heritability is uniform across populations of different sizes.
56. Heritability remains constant regardless of the method of estimation, data source, breed, or species
57. Heritability is generally low for reproductive traits and high for physiological characters.
58. In recurrent selection, which population is purebred and improved in reference to the other population?
59. Inbred line
60. Crossbred line
61. Tester line
62. Random population
63. What type of genetic variance is utilized in recurrent selection?
64. Additive genetic variance
65. Dominant genetic variance
66. Non-additive genetic variance
67. Both additive and dominant genetic variance
68. In Reciprocal Recurrent Selection, what is increased in frequency?
69. Additive genes
70. Non-additive genes
71. Both additive and non-additive genes
72. Random genetic elements
73. What is a potential drawback of the Independent Culling method in poultry breeding?
74. Simultaneous improvement of several traits
75. Not easily implementation
76. Birds outstanding in some traits may be culled
77. Decreased selection intensity
78. Why is the Selection Index method considering the most effective?
79. It involves several traits at a time
80. It is cost effective
81. Each trait is assigned its respective weightage
82. It is the easiest method to implement
83. . What is the formula for calculating breeding value in a breeding program?
84. Breeding value = Population mean - Average progeny
85. Breeding value = 2 (Average progeny - Population mean)
86. Breeding value = 2 (Population mean - Average progeny)
87. Breeding value = Population mean - Average progeny
88. Why is the breeding value quantified as twice the difference of the expected progeny mean from the population mean?
89. Progeny carry all of the parent's genes.
90. Progeny carry only a quarter of the parent's genes.
91. Progeny carry half of the parent's genes.
92. Progeny carry twice of the parent's genes.
93. What is the source of error that reduces precision in genetic studies, having non-genetic origins?
94. Genotypic variation
95. Dominance deviation
96. Environmental deviation
97. Breeding value
98. What is the primary genetic factor responsible for dwarfism in birds used in broiler breeding operations?
99. Dominant gene Dw
100. Recessive gene dw
101. Sex-linked gene D
102. Recessive gene D
103. When dwarf female breeders are mated to a normal non-dwarf male line, what is the phenotype of the progeny?
104. Dwarf
105. Normal
106. Variable (both dwarf and normal)
107. Recessive
108. How is a variety in poultry defined?
109. A group of standard breeds within a class
110. A subdivision of a breed distinguished by shape and weight
111. A family of birds carefully bred for specific purposes
112. A geographical region where breeds develop
113. What is the primary purpose of Khaki Campbell ducks?
114. Meat production
115. Egg production
116. Ornamental purposes
117. Pet keeping
118. Which breed is known for laying blue or green coloured eggs?
119. Rhode Island Red
120. Leghorn
121. Araucana
122. Australorp
123. What is the reversed condition of sex chromosomes in avian species compared to mammals?
124. XY in males, XX in females
125. ZW in males, ZZ in females
126. ZZ in males, ZW in females
127. WZ in males, ZZ in females
128. How is HDEP calculated?
129. Total number of eggs produced divided by the number of hens housed
130. Total number of eggs produced divided by the number of hen present on the day
131. Average number of eggs laid by each survivor
132. Total number of eggs laid by survivors divided by the number of surviving birds
133. What does persistency in economic traits for layers measure?
134. Egg production
135. Moulting performance
136. Age at sexual maturity
137. Laying ability
138. Which method of selection used for multi-trait selection:
139. Pedigree selection
140. Family selection
141. Tandem selection
142. Progeny selection
143. How many females are typically mated in the case of broiler stocks during pen mating?
144. 10 to 15
145. 6 to 8
146. 20 to 25
147. 2 to 4
148. Which mating method involves segregating a single male with a group of breeder hens during the breeding period?
149. Flock mating
150. A.I.
151. Pen mating
152. Stud mating
153. What is the breeding origin of CARI-Gracy?
154. Cross of Nicobari and RIR
155. Cross of CARI Red and Aseel
156. Cross of Nicobari and CARI Red
157. Cross of Native and RIR
158. For which conditions is CARI-Nirasafed specifically developed?
159. Winter conditions
160. Tropical conditions
161. Arctic conditions
162. Desert conditions
163. What is the home tract of the Aseel (Lucknow ka Murga) chicken breed?
164. Gujarat
165. Maharashtra
166. Andra Pradesh
167. Meghalaya
168. Which quality is Aseel known for?
169. Excellent egg-laying ability
170. Majestic gait and dogged fighting qualities
171. High resistance to diseases
172. Poor mothering ability
173. What is the utility of the Kadaknath (Kalamasi) chicken breed?
174. Excellent egg-laying ability
175. Meat and religious ceremonies
176. High stamina for long flights
177. Good game bird
178. Which of the following is NOT a condition necessary for the maintenance of Hardy-Weinberg equilibrium?
179. Random mating
180. Large population size
181. Migration
182. Absence of mutation
183. What is the purpose of judging in poultry breeding?
184. To discourage breeders from participating in competitions
185. To evaluate the health and Vigor of birds in a flock
186. To promote healthy competition among breeders and develop superior quality birds
187. To reduce the diversity of bird breeds
188. In production judging of layers, what character is NOT considered in the score card?
189. Pigmentation
190. Feathering
191. General appearance
192. Beak colour
193. What is an essential characteristic of a good layer's vent?
194. Small, round, and puckered
195. Large, oval, and moist
196. Dry and scaly
197. Contracted and fatty
198. What is the frequency of artificial insemination in chickens?
199. Every 2 weeks
200. Every 3-5 days
201. Once a month
202. Once a year
203. What is the primary advantage of using semen diluents in artificial insemination?
204. Increase fertility
205. Reduce the number of males needed
206. Prolong semen storage time
207. Enhance sperm concentration
208. Where is the semen deposited during artificial insemination in poultry?
209. Cloaca
210. Ovary
211. Uterovaginal junction
212. Vagina
213. What is the recommended inseminating dose for chicken semen?
     1. 0.01 ml
     2. 0.025 ml
     3. 0.1 ml
     4. 0.5 ml
214. What is the holding temperature for the Modified Ringer's Solution semen extender?
215. 5 °C
216. 10 °C
217. 37 °C
218. -4 °C
219. Which of the following is not a variety of Leghorn?
220. White
221. Dark
222. Light
223. Rock
224. Which breed is mentioned as the best egg-producing breed among ducks?
225. Indian Runner
226. Khaki Campbell
227. Nageshwari
228. Muscovy
229. What is the domesticated version of the common wild quail (Coturnix coturnix)?
230. Indian Quail
231. Japanese Quail
232. Rain Quail
233. Grey Quail
234. Which class of breeds is characterized by large bodies, feathered shanks, and yellow skin?
235. American class
236. Asiatic class
237. Mediterranean class
238. English class
239. What distinguishes Mediterranean breeds from others?
240. Broodiness
241. Brown-shelled eggs
242. White ear lobes
243. Feathered shanks
244. What is distinctive about the Australorp breed?
245. Developed in America
246. Known for broodiness
247. Lustrous greenish-black plumage
248. Feathered shanks
249. What are the four pure breeds of fowls indigenous to India mentioned below?
250. Miri, Ankaleshwar, Aseel, Brahma
251. Aseel, Chittagong, Busra, Kadaknath
252. Langshan, Brahma, Hansli, Aseel
253. Chittagong, Aseel, Tellicherry, Sussex
254. What organization developed PD-2, and where is it located?
255. ICAR-IVRI, Izatnagar
256. ICAR-DPR, Hyderabad
257. National Bureau of Animal Genetic Resources, Karnal
258. CARI, Izatnagar
259. Narrow-sense heritability (h2) includes:
260. Additive genetic variance only
261. Dominance genetic variance only
262. Interaction genetic variance only
263. All of the above
264. In a breeding program, which genetic factor can be readily selected for?
265. Dominance genetic variance
266. Interaction genetic variance
267. Additive genetic variance
268. All of the above
269. What is the main application of heritability in breeding programs?
270. Predicting environmental factors
271. Predicting genetic factors
272. Predicting the improvement potential of a population
273. Predicting phenotypic variance
274. The Major Histocompatibility Complex (MHC) is responsible for:
275. Egg production
276. Adaptability
277. Bone structure
278. All of the above
279. Which gene is effective for cellular resistance to Lymphoid leukosis?
280. C12
281. B21
282. Nramp 1
283. TNC
284. Which MHC genes are associated with superior egg production and adult viability?
285. B1 allele
286. B2 and B21
287. B19
288. Lysozyme gene
289. What does the B21 genotype in chickens impart strong resistance to?
290. Salmonellosis
291. Marek’s disease
292. Lymphoid leukosis
293. Coccidiosis
294. Which genes are linked with resistance to salmonellosis?
295. B21 and B19
296. Nramp 1 and TNC
297. C12 and B21
298. B1 genes
299. What is the primary focus of QTL mapping in poultry genetics?
300. Identifying genes responsible for specific traits
301. Classifying breeds based on qualitative traits
302. Analysing sex-linked characteristics
303. Studying mitochondrial DNA variations
304. Which term refers to the specific location on a chromosome where a QTL is found?
305. Gene hotspot
306. Chromosomal hotspot
307. Locus
308. Allele site
309. Which of the following is a key advantage of GWAS in poultry breeding?
310. Coverage of the entire RNA sequencing
311. Focusing only on known candidate genes
312. Targeting a single trait at a time
313. Exploring the entire genome for trait associations
314. Which technology is commonly used in GWAS for genotyping thousands of genetic markers simultaneously?
315. Polymerase Chain Reaction (PCR)
316. Restriction Fragment Length Polymorphism (RFLP)
317. Random Amplified Polymorphic DNA (RAPD)
318. Microarray Technology
319. In GWAS, what does a "Manhattan plot" visually represent?
320. The genetic structure of poultry breeds
321. Chromosomal distribution of traits in poultry
322. Associations between genetic markers and traits across the genome
323. Poultry farming practices in different regions
324. How does MAS contribute to poultry breeding efficiency?
325. Increases randomness in mating
326. Reduces reliance on genetic information
327. Allows for precise selection of desired traits
328. Promotes natural variation
329. Which aspect of breeding does MAS help address more efficiently?
330. Environmental factors
331. Long generation intervals
332. Phenotypic expression
333. Reproductive barriers
334. Give below are three statements:
335. *Gallus gallus* is the main progenitor for the present-day domestic fowl.
336. Fowls come under the family Phasianidae.
337. Scientific name of green jungle fowl is *Gallus lafayettei.*

Choose the most appropriate answer from the options given below

1. a and b
2. b and c
3. a and c
4. a, b and c
5. Give below are three statements:
6. Geese and Japanese quail have 39 pairs of chromosomes.
7. Turkeys, chicken and ducks have 40 pairs of chromosomes.
8. Pheasants have 41 pairs of chromosomes.

Choose the most appropriate answer from the options given below

1. a and c
2. b only
3. c only
4. a, b and c
5. Qualitative traits are:
6. Mostly mono-factorial inheritance
7. Influenced by environmental variations
8. Analysis by counting numbers or ratios.
9. The effect is small and additive
10. Variations observed are discrete

Choose the most appropriate answer from the options given below

1. a, b and c
2. a, c and e
3. a, b, c and d
4. a, b, c, d and e
5. Sex-linked characters used for auto-sexing or feather sexing are:
   * 1. Barring and non-barring
     2. Silver plumage and Golden plumage
     3. Slow feathering and fast feathering

Choose the most appropriate answer from the options given below

1. a and b
2. c only
3. b and c
4. a, b and c
5. Which are not the economic traits of layers:
6. Egg size and Egg quality
7. Feed Conversion Efficiency
8. Body size and conformation
9. Growth rate
10. Hatch weight
11. Liveability
12. Dressing percentage

Choose the most appropriate answer from the options given below

1. a, c, d and e
2. b, c, d and g
3. c, d and g
4. d and g only
5. Osborne Index
   * 1. It is used for improving egg production in poultry
     2. It is a type of selection index
     3. It is used in broiler improvement methods

Choose the most appropriate answer from the options given below

1. a and b
2. b only
3. a only
4. b and c
5. Give below are four statements about heritability of traits in poultry:
   1. The egg quality traits, both exterior and interior, is generally low heritable.
   2. Body weight at all stages exhibits a high degree of heritability.
   3. Traits such as fertility and hatchability have moderately heritability.
   4. Growth rate shows a moderate to high level of heritability.

Choose the most appropriate answer from the options given below

1. a and c
2. b and d
3. b only
4. d only
5. Heritability
6. It is the heritable portion of phenotypic variance.
7. Heritability is the regression of breeding value on genotypic value.
8. Ranges from 0 to 1.
9. The correlation between the breeding value and the phenotypic value is equal to square of heritability.
10. Realized heritability is ratio selection and selection differential.

Choose the most appropriate answer from the options given below

1. a, b and c
2. a, b, c and e
3. a, c and e
4. a, c, d and e
5. Selection:
6. New genes are created by selection.
7. Frequency of the more desirable genes is increased.
8. The main genetic effect of selection is to change the gene frequencies and create new genes in gene pool.

Choose the most appropriate answer from the options given below

1. a and c
2. b and c
3. b only
4. c only
5. Give below are four statements:
6. Cochin also known as Sanghai fowl.
7. Cornish is also known as Red-faced Spanish bird.
8. American class of chicken feathered shank present.
9. English class of chicken are known for dual purpose breed.

Choose the correct answer for the options given below:

1. a and d
2. b, c and d
3. c and d
4. a, b and c
5. The Government of India is conducting Random Sample Performance Tests at its Central Poultry Breeding farms at:
   1. Bangalore
   2. Bombay
   3. Bhopal
   4. Chandigarh
   5. Bhubaneshwar
   6. Gurgaon

Choose the correct answer for the options given below:

1. a, b, c and f
2. a, b, e and f
3. c, d, e and f
4. a, b, c and d
5. Characteristics of Poultry Semen:
6. Fowl semen is generally highly concentrated (3 to 8 billion spermatozoa per ml for broiler fowl).
7. Cock starts producing semen from the age of 10 weeks.
8. Cocks from 22 or 24 weeks of age are used for semen collection.
9. The natural colour of poultry semen is white or pearly white.

Choose the correct answer for the options given below:

1. a, b and c
2. a and b
3. c and d
4. a, c and d
5. Different comb types of chicken (choose the correct match):
6. Single comb: The gene for single comb is recessing to the gene for Rose and Pea comb.
7. Pea comb: It is very well seen on the head of a well-bred Brahma.
8. Rose comb: It is narrow and has spikes in line behind each other.
9. Strawberry or Walnut comb: Cross of rose comb and pea comb.

Choose the correct answer for the options given below:

1. a, b and d
2. b, c and d
3. a and d
4. a, c and d
5. Process of artificial insemination:
   1. Dilution of semen
   2. Preparation of males
   3. Evaluation of semen
   4. Deposition of semen in vagina of female
   5. Collection of semen from males

Arrange the provided steps to select the correct answer from the given options:

1. a, c, d, b and e
2. c, e, a, d and b
3. b, e, c, a and d
4. e, c, d, a and b
5. Chittagong
6. Known as Malay
7. Meat type bird.
8. Pea comb, white ear lobes
9. Over-hanging prominent eyebrows

Choose the correct answer for the options given below:

1. a and d
2. b and c
3. a and b
4. c and d
5. English Class:
   1. Lean shank
   2. White skin
   3. White ear lobes
   4. Dual purpose
   5. Single comb
   6. White shelled eggs

Choose the correct answer for the options given below:

1. a, b, c and d
2. a, b, d and e
3. a, b, c and e
4. b, c, d, e and f
5. What represents a distinguishing feature in the contrast between animal breeding and poultry breeding?
6. Animal breeding has shorter generation interval
7. Poultry breeding produces greater number of offspring from parents
8. The unique chromosomal arrangement in poultry where females are heterogametic and males are homogametic

Choose the correct answer for the options given below:

1. a and c
2. b and c
3. a, b and c
4. none
5. Taxonomical classification of chicken
6. Phylum: Chordata
7. Class: Aves
8. Order: Phasianidae
9. Family: Galliform

Choose the correct answer for the options given below:

1. a and d
2. a and b
3. c and d
4. a, b and c
5. Classification based on utility
6. Game type: Aseel
7. Meat type: Cornish, Wyandotte
8. Egg type: Leghorn, Sussex
9. Dual type: Rhode Island Red, New Hampshire
10. Fancy: Silky, Frizzled

Choose the correct answer for the options given below:

1. a, b and c
2. a, d and e
3. c, d and e
4. b, d and c
5. Vanaraja:
6. Dual-purpose commercial chicken variety.
7. Adult body weight at 40 weeks of age ranges from 2.4 to 2.8 kg in female and from 3 to 3.5 kg in male.
8. Single comb, multicoloured plumage, yellow colour skin and shank and lays brown coloured eggs.
9. The annual egg production varies between 190 and 215 eggs.

Choose the correct answer for the options given below:

1. a, b and c
2. a, b and d
3. b, c and d
4. a and c
5. Maithili Duck:
6. Distribution in Bihar
7. exhibit uniform light/dark brown feathers
8. Average age at first egg range 159-223 days.
9. Average annual egg production range 150-170.

Choose the correct answer for the options given below:

1. a, b and c
2. a, b and d
3. b, c and d
4. a and c
5. Steps in Reciprocal Recurrent Selection (RRS):
6. Rank the sires from strain A and dams from strain B based on the performance of the AB cross progeny. Simultaneously, rank the sires from strain B and dams from strain A based on the performance of the BA cross progeny. Select the top-performing sires from strain A and B, as well as the best dams from strain B and A.
7. Choose two high-performing strains, designated as A and B, both having a history of exceptional cross performance.
8. Assess the performance of the cross progeny from each parent for the desired traits.
9. Reproduce strains A and B separately by mating the selected best A males with A females and the best B males with B females.
10. Cross the two strains by pairing A males with B females to generate AB cross progeny, and A females with B males to produce BA cross progeny.

Choose the correct sequence for the options given below:

1. a, b, c, d and e
2. b, c, e, a and d
3. b, e, c, a and d
4. a, e, b, d and c
5. Characteristics of h2 :
6. Heritability is constant for a specific trait within a species or strain.
7. The size of the population influences heritability.
8. Heritability is subject to fluctuations based on factors like estimation method, data source, breed, and species.
9. Reproductive traits like fertility, hatchability, egg production, and viability generally exhibit moderate heritability,
10. Physiological characteristics such as growth rate and egg size tend to have low heritability.

Choose the correct answer for the options given below:

1. a and b
2. b and c
3. c and e
4. b and e
5. Grandparent Stock:
6. Generation of pure genetic lines for future breeding programs.
7. Selecting superior traits for transfer to parent stock.
8. Conformation to breed standards.
9. Laying eggs for commercial hatcheries.
10. Raised in larger numbers compared to parent stock.
11. Maintains genetic diversity and purity within the flock.

Choose the incorrect option given below:

1. a and b
2. b and c
3. d and e
4. e and f
5. Parent Stock:
6. Selected based on traits relevant to meat or egg production.
7. Raised in larger numbers compared to grandparent stock.
8. Heritability is subject to fluctuations based on factors like estimation method, data source, breed, and species.
9. Directly involved in the production of broilers or commercial layers for the market.
10. Represents the link between the grandparent stock and the final consumer product.

Choose the correct answer for the options given below:

1. a, b, c and e
2. b, c, d and e
3. a, c, d and e
4. a, b, c, d and e
5. Give below are two statements:

Statement Ⅰ: Barred plumage and rose comb are dominant Character.

Statement Ⅱ: Yellow Skin and feathered shanks are recessive Character.

Choose the most appropriate answer from the options given below

1. Both statement Ⅰ and statement Ⅱ are true
2. Both statement Ⅰ and statement Ⅱ are false
3. Statement Ⅰ is true and statement Ⅱ are false
4. Statement Ⅰ is false and statement Ⅱ are true
5. Give below are two statements:

Statement Ⅰ: Epistasis occurs when the presence of a gene at one location conceals or affects the expression of another gene at a distinct locus.

Statement Ⅱ: The gene responsible for suppression is referred to as the epistatic gene, while the gene undergoing suppression is termed the hypostatic gene

Choose the most appropriate answer from the options given below

1. Both statement Ⅰ and statement Ⅱ are true
2. Both statement Ⅰ and statement Ⅱ are false
3. Statement Ⅰ is true and statement Ⅱ are false
4. Statement Ⅰ is false and statement Ⅱ are true
5. Give below are two statements:

Statement Ⅰ: The number of eggs continuously laid by a hen without a break is called clutch.

Statement Ⅱ: The clutch size is low heritable, while, the rate of lay is high heritable.

Choose the most appropriate answer from the options given below

1. Both statement Ⅰ and statement Ⅱ are true
2. Both statement Ⅰ and statement Ⅱ are false
3. Statement Ⅰ is true and statement Ⅱ are false
4. Statement Ⅰ is false and statement Ⅱ are true
5. Give below are two statements:

Statement Ⅰ: Hen-housed egg production take mortality into account.

Statement Ⅱ: Hen-day egg serves as a valuable indicator for scientific studies.

Choose the most appropriate answer from the options given below

1. Both statement Ⅰ and statement Ⅱ are true
2. Both statement Ⅰ and statement Ⅱ are false
3. Statement Ⅰ is true and statement Ⅱ are false
4. Statement Ⅰ is false and statement Ⅱ are true
5. Give below are two statements:

Statement Ⅰ: Egg weight and hatch weight are not positively correlated.

Statement Ⅱ: 50 to 55% of the egg weight will be the chick weight.

Choose the most appropriate answer from the options given below

1. Both statement Ⅰ and statement Ⅱ are true
2. Both statement Ⅰ and statement Ⅱ are false
3. Statement Ⅰ is true and statement Ⅱ are false
4. Statement Ⅰ is false and statement Ⅱ are true
5. Give below are two statements:

Statement Ⅰ: Heterosis occurs when the offspring resulting from crosses between inbred lines or purebred populations surpasses the average performance of the two parent populations.

Statement Ⅱ: Heterosis is due to additive gene action.

Choose the most appropriate answer from the options given below

1. Both statement Ⅰ and statement Ⅱ are true
2. Both statement Ⅰ and statement Ⅱ are false
3. Statement Ⅰ is true and statement Ⅱ are false
4. Statement Ⅰ is false and statement Ⅱ are true
5. Give below are two statements:

Statement Ⅰ: Application of Mendelian principles to animals was first demonstrated by Bateson and Punnett for plumage colour of chickens.

Statement Ⅱ: first case of sex-linked inheritance involving barring gene was demonstrated by Bateson.

Choose the most appropriate answer from the options given below

1. Both statement Ⅰ and statement Ⅱ are true
2. Both statement Ⅰ and statement Ⅱ are false
3. Statement Ⅰ is true and statement Ⅱ are false
4. Statement Ⅰ is false and statement Ⅱ are true
5. Given below are two statements: one is labelled as Assertion (A) and other is labelled as Reason (R):

Assertion (A): Genetic improvement is quicker in poultry.

Reason (R): Generation interval is shorter in poultry.

Choose the most appropriate answer from the options given below

1. Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
2. Both assertion (A) and reason (R) are true and reason (R) is not the correct explanation of assertion (A)
3. Assertion(A) is true but reason(R) is false.
4. Assertion(A) is false but reason(R) is true.
5. Given below are two statements: one is labelled as Assertion (A) and other is labelled as Reason (R):

Assertion (A): Silver plumage is dominant to Golden plumage.

Reason (R): When silver plumaged Sussex female (S -) is crossed with Golden plumaged RIR male (ss), the F1 progeny will be Silver plumaged male and Golden plumaged females.

Choose the most appropriate answer from the options given below

1. Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
2. Both assertion (A) and reason (R) are true and reason (R) is not the correct explanation of assertion (A)
3. Assertion(A) is true but reason(R) is false.
4. Assertion(A) is false but reason(R) is true.
5. Given below are two statements: one is labelled as Assertion (A) and other is labelled as Reason (R):

Assertion (A): Rapid feathering gene is dominant to slow feathering gene.

Reason (R): At day-old age, sexing is accomplished by examination of primary and covert feathers on the tip of the outspread wings.

Choose the most appropriate answer from the options given below

1. Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
2. Both assertion (A) and reason (R) are true and reason (R) is not the correct explanation of assertion (A)
3. Assertion(A) is true but reason(R) is false
4. Assertion(A) is false but reason(R) is true
5. Given below are two statements: one is labelled as Assertion (A) and other is labelled as Reason (R):

Assertion (A): Persistency refers to the onset of moulting at the end of the lying cycle.

Reason (R): A hen that undergoes a late moult or continues laying eggs while moulting is considered to be a productive layer.

Choose the most appropriate answer from the options given below

1. Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
2. Both assertion (A) and reason (R) are true and reason (R) is not the correct explanation of assertion (A)
3. Assertion(A) is true but reason(R) is false
4. Assertion(A) is false but reason(R) is true
5. Given below are two statements: one is labelled as Assertion (A) and other is labelled as Reason (R):

Assertion (A): Slow feathering is a dominant trait over rapid feathering in chickens.

Reason (R): Sexing at day-old age is determined by examining the relative length of primaries and coverts on the tip of the outspread wings, with coverts emerging from the top surface and primaries from the lower edge.

Choose the most appropriate answer from the options given below

1. Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
2. Both assertion (A) and reason (R) are true and reason (R) is not the correct explanation of assertion (A)
3. Assertion(A) is true but reason(R) is false.
4. Assertion(A) is false but reason(R) is true.
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. American breeds | 1. Orpington |
| 1. English breeds | 1. New Hampshire |
| 1. Mediterranean breeds | 1. Langshan |
| 1. Asiatic breeds | 1. Andalusian |

Choose the correct answer for the options given below:

1. A-2, B-4, C-1, D-3
2. A-2, B-1, C-4, D-3
3. A-3, B-4, C-1, D-2
4. A-3, B-1, C-4, D-2
5. Which is not correctly matches

|  |  |
| --- | --- |
| * 1. Directional selection | Involves shifting the normal distribution to either the right or left. |
| * 1. Stabilizing selection | Results in a narrower normal distribution, with fewer individuals observed at the extremes. |
| * 1. Disruptive selection | Occurs when individuals with any extreme trait experience higher fitness |

Choose the most appropriate answer from the options given below

1. a and c
2. b and c
3. all correct
4. all incorrect
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| * + 1. Selection differential | 1. The superiority of the selected parent over the population mean. |
| * + 1. Intensity of selection | 1. One of the populations is an inbred tester line with respect to which the other population which is open bred or synthetic will be developed for commercial purposes |
| * + 1. Recurrent selection | 1. Difference between the mean of the offspring generation and mean of parent generation. |
| * + 1. Genetic gain | 1. It is the ratio of selection differential and phenotypic standard deviation of trait. |

Choose the correct answer for the options given below:

1. A-1, B-4, C-3, D-2
2. A-2, B-1, C-4, D-3
3. A-3, B-4, C-1, D-2
4. A-1, B-4, C-2, D-3
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. **Top crossing** | 1. Crosses will be made in all possible combinations. |
| 1. **Grading up** | 1. Cross-bred females are mated with males from either of the populations. |
| 1. **Diallel mating** | 1. Mating of inbred males with females of non-inbred populations. |
| 1. **Rotational cross-breeding** | 1. Back crossing to the same superior breed for several generations. |

Choose the correct answer for the options given below:

1. A-1, B-4, C-3, D-2
2. A-2, B-1, C-4, D-3
3. A-3, B-4, C-1, D-2
4. A-1, B-4, C-2, D-3
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. **CARISONALI** | 1. White Leghorn × Rhode Island |
| 1. CARINIRBHEEK | 1. Frizzle × CARI Red |
| 1. UPCARI | 1. Aseel × CARI Red |
| 1. **CARI Gracy** | 1. Nicobari × CARI Red |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-2, B-1, C-4, D-3
3. A-1, B-2, C-3, D-4
4. A-1, B-4, C-2, D-3
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. **Genetics** | 1. Hagedoom |
| 1. Random Sample Test | 1. Bateson |
| 1. Linkage | 1. Morgan |
| 1. Heterosis | 1. Shull |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-2, B-1, C-4, D-3
3. A-1, B-2, C-3, D-4
4. A-2, B-1, C-3, D-4
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. CARIUTTAM | 1. White Feathered Quail |
| 1. CARIUJJAWAL | 1. Brown Feathered Quail |
| 1. CARISWETA | 1. Broiler Quail |
| 1. CARIBROWN | 1. White Breasted Quail |

Choose the correct answer for the options given below:

1. A-4, B-3, C-2, D-1
2. A-2, B-1, C-4, D-3
3. A-3, B-4, C-1, D-2
4. A-3, B-1, C-3, D-2
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. Creeper | 1. Autosomal recessive |
| 1. Short upper beak | 1. Dominant autosomal |
| 1. Brachydactyly | 1. Incomplete dominant |
| 1. **Frizzling** | 1. Incomplete dominant autosomal |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-2, B-1, C-4, D-3
3. A-1, B-4, C-2, D-3
4. A-1, B-2, C-3, D-4
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. Hen feathering | 1. Sex limited dominant |
| 1. Silver and golden plumage | 1. Incomplete dominant |
| 1. Nacked neck | 1. Sex linked trait |
| 1. **Feathers on the feet** | 1. Dominant |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-1, B-2, C-3, D-4
3. A-1, B-4, C-2, D-3
4. A-2, B-1, C-4, D-3
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. Duplicate recessive epistasis | 1. 9:7 |
| 1. Duplicate dominant epistasis | 1. 13:3 |
| 1. Dominant epistasis | 1. 9:3:4 |
| 1. **Recessive epistasis** | 1. 15:1 |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-4, B-2, C-3, D-1
3. A-1, B-4, C-2, D-3
4. A-2, B-1, C-4, D-3
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. Rose comb | 1. Brahma |
| 1. Walnut comb | 1. Polish |
| 1. Duplex comb | 1. Malays |
| 1. **Pea comb** | 1. Assel |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-4, B-1, C-2, D-3
3. A-2, B-1, C-4, D-3
4. A-4, B-3, C-2, D-1
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. Leghorn | 1. 2 verities |
| 1. RIR | 1. 4 verities |
| 1. Cornish | 1. 6 verities |
| 1. **Plymouth rock** | 1. 12 verities |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-4, B-1, C-2, D-3
3. A-2, B-1, C-4, D-3
4. A-4, B-3, C-2, D-1
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. Nicobari | 1. Short legged chicken |
| 1. Assel | 1. Duplex comb |
| 1. Polish | 1. Pea comb |
| 1. **Silkies** | 1. 5 toe bird |

Choose the correct answer for the options given below:

1. A-1, B-3, C-2, D-4
2. A-4, B-1, C-2, D-3
3. A-2, B-1, C-4, D-3
4. A-4, B-3, C-2, D-1
5. Match list 1 with list 2

|  |  |
| --- | --- |
| List 1 | List 2 |
| 1. Tail feather | 1. Oval |
| 1. Base of feather | 1. Rachis |
| 1. Shaft of feather | 1. Rectrices |
| 1. **Broiler bird** | 1. Cumulus |

Choose the correct answer for the options given below:

1. A-4, B-3, C-2, D-1
2. A-2, B-3, C-4, D-1
3. A-2, B-1, C-4, D-3
4. A-3, B-4, C-2, D-1

**Answer Key:**

* **Fill in the blanks:**

|  |  |  |  |
| --- | --- | --- | --- |
| S. No. | Answers: | S. No. | Answers: |
| 1. | Class | 26. | Family and sib selection |
| 2. | Breed | 27. | Tandem method |
| 3. | Variety | 28. | Independent culling method |
| 4. | Strain | 29. | Additive |
| 5. | Aracuana | 30. | Tester or test |
| 6. | Aseel | 31. | Additive and non-additive |
| 7. | Frizzle | 32. | Phenotypic; genetic |
| 8. | 39 | 33. | Additive |
| 9. | 6; 33 | 34. | Selection differential |
| 10. | Female; male | 35. | Intensity of selection |
| 11. | Epistasis | 36. | Selection differential |
| 12. | Sex- linked | 37. | Plateau or selection limit |
| 13. | Polygenic | 38. | Increased |
| 14. | 5 to 6 | 39. | 4 or 5 |
| 15. | Clutch | 40. | Single |
| 16. | Sex- linked | 41. | Complementary |
| 17. | Highly | 42. | 30 |
| 18. | Population mean | 43. | 3 to 8 billion |
| 19. | Environmental variance | 44. | 16 weeks |
| 20. | Culling | 45. | Bangalore; Bhubaneshwar |
| 21. | Individual or mass selection | 46. | Aseel |
| 22. | Heritability | 47. | English |
| 23. | Progeny testing | 48. | CARIPRIYA |
| 24. | Family selection | 49. | Synthetic male |
| 25. | Sib selection | 50. | Guinea fowl |

* **MCQs:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S. No. | Answers | S. No. | Answers | S. No. | Answers | S. No. | Answers |
| 1. | a | 31. | b | 61. | b | 91. | c |
| 2. | b | 32. | c | 62. | b | 92. | b |
| 3. | b | 33. | c | 63. | a | 93. | c |
| 4. | d | 34. | b | 64. | c | 94. | d |
| 5. | a | 35. | c | 65. | d | 95. | c |
| 6. | b | 36. | b | 66. | d | 96. | a |
| 7. | d | 37. | b | 67. | c | 97. | c |
| 8. | b | 38. | c | 68. | c | 98. | d |
| 9. | c | 39. | c | 69. | b | 99. | b |
| 10. | a | 40. | d | 70. | a | 100. | c |
| 11. | c | 41. | b | 71. | c | 101. | a |
| 12. | d | 42. | b | 72. | b | 102. | a |
| 13. | d | 43. | b | 73. | d | 103. | a |
| 14. | c | 44. | c | 74. | c | 104. | d |
| 15. | c | 45. | c | 75. | a | 105. | b |
| 16. | c | 46. | b | 76. | b | 106. | a |
| 17. | c | 47. | d | 77. | c | 107. | b |
| 18. | c | 48. | b | 78. | c | 108. | c |
| 19. | b | 49. | b | 79. | a | 109. | d |
| 20. | c | 50. | b | 80. | b | 110. | c |
| 21. | c | 51. | c | 81. | d | 111. | a |
| 22. | b | 52. | c | 82. | a | 112. | d |
| 23. | b | 53. | b | 83. | c | 113. | c |
| 24. | b | 54. | b | 84. | a | 114. | b |
| 25. | b | 55. | a | 85. | b | 115. | a |
| 26. | c | 56. | c | 86. | b | 116. | c |
| 27. | c | 57. | c | 87. | b | 117. | d |
| 28. | b | 58. | d | 88. | b | 118. | b |
| 29. | b | 59. | a | 89. | c | 119. | a |
| 30. | c | 60. | b | 90. | a | 120. | d |