ANIMAL SCIENCE REVIEWER BASED ON TOS (MODULE C: GENETICS & ANIMAL BREEDING) BY AGRICULTURE REVIEW

Practice Examination Questions (Items 1 to 50)

Select the best answer from choices a, b, c, or d for each question. A comprehensive answer key with detailed explanations is provided immediately following item 50.

1. A beef cattle breeder mates two roan Shorthorn animals that are heterozygous for coat color. What proportion of the resulting calf crop is expected to display the roan phenotype?

- **a.** 25 percent
- **b.** 50 percent
- **c.** 75 percent
- **d.** 100 percent

2. In poultry, comb shape is controlled by two interacting gene pairs. When two walnut-combed chickens heterozygous at both loci are mated together, what fraction of their chicks is expected to exhibit a single comb?

- **a.** 1 out of 16
- **b.** 3 out of 16
- **c.** 9 out of 16
- **d.** 1 out of 4

3. A hatchery manager crosses a barred Plymouth Rock hen with a non-barred Rhode Island Red rooster to enable autosexing at day one. How can the chicks be accurately separated by sex upon hatching?

- **a.** All female chicks show barred plumage while all male chicks are solid non-barred
- **b.** All male chicks show barred plumage while all female chicks are solid non-barred
- **c.** Half of each sex shows barred plumage regardless of parental cross direction
- **d.** Both male and female chicks hatch with barred plumage and separate only after molting

4. In Ayrshire cattle, mahogany-and-white coat color is dominant in males whereas red-and-white is dominant in females. If a heterozygous mahogany-and-white bull is mated to a homozygous red-and-white cow, what coat color will the heterozygous female calves express?

- **a.** Mahogany-and-white
- **b.** Roan spotted
- **c.** Red-and-white
- **d.** Solid black

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5. **In a large random-mating herd of Angus cattle, 4 percent of calves are born with the autosomal recessive red coat color. Assuming Hardy-Weinberg equilibrium, what percentage of the herd is expected to be heterozygous black carriers?**

- **a.** 16 percent
- **b.** 20 percent
- **c.** 32 percent
- **d.** 64 percent

6. **Analysis of weaning weight records in a commercial swine herd reveals an additive genetic variance of 18 kilograms squared and a total phenotypic variance of 60 kilograms squared. What is the narrow-sense heritability of weaning weight in this herd?**

- **a.** 0.18
- **b.** 0.30
- **c.** 0.42
- **d.** 0.60

7. **A dairy enterprise selects exclusively for higher milk volume over ten consecutive generations and observes a progressive decline in milk fat percentage and conception rate. Which genetic phenomenon primarily explains this unfavorable correlated change?**

- **a.** Positive maternal heterosis across lactation cycles
- **b.** Negative genetic correlation caused largely by pleiotropy
- **c.** Random genetic drift eliminating lethal recessive alleles
- **d.** Complete dominance of fertility genes over lactation genes

8. **Litter size in swine typically exhibits a heritability below 0.15, whereas backfat thickness exceeds 0.45. What practical implication does this contrast hold for a farm manager aiming to increase piglets born alive?**

- **a.** Mass selection of gilts from large litters will produce rapid single-generation gains
- **b.** Improving nutrition, farrowing hygiene, and breeding management will deliver faster immediate progress
- **c.** Inbreeding the highest-producing sow line will permanently fix superior litter size
- **d.** Eliminating environmental variation will lower the heritability of backfat thickness

9. **When a male donkey with 62 chromosomes is mated to a female horse with 64 chromosomes, the resulting mule is vigorous but almost always sterile. What cytogenetic factor accounts for this sterility?**

- **a.** Absence of functional gonadotropin receptors in the anterior pituitary
- **b.** Failure of homologous chromosomes to pair normally during meiosis due to an odd diploid number of 63
- **c.** Complete degeneration of the seminiferous tubules caused by elevated scrotal temperature
- **d.** Premature luteolysis triggered by incompatible placental hormones

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10. How does genomic selection significantly increase the annual rate of genetic gain in dairy cattle compared with conventional progeny testing?

a. It eliminates the influence of environmental factors on milk yield

b. It allows accurate prediction of breeding values at birth using genome-wide single nucleotide polymorphism markers, drastically reducing generation interval

c. It induces targeted mutations in the casein gene cluster prior to embryo implantation

d. It doubles the heritability of reproductive traits in lactating cows

11. Why do crossbred piglets show marked heterosis for pre-weaning survival and growth rate while showing minimal heterosis for carcass leanness?

a. Carcass leanness is controlled mainly by additive gene action, whereas fitness and growth traits involve substantial non-additive dominance and epistasis

b. Carcass leanness is sex-linked on the Y chromosome and cannot benefit from maternal alleles

c. Pre-weaning survival has a heritability above 0.70, which amplifies hybrid vigor

d. Dominance variance affects only anatomical traits measured after slaughter

12. Two phenotypically normal carrier beef cattle previously produced a stillborn bulldog calf caused by an autosomal recessive lethal allele. If the same parents are mated again and produce a live, phenotypically normal calf, what is the probability that this surviving calf is a carrier?

a. 25 percent

b. 50 percent

c. 66.7 percent

d. 75 percent

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13. In evaluating pre-weaning growth of beef calves, why can a calf with average direct genetic merit for growth still achieve a heavy weaning weight?

a. Its dam possesses superior maternal genetic merit for milk yield and mothering ability

b. Pre-weaning weight is governed solely by non-nuclear mitochondrial mutations

c. Additive genetic variance is zero until after sexual maturity

d. Epistatic gene interactions suppress maternal nutrition prior to weaning

14. A Holstein cow produces 6,000 kilograms of milk in her first lactation in a herd averaging 5,000 kilograms. Given a repeatability of 0.50 for milk yield, what is her predicted milk production in the next lactation?

a. 5,250 kilograms

b. 5,500 kilograms

c. 5,750 kilograms

d. 6,000 kilograms

15. A commercial pig breeder applies DNA marker screening to cull prospective herd boars carrying the mutant ryanodine receptor allele. Which major meat quality problem is the breeder preventing?

- **a.** Dark, firm, and dry beef syndrome
- **b.** Pale, soft, and exudative pork linked to porcine stress syndrome
- **c.** Boar taint caused by elevated skatole deposition
- **d.** Excessive yellow fat pigmentation in finishing hogs

16. In a broiler breeding flock, the mean body weight at 35 days is 1,800 grams, the selected parent stock averages 2,200 grams, and heritability for body weight is 0.40. What is the expected genetic gain in the next generation?

- **a.** 80 grams
- **b.** 160 grams
- **c.** 240 grams
- **d.** 400 grams

17. A beef cattle improvement program maintains a selection differential of 20 kilograms for yearling weight, a heritability of 0.40, and an average generation interval of 5 years. What is the expected annual rate of genetic progress?

- **a.** 0.8 kilograms per year
- **b.** 1.6 kilograms per year
- **c.** 4.0 kilograms per year
- **d.** 8.0 kilograms per year

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18. A swine nucleus farm aims to improve average daily gain, feed conversion ratio, and backfat thickness simultaneously while allowing outstanding superiority in one trait to offset minor deficiency in another. Which selection method will yield the highest aggregate economic gain?

- **a.** Tandem selection
- **b.** Independent culling levels
- **c.** Selection index method
- **d.** Phenotypic mass culling

19. A poultry breeder establishes minimum thresholds requiring every replacement hen to lay at least 260 eggs per year and achieve an average egg weight of at least 55 grams, automatically culling any bird failing either standard. Which selection method is being implemented?

- **a.** Tandem selection
- **b.** Independent culling levels
- **c.** Best linear unbiased prediction
- **d.** Recurrent reciprocal selection

20. Because dairy bulls do not express lactation traits directly, which traditional selection method provides the highest accuracy for ranking bulls on genetic merit for milk yield?

- **a.** Individual phenotypic selection based on body conformation
- **b.** Progeny testing using the lactation records of their daughters across multiple herds
- **c.** Tandem selection based on scrotal circumference
- **d.** Pedigree selection using only the paternal grandsire

21. A breeder wishes to select replacement boars for carcass marbling and loin eye area, traits that require slaughter for direct measurement. Which selection strategy allows accurate evaluation while keeping the breeding candidates alive?

- **a.** Individual mass selection after farrowing
- **b.** Sib testing based on carcass measurements of slaughtered full or half brothers and sisters
- **c.** Repeatability estimation across multiple seasons
- **d.** Outcrossing with unrelated native breeds

22. A full brother and full sister produced from unrelated, non-inbred parents are mated together in a closed experimental flock. What is the inbreeding coefficient of their offspring?

- **a.** 6.25 percent
- **b.** 12.5 percent
- **c.** 25.0 percent
- **d.** 50.0 percent

23. When a closed swine population undergoes intense inbreeding for five consecutive generations, which category of production traits typically suffers the most severe inbreeding depression?

- **a.** Adult skeletal height and ear length
- **b.** Carcass yield and loin eye area
- **c.** Fertility, litter size, and pre-weaning piglet survival
- **d.** Coat color uniformity and hair density

24. A purebred Brahman breeder repeatedly mates descendants back to a proven champion foundation bull while avoiding close brother-sister matings. What is the primary strategic goal of this mating system?

- **a.** To maximize individual heterosis in every calf crop
- **b.** To concentrate the genes of the outstanding ancestor while keeping inbreeding depression manageable
- **c.** To convert a native herd into a purebred herd within four generations
- **d.** To eliminate all additive genetic variance within one generation

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25. In Philippine commercial hog farms, crossbred Large White by Landrace gilts are routinely bred to purebred Duroc boars for market pig production. Why is this specific three-breed terminal cross preferred?

a. It utilizes the maternal heterosis and prolificacy of the white breeds together with the rapid growth and carcass merit of the Duroc terminal sire

b. It ensures that all market pigs can be retained as purebred replacement gilts

c. It prevents the expression of dominance gene action in finisher pigs

d. It lowers the generation interval by eliminating the need for boar selection

26. A smallholder farmer upgrades native Philippine carabaos by continuously mating each generation of female offspring to purebred Murrah buffalo bulls. What theoretical percentage of Murrah inheritance will the fourth-generation calves possess?

a. 75.00 percent

b. 87.50 percent

c. 93.75 percent

d. 96.88 percent

27. A commercial beef ranch adopts a two-breed rotational crossbreeding system alternating between Brahman and Hereford sires over many generations. Approximately what proportion of maximum possible heterosis is retained at equilibrium?

a. 33.3 percent

b. 50.0 percent

c. 66.7 percent

d. 85.7 percent

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28. Why does best linear unbiased prediction outperform simple phenotypic averages when comparing the genetic merit of dairy sires used across different regions and years?

a. It ignores pedigree relationships so each bull is judged independently

b. It simultaneously adjusts for fixed environmental effects such as herd and season while incorporating records from all relatives

c. It requires only a single lactation record per cow to reach 99 percent accuracy

d. It converts non-additive dominance variance into permanent additive gain

29. In a large beef cattle herd, only the top 5 percent of bulls are selected for breeding whereas the top 60 percent of heifers are retained as replacements. How does this difference influence herd genetic improvement?

a. Female selection contributes more genetic progress because cows produce more milk than bulls

b. Higher selection intensity among bulls makes sire selection the primary driver of herd genetic gain

c. Equal genetic contribution is forced because each calf inherits half its chromosomes from each parent

d. Selection intensity has no effect on genetic gain unless heritability exceeds 0.80

30. When establishing a breeding objective for pasture-based beef cattle in tropical smallholder systems, why should breeders avoid unlimited selection for larger mature cow size?

a. Larger cows always transmit recessive dwarfism alleles to their progeny

b. Higher maintenance energy requirements of oversized cows can impair rebreeding performance when forage is seasonally scarce

c. Mature cow weight has a heritability of zero under grazing conditions

d. Larger framed cows produce milk with lower lactose concentration

31. In a non-pregnant cow around days 16 to 18 of the estrous cycle, which hormone secreted by the uterine endometrium causes regression of the corpus luteum to allow a new cycle to begin?

a. Progesterone

b. Oxytocin

c. Prostaglandin F2 alpha

d. Relaxin

32. Which anterior pituitary hormone experiences a sharp pre-ovulatory surge triggered by high circulating estrogen, directly causing rupture of the mature Graafian follicle?

a. Prolactin

b. Luteinizing hormone

c. Adrenocorticotropic hormone

d. Follicle-stimulating hormone

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33. A dairy cow is first detected standing firmly to be mounted by herdmates at 6:00 AM. Following the standard morning-afternoon rule to maximize conception rate, when should she be artificially inseminated?

a. Immediately at 6:00 AM

b. Around 6:00 PM on the same day

c. Around 12:00 noon the following day

d. Around 6:00 PM the following day

34. How does the timing of ovulation in cattle differ from that of swine, sheep, and horses, necessitating careful scheduling of artificial insemination?

a. Cattle ovulate immediately before the onset of behavioral estrus

b. Cattle ovulate spontaneously only after copulation stimulates cervical nerve endings

c. Cattle ovulate approximately 10 to 14 hours after the end of standing estrus

d. Cattle ovulate at the exact midpoint of the luteal phase

35. A commercial sow is successfully bred on March 1. Based on the standard porcine gestation length of 114 days, around what date should the herdsman expect her to farrow?

a. June 15

b. June 23

c. July 1

d. July 14

36. A bilateral cryptorchid boar whose testes remain retained inside the abdominal cavity displays normal libido and mating behavior yet fails to impregnate sows. What physiological mechanism explains this condition?

a. Abdominal heat halts spermatogenesis in the seminiferous tubules while Leydig cells continue secreting testosterone

b. Retained testes produce excessive estrogen that blocks sperm motility in the epididymis

c. The vas deferens fails to connect with the urethra in cryptorchid males

d. Lack of scrotal descent prevents the anterior pituitary from secreting gonadotropins

37. Freshly ejaculated bull spermatozoa cannot penetrate an oocyte immediately upon entering the female reproductive tract until they undergo capacitation. What key change occurs during capacitation?

a. Duplication of the haploid chromosome set inside the sperm nucleus

b. Removal of surface glycoproteins and cholesterol from the sperm head membrane to permit the acrosome reaction

c. Loss of the sperm tail to facilitate passive transport through the oviduct

d. Fusion of mitochondria in the midpiece to halt progressive motility

38. During routine bovine artificial insemination using the rectovaginal technique, where should the technician deposit the thawed semen to achieve optimal fertilization rates?

a. In the anterior vagina just behind the external cervical os

b. In the middle of the cervical rings to mimic natural service

c. Inside the uterine body immediately past the anterior end of the cervix

d. Directly into the ovarian bursa via transrectal puncture

39. Why is glycerol routinely incorporated into bull semen extenders before cryopreservation in liquid nitrogen at minus 196 degrees Celsius?

a. It supplies rapid fructose energy for sperm motility after thawing

b. It acts as a cryoprotectant that reduces lethal intracellular ice crystal formation during freezing

c. It inhibits bacterial growth during long-term storage in liquid nitrogen

d. It lowers the pH of the extender to trigger premature capacitation

40. **What essential protective function does egg yolk or soy lecithin perform in a semen extender as diluted semen is cooled from body temperature to 5 degrees Celsius?**

a. It buffers lactic acid produced by anaerobic glycolysis

b. It protects sperm plasma membranes against irreversible cold shock

c. It binds excess calcium ions to prevent sperm agglutination

d. It stimulates acrosomal enzyme release before insemination

41. **A rancher injects prostaglandin F2 alpha into a group of cycling beef cows to synchronize estrus, but several cows do not exhibit heat within five days. What is the most likely physiological explanation?**

a. Those cows were in days 1 to 5 of the estrous cycle when the newly forming corpus luteum is unresponsive to prostaglandin

b. Prostaglandin F2 alpha is effective only in heifers that have never calved

c. Those cows were in the mid-luteal phase when progesterone blocks prostaglandin receptors

d. Prostaglandin F2 alpha induces ovulation directly without causing behavioral estrus

42. **In a fixed-time artificial insemination protocol for dairy cows consisting of gonadotropin-releasing hormone on day 0, prostaglandin F2 alpha on day 7, and a second gonadotropin-releasing hormone injection on day 9, what is the role of the day 9 injection?**

a. To regress the mature corpus luteum rapidly

b. To synchronize the luteinizing hormone surge and tighten ovulation timing for timed insemination

c. To suppress follicular wave emergence for 14 days

d. To stimulate uterine contractions that transport semen into the oviduct

43. **To stimulate superovulation in an elite donor cow enrolled in an embryo transfer program, which hormone is typically administered in decreasing twice-daily doses over four days during the mid-luteal phase?**

a. Oxytocin

b. Follicle-stimulating hormone

c. Progesterone

d. Melatonin

44. **How does multiple ovulation and embryo transfer accelerate the rate of genetic improvement in a cattle population beyond what artificial insemination alone achieves?**

a. It increases selection intensity on the female pathway by allowing superior cows to produce many offspring per year

b. It eliminates the need to select superior sires for breeding

c. It doubles the heritability of milk yield in recipient cows

d. It prevents genetic recombination during meiosis in donor oocytes

45. A modern dairy farm breeds its genetically top heifers exclusively with X-bearing sexed semen while mating its lowest-merit cows to beef sires. How does this strategy improve both genetic progress and farm economics?

a. It generates replacement heifers exclusively from superior dams while producing higher-value crossbred beef calves from inferior dairy cows

b. It increases conception rates above those of conventional unsorted semen in older cows

c. It eliminates inbreeding entirely without tracking pedigrees

d. It shortens the gestation length of dairy heifers by three weeks

46. Why does transvaginal ovum pick-up paired with in vitro embryo production offer a distinct genetic advantage over conventional superovulation and uterine flushing in dairy cattle?

a. It requires no laboratory incubator or culture media

b. It allows repeated oocyte retrieval from prepubertal heifers and pregnant cows, further shortening the generation interval

c. It guarantees 100 percent pregnancy rates in recipient cows

d. It produces genetically identical clones without requiring fertilization by sperm

47. Around days 15 to 17 after breeding in a pregnant cow, what embryonic signal prevents luteolysis and maintains the corpus luteum of pregnancy?

a. Estradiol secreted by the trophoblast

b. Interferon tau secreted by the elongating conceptus

c. Prolactin secreted by the maternal anterior pituitary

d. Relaxin secreted by the maternal ovary

48. Why do nursing beef cows generally experience a longer postpartum anestrus interval than dairy cows whose calves are separated shortly after birth?

a. Beef breeds lack functional ovarian follicles for 90 days after calving

b. Frequent suckling stimuli suppress hypothalamic gonadotropin-releasing hormone pulses and delay luteinizing hormone release

c. Nursing causes permanent regression of the uterine endometrium

d. Colostrum production depletes all circulating progesterone precursors

49. Which primary endocrine trigger initiates the hormonal cascade leading to normal parturition in cattle and sheep?

a. A sharp surge in maternal progesterone secretion from the corpus luteum

b. Increased fetal cortisol secretion that shifts placental steroid synthesis from progesterone to estrogen

c. Abrupt cessation of maternal oxytocin release from the posterior pituitary

d. Elevated maternal melatonin secretion during the final week of gestation

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50. From a population genetics perspective, why does somatic cell nuclear transfer alone fail to advance the genetic ceiling of a livestock breed beyond existing elite individuals?

a. Cloned animals are always sterile and cannot pass genes to future generations

b. It duplicates an existing genotype identically without creating superior new allele combinations through sexual recombination

c. Nuclear transfer deletes additive genes responsible for milk and meat production

d. Cloned embryos cannot develop to term in surrogate recipients of the same breed

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Detailed Answer Key & Rationales (Items 1 to 50)

Complete solutions, genetic formulas, and physiological explanations for all 50 examination items.

1. b **50 percent**

Coat color in Shorthorn cattle exhibits codominance between the red allele (R) and white allele (W). Mating two heterozygous roan animals (RW × RW) produces a genotypic and phenotypic ratio of 1 RR (25% red) : 2 RW (50% roan) : 1 WW (25% white).

2. a **1 out of 16**

Poultry comb shape is governed by complementary gene interaction between two loci (R and P). Crossing two double heterozygotes (RrPp × RrPp) yields 9 R_P_ (walnut) : 3 R_pp (rose) : 3 rrP_ (pea) : 1 rrpp (single). Only the double homozygous recessive genotype (rrpp) produces a single comb, representing 1/16 of the progeny.

3. b **All male chicks show barred plumage while all female chicks are solid non-barred**

In birds, males are homogametic (ZZ) and females are heterogametic (ZW), and the barring gene (B) is Z-linked. Crossing a barred hen (Z^BW) with a non-barred rooster (Z^bZ^b) yields crisscross inheritance: all male chicks inherit Z^BZ^b (barred, showing a white head spot at hatch), whereas all female chicks inherit Z^bW (solid non-barred).

4. c **Red-and-white**

Ayrshire coat color is a classic sex-influenced trait where the mahogany allele (M) is dominant in males while the red allele (R) is dominant in females. Mating a heterozygous mahogany-and-white bull (MR) to a homozygous red-and-white cow (RR) yields 50% MR and 50% RR calves. Because R is dominant in females, both MR and RR female calves express the red-and-white phenotype.

5. c **32 percent**

Under Hardy-Weinberg equilibrium, the frequency of homozygous recessive red calves is $q^2 = 0.04$, so the recessive allele frequency is $q = \sqrt{0.04} = 0.20$, and the dominant black allele frequency is $p = 1 - 0.20 = 0.80$. The heterozygous carrier frequency is $2pq = 2(0.80)(0.20) = 0.32$, or 32 percent.

6. b **0.30**

Narrow-sense heritability (h^2) is the ratio of additive genetic variance (V_A) to total phenotypic variance (V_P). Substituting the herd values gives $h^2 = V_A / V_P = 18 / 60 = 0.30$.

7. b **Negative genetic correlation caused largely by pleiotropy**

When single-trait selection for milk volume causes a simultaneous decline in milk fat percentage and fertility, the traits share an unfavorable (negative) genetic correlation. This occurs primarily due to pleiotropy, where single genes influence multiple metabolic pathways and partition nutrients toward fluid milk synthesis at the expense of milk solids and reproductive energy balance.

8. b **Improving nutrition, farrowing hygiene, and breeding management will deliver faster immediate progress**

Because litter size has low heritability (below 0.15), over 85 percent of its observed variation stems from non-genetic environmental factors. Consequently, optimizing sow nutrition, farrowing supervision, sanitation, and mating timing yields far faster immediate improvement than relying solely on mass phenotypic selection.

9. b **Failure of homologous chromosomes to pair normally during meiosis due to an odd diploid number of 63**

A mule inherits 31 chromosomes from its sire (jack, 2n = 62) and 32 chromosomes from its dam (mare, 2n = 64), resulting in an odd diploid count of 2n = 63. During prophase I of meiosis, chromosomes lack exact homologous partners for proper synapsis, preventing viable gamete formation.

10. b **It allows accurate prediction of breeding values at birth using genome-wide single nucleotide polymorphism markers, drastically reducing generation interval**

Conventional progeny testing requires waiting 5 to 6 years until a bull's daughters complete lactations. Genomic selection evaluates DNA using high-density SNP panels immediately at birth, cutting the sire generation interval to roughly 2 years and roughly doubling annual genetic gain.

11. a **Carcass leanness is controlled mainly by additive gene action, whereas fitness and growth traits involve substantial non-additive dominance and epistasis**

Heterosis (hybrid vigor) arises from non-additive gene effects—specifically dominance and overdominance masking deleterious recessive alleles—which heavily govern survival, reproduction, and pre-weaning growth. Highly heritable carcass traits are controlled mostly by additive gene action and therefore show little heterosis.

12. c **66.7 percent**

Crossing two carriers (Aa × Aa) yields 1 AA : 2 Aa : 1 aa. Because the homozygous recessive (aa) bulldog calf is stillborn and excluded, the surviving phenotypically normal pool consists of 1 AA and 2 Aa calves. Thus, 2 out of 3 (66.7 percent) of the live normal calves are heterozygous carriers.

13. a **Its dam possesses superior maternal genetic merit for milk yield and mothering ability**

Pre-weaning calf growth depends on two distinct genetic components: the calf's own direct genetic merit for growth and the dam's maternal genetic merit, which creates the pre-weaning nutritional environment through milk production and maternal care.

14. b **5,500 kilograms**

Most Probable Producing Ability (MPPA) predicts future performance using the formula: MPPA = Herd Mean + [nR / (1 + (n − 1)R)] × (Cow Average − Herd Mean). For n = 1 lactation and R = 0.50: MPPA = 5,000 + 0.50 × (6,000 − 5,000) = 5,000 + 500 = 5,500 kilograms.

15. b **Pale, soft, and exudative pork linked to porcine stress syndrome**

A point mutation in the porcine ryanodine receptor gene (RYR1, also called the halothane gene) causes abnormal calcium release in skeletal muscle under stress, leading to porcine stress syndrome (PSS) and rapid post-mortem glycolysis that produces pale, soft, and exudative (PSE) pork.

16. b **160 grams**

Expected genetic gain per generation (R) equals heritability (h^2) multiplied by the selection differential (S). Here, S = 2,200 − 1,800 = 400 grams, so R = 0.40 × 400 = 160 grams.

17. b **1.6 kilograms per year**

Annual genetic progress (ΔG/year) is calculated as (h^2 × S) / L, where L is the generation interval. Substituting the figures gives (0.40 × 20 kg) / 5 years = 8.0 / 5 = 1.6 kilograms per year.

18. c **Selection index method**

The selection index combines multiple traits into a single net merit score weighted by economic value, heritability, and genetic correlations. Unlike independent culling levels, it permits high superiority in one trait to compensate for slight weakness in another, maximizing total economic progress.

19. b **Independent culling levels**

Independent culling levels establish strict minimum performance standards for each trait simultaneously; any animal falling below the threshold for even a single trait is culled regardless of excellence in other traits.

20. b **Progeny testing using the lactation records of their daughters across multiple herds**

For sex-limited traits such as milk production, a bull's breeding value cannot be measured directly on his own phenotype. Evaluating large numbers of daughters across diverse herds provides the highest selection accuracy in traditional breeding programs.

21. b **Sib testing based on carcass measurements of slaughtered full or half brothers and sisters**

Carcass composition traits require slaughter and cannot be measured directly on live breeding candidates. Sib testing evaluates the slaughtered full-sibs or half-sibs of prospective boars to estimate their breeding values without sacrificing the candidate animals.

22. c **25.0 percent**

Full siblings share two common non-inbred grandparents (each contributing a path of $n_1 + n_2 + 1 = 1 + 1 + 1 = 3$). The inbreeding coefficient is $F = (1/2)^3 + (1/2)^3 = 0.125 + 0.125 = 0.25$, or 25.0 percent.

23. c **Fertility, litter size, and pre-weaning piglet survival**

Inbreeding increases homozygosity and exposes harmful recessive alleles. Low-heritability fitness and reproductive traits—such as conception rate, litter size, and neonatal survival—suffer the greatest inbreeding depression, whereas structural and carcass traits are minimally affected.

24. b **To concentrate the genes of the outstanding ancestor while keeping inbreeding depression manageable**

Linebreeding is a mild, deliberate form of inbreeding designed to maintain a high genetic relationship to an exceptional ancestor while avoiding intense close matings (such as parent-offspring or full-sib) that cause severe inbreeding depression.

25. a **It utilizes the maternal heterosis and prolificacy of the white breeds together with the rapid growth and carcass merit of the Duroc terminal sire**

In a three-breed terminal cross, F1 Large White × Landrace sows express 100 percent maternal heterosis for litter size and milk yield, while the Duroc terminal sire contributes superior post-weaning growth rate, feed efficiency, and intramuscular marbling to market hogs.

26. c **93.75 percent**

Grading up increases purebred inheritance according to the formula $1 - (1/2)^n$, where n is the generation number: G1 = 50%, G2 = 75%, G3 = 87.5%, and G4 = $1 - (1/2)^4$ = 15/16 = 93.75 percent.

27. c **66.7 percent**

In rotational crossbreeding, retained heterosis at equilibrium equals $(2^k - 2) / (2^k - 1)$, where k is the number of breeds. For a two-breed rotation (k = 2): $(4 - 2) / (4 - 1) = 2/3$, or 66.7 percent of maximum F1 heterosis.

28. b **It simultaneously adjusts for fixed environmental effects such as herd and season while incorporating records from all relatives**

Best Linear Unbiased Prediction (BLUP) uses mixed-model equations and the numerator relationship matrix to separate true genetic merit (Estimated Breeding Value) from systematic environmental differences across herds, years, and seasons.

29. b **Higher selection intensity among bulls makes sire selection the primary driver of herd genetic gain**

Because each bull sires many calves whereas each cow produces only one calf per year, breeders can apply far stricter culling on males (top 5%) than females (top 60%). Higher selection intensity gives the sire pathway the largest share of genetic improvement.

30. b **Higher maintenance energy requirements of oversized cows can impair rebreeding performance when forage is seasonally scarce**

Basal metabolic maintenance requirements scale with body weight. In tropical pasture systems with dry-season feed shortages, excessively large cows suffer negative energy balance, delayed postpartum estrus, and lower calving rates.

31. c **Prostaglandin F2 alpha**

In the absence of a viable conceptus, the non-pregnant bovine endometrium secretes pulses of prostaglandin F2 alpha (PGF2α) around days 16 to 18, inducing luteolysis of the corpus luteum and allowing a new follicular wave to ovulate.

32. b **Luteinizing hormone**

Rising estradiol from the dominant pre-ovulatory follicle triggers a positive-feedback surge of gonadotropin-releasing hormone (GnRH) and luteinizing hormone (LH), which initiates enzymatic breakdown of the follicular wall and ovulation.

33. b **Around 6:00 PM on the same day**

Under the standard AM-PM breeding rule in cattle, cows first observed in standing estrus in the morning (6:00 AM) are inseminated that same afternoon or evening (around 6:00 PM) so capacitated sperm reach the oviduct just prior to ovulation.

34. c **Cattle ovulate approximately 10 to 14 hours after the end of standing estrus**

Unlike mares, ewes, and sows—which ovulate prior to the end of behavioral heat—cattle are unique among farm livestock in ovulating roughly 10 to 14 hours after standing estrus has ended (about 24 to 30 hours after estrus onset).

35. b **June 23**

Swine gestation averages 114 days (3 months, 3 weeks, and 3 days). Counting 114 days from March 1: 30 remaining days in March + 30 days in April (60) + 31 days in May (91) + 23 days in June = 114 days, placing expected farrowing on June 23.

36. a **Abdominal heat halts spermatogenesis in the seminiferous tubules while Leydig cells continue secreting testosterone**

Normal spermatogenesis requires a testicular temperature 2 to 5 degrees Celsius cooler than core body temperature. Elevated abdominal heat destroys developing germ cells, causing sterility, while interstitial Leydig cells remain functional and secrete testosterone that maintains normal libido.

37. b **Removal of surface glycoproteins and cholesterol from the sperm head membrane to permit the acrosome reaction**

Capacitation is a physiological maturation process in the female tract during which seminal plasma coating proteins and membrane cholesterol are stripped from the sperm head, destabilizing the plasma membrane so the acrosome reaction can occur upon binding the zona pellucida.

38. c **Inside the uterine body immediately past the anterior end of the cervix**

In bovine rectovaginal artificial insemination, the insemination gun is guided through the cervical rings and thawed semen is deposited directly into the short uterine body just anterior to the internal cervical os, ensuring equal distribution into both uterine horns.

39. b **It acts as a cryoprotectant that reduces lethal intracellular ice crystal formation during freezing**

Glycerol is a penetrating cryoprotectant that enters sperm cells, lowers the freezing point of intracellular water, and prevents sharp ice crystals from rupturing cell membranes during cryopreservation at minus 196 degrees Celsius.

40. b **It protects sperm plasma membranes against irreversible cold shock**

Phospholipids and low-density lipoproteins in egg yolk or soy lecithin coat and stabilize the sperm plasma membrane as semen is cooled from 37 degrees Celsius to 5 degrees Celsius, preventing cold-shock membrane phase transitions and loss of motility.

41. a **Those cows were in days 1 to 5 of the estrous cycle when the newly forming corpus luteum is unresponsive to prostaglandin**

During metestrus and early diestrus (days 1 to 5 post-ovulation), the developing corpus hemorrhagicum/early corpus luteum lacks sufficient PGF2α receptors and does not regress following a single prostaglandin injection.

42. b **To synchronize the luteinizing hormone surge and tighten ovulation timing for timed insemination**

In the Ovsynch protocol, Day 0 GnRH initiates a new follicular wave, Day 7 PGF2α regresses the corpus luteum, and Day 9 GnRH induces a synchronized pre-ovulatory LH surge so all cows ovulate within a narrow window for fixed-time AI 16 to 20 hours later.

43. b **Follicle-stimulating hormone**

Follicle-stimulating hormone (FSH) rescues subordinate ovarian follicles from atresia so multiple follicles mature simultaneously. Because purified FSH has a short biological half-life, it is injected twice daily in tapering doses over four days.

44. a **It increases selection intensity on the female pathway by allowing superior cows to produce many offspring per year**

Normally a cow produces only one calf per year, severely limiting female selection intensity. Multiple ovulation and embryo transfer (MOET) enables genetically elite donor cows to produce 15 to 30 or more calves annually via recipient surrogates.

45. a **It generates replacement heifers exclusively from superior dams while producing higher-value crossbred beef calves from inferior dairy cows**

Targeting X-sorted dairy semen to top heifers concentrates replacement breeding in the highest-merit females, while breeding lower-merit cows to beef sires prevents inferior genetics from entering the milking herd and yields higher-value beef-cross calves.

46. b **It allows repeated oocyte retrieval from prepubertal heifers and pregnant cows, further shortening the generation interval**

Unlike conventional superovulation and uterine flushing—which require cycling, non-pregnant females—ultrasound-guided ovum pick-up (OPU) harvests immature oocytes from young heifers before puberty and during early pregnancy, dramatically reducing the maternal generation interval.

47. b **Interferon tau secreted by the elongating conceptus**

In ruminants, maternal recognition of pregnancy occurs around days 15 to 17 when mononuclear trophectoderm cells of the elongating conceptus secrete interferon tau (IFN-τ), which downregulates endometrial oxytocin receptors and blocks luteolytic PGF2α pulses.

48. b **Frequent suckling stimuli suppress hypothalamic gonadotropin-releasing hormone pulses and delay luteinizing hormone release**

Suckling and maternal-offspring bonding stimulate endogenous opioid pathways in the hypothalamus that inhibit pulsatile GnRH secretion, suppressing the LH pulse frequency required for dominant follicles to complete final maturation and ovulate.

49. b **Increased fetal cortisol secretion that shifts placental steroid synthesis from progesterone to estrogen**

Maturation of the fetal hypothalamic-pituitary-adrenal axis triggers a sharp rise in fetal cortisol, activating placental 17α-hydroxylase to convert progesterone into estradiol, which stimulates myometrial oxytocin receptors and uterine PGF2α release to initiate labor.

50. b **It duplicates an existing genotype identically without creating superior new allele combinations through sexual recombination**

Somatic cell nuclear transfer produces an asexual genetic copy of an existing donor animal. Because no meiosis, segregation, or recombination occurs, cloning multiplies elite genotypes but cannot generate new, higher-merit allele combinations to push the breed's genetic ceiling upward.

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