

UNIVERSITY OF MARYLAND
COLLEGE OF AGRICULTURE AND NATURAL RESOURCES
ANSC327/627 (Molecular and Quantitative Animal Genetics), Spring 2007
Final Examination (Siewerdt)
College Park, May 12, 2007

Code of Academic Integrity: *"I pledge on my honor that I have not given or received any unauthorized assistance on this examination."*

Last name:

Signature:

Date:

There are seven multiple-choice questions in this portion of the exam. Each one is worth 5 points. Multiple choice questions have only one correct alternative, except for question 3 that has TWO correct answers. You will also find four additional open questions that are worth 10 points each. Formulas that may be useful for solving some questions are found at the end of the last page. Good luck!

Question 1. Consider a diploid organism, like all farm animals. In a particular locus there are four polymorphisms (alleles): D1, D2, D3 and D4. How many possible genotypes are there for this locus? How many of those are heterozygotes?

- 12 genotypes and 4 heterozygotes.
- 8 genotypes and 4 heterozygotes.
- 16 genotypes and 8 heterozygotes.
- 10 genotypes and 6 heterozygotes.
- None of the above are correct.

Question 2. Hardy-Weinberg equilibrium is a theoretical dynamic state of a population in which allelic and genotypic frequencies remain constant generation after generation. All assumptions below must be true for a population to be in Hardy-Weinberg equilibrium, **EXCEPT** for:

- Matings occur at random.
- No mutations occur.
- The population size must be "large", in order to avoid loss of alleles by drift.
- No dominance effects are present.
- There is neither migration nor selection.

Question 3. Which **TWO** populations below are in Hardy-Weinberg equilibrium?

- $f(GG) = 0.10$; $f(Gg) = 0.70$; $f(gg) = 0.20$.
- $f(GG) = 0.16$; $f(Gg) = 0.16$; $f(gg) = 0.68$.
- $f(GG) = 0.36$; $f(Gg) = 0.48$; $f(gg) = 0.16$.
- $f(GG) = 0.81$; $f(Gg) = 0.18$; $f(gg) = 0.01$.
- $f(GG) = 0.00$; $f(Gg) = 1.00$; $f(gg) = 0.00$.

Question 4. DNA samples were collected in a large sample of female Duroc pigs and genotypes for a particular locus were obtained. At 150 days of age, the following phenotypic measures were observed for backfat thickness in each of the three genotypes: T_1T_1 (32mm), T_1T_2 (27mm), and T_2T_2 (22mm). These same group of females later produced their first litters with average sizes of 9.2 piglets (T_1T_1), 11.7 piglets (T_1T_2) and 10.3 piglets (T_2T_2). The types of gene action observed for backfat thickness and litter size are, respectively,

- Additivity and overdominance.
- Additivity and incomplete dominance.
- Complete dominance and overdominance
- Complete dominance and incomplete dominance.
- Incomplete dominance and epistasis.

Question 5. What is the coancestry coefficient between two full-sibs (L and M), assuming that the parents are not related and are non-inbred?

- $f_{LM} = 0.0625$.
- $f_{LM} = 0.125$.
- $f_{LM} = 0.25$.
- $f_{LM} = 0.50$.
- $f_{LM} = 0.75$.

Question 6. If the repeatability of a trait is 0.40, this means that:

- 40% of the total phenotypic variance is explained by the genotypic variance.
- The heritability of that trait is, at most, $h^2 = 0.40$.
- Collecting a second record on each animal will improve accuracy of genetic evaluation by 40%.
- Genetic progress due to selection will equal 40% of the selection differential.
- None of the above are correct.

Question 7. If you mate an Ayrshire bull to a $\frac{1}{2}$ Ayrshire $\frac{1}{2}$ Holstein cow, the progeny expresses:

- 50% individual heterosis and 100% maternal heterosis.
- 50% individual heterosis, but no maternal heterosis.
- 100% individual heterosis and 100% paternal heterosis.
- 100% individual heterosis and 100% maternal heterosis.
- None of the above are correct

Question 8. Consider the following statement: “The bases for genetic improvement of livestock populations are the accumulation of copies of favorable alleles and the optimal combination of these alleles.” Discuss this statement; explain the underlying principles and practical ways to achieve these goals. Include contents covered in any of the lectures. You need not limit the contents to the quantitative genetics portion of the course.

Question 9. You are trying to improve the number of eggs laid from sexual maturity to 64 weeks old. Data on egg production is collected on 60 families of 25 full-sib females each. The heritability in this population was estimated to be $h^2 = 0.18$. The population mean production was 227 eggs. You select the top 15% laying females (average of 267 eggs). No selection is done on the males.

- (a) What is the selection differential that was obtained?
- (b) What is the predicted genetic progress for number of eggs after one generation of selection?
- (c) Say that you repeat this selection scheme for 5 consecutive generations. If the heritability remains constant, what will be the average number of eggs laid by hens in this population?

Question 10. Why is it important to have a low generation interval in a selection program? Give an example.

Question 11. Explain in your own words what is epistasis. What is the genetic basis of epistasis?

Formulae

$$P = G + E + GE$$

$$p = P + \frac{1}{2}H$$

$$q = Q + \frac{1}{2}H$$

$$P + H + Q = 1$$

Under Hardy – Weinberg :

$$p = f(A); q = f(a), \text{ and}$$

$$f(AA) = p^2; f(Aa) = 2pq; f(aa) = q^2.$$

$$f_{XY} = P(a_i \equiv b_j)$$

$$F_X = \sum \left(\frac{1}{2}\right)^n (1 + F_A)$$

$$MPP = \mu + \frac{nR}{1 + (n-1)R} d$$

$$\Delta G = h^2 S$$

$$\Delta G_a = \frac{r_{AC} i \sigma_A}{I}$$

$$P = G + E_p + E_t$$

$$\sigma_P^2 = (\sigma_G^2 + \sigma_{Ep}^2) + \sigma_{Et}^2$$

$$\hat{h}^2 = \frac{\sigma_A^2}{\sigma_P^2}$$

$$\hat{R} = \frac{\sigma_G^2 + \sigma_{Ep}^2}{\sigma_P^2}$$

$$F_X = f_{AB}$$

$$f_{XX} = \frac{1}{2}(1 + F_X)$$

$$f_{XY} = \frac{1}{4}(f_{AC} + f_{AD} + f_{BC} + f_{BD})$$

$$f_{XY} = \frac{1}{2}(f_{XC} + f_{XD})$$

$$H = \bar{x}_{CROSSBRED} - \frac{1}{2}(\bar{x}_{Breed1} + \bar{x}_{Breed2})$$

$$H\% = \frac{100 \times H}{\frac{1}{2}(\bar{x}_{Breed1} + \bar{x}_{Breed2})}$$