Tentamentsskrivning i **TMS105: Population genetics, 4p.**

Tid: Fredagen den 9 mars 2001 kl 8.45-12.45.
Lärare och Jour: Serik Sagitov, tel. 772-5351, rum MC 1420.
Hjälpmedel: Räknedosa utan manualer och med tömda minnen, egen formelsamlingen fyra A4 sidor, utdelade tabeller

Grading system (preliminary):	points	0-11	12-16	17-21	22-30
	grade	U	3	4	5

1.(4 points) The frequency of newborn individuals homozygous for a lethal gene in a random mating population is 1/10000.

a. If the population is in equilibrium between mutation and directional selection, calculate the mutation rate. Selection is such that the lethal gene is fully recessive.

b. Ignoring mutation, and assuming that the gene is maintained by overdominance, what are the relative fitnesses of the heterozygote and the 'wild-type' homozygote?

2.(3 points) Albinism occurs with a frequency of about 1 in 20000 in European populations. Assuming it to be due to a single autosomal recessive gene, and assuming the population to be in Hardy-Weinberg equilibrium, what proportion of peoples are carriers? Only an approximate answer is needed.

3.(4 points) Three allelic variants, A, B, and C, of the red cell acid phosphatase enzyme were found in a sample of 178 English people. All genotypes were distinguishable by electrophoresis, and the frequencies in the sample were

Genotype	AA	AB	BB	AC	BC	CC
Frequency (%)	9.6	48.3	34.3	2.8	5.0	0.0
Enzyme activity	122	154	188	184	212	-

a. What are the gene frequencies in the sample?

b. Why were no CC individuals found?

c. What is the mean enzyme activity in this population?

4.(4 points) A stock of mice consisted of 18 lines all derived from the same base population but bred separately thereafter. The stock was polymorphic for an autosomal enzyme locus, $Got-1$, with two alleles, a and b. After 27 generations mice from all the lines were typed by electrophoresis for the genotypes at this locus and the following numbers were found.

aa	ab	bb	Total
42	76	448	566

a. What is the inbreeding coefficient indicated by these numbers?

b. Explain the meaning of the obtained inbreeding coefficient in terms of the fixation index.

c. What does Wahlund's principle say in this case?

5.(3 points) What is the coancestry of the children of a pair of identical twins married to unrelated individuals?

6.(4 points) Suppose that an isolated natural population goes through a regular 5-year cycle of numbers, with the numbers of breeding pairs in successive generations beeing 500, 50, 100, 200, 400.

a. What is the effective population size?

b. In the absense of mutation the heterozygosity of the finite size population decreases to zero due to the random genetic drift. In how many generations will the expected heterozygosity be 5% of the initial value if in the above mentioned population mating is random.

7.(4 points) Consider a locus, overdominant with respect to a metric character, such that

Genotype	A_1A_1	A_1A_2	A_2A_2
phenotypic value	110	150	90

a. What gene frequency would give a random mating population its maximum mean value, and what would the mean be?

b. Find the breeding values and dominance deviations of the three genotypes when the A_1 allele frequency equals either 0.2, or 0.4, or 0.6.

c. Compute the additive genetic variance and the dominance variance for these three allele frequencies. Compair the obtained variances and explain the relation between the variances and the allele frequencies.

8.(4 points) Individuals in a population of *Drosophila melanogaster* have, on average, 114.3 bristles on their abdomen and the heritability of bristle number is 0.384.

a. What is the expected mean bristle number after one generation of selection when the selection differential is 4 bristles?

b. What is the expected number after 10 generations of equally intense selection?

Partial answers and solutions are also welcome. Good luck!

Numerical answers.

1a. μ=0.0001
1b. w_{AA}=0.99, w_{Aa}=1, w_{aa}=0

2. 1.4%

3a. p_A=0.35, p_A=0.35, p_C=0.04
3b. The pop. is close to HWE and p_{CC}=0.0016. Given n=178,
P(no CC-individuals in the sample)=$(0.9984)^{178}$=0.75
3c. 166.3

4a. F=0.45

5. F_{XY}=1/8

6a. N_e=253
6b. Since $H = 2pq(1-F)$ and $1 - F_t = (1 - \frac{1}{2N_e})^t(1 - F_0)$ we have to solve the equation $0.05 = (1 - \frac{1}{2N_e})^t$. It gives $t = 1514$.

7a. A_1: p=0.6, A_2: q=0.4; μ=126.
7b.

p	0.2	0.4	0.6
μ	110	122	126
α	40	20	0

p=0.2	A_1A_1	A_1A_2	A_2A_2
A	64	24	–16
D	–64	16	–4

p=0.4	A_1A_1	A_1A_2	A_2A_2
A	24	4	–16
D	–36	24	–16

p=0.6	A_1A_1	A_1A_2	A_2A_2
A	0	0	0
D	–16	24	–36

7c. As the allele frequency approaches its equilibrium the σ_a^2 decreases to zero. Even the σ_d^2 is large the allele frequency can not be changed by selection (fundamental theorem of natural selection).

p	0.2	0.4	0.6
σ_a^2	512	192	0
σ_d^2	256	576	576

8a. 115.8
8b. 129.7