

## MS Module 22 chisq test phenotype equilibrium practice exam questions

(The attached PDF file has better formatting.)

[The practice problems in the 24 modules explain the statistical procedures; the practice exam questions in this thread shows what you will be asked on the final exam.]

The groups of phenotypes, R, S, and T, are in equilibrium if for some  $\theta$ :

- !  $P(R) = p_1 = \theta^2$
- !  $P(S) = p_2 = 2\theta(1-\theta)$
- !  $P(T) = p_3 = (1-\theta)^2$

A sample from a population has the following number of observations in each group:

- ! Group R:  $n_1 = 101$
- ! Group S:  $n_2 = 261$
- ! Group T:  $n_3 = 138$

The null hypothesis  $H_0$  is that the population is in equilibrium for some parameter  $\theta$ .

Question 22.1: Maximum likelihood estimate for  $\theta$

What is the maximum likelihood estimate for  $\theta$ ?

Answer 22.1:  $(2 \times 101 + 261) / (2 \times (101 + 261 + 138)) = 0.463$

(formula derived by maximizing the loglikelihood is  $\theta = (2n_1 + n_2) / 2(n_1 + n_2 + n_3)$ )

total count =  $N = 101 + 261 + 138 = 500$

- !  $n_1 = N \times p_1 = N \times \theta^2 = 500 \times 0.463^2 = 107.1845$
- !  $n_2 = N \times p_2 = N \times 2\theta(1-\theta) = 500 \times 2 \times 0.463 \times (1 - 0.463) = 248.6310$
- !  $n_3 = N \times p_3 = N \times (1-\theta)^2 = 500 \times (1 - 0.463)^2 = 144.1845$

Question 22.2:  $\chi^2$  statistic

What is the  $\chi^2$  statistic to test the null hypothesis that the population is in equilibrium?

Answer 22.2:  $\sum (\text{observed} - \text{expected})^2 / \text{expected} =$

$(101 - 107.1845)^2 / 107.1845 + (261 - 248.6310)^2 / 248.6310 + (138 - 144.1845)^2 / 144.1845 = 1.237$