

1. Consider an autosomal marker with alleles a_1, a_2, \dots, a_k at frequencies p_1, p_2, \dots, p_k , and a pair of non-inbred individuals. Let IBD = the number of alleles they share identical by descent and IBS = the number of alleles they share identical by (or in) state. Calculate, under Hardy-Weinberg equilibrium, $\Pr(\text{IBS} = i | \text{IBD} = j)$ for $i, j = 0, 1, 2$.
2. Calculate the IBD distribution (at the disease gene) for a *discordant* sib pair (one affected, one not affected) in the case of a single, fully penetrant, recessive disease gene (i.e., penetrances $f_0 = f_1 = 0, f_2 = 1$), when the disease allele frequency is $p = 0.05$, assuming random mating and Hardy-Weinberg equilibrium.
3. Calculate the IBD distribution for the pair as in (1) at a marker which is a recombination fraction 5% away from the disease gene.