1. Calculate the inbreeding coefficient for individual A in the following pedigree.

2. Consider an autosomal marker with alleles \( a_1, a_2, \ldots, a_k \) at frequencies \( p_1, p_2, \ldots, p_k \), and consider a pair of non-inbred individuals. Let \( X_1, X_2 \) = the numbers of \( a_1 \) alleles that the two individuals have, respectively. (\( X_i = 0, 1 \) or 2.) Show that, under Hardy-Weinberg equilibrium,

\[
\text{var}(X_i) = 2p_1(1 - p_1) \\
\text{cov}(X_1, X_2) = 4\Phi p_1(1 - p_1) \\
\text{corr}(X_1, X_2) = 2\Phi
\]

where \( \Phi \) is the kinship coefficient for the pair.

3. Again consider an autosomal marker with alleles \( a_1, a_2, \ldots, a_k \) at frequencies \( p_1, p_2, \ldots, p_k \), 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, \( \Pr(IBS = i | IBD = j) \) for \( i, j = 0, 1, 2 \).