1. (13 points) In the 1950s, bacteriologists ran artificial populations of bacteria ("chemostats") and found a strange phenomenon. They were following genotypes at a locus in haploid strains without recombination, so they could see the changes in the frequencies of two alleles, A and a. These would not change much and then suddenly, the frequency of one of them (say A) would zoom up to 1. This they called "periodic selection". The explanation seemed to be that a favorable mutation occurred at another locus (let's call it B) in the A haplotype, and as it rapidly spread, it dragged A rapidly toward fixation (frequency 1).

Use the equations for change of haploid gene frequencies to model this. Start from a state where 0.5 of the haplotypes are ab, 0.499 of them are Ab, and 0.001 are AB. The fitnesses of B and b are respectively 1 : 2 : 1, and there are no fitness differences at the A locus. There are no aB haplotypes. Note that there is not any recombination between these loci (and do not have to compute linkage disequilibrium). The population is effectively infinite.

(a) Among the b haplotypes, what is the frequency of A (the fraction of b haplotypes that also have A)?

(b) How will that conditional frequency change in this scenario?

(c) What will the frequency of B in the whole population be after 20, 40, 60, and 80 generations? (Hint: This can be done using only one-locus selection equations – using ratios of \( p/(1 - p) \) and taking logarithms will help greatly). Please give me answers accurate to at least 4 places after the decimal.

(d) What will the frequency of A in the whole population be in those generations?

2. (12 points) Suppose that we have a sex-linked locus in an X/Y sex determination system (like ours), with a recessive lethal allele a that dies after birth. The a individuals among males also die after birth. Suppose that the gene frequency of a among adult females is q.

(a) What will the genotype frequencies among female offspring be at their birth?

(b) Is this Hardy-Weinberg proportions? Why or why not?

(c) What will the gene frequency be among these female offspring at their birth?

(d) Do we have to keep track also of the gene frequency of a among males?

(e) What fraction of the selection that changes the frequency of a occurs in females?