POPULATION GENETICS ANSWERS

Natural selection

Problem 4

A1A1	A1A2	A2A2	s	h	Favored allele
1	1	0.75	0.25	0	A1
1	0.6	0.6	0.4	1	A2
0.4	0.8	1	0.6	0.33	A2
0.8	1	0.55	$s_1 = 0.2$ $s_2 = 0.45$	Not applicable	A1 and A2

Problem 5

Relative fitness values: $w_{TT} = 1$, $w_{Tt} = 0.8717$, $w_{tt} = 0.1585$

Initial generation
Allele frequencies in newborns: Freq(T) = p = 0.7667, Freq(t) = q = 0.2333
Allele frequencies in adults: Freq(T) = p = 0.8214, Freq(t) = q = 0.1786

Next generation
Genotype frequencies in newborns:
Freq(TT) = 0.6747
Freq(Tt) = 0.2934
Freq(tt) = 0.0319

Genotype frequencies in adults:
Freq(TT) = 0.7213
Freq(Tt) = 0.2733
Freq(tt) = 0.0054

Problem 6

	w		p		Equilibrium		
Situation	**Population 1**	**Population 2**	**Population 1**	**Population 2**	**p**	**q**	**Faster**
Favored dominant allele	Same in both		p = 0.8	p = 0.1	1	0	Population 1
Favored dominant allele	$w_{aa} = 0.8$	$w_{aa} = 0.2$	Same in both		1	0	Population 2
Favored recessive allele	Same in both		p = 0.8	p = 0.2	0	1	Population 2
Favored recessive allele	$w_{AA} = 0.7$	$w_{AA} = 0.2$	Same in both		0	1	Population 2

Problem 7

Fitness values: $w_{A1A1} = 1$, $w_{A1A2} = 0.6$, $w_{A2A2} = 0.2$

Allele frequencies in next generation
Zygotes: Freq(A1) = p = 0.4, Freq(A2) = q = 0.6
Adults: Freq(A1) = p = 0.5846, Freq(A2) = q = 0.4154

Problem 8

Type of selection
Without warfarin: Directional selection favoring allele S
With warfarin: Heterozygote superiority

Allele frequencies in next generation adults
Without warfarin: Freq(S) = p = 0.8435, Freq(R) = q = 0.1565
With warfarin: Freq(S) = p = 0.7730, Freq(R) = q = 0.2270

Allele frequencies at equilibrium
Without warfarin: Freq(S) = p = 1, Freq(R) = q = 0
With warfarin: Freq(S) = p = 0.6632, Freq(R) = q = 0.3368

Problem 9

Current situation
Freq(PKU) = q_{eq} = 0.00447
Proportion of affected individuals at equilibrium = 0.00002 (1/50,000 individuals)

Increased fitness of affected individuals
Freq(PKU) = q_{eq} = 0.00707
Proportion of affected individuals at equilibrium = 0.00005 (1/20,000 individuals)

The frequency of PKU-causing alleles increases in the population when the fitness of the affected individuals increases because fewer alleles are being eliminated from the population by natural selection and mutation rate is still the same.

Problem 10

Totally recessive	μ = 0.0003
Partially dominant	μ = 0.003464

Natural selection is more efficient eliminating mutations that are partially dominant compared to recessive mutations, so a higher mutation rate is needed to maintain the observed frequency of blind mice in the situation where the disease is partially dominant (heterozygotes have lower fitness than homozygotes for the wild-type allele). The mutation rate is higher because more mutant alleles need to be created to compensate that a higher proportion are being eliminated by selection.