1. The first graph shows how natural selection selected differentially among the different genotypes in terms of survival to adulthood. This graph emphasizes that natural selection can work *within* a generation of individuals, changing the genotype frequencies of the population. However, for evolution to take place, we need to consider how allele frequencies change *across* generations as a result of natural selection. The second graph gives an indication of which genotypes have the greatest impact on the next generation’s gene pool, relative to other genotypes. $W$ is the absolute fitness, or the growth rate of genotypes from one generation to the next; $w$ is the relative fitness; and $S$ is the selection coefficient, which indicates how natural selection affects genotypes across generations relative to other genotypes.
2. The $A_2$ allele persists in the population because the heterozygote has a high fitness in the population. Since heterozygotes are able to survive and reproduce as well as the $A_1 A_1$ genotype, its gametes will be incorporated into the next generation. Approximately _ of its gametes will be $A_1$, and _ will be $A_2$. Thus, the $A_2$ allele will persist because selection works on genotypes, not on alleles. If you extend your model to 100 years (by copying the formulae in cells I27:L27 down to row 117, you will see that the $A_2$ allele “stabilizes” in frequency at around 0.012.

![Change in $p$, $q$, and $N$ over Time](image)

3. Although $A_2 A_2$ has a lower survival probability, those individuals that survive to adulthood now contribute a large number of gametes to the next generation’s gene pool. The result is that the $A_2 A_2$ genotype has the same absolute fitness as the $A_1 A_1$ and $A_1 A_2$ genotypes. Thus, an important point to keep in mind is that fitness has two components: survival and reproduction, and both need to be considered when predicting the impacts of natural selection on evolutionary change.

4. You should see that, although $W$ has changed for each genotype, $w$ remains the same. You should also see that $p$ and $q$ remain unchanged in the next generation because relative fitness (the growth of genotypes relative to some standard) is the important factor in determining the frequencies of $p$ and $q$ in the next generation.

5. The weighted average of the $W_{ij}$’s is $=C12*C9+D12*D9+E12*E9$. The computation for $\hat{N}$ in cell M18 is $=L19/L18$. Both should yield the same result: 1.2, which indicates that the population has grown by 20% from time $t$ to time $t + 1$. This general relationship should hold no matter what values are entered, because the weighted average of the absolute fitness is the same thing as $\hat{N}$, the finite rate of increase for the population. Each $W$ is multiplied by the frequency of individuals of a given genotype. For example, $W_{11}$ is multiplied by $p^2$, $W_{12}$ is multiplied by $2pq$, etc. This weighting is necessary because it reflects the number of individuals in the population. Thus, if $A_1 A_1$’s and $A_2 A_2$’s make up 80% and 20% of the population, respectively, $W_{11}$ is multiplied by 0.8 and $W_{22}$ is multiplied by 0.2. This puts more “weight” on the $W_{11}$ fitness because this genotype (and hence $W$) dominates the population. When the weighted $W$’s are added,
the result is [].

6. When there is selection against the heterozygote, the course of evolution for the $p$ and $q$ depends on the starting genotype frequencies in the population. When $p > q$, and there is strong selection against the heterozygote, $p$ increases in frequency until fixation ($q = 0$).

However, when $q > p$, and there is strong selection against the heterozygote, $q$ increases in frequency until fixation ($p = 0$).
7. You should see that when there is selection for the heterozygote and when the homozygotes have the same relative fitness, \( p \) and \( q \) will eventually reach an equilibrium at 0.5 (The symbols overlap each other on the graph).