**Heterozygote Advantage – a special case in Natural Selection where carrying one allele for a deadly recessive trait is an advantage in some circumstances.**

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| ***Principle of Natural Selection*** | **Deadly Recessive Disease** | | |
| **Sickle Cell Anaemia** | **Tay Sachs Disease** | **Alpha Thalassemia** |
| *There is variation of characteristics within a species.* | Some of the population has a recessive allele that causes sickle shape (sickling) of RBC. | Some of the population has recessive allele that causes malfunctioning of an enzyme that metabolises lipids. | Some of the population has recessive alleles that cause incorrect production of the alpha globin chains on haemoglobin. There is more than one gene involved in this cases. |
| *More offspring are produced than survive and reproduce.* | Offspring born with two sickling alleles (homozygous recessive -ss) cannot adequately transport oxygen and die in childhood. | Offspring with two recessive alleles (tt) can’t metabolise lipids. These build up in the CNS and cause extreme disability and death in early childhood. | Offspring with all recessive alleles for alpha globin production (aaaa) cannot produce functional haemoglobin. They cannot carry oxygen and die in early childhood |
| *There is competition for survival and this is linked to environment.* | Presence of malaria increases competition (selection pressure) | Presence of tuberculosis increases competition (selection pressure) | Presence of malaria increases competition (selection pressure) |
| *Individuals with characteristics most suited to the environment have more chance of surviving and reproducing.* | Individuals carrying one sickling allele (heterozygous - Ss) do not have anaemia, and are also resistant to malaria. In areas with malaria, this is a survival and reproductive advantage. | Individuals carrying one Tay Sachs allele (heterozygous – Tt) are still able to metabolise lipids, and are also resistant to tuberculosis. In areas where tuberculosis is present, being heterozygous for Tay Sachs is a survival and reproductive advantage. | Individuals carry some recessive alleles for alpha globin production (eg AAaa), can still make some functional haemoglobin so are able to survive and reproduce, and are also resistant to malaria. In areas where malaria is present, being heterozygous for alpha thalassemia is a survival and reproductive advantage. |
| *Favourable characteristics are passed on to the next generation.* | In areas with malaria the sickling allele is more likely to be passed on, as people without the allele (SS) are more likely to die from malaria. | In areas with tuberculosis, the recessive allele for Tay Sachs is more likely to be passed on, as people without the allele (TT) are more likely to die from tuberculosis. | In areas where malaria is present, the recessive alleles for alpha thalassemia are more likely to be passed on, as people without the allele (AAAA) are more likely to die from malaria. |
| *The proportion of favourable alleles in the population gradually increases.* | We see a greater allele frequency for the sickling allele in areas where malaria is present. | We see a greater allele frequency for the Tay Sachs allele in populations where tuberculosis is present. | We see a greater allele frequency for the alpha-thalassemia allele in populations where malaria is present. |