**Natural Selection – Important Case Studies**

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| **Example and Brief Description** | **More Offspring than will Survive** | **Variation** | **Selection Pressures** | **Who survives and breeds?** | **Potential Consequences** |
| **Antibiotic Resistant Bacteria**  Bacteria populations develop the ability to withstand the effects of many different antibioticsantibiotics. These are sometimes called “superbugs”.  It is the ability of a microorganism to withstand the effects of an antibiotic | Bacteria have the ability to reproduce quickly through binary fission  This means more bacteria are produced that can be supported by the environment, this results in competition for limited resources | Created by mutation.  Some bacteria may have genes that help them to survive the effects of antibiotics  Resistant bacteria can pass their genetic material onto other bacteria via horizontal gene transfer | Presence of antibiotics in the environment  Antibiotics kill bacteria and will kill most bacteria in any population  Misuse of antibiotics lead to greater exposure of bacteria to antibiotics and a greater chance of bacteria developing resistance | The bacteria with the antibiotic resistance mutation will survive & reproduce asexually and pass their beneficial alleles onto their offspring | Over many generations, the frequency of the resistant gene increases & antibiotic susceptibility decreases in the population  Current antibiotics become useless, so bacterial diseases become less controllable.  Potentially affecting human populations and food security.  Example: MRSA (methicillin resistant Staphylococcus aureus) is resistant to most antibiotics. It is now the most prevalent drug-resistant pathogen in hospitals & has been reported in community outbreaks |
| **Glyphosate Resistant Weeds** | Weeds produce many seeds and disperse them widely  A large plot of crop with a population of both superweeds and susceptible weeds. Only those who are resistant to the herbicide will be able to pass alleles onto the next generation due to the selection pressure of applying herbicide. | Created by mutation or cross pollination from Agricultural GMO that has resistance gene  Herbicide resistance is shown at low frequencies in weed populations before herbicide is first applied. | Spraying of Glysophate based Herbicide such as Roundup, kills weeds without resistance  The greater the number of susceptible individuals killed by the herbicide, the higher the selection pressure. | Those weeds that have resistance survive  Herbicide resistance is an adaptive evolutionary process in response to new environmental conditions (i.e., weed chemical control) in the agroecosystem.  Herbicide resistance alleles are beneficial mutations that rapidly spread in weed populations under recurrent herbicide exposure.  The beneficial effect of herbicide resistance mutations is realized in herbicide treated areas due to the survival advantage they confer.  Herbicide resistance mutations will spread over time in continuously herbicide-treated environments.  Will eventually disclose a deleterious effect as an adaptive disadvantage. Thus, a resistance mutation expressing a fitness cost in a particular herbicide untreated ecological environment will exhibit limits to evolve by natural selection. | Formation of a population of superweeds that are resistant to Glysophate herbicides  The widespread and repeated use of herbicides without diversified weed management has caused an increased selection in glyphosate resistant weeds, such as Goosegrass, Wild poinsettia, Horseweed, etc.  Increase in costs of weed management  Over reliance on development of new herbicide resistance will only result in multi-resistance in weeds.  Environmental quality concerns (about groundwater) that have reduced the use of some preemergence herbicides |
| **DDT Resistance**  Summary of DDT. For more detail see last page of document off natural selection of DDT resistant mosquitoes | Many insect are produced via eggs not all can survive | Mutation results in some insects having a resistance to DDT   * Stronger physical barrier * Detoxification by enzymes | DDT pesticide kills most insects in the population, those who have no resistance | The insect which has the gene for resistance | Insecticide can be rendered unusable if population of resistant insects is formed over generations, higher doses needed |
| **Peppered Moth**  Is a temperate species of night-flying moth. It is normally white with black speckles across the wings, giving it its name. This patterning makes it well camouflaged against lichen-covered tree trunks when it rests on them during the day. | More moths are produced than can survive due to competition for resources | Some moths have dark colour, some have light.  Both alleles exist in population dark colour probably due to mutation | Predation by birds  Before the industrial revolution, **light moths** had a selective advantage = able to camouflage against the lichen-covered trees, they were better able to avoid predator,  Therefore, white moths became more common over time,  However, during the industrial revolution, blackening of tree trunks & the death of the lichen covering the trees by the soot presented a new environmental pressure for the moth population.  The dark-coloured moths were better able to evade bird predation than the common white speckled form. | Those who are better able to camouflage with the tree bark survive & reproduce to pass on advantageous alleles to offspring.  Dark moths after industrial revolution killed all the lichen.  Now and prior to the industrial revolution, white moths are able to camouflage with the lichen covered birch tree trunks | Light coloured allele may be eliminated from population if the selection pressure continues (specifically predation from birds of light coloured moths during the industrial revolution) |
| **Tuskless Elephant** | More offspring produced that can the environment resources can support | Variation occurs due to the mutations in the alleles and through sexual reproduction.  Only tuskless female elephants are produced so therefore it must be due to a mutation on the X chromosomes which is fatal to males and dominant to females. | Ivory Poaching by humans  The elephants without tusks will survive longer as they are not being poached for their tusks (made of ivory).  This leads to them surviving longer and able to reproduce more than the others. | The tuskless elephants are only females and so only the females will carry the trait, therefore when they breed with an elephant with tusks, if they produce female offspring, they will not have tusks due to it being a dominant mutation on the X chromosome. | Because the mutation is fatal to males this means a lower number of elephants overall as now the females will not have as many males to breed with, as less are being born.  This can drastically affect the whole ecosystem as they are a keystone species – organisms rely on them. |

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