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W7L36_Mechanism of Evolution

Good morning. Today, I am going to continue the topic of evolution. Today, we are going to talk about the mechanisms of evolution that means how does evolution happen. I had discussed this in the previous section, slightly talked about natural selection. So, today we are going to elaborate on natural selection, mutation, drift and gene flow. These are the mechanisms of evolution and we are also going to touch upon sexual selection and the difference between natural selection and sexual selection and finally going to talk about misconceptions about evolution.

So, let us look at natural selection. So, let us take this familiar examples of beetles of various colors. So, let us say that in a population there are different color morphs that means that there are different colored beetles, all of the same species but the individuals show certain variation in color okay and these are heritable traits. Remember for evolution to occur, the traits have to be heritable. right?

So, in a population there are brown morphs and green morphs and say there is a bird comes and eats more green beetles than brown beetles because these are all sitting on a tree bark and brown ones are more camouflaged and over time in the next generation because there are more brown beetles left, you will get more and more brown beetles remaining because that particular color trait is more advantageous and those are selected over time and that is basically mechanism in which natural selection operates. okay So, whatever trait is advantageous in a population that is favored over other traits. So, in that sense fitness or Darwinian fitness can be thought of as an ability of individual to survive and reproduce. You should not think or you should not confuse that with physical fitness, it is not that the fittest of the organism survives, it is not that that organism has to be really strong in terms of physical fitness or really loud or really have the best of the plumage or best of the colors, it is not the best. You might have heard of this term called survival of the fittest, but it is not the fittest of the lot, it is as long as that trait confers the

ability of an individual to reproduce, survive and reproduce that gets selected.

So, in that term fitness is also relative. So, it is how well an individual survives and reproduces compared to other individuals of its own species and the trait that increases an organisms fitness relative to other organisms that are lacking it is called adaptation and that is an important term to remember and understand. So, adaptation is something, it is a trait that increases an organisms fitness relative to others that lack it. Let us take up a concrete example of adaptation. Let us look at this leaf mimicking katydid, which is basically an insect which resembles green leaf as you can see here, the veins of the leaf and even some deformities of the leaf are also you know mimicked by these insects.

So, it is not that this insect in one generation, you know within a generation it kind of starts looking like a leaf, it is not like it has some kind of a cognitive ability saying that oh okay I have to look and sit near a leaf. It is evolved over time to look like this and it has an advantage because it gains protection from predators because because predators especially visual predators cannot recognize that or maybe they are unable to recognize that this is in fact an insect. So, in that way it is an adaptive trait where by mimicking a leaf some insects are able to get protection from their predators. Another example is that of eucalyptus tree where the seeds are fire tolerant and the eucalyptus oil itself is toxic to many, many, many animals and the leaf as you can see here hangs down to avoid transpiration because it is very hot in which where eucalyptus is usually present or distributed. So, this is also various adaptations.

So, fire tolerance or toxic oil and you know leaf kind of hanging down are various kinds of adaptations that this plant has evolved over time. Okay, another example of evolution or another mechanism in which evolution occurs is that of mutation. So, one thing which is really important to understand is that not all mutation matter to evolution. Only that those mutation which happen in the germ line is actually important for evolution because it can be passed on to the next generation. So, if a mutation happens on the skin or elsewhere in the body those are all somatic mutations and that is unless it is coded in the germ line that means that it has you know if it is heritable and it is present in the germ line only then those mutations are transferred.

Another example or another important thing about mutation is that they are random. There is nothing that all mutations are bad. Okay, mutations can be beneficial, they can be neutral or even detrimental to the organisms. We mostly hear things which are really lethal to you know human beings, but there are various examples. Let us take up one such example which is neutral.

So, which does not have any effect on the organism. So, there is a mutation which causes cat ears to curl. So, you can see that these the cat's ears are kind of curled up. right? So, that is a neutral mutation that means that there is no effect on of this mutation on cats. Let us say, let us take an example of beneficial mutation which has a positive effect on the organism which has that mutation.

So, back in you know 1940s, DDT was considered a miracle drug because mosquitoes killed lot of insects especially mosquitoes and that prevented cause of lot of diseases including malaria, right. So, people were spraying DDT very, very widely and you can see in this advertisement, it was being broadcasted as DDT is really very effective and very good. So, it was pre-preyed on your domestic animals and also various crop plants and human beings and wildlife. So, the thing is insects develop resistance for this DDT very quickly. So, from an insect's perspective, the gene which confers resistance to DDT is a beneficial mutation.

So, some nucleotide or a bunch of nucleotides in the gene would have gotten mutated and the new variant would be basically resistant to DDT and that is why we are saying that it is of course it is detrimental to several other things down the line. We have known that DDT now is actually bad for several other things, but it is beneficial for insects those who have gotten resistance towards it. So, that is an example for beneficial mutation. There are several examples of harmful or lethal you know mutation being harmful or lethal. There are several diseases and we are not going to go into details, but Huntington's disease and Marfan syndrome are some of it.

You can actually look up what are the symptoms of these diseases and apart from this, there are several diseases. Some are actually lethal, some are really harmful for various organisms including human beings. Okay, so now let us look at the next mechanism of evolution that is genetic drift. So, let us get back to our favorite example of beetles in a population in an area and of course green beetles and brown beetles and let us say just by chance alone say you know some individuals get destroyed. Say here it is depicted as like a human being stomping on you know certain beetles that is a literal example, but it can be that just by chance alone some beetles are dead or some beetles are destroyed or killed more than the other kind.

So, if that happens I am saying that some individuals with specific alleles reproduce more than other individuals. What do I mean by alleles? Allele is a variant of a gene, so you can imagine that you know the color green is caused by a kind of allele and brown color is caused by another kind of allele. So, when it comes to you know genetic drift or gene pool we often think about allelic distribution, you know how are the gene variants are distributed in a population. So, let us say that a specific allele gets you know there are

fewer and fewer in number in a population when compared to other you know other alleles and as a result in the next generation the distribution or the frequency of alleles is altered, right. Some reproduce, some survive more than others and as a result there is differential reproduction.

So, genetic drift happens in all population big and small, but its effect is more pronounced in smaller populations because say suppose there are only six individuals of this beetle and two of those green beetles die and then going forward there is only one green beetle left and three brown beetles left, right. So, you can see that how certain alleles can get lost meaning they are not present in the next generation and because of this you know certain traits can completely change in a population and this over time results in evolution because there is changing you know frequency of alleles and it further leads to evolution. Okay, next mechanism of evolution is gene flow. Gene flow is nothing but migration that is movement of individuals within a population to some other another population, okay. So, as depicted again by the beetle example let us say there is these brown colored beetles in one area and they move to another area where there are largely green colored beetles, again all of the same species.

So, these are talking about individuals which having variation within them. So, say let us say there are some brown colored beetles which go to the you know population where they are dominated by green colored beetles. You can think about movement of individuals or movement of alleles or genes from one place to another place. So, because of that there is mixing of allelic frequencies, right. So, you can think about gene flow as if there is continuous gene flow it maintains some kind of mixing of various alleles within that population and if there is barrier to gene flow that is say suppose for example there is big river flowing between two populations and these beetles cannot cross the river in order to go to this particular area.

So, barriers can be anything, natural barriers such as rivers or canyons or volcanoes whatever it is and these ultimately could result in speciation and my colleague will talk about allopatric and sympatric speciation later on. But this is another mechanism in which evolution can occur. Now we are switching gears and thinking about sexual selection. Before that let us take a look at these various pictures here, right. So, whether you can look at these so you can see that one individual has slightly different kinds of ornaments than the other.

This is a very common example, right. You all know that peacocks have this flamboyantly brilliantly colored feathers whereas peahen don't. So, male and female differences are known as sexual dimorphism. Fishes, sword-tailed fish again there is a difference between male and female. Lions of course you can see the very clear

differences and also frogs and this is an example of spiders where there is drastic size difference.

This is actually the female and this tiny fellow is a male. So, there are various differences between the sexes and that is known as sexual dimorphism. It can be color, it can be size, it can be some kind of an ornamentation, it can be hair. So, all these differences are known as sexual dimorphism. So, the question is why should male and female of the same species be different? So, the idea is that it is because of sexual selection and sexual selection favors an organism's ability to mate, right?

So, these traits are basically selected by the opposite sex. Often the female would basically decide by looking at these traits you know which male to mate with. So, there is a strong selection pressure which is selecting for some specific traits and that is known as sexual selection. Formal definition is basically sexual selection favors an organism's ability to obtain a mate. So, it is also powerful, so powerful that you know certain traits can be harmful for the survival of the individual.

Now, what do I mean by that? So, let us take peacock itself as an example, right. So, peacocks have this really big tail with all these brightly colored feathers, right? But though the female is preferring this kind of a trait, there are certain disadvantages to having such a big tail. You might want to think about what are the disadvantages. One obvious disadvantage is that because of such heavy tail the peacocks are not able to fly very fast and hence they would not be able to escape from predators very quickly.

So, though it is an advantage is to have these brightly colored tail to attract females. On the other hand, it is costly for the males to produce these things because these tails because it hinders its ability to escape from predators because it cannot fly very fast. Natural selection and sexual selection as you can see works in actually different directions. Through natural selection, actually if you take peacock as an example, natural selection would favor for shorter tails perhaps because it is easy to fly and not so conspicuous tails because it attracts predators, right? But on the other hand, sexual selection would favor brightly colored tails and longer tails because perhaps the female you know would mate with individuals with longer tails and more you know eyespots.

So, this is an example where drive or the selection, natural selection is pulling the organism in one way and the sexual selection is in the other way. So, whatever the selection pressure of whatever is stronger that is how the evolution will basically, that is the direction evolution will take. So, to summarize, so till now we have talked about various mechanisms of evolution. So, we talked about natural selection, we talked about mutation, how there can be neutral or beneficial or harmful mutation. We also talked

about genetic drift and how because of just chance alone the allelic frequency might change in a population.

We also talked about gene flow that is basically movement or migration of animals, individuals from one you know one population to another and because of which you know if there is barrier to gene flow that can basically cause speciation. And finally, we talked about sexual selection that influences and that favors the organism's ability to mate and we also learned about how natural selection and sexual selection are basically two opposing forces acting upon a species.