Course Name: I Think Biology

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W7L34_Introduction to Evolution

Hi, my name is Divya. I am from Azim Premji University and I am going to be talking about evolution today for the I Think Biology course as part of the NPTEL course. Let us look at the slide which has various diverse kinds of plants animals and microbes on this. This is a cartoon representation of the breathtaking diversity that we can see in nature on our planet. So there are various kinds of organisms here. So the question is how did this diversity come about and how did so many species arise in nature? How can we see even newer species are arising and evolving and what is the reason behind this kind of diversity and various life forms on Earth? So today's lecture we are going to talk about the historical context for evolution.

So I am going to set a stage about what people were thinking before the idea of evolution came about, a formal definition of evolution and ways in which evolution can occur, pieces of evidence of evolution, and why we even have to care about evolution. So that is the outline of today's lecture. So earlier, so this is before the 1800s, mostly in Europe, people thought that God created various life forms and each species was independently and separately created. Earth is very young and life on earth is also very young and species once created don't change on their own.

So this was a creationist kind of view of the history of life. But then several people in the early 1800s started looking at various geological formations on earth and they also looked at fossil records. Linnaeus was grouping organisms, binning organisms that looked alike, and classifying organisms around that time people started, and they had different notions about how life is present, how life forms are evolving, or how life is organized. So this is the idea of descent with modification. That means that life species or life or different species or organisms change over time.

New life forms arise from older ones and all life forms on earth are related. That means they have a common ancestor and the earth itself is very old and life on earth is also quite old, that is around 3.5 billion years ago. So let me expand on this life on earth being quite old. Let us compress this life on earth concept, this 3.5 billion, around 3.5 billion years ago into a year. So

this is a graphical representation of that. So this is said in a calendar, let us say the Big Bang happened in January. Life didn't come about till the first cell or first life form didn't come about till September.

So if we are dividing the entire life on earth for 12 months, how did life progress? So for about August till September, nothing happened after the Big Bang, and then people are, this is all through the fossil record and other kinds of information that first life might have evolved only as late as September and first multicellular organisms evolved or came into the picture only in the last one or two months, that is only in November if we can think first multicellular organisms came about. And in December a lot of events happened. Oxygen was not present in the atmosphere and oxygen came about roughly maybe around early in December if you look at several other popular events such as when dinosaurs evolved or when mammals evolved, that is only in the last week of December. And if we look at when humans evolved on earth, it is only at the very end, so December, the last day of December, very close to midnight is when human beings came to earth and human beings evolved. So this is, it is not to say that okay only in December did human beings evolve.

I am compressing the entire life on earth several billions of years of information if we, it is difficult to understand billions of years. So people have represented it in a calendar year or it can even be viewed as you know if you had only 24 hours then how did life evolve but this is in a calendar year how did or when did different events happen? So this is a timeline for you to understand when different things evolved when organisms evolved, or when known things like human beings evolved on earth, evolution happened on earth. But in the time of 1800s, people were still thinking that you know life and the earth were young and that once-formed species do not change. those ideas were challenged and they were modified by several people but the two most important people are Charles Darwin whom most of you would have heard and Alfred Russell Wallace who was a contemporary of Darwin and also simultaneously had this idea that life form changes over time and all the species on earth are related to each other and they have evolved from a common ancestor. So both these naturalists and scientists independently came about this idea but of course, we know that Darwin proposed the idea formally proposed the idea of evolution and speciation through his book but what is less known is Wallace also independently came up with this.

Wallace worked in the Malay archipelago and he worked on several invertebrates and he worked on mimic concepts of mimicry and camouflage in fact, through all those ideas he wrote a letter to Darwin saying look maybe we can explain the origin of life and how interconnected different species are by the concept of natural selection and evolution and they had exchanged letters back then. So moving on I want to talk a little bit about what is evolution and what is not by this example. So let's take a tree which has you know changes over time it say this is a tree which has no leaves and over time over seasonal changes it develops leaves and of course, over summer

time the leaves might fall it might change color it might you know in the fall it might change color and finally fall off to become again leafless so it might change over time but this is not a biological evolution. Changes happening over its lifetime are not biological evolution. Let's look at this example here there is an ancestral life form tetrapod that means it has four legs and from that there are several other tetrapods that have come from this common ancestor be it a whale, human lizard, or a bird from these have changed from a common ancestor it has modified from a common ancestor turning into various other species.

It's not that what I'm saying is not that this particular thing has changed into these many species but all of them have a common ancestor. So this is biological evolution which means that a formal definition of evolution is descent with modification which means life forms all are related but they change over time and modify over time that particular trait that undergoes modification has to be inherited only then it's considered evolution.

Let's take one more example of which of these following are not evolutionary changes: A monkey learns to steal food from your house, a young man starts lifting weights and builds his biceps, and there is a plant that is pruned to make a bonsai or antibiotic resistance in bacteria. I will give a bit of time for you to think about what are not evolutionary changes. As you can tell the first three: a monkey stealing food from the house, a man building his biceps, or a plant that is pruned to become a bonsai all change within the lifetime and these are acquired changes and this is these changes are not transferred to the next generation.

So these are not evolutionary changes whereas antibiotic resistance in bacteria is I will explain this in a bit but this is an evolutionary change because certain bacteria might have acquired resistance or it might have certain genes that might have mutated and might have acquired resistance and if those are heritable changes that means that if it can pass on that quality or that trait from one generation to next generation or even through horizontal transfer if another bacteria acquires that information and also develops resistance to a particular antibiotic that is considered evolution. So to consider it to be a biological evolution these changes have to be inherited from one generation to the next. So here is a formal definition of evolution: it is descent with modification from a common ancestor and evolution is responsible for all the similarities between related organisms and also a huge diversity of life. So what I showed you in the first slide about life, this you know fascinating diversity of life is because evolution is responsible for that diversity of life also. So there are three primary requirements for evolution to act.

Now we are looking at the population of a particular species so let us take this cartoon example of a beetle. So I have written here that there is variation in a population which means that let us imagine there are brown-colored beetles and green colored beetles so that is there are different coloration in the beetle population. It is like saying in human beings there are some tall individuals and some shorter individuals in a classroom let us imagine you go to a particular

class or in your own you know the larger community there are some tall individuals and some short individuals and that represents variation in the trait of you know being tall or short. Here it is color variation so in any given population there is there has to be some kind of variation for evolution to act on. Then those particular variation has to be heritable which means that it is not enough to have variation but a particular say what I mean by heritability is that that trait whether it is the height of an individual or whether it is the color of a beetle has to be encoded in the DNA to pass it on to the next generation of the population next generation of individuals.

So there has to be variation in a population and that trait has to be heritable and there has to be differential survival or differential reproduction in that population. So here there is a bird which is selectively eating you know green beetles which are kind of sticking out because they are sitting on a brown tree whereas brown beetles here are kind of camouflaged so that birds find it difficult for them to eat. So because of various reasons only these brown beetles could get to reproduce more than these green beetles. So there is also differential reproduction. So all these traits and variations in a population heritable nature of that particular trait and differential reproduction are important for evolution to act on.

Let us take one more example. This is a fascinating and beautiful insect called leaf mimicking katydid. You might even find it difficult to spot this in nature. So this look at its wings is exactly like you can even see the veins on the insect wing which mimics the leaf wing and there are some you know ruptures it almost feels like okay some leaf is old or broken and it is as if it is sitting on a green leaf it looks it is camouflaging against its background. So this is a very good example of a product of natural selection or you can say that evolution is a product of evolution.

Now how did this come about or why are we saying that this is a product of natural selection? By the way, natural selection is one of the mechanisms by which evolution can act. We will talk a little bit more about natural selection in the next lecture but there are various other mechanisms also such as you know gene flow, genetic drift, mutation, and natural selection are four ways in which evolution can act. Now let us take this example and think about how it is a product of natural selection. Okay, I am going to stop here and continue this in the next lecture.