Course Name: I Think Biology

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W7L37_Misconceptions about Evolution_Discussion

Hi, my name is Jayanti Mukherjee and I have here Dr. Divya Uma with me. We both are Biology Faculty at Azim Premji University and today we are going to talk about some of the common evolutionary misconceptions and this is for our NPTEL course that we are offering online. Divya, why don't you introduce yourself a bit, and then we can proceed with the questions? Okay, I teach Biology at Azim Premji University. I usually teach introductory Biology courses as well as elective courses such as animal behavior and I work on insects and spiders and their various behavioral ecological processes.

So we can now start with various misconceptions of evolution. So both of us will ask questions to each other. These are very well-known misconceptions in evolution so we'll proceed. Yeah, so my first question would be you know we often face when students look at Google images they often see that a monkey is evolving into a human and this is one of the most common misconceptions existing.

So what do you say? Is that a correct interpretation of evolution? Yeah, here is what we have to imagine. As you can see in the slide, a monkey is making a linear transition to a human being. So it's not correct, it's a wrong depiction. A monkey doesn't turn into a human, right.?So what we can say is both humans and monkeys have a common ancestor.

So that's the correct interpretation. So yes, all of us, all organisms have a common ancestor and we are all related to each other but that doesn't mean that one species, monkeys will all become human beings. So that is a misconception. So when we look at it more closely we can say that we are closest relatives of other great apes such as chimpanzees and bonobos. From the great apes we have evolved, so we have diverged from them seven million years ago.

So human beings, that's homo genus, separated from chimpanzees and bonobos seven million years ago and both these lineages have evolved independently. So that is the full picture and of course, there are orangutans, there are gorillas, and all these are other primates and they are also in that phylogenetic tree. So it is wrong to say just give one figurine like that saying that okay

monkey has turned into a human being. So we have to look at it from a tree perspective and see which organism kind of diverges at which point in time. I have a question for you now.

So for example, we often think that evolution is occurring always at a slow pace. So when I was going to college and we were taught evolution for the first time, we always thought that gradualism is the way of evolution and also that sometimes we confused with you know that seasonal change of plants or anything very rapid change also. Can that be evolution? How do you separate? How can students get confused here? That's an important point, So evolution can happen fast or it can happen slowly. That depends on two things

One is the lifespan of an individual. Say, for example, bacteria that divides so frequently as every 20 minutes can divide right. So in that it can happen you know one bacteria can give rise to many more very fast. The generation time of bacteria is very very rapid. So in that evolution can occur very fast but it also depends on the selection pressure. So the changes come faster.

Changes coming faster. Yes, so it depends on the basic lifespan and also the selection pressure on that organism. So I'll give you one example. So say we often talk about okay there is antibiotic resistance in some bacteria. That resistance say for example there are some bacteria which are you know staying in us and say we take in an antibiotic and what happens is generally all bacteria because of that drug but there might be few bacteria in that population which might have that resistance towards that antibiotic right.

So what happens is those bacteria that survive will reproduce giving rise to many more bacteria. So that pressure of here antibiotic is that pressure external pressure where this bacteria has mutated or some changes have happened where it has grown resistant to that particular antibiotic. So evolution can occur fast in this bacterial population because of that strong selection pressure. So it's not only a small you know short lifespan of a bacteria and a huge selection pressure that the bacteria have. Evolution can happen fast. But say suppose selection pressure is not there then and also organisms which have long lifespans maybe the evolution is quite slow.

So it depends on that context whether you know something can be fast some evolution can be very rapid or evolution can be rather slow. It depends on both lifespan and also selection pressure of animals. Of course, there are animals and plants and of course bacteria, all organisms! So now I think about it when I think about this that is the reason also when we are selecting for plants or animals in plant breeding or animal breeding that selection pressure is much higher than it is in nature. That is the reason they show that changes very fast in those populations, for example, rice. In books we have studied rice and cotton, so changes there with selection become much faster compared to a natural population that is evolving in nature.

Yeah, so you mean to say that humans are selecting them artificially to grow you know bigger

tomatoes or sweeter corn or rice varieties. So we are kind of putting that selection pressure to select certain traits so that those traits are picked up and they are transferred to the next generation. We are only picking those traits. So in that terms, even humans are giving some kind of selective pressure. That brings me to a good question.

So can we as humans influence the evolution of other organisms? Yeah, this is very complex and I would say not difficult but its comprehension is very complex. So let's talk about, of course, we all know I'll take a basic example first and then take it to a little bit more complicated. When scientists talk about this influence, and how humans are influencing, they mostly talk about eco-evolutionary dynamics but not exactly evolution because evolution manifestation takes time. So in a shorter while say for example we are polluting our environment right now we are changing the land we are fragmenting the land we are making urbanization so in this way we are changing the environment of other species and that is how pollution is known to cause higher rates of mutation or different rates of mutation which will genetically get incorporated into an organism. So this is one part of it and in how indirectly you are actually may change the genetic composition of other species.

Another part that will have a direct impact would be we are causing because of our influence we are causing the extinction of some species. We are wiping out. Wiping out some species right we are introducing some species to a new area where it is evolving in a different trajectory. So these kinds of interventions don't have enough knowledge background knowledge and that can have a direct impact on the macroevolution of life itself. So that is how we are definitely impacting organisms and not to keep in mind here is that we are not alone right?

Any organism is not alone. Humans are not alone. So we have a lot of things impacting them, they are also impacting us. So everything is co-evolving together we are all interconnected. So how that is going that trajectory is very unpredictable. So the outcome is we are giving something but the input we are giving something but the outcome that we might receive is completely not known about what it is going to be.

And a lot of species influence each other. A lot of species have gut microbes, we have other microbes some beneficial some not beneficial. So how do all these things interactions impact and we are also influenced? That brings me to another question for you: humans, are we also evolving? So because our generation time is quite large right now we have now an average of 75 years we live. So how is that impacting us? Of course, we are animals too so we are also evolving It's not that humans have stopped evolving and that's another misconception. When we think about it right I think probably way back in Aristotle's times there is this again a chart which says that human beings are depicted at you know at the very end of a pyramid kind of thing.

So you know it starts from microbes and you go on or even stones for that matter non-living

things and you go reach human beings and we might think that you know humans are like the pinnacle of evolution and human beings are perfect but that's not the case. So I'll talk about two examples, two specific examples here. So one is about how in certain areas in Africa where there is rampant malaria. So malaria is caused by you know a parasite which is which ravel plasmodium is a parasite but that is carried by mosquito. So there are malaria-causing mosquito parasites which is borne by this mosquito.

There are areas in Africa where Africans are resistant to malaria. So I'm going to tell how they have evolved resistance to malaria. So there is a particular gene called DARC that's the kind of a short form of the one. That gene codes for a protein that's on the surface of red blood cells. Okay, so this protein helps malarial parasites to bind to that surface.

So malarial parasites bind to that surface protein to enter RBC cells. So what humans have evolved is when where there is rampant malaria there is a mutation in the DARC gene which causes some changes in that surface protein so that the plasmodium that malarial parasite can no longer bind to that particular protein. It's fantastic right wherever there is the need or wherever there is selection pressure mutation has happened where the population is now resistant to malaria. But there is another point to this where it's not that now the whole African population is resistant to malaria. It's only in pockets where there is extreme you know malarial cases those pockets have evolved resistance.

But they're also more prone to HIV. So it's not that okay there's everything good happening. There might be certain benefits of a particular mutation but there might be also some trade-offs of that particular mutation. So it's not that always certain things are beneficial. There might be another kind of you know problems with it.

So that's one example. The other very very interesting example is lactose tolerance in humans. So all mammals when mammals are young so mammals are human beings. It can be cats, monkeys, you know donkeys. All we know all the mammals. So when mammals are young they need milk to grow. Milk has this lactose which gives a lot of energy for young ones to grow. So but after growing up we don't need milk. So what happens is when we take in milk lactose is quite large and it is difficult to digest it. So what we have meaning all mammals have is one enzyme called lactase. So this enzyme breaks down that so that's during the young ones okay.

So basically this lactase enzyme is coded by a gene. So that gene is active when we are young. But when we grow up of course we don't eat milk and we don't need that enzyme is not there. That lactase enzyme is inactive or it's not present. So in all mammals, you take a cat or a dog whatever mammal it is.

When it grows up if it drinks milk it's not good for its health. So please don't give milk to your

cat because it can't digest it. Adult cats can't digest milk. What happens is there might be gas produced or they might have diarrhea or bad stomach cramps. Humans also have it right.

We don't realize it concerning other animals but we are intolerant of lactose. So it turns out that one-third of the human population in the world is lactose tolerant. So you might ask how are they tolerant of lactose. So it turns out that this is this takes us back to 10,000 years back when humans were first to kind of you know start domesticating cattle okay? So at that time civilization had just started and there was domestication of cattle.

So a lot of people in Africa and also in some parts of northern Europe and a lot of cattle that gave us them a lot of milk. So this was also of course these are all hypotheses okay. People have looked at you know DNA evidence and other evidence to kind of think about this and come up with this idea. That was also a time when there was a lot of famine and drought and diseases and stuff. So in a population if people consumed milk and if they were able to digest that milk and if they grew stronger those were the people who succeeded and they survived right.

So they had a mutation this was a mutation where the lactase gene is always on. The lactase gene or the enzyme is active so they could break down lactose and hence they could do quite well. So this is a fascinating story actually and this shows that it's not that humans have stopped evolving depending on the circumstances and need and the context we are still evolving. I mean the story is just 10,000 years old and then that's very very recent in that aspect.

So that's one example. I had forgotten to ask you one more question in this context. So we talk about you know evolution making everything very fit or making organisms fit or perfect. So is that true organisms become perfect? Yeah, this is a very important thing to understand. Perfection is relative right and so that directly emphasizes that nature is putting the selection we call selection by nature and nature is not trying to make us a perfect organism or superorganism. Nature is what it is doing it's giving some pressures in an environment so it is very relative to the environment we are in and that selection pressure is randomly put on the organisms and the random organisms whichever is best fitted in that.

Say for example you just talk about two-thirds of the population as good in lactose, digesting lactose. So similarly say there is a population where only two-thirds or half of the population is very fit for that environment. Say for example let's take an example of rice. A very drought tolerant rice variety is growing in one pocket and that population is very strict pressure or very high pressure of drought is given and only a few individuals or half of the individuals survive and then in the next generation it will go so that kind of some genes re-triggered there next generation it will go those characters will be emphasized. So slowly over the generation in that region, the rice variety will be very drought tolerant.

Okay, it happens slowly. It happened it will say it happens slowly but if you put a very high selection pressure in that area it might also happen that some other beneficial genes might get lost. For example, if there is a drought-tolerant variety of rice it might be giving less yield in that environment. So it's not always that perfect in one sense but it may not be perfect in another So there's always a trade-off, evolutionary trade-off we call and if you now bring that drought tolerant individual or population to a mesic environment where there's a lot of moisture or water it might not need to become drought tolerant but then it still can't produce too much yield what we need in that environment because it is already fixed its gene in that particular environment. So it will take a lot more generations to do again.

So it may not do well in a different context. So it's not that nature is selecting something perfect it's that perfect or best fit for that environment I know this is a very common misconception and sometimes even adults make mistakes right but it is not perfect so then we can all if it is perfection, we want to produce food. We also are humans, and we want to produce our food why don't we start photosynthesizing? That is not possible, right? So those things are perfect in a particular environment and whatever traits you have evolved to do this. I'm reminded of this common saying that it's survival of the fittest that is also not correct yeah right because it's not that partially correct it's just you know all of them who are only fit or the fittest will survive because it's not like that because even the not so fit organisms will also survive because the fit is not fit in all aspects as you were rightly saying and the not so fit plants or animals or you know organisms they might be fit in other ways. So it's a misnomer or it's not fully correct to say that survival of the fittest. Yeah actually yeah it's a very good thing that you brought it up because fitness also can be taught in terms of Darwinian fitness or just existing in that environment because Darwinian fitness directly connects to the offspring you produce.

Okay so fitness has an English connotation, yes fit is not just you know okay you can go to a gym and become very fit. It's not just that, no but in biology also fitness means reproductive fitness or Darwinian fitness okay where it produces more so you have to, yeah you have to sustain that in that environment but you have to be fit to produce offspring which will be taking your generation towards forward so that it's Darwinian fitness which we often forget to keep in mind.

All right so I would like to expand on this, yeah so again when we think about you know how would other organisms say for example one is very fit but there are, I just said that there are other not-so-fit organisms. In that you know individuals in that species will also survive right how would they survive? There might be several strategies. One interesting strategy is they might simply cheat to survive so these are various adaptations as I said earlier I work on insects and spiders yeah so there are a lot of things like there are a lot of cheaters so what I want to tell you is it's not that cheating is bad in that sense of course you know it's also relative so I'm not talking about cheating in that English sense but it's it as a strategy where that's also a strategy where they are fooling certain individuals it might be predators it might be mates or whatever and then

getting away and also surviving. Yeah best example comes from your mimicry mimics group yeah so they might fool a predator and they might survive equally well so it's not that there is one strategy yeah in life to be the best fit in that environment you can evolve several different strategies several different strategies and it's not that everybody, as you said, is a perfect organism. Some things like coexistence in nature happen only if some are dominant and some are docile right everybody wants to dominate the system that is not possible so coexistence can only happen that way I think we are running out of time so we will conclude here our session. Please feel free to contact us on our online platform. We can have an interactive session where you can bring your questions please think about these questions ponder on them and get back to us.