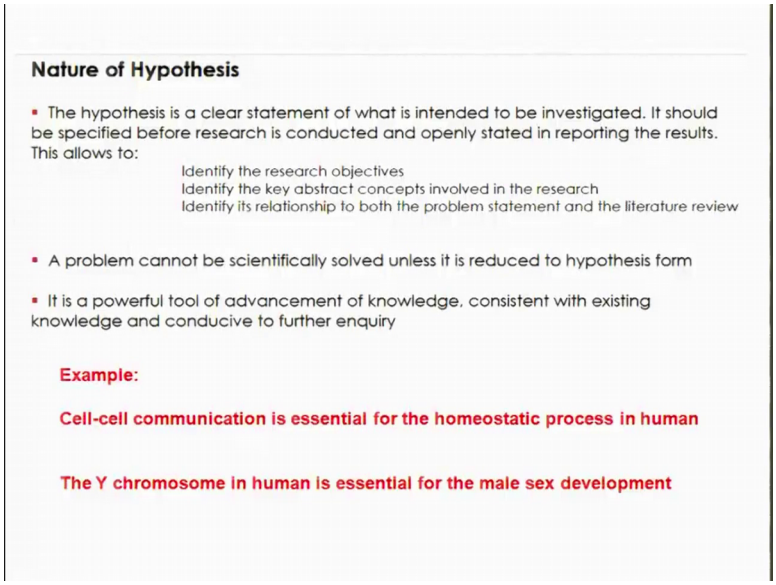
Introduction to Professional Scientific Communication
Prof. S. Ganesh
Department of Biological Sciences & Bioengineering
Indian Institute of Technology, Kanpur

Lecture – 05
Scientific Hypothesis (contd.)

So, we have been discussing the concepts about hypothesis and importance of hypothesis in the research project, wherein I introduce a specific paper which talks about how it is important? How important it is to develop a good hypothesis which would result in a good scientific project and good outcome.

(Refer Slide Time: 00:33)



So, let us see what is an hypothesis and how you develop? The nature of hypothesis, the hypothesis we have already introduced we are going to talk about the nature of hypothesis. So, what is the nature of hypothesis? We are going to narrate something, which you believe is the answer for the question that you are asking. So, it is a kind of expectation or prediction which can be tested and I can be proven.

So, it is a simplified statement for a larger problem. So, hypothesis is a clear statement of what is intended to be investigated. It should be specified before research is conducted and openly stated in reporting the results, this allows to identify the research objectives, identify the key abstract concepts involved in the research, identify it is relationship to both problem statement and literature review.

So, what you do is something based on preexisting knowledge. So, you read, you observe, you do experiments and then you contribute something new with which you are going to say something new that is not known before, we are going to advance the knowledge. Therefore, readers or whoever listening to this your research outcome should be made aware as to what exactly you have done and why you have done that, so that is what called as the hypothesis. You have to state exactly why you have done? What you have done? What you obtained? And what it means? So, these are the sequences.

So, the problem cannot be scientifically solved unless it is reduced to hypothesis, say for example, you are talking about human system, the human system is a very extremely complex system you talk about brain, you talk about so when you study for example, human physiology, the normal textbook would say you have circulatory system, you have extra what is called muscular skeletal system, it will say digestive system, it is say nervous system. So, it simplifies each system as nervous system and so on, but it is not as different 1 another from each other as it is mentioned in the text book.

The reason being you know you cannot combine everything and study it is too complex the study everything. So, limit yourself to certain key questions and you answer only those without really bothering about how that may affect the other system because it is too complex we will expand some of those things little later.

So, by developing an hypothesis you basically simplify and you go to a system which is very simple for example, I talk about immune system in the human and I talk about how the immune cells respond to for example, any infection and so on, some of the studies are done in cultural test tubes or you know in (Refer Time: 03:33) where in you grow these cells and expose them to some pathogen and see how the secrete certain molecules and so on.

So, you cannot do it inside the system because there are too many variables, you do not know what comes in what comes out. So, when you make a simpler model you are able to understand the specific process with which you are able to extrapolate and tell perhaps that is what happening in the body. So, the cell system that is used in a test tube or a culture dish really does not mimic exactly the condition or all the condition that you see in the human body, but still that is the simplest system that you can work with manipulate and ask questions.

So, it is a powerful tool because you know whatever you know new discoveries are knowledge that you generate, is going to help others to advance their project as for, for example you are used a cell system to understand how the circulating human cells can respond to an invading pathogen and they secrete certain new molecules that are not known before and you have characterized it. Now, some other group who is working on human the samples can now look at whether the human samples have such molecules present in the blood serum for example.

So, now they may come up with ways to tell, if I detect this particular molecule in the serum that would mean that they are infected with a given pathogen, so it becomes a kind of a diagnostic test. So, you have infection, you have certain symptoms for a doctor to know whether you have the infection of that particular pathogen, they may take out little blood and send it to a lab where they quickly do whether you have that molecule compound in higher amounts that would suggest that you have infection. So, that is how even a simple you know cultural system can contribute to understanding even to cure a particular infection and the human. So, that is how it is powerful, useful so, but you simplify in order to manipulate, understand and you know design your experiments which otherwise is not possible.

This is the example that I gave cell-cell communication for example, this is a hypothesis let us say cell-cell communication is essential for the homeostatic process in human. So, when you talk about let us say the blood glucose level you know. So, the blood glucose level in the body tries to keep you know within certain levels.

Therefore, all the cells get the nutrient whenever you are hungry, when you do not have food left what happens is, that blood glucose level goes down or maybe because you are doing certain exercise, you have increased consumption of glucose, then your body has to metabolize the glycogen that is stored in liver muscle and then you know push it to the blood therefore, the blood glucose level is maintained.

So, how possibly you know this kind of a communication could happen? One may say that there are hormones that are secreted, there are comes out of the cell and then tell that the level of the glucose in my body is very low or that could be other ways by which the cell can communicate with each other.

That is what you called cell-cell communication, but it is extremely difficult to test it in human body because you cannot do experiments. So, what you do? You can move to simpler cultural models and ensure for example, if you starve the cells of glucose in the medium and then the cells would start using the glycogen, now on the glycogen level goes down the cell would like to have more glucose pumped in. So, they may have certain proteins which help them to take more glucose inside, now they may send them outside to the membrane.

So, this is a process was possibly by which they can update, take more glucose inside and this you can study using certain conditions simple cell models that would help and all our understanding with regard to how insulin possibly regulate the glucose uptake in the cell have come from such kind of a models. So, that is one simple modem which really helped us to understand, even solve what is called as a diabetic condition.

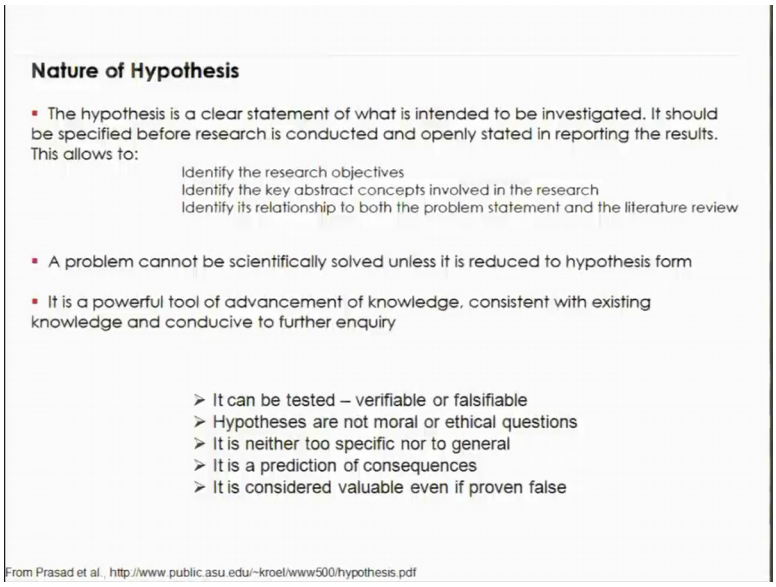
The other important question that still you know much more work is in understanding how for example, the y chromosome in human this is again say this statement is an hypothis, let us say the y chromosome in human is essential for the male sex development, if it is in hypothesis how are you going to test it? Is going to be extremely difficult again to test; so what you need to do? You need to prove for example, all males have y chromosome, all females have no y chromosome in their body.

So, then you have to look into those individuals that are having y chromosome, but female and vice versa and then look at what are the genes that are involved and there are many other aspects that look people look into. What we know now is indeed this statement it is true to some extent meaning it is not the entire y chromosome is essential for the male sex, but a part of the y chromosome is essential for the male sex and that has got certain genes, these genes trigger certain process during development which allow the embryo to become male.

So, if you do not have a gene or if you have the gene on the x chromosome 5 by some process that are abnormal, but the gene got transferred to x chromosome. So, even if that individual is xx, but having this gene he the embryo would become male and if the gene is defective even if that individual the embryo is xy the embryo would develop into a female. So, this is how we know now.

So, infer form what has happened and then you sort of support the hypothesis and there of course, experimental evidences later on people have, then what is called as a transgenic animals, you take the gene pull inside xx embryo in mouse and then that embryo though it is xx now becomes male, sort of proven that that is the gene that is critical. So, you develop hypothesis based on certain operations and then, you test them and then now you know that no longer hypothesis these are facts that is why it happened.

(Refer Slide Time: 10:07)

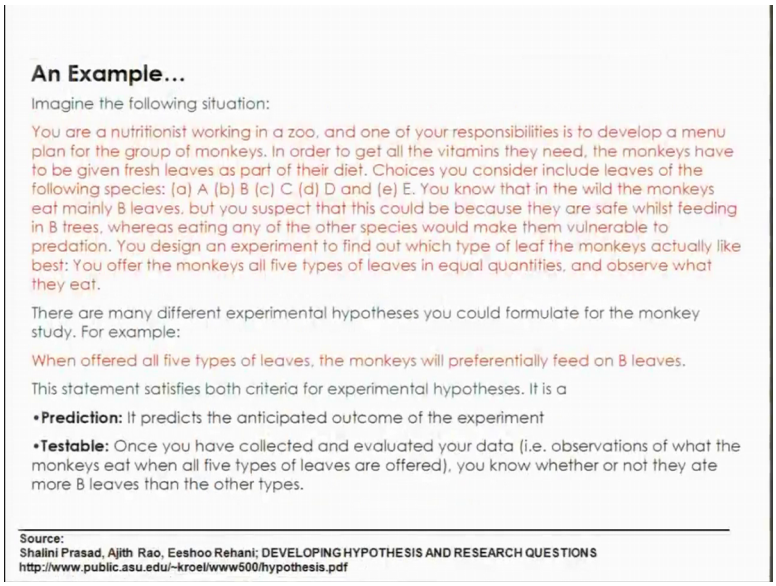


So, the hypothesis is something it can be tested, verifiable meaning you prove your hypothesis or falsifiable that the hypothesis is not correct, hypothesis are not moral or ethical questions, when you talk about you know whether it is x chromosome or y chromosomes, males have additional chromosome, which females not have.

If you make this statement that it is not talking about the ethical issues or anything it is a scientific question that you are asking, it is not about moral ethical questions we are asking specific questions, it is neither to specific not to general. So, it is you cannot be extremely specific because you generally try to generalize and if it is too general you cannot test it. So, that it is somewhere in between.

It is a precondition of a consequences, you sort of predict as to what would happen due test and see what happens, is considered valuable even if proven false, in the sense that if it is not correct then you go back and look into alternate hypothesis.

(Refer Slide Time: 11:06)



So, you are going to look into some examples and these examples are from a beautiful and a presentations made available by 1 and Shalini Prashanth and others, it is available in the link that is given below. So, what I have done is pretty much have copied and present it here because I found that to be extremely interesting and you all could get benefited.

So, I want to read out the text here and then will take out that and hypothesis prediction and we can see whether the hypothesis correct or not. Imagine the following situation, you are a nutritionist working in a zoo and one of your responsibilities is used to develop a menu plan for the group of monkeys. So, basically here to prepare certain you know food combination for the monkeys that is there in the zoo.

In order to get all the vitamins they need, meaning the monkey need the monkeys have to be given fresh leaves as part of the diet because that is your goal that you have to keep that the vitamins is you know whatever they require it is balanced. Choices you consider include leaves of the following species of plants basically A, B, C, D and E these are the combinations.

You know that in the wild when the monkeys live in the forest they mainly eat B leaves meaning the leaves from the tree that you called as B, but you suspect that this could be because they are safe while feeding on in B trees because maybe they are taller, they stay there and that possibly makes them to feel comfortable.

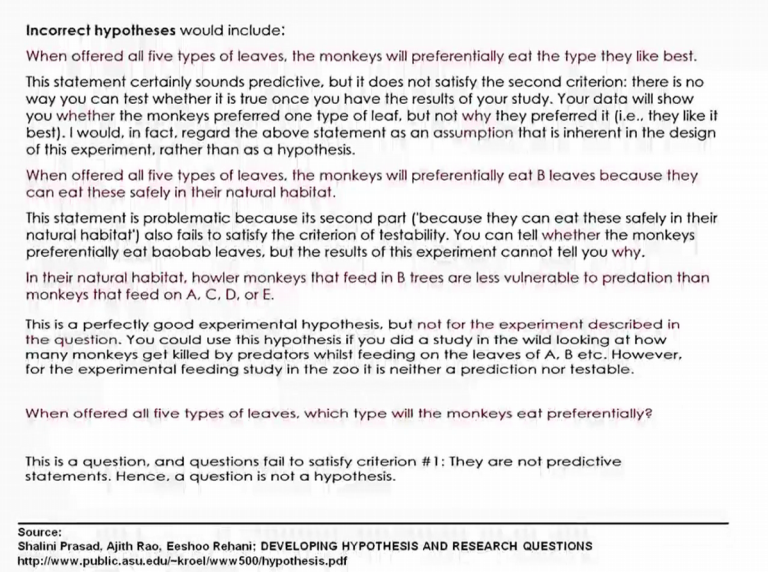
Therefore, they otherwise you know eat in the B tree, whereas eating only any of the whereas, eating any of the other species of the tree would make them vulnerable to predation, the other you know for example, plants where we talk about the leaves B, C, D or E they may short haired plants taken at withstand the weight of the monkey; therefore, they do not climb up you know the predators may come there is a possibility.

So, they go for b even if they do not rightly you know like that much still they feel safe therefore, they can get. So, that you design an experiment to find out which type of leaf monkeys actually like the best. So, we want to now test, you offer the monkeys all 5 types of leaves in equal quantities and observe what they eat and based on the observations now you have to you know come up with certain hypothesis.

So, there are many different experimental hypothesis you could formulate for the monkey study for example, when offered all 5 types of leaves, the monkeys will preferentially feed on B leaves because this is what you think because that is what happens in the wild, so that is the hypothesis.

This statement satisfies both criteria for experimental hypothesis that is we can test this. The prediction, it predicts that the anticipated outcome of the experiment because you expect that it will eat B leaves and it is testable because we can give all 5 and you see what leave they eat, once we have collected and evaluated your data, for example now, which monkey eat how many leaves and so on, you know your hypothesis is correct or not, so that is how it is, just look into that.

(Refer Slide Time: 14:39)



So, the incorrect hypothesis would include the following, when offered all 5 types of leaves, the monkeys will preferentially give the type they like the best, think that if I give 5 different variety of sweets to you, pick up the 1 that you like the best, right. So, does it apply to the monkeys as well, right.

So, it this statement is predictive meaning you can test it, if that is the case, but it does not satisfy the second criteria, that is there is no way we can test whether the monkeys you know when they take particular type of leaves, that they do not say that they like the best, that is the leave that they like best, that you do not have any data it could be because if you will say for eating that tree right. So, the data will show you whether the monkeys preferred 1 type of leaf over the other, but why they preferred that particular leaf is not something that your data could predict.

So, what you looked at this particular slide is the hypothesis based on a situation that is just now explained we are looking at an hypothesis and we looking at the in correct hypothesis if you were to predict some. So, one of the incorrect hypothesis would be, when offered all 5 types of leaves, the monkeys will preferentially eat the type they like best, this is true if it is human because if I give you 5 different types of sweets and you pick up 1 and eat and I ask you why did you eat, he will say this is the one I like the first, but you cannot ask the same questions to monkeys.

So, they may eat something not necessarily because they like the most, but because probably they feel by eating that they may feel that they are safer, you remember have

narrated that in the wild, they may live on tree that are stronger, taller and because they live on these is they may eat these leaves and when you offer such leaves in the zoo as well, they may preferred that because that would make them safer, so that is exactly was mentioned here.

The statement certainly sounds predictive because we can test by offering all types of leaves, but there is no way we can test whether it is true once you have the results of your study. The data will show whether the monkey preferred 1 leaf over the other, but why it did so is something that you cannot really do. The second hypothesis again incorrect hypothesis is when offered all types of leaves the monkeys will preferentially eat B leaves because they can eat the safely in their natural habitat.

This is again is incorrect hypothesis because the statement is problematic, because this second part because they can eat these leaves safely in their natural habitat something that you cannot test because you have them here which is you know encaged, so we cannot really test it, again the third incorrect hypothesis in their natural habitat; however, monkeys feed, that feed on B trees or less vulnerable to predation then monkeys that feed on ACD or E, again this is a perfectly good experimental hypothesis, but not for the experiment described in the question because you are in the zoo, you are going to test with a monkeys that are captive in zoo, so you cannot test it.

So, you need to know when you develop an hypothesis and you want to defend the hypothesis by carrying out experiment, whether your test method test tools or the methodology that you going to use can test the hypothesis, only then he know quite help you. So, therefore, you should know what methods that are under disposal to you and whether you can use it.

The fourth example, when offered all types of leaves, which type will the monkey eat preferentially, this is hypothesis is not an hypothesis it is a question. So, often you say the hypothesis something, you know it is a kind of answer to your question, but even you make a question he does not really you know because it is not having any predictive value, you ask a question he does not say what could possibly happen, you know that predictive value is missing; therefore, it is not an hypothesis.

So, that is you know what we talk about in the hypothesis and with this we end here and we will start again in the next lecture, more examples and discuss.