Bioengineering: An Interface with Biology and Medicine
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Lecture - 40
Ethics in Research and Publications

Welcome to the MOOC NPTEL course on bioengineering an interface with biology and medicine. Today, we have reached to the last lecture of this course. In last several lectures, we have discussed about various biological processes associated with cell cycle, development, cloning, cell reprogramming. We have also discussed many other interesting biological concepts in genetics and cell biology.

We have seen how DNA tools and biotechnology is driven by lot of technological advancements, different techniques we have taught. We have also discussed about proteins and protein detected technologies. In addition to these topics, I think it is very important for me to emphasize that there is a need to have ethics in research and publications.

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So today we are going to talk about this topic which is not directly linked to the biology but it is highly relevant when you are doing science and research. These kind of discussions, these points are very important for you to remember. So let us start today about ethics in research and publication. So whether you make engineering devices, products or scientific basic research, ethics in research and publication is of paramount importance.

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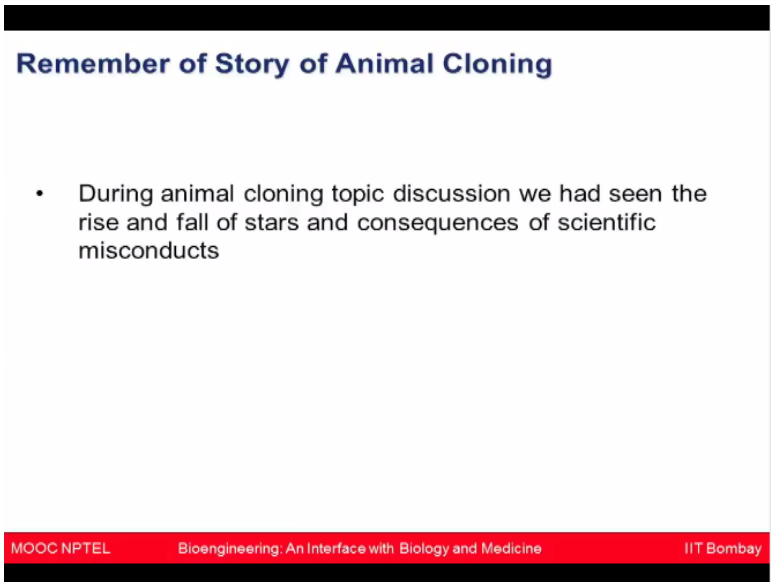

Remember the story of animal cloning. We talked about how the rise and fall of stars happen in the research of cell reprogramming and cloning and you have seen also the various consequences of scientific misconduct.

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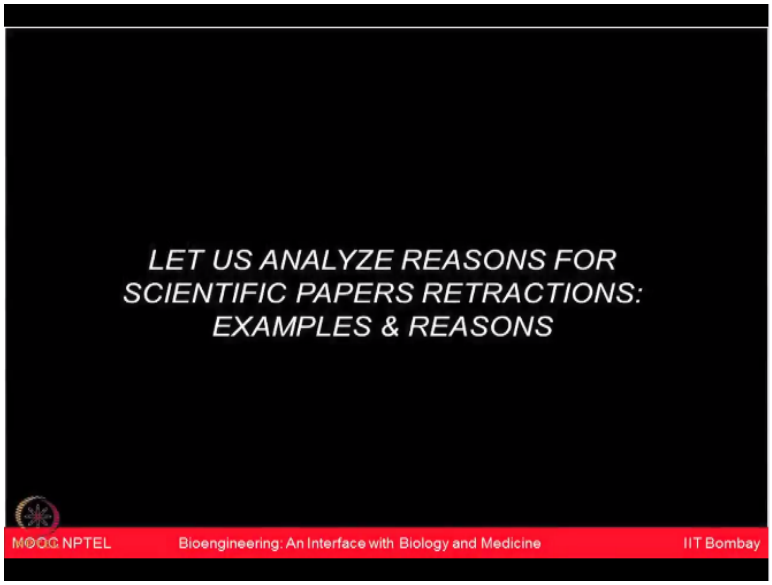

So today let us analyze the reasons for scientific papers retractions. Let me take you to some examples and possible reasons that why a scientist do perform these scientific misconduct.

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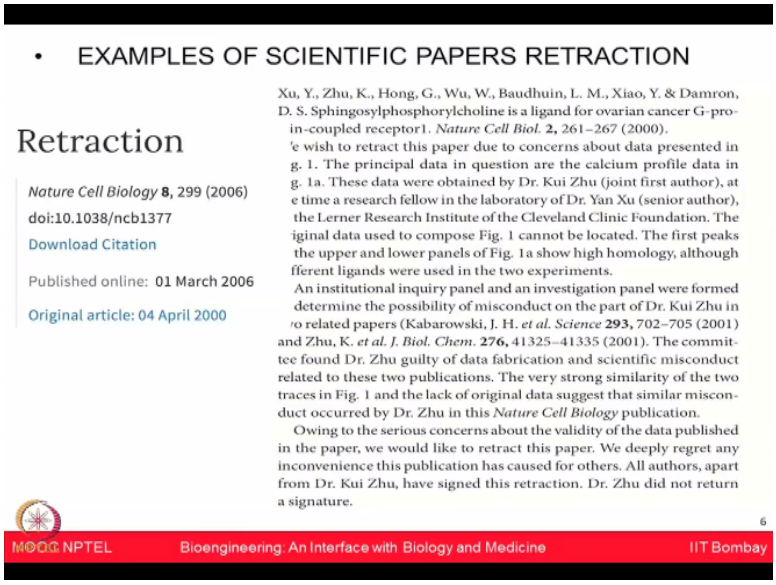

So I have shown you here some of the examples of scientific paper retraction. You can see this paper from Nature Cell Biology.

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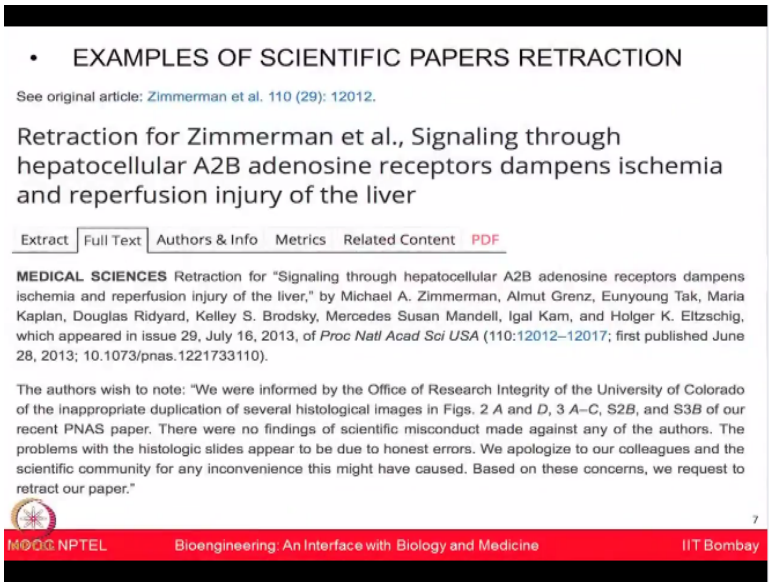

I have shown you another example here where another paper was retracted.

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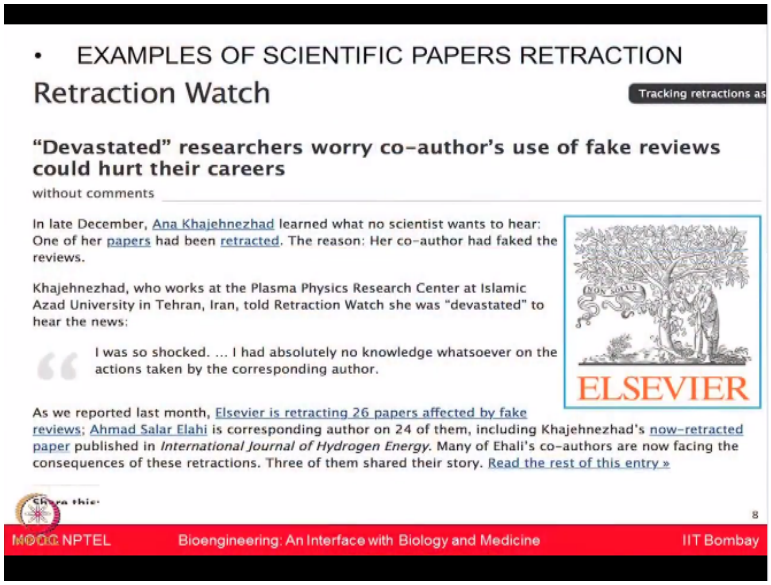

One more example here and in this case even the co-authors were not aware of what were the issues happening and one of the co-author had mentioned that I was so shocked in fact I had absolutely no knowledge what so over on the actions taken by the corresponding author. So I think it is very important that if you are part of a team, the corresponding author should inform all the co-authors about any development which are happening related to your scientific work and the publications.

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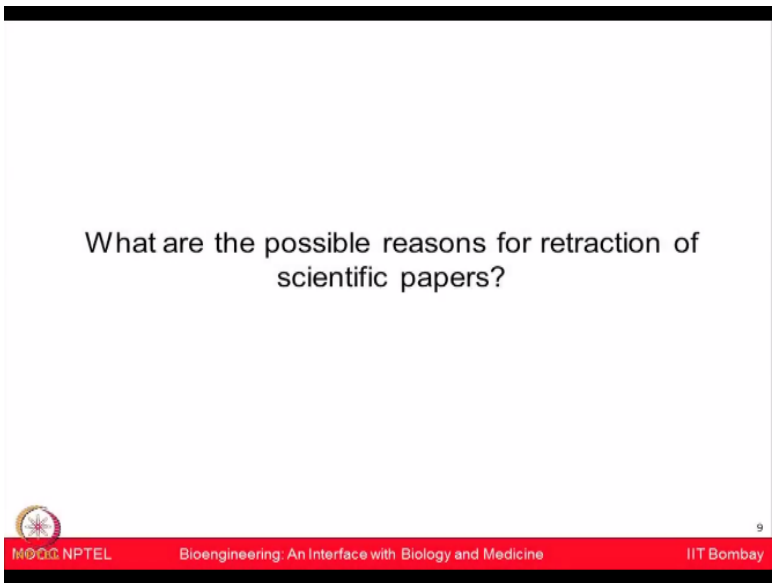

Let us now analyze and discuss what are the possible reasons for retraction of scientific papers? There are increasing number of scientific paper retractions happening which is really you know bad and alarming news.

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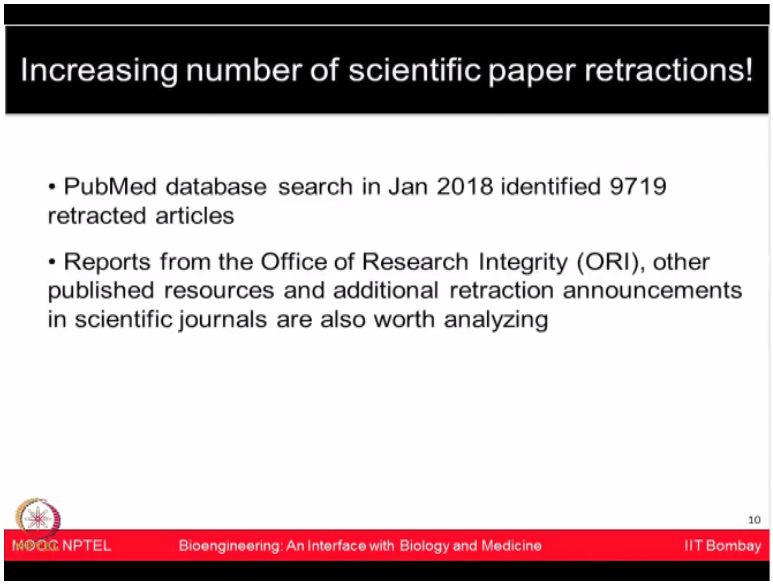

If you do PubMed research, in Jan 2018 they identified almost 9800 articles were retracted. The report from the Office of Research Integrity and other published resources and additional retraction announcements are also happening in scientific journals which are also worth analyzing.

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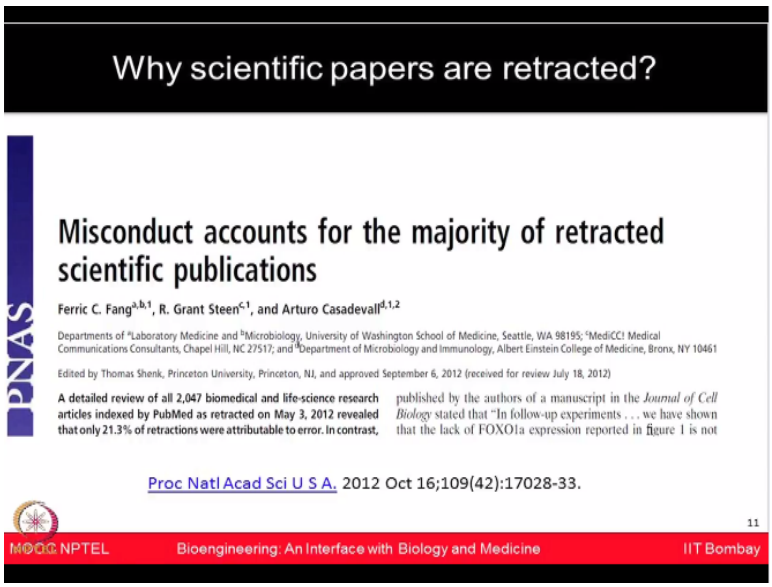

In journal PNAS, they try to analyze what are the reasons for the scientific misconduct and why scientific papers are retracted as you can see in this slide in the published article from PNAS.

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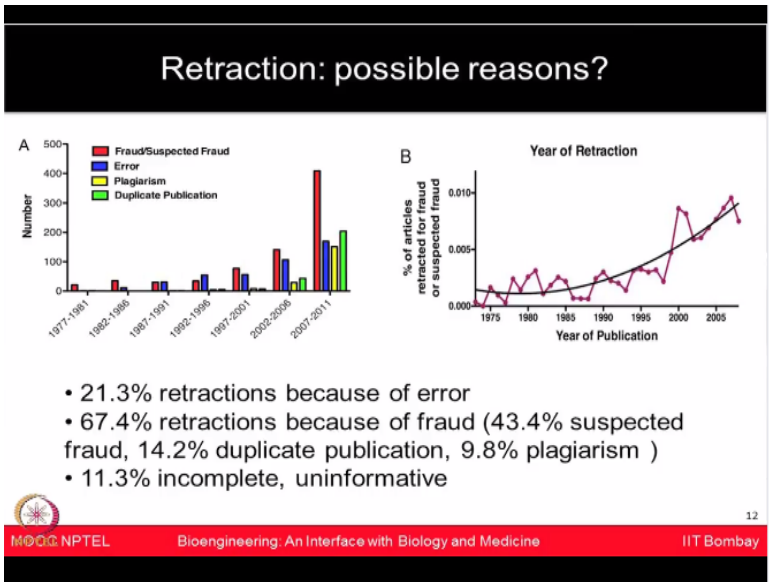

They try to analyze various reasons for possible retractions and found that while small number of papers almost 20% were because of some errors which has happened in the process. People have not made the knowing mistakes but there were almost 67% scientific papers were retracted because of fraudulent cases could be suspected for the duplicated publications or even plagiarism.

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It seems the image manipulation is one of the favorite area for the fraudulent researchers to manipulate and then do the changes in the results. I have shown you here couple of examples.

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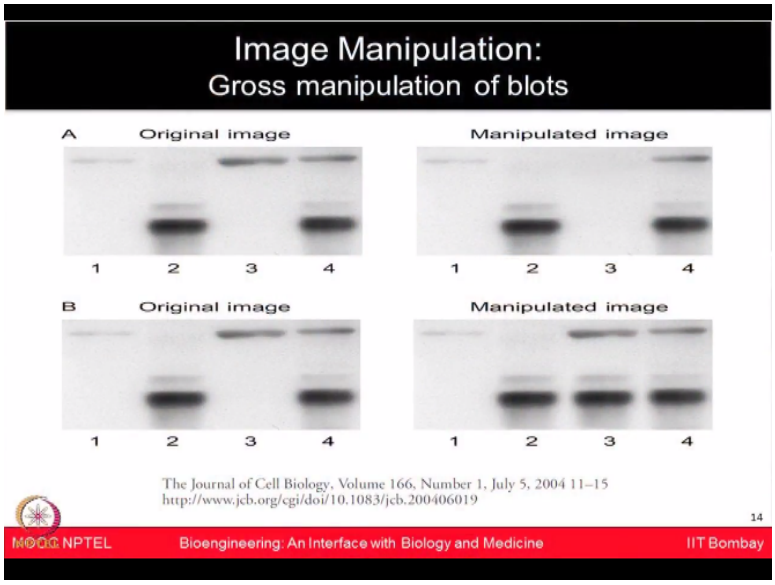

Let us look at here this image manipulation where a protein analysis is happening and the blot is actually manipulated. This is shown here from the journal of Cell Biology paper on the left side the original image.

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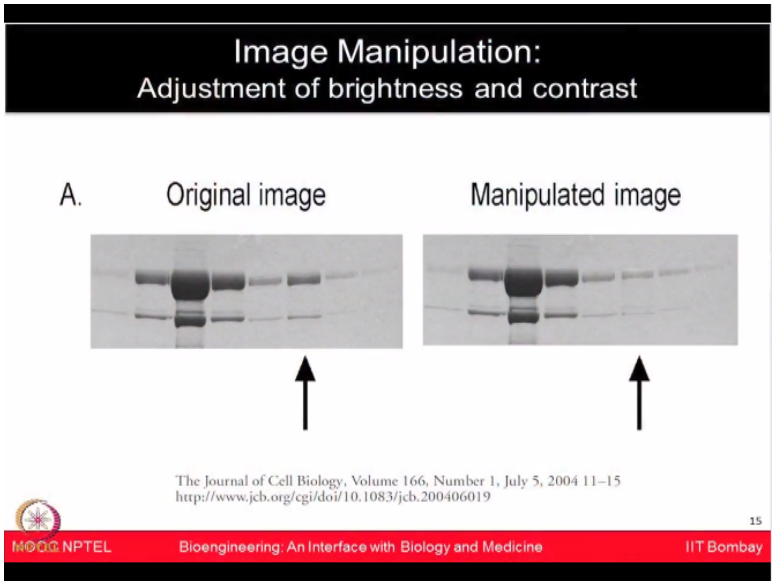

And on the right side you can see the manipulated image, how the bands have been removed to look very different. So image manipulation by adjusting brightness and contrast is another area where lot of manipulations happen. As you can see on the left side the original image and right side the image which is manipulated just by changing the contrast how different these bands are looking like.

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In the next slide, you can see again by changing the brightness and contrast even the gel which has you know many contaminants could be you know avoided and just you know a single band is shown on the fourth panel in the right side in the image.

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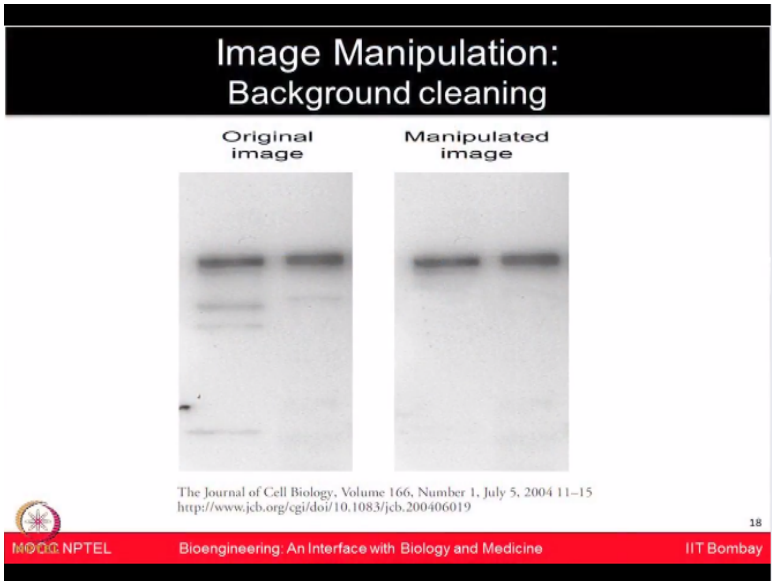

Again, you can see another example where original image was manipulated and now all the bands which are visible in the lower side they have been removed and now you can only see single band from the gel. Looking at the cell morphology, cell under microscopy again lot of manipulations happen.

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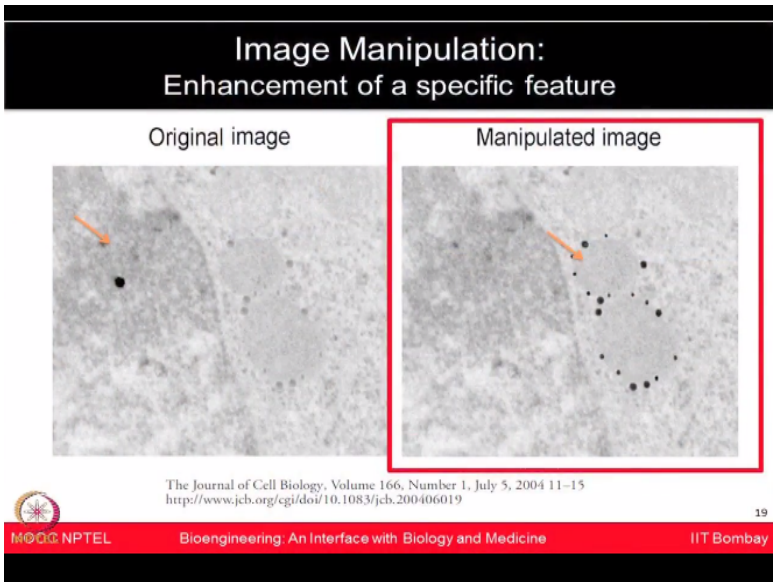

For example, enhancement of a specific area is shown here in the image which is manipulated on the right hand side and now you can see that you know some of the misrepresentation of microscopic images.

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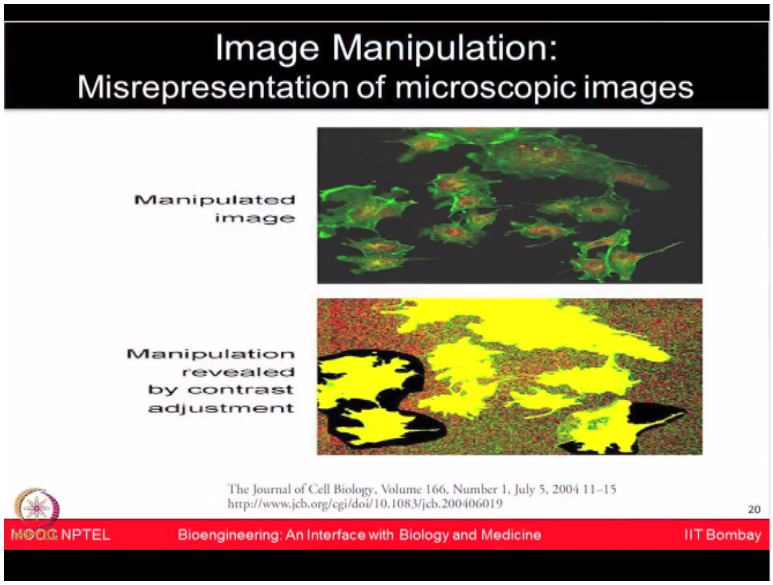

Something shown on the top panel is an image which is manipulated and now you know later on if you change the contrast you can see how this was manipulated. So journal Science, they looked into the image manipulation very seriously.

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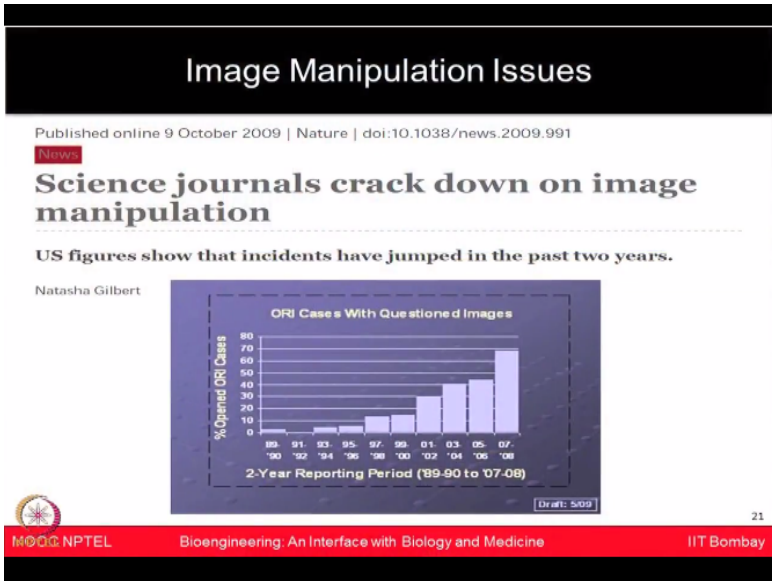

And their you know data and analysis showed that large number of publications have actually been retracted because of the manipulation in the images and therefore now you know many of these journals they have their editors and they have the you know the technical team who also looks at the images quite seriously even before the manuscripts are being sent for the PI review process.

So the question is that you know if you are you know a PI or the head of a lab and you do not have you know very much experience about you know how to operate these you know photo imaging softwares or the photo editing softwares, you may not able to you know really make sense that you know what is exactly the correct image or what could be the manipulated image.

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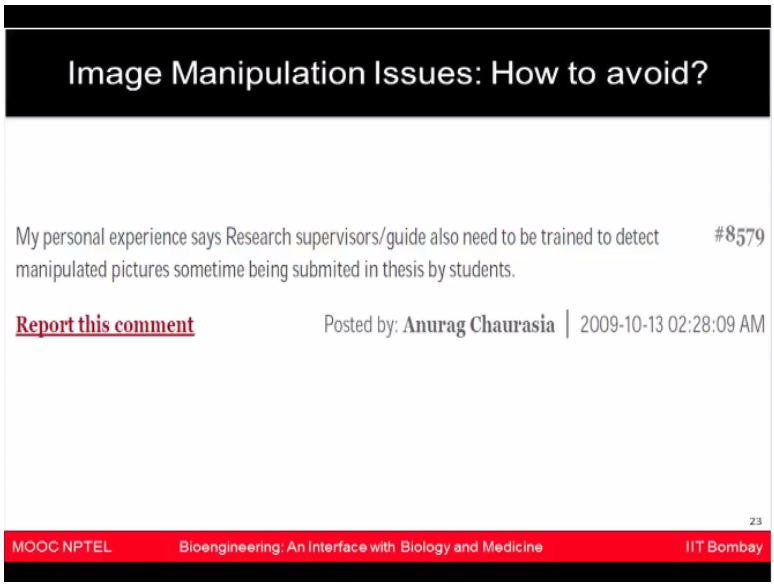

So one of the researcher actually mentions here in one of the blogs that my personal experience says that research supervisors and guides they also need to be trained to detect the manipulated pictures sometime because you know the students can make these changes and manipulate this and even they may not able to figure it out. So it is really important that on one hand you know one should not make any these kind of changes.

But there should be a stringent PI review process involved where you can correct these kind of any suspected practices.

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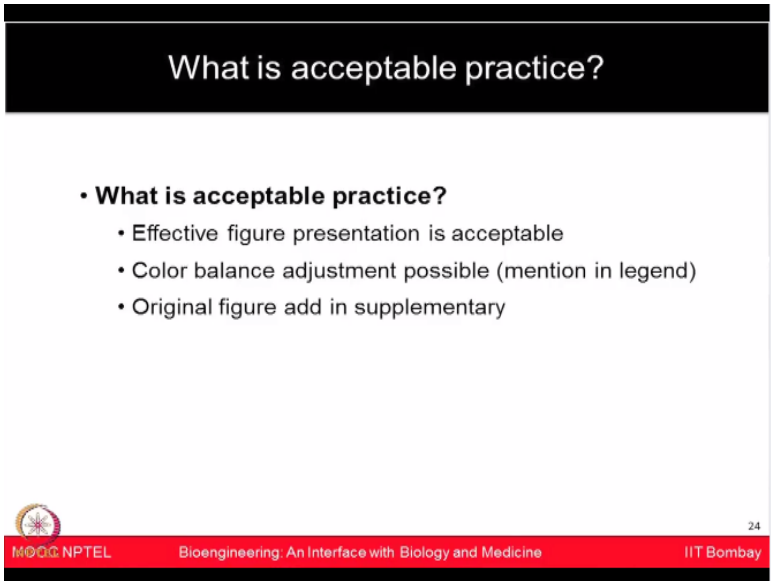

So what is acceptable practice for presenting a data and the images? So the acceptable practice is to show your figure effectively. Of course, that is accepted, you do not want to show you know just the raw image without any you know the copying the background; however, if you are doing lot of color adjustments or color balance you should mention that in the figure legend that you have used these settings to change or modify this image.

And of course you can put the raw image original figure in the supplementary which is part of the manuscript and reader when they are reading it, they can actually try to go back and look at their original image as well. So what is research misconduct?

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The research misconduct is defined as fabrication, falsification or plagiarism in performing research or reporting research results. The National Science Foundation has defined these guidelines for defining the research misconduct.

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So fabrication is making up results and recording or reporting them. Falsification is manipulating research materials, equipment, or processes or changing or omitting data or results such that the result is not accurately represented in research record. Plagiarism is appropriation of another person's idea, processes, results or words without giving them appropriate credit.

Source for these definitions are used from National Science Foundation. So what are the major types of scientific misconduct?

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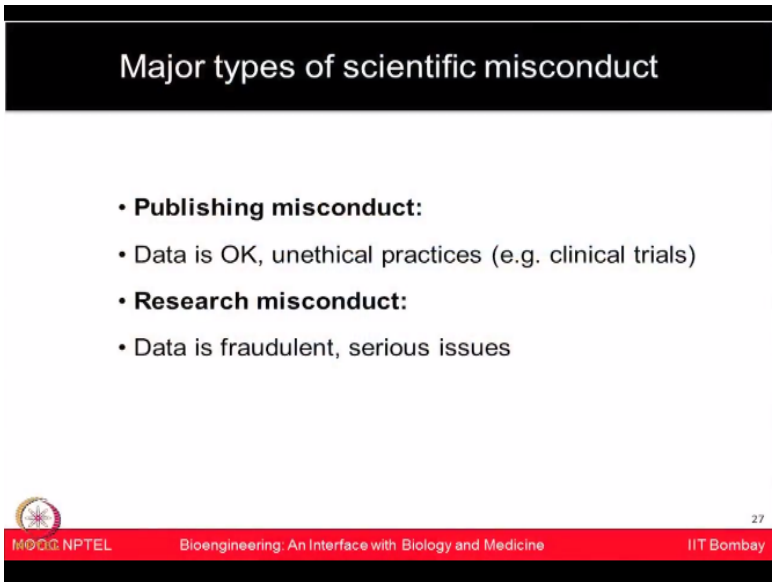

One of them is publishing misconduct. Your data is okay but one has performed unethical practices. For example, to do a clinical study the clinical trials, the proper concerns were not used and then has been misuse of the sample which was obtained, that is unethical practice which is a publishing misconduct. The research misconduct is that the data itself is fraudulent, that data was generated in wrong manner which is much more serious issue.

Of course, any kind of misconduct is serious for that matter but changing data or representing in a different form is of course much more serious and there has been lot of you know analysis in which way people have done misconducts from different parts of the world.

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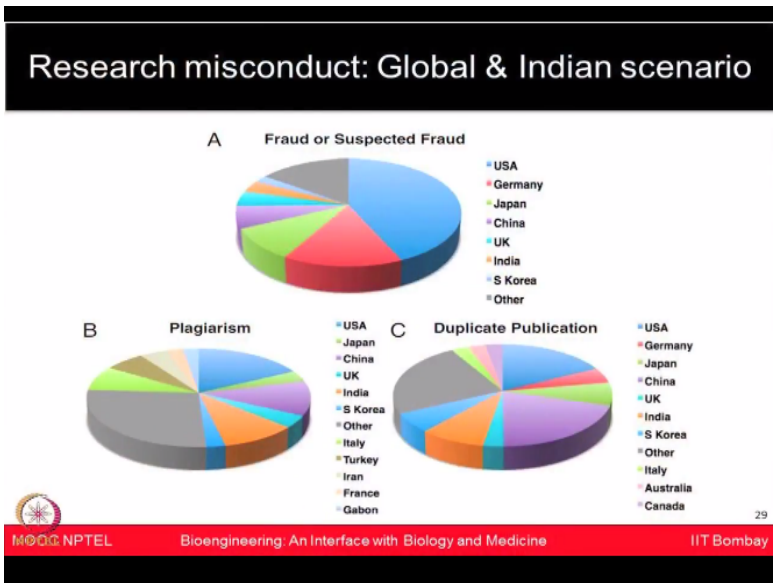

And if you can see here you know in this graph from this paper where it shows that you know large number of frauds or suspected fraud papers actually came from USA. There are many countries part of it including India. Of course, you know USA shown in the largest fraction not only because you know there are lot of misconduct is happening but mainly because that large number of publications are coming from USA and lot of research is happening and therefore is you know a fraction of that is also suspected frauds.

People have found even plagiarism and duplicate publication in all of these categories from almost all part of the world are actually you know involved in this kind of stuff which is not happening around a specific continent and if you look at the journals where the most of these articles have been retracted.

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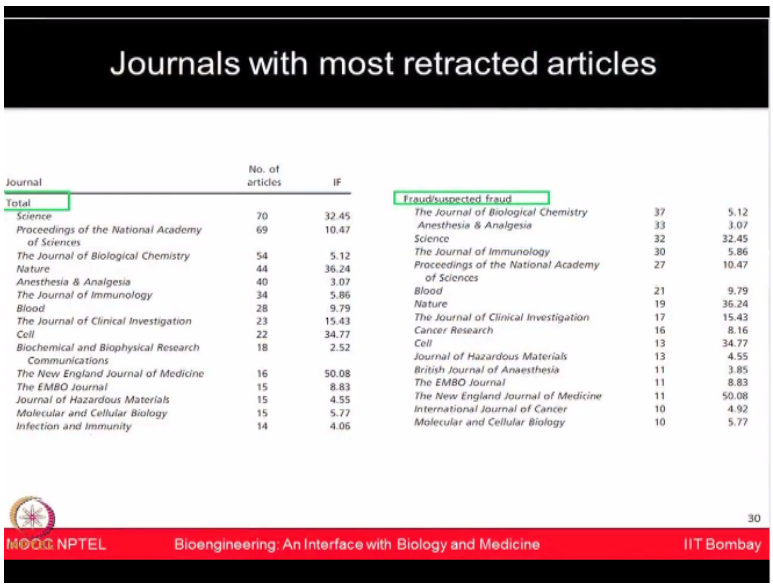

It is alarming to see that they were the most prestigious journals including Science, PNAS, Nature, JBC all of these journals they have reported many articles which were retracted.

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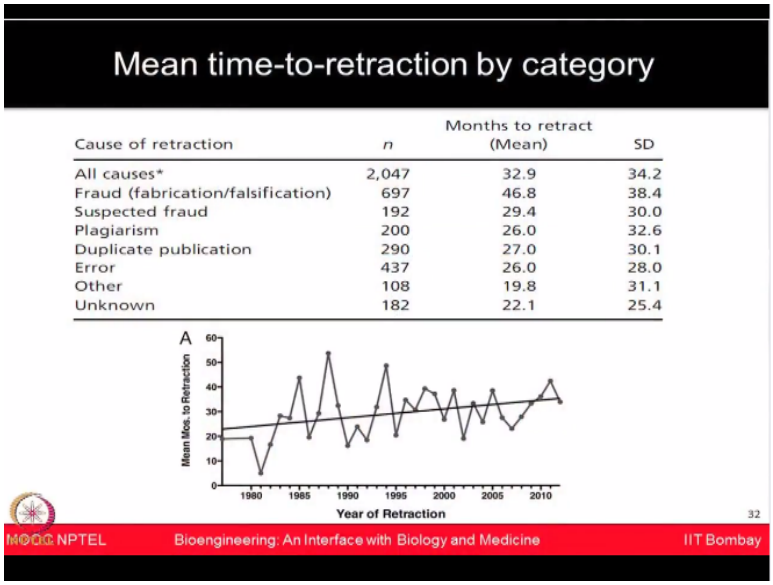

People have also tried to analyze that you know what is the mean time to retraction by the category that how many years that will it take for you know the fraud to be figured out and the articles to get retracted.

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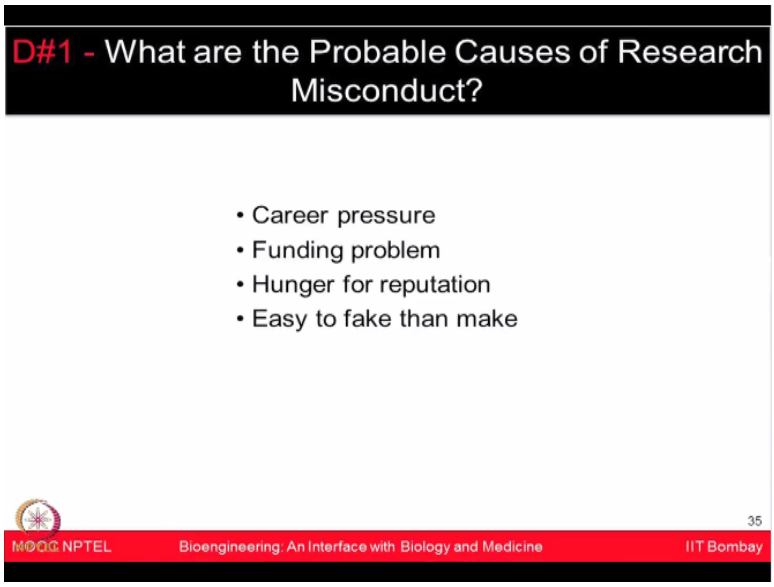

But you know the main question is that what is the probable cause of research misconduct? Is this the career pressure or looking at more sort of funding opportunities? sometimes there is hunger for reputation, it is very easy to fake than make. Many times when you are part of a team which is you know let us say as a student when you are competing for some you know competitions you are going to the international competitions and you are part of a team which is making some devices, some sort of you know robots.

And then at that time to be the first to be the top in the world I think you know if you change your mind sometime and kind of you know get engage into any kind of misconduct, you are using somebody's already (()) (12:28) idea and trying to represent as your own, I think that will probably lead to the misconduct which is you know sometime that kind of pressure of whether it is career pressure or competition pressure I think should not affect your originality which is really crucial.

Let say you are working in a research lab, now you are as undergrad students you are going to work in a scientific laboratory you know of course you are most junior over there and there are you know many senior PhD students and the postdocs, they are all working in that lab and you actually somehow get sense that you know something suspicious is happening some sort of scientific misconduct is happening in this lab so what should be your role?

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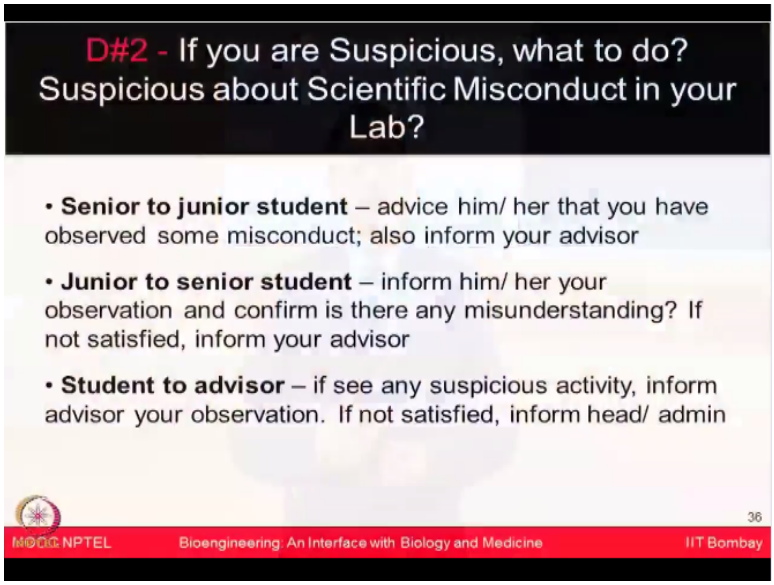

I think you know because you are very junior that time and you may not know exactly that you know what should be the best ethical practices for doing research. It is important that you can talk to your senior that you know feel that something the way it is being done in this particular you know result which you are showing is not correct you know and this is my understanding you know please correct me if I am wrong.

And let say know if sometime you are a senior and junior student comes to the lab and now you are you know finding that the junior is doing some mistakes and he is doing some sort of suspicious things and changing the data, changing the gel images and then doing something which is just for the publication sake then I think it is your you know responsibility to inform

your seniors to inform your PI to the professor that you know something suspicious happening and let them kind of you know decide what to be done.

Let us think about extreme situation that would professor or the PI itself is actually engaged in some sort of you know plagiarism or these kind of suspicious activity or scientific misconduct that is very you know difficult situation because you as a student will actually hesitate to say that you know how to handle this kind of situation but I think it is still your responsibility to go back and you know talk to the professor.

But if you do not have courage to do that you can actually inform your you know head of the department or the deans so that you know they can do investigation.

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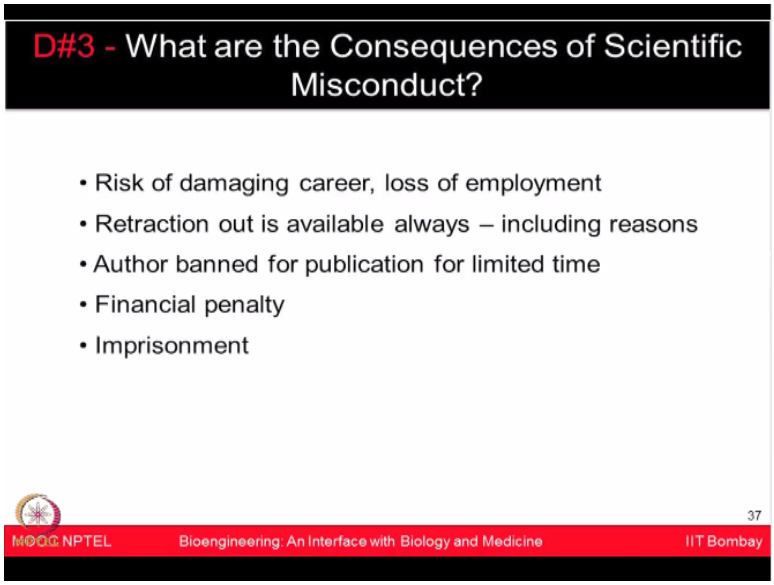

Next question is you know what are the possible consequences of scientific misconduct? I am sure in the context of discussion of the animal cloning you have seen that you know many of the researchers who are involved in doing the fraudulent work, their carrier got totally damage, they lost employments and these kind of retractions you know are very detrimental for the you know any researcher's carrier.

Because there are always you know published, they are always out that you know and the reasons are mentioned that you know what are the possible misconduct reason in that paper. Sometime you know authors could be even banned for publishing for limited time you have seen that in case of the you know the cloning story. There is lot of financial penalty were given in fact even imprisonment was also given.

So lot of you know the consequences you will face if you do the scientific misconduct. So it is really important that you know make sure that you know you are spending enough time to obtain the good results and you are not you know kind of (()) (15:27) doing the scientific misconduct. So I must say that you know it is very nice statement made by National Academy of Science in 1995 that someone who has witnessed the misconduct has an unmistaken obligation to act.

So if you see that you know some misconduct is happening around you, you are part of a team which is going to compete in an international game and you feel that you know one of your colleague is actually you know doing some sort of misconduct and if you do not report that just because you know your friend is involved in doing that that is not correct.

Because you have to report that kind of misconduct if you are part of the team because every coauthor or the every colleague of that particular work is going to be equally you know involved in that kind of misconduct. So it is really crucial for you to take act on this

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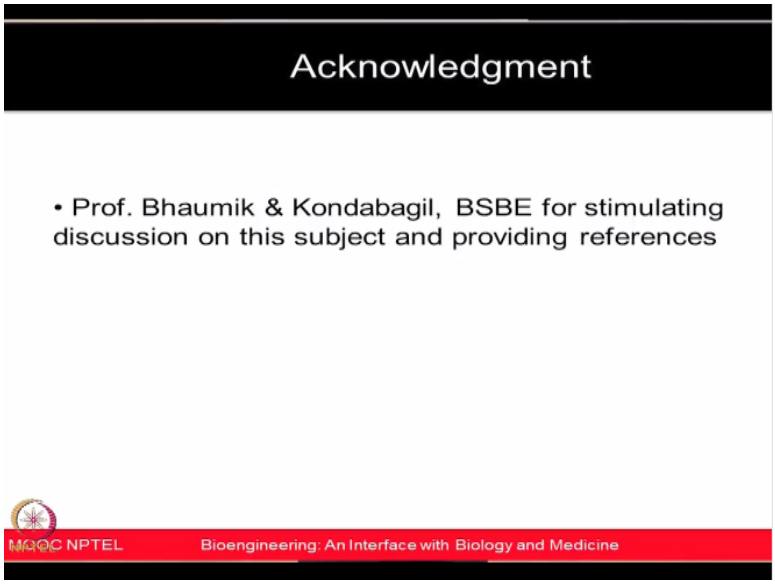

I would like to acknowledge for this lecture two of my colleagues from Department of Bioscience and Bioengineering professor Bhaumik and Kondabagil who has provided me some very stimulating discussions and good references for this kind of you know scientific misconduct based you know various articles published in last couple of years' time. So students I hope this course has now made you very much excited to study biology. Let us now review what we have learnt during these last 8 weeks.

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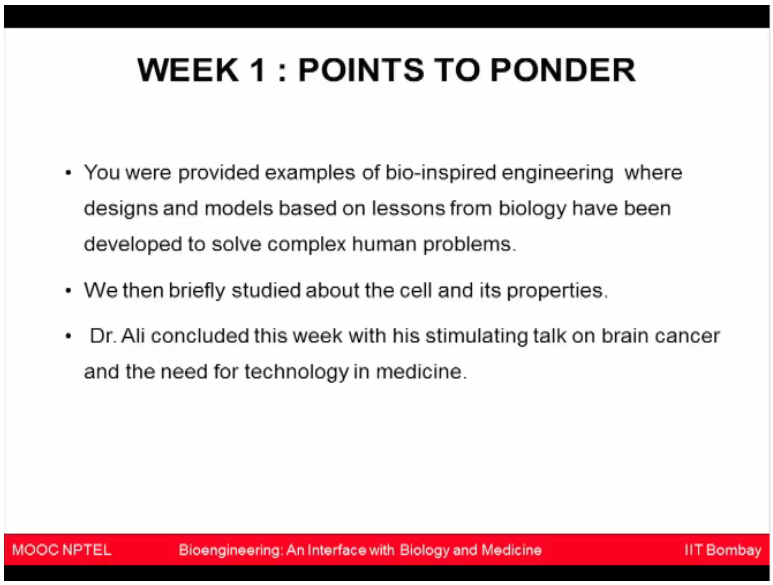

During the very first week, you were introduced to the major life problems and how we require interdisciplinary skills to find effective solutions to these problems. We provided you examples of bio-inspired engineering where designs and models based on lessons from biology have been developed to solve very complex human problems. We then briefly studied about the cell and its properties.

A clinician Dr. Aliasgar Moiyadi was introduced who talked to you about brain tumors and how there is a need for engineering interventions for the medicine.

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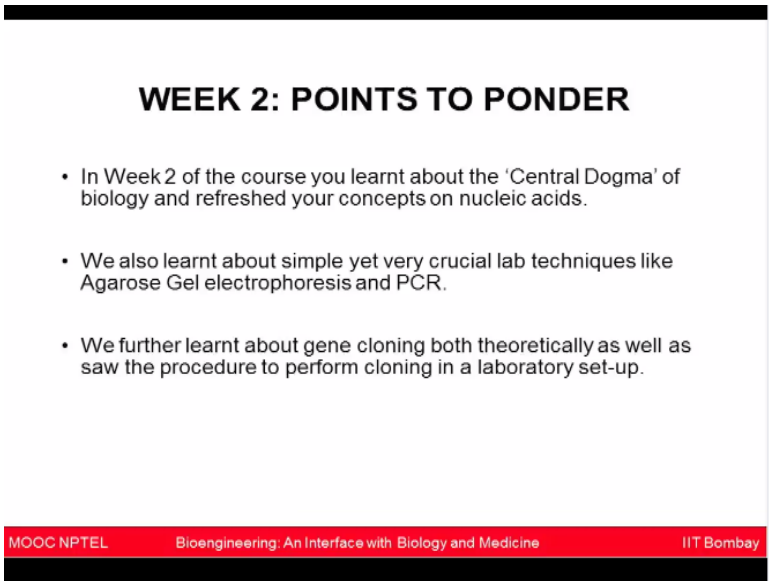

During the week 2, you learnt about central dogma of biology and refreshed about the concepts of nucleic acids. We also learnt about the simple yet very crucial lab techniques like

Agarose gel electrophoresis and polymerase chain reaction. We further learnt about gene cloning both theoretically as well as the lab demonstration sessions where you have seen how to do the cloning, how to perform these molecular biology experiments in a laboratory settings.

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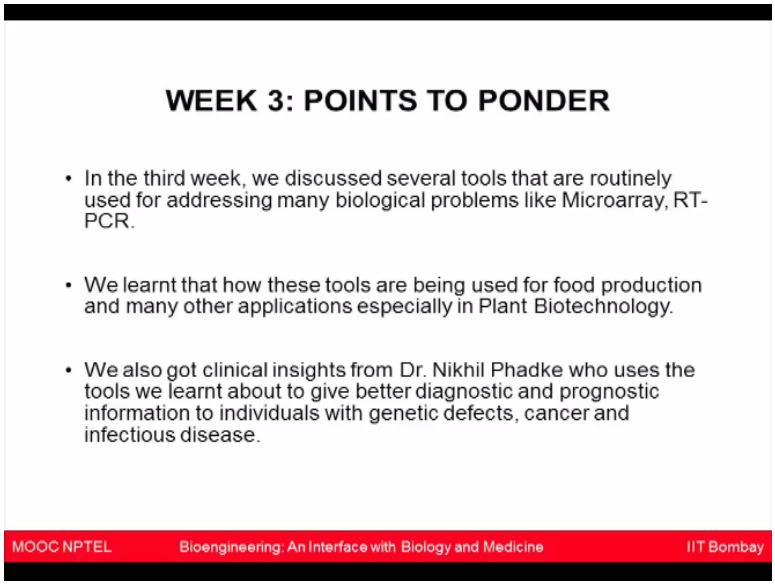

In week 3, we discussed about several biotechnology tools that are routinely used for addressing many biological problems. These tools included microarrays, RT-PCR and sequencing technologies. We learnt how DNA sequencing has revolutionized the field of modern molecular biology and paved the way for next generation sequencing. Furthermore, we learnt how these DNA tools are being used for many applications such as food production as well as in plant biotechnology.

We also got clinical insights from Dr. Nikhil Phadke one of the clinician who uses these tools for patient care to provide better diagnostic and prognostic information to individuals with genetic defects, cancer and infectious diseases.

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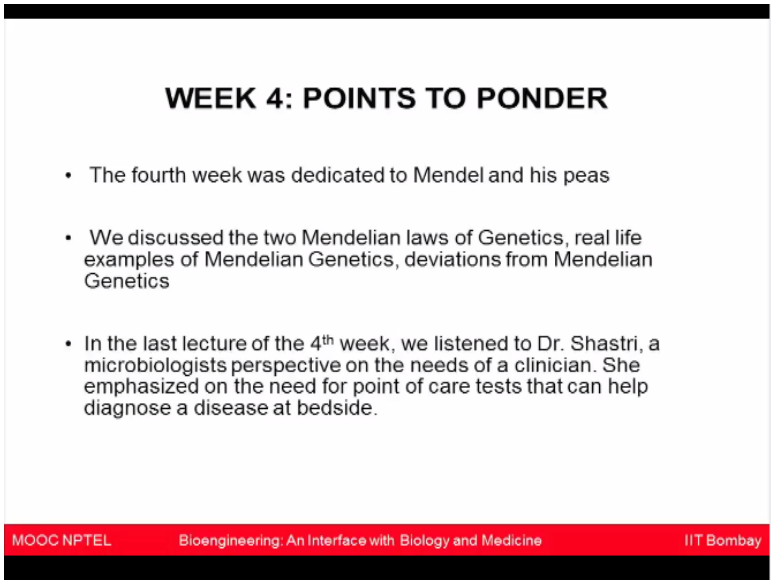

During the fourth week, we dedicated our time for Mendel's experiment especially pea plants. We discussed the two Mendelian laws of Genetics, the real life examples of Mendelian Genetics as well as cases where there is deviation from the Mendelian Genetics. In the last lecture of the fourth week, we introduced you to Dr. Jayanthi Shastri, a microbiologist who provided her perspective on needs of a clinician.

She emphasized on the needs for the point of care tests which could help to diagnose a disease at the bedside.

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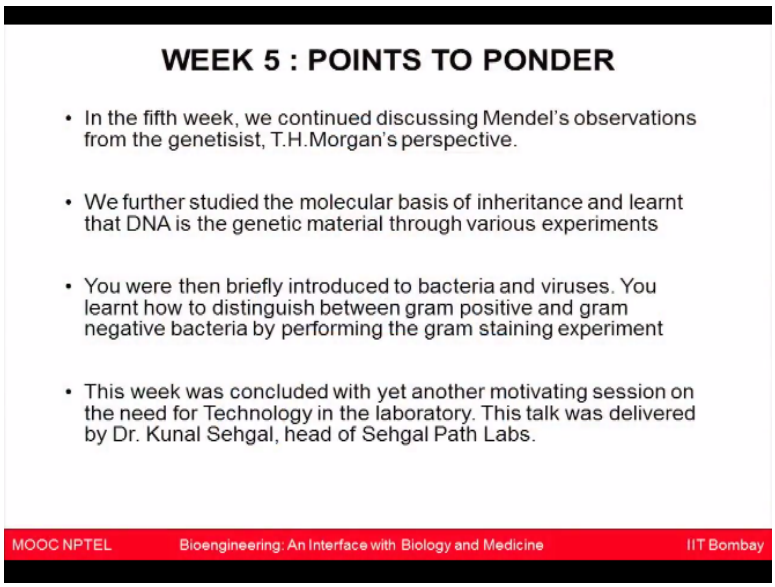

Next in the fifth week, we continued discussing about Mendel's observation and we moved on to Morgan's elegant experiment on genetics. We learnt how Mendelian inheritance has its physical basis in the behaviour of chromosomes. We further studied the molecular basis of

inheritance and learnt that DNA is the genetic material through various experiments. You were then briefly introduced to basics of bacteria and viruses.

You learnt how to perform experiments to distinguish the gram positive and gram negative bacteria. This week was concluded with another motivating session from a clinician Dr. Kunal Sehgal who heads the Sehgal Pathology Labs.

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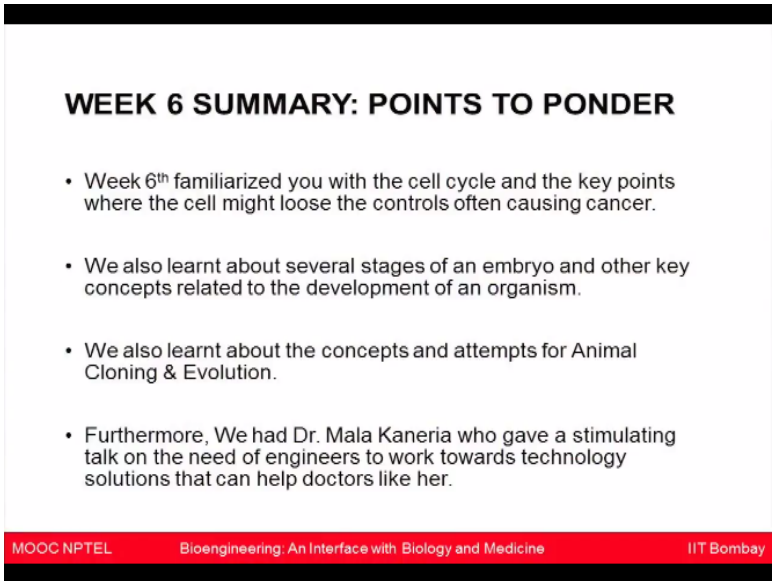

The week 6 familiarized you with the basic concepts of cell cycle and key points where the cell might lose the control and often cause disease like cancer. We also learnt about several stages of an embryo, another key concept which are related to the development of an organism. We also learnt the concepts of animal cloning and then the lessons on evolution was given to you to appreciate the diversity of the life and also gave you the scope to explore the field of population genetics.

Furthermore, this week we had Dr. Mala Kaneria from Nair Hospital who again gave you a very stimulating talk on need of engineers to work towards technology solutions that can help doctors like her.

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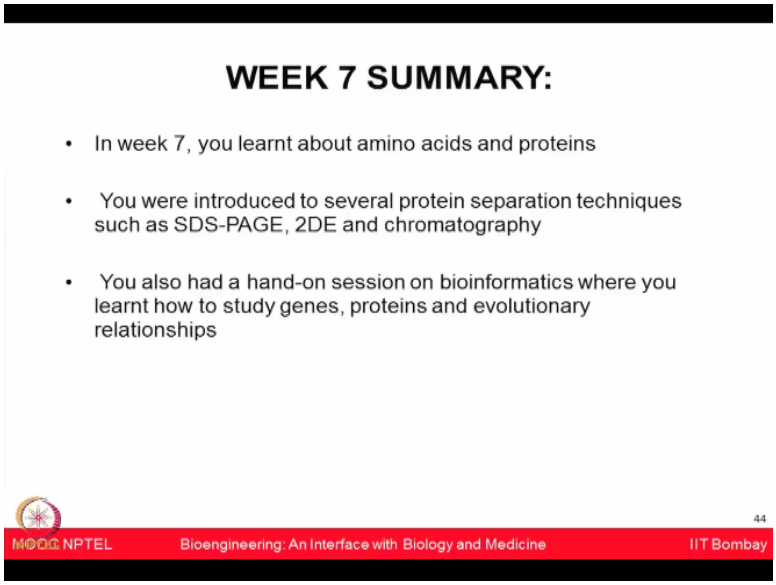

Next week which was week 7 we started talking about basics of amino acids and proteins. You introduced to several protein separation technologies such as SDS-PAGE, 2-dimensional electrophoresis and chromatography. You also had a hands-on session on bioinformatics where you learnt how to study genes, proteins and evolutionary relationships.

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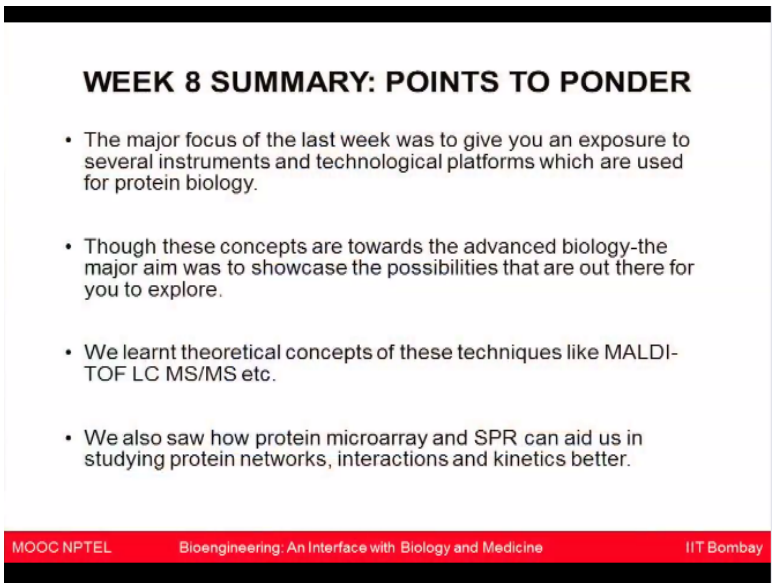

From this week then we moved to the last week the week 8 where we had major focus on protein separation technologies and protein technologies so in this week we performed few experiments which gave you the good understanding that how advancements in protein technologies are now able to provide us a comprehensive overview of various complex physiological processes.

We learnt how protein microarrays and label-free technologies like surface plasmon resonance can aid our understanding for studying protein interaction networks and finding their kinetics to provide us better understanding. So the aim of this course was to encourage you all to see biology in a very different way. We hope now you agree that biology is much more than just a subject.

There is a lot of scope for biology and engineering to coexist and bioengineering can offer many unique solutions that can be useful for agriculture, medicine, health and many other applications. Thus, I hope you are now motivated to learn more about these tools and the areas of bioengineering. Before I finish let me thank the NPTEL head and technical team for all the support in bringing this course to the students on time.

I would also like to acknowledge all the course TI's for their very high quality work. Many thanks to my students of IIT Bombay BB101 course as they keep motivating me to teach biology course to engineers with their very naïve but very interesting questions. Also a note of gratitude to the members of my proteomics lab who have enhanced the course by their lab demonstrations.

We need you and your risk is to tackle many research problems. Let us continue this journey together.

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