Nanobio Technology Enabled Point-of-Care Devices
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Lecture - 03
Translational Research and NanoBiosensing

Ok, students so today I will teach you a new topic on Translational Research that can be very much useful for NanoBiosensing. So, what is the transnational research?

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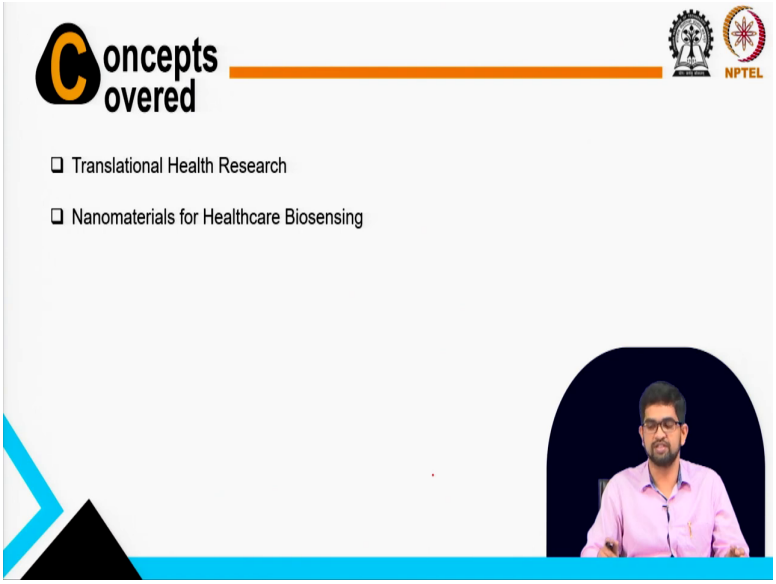

So, the main contents of the today's teaching the translational research for the nano biosensing especially you can think about the what is the definition of translational research first for today's lecture and then nanomaterials for the healthcare and the biosensing these two topics mainly I will cover to this slide.

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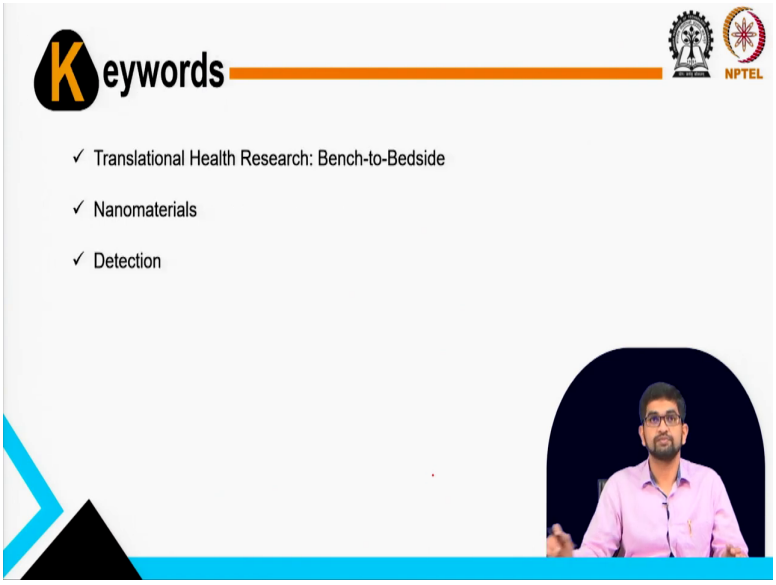

So, main keywords for this teaching for today is the translational research that is the bench to bedside, the main definitions of the translational research whatever we are doing in the lab that can be useful for the point of care diagnosis that is the near the patients that is called the bedside. So, that I will show you in details away, then nanomaterials for fabrications of the biosensors and the detections and how we can use the translational research for nano biosensing.

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See, the translational research is very unique topic it is the thing is the laboratory breakthrough to the patient care. It translational research the main thing it can expedite the discovery of the new diagnostic tools that can use the multidisciplinary technique. So, why translational research is needed?

Well, it can expedite the discovery. Now, let us come to the translational research first. So, you can see in the image in the left side in this slide that at first we are doing different kind of research in the laboratory, then we are going for annual trial and we are validating our concept.

Now, we are transferring this idea to human trial for applications maybe we are developing some drug or developing some new therapy that we have to try for human trial before that we have to optimize all the conditions in the lab. You can see in the selected sites here actually

we are first doing the laboratory testing. Now, we are transferring this idea to human trial. Now, we are giving to the doctors and they are trying this drug or your technique suppose we are developing some detections method.

So, we have to after the validation you have to give to the doctors that they will validate it and it is not the unidirectional method it is actually the both directions. Once we developed in the lab and we are giving to the doctors they may find some problem it may not be useful there may be some side effect or maybe we can improve this technique it is useful, but may not be perfect. So, what we can do? We can come back again to the laboratory again and we can improve and we can try to recover the issues hm.

So, again we can come back to the lab we can do the testings again we can again go for the annual trial and again we can give to the doctors or to the hospitals they can try again they can validate your technique like this way. So, like this way only we can expedite the your technology your development and that can be useful for point of care.

So, that I taught you the nano biotech sensing technology that is same thing what we are doing in the laboratory we have to go for the real sample testings, then we can ask the doctors to use this and if they find it is good then we can go for commercialization.

So, as that is why I am saying it is very much multidisciplinary and it is the highly collaborative means basic scientist we are doing the research in the lab then we are giving this one to the doctors. So, we need the always the collaborations with the clinicians ok.

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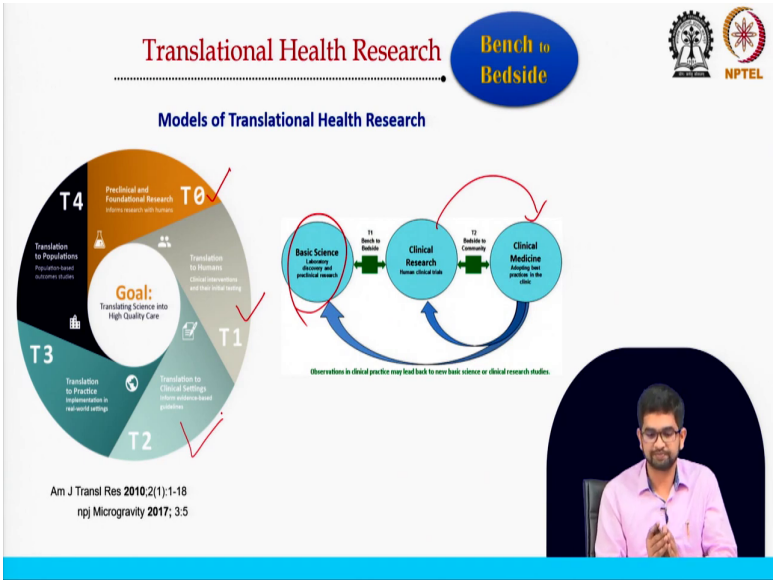

Now, before going to the nano biosensing translational health research very briefly I will tell you the some models of the translational health research there is some models like T 0, T 1, T 2, T 3, T 4. So, T 0 is the very basic stuff that we are doing inside the lab that is the very basic science ha, then we are going to the T 1 and T 2 and this highest phase that is the clinical trial and the finally, the medical.

Applications means first we will try in a small group of the members maybe in the after the animal trial to small group of member to the human trial, then we can get the large members then we can spread this one to not only the maybe suppose you are thinking the local region to the nationally, then we can spread to the like internationally I mean how much effective in the region wise your technique.

So, that is a different technique that is why. So, this is the very preliminary then translational human research a small group to the higher group and then we are trying this technique to validate in the all over the region. So, our main goal of the translational research that is why you are validate your technique for the mankind.

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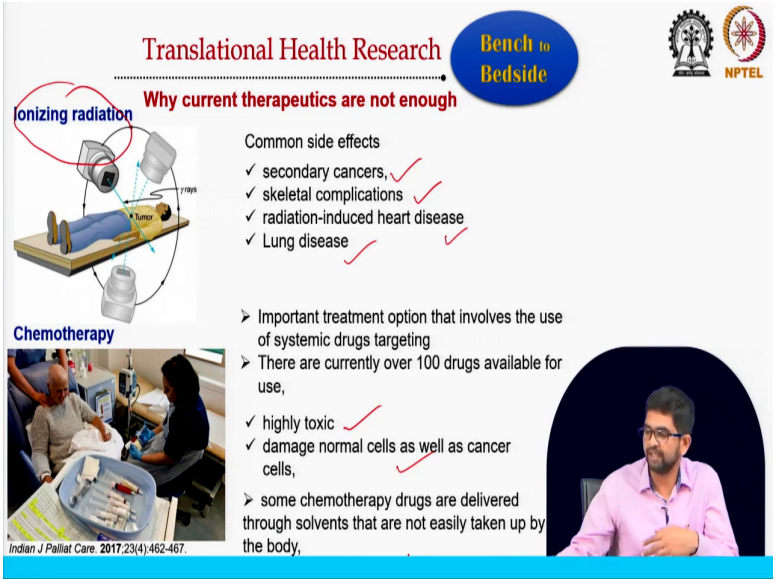

So, why translational health research is needed? Because there is some current issues with whatever we are developing in the therapeutic or the medicine for example, in the cancer right.

So, we are using the ionizations radiations, but there is some drawbacks what kind of drawbacks? Like there can be secondary cancers possible that is skeletal complications possible there is radiation induced heart disease lung disease. So, we have to improve the

technique right another things like chemotherapy case I think you already heard about this the chemotherapy its not the very easy technique.

Where it is highly sometimes toxic damage the normal cells as well as the cancer cell is damaging at the side by side can damage the normal cells also there is some can secondary cancer also may be possible and some chemotherapy drugs delivered through the solvent that are not easily taken up by the body. So, you need the further improvement right.

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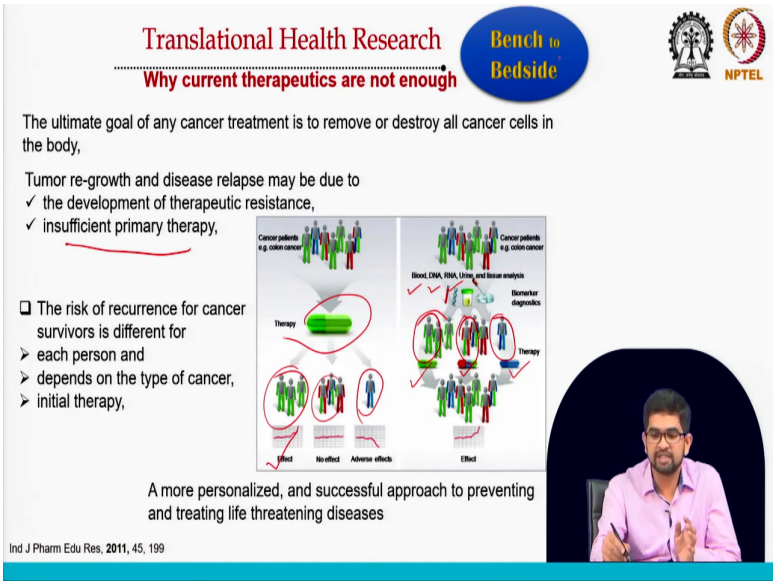

So, that is another things I will show you this image that there possible by the tumor re-growth also insufficient primary therapy, so this kind of problem. There is a risk can be recurrence again like because the therapy or drug we develop sometimes different person to person is not be useful for everyone.

So, we need some further development that is why I will show you one image here if you see generally what we are thinking that like a cancer patients we can go for the therapy. So, we can we are giving some medicine. So, it may be useful for certain group of the people, so it is very much effective, but some group case there is no effect, but some group of the people they may be adverse effect. So, what translational research can do? You can go for further study.

What you can do you can go for blood DNA RNA testing ha then we can divide the people like certain group. So, then we can apply some certain therapy for the different different group. So, it is the more personalized we can develop and these approach can be more successful.

So, you understand right the translational research is very simply and very briefly I am saying because it is this course is not for the translational research, but this concept is useful for biosensing. So, main thing theme is the bench to bedside that we are planning.

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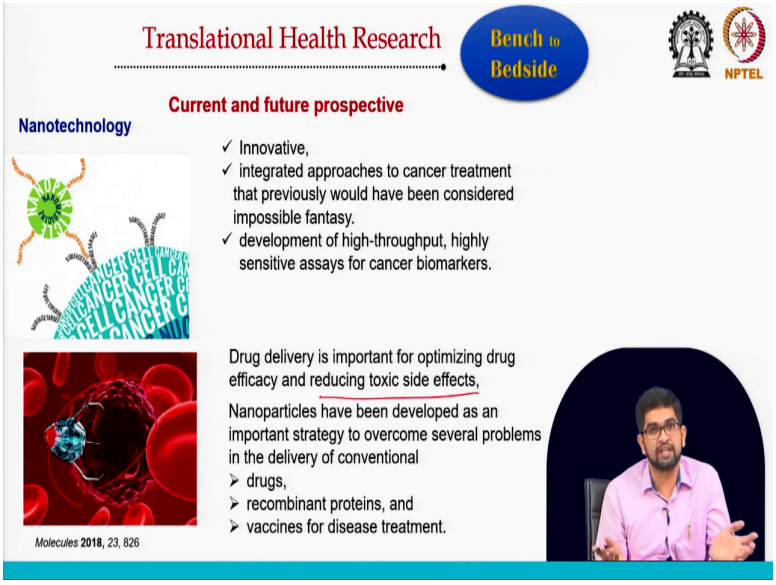

So, let us come to that. So, now nanotechnology the nano biosensing that is I told. So, it is very innovative technique and we can easily integrate this one we using different kind of nanomaterial. So, few years before we are thinking this kind of the impossible fantasy, but now we are really using this nanotechnology for current drug development for current like therapy and there is lots of future prospectives are there.

You see that for the drug delivery is also the very important and it can optimize the drug efficiency and it can reduce the toxic effect if you can use this kind of the nanomaterial base. So, these bench to bedsides applications using the nano technology is really it has a future prospective we can use this one. Now, let us come back this translational health research how we can use for nanobiosensing, it is not only the nanobiosensing like any kind of medical innovation.

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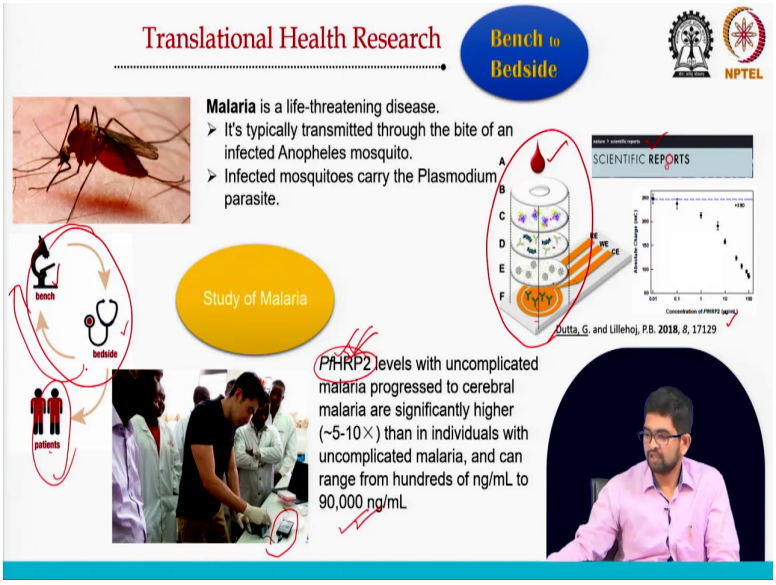

See I will give you one example that is the study of malaria. So, see the malaria is a life threatening disease that mainly infected by the mosquito carry the plasmodium parasite. So, we can think about the bench to bedside applications like we can developed a sensing technology. So, that we can detect the malaria in the early stage and we can go for further I mean treatment.

So, doctor should know that it is because of malaria or not if you come to the doctor with fever, so people should detect the it is because of malaria or not. So, what we are doing? So, first we can develop some sensing method you can see here in this pictures actually collaboratively work with Professor Peter Lillehoj in the Michigan State University.

So, where we developed a mobile phone based smart nanobiosensors that can detect the malaria. See when we use this kind of mobile phone based sensor for detection of some

malaria we tried in the African countries in there and we developed some sensor that was beautifully worked in lab.

But when we went for the trial, we faced some issues we are developing so many techniques, but you may plan ok it is very much useful for the patients it is very much it is very sensitive we can use for the point of care which absolutely fine. But maybe there is some another requirement for the field testing right.

So, I can show you the requirement now. So, we first went for the testings so, Professor Peter Lillehoj group they for testing this one, then they found actually PfHRP2 level is for the uncomplicated malaria progress to cerebral malaria is significantly higher concentrations of the PfHRP2 level. PfHRP2 is a biomarker that cause the malaria.

So, it can we can detect this biomarker if you have a malaria. So, we found that this marker is very very high concentrations in the blood samples and it can go up to 90,000 nanogram per ml. But whatever biosensors we developed that is very sensitive it can detect like picogram to nanogram level, but not it cannot detect like 90,000 nanogram per ml.

So, our sensor now failed because it becomes it is saturated it cannot detect the very very high concentrations, it can detect very low concentration not very high concentration, but in the case of uncomplicated case this concentration is very high. So, then how we can use your sensor? So, it is really a problem that problem we found where we went for the field testing.

Now, what we did? So, we came back to the lab then we developed the another sensors very simple sensors it is a paper based sensors. After few class I will teach you this kind all the electronic electrochemicals all the this kind of like what is reference electrode working counter electrode that I will teach you later.

But here you can see a very simple sensor we designed for this malaria detections where we use the blood samples and different different paper membrane we used and we used some

bioreceptors of the antibody on the sensor surface that can specifically detect the PfHRP2 and it will not be saturated easily ha it can detect very high concentration.

So, we use some technology here that technology I will describe you another day, but what we developed some new technology that can detect the PfHRP2 in blood sample in a very high concentration. You can see here that we published from we published I worked with the Professor Peter Lillehoj group.

So, there we published that scientific report where you can see that very very high concentration in the microgram per ml like 100 microgram per ml in this much concentrations we can detect the malaria. See so, then we can we solve this issue in the lab that whatever like pico gram like very very small concentrations to high concentration now we can detect. So, this by this sensor is ready now for again field testing.

So, see that is why we put here see this both directions like first we tried in the lab whatever you did your technology, then you went for the testings for filter then we face the issues like your sensor is not applicable because it cannot be high concentrations then we came back to the lab again.

Then we developed again a sensors that can detect the very high concentrations of the biomarker. Now, this sensor is ready so, we can now commercialize this kind of technology. So, this is very very like important technique for nanobiosensings also ok.

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So, there is you should read some reference papers also that I told you that I already referred some journals also you can investigates like this kind of the papers is really importants you please check it.

And you will get lots of more informations for the translational research and this is not only for biosensing for different kind of like cancers and other disease marker detections not only the like simple device development you can go for like therapy or like in nano technology based some drug, treatment that also you can check.

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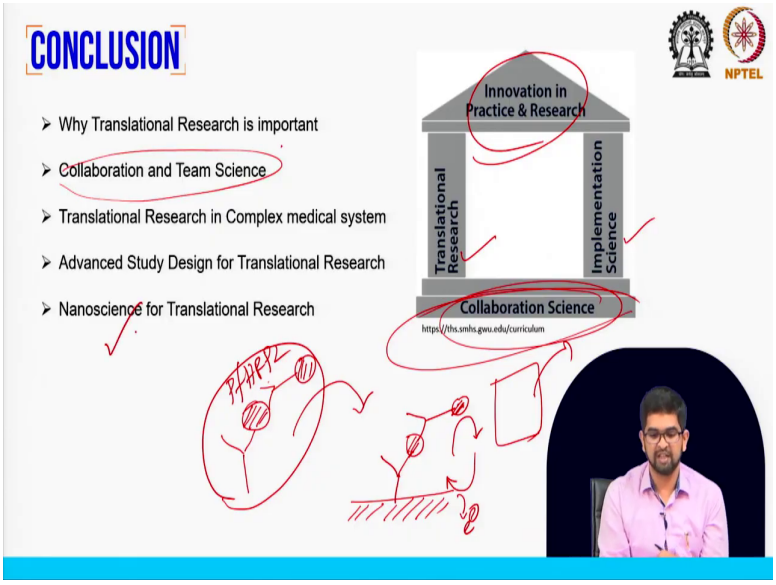

So, the conclusions of this story that is why the translational health research is very very important and I will show you one image here see. So, this image you can clearly see the our main innovations practice and research that is why it stands with a two very important strong pillar one is translational research on implementation science. So, we have to implement our research so, based on this translational research and this main base is the collaborations. So, only basic scientists cannot do.

See so, only like one chemist or one biologist they can develop very sense very simple technique they can tell you like antibody they can detect the some specific like PfHRP2 antigen it can detect by the help of like maybe you can develop some sandwich method biology that basic biologist that can tell it can tell you.

But you have to translate this technology to a sensor surface so, that one engineers who are developing the sensing technology he can help you like he can design or he can pattern a sensor on a like nanomaterial coated by one gold surface or any kind of like a different carbon surface so he can pattern for you, then you can translate this very basic concept on the sensor pattern surface right

So, now you checked this sensor is working. Now, you have to collaborate with a device maker like who are developing the device maybe you have to collaborate with the electronic background people's also because whatever signals you are getting from because of these reactions and you are getting some electron transfer now because of this reaction. So, you have to collect those electron and you have to amplify those signal and you have to show this signal to a display board.

So, you need some electrical circuit some display like a mobile phone based some technology you need. So, some electronic people they can help you. So, you need basically the collaboration with them, then once your sensor ready then you have to collaborate with some medical doctor right its a clinicians they will help you for validations right.

So, that is why I said these translational research is very important and it is very much collaborative approach then only your innovation can be successful with collaboration with other group. So, we can go for the collaborations and the team science for complete development of your innovations and translational health research also can be useful in a complex medicine medical systems.

So, not only that this very simple technique even in the complex diagnostic technique complex therapeutic technique you know sometime that is why development of a certain drug can take 10 to 12 year why it is taking too long time? Because of this because first you are developing some medicines then you are going for trial and then finally, you are validating.

So, it takes something too long time, but these translational research also can reduce the time. Then translational research it is a very advanced study design this translational research is

very very advanced technique and nano science for translational research can help you for further improvement also it can help to reduce the time this nano science ok.

So, that is all for this translational research in the next topic now I will show you the different nano biosensor based on nano material and that can be useful for the different signal amplification and the biosensor development.

Thank you all.