**Biophotonic**
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**Lecture 15**
**Remaining Topics**

Welcome back. Let us finish the third topic that is basic biology in our last class. Here I will very briefly go through some of the remaining topics that I found important and relevant to this particular course.

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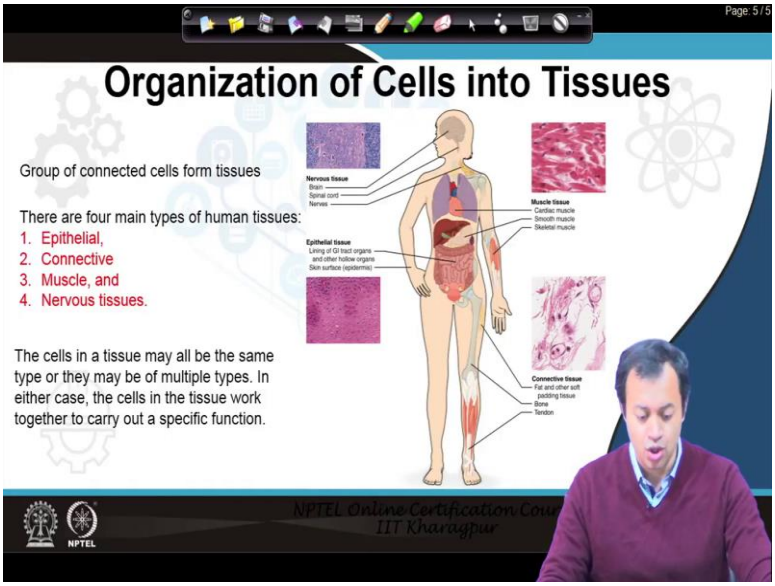


So, one of the fundamental characteristics of eukaryotic cells that are animal cells, animals and plant cells, is that here the cells can organize into tissues. The cells can combine to form a specific pattern in a specific arrangement and thereby this arrangement of cells, which we call as tissues perform a very, very specific function.

Now, human body can be divided into four major categories of tissues. Four major categories of tissues. They being epithelial, connective, muscle and nervous tissues. Human body is made up of four specific, four different types of tissues. Each tissue is a specific arrangement of a cell in a particular pattern to perform very, very specific function.

The most common of them being epithelial tissue. Epithelial tissue is the outer wall. It is the tissue that covers our organs, it covers our skin, it covers blood vessels, is the overall tissue that is present, that is there as an outer wall, as an outer protective and they are semi-permeable. They allow certain materials to pass through, dis-allow certain materials to pass through.

Then there is connective tissue, as the name suggests it connects. These are usually the tissues that are present between two different types of tissues. So between muscle and bone, you will find a connective tissue. Connective tissue is there to connect different types of tissues.

Muscle, well, obviously, you know, these are the types of tissues that are presents well, whose function is basically to contract. Gives us flexibility as well as give us structural support along with bone to do contraction, to move, gives us overall flexibility. Remember, this is human beings we are talking about. Organ, we are talking about human tissues. We are not talking about plants or anything because information on tissues will be required when you will be looking into tissues under the microscope and eliminating them with different types of light.

And finally, the nervous tissue. The nervous tissue is there mostly for control. It is there specifically for you to pass information, past signal, the cognitive functions, mental ability that is basically all of that are carried out with the help of nervous tissues. The cells in a tissue may be, may all be of the same type or may be off multiple types. Be aware in either case, the cells in the tissue work together to carry out a specific function. And this part is quite important. This specific function part that each of them have a specific function to do. Meaning epithelial tissue cannot be used to perform the function of nervous tissues.

Nervous tissues cannot be utilized as a connective tissue. Remember there will be exceptions, but here we are mostly dealing with what is the norm. In biology you might find one particular organism that does not follow a particular sets of rules. And I am dreading for the medical students of this course to figure out the mistakes that I have made. And there will be something obviously coming up, but overall, for all intent and purpose, these are the four major human tissues and they perform the specific functions.

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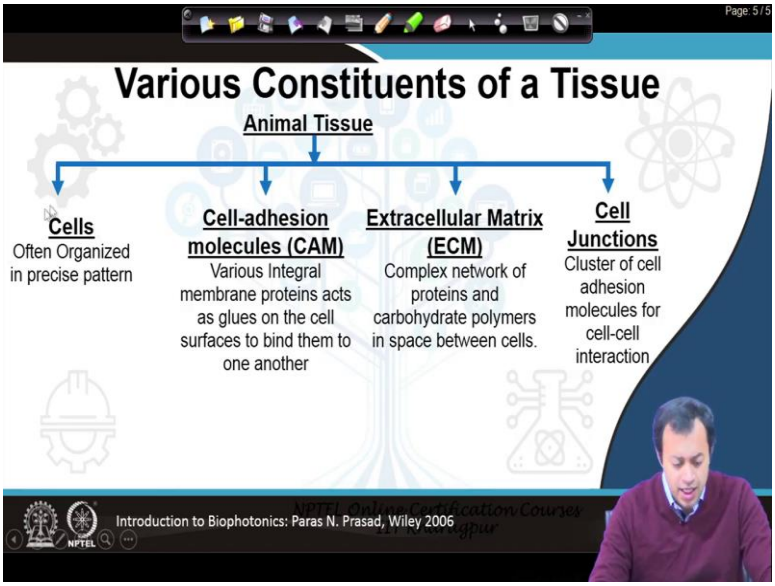


How they are formed. Well, they can be organized, or if you break them down into obviously cells, they are in a precise pattern. But in between the cells, you have cell-adhesion molecules. These are again proteins as if there could be anything else. Remember in the earlier class, I told you that when they were thinking of basic unit of hereditary, how information is passed from generation on to generation, from parents to offspring, they were thinking it is proteins.

Now, you know why, all body functions are done by proteins. It is just that the hereditary thing is done by nucleic acids. And that is their primary work, nucleic acids, makes protein. It is not protein that make protein, but protein help in making proteins. I understand enzyme, but overall it is the nucleic acid that makes protein.

So, here also you have a protein which acts as glues, which attaches two cells together. And then thousands of cells join together to form a tissue and all of these work in tandem and they performance specific function, another bad analogy I am known for making very bad analogies. If you consider a fair, a mela, a crowd, people move here and there that is prokaryotic cells. But if you look at a march-past, in a military formation where they are marching up and down, or there is a group dance competition happening that can be considered as tissues.

I know bad analogy, but let me paint this picture in your mind, crowd, every cell moving differently, a march-past or a dancing sequence, a group dance where multiple people are dancing that can be considered as tissues. And they are joined together, these different cells.

They are glued together by this cell-adhesion molecules. These are basically proteins that glues.

Then you have extra cellular matrix, the complex networks of proteins and carbohydrates that is present between the cell, in the space between the cells. So, you have intracellular metrics, those carbohydrate and protein networks, which are inside the cell. And there is extra cellular matrix. These are the networks. These are forming the networks between one cell and another cell.

And then there are cell junctions, clusters of cell-adhesion molecules and they are there for cell to cell interaction. Two cells of the same tissue need to interact. And you have several molecules and they are presented between these junctions to help you. Again, this is very, very basic. Each one of them, require your own PhD.

A person can do finish a five-year, six years of PhD, just on cell addition, molecules, their nature, their topic, how they can attach to one particular cell to make one particular tissue, but not to other etcetera, et cetera. But I dare not because this was basic of biology. So I will simply stop here on the tissue part.

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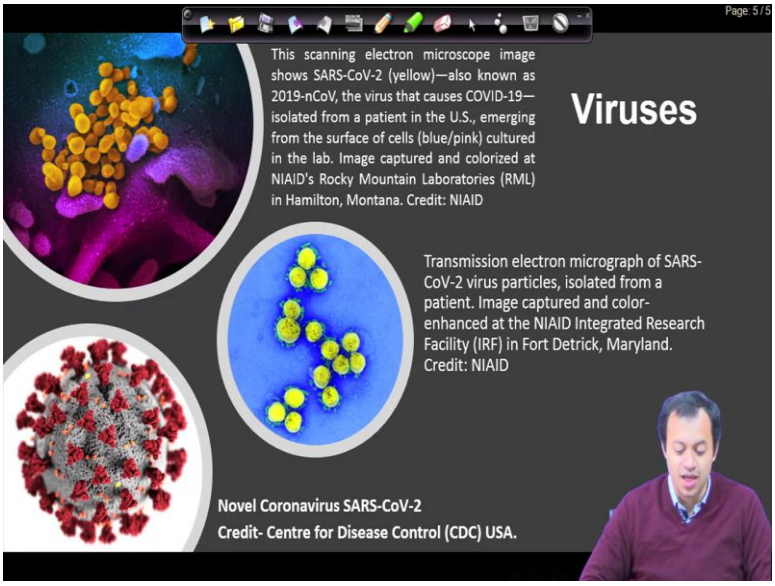


The next part, which I think all of you should know from basic biology as the viruses. No point guessing why I chose this and all of these images credited by disease control, Center for Disease Control are that of corona virus. So what are viruses? Viruses are organisms at the edge of life, some people will have problem calling it an organism, they are let us call it entities. They are things at the edge of life. They are as dead as possible without the host,

they are simply called virions. They are particles. As soon as the receive, they get into a host, they become alive. They simply lack the mechanism to reproduce.

So, this is an electron, transmission electron micrograph image. Look how beautiful these images are. So basically they have this outside protein capsid. This is an outer shell on which inside there is the genetic, which is RNA or DNA. And they contain these hooks, these tentacles, these claw like things. They are protein, but sometimes they also contain lipids.

The genetic material in between them could be RNA or DNA. I think I have discussed this before. This is the image of Corona virus coming out of cell, this pink and this blue part are the cellular parts and this orange part or yellowish orange part is the corona virus that after pulverizing, after destroying the cell is, the spore is coming out of it.

Beautiful, beautiful pictures. Now, let us try to understand very, very basic mechanism of what it is. When the coronavirus is simply like this or any virus is simply like this. It is a dead particle infectious, but dead. It has no consequences. It cannot reproduce by itself. As soon as it receives a host, it reaches a host. It holds on to it by these tentacles, by these hooks, these kinds of hooks, they simply attach themselves to a specific portion of the cell wall of a organism.

It is like attaching with a hook, like you capture a fish with the bait with the hook, you capture a fish, just like that the tentacle attaches to a specific location of the cell membrane. We are thinking that the specific receptor of the cell membrane in human bodies are the ACE-2, A alpha, C for Charlie, E 2 that is the point, that is the location, that is the protein, that is the part of the cell membrane, which this tentacle of the corona virus is actually hooking on to, actually capturing on to. But there is a lot to unpack. Again, I will not go into too much detail overall because, I will digress.

But understand this, all viruses react in this particular manner. They attach with their spikes, spike protein, most viruses, medical people will say, no, I have one virus that does not do like that. But anyways, most viruses, they have these tentacles, they attach to specific location of the cell membrane through which they open up, they enter and they enter inside the cell. They look at the nucleus. As soon as they locate the nucleus, they break the nuclear wall and they deposit their genetic material, either RNA or DNA.

Coronavirus is an RNA virus. There are several other DNA viruses as well. They inject their DNA or their RNA, their genetic material inside the nucleus. Now thereby injecting the

nuclear, injecting their genetic material inside the nucleus. They perform what they do. They perform the process of hijacking. Just like you hijack a plane, the terrorists, go inside the cockpit and ask the pilot to drive the plane in a different direction. Same thing happens here.

The genetic material that is inside the nucleus now hijack the nucleus's reproduction machinery and the nucleus no longer produces the genetic material, no longer produces anything else, but the virus itself, meaning the virus gets inside the cell, breaks it apart, goes into the nucleus, hijacks, the nucleus machinery and compels the nucleus of the host cell to reproduce, to create more number of its own genetic material, which is a foreign body, which is a foreign genetic material.

So, I have a cell that produces DNA A that got infected by virus B. Now my cell will no longer be producing DNA A anymore, it will only be producing DNA B as long as it is capable, as long as it is possible and then from one genetic material, DNA B, it will create more DNA B, copies of DNA B, they will multiply and finally, they will rupture the cell and come out of it like this. And then they start infecting other cells nearby.

Corona virus basically does this to our respiratory cells. Thereby we get this dry cough, we have difficulty breathing, etc, but do not worry our body has different mechanism. As soon as this enters our body. As soon as the infection starts, our body starts producing proteins. Yes, proteins, antibodies. These antibodies starts attacking these viruses. There is a fantastic mechanism on immunology, again, I want you to look into it at your spare time.

These proteins then started wrapping them up. These proteins then started eating either the capsid or the genetic material itself. i.e. trying to take control of the nucleus of the cell. Sometimes it simply destroys the cell itself. So two or three part of the cells have been, two or three cells have been affected that let us eat up the entire thing.

Immunity that is how beautiful or how fascinating this is just like any video game or any real life war scenario where terrorists have hijacked aircraft and then commandos are coming to dislodge the terrorist from the aircraft without harming the passengers. Read a bit more about this.

This is not exactly part of the course. I am simply giving you glimpses so that you understand what the basic of biology is, how we can then go on utilizing photonic technologies to either look into either, try to get picture as beautiful as this or try to knock off a particular gene, edit a particular gene using light.

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So, that overall brings us to the end of my chapter number three, which is basic of biology. I have assumed that thus far, chapter one, chapter two, and chapter three, there was nothing that I said is something you did not know already. I have assumed that you knew all of these things already and hence I just revised you.

Some of the knowledge that has long forgotten got revised, at the same time I skipped a large amount, both from basic of biology, as well as from basic of physics. These are oceans in themselves, and I had simply looked into a drop from the ocean. But then again, my argument here is that we cannot spend more time on understanding biology itself or physics itself when there are other courses on biology and physics and most importantly, this course is biophotonics, whatever information I have given to you is always relevant to the course.

There are several other important topics in biology, as well as in physics which you might like, or who might think is quite important. Granted, they are very important, very fascinating, very interesting, but I have skipped because A time is less B, they may not be directly relevant to what am I going to teach you now.

Now, we are at the realms of biophotonics, we have thus far have a very basic idea of biology at the same time, a very, very rudimentary understanding of physics. I simply catered biology for those people who have not studied biology for a long period of time. Hence I used a large number of analogies. None of them were accurate, none of them were hundred percent correct. Granted, at the same time for biology people who have long forgotten physics, I tried to simplify it as such.

And while simplification, some accuracy might have lost. I accept it and I want you to acknowledge that perhaps this was, if not the best, one of the best ways to bring together a wide variety, a wide group of people, to an interdisciplinary subject. From next class, next chapter onwards, we will go on to the heart and matter, heart and mind of biophotonics. I plan to see you there as well. Thank you very much.