Nanobiophotonics: Touching Our Daily Life
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Lecture No. 26
Genetic Code

Hello, and welcome. We will continue our discussion on Nano Bio Photonics and today is a very new module, module number 6 in which we are going to discuss about the Bio Photonics Technology to detect genetic disorder. What are the genetic disorders and how we can utilize bio photonics technologies to ah understand them to detect them to identify them. Now, I have broken down this ah particular chapter thusly. ah First and foremost in today's lecture we are going to discuss what the genes are. We in since we are talking about genetic disorder we need to understand what genetic or gene actually is what genetic material stands for what gene actually is.

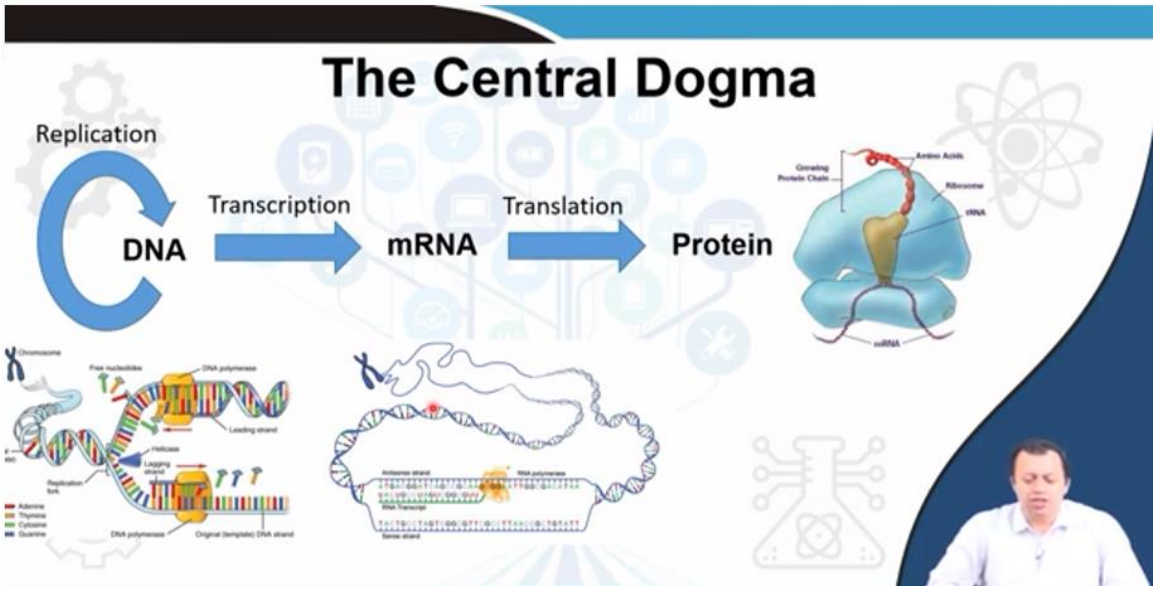
And in the next lecture we are going to look for something called biosensing. Biosensing ah as the name suggests it sense some biological material. So, these two lectures lecture number 26 and lecture number 27 will form the preliminaries of ah this entire module. Only from ah lecture 28 onwards that is 28, 29, 30 we will go directly onto the application that is what are the technologies available to detect genetic disorder.

In order to understand the technologies available to detect particular disorder we need to understand the disorder first. We need to understand what genes are then only we will be able to understand what are the disorders that can happen. So, let us start in today's lecture we are going to discuss the overall genetic code. Now, be aware ah I cannot ah summarize the entire concepts of genetics in 130-minute lecture. So, ah what I will be giving you is very very brief introduction in simplified rudimentary ah terms of what gene and genetic material actually are right.

Those of you who are from biology or medical background feel free to skip this because you your knowledge on gene and genetic material will be far greater than mine I am at the end of the day an electronics engineer. So, I have tried to understand genes from my point of view and I will be telling you my point of view and there will be several inaccuracies no doubt about it genetic engineering or gene or you know molecular genetics is is is a vast vast field it cannot be summarized in 30 minutes lecture, but I will try to do it nonetheless and several important topics which you think is important is going to get skipped. But I have kept this part I have kept the genetic code this particular lecture targeting towards non-medical people from physics or people from electronics background or any other engineering background non-medical non-biotechnology non-biology background.

So, here I go. So, we have previously discussed the central dogma the central dogma as I said was one of the fundamental aspects of biology it is Schrodinger equation theory of relativity Maxwell's law of electromagnetism also combined together and very rudimentary it says that DNA converts into RNA messenger RNA there are different types of RNA ah medical students know it far more, but for us mRNA the type of RNA messenger RNA is the important part DNA converts itself to messenger RNA messenger RNA converts itself to protein I gave you the analogy no analogy is perfect this is also not perfect the DNA is like the recipe book it is like the circuit diagram it is like the blueprint for you civil engineers out here the mRNA is the actual process of cooking it is it is it is where you require certain other materials ah like like the ah pot and the pan and the spoon and the spatula and this rolling pin and all of these things water ah heat gas etcetera in order to replicate this to this this is information the circuit diagram you require wires printed circuit boards resistors capacitors diodes all of these things to make some sort of a circuit proteins is the final output proteins are the final final output that is the output of this based on this this is the information this is the entire process and this is the outcome proteins are us we are protein every single function that is happening in your body a protein is either directly involved or indirectly involved you are breathing because of oxygen present in your body which is carried out through your blood circulating all over the body blood contains hemoglobin hemoglobin is a protein right.

So, very basic functions respiration vision reproduction every basic function of that may that makes life is what ah a protein creates at the same time in the colour of your skin the colour of your eyes the colour of your hair how tall you are how short you are whether you will be susceptible to diabetes etcetera all of them are somehow regulated by protein at the end of the day.



So, if we break it down if we break it down the central dogma into the real actual biological stuff you will see this is far far more complicated it is far far more complicated and I will try to explain it now that the analogy part is over I will try to explain it in in in a slightly more detail. Now, understand that people spend their lifetime understanding just one part as in how DNA converts into mRNA or how mRNA creates protein people send their entire lifetime people have spend their entire lifetime understanding that. So, whatever analogy or however, ah ah hard I try to make you understand this this is never going to be enough this is never going to be enough several important aspects will be not taught, but that is not the point I do not think on a daily basis an electronics engineer a mechanical engineer or civil engineer will be utilizing their ah central dogma as long as my aim here is to ah give you a basic understanding the first draft you can say the first draft of the basic understanding of central dogma. Obviously, first draft is inaccurate, but it is a starting point.

So, today I am going to give you a starting point upon which if you are interested physics people engineers etcetera you can build it you can go it you can modify it like computer science people make codes first code the first run of the algorithm is never the perfect one, but that is a starting point that is a starting point you then optimize you then modify. So, I am trying to give you the first group after which you will go on read it yourself to go further details on to it. So, here we go DNA the double stranded helical structure double stranded helical structure can self replicate it can self replicate i.e. it reproduces itself.

So, it has it can do two things first it can replicate itself DNA converts into DNA or it can transcript i.e. DNA converts into RNA right DNA can convert into DNA itself DNA can convert into RNA the process in which DNA converts into itself as in it reproduce is called replication replication duplication or replication how does this happen it simply. So, the

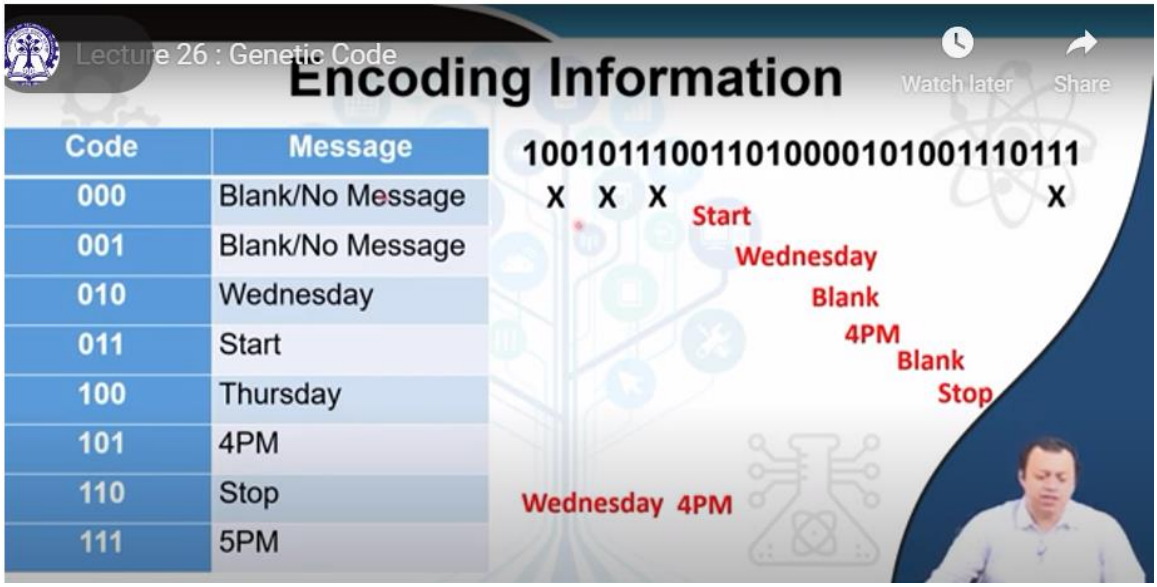
double strand simply opens up like you have a zipper you simply open it up and it it it it bifurcates. So, the double stranded DNA simply opens it up it opens up this this this double chain double helical structure it opens up then there are certain enzymes these are at the end of the day proteins etcetera DNA polymerase these proteins these proteins comes in this DNA polymerase this enzyme starts coming in and it starts adding the components complementary base pair it starts adding complementary base pair to create a new ah chain a new DNA.

So, you have ATCG one strand is AAAT the complementary strand you can tell them right A will only combine adenine will only combine with thiamine and cytosine will only combine with guanine A with T C and G. So, if you have a strand if you have just one strand with AAAAT then you immediately know the complementary is TTTA yeah. So, it opens up it opens up this part starts adding its complementary chain this part starts adding its complementary chain ok and it stops somewhere and it comes out that is it that is it. Now, this chain will end at a specific point AAAAT this chain will end at another point there is no no no no reason that entire this copy will be replicated. What I mean to say is DNA replicates semi conservatively what the semi conservatively means meaning that of the two strands its double helical structure one part is its parental DNA one part is what it has previously brought from its parent this is the original part and this is the new part it has gone then it has open up this part will remain something new will come up the other part it will remain something new will come up.

So, again DNA double helical structure it will open up this will add something this will add something and make make double structures and it will make double structure. So, one strand so, one strand of the DNA will remain what its parental DNA from which it has replicated itself as. So, it is called semi conservative process where some part is still conserved some part from the parent is still still conserved. So, this mechanism how this DNA polymerase this enzyme comes how the different base pair starts adding up and then it simply slices cuts itself to become one another separate DNA somewhat matching its parent, but not entirely matching with parent and then combining it into chromosomes I told you about chromosomes in the basic biology. This entire process this entire process is replication and as you can understand this is very very fundamental and very interesting and incredibly complex I cannot cannot describe it to you in full detail without you know taking an entire course into it people the hence I said people send their life times on to it, but for the time being understand that a strand simply opens up this part remains this part remains this adds things this adds things and so on and so forth the replication keeps on happening.

The other thing is when DNA converts into mRNA messenger RNA a type of RNA here here in you have instead of ah the DNA the RNA it has RNA polymerase for the replication

you have DNA polymerase the protein the enzyme that helps DNA replicate into ah DNA here you have RNA polymerase where you utilize ah this enzyme this RNA polymerase enzymes what it does it simply takes out thiamine thiamine is part of ah DNA and converts it into uracil uracil. So, 4 base pairs of DNA A T C G in RNA instead of T you have U uracil and A C and G remains as it is. So, all that RNA does is start replacing the T part of the DNA and replace it with U it replaces it with U everything remains as it is previously A was matching with T in DNA in RNA A will match with U C and G will remain as it is C will match with G G will match with C as such. So, the T part will get removed the RNA transcription will happen and you will have ah a single strand of RNA molecule RNA strand happen this RNA that has come from DNA DNA is double helical remember DNA is double helical this ah RNA then goes inside the ribosome part of your cell ribosome organelle of the cellular matrix where it has the information where the amino acids are starting to form the amino acids are created based on the information that is present in mRNA where is the mRNA getting the information from it is getting the information from DNA. So, the DNA molecule which is replicated and broken down creates mRNA this mRNA goes into the ribosome organelle where depending on the strands depending on the type of base pairs that is present in RNA different types of amino acids starts forming a combination of several amino acids give rise to protein very very crudely.



Now I understand that it is still little bit vague i.e. the most important part how exactly is information coded inside what what what do you mean by ah information getting coded. So, I will try to explain it from an electronics engineering point of view right suppose you are sending information in bits bits 0s and 1s and you have decided that you want to send information in the form of triplets 3 bits at a time right 0 0 0 0 0 1 etcetera etcetera 3 bits and all of these bits have a hidden message this part only you know this this this code versus message only you know and there are certain rules that you are following you know information can be sending bits information can be sending bits streams in sets of 0s and 1s. So, we have decided to send an information this is just an analogy in the form of ah

triplets 3 bit at a time has a particular message.

So, 0 0 0 0 0 1 are blank or no message they act as space you also have a rule that we will send bits of streams, but only when the start message is there 0 1 1 the message will start making sense the message will start decoding. There are other information's available and then you have a start ah ah ah stop part as well. So, sets of messages sets of code sets of triplets sets of bits are sent only the message that starts with the start bit that is 0 1 1 and stops at the stop bit 1 1 0 is valid everything else before everything else after you do not accept everything else before everything else after you do not accept. So, if I have given you this stream this is randomly generated you can decide it yourself semi randomly because you will see 1 0 0 is it the start code no. So, you ignore it unless it is a start code you ignore any message then 1 0 1 is it a start code no you ignore it then 1 1 0 is it a start code no you ignore it then you have 0 1 1 ok 0 1 1 we are in business you have the start bit.

Now the message will have relevant information prior to that it might have relevant information, but since the start code was missing we have ignored it right then you have 0 1 0 0 1 0 stands for Wednesday and then you have 0 1 0 0 0 0 which is blank message a space then you have ah 1 0 1 which is 4 p m which is 4 p m and then again blank message 0 0 1 and then finally, you have got the stop message 1 1 0 stop. So, overall if you have decoded anything after stop is also ignored 1 1 1 might have some information, but since stop has come before it you have ignored. So, any information before start any information after stop is simply ignored the total information present in this bit stream is considered as this witnessed it 4 p m I got this analogy from from a from a movie ah the fourth protocol Frederick Forsythe's ah famous novel ah the fourth protocol they even made a movie out of it out of the fantastic novel. So, anyways so this is the analogy by which I am going to explain it to you how the information is coded how the genetic information are coded inside an RNA. So, just like we have used triplets 0 0 0 0 0 1 3 bits triplets 3 bits at a time to encode a message and we have certain rules inside the

RNA does exactly that the RNA does exactly that it has this three base pairs each of them produces a specific specific new ah amino acid a specific specific amino acid is present in each triplet of the base pairs.

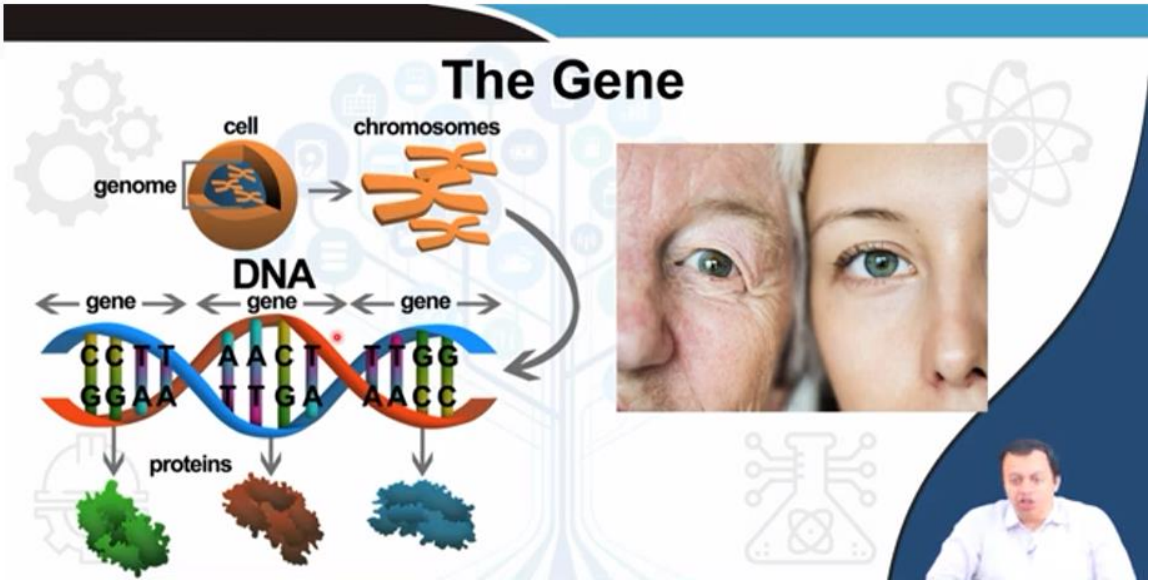
So, the RNA molecule the RNA stands is broken down into three base pairs at a time each ah base pair at a time this triplets are representative they create they have like we have the messages encoded they have the message to create a particular particular protein. So, it was I think Soviet ah American physicist George Gamow along with Crick who came up with this idea that only three base pairs three base pairs at a time this all these combinations are enough are enough to create a complete plethora of all 21 22 amino acids that we require and it follows the exactly same procedure you have a stop codon you have an initiation or start codon oh what are codons these three this triplets this triplets this 0 0 0 0 0 1 similarly this AAA AUG AAC AAG all the combination this three at a time this three bits this triplets are called codon the triplets of RNA base pairs are called codons you replace you with T you will get the DNA base pair they can also be considered as codon. So, codon is basically this triplet these triplets AA AA U etcetera they all just like previously you have certain information coded into them here they have the information to create a particular amino acid inside each three set of base pairs this three sets this triplet of set is called codon right. So, if you just like the previous stream just like this previous stream if you have this you then start looking for the initiator or start codon ACG. So, AUG nothing UUU nothing as long as you sorry beg your pardon AUG this is this side this is this side AUG is the initiator codon.

So, if you have the initiator codon the start codon then only you start reading your message AUG is the start codon AUG is equivalent to this 0 1 1. So, you start with this then you look into the next part the next codon UUU UUU is the phenylalanine amino acid. So, am

phenylalanine amino acid will be created by this strand of DNA then you have UUC another three-part UUC is another phenylalanine you go just like that UUC create another phenylalanine so on and so forth. And finally, you receive UGA which is basically ah UAA or UAG which is your ah stop codon. So, there are stop codon and you have initiator start codon.

So, any information has to start with this start codon and ends in the stop codon there are multiple stop codon and to the best of my knowledge there is only one initiator codon that is required oh UGA is also the stop codon there are multiple stop codon. So, UGA you have UGA at the end this this part so UGA stop codon. So, break it down from this table chart what are the amino acid this particular strand of RNA ribonucleic acid is forming. So, when this messenger RNA goes into the ribosome the ribosome will read it just like your CD is being read you know the CD disk is being read the ribosome will read it no initiator codon no information no protein no amino acid initiator codon started ok UUU. UUU stands for phenyl amine amino acid it will start putting ingredients to create phenyl amine amino acids.

Next part another phenyl amine another serine another ah isoleucine etcetera etcetera it will start creating those and as long as it is not reaching stop if it reaches the stop codon UGA or another stop codon UAG it stops that is it fascinating process fascinating process simply looking at a ribosome inside the cell which is so common present in every cell almost every cell you you get you know fascinated by it. So, this is how information to create protein is encoded into RNA which gets its information from the DNA. DNA is simply double helical RNA is the single strand similar thing, but instead of amine you have uracil instead of T you have U everything else remain as it is.

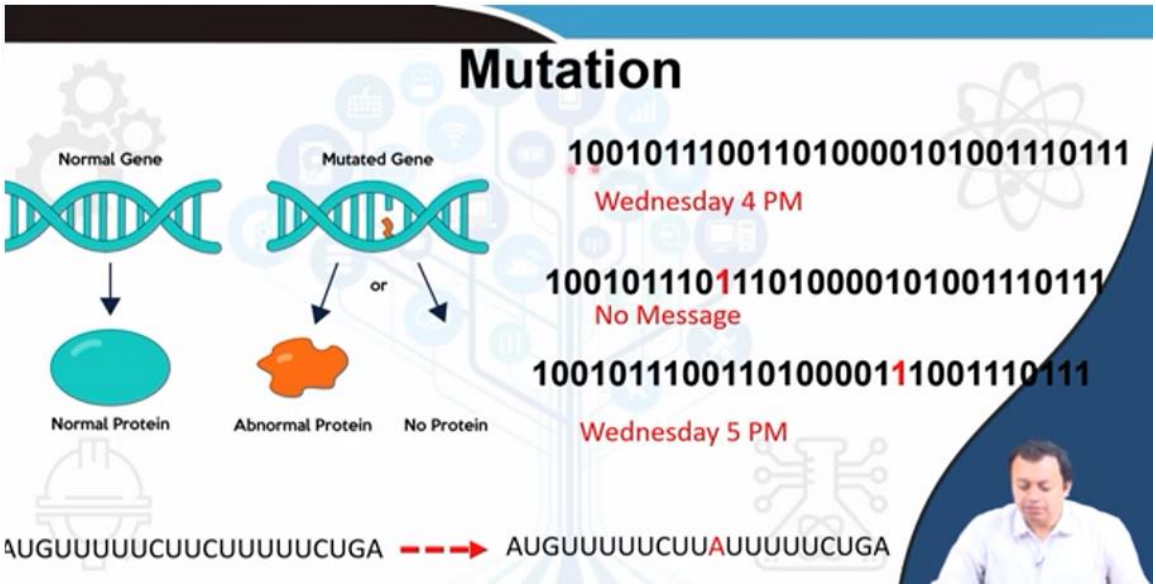


So, what exactly are genes what exactly are genes or genome or genetic material etcetera? Genes are strands of DNA listen to me very very carefully genes are strands of DNA that has the capacity to convert itself to express itself to synthesize itself into a relevant protein. Again, genes are strands of DNA that has the capacity that has the capacity the potential to convert itself into a specific into a particular into a relevant protein.

The most important thing to understand here is capacity potential it does not mean it will I will give you an analogy take a coin and toss it it will either be head or tail yeah right. If I say a coin has the capacity to produce head upon tossing it upon flipping it it is not guarantee yeah it is not guarantee that always head will come tail may come yeah, but the process is there the potential is there whether this potential will be fulfilled whether the gene will actually express itself whether the DNA will actually synthesize this protein is semi random is semi random, but there is no other way this protein can synthesize without coming from the without coming from the DNA without having this information present in the DNA just like without tossing the coin you will never get head or tail head or tails will not come out of thin air you need a coin to toss you require the coin, but there is no guarantee that there will be head at the end it could be something else either it is random or you can bias the outcome whether it will be head or tail by some external factors there are several ways you can bias the outcome with external factors when you are tossing a coin that ah head comes you cheat you cheat it is an unfair coin you use some kind of a magnet you can use you can you know flip it and then you can surreptitiously cheatingly put the ah tail side little bit thicker with more in ah more mass so that it falls etcetera etcetera very similar to genes yeah a gene is set of DNA that has the capacity to produce proteins, but but but but there are external factors there are external factors that can contribute in modifying this part of the gene so that either the stop codon is modified or the ah start codon is changed or you have changed one ah ah strand here and as a result either the gene cannot create this protein or create something of a bad protein. Remember in previous class we discussed about ah phenotype or genotype if not then do not worry ah I think I have discussed it somewhere else ah genotype is this this entire information right. So, again gene is simply setting of DNAs that has the capacity that has the potential to produce to express itself into proteins and remember semi conservatively I told you we get DNAs from the parental DNA. So, we we we carry information from our parents we carry genetic information from from our parents.

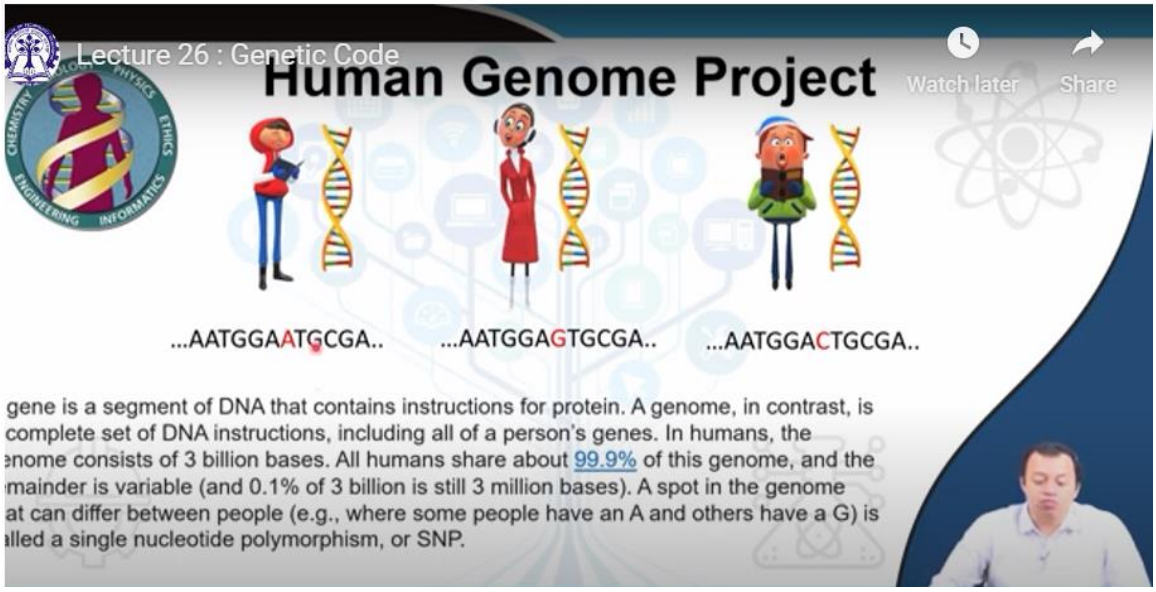
So, if you look at your father or your grandfather you can easily say and this is precisely that I carry my grandfathers eye color grandmothers eye color or I am I am there are so many people diabetic in my family. So, I may also be diabetic because this semi conservative nature of DNA we are getting DNA at least a strand from from from parental part from parental part we can clearly say that some amount of information is borrowed is is is still being passed from generation on to generation it gets modified it is get modified,

but certain part certain section still belongs to our ancestors and that is what genetic or hereditary means. Gene is the basic unit of hereditary gene determine what sort of proteins your body can synthesize whether it will be synthesized or not that is a completely different factor you may. So, happen it may. So, happen that you contain the gene of your parents of your grandfather of your grandmother, but the eye color your eye color is not matching that of your grandfather the gene is not active the gene did not run the gene was unable to synthesize the particular protein that gives the eye color this this particular blue or green tinge why well so many factors A random B something went wrong ah when the when your eye was getting formed inside the womb some kind of modification happened food habit ah external factors ah stress smoking alcohol so many so many different things can come up random part is also a bit.



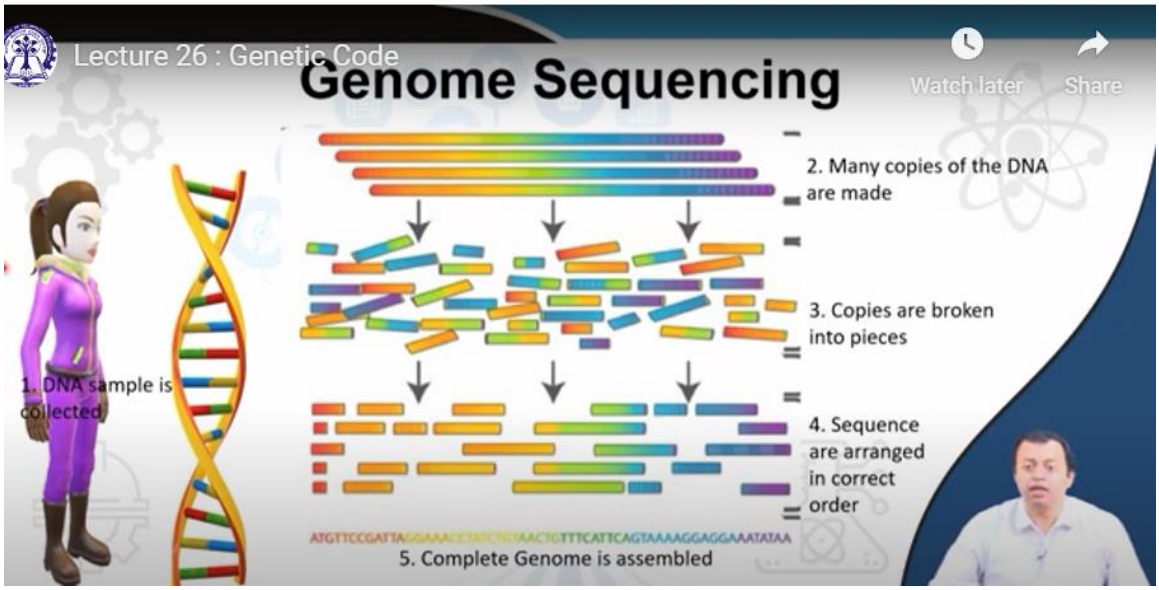
So, this is simply the gene. So, as I was saying that you can send information in in in this bit information in this bit stream this information reads Wednesday 4 p.m. the basic unit of information is bit if you change a bit yeah this 0 to 1 read it using the same chart that I have given you will see there is no message this no message is because the start bit is simply removed. So, this the same stream just one single modification one single modification results in no message being read another single modification here it was ah 1 0 1 you made it 1 1 1 same stream just one bit is getting changed and you are getting a wrong information you are getting a wrong information instead of Wednesday 4 p. m. you are getting Wednesday 5 p.m. Exactly same thing happened with mutation mutation is where the base pair one single base pair this AUGUUUUU one of this this A UAU as compared to UUU this one one thing sorry this part CUU CUU instead of CUU AUU had happened this one one point has has changed as a result the normal protein has either converted or either created into a different protein an abnormal protein or no protein at all no protein will not give you the particular process that you are hoping abnormal protein abnormal protein may lead to several different types of diseases several different types of diseases the genetic disorder your gene was supposed to produce this, but now that one bit

one base pair is changed one base pair is changed now it is giving something completely different completely different from what it was intended to give the idea here is to detect these genetic disorders using biophotonic technologies.



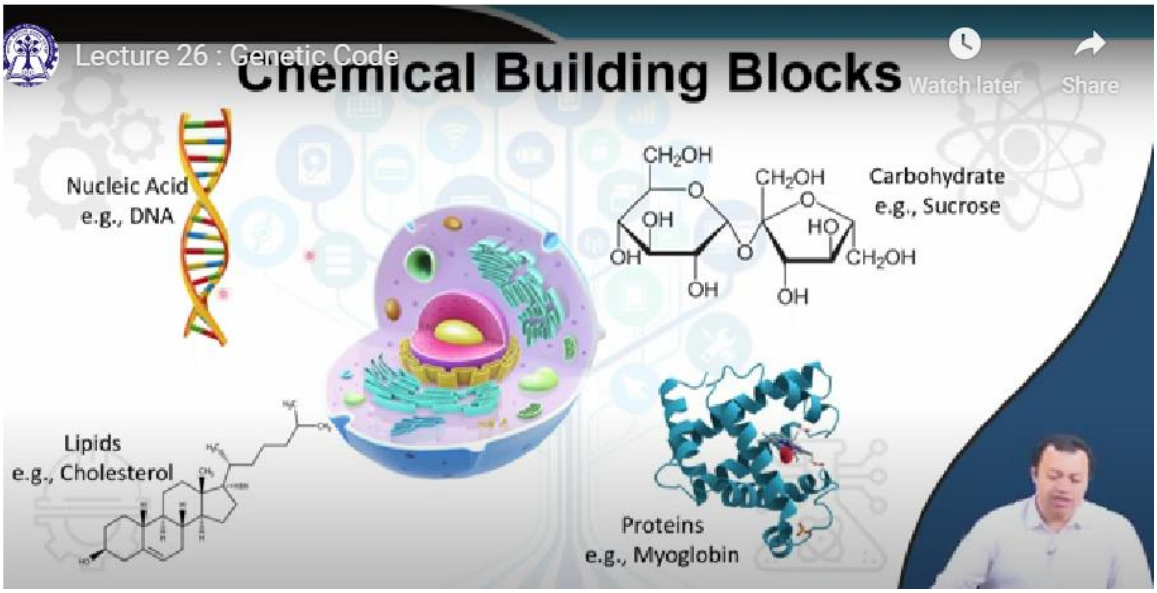
So, I would ask you to go through and read this fantastic work that the entire planet work together the human genome project to understand the various you know the the the the the entire DNA strands present in human beings and to find out how common we are to one another the different aspects of gene basically the entire life processes all humans every single human being share about 99.9 percent of the genome what is genome genome is the entire genetic material genome is the entire dictionary of words each word can be considered as a gene genome is the entire set of all the gene all the information present in a human body starting from how tall how how fat how athletic you will be whether you have this talent that talent eye color hair color everything everything every information that makes you you is in your genome that is the entire information all the information that is present in your gene is the genome human beings every single human being irrespective of your religion every irrespective of your race irrespective of which part of the planet you are from irrespective of your skin color irrespective of your caste creed etcetera share 99.9 percent of their genes 99.9 percent everything from you to anybody at the other end of the world is same 99.
9 percent same what makes you you is that 0.1 percent or 0.01 percent and think about it we keep on fighting based on this 0.1 percent dissimilarity we choose to disregard 99.9 percent similarity among ourselves and try to focus on that 0.
01 this is mathematically proved right I am not making any philosophical argument I am making a scientific ah mathematical argument that all human share about 99.9 percent of the genome and we choose conveniently to disregard this amount of similarity this amount of similarity is like a student coming to home and saying that he got 99.9 percent result in

exam and the parents are saying no you have failed because you could not get 0.1 percent how ridiculous it would be right next time next time you feel you know demonizing a group of people or a community or anybody else remember this part remember this part that we are 99.9 percent similar right



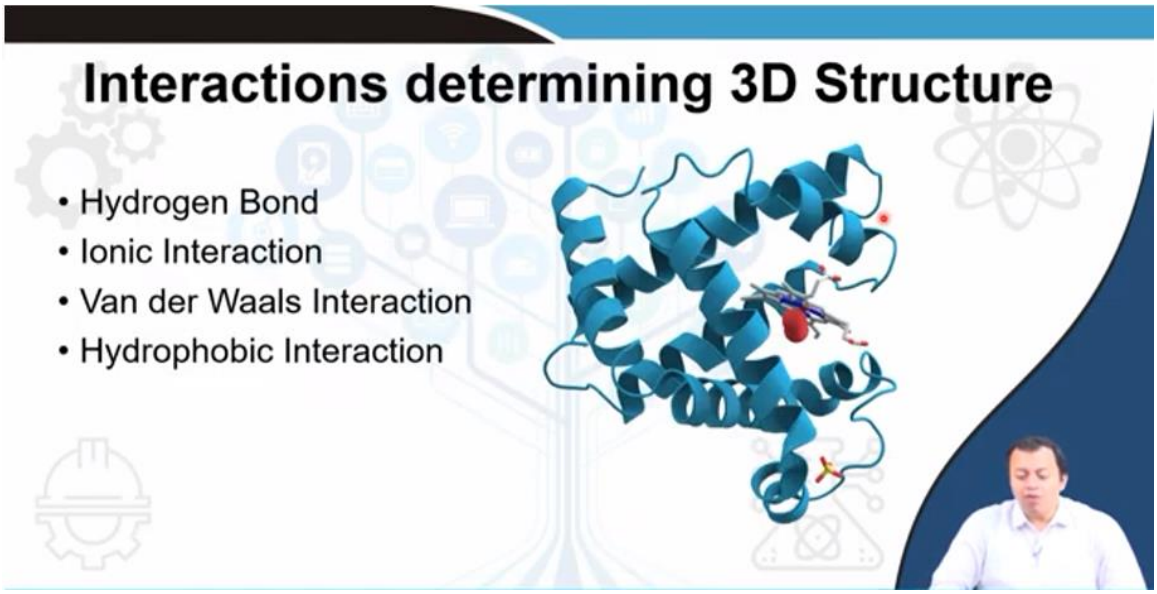
what human genome project did was to read read the information this 99. 9 percent information the overall entire genome sequence of human beings the entire how much amount of these these these gene sequences were present has was read by several different institutes they simply took DNA samples from a large group of people from different places different countries hm different age group different gender made copies of the DNA these copies were later broken down and then they were arranged in a particular sequence and then complete genome is assembled in a large number of supercomputer just go and read it this is not part of biophotonics the human genome project, but I want you to read it because this is one of the fascinating thing where scientists from different countries all over the world came together ah and tried to read our genetic material and then came to this conclusion that we are 99.9 percent same right.

So, ah several additional things that I need to add hm just ah touching ah you a bit. So, genes can be edited in a in a human being this Cas9 protein this kind of a specific protein can be present that can be given inside a human and a particular gene can be you know just like engineered just like taken out. So, supposedly you have a bad gene like which make you susceptible to diabetes or heart attack or makes you prone to certain types of cancer they can simply be ah using a protein taken out replicated modified. So, this this this gene can be actually modified in a live human being and this was proved by ah Jennifer Doudna and Emmanuel Charpentier Max Planck Germany and ah I think ah California Berkeley, but ah similar things similar this crisper ah editing was also ah parallely separately ah discovered by professor Siksnys at Lithuania and these two ah scientists got the Nobel prize in chemistry in the year 2020 where they can they they they found out that a live human beings gene could be modified could be edited. Now, understand this very well that the basic unit of an information is this bit 1 or 0 you change 1 to 0 or 0 to 1 you are changing the entire information yeah, the information is completely changed. The basic unit of matter is atom you change the atom you change the matter the basic unit of hereditary is your gene you change the gene you change the organism would you like to change the organism would you like to change yourself what makes you you. The Nobel prize discovery of gene editing is literally that you edit your genes in a live human being a live organism right.



Very quickly we will go through I know I am running out of time that cells have these building blocks you know about nucleic acids and proteins nucleic acids produces proteins apart from that there are other things associated lipids like ah chloresterols lipids are basically you know fats or well they are used simultaneously, but there are slight different fats are a type of lipids.

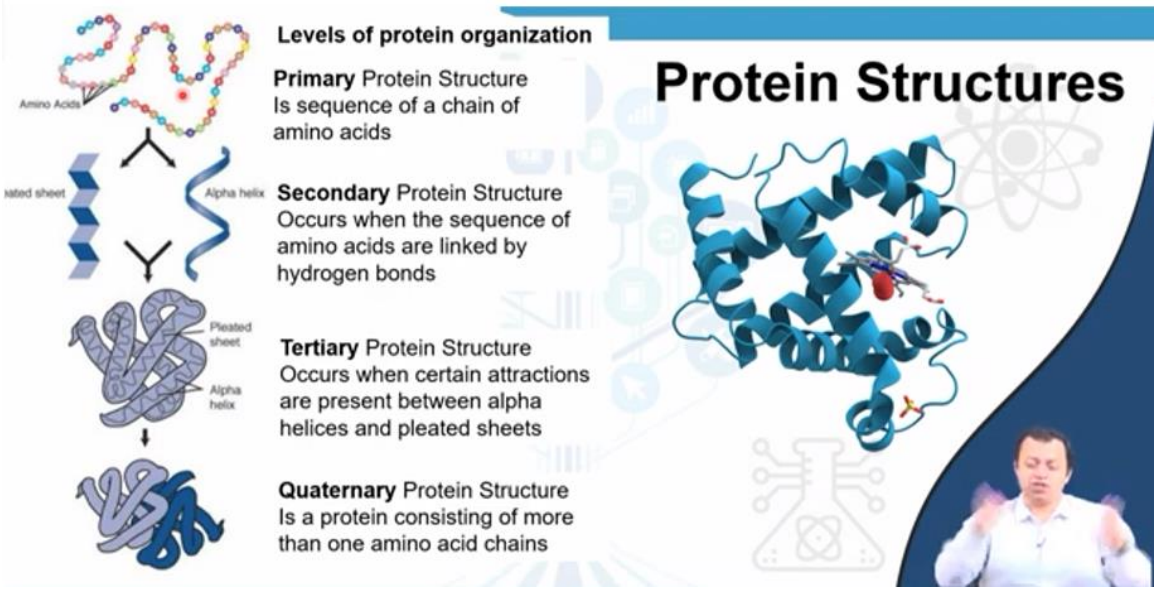
So, they basically give some kind of a cell signaling, but at the same time some sort of a structural integrity to the cell you have carbohydrate glucose sucrose etcetera glycogen they can be broken down for energy then and all of these all of these forms part the chemical building block of proteins. Proteins are of course, the most important part, but it should not be considered that lipids or ah carbohydrates have no no application they are also equivalently important of not, but we are more interested in genes and genetic materials at least for this particular chapter.



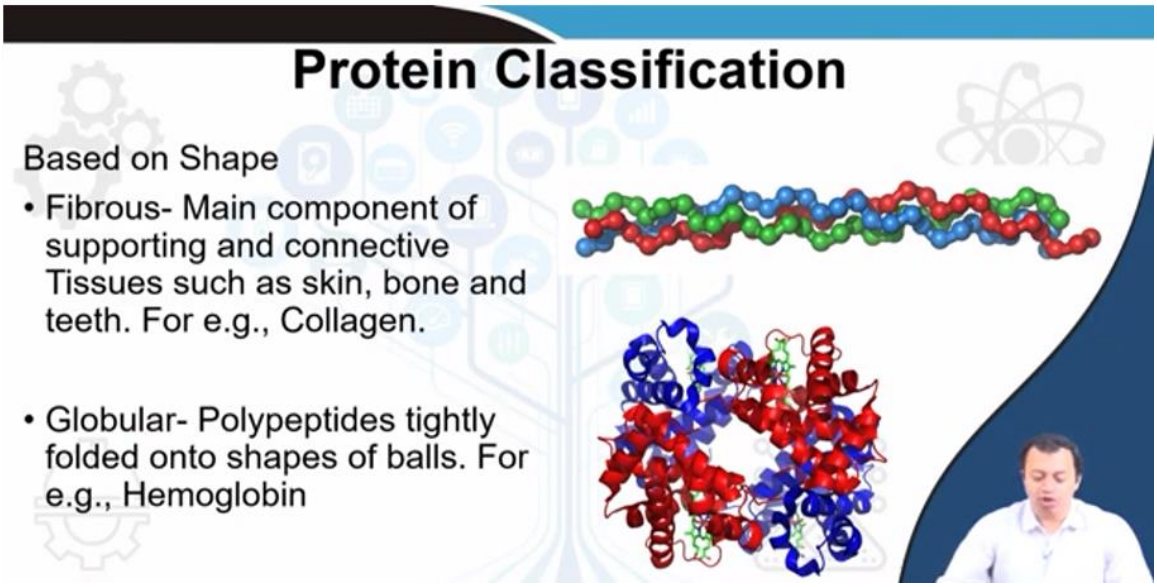
So, how exactly are proteins working? So, proteins are long polymeric chain of amino acids those amino acids that your messenger RNA synthesizes in the ribosome in the ribosome in the ribosome of your cell and they not only have a chemical structure they have a physical structure i.e. they are into ah they have a three dimensional folded structure and they are folded using these bonds hydrogen bond ionic interaction van der waal interaction hydrofluorine interaction hydrogen bond is when a hydrogen is connected with a electron rich ah atom like water like oxygen is electron rich hydrogen is connected with it ionic interaction two different ah types of ions are connecting with one another electrostatic force van der waal interaction random fluctuation of electrons hydrophobic interactions these are those non polar interaction C C or C H meaning these interaction are very very weak they are not covalently bonded making your protein very very flexible making your protein adapt add multiply modify and as a result create this diversity of life your life in this planet is very very diverse it is also very very fragile very very vulnerable because the bonds can be broken down very easily any temperature change any pH change and life form simply ah stop to exist why do you think people are so worried about climate change right if our temperature of this planet increases by couple of degrees several life forms will seems to exist because the proteins will simply disintegrate denature or form a different fold a different 3D structure which will result in the life not propagating in a way that it is supposed to be why because the proteins are connecting with each other in very very weak bonds advantage it can have a variety it can have a flexibility it can have a large plethora of different proteins ah disadvantage it is very very fragile it can be broken down immediately.

So, proteins starts at the ribosomes with amino acid sequence forming then protein structure is sequence of amino acid then it form a secondary structure protein structure occurs when the sequence of amino acids are linked by hydrogen bonds these amino acid

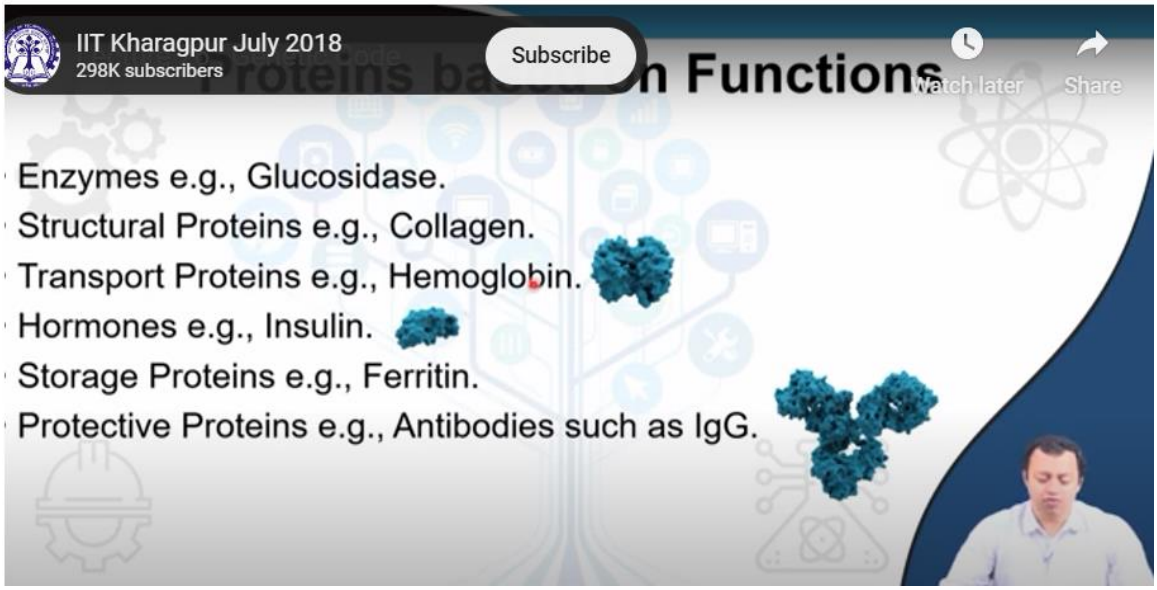
chain fold into each other into these kinds of alpha helix or beta sheet type things then you have the tertiary structure protein structures occur when certain attractions are present between alpha helixes and pleated sheet it starts with these individual amino acids combining together these amino acids.



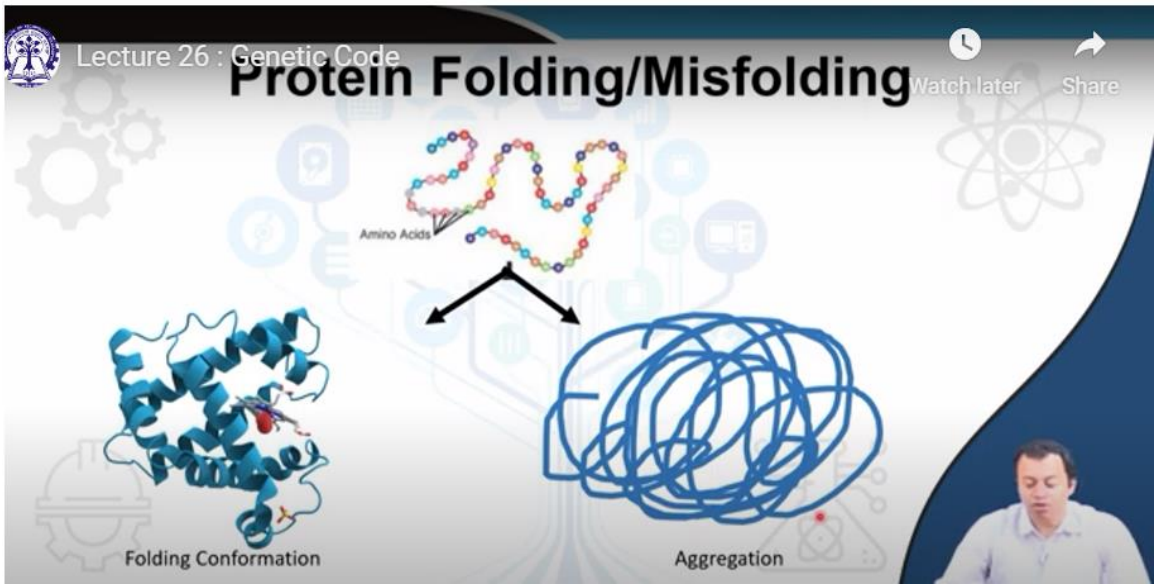
So, take a long string and then you know make it fold it into different structure you know people fold there is this Japanese art of origami same piece can be page can be converted into a flower an aeroplane a ship. So, proteins forms exactly like that ah first it was linked by hydrogen bonds then there is certain attractions like ionic attractions etcetera into alpha helix and then finally, protein structure where protein consists of more than one amino acid change more than one paper more than one amino acid chains combined together and form a three dimensional structure proteins not only has a chemical structure, but it has a morphological it has a particular 3D face a 3D morphology a 3D shape if my shape gets changed people will have difficulty recognizing it. Similarly, if your body is protein chemically remains as it is, but the 3D structure changes then the body has difficulty recognizing it.



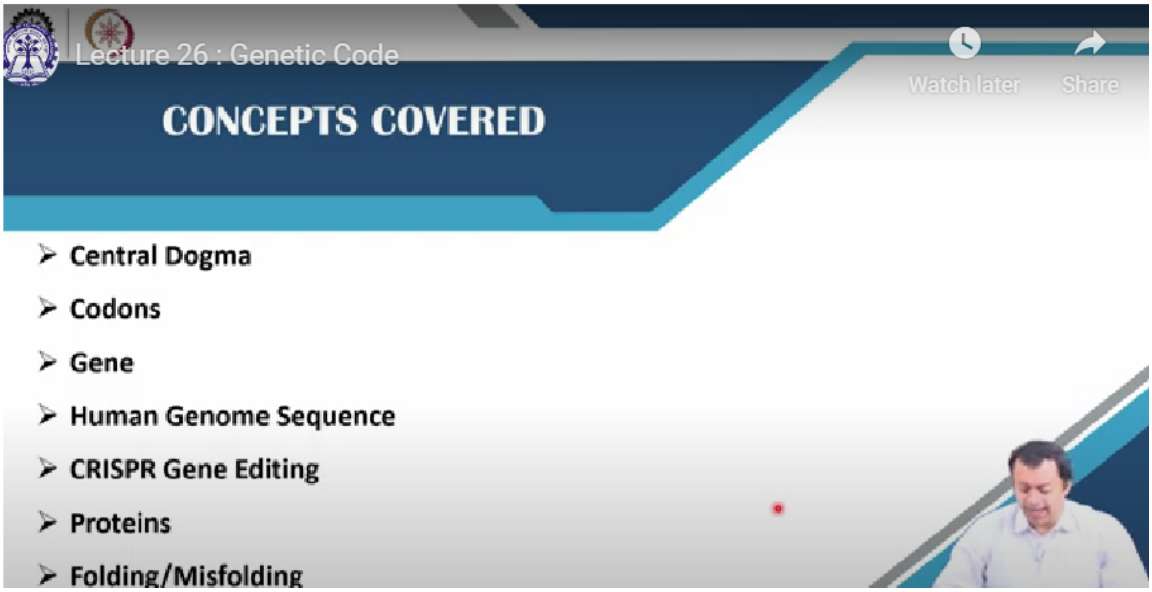
Proteins can be classified based on their shapes fibrous or it can be converted into globular polypeptides tightly folded into shapes of balls it can be decided into function different types of enzyme structural protein like collagen present in your muscles



transport protein hemoglobin I do not have to tell what these are insulin you know ask somebody who is diabetic in your family ah what insulins are and then you have of course, antibodies like egg g they are y shape structures like this.



Proteins not only have a chemical information chemical ah sequence, but they have a particular folding particular 3D structure as I was saying if this thing goes wrong this thing goes wrong just like your paper can fold and not make a aeroplane or a flower or your string cannot make a garland, but some kind of a you know mess ah this bad proteins can cause several misfolded proteins can be associated with several diseases like alzheimer's parkinson's etcetera which we have still difficulty understanding.



So, this is enough I think background information for me for today and these are the concepts covered these are

references please go through human genome project and I will see you in the next class. Thank you very much.