hello everyone i welcome you all in
the series of lectures on biomolecules before going to the main course of today's
lecture i will like to recap to the last lecture in the last lecture we have discussed about lengthening of chains in the carbohydrates and
there we talked about the kiliani synthesis and then we also discussed shortening of
the chains ah which is ah done by the whole degradation we also talked about the
disaccharides and there is structure polysaccharides and the structure ah and with
the special reference to the you know starch and we also discussed ah you know some problems
related with the you know carbohydrates today we will start another bio molecule amino acid ah
so we will talk about the amino acids and protein in today's lecture ah let us
define that what is amino acids amino acids how do you define
amino acids an amino acid an amino acid is a carboxylic acid with a protonated amino group with a protonated amino group amino group on the alpha alpha carbon
so how to define amino acid and amino acid
is a carboxylic acid with amino group at the alpha carbon what is
so special as we know that
amine group is basic in nature and carboxylic is acid group actually carboxylic group is
a acid group
so amino acids are very unique where nature has brought base and acid together
in the same framework and particularly in the case of amino acid this base group is alpha add
to the carboxylic acid
so it it becomes very interesting now let us look over that you know
how nature is able to bring these two ah into the you know same scaffold we will learn about its
chemistry and ah its structure and how are the important in the biological system
so let me
write the structure of amino acid as i mentioned an amine protonated amine group at the alpha
position
so first i will draw the carboxylic acid group and at the alpha position i am
drawing here protonated amine group this is the structure of you know a general structure
of amino acid where a at the alpha position we are having the protonated amine group and
a carboxylic acid group is there in the same scaffold based on the structure you know we can
classify this amino acid in the several subgroup and the very first one is you
know aliphatic side chain where the variation in the aliphatic side chain
so aliphatic side chain i will first name aliphatic side chain amino acid here main core will be same however the
side chain will be different

so main core is same carboxylic
group and the protonated it has at the alpha position it
has hydrogen at a substituent and we know this amino acid is known as glycine
glycine another it has methyl substitution and methyl substitution
this amino acid is known as elanine elanine another example again i'm at the
alpha position it has isopropyl as
a substitution and this is known as valine valine what is different different in
all these
cases in one case in the case of glycine at the alpha position we have
hydrogenated substituent
in the case of elaline we have c s three these are all you know aliphatic size
in isopropyl
group we are having in the case of violin and there is another aliphatic side
chain where like you know
homo isopropyl group is there which is known as leucine leucine and another
example of aliphatic side chain amino acid where the side chain is having
slightly different substituent the isomer of you know homo
ah you know homologated isopropyl group i can say same that what we have here
like you know four carbon unit four carbon ah alkyl
group
so here we are having alkyl group and in the case of isoleucine just
the position of methyl group on the you know alkyl chain at the alpha position
is
getting changed this is isoleucine isopropyl group here attached with the
ch two where as you know the position of this methyl group is getting
changed in the case of isoleucine isoleucine
so you can see here that you know with the amino
acid with the alpha size chain in the case of glycine it has hydrogen elenin
it has cs3 in
valine it has isopropyl group and in the leucine it has you know isopropyl ch2
and in the
isoleucine it has you know isomer of ah this you know ah alkyl group in the ah
isoleucine case now
the another class is hydroxy containing amino acid hydroxy containing amino
acids in the hydroxyl containing amino acid
the very first amino acid is serene serene serine is the ch2oh as a ch2oh as the
you know substituent at the alpha position this
is serine then threonine the another molecule is threonine where again hydroxyl
group is part of substituent you can see in all these amino acid only the
substituent is getting changed at
the alpha position
so this is the threonine now the another class
is sulphur containing amino acid sulfur containing amino acids sulphur
containing amino acids this is a cysteine and another member of sulphur
containing amino acid is methionine where the substituent
is you know sulphur thioeth are basically s c h two c h two methionine
methionine
so these two are the sulfur containing in cysteine we have you know
ch2 sh thiol whereas here thio ether as a substituent
at the alpha carbon methionine now the acidic amino acids
so acidic
amino acids means it has carboxylic group extra than the what is you
know ah required core that amine group and carboxyl group
so extra carboxylic group is

there
so let us talk about the acd amino acid acidic amino acids in case of acidic amino acid first
i will draw the required core and then the substituent this is experted or you know aspartic acid a spartic acid another is which has you know linka c s two c h two and then carboxylic acid group this is called glutamic acid glutamic acid
so one is having only one
ch2 as a linker at the alpha position in between the carboxylic acid at the alpha position this is aspartic acid and the glutamic
cases having two ch two as a linker one and two and carboxylic group now the another class is amides of acidic amino acids amides of acidic amino acids
so first amides
of acidic amino acid we started with aspartic acids
so we will form the aspartic acids you
know amides
so let me draw the require core and this is known as this
amide is known as aspar gene which is from the aspartic acid
aspartic acid amide s per gene and similarly for the glutamic acid one glutamine glutamine which is derived from the glutamic acid now basic amino acids the another
class is basic amino acids we had acidic amino acid now basic amino acid basic amino acids basic amino acids as we have in the case of sd amino
acid we had extra acid group in the case of basic amino acid also we need to have another you know extra basic group and the first example is lysine
so which which has like you
know four carbon linker and amine group in the ammonium form which
is known as lysine and the arginine which has three carbon linker
and guanidinium as a substituent this is arginine arginine
so lysine case has alkyl basic group as a you know
substituent at the alpha position whereas arginine group have alkyl guanidine as a substituent both are basic in
nature these two are ah known you know basic amino acid now i will talk about amino acids with the benzene ring with the benzene ring amino acids between generally so
first i build other main core that ch and the benzene benzyl group ch2
so this is ah phenylalanine only phenyl group is extra if you compare with the anion thats why it is known as phenyl ela nine phalanin another example is tyrosine
so what is difference tyrosine phalaenoline tyrosine now heterocyclic amino acids heterocyclic amino acids heterocyclic amino acids as the name itself suggests that you know it will have heterocycle core extra than the main core
so heterocyclic
amino acids
so proline is the this is proline this is its forming
heterocyclic core proline see this is the another example is histidine excuse me histidine has immediate joule core in its scaffold
so this is a histidine histidine another molecule is tryptophan which has indole methylene door in its in its core
so this is tryptophan crypto fund typo fund
so again i will repeat ah all the
you know ah amino acids
so that you can ah understand that you know how how
how did did i you know ah starts
so aliphatic side chain where we saw that in the

glycine elanine valine and at the alpha position it has hydrogen ch3 and isopropyl group then then
i went to the leucine leucine and isoleucine in the leucine case it has you know four carbon
branched substituent at the other position in the isoleucine just a you know isomer of that
alpha substituent then hydroxy containing amino acid c h two o h ah as a ah substituent
at the alpha position which is serine then threonine we had like you know c s three c h o h
at the alpha position threonine sulphur containing amino acid cysteine where the alpha position has
ch2sh and methionine where it has like you know thigh with her ch3s ch2ch then act amino acids
where extra carboxylic group is there in the case uh that case like aspartic acid whereas ch2coo
h group and glutamic acid here ch2ch2cooh group that is glutamic acid and then
amides of acidic amino acid same amide amide of aspartic acid is known as asparagine where it becomes c o n s two and similarly for the glutamic acids it becomes you
know c h two c s two c o n h two glutamine then basic amino acid where like alkyl amine group as
a substituent at the alpha position here you can see that four carbon nh2 group is the substituent
corresponding ammonium group in the case of lysine where in the case of arginine ch2 ch2ch2 guanidine
group as a substituent at the alpha position then fin amino acid with the benzene ring and
they are you know ah phenyl group if we put at the elanine that becomes phenylalanine and in the
case of you know tyrosine we have ch2 phenyl oh ig substituent and the last one is the
heterocyclic amino acid where we saw that you know in the case of proline it has cyclic that amine
group is in the form of cycle pyrolidine cycle pyrodine ring and that is why it is known as
a proline ah and ah the other one is the ch2 imidazole group as a substituent which is known
as histidine and the final one is the tryptophan where the ch2 indole as a substituent on the
required framework after looking over all these ah you know structures of you know different amino
acids i will like to talk about the configuration of amino acids you know we have already discussed
in the bio molecule the configuration of sugars
so here i will like to discuss
again the configuration of amino acid configuration of amino acids
so first i
would like to compare as we have seen in the case of ah sugars ah d glyceraldehyde and
l-glyceraldehyde
so i will like to write here d glyceraldehyde and l glyceraldehyde
so this is d glycerol dihyde and l l glyceraldehyde

so in the d hydroxyl as we have
already discussed that in the d hydroxyl group remains at the right side whereas in the case of
l ah it remains at the left side you can see here in the d it is at the right side
and in the l it is left side ok now similarly i will like the i will i will i will write the structure of d amino acid d amino acid and l amino acid now you can see in the case
of d amino acid i have kept ammonium group n s three plus at the
right side and the case of l amino acid it is in resemblance with the you know d glyceraldehyde and l glyceraldehyde
so this is d amino acid d amino
acid and this is l amino acid ok now one thing i will like to emphasize here that unlike monosaccharides monosaccharide in the case of monosaccharide d isomer is the you know found in nature and most amino acid found in nature are l have
the l configuration l configuration is the most amino acid why these sugars and l amino acid this
is again a very you know interviewing question ah in front of chemist but you know we know that
nature is very specific um you know why there would be some reason that why it has selected to
synthesize l amino acid in preference whereas you know in the case of sugar it has ah selected
like you know d ah you know uh um sugars
so ah you know this is ah still a you know a
very ah important question to be solved now we will talk about ah you know acid based properties of amino acids acid-base properties of amino acid as i mentioned
in the beginning itself in the amino acid we have carboxylic group and we have basic
amino group these two groups are and we all know that chemistry of carboxylic group and the
chemistry of amine group are completely 180 to each other you know one is base another is acid
and how
so it becomes very very ah interesting that you know how if these two groups are in the same molecule how the molecule will be have
so let us look over ah the you
know ah acid basic properties of amino acid so as we know that base will very quickly get
protonated in presence of acid and at the same time acid will lose proton in the presence
of base and it will form the you know ah corresponding ah counter you know ah base and
the same way base will form the counter acid so every amino acid has a carboxyl group and
amino group as we know and as i told you that base bill like to have a proton whereas acid
be like to lose a proton that is the reason in amino acid the amine group likes
to be in the form of ammonium ion whereas the carboxylic acid group likes
to be in the form of carboxylate however this can easily equilibrate with its you know other firm other firm where where ah ammonium can be the amine form

and
carboxylic acid can be the carboxylate form the other possibility where you know
carboxylic acid remains in the acid form and amine will be in the ammonium form now the structure where amine in the ammonium form
and carboxylic acid in the carboxylate form the total charge on the compound is zero if you see
it has one positive charge and one negative charge and if you sum both one positive
charge and one negative charge then it becomes zero in total it has zero charge however inside the molecule itself it has both the
charges and that is why this is called a juter ion deuteron and this juteran is possible at
neutral ph neutral ph means neither acidic nor basic and that is why i am writing here ph
seven juteran firm is available at the ph seven however if you go at the you know um basic
side if you have ph 12 then there we will see that you know this ammonium ion will remove its h plus and try to remain in
the amine form
so amine and this carboxylate form at the p h twelve and similarly if we go towards
the acidic side means p h zero various dick side in that case you know this carboxylate
will convert into the carboxylic acid form and amine will be in the protonated for ammonium
form
so this is very important to remember that the amino acid can exist in the you know
these two possible another these two possible you know structures based on the ph of the
solution at ph seven it will try to remain you know in the deuteronic form where the amine
will be in the ammonium form and carboxylic acid group will be the carboxylate form whereas at the
acidic side when ph is 0 the amine will convert into the ammonium and the carboxylate will convert
into the carboxylic acid whereas in the basic side what happens that you know ammonium will liberate
its proton and ah it will form the you know amine and carboxylate will remain as it is at
the basic side
so these are the you know possible ah structures based on the ph of the solution
however this is the case where the side chain does not have any ionizable hydrogens ironizable
hydrogen means if it is having you know aliphatic substituent then its fine ah but if it has
ionizable ah you know hydrogen as in the form of you know if it has a carboxylic acid group ah if
it has ah you know um ah a mean as a substituent ah at the side chain if it has you know ah
heterocycle as the substituent then in that case other possible you know ah structures

ah other structures are also possible so make it clear i will like to take exam an
example of histidine histidine where we know has immediate oil methyl group methylene group as a substituent at the alpha position
so let me draw the main core and then imidazole group i am drawing here
so this is the histidine now this histidine
has ionizable ah you know hydrogens and usable hydrogens means this you know this amine can also get ionized ok ah
so based on the ph various
structure for this one is possible
so histidine okay this one is possible at ps4 ps4 we have this ammonium group and you know
carboxylate group ok and here it gets protonated at p h four
when we go more acidic side in the case of more acidic then the carboxylate group will also get protonated
so this becomes at p h zero more acidic side now i will go towards the neutral ah ph ph
eight in that case this proton will not be there this becomes at ph eight as i told you you know towards
the neutral side and the final very basic ph very basic ph
so p h twelve all ironizable you know proton has been removed
at the basic one
so it it it is only in the carboxylate form you can see ah whereas the ph eight you know this riemann remains at the geoterranic form and if we go slightly acidic
then the you know ionizable ah proton gets ah energizable then again that basic nitrogen of the
imedus welding ah gets protonated and at the p at the acidic side highly acidic side ah what happens
that you know all the you know i mean carboxylate gets protonated and the two amines gets protonated
so what happens that you know based on the ph the same molecule can go to the different you know
structures different you know protonated forms now i will talk about the isoelectric point isoelectric point ah what is isoelectric
point the isoelectric point of an amino acid the isoelectric point of an amino acid is the ph at which at which it has no net charge it has no net charge known hr means it is in the
geothermic form in other words in other words it is the ph at which the amount of positive charge amount of positive charge on an amino acid exactly balances the amount of negative charge the amount of the negative charge negative charge
so p i is equal to ph
at which there is no net charge at which there is no net charge is no net charge now let us determine determining
the p i of an amino acid how can we determine the p i of an amino
acid ah as i define it that isoelectric point of an amino acid is the ph at which it has no net charge or in other words the positive charge on the amino acid balances
to the negative charge on the molecule so p i is equal to ph at which there is no net
charge now let us determine determining the pi pi of handling residue without an ionizable side chain ionizable side chain determining the p i of an amino acid without an
ionizable side chain let me write the structure of elanin c s three c h

so p k for these two functional group
for carboxylic acid p k here is two point three four and p k for this ammonium group is nine point six nine how can we
evaluate the p i p i is equal to p i is equal to summation of these two p k a p k a one and p k two divided by two two point
so two point three four plus
nine point six nine divided by two is equal to twelve point zero three divided
by two is equal to six point zero two six point zero two is the you know pi isoelectric point for you know ah this elanin amino acid now we will determine the p i of
an amino acid with an ionizable side chain determining the v i of an amino acid with an ionizable side chain ionized visible side chain i will take here example of lysine which has like
you know amine group its a basic amino acid
so let me write its structure one two three four and then amin all right
so let then p k of
all the functional group p k for the carboxylic group two point
one eight then ammonium group p k is eight point nine five
and then final the side chain ammonium group p k is ten point seven
nine you can see this one is more basic in comparison to that you know one next to
the you know carboxylic group here what we do that we take generally you know both
basic group in the case of you know if it is having basic substituents
so we take that
both basic group you know p k
so p i is equal to p i is equal to p k 1 which is eight
point i they told the both basic group p k
so eight point nine five and the
p k two is for the substitut you know side chain basic side chain that is ten point
seven nine divided by two then nineteen point seven four divided by two is equal to nine point
eight seven now i will take another example acids example
so i will
take glutamic acid over here glutamic acid has acid group
in the side chain in this case for the carboxylic group p k is p k is 2.
19 2.
19 and for the side chain carboxylic
group is p k is four point two five four point two five here it is more acidic
this is lesser and then the amine group is p k is nine point six seven nine point six
seven now p i is equal to isoelectric point as we saw in the case of basic amino acid
we took the p k of the two basic group that you know amine group and the substituted
amine group in case of acidic amino acid ah we can take we will take that you know ah
p k of acidic group in the case of you know ah glutamic acid
so first p k a one
is two point one nine and then p k two is four point two five divided by two
that becomes six point four four divided by two three point two two

so this
is the glutamic acid case glutamic acid in the case of acid
what are we taking the p k of acid group while calculating isoelectric point
we have ah added and then divided it by two that becomes the isoelectric point
ah whereas
in the case of lysine in the case of lysine we have taken the bases ah this
ammonium
group p k as well as the side chain you know this ammonium group p k these two
we have
added divided by two to get the you know ah p isoelectric point now i will talk
about the ah you know an introduction
to the to protein structure an introduction to protein structure
so ah as we know that protein is made up of
you know um ah polypeptide ah chains and this polypeptide chains are we can
say that peptide
chains are made up of amino acid amino acid is basic unit of you know you can
say ah protein
and to learn about the structure of protein we need to know that you know how
these peptide
chains are arranged in the protein and how these amino acids are you know ah i
mean placed there in
the peptide chain
so ah i can ah mention here that the primary and based based on this
arrangement
several structure has been suggested the primary structure secondary structure
tertiary structure
and quaternary structure of amino acid first we will talk about the primary
structure of ah you
know protein
so the primary structure of a protein protein is the sequence of amino acid the
sequence of the amino acids amino acids in the chain in the chain and the
location
of all the disulphide bridges and the location of all the disulfide all the dye
sulfide bridges
so primary structure deals with
the you know sequence of amino acid in the chain and how these chains are
linked with the you know
disulfide bridges and the location of all not not the link location of the
you know disulfide bridges then secondary structure secondary structures are
secondary structures are regular conformations assumed by segments of the
proteins backbone when it falls assumed by segments of the proteins proteins
backbone when it folds then third one is tertiary structure the tertiary
structure is the three dimensional
structure of the entire protein three dimensional structure of the entire
protein three dimensional tossery structure is three
dimensional structure of the entire protein now if a protein has more than one
polypeptide more than one polypeptide chain it also has a quaternary structure
quaternary structure the quaternary structure is the way the individual
polypeptide chains are entered the individual polypeptide chains are arranged
polypeptide chains are arranged
with respect to another one another
so we talked about primary structure the primary structure of
protein is the sequence of amino acids in the chain and the location of
disulfide

bridges secondary structure are regular con conformation assumed by segment of the proteins backbone when it folds and the tertiary structure is the three
dimensional structure of the entire protein whereas quaternary in the quaternary structure
you know different polypeptide pep if a protein has you know more than one polypeptide chains in
the quaternary structure how polypeptide chains are arranged with respect to inter that is the
quaternary structure we will discuss about all these structures in detail ah in the next class ah
thank you very much for attention i will stop here you