

hello everyone ah i am ravi p singh from
ah department of chemistry iit delhi i am going to discuss about the
biomolecules in this unit we are going to talk about different kind of
biomolecules such as
carbohydrates proteins and ah nucleic acid we are going to ah classify
carbohydrates protein
nucleic acid and vitamins based on their ah structures and ah we are going to
learn about ah
differences between the ah dna and rna ah these are the nucleic acid and we
are also going
to appreciate the role of biomolecules in ah in the system
so first let us talk about the
biomolecules biomolecules are ah organic compound found in living system found
in living system are we can say that living systems are built
up of various complex ah bio molecules such as carbohydrates proteins nucleic
acid lipids etcetera particularly carbohydrates and
proteins are essential constituent of our food essential constituent of our food
and their interaction their interaction constitute logic of life processes
carbohydrates serve as a major
source of metabolic energy major source of metabolic energy now
so before discussing about
carbohydrates ah let us talk about that you know what are carbohydrates
chemically
what is the question here what are carbohydrates carbohydrates are usually
defined as polyhydroxy poly hydroxy aldehydes aldehydes are ketones poly hydroxy
aldehydes are ketones are the
compounds that yield after the hydrolysis poly hydroxy aldehyde are ketones
so
again i will like to ah rephrase it the definition of ah carbohydrate
carbohydrates
are usually defined as poly hydroxy aldehydes are ketones are the compound
after hydrolysis
generates poly hydroxy aldehydes and ketones the chemical structure of
carbohydrates are
commonly represented by fischer projection fischer projection formulae here i
will show you two examples of
carbohydrates ah first one is glucose and the second one is fructose both these
glucose and fructose
have the molecular formula c six h twelve o six consistent with
the journal formula c six h two o six that made early chemist think that
basically carbohydrates are hydrates of carbon hydrates of carbon now lets look
over the you know these
structures fischer projection d glucose and ah you know ah d fructose
so here i am going
to draw the fischer projection structure of d glucose here you can see that
this
molecule has ah four chiral center and it has aldehyde in its framework this
is fischer projection formula of d glucose now i will draw fischer
projection formula of d fructose this is d fructose if you look over these two
compounds one
is d glucose is ah poly hydroxy aldehyde and ah d fructose is poly hydroxy
ketone now i will
talk about the classification of carbohydrates classification of carbohydrates
the

term carbohydrates are saccharide or sugar are interchangeably used and saccharide comes from our early language if you look over in sanskrit it is known as sarkara sarkara in sanskrit and saccharon in greek sacharon in greek and sacrament latin

so term carbohydrates are saccharides

are sugars which are used interchangeably has been derived from our ancient languages

as i mentioned that in sanskrit it is known as sarkara in greek it is known as

saccharon and in latin it is known as saccharum we can classify it into ah two part

first one is simple carbohydrates simple carbohydrates simple

carbohydrates are monosaccharides simple carbohydrates are ah monosaccharide

and they can be also called as single sugar single sugar second one is complex

carbohydrate complex carbohydrates contain two are more monosaccharide contain

two are more monosaccharide monosaccharides which are linked together now

these complex carbohydrates ah can

be further subdivided into three parts first one is disaccharides disaccharides which contain

two monosaccharide contains two monosaccharides second one is oligosaccharide

oligosaccharide contains three to ten

monosaccharides three to ten monosaccharide monosaccharides and the last one is

polysaccharide polysaccharide which contains more than ten more than ten ah

monosaccharide units

so here we ah subdivided complex carbohydrates

based on the number of monosaccharides in three subdivision disaccharide

oligosaccharide

and polysaccharide disaccharides contains two monosaccharides oligosaccharide

contains three

to ten monosaccharides and polysaccharide contains more than ten

monosaccharides

which are linked ah with each other to make you understand in a better way i

would

like to write here a schematic representation where various monosaccharides

are linked with each other and this is getting hydrolyzed after the hydrolysis

it will generate many monosaccharide units here in this polysaccharide m is a

monosaccharide unit monosaccharide unit its a sub unit i can say and here after

the

hydrolysis it generates number of monosaccharides this molecule is

polysaccharide

so a polysaccharide where number

of monosaccharides sub units are linked with each other is getting

hydrolyzed and that generates that many number of monosaccharide after the

hydrolysis now i would like to classify monosaccharides that what are

monosaccharides let

us talk about classification of monosaccharides classification of

monosaccharides it can be classified in two way based on the number of carbon

atom present in the molecule carbon atoms present in the molecule second whether

they contain an aldehyde are keto group

so two things we have to remember regarding

the classification of monosaccharides it can be classified based on the number of carbon

atoms in the molecule and the second thing that it has an aldehyde are keto

group

these are the two factors thus let's take example the monosaccharide containing three carbon atom with three carbon atom is called as triose tri- stands for three and -ose stands for the sugar three carbon atoms triose if it has four carbon atom one molecule contains four carbon atom then it is called tetros please remember that -ose stands for the four carbon atoms then triose if it has four carbon atom tetros and if it has five carbon atom then it is called pentose similarly it can go to hexose heptos etcetera now a monosaccharide containing an aldehyde group an aldehyde group is called aldose aldehyde group is called aldose whereas a monosaccharide containing a keto group is called ketose now it is clear that we have classified monosaccharide based on two criteria if a monosaccharide is having three carbon atoms then it is called triose if a monosaccharide is having four carbon atoms then it is called tetros similarly five carbon atom then pentose and six and seven then hexose and heptos etc the another criteria is based on the functional group if it has aldehyde functional group in its framework then it is called aldose whereas if it has a ketone in its functional group in its framework then it is called ketose these two classification are frequently combined a C four aldose for example is called aldohexose aldohexose stands for the aldehyde aldohexose aldohexose similarly a C five ketose is called ketopentose now I will show you few examples of these aldoses and ketoses to make you understand in a better way so let us take you know structure of an aldose as I mentioned aldose will have an aldehyde group and according to definition it will also have poly hydroxy framework so to represent it I am making this structure this is an aldose for ketose we need to have an a ketone group and poly hydroxy framework which I am denoting by this structure this is a ketose now I will take an specific example such as an aldohexose in aldohexose as I mentioned it will have an aldehyde group as well as it will have four carbon numbers because while discussing the classification of a monosaccharide we were focusing on two things one is the number of carbon atoms and the other thing is the type of functional group does it has an aldehyde or a ketone so here I am taking example of an aldohexose so aldohexose means it has aldehyde and hexose means it has four carbon atom so an aldohexose it has C four similarly I will take from ketose group ketohexose ketohexose means that it has like ketone in its framework and poly hydroxy framework and since it is ketohexose it has like you know five carbon atoms one two three four five

so this is a ketopentose ketopentose its c5 now we will take some practice problem ah that you know ah how many chirality centers are there in uh aldo tetros and in ketopentos

so lets take a

look on the structure of eldor tetros if you look over in the case of l two tetros we have two chiral center one and two similarly in the case of a ketopentose

it has two chiral center one and two another problem we can think that how many stereoisomers are possible for these two ah monosaccharide ah for aldo tetros and for

keto pentose

so as we know that it depends on the number of ah chiral center and ah since it

has like two chiral center

so four stereo isomers for both the molecules are possible now i will talk about d l

designation of monosaccharide dl designation of monosaccharides the simplest monosaccharide are the glyceraldehyde and dihydroxy stone the simplest ah monosaccharides are ah compounds glyceraldehyde and dihydroxy acetone let me draw the structure of

glyceraldehyde and dry high dihydroxyacetone glyceraldehyde has one chiral center and one aldehyde group in its scaffold whereas dihydroxy ac tone has two hydroxyl group and one ketone group in its scaffold and based on the nomenclature we can tell them

basically glyceraldehyde is an aldo triose why it is aldo trios because it has aldehyde group and it has three carbon in its scaffold and this

dihydroxy stone is a ketotriose now because of the three carbon atoms and similar way ketone group we have named it ketotriose of these two compounds only

glyceraldehyde contains a chirality center you can see there only

glyceraldehyde

has one chiral center whereas dihydroxyacetone does not have ah any chiral center therefore glyceraldehyde exist in the ah firms and that are known to be ah i mean

ah based on their absolute configuration ah are glyceraldehyde and s

glyceraldehyde

ah i will ah discuss in you know detail ah first i would like to write there is structure

so ah based on the absolute configuration the two glyceraldehydes are possible because it

has one chiral center ah first one is where the aldehyde group it attached to the carbon and hydroxyl group and hydrogen it

so this is

the carbon which is a chiral with which you can see here one aldehyde group and c s two h is attached and one hydroxyl and hydrogen is

attached this is plus glyceraldehyde another example is where now this is minus glyceraldehyde in plus glyceraldehyde what is important here

that hydroxyl is right side whereas in the minus glyceraldehyde hydroxyl is at the left side

this this is the you know basic difference between the plus and minus glyceraldehyde

for absolute configuration i will like to remind you that you know um tan in gold prelog

ah convention generally plus glyceraldehyde plus glyceraldehyde is known as r

plus glyceraldehyde whereas the minus glyceraldehyde is the minus glyceraldehyde now this nomenclature is based on the you know absolute configuration and before this nomenclature came in practice which is

based on the absolute configuration there was another system which was introduced

in 1906 in 1906 by Merose and Rowland which is known as the dl system

the system in the dl system plus glyceraldehyde is known as the d plus glyceraldehyde whereas the minus glyceraldehyde is known as the l minus glyceraldehyde these two compounds moreover serve

as configurational standards for the rest of the sugar molecules

as you can say that for the monosaccharide a monosaccharide

whose highest chirality center is having the same configuration similar to the d plus glyceraldehyde is known as the d sugar and if it has the same configuration similar to the

l glyceraldehyde then it is known as the l sugar now I will explain it with the example of these two

so one whose highest number chirality center has the same configuration as the you know d it is called the d sugar

glyceraldehyde with the d glyceraldehyde and is called the d sugar and with the same having the same absolute configuration

similar to the l-glyceraldehyde is called the l-sugar let me write here the structure of these

two sugars

so first I will write the structure of the aldose as I mentioned that aldose

so it has

to have an aldehyde in its scaffold and then now you see that it has the highest chirality center this is the highest chirality center

so one two three four four is the one two three four four four the highest

chirality center and this is five this is a d-aldopentose a d-aldopentose another

example of ketose is an l-ketohexose here again since it is a ketohexose it has to have a ketone group in its scaffold and finally the carbon the last you know chirality

center containing carbon now here these two these are the highest numbered chirality center sorry highest numbered chirality center highest number chirality center now let

us compare it with the d-glucose and l-glyceraldehyde if you look over in the case

of d-glyceraldehyde it has resemblance with the d-glyceraldehyde that highest numbered chirality center

so that is why it is

called d-aldopentose whereas in the ketose case it is similar to l

glyceraldehyde hence it is called l-ketohexose l-ketohexose now I will like to discuss some of the practice problem and classify the following monosaccharides

here I am

writing some monosaccharides and based on their absolute configuration based on their you know

the configuration of the highest numbered chirality center you have to do

classify them

so let me draw

the fisher projection formula of these example this is one another one is having the ketone group

so if we name it without the configuration we can say that

it this first example is having like you know one two three four five five carbon

so it becomes

aldo pentose and aldehyde group

so it becomes aldo pentose the second example has one two

three four five six seven seven carbon atoms

so it becomes and ketone group

in its scaffold

so it becomes keto haptose and the third example

which i want to introduce is is aldo aldo hexose now since we have to classify these

monosaccharides ah based on the dl ah you know designation let us look over the

structure ah and look over the highest numbered chirality center in all these cases let

us take first example in this example the highest numbered chirality center has configuration

similar to the d glyceraldehyde

so it becomes d then in second example again it has

configuration similar to the d glacier aldehyde

so it becomes d and similarly in the

third also it has configuration similar to the d glyceraldehyde

so it becomes d now i will

give you some more example to ah classify the ah monosaccharide based on the

ah they are you know ah configuration of ah

highest ah numbered chirality center ah indicate whether each of the following these

glyceraldehydes are d r l glyceraldehydes let me take the practice problem ah

of glyceraldehyde and we will identify that it

has d r l configuration

so here i am drawing the glyceraldehyde now we need to identify that it is d r l

glyceraldehyde ah you would have learned in your stereochemistry class that

one interchange of the substituent on a symmetric carbon atom

leads to the enantiomer whereas the two interchange of the substituent leads to the same

molecule

so here what i am going to do that ah before comparing with the d r l

glyceraldehyde

i will do two interchange first interchange will lead to hydroxyl group left

hand side and second interchange will lead to exchange between the hydrogen

and hydroxy methyl group now let us compare it with ah glyceraldehyde d

glyceraldehyde and ah l glyceraldehyde now i am bringing again back that

you know the highest membered chirality center when it is similar to the d

then it is called

d glyceraldehyde and when it is similar to the l glyceraldehyde then it is

called ah l ah

sugar here in this case it is similar to the l as hydroxyl is in left side so

it becomes l ah glyceraldehyde now i will take another example again we will do

that two interchange because
two interchange will give the similar ah compound
so let me first write it in the three dimensional form now the first
interchange will take place between the
hydroxyl and ch₂oh group sorry first interchange will take place
between the hydrogen and aldehyde group
so and second interchange will take place between
the hydrogen and ah hydroxy methyl group
so it becomes hydroxyl here and hydrogen and then now let us compare it with
the d and l glyceraldehyde since hydroxyl group in this part
is left hand side
so it becomes l glyceraldehyde now i will like to talk about
the configuration of aldoses aldo tetros have two asymmetric center therefore
four stereo isomers are possible whereas elbo pentose has three stereo centers
hence ah you
know eight is two isomers are possible whereas the aldo hexose has four stereo
centers hence sixteen
stereo isomers are possible
so all these ah dependent the these ah stereo isomers are possible
based on the number of chiral centers ah available in the scaffolds ah i will
like to stop here and
in the next class i am going to talk about the you know possible ah aldo
hexoses possible aldo
pentoses and possible eldo tetroses thank you you