Hello everyone.

And welcome to Types of mutations

Part One. Today we will be

going through point mutations,

Tautomerism, base pair substitutions,

Transitions and transversions. At the

end of this presentation you will be

able to understand point mutations.

You will be able to explain tautomerism.

You will be able to illustrate

base pair substitution

mutations and distinguish between

transitions and transversions.

To begin with, let us define point mutations.

So a point mutation is a gene mutation

involving only a single base pair.

OK, so it is a mutation where

in a single nucleotide.

Is changed from a sequence of DNA or RNA . As

you see in the example given in the slide,

there is a single nucleotide,

or a single nitrogenous base C cytosine,

which gets changed to A that is adenine,

so such a change involving a single

nucleotide is a point mutation. We are

all familiar with the DNA replication,

and we know that DNA replication

follows the semiconservative mode and

it follows Watson and Crick pairing

wherein adenine pairs with thymine

and guanine pairs with cytosine.

In most cases, DNA replication proceeds well.

Error free,

kind of, however many a times there

are mistakes in DNA replication.

These errors in DNA replication are

attributed by biologists to tautomeric

shifts that occur in the nitrogenous bases.

As a result of which there

are mismatched base pairs,

for example adenine pairing with cytosine

or guanine pairing with thymine.

OK, not following the normal Watson

and Crick pairing.

Now what are tautomeric shifts?

Let's define tautomerism.

Tautomerism is the relationship

between the structural isomers

that are in chemical equilibrium,

wherein the isomers readily

Change into one another.

The nitrogenous bases in DNA that

is the purines and the pyrimidines

exist in two isomeric forms

or they have two tautomeric forms,

the keto and the enol form,

and the amino and the amino form.

If you look at the slide,

the two isomeric forms of the four

nitrogenous bases are displayed here.

Now, if you look at the isomeric forms,

you see that the protons occupy

different positions in the two isomers.

Let's take, for example,

the nitrogenous base adenine.

You see the proton present here.

In this form, the amino form.

While here the proton, the hydrogen atom,

Moves to the ring nitrogen atom in

the imino form, so hydrogen atoms can

move from one position to another

from the amino group to the ring

Nitrogen and this movement of

hydrogen atoms is reversible.

So you have one isomer readily

changing to the other.

The keto form readily changing

to the enol form and the amino form

readily changing to the imino form. In

DNA, the nitrogenous bases,

guanine and thymine,

are found to be most stable in the keto form,

so guanine and thymine are stable

in the keto form,

while adenine and cytosine are

more stable in the amino form.

So whichever form they are most stable in,

they are found to be more commonly occurring.

So the keto and amino forms are the common

forms of purines and pyrimidines.

While the enol and the imino forms are

the rarer forms of the nitrogenous bases.

Nonetheless, as we said earlier,

they can shift from the more stable

form to the less stable form. OK,

but when they shift to the less stable form,

nitrogenous bases are found to exist

only for a short period of time

in the less stable form.

So they are found in the less stable

form for a small shorter period of time,

so the less stable form is a rarer

form of the nitrogenous bases,

namely the enol and the imino forms are

the rarer forms of the nitrogenous bases.

Now at the time of DNA replication,

when DNA replication begins,

if the nitrogenous bases of the template

strand are present in the rarer form.

If they are present as the

rare tautomeric form,

then their base pairing

characteristics get affected.

For example,

the rarer form of adenine is the imino form.

OK, so during DNA replication,

if adenine from the amino form has undergone

a tautomeric shift to the imino form,

then this imino form of adenine pairs

with cytosine instead of thymine.

Likewise, if at the time of DNA replication,

guanine is present in the enol form,

which is its rare tautomeric form.

It pairs with thymine.

This gives rise to mismatched base pairs.

So tautomerism is the cause or

it gives rise to mismatched base

pairs contributing to errors in DNA

replication and such errors in DNA

replication result in mutations.

In this illustration,

as you see in the slide we have

tautomeric shift being depicted during

semiconservative replication on

the left hand side. Here you see.

A double stranded DNA.

As it undergoes replication,

the first step is unwinding of

the double stranded DNA.

OK,

to give rise to separate single strands,

and each of these single strands

will act as templates,

where in DNA polymerase will add

nucleotides complementary to these

nucleotides on the template strand.

At this point,

if one of the nitrogenous bases

undergoes a tautomeric shift.

So in this example,

we are assuming that the nitrogenous

base adenine has undergone a tautomeric

shift from the amino form to the imino form.

So if it is undergoing a tautomeric

shift during the process of replication,

then DNA polymerase which polymerizes

the newly synthesizing strand

complementary to the template,

brings a cytosine residue opposite

the tautomer of adenine.

So this becomes a mismatched base pair

that is formed in the daughter strand.

But if you look at the other daughter strand,

the other daughter DNA strand is

normal as there was no tautomeric

shift in the template strand.

OK,

now these two daughter strands

in turn will proceed for DNA

replication in the next round.

Let us see what happens in

the next round of replication.

So these are the two daughter DNA

strands obtained from the first round

and these two daughter DNA strands

are now proceeding to the next

generation of DNA replication.

So each of these double stranded DNA

are going to unwind and separate.

OK, as you see in the presentation here.

Now as they unwind separate and

proceed for DNA replication,

remember we had a tautomer in this

double stranded daughter DNA.

And this tautomer was the imino form.

The rarer form of adenine.

And we've also known or

We also noticed that or we understood

earlier that the rarer forms exist

only for a short period of time.

So during the second round of replication,

this tautomer can shift back to the amino form,

so the imino form of adenine

shifts back to the amino form,

and if it shifts back to the

amino form when DNA polymerase

is copying the template strand,

it will now add thymine opposite

this adenine on the template strand.

Thus it restores the normal base pair T.

But in the other strand.

the other template strand

had already incorporated cytosine at

this point and so, opposite, cytosine.

It takes up guanine.

So the second base pair in this stretch

of DNA becomes a changed base pair.

If you compare this double stranded

DNA with the other daughter DNA's,

the other three daughter DNA

molecules produced,

you see that in the second

position we have an A -T base pair in

the three daughter DNA molecules.

While in this 4th daughter DNA molecule,

the second base pair is a G-C base pair.

So we have a change from an

AT to a GC base pair.

The A T base pair is substituted

by a GC base pair.

Such a change is called as a

base pair substitution or a

base pair substitution mutation.

So as we said earlier,

a base base substitution is a

change in the gene such that one

base pair is replaced by another.

That's what we saw in the.

previous slide. Now base pair substitution

mutations can be of two types: 1).

Transition and 2) transversions.

Now what is base pair transition?

Transition is the replacement

of a purine in one strand with

another purine or replacement of

pyrimidine in the complementary

strand with another pyrimidine.

So as you see here in the example taken here,

the guanine that is shown in

red is replaced by adenine,

so purine guanine replaced

by another purine adenine,

and in the complementary strand

you have cytosine the pyrimidine

replaced by another pyrimidine.

thymine that is shown in red OK,

so the GC base pair is replaced

substituted by an AT base pair.

such a base pair substitution is

called a transition. Transversions

on the other hand,

involved substitution of a purine

by a pyrimidine.

So as you see in the example,

the red colored base nitrogenous base,

guanine, is substituted by cytosine,

so purine substituted by pyrimidine and vice versa.

OK so you have a GC base pair

substituted by a CG base pair

such a base pair substitution

is called as a transversion.

Transversions are usually rare

while transitions are more common.

What is the effect of such base

pair substitutions in DNA?

So as you see here,

a single base pair change in the gene

results in a change in the mRNA

Have a look at the example given here.

We have a single base pair change,

cytosine which is changed or substituted by

adenine. This change results

in a change in the mRNA codon.

If this is your new strand,

the second codon in the normal DNA

reads GAG while in the changed DNA where

there was a base substitution.

The codon now reads GAU.

So it's a different codon that

codes for a different amino acid as

compared to the normal DNA strand.

So a change in the gene results

in a change in the mRNA codon,

which results in a change in the

amino acid and which may alter the

function of the resultant protein.

All these effects are because of

one base that was substituted and

since it is one base, a single base,

a single nucleotide substituted.

It is called as a point mutation,

so to conclude.

We can say that nitrogenous bases

that undergo tautomeric shifts are

the cause of mismatched pairing

and errors in DNA replication.

Substitution of one base pair by another

takes place in such types of mutations,

and since it involves only a single base

pair, it is called a point mutation.

Base pair substitutions can be either of the

transition type or the transversion type,

and they may alter the function

of the resultant protein.

OK,

these are a few references that

you can go through,

thank you.