

Hello students, I am Katelyn

Gonsalves from Saint Xavier's College

and today we will go through the

differences in transcription between

prokaryotic and eukaryotic systems.

In this module we will learn the key

features of transcription and highlight

the differences between the process in

prokaryotic and eukaryotic systems.

At the end of this session

you will understand how the synthesis and

processing of eukaryotic and prokaryotic

messenger RNA differ from each other.

A gene expresses itself

by copying the DNA sequence to

make a messenger RNA molecule,

this is done by the enzyme RNA

polymerase that copies nucleotide

sequence in the template DNA

strand to an intermediate molecule,

which is the messenger RNA or mRNA.

Transcription is a universal process occurring in prokaryotic as well as eukaryotic cells, and although the overall process is similar in both systems, there are important differences that exist between these groups.

As you have learned earlier, transcription involves three stages.

Initiation, elongation and termination. initiation is the beginning of transcription where RNA polymerase binds to the promoter region, which is the start of the gene causing unwinding of the DNA, and it begins constructing a messenger RNA complementary in sequence to the template DNA.

This is followed by the elongation stage in which RNA polymerase

reads the unwound DNA strand and

synthesizes mRNA rapidly in the

five prime to three prime direction

by adding ribonucleotides.

In termination,

RNA polymerase reaches the end of the

gene or termination, or a stop signal.

The completed mRNA strand

is detached from the DNA.

Here you can see the three stages

of transcription initiation,

elongation and termination

with the released product.

That is,

messenger RNA molecule.

Transcription in prokaryotic

and eukaryotic systems

is fundamentally similar.

There are similarities with respect to the

following points in both kinds of cells.

DNA provides the template for RNA synthesis.

One strand of the DNA duplex, the template strand is read by the enzyme RNA polymerase.

In both cases it results in production of RNA, which are similar in chemical composition.

The direction of RNA synthesis by RNA polymerase in both cases is also in the five prime to three prime direction.

Though there are similarities.

There are key differences between prokaryotic and eukaryotic transcription.

And these differences are with respect to the following criteria.

Transcription location.

The rate of transcription and translation.

The nature and type of RNA polymerase.

The initiation stage including the nature of the consensus sequences that make up the promoter and the existence of post transcriptional modifications.

Let us now go through some of the differences in prokaryotes and eukaryotes

with respect to transcription.

The first main difference lies in

the location of transcription.

In prokaryotes it occurs in the cytoplasm,

while in the case of eukaryotic cells

it occurs in the well defined nucleus.

Transcription in eukaryotes is much

more complex as compared to the prokaryotic system.

In case of prokaryotic or bacterial cells

another key difference

is the coupled transcription and translation,

which is seen only in case of prokaryotes.

As a result, transcription and

translation in prokaryotic systems

occurs simultaneously and continuously,

leading to an overall rapid

rate of protein production.

Transcription and translation

in the case of eukaryotes are

separated by the nuclear membrane

and cannot take place simultaneously,

and the overall rate is therefore slower. With respect to the difference in the nature and type of the enzyme RNA polymerase which is responsible for transcription.

In prokaryotic systems, a single multi subunit enzyme RNA polymerase is responsible for the synthesis of all RNA in the cell.

While in eukaryotes, there are three different RNA polymerases, namely RNA polymerase 1, 2 and 3,

each of which synthesize the three classes of RNA. With respect

to the promoter sequences,

which are the recognition

sites for the RNA polymerase,

there are differences in the nature of

the conserved or consensus sequences,

and their location in prokaryotic

and eukaryotic sequences.

During transcription initiation,

there is also a difference.

RNA polymerase requires the help

of a Sigma protein to recognize

and bind at the promoter.

Eukaryotic transcription

is much more complex,

requiring the aid of

several initiation factors.

Referred to as TFII.

The transcribed mRNA,

the product of transcription in

case of prokaryotes is said to

be polycistronic or polygenic,

which means that it has information

for coding of two or more polypeptides,

while in the case of eukaryotes,

the messenger RNA is a monocistronic

one with the sequence for coding

of only one polypeptide.

Another very important difference

lies in the fact that the synthesized messenger RNA in prokaryotes is a fully functional mRNA molecule that can undergo translation.

This is not the case in eukaryotes.

The primary transcript that is formed is a large precursor molecule called heterogeneous nuclear RNA or hnRNA,

which is synthesized

only in case of eukaryotes. this

hnRNA needs to undergo several modifications referred to as post transcriptional modifications.

These include addition of multiple

adenosine residues at the three prime

end by the enzyme Poly adenylate polymerase.

This results in a Poly A tail

at the three prime end.

Another modification is the addition

of a 7 methyl Guanosine residue.

That is a cap at the five prime end.

Eukaryotic genes being split genes

result in the primary transcript

having sequences which are non

coding or the intron sequences.

These sequences need to be looped out

and excised or cut out by RNA splicing

before the mRNA can be translated.

None of these post transcriptional

modifications are seen in

the case of prokaryotic mRNA.

And finally,

with respect to inhibitors of transcription,

rifampin inhibits selectively the beta

subunit of the bacterial RNA polymerase

while it has no action on

the eukaryotic system.

On the other hand,

alpha amanitin the poison

from the mushroom Amanita

has no effect on the bacterial

RNA polymerase,

but it can disrupt transcription

by blocking RNA polymerase II of animal cells.

Here in the figure you can see the

main differences between prokaryotic

and eukaryotic transcription from

coupled transcription translation in

prokaryotes to the location of transcription.

In the eukaryotic cell you can

also note the post transcriptional

processing which takes place in

the form of the Poly A tail,

the five prime cap and RNA splicing

to give you the mature mRNA which

then moves out of the nucleus

and undergoes translation

in the cytoplasm. Thus

we have learned today that although

prokaryotic and eukaryotic transcription

are fundamentally similar,

they share quite a few differences.

Main differences lie in the location,

The nature and type of the

enzyme RNA polymerase.

The final product being a

polycistronic mRNA in prokaryotes,

while in eukaryotes it is a monocistronic

mRNA and the existence of post

transcriptional modifications which

occur only in eukaryotic systems.

If you want to know more about

this topic then these are the

references that I would suggest.

Thank you.