Welcome to this presentation on

Milestones in genetic engineering.

In this presentation.

We will go through a brief

introduction to genetic engineering.

And important milestones in genetic

Engineering. At the end of the

presentation you will be able

to define genetic engineering,

and explain why and how it is carried out.

We will also be able to list important

contributions made by scientists in

the field of genetic engineering.

So let's begin with the introduction.

We all know that genes are

the blueprint of life.

They have conserved the genetic

traits since millions of years.

And will do so in future too.

The last decade of the 20th century witnessed

much advancement in molecular biology.

Genes of 1 Organism can be cut and

joined with other genes and introduced

into cells of other organisms.

So gene editing was made possible.

Gene manipulation was made possible.

Such changes in the gene is

actually genetic engineering.

It involves 2 main steps. 1.

Synthesis of a recombinant DNA molecule.

2 gene cloning.

In the first step,

DNA from one Organism is isolated.

It is cut into fragments in vitro using enzymes.

Similarly, plasmids are isolated.

Plasmids are double stranded circular

DNA molecules capable of self

Replication, autonomous replication.

Such plasmid molecules are also cut enzymatically.

The double stranded ring is opened and

the DNA fragment that is obtained by

enzymatic cutting is fitted into this

plasmid molecule and joined again

enzymatically using enzymes. And

all this is carried out in vitro.

This yields a recombinant DNA

molecule or a recombinant plasmid.

The recombinant plasmid is then

introduced into a host cell

where the plasmid replicates.

And along with the plasmid,

the DNA fragment that was inserted

also replicates and forms many copies.

This step is called gene cloning.

Thus,

the new host cell receives a

new set of genes.

In this illustration,

for example,

the host cell is B and it

receives genes from A.

Such a deliberate modification

of an organism's genetic information

is what is “genetic engineering”,

and it is accomplished by a collection of

methods known as recombinant DNA technology.

Genetic engineering has produced

several novel products which

are of use in various fields.

In the field of industry, in

the field of medicine, agriculture,

the environment and so on.

The story of the ‘Super bug’ at this

moment would be worth going through.

So we have we have come across

pollution taking place in the environment

or we've heard of pollution taking

place in environment due to the

presence of various toxic chemicals.

These toxic chemicals can

be broken down by enzymes.

Enzymes produced in bacteria

or in microorganisms.

Enzymes are coded by genes.

And genes coding for these

enzymes are present on plasmids.

So you have genes which code for enzymes

to breakdown camphor on one plasmid,

genes to breakdown naphthalene on

another plasmid, and so on and so forth.

Now, Dr Anand Mohan Chakraborthy,

an Indian born American scientist,

came up with this bright idea.

He isolated these plasmids

from the individual cells.

And by the method of genetic engineering

put them all into one new cell.

He chose *Pseudomonas putida* for this.

This resulted in the formation

of a cell that had the ability to

degrade various types of substrates.

So 1 cell could degrade

Camphor, naphthalene,

xylene, toluene and so on.

Such a cell was called a super bug.

Since such a cell can degrade

a wide range of substrates

it could easily grow on an

oil rich /crude oil medium.

And therefore it thrived as compared

to other individual cells that

had only single plasmids in them.

In 1990,

the US government approved

the use of the Super bug

to treat oil slicks/ to treat oil

spills in a water body in Texas.

Thus Dr. Anand Mohan

Chakraborthy is credited to have

created the Super Bug to clear oil

spills and thus reduce environmental

pollution by genetic engineering.

This happened in 1990,

but genetic engineering actually

began way back in 1970.

Let us quickly run through various

milestones in genetic engineering.

One of the most important early

milestones that we need to acknowledge

is the discovery of the double helical

structure of DNA by Watson and Crick,

which was done in 1953 and Rosalind

Franklin's work on X ray diffraction

images of DNA proteins which

contributed to this discovery,

which was done way back in 1950.

After that a number of enzymes

were discovered, polymerases,

ligases, etc.

In 1960, DNA ligase. 1960s DNA

Ligases and restriction enzymes.

Polymerases were also discovered.

Important of all,

these enzymes are ligases and restriction

enzymes or restriction endonucleases.

These two are important,

I say with respect to genetic engineering.

In 1967, to be specific,

DNA ligase was discovered.

At that time,

it was known to play a role in

DNA repair and DNA replication.

Later on,

it was found that recombinant DNA

technology couldn't happen without

the presence of DNA ligases.

So these DNA ligases were

called as molecular sutures.

In 1968 came the restricted discovery

of the restriction enzymes.

These enzymes were discovered

when scientists were working on

bacterial cells which were infected

by phages and they found that the

infection of phages was kind of

restricted by these bacterial cells

by producing these enzymes,

and therefore they were

called as restriction enzymes.

These enzymes are kind of star tools

in recombinant DNA technology,

without which no genetic

engineering can happen.

So the era of 1960s is called the era of

molecular sutures and molecular scissors.

In 1970, Type 2 restriction

enzymes were purified,

and as you read up further and

you go through the modules

later on that are coming up,

you will understand that it is Type 2

restriction enzymes which are actually

involved in genetic engineering.

The first recombinant DNA

was created in 1972,

where in DNA from one bacterium

was inserted into another.

Therefore,

the 1970s is considered as the

era of genetic engineering,

where Genetic Engineering actually took off.

In 1978 there was a big discovery

made kind of, in the field of medicine,

with the production of human insulin,

recombinant human insulin. Diabetic

patients initially were treated with

insulin obtained from bovine sources.

This was expensive and also elicited

immune responses because the insulin

from bovine sources was not exactly

similar to the human insulin.

Recombinant insulin produced from *E.*

coli could be produced in large amounts,

thereby reducing cost.

Also, it was similar,

or it was the same human insulin,

that was produced, chemically,

and there were no immune

reactions that were reported.

The 1980s is considered as the era

where genetically engineered vaccines
and various products for treatment of
diseases in humans were discovered.
You had the discovery of the first or the
production of the first transgenic animal.
The human insulin that was produced in
the 70s was approved for use by the US
FDA and it was marketed as Humulin.
After insulin, various other hormones were
also produced by genetic engineering.
In the 80s also,
genetically engineered Ti plasmid
was used to transform plants.
And the first successful production
of genetically engineered BT cotton
happened in the year 1988.
A landmark discovery or invention
in the 80s was the invention of
the polymerase chain reaction,
which was developed by Kary
Mullis and this invention really

revolutionized molecular biology.

1990s is considered as the period

of genetically modified organisms

and the period of cloning.

Transgenic pigs and goats were

developed that could produce proteins.

Like human hemoglobin.

In 1993,

the first genetically engineered tomato

flavr savr was sold in the market.

The speciality of this tomato was

that it was genetically engineered

such that it could remain ripe for

a longer period of time on shelves,

thus avoiding spoilage of tomatoes in

transit from the field to the supermarket.

In 1994,

human monoclonal antibodies were

produced which had wide applications

in the field of medicine.

And 1996 again made headlines

when the first clone of a lamb or

clone of a sheep was produced

called Dolly, and the scientists responsible

for this were Ian Wilmut and his

team at the Roslin Institute in Scotland.

After that,

many other animals were cloned.

2000 that period.

Witnessed

Sequencing of the human genome.

Craig Venter and Francis Collins

published the sequence of the

human genome in Nature and Science.

The project got completed later on

after two years somewhere in 2003.

In the same time of the year 2003

Human cloning was experimented in France,

However, in 2005 this human cloning

was opposed by the United Nations

and therapeutic cloning to produce

stem cells was researched

during this period.

Later in 2006 and 2008,

the first synthetic genome was constructed.

The period from 2010 to 2020 that

is the last decade is known as the

CRISPR period during this period.

Clustered Regularly InterSpaced

Palindromic Repeats

were introduced as important genome

engineering tools and a lot of

research in the field of genetic

engineering is happening using CRISPR.

In fact, the year 2020.

They awarded a Nobel Prize.

for the treatment of sickle cell

anemia using CRISPR and the year 2020

is considered as the year of CRISPR.

In this way there are lots of landmark

or milestone discoveries and inventions

in the field of genetic engineering.

To sum up,

Recombinant DNA technology and gene

cloning are powerful tools ever

developed in the field of biology.

Like any powerful tool,

genetic engineering also has to be

used carefully and if used wisely,

it promises to enhance the

quality of human life.

But if used carelessly,

it can negatively impact the quality

of life. The choice depends

on the user. Thank you.