



ATOMIC ENERGY CENTRAL SCHOOL 4 MUMBAI

UNIT- IX BIOTECHNOLOGY CH - 12 : BIOTECHNOLOGY AND ITS APPLICATION MODULE : 1/3

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TOPICS TO BE COVERED

❖ BIOTECHNOLOGICAL APPLICATIONS IN AGRICULTURE

THERAPEUTICS

ENERGY PRODUCTION

DIAGNOSIS

Applications of Biotechnology

WASTE TREATMENT

GENETICALLY MODIFIED CROPS

BIO REMEDIATION

PROCESSED FOOD

Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms. It is the chemical basis of biological inheritance. It is a long molecule of two strands, each of which is a double helix. The DNA strands are joined together by hydrogen bonds between the nitrogenous bases of the two strands. The DNA molecule is a polymer of nucleotides. Each nucleotide consists of a phosphate group, a deoxyribose sugar, and a nitrogenous base. The nitrogenous bases are adenine, thymine, cytosine, and guanine. Adenine and thymine are paired together, as are cytosine and guanine. This pairing is called base pairing. The sequence of bases in a DNA molecule determines the sequence of amino acids in a protein. The code is read by copying stretches of DNA into the related nucleic acid RNA, in a process called transcription.

Chemically, DNA consists of two long polymers of simple units called nucleotides, with backbone made of sugars and phosphate groups joined by ester bonds. These two strands run in opposite directions to each other and are therefore anti-parallel. Attached to each sugar is one of four types of molecules called bases. It is the sequence of these four bases along the backbone that encodes information. This information is read using the genetic code, which specifies the sequence of the amino acids within proteins. The code is read by copying stretches of DNA into the related nucleic acid RNA, in a process called transcription.

Within cells, DNA is organized into long structures called chromosomes. These chromosomes are duplicated before cells divide in a process called DNA replication. Eukaryotic organisms (animals, plants, fungi, and protists) store most of their DNA inside the cell nucleus and some of their DNA in organelles, such as mitochondria or chloroplasts. In contrast, prokaryotes (bacteria and archaea) store their DNA only in the cytoplasm. Within the chromosomes, chromatin proteins such as histones compact and organize DNA. These complex structures guide the biochemical reactions of DNA and other proteins, helping control which parts of the DNA are transcribed.

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DNA codes in many possible combinations that include A, C, G, and T. DNA has been directly observed only in cells and 2-DNA has been directly observed only in ground of structure in molecular biological DNA. In a paper published in 1953, James Watson and Francis Crick proposed a model of DNA structure. The model was based on the work of Rosalind Franklin and Maurice Wilkins. The model showed that DNA is a double helix. The two strands are joined together by hydrogen bonds between the nitrogenous bases of the two strands. The DNA molecule is a polymer of nucleotides. Each nucleotide consists of a phosphate group, a deoxyribose sugar, and a nitrogenous base. The nitrogenous bases are adenine, thymine, cytosine, and guanine. Adenine and thymine are paired together, as are cytosine and guanine. This pairing is called base pairing. The sequence of bases in a DNA molecule determines the sequence of amino acids in a protein. The code is read by copying stretches of DNA into the related nucleic acid RNA, in a process called transcription.

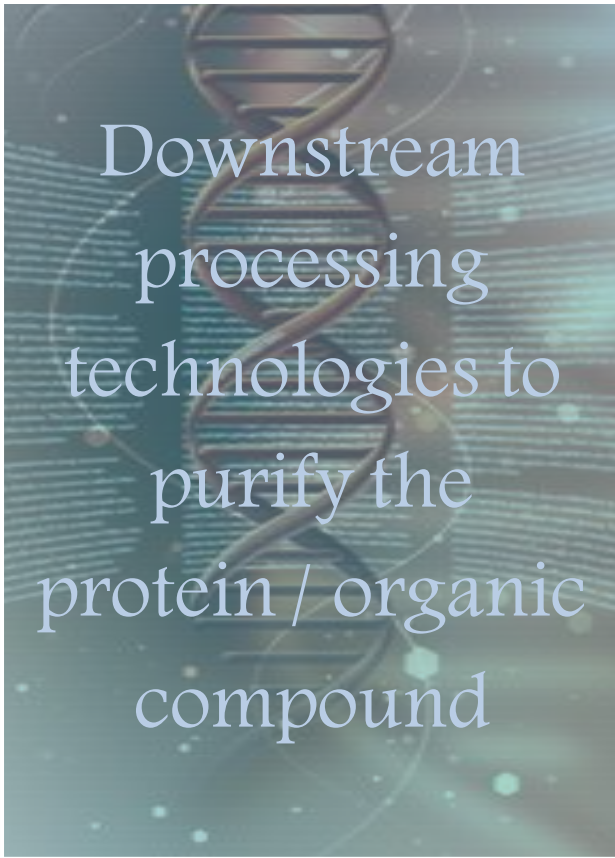
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Three critical research areas of Biotechnology

Providing the best catalyst in the form of improved organism usually a microbe or pure enzyme

Creating optimal conditions through engineering for a catalyst to act



Downstream processing technologies to purify the protein / organic compound



How food
productivity can be
increased ?

Agrochemical based Agriculture

- Green Revolution
- Use of improved crop varieties
- Use of Agrochemicals

Organic Agriculture

- Use of Bio fertilizers
- Manures
- Bio pesticides
- Bio control

Genetically Engineered Crop based Agriculture

- Use of genetically modified crops
- GMOs

WHAT ARE GMOS?








GENETICALLY MODIFIED ORGANISMS ARE THOSE WHERE THEIR GENES ARE ALTERED BY MANIPULATIONS.

ADVANTAGES OF GM CROPS:

- MORE TOLERANT TO ABIOTIC STRESSES
- REDUCED RELIANCE ON AGROCHEMICALS
- REDUCED POST HARVEST LOSS
- INCREASED EFFICIENCY OF MINERAL USAGE BY PLANTS
- ENHANCED NUTRITIONAL VALUE OF FOOD
 - E.G. GOLDEN RICE IS VITAMIN – A ENRICHED RICE
- CREATE TAILOR MADE PLANTS TO SUPPLY ALTERNATIVE RESOURCES TO INDUSTRIES, IN THE FORM OF STARCHES, FUELS AND PHARMACEUTICALS.

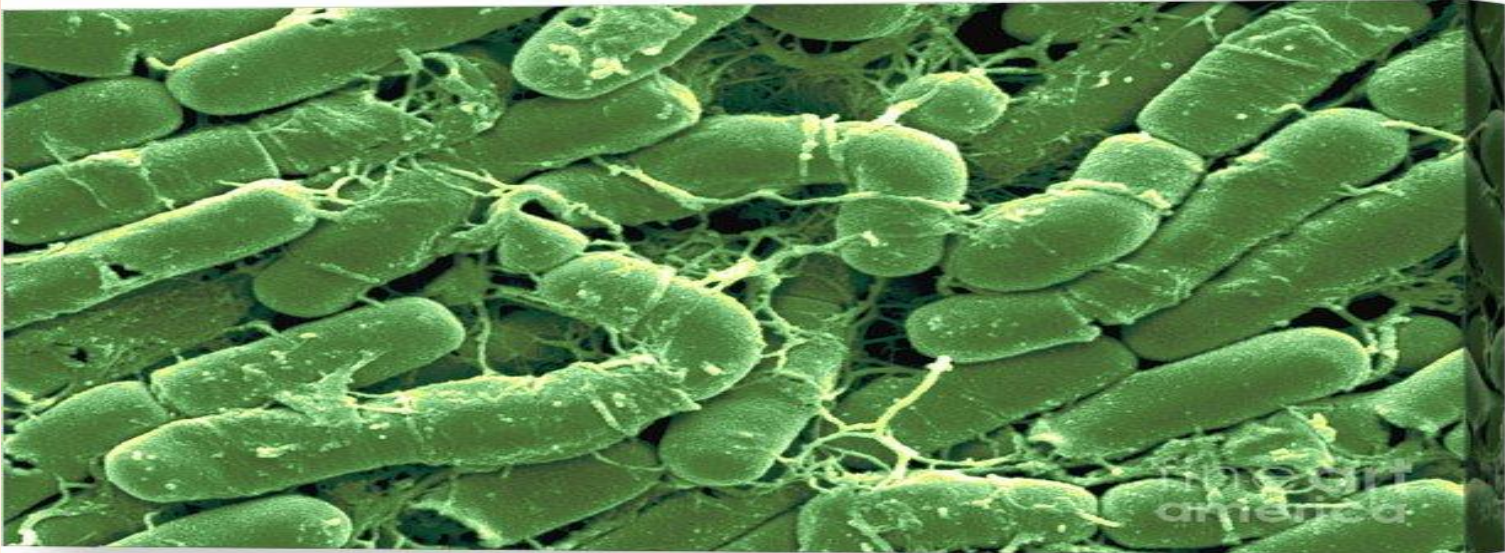
SOME EXAMPLES OF GMOS

GMO	Description	Picture
Golden Rice	Rice modified with daffodil genes to have more beta-carotene, which the body converts to Vitamin A	
Flavr Savr Tomatoes	Tomatoes modified by the removal of genes responsible for the softening of fruit, meaning the tomatoes spoil more slowly	
Bt Corn	Corn modified with a bacterial insecticide gene so that it produces insect toxins within its cells, protecting it from pest species	
Aqua Advantage Salmon	Salmon modified with growth hormone regulating genes in order to grow to market sizes in significantly less time	
Glow in the Dark Animals	Animals modified with genes for fluorescent proteins will glow in the dark – this novel feature serves no practical purpose	

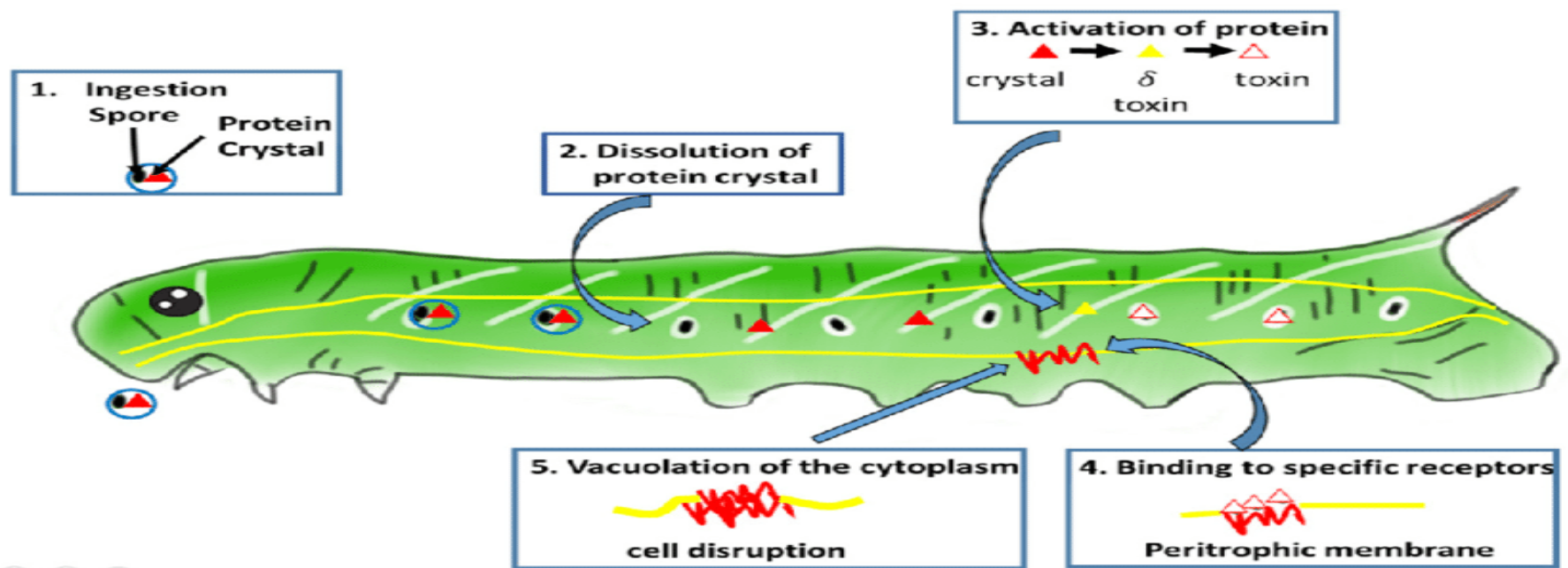
PEST RESISTANT PLANTS

HEARD ABOUT BT CROPS?

Bacillus thuringiensis

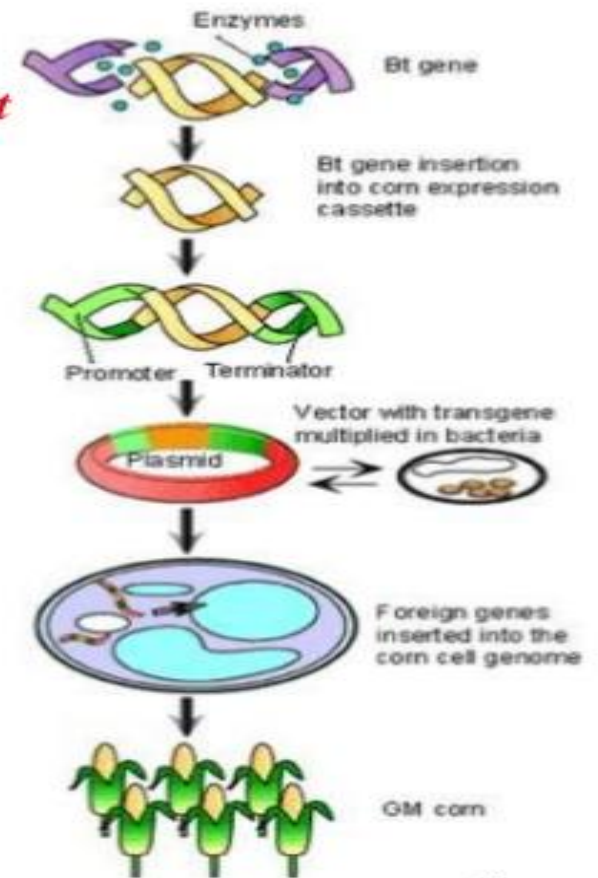
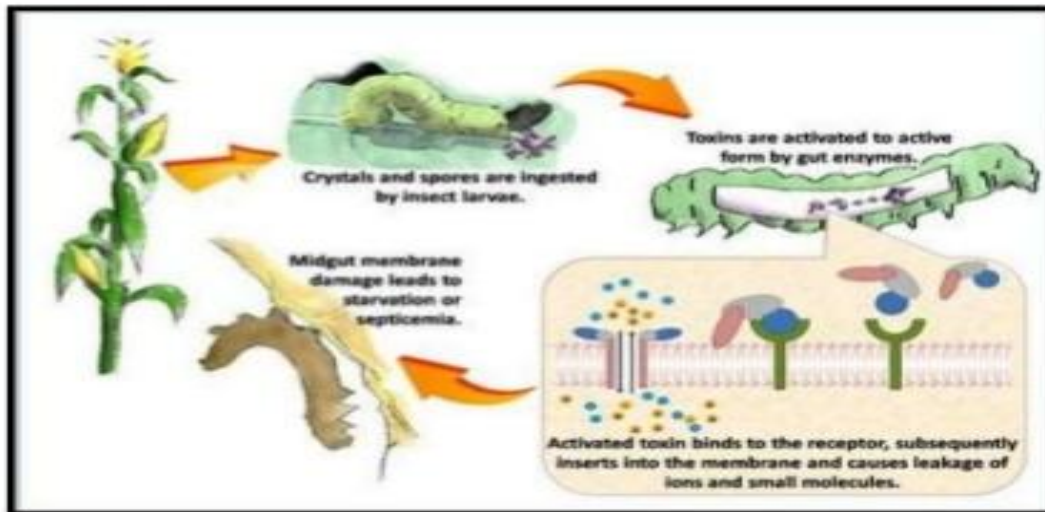


- Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as lepidopterans, coleopterans and dipterans.
- *Bacillus thuringiensis* form protein crystals which contain a toxic insecticidal protein.
- This protein is present in its inactive form once it is ingested by the insect in its gut due to alkaline medium it is converted to active protein which cause binding of active toxin to the surface of mid gut epithelial cells and create pores that cause cell swelling and lysis and eventually death of the insect.



Endotoxin gene from *Bt*

The gene responsible for producing endotoxin is isolated from *Bt* and cloned into plants to develop resistance to insects



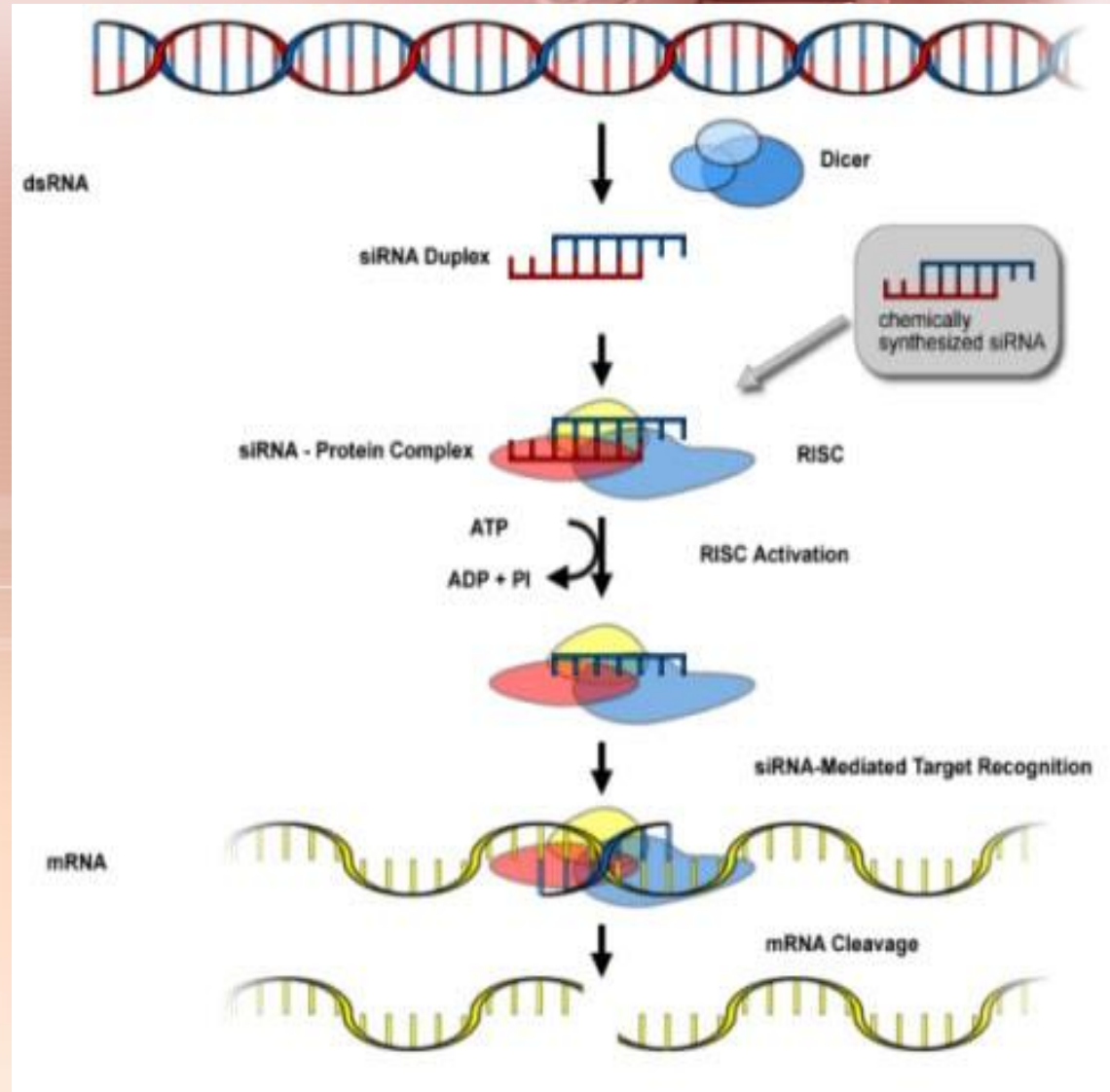
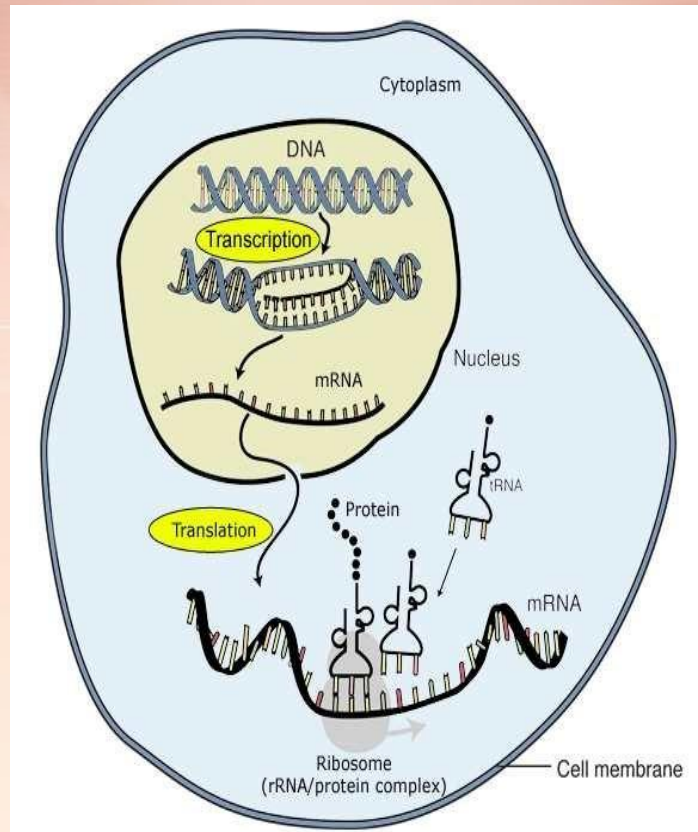
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- ❖ Bt toxins are insect group specific.
- ❖ Toxin is coded by a gene cryIAC named cry.
- ❖ Proteins encoded by the gene cryIAC and cryIIAb control the cotton boll worms and cryIAb controls corn borer.

PEST RESISTANT PLANT

- ❖ Many plants and animals are parasitized by nematodes.
- ❖ If it parasitizes a crop ultimately productivity is reduced.
- ❖ Tobacco plant often is parasitized by *Meloidogyne incognitia*, a nematode.
- ❖ A novel strategy was recognized by Fire and Mello in 1998 to prevent this infestation that was based on the process of RNA interference (RNAi).
- ❖ RNAi takes place in all eukaryotic organisms as a method of cellular defense.
- ❖ This method involves silencing of a specific mRNA.
- ❖ *Agrobacterium* vectors are used, nematode specific genes are introduced into the host plant.
- ❖ The introduction of the DNA produces both sense and anti-sense RNA in the host cell.

- ❖ These two RNAs being complimentary to each other forms a double stranded RNA (dsRNA) that initiates RNAi.
- ❖ A normal transcription and translation can be seen in the given diagram.
- ❖ But in RNAi it is not like this.



STEPS INVOLVED IN RNAi

- dsRNA are processed into approximately 21–23 nucleotide RNAs with two nucleotides. An RNase enzyme called DICER cuts the dsRNA molecules into small interfering RNAs (siRNAs).
- Each siRNA complexes with ribonucleases (distinct from Dicer) to form an RNA induced silencing complex (RISC).
- The siRNA unwinds and RISC is activated.
- The activated RISC targets complementary mRNA molecules. The siRNA strands act as guide where the RISCs cut the transcripts in an area where the siRNA binds to the mRNA. This destroys the mRNA.
- When mRNA of the parasite is destroyed no protein was synthesized. It resulted the death of the parasite in the transgenic host. Thus the transgenic plant gets protected.

ACKNOWLEDGEMENT

The following text books and the sites were referred to complete this PPT:

1. Text book of NCERT Class – XII

2. Trueman's Elementary Biology Part – 2

3. Google images



Thank You