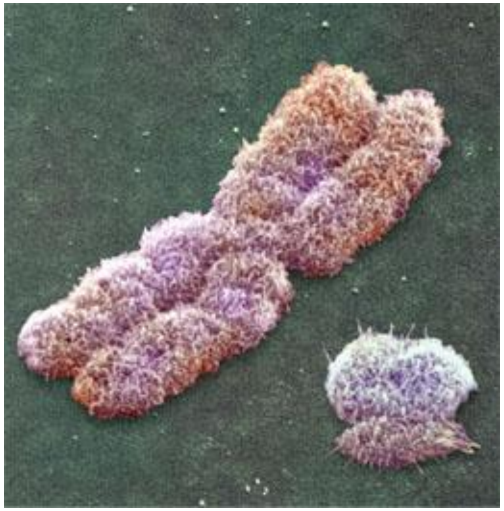
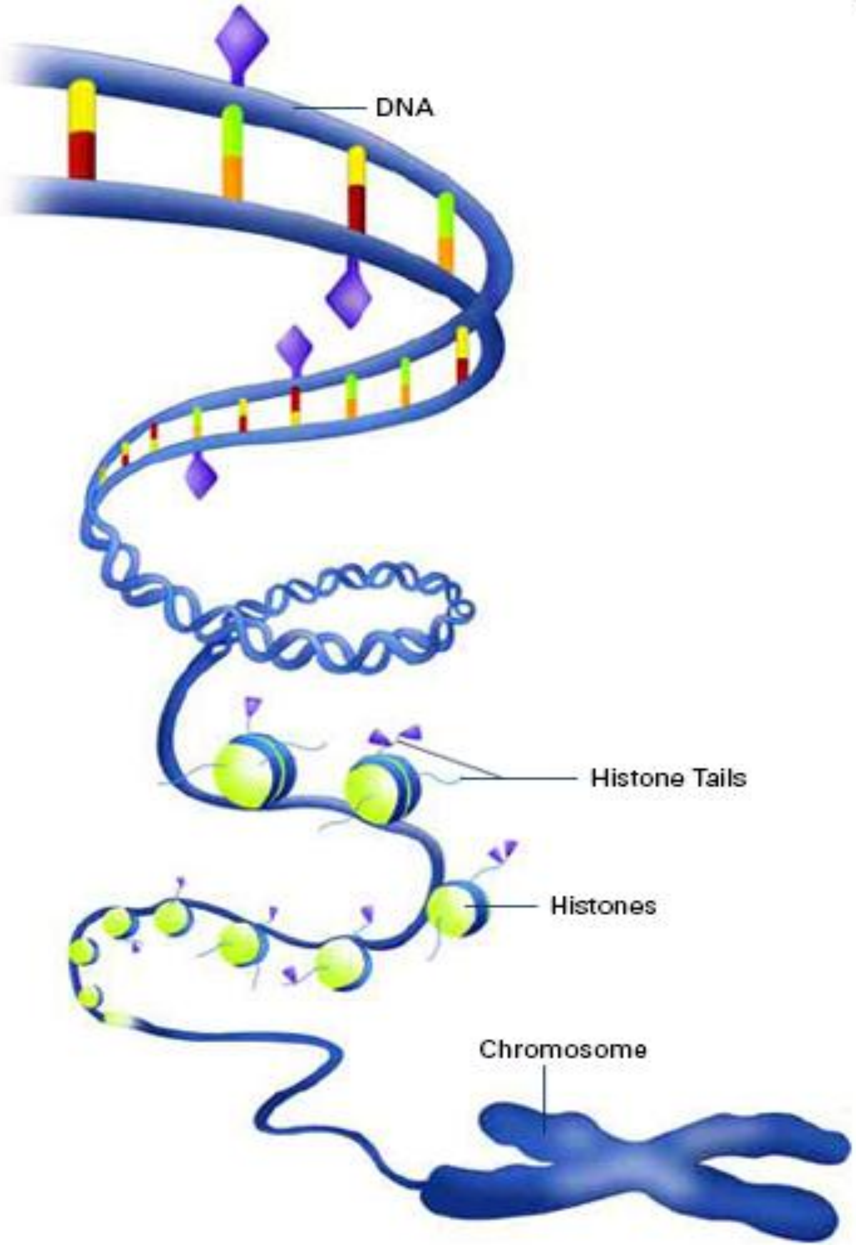
Transcription and translation





Transcription

Transcription is the process by which DNA is copied (*transcribed*) to mRNA, which carries the information needed for protein synthesis. pre-messenger RNA is formed, with the involvement of RNA polymerase enzymes. The process relies on Watson-Crick base pairing, and the resultant single strand of RNA is the reverse-complement of the original DNA sequence. The pre-messenger RNA is then "edited" to produce the desired mRNA molecule in a process called *RNA splicing*.

Formation of pre-messenger RNA

The mechanism of transcription has parallels in that of DNA Replication. As with DNA replication, partial unwinding of the double helix must occur before transcription can take place, and it is the RNA polymerase enzymes that catalyze this process.

Unlike DNA replication, in which both strands are copied, only one strand is transcribed. The strand that contains the gene is called the *sense* strand, while the complementary strand is the *antisense* strand.

Step of Transcription

1- promoters : specific sequence at the beginning of gene

2- synthesis 5 to 3 from 3 to 5 DNA strand

A- RNA complementary

B-Uracil replaces Thyamine in compelmentary RNA strand

3-Release of transcription

4-Transcript modification

A- Introns which are non coding removed

B-Exons are the protein that are read

C- cap at one end poly amine tail on the other

Reverse transcription

In reverse transcription, RNA is "reverse transcribed" into DNA. This process, catalyzed by reverse transcriptase enzymes, Reverse transcriptase enzymes have also found applications in biotechnology, allowing scientists to convert RNA to DNA for techniques such as PCR.

Translation

The mRNA formed in transcription is transported out of the nucleus, into the cytoplasm, to the ribosome (the cell's protein synthesis factory). Here, it directs protein synthesis. Messenger RNA is not directly involved in protein synthesis - transfer RNA (tRNA) is required for this. The process by which mRNA directs protein synthesis with the assistance of tRNA is called *translation*.

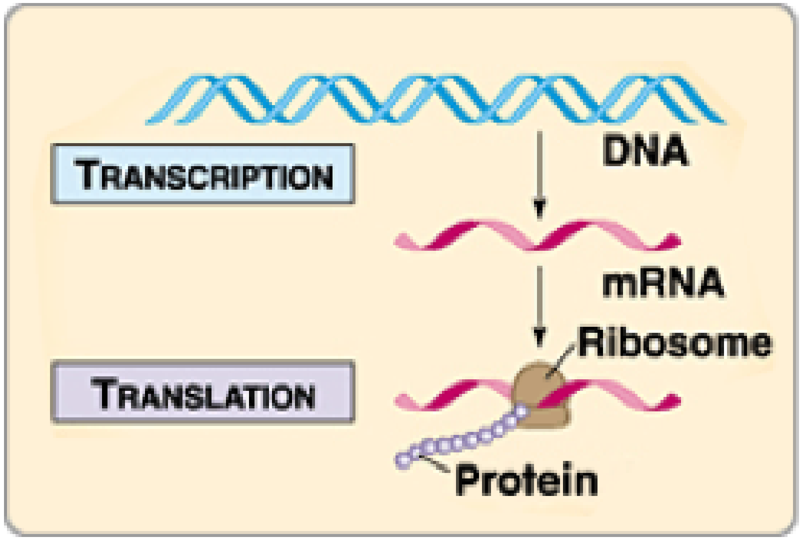
The ribosome is a very large complex of RNA and protein molecules. Each three-base stretch of mRNA (triplet) is known as a *codon*, and one codon contains the information for a specific amino acid. As the mRNA passes through the ribosome, each codon interacts with the *anticodon* of a specific transfer RNA (tRNA) molecule by Watson-Crick base pairing. This tRNA molecule carries an amino acid at its 3'-terminus, which is incorporated into the growing protein chain. The tRNA is then expelled from the ribosome.

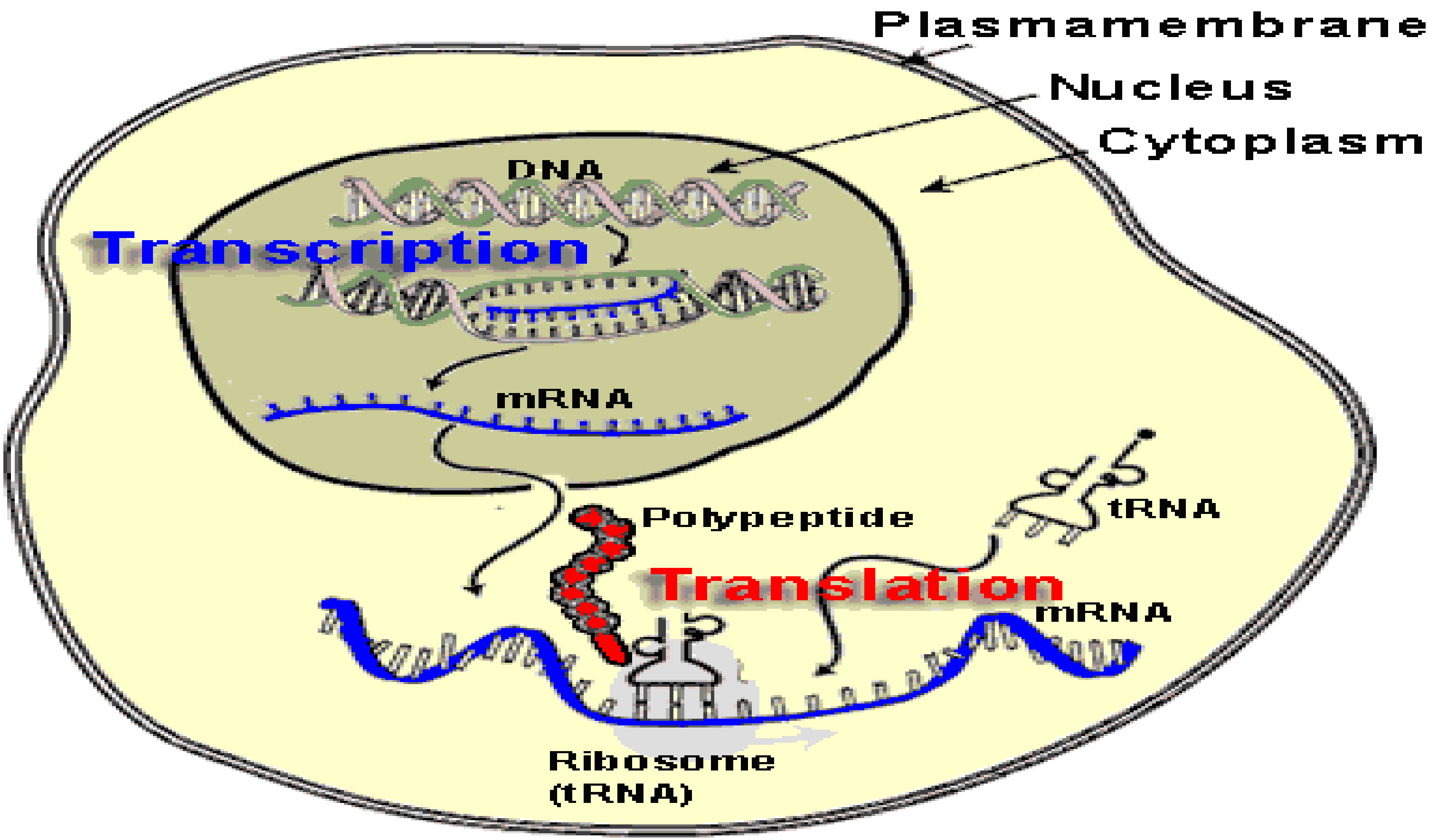
Each amino acid has its own special tRNA (or set of tRNAs). For example, the tRNA for phenylalanine (tRNAPhe) is different from that for histidine (tRNAHis). Each amino acid is attached to its tRNA through the 3'-OH group to form an ester which reacts with the α-amino group of the terminal amino-acid of the growing protein chain to form a new amide bond (peptide bond) during protein synthesis. The reaction of esters with amines is generally favourable but the rate of reaction is increased greatly in the ribosome.

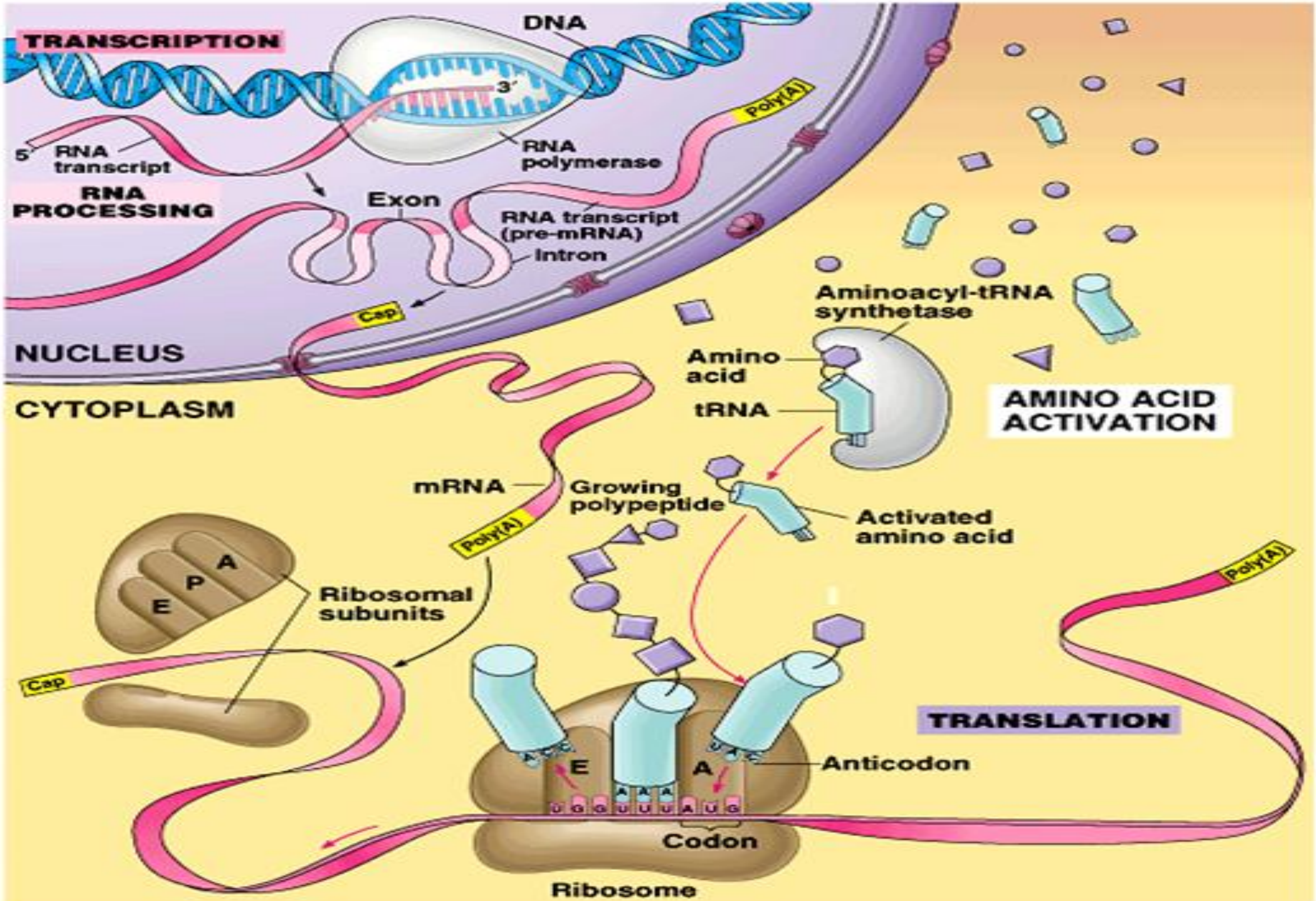
What is difference between transcription and translation?
Transcription is the process of copying a gene's DNA sequence to make an RNA molecule and translation is the process in which proteins are synthesized after the process of transcription of DNA to RNA in the cell's nucleus. Translation synthesizes proteins from RNA copies.

Transcription & transcription: overview

- *Transcription*
  - DNA → mRNA
  - Synthesis of mRNA from DNA
- *Translation*
  - Converting genetic information into proteins
  - mRNA is code for proteins synthesized at ribosome




Plasmamembrane
Nucleus
Cytoplasm
DNA
Transcription
mRNA
Polypeptide
tRNA
Translation
mRNA
Ribosome
(tRNA)



TRANSCRIPTION
DNA
3′
5′
RNA transcript
RNA polymerase
Poly(A)
RNA PROCESSING
Exon
RNA transcript (pre-mRNA)
Intron
Cap
NUCLEUS
CYTOPLASM
Aminoacyl-tRNA synthetase
Amino acid
tRNA
AMINO ACID ACTIVATION
mRNA
Growing polypeptide
Activated amino acid
Poly(A)
A
P
E
Ribosomal subunits
Cap
Poly(A)
TRANSLATION
E
A
Anticodon
U G G U U U A U G
A A A
Codon
Ribosome

What is Antisense RNA Technology?

Antisense technology is a new and promising tool for controlling gene expression in a cell. Using synthetic antisense oligonucleotides, it targets genes at the level of mRNA, rather than DNA, and prevents them from producing proteins.

Applications of antisense RNA in plants

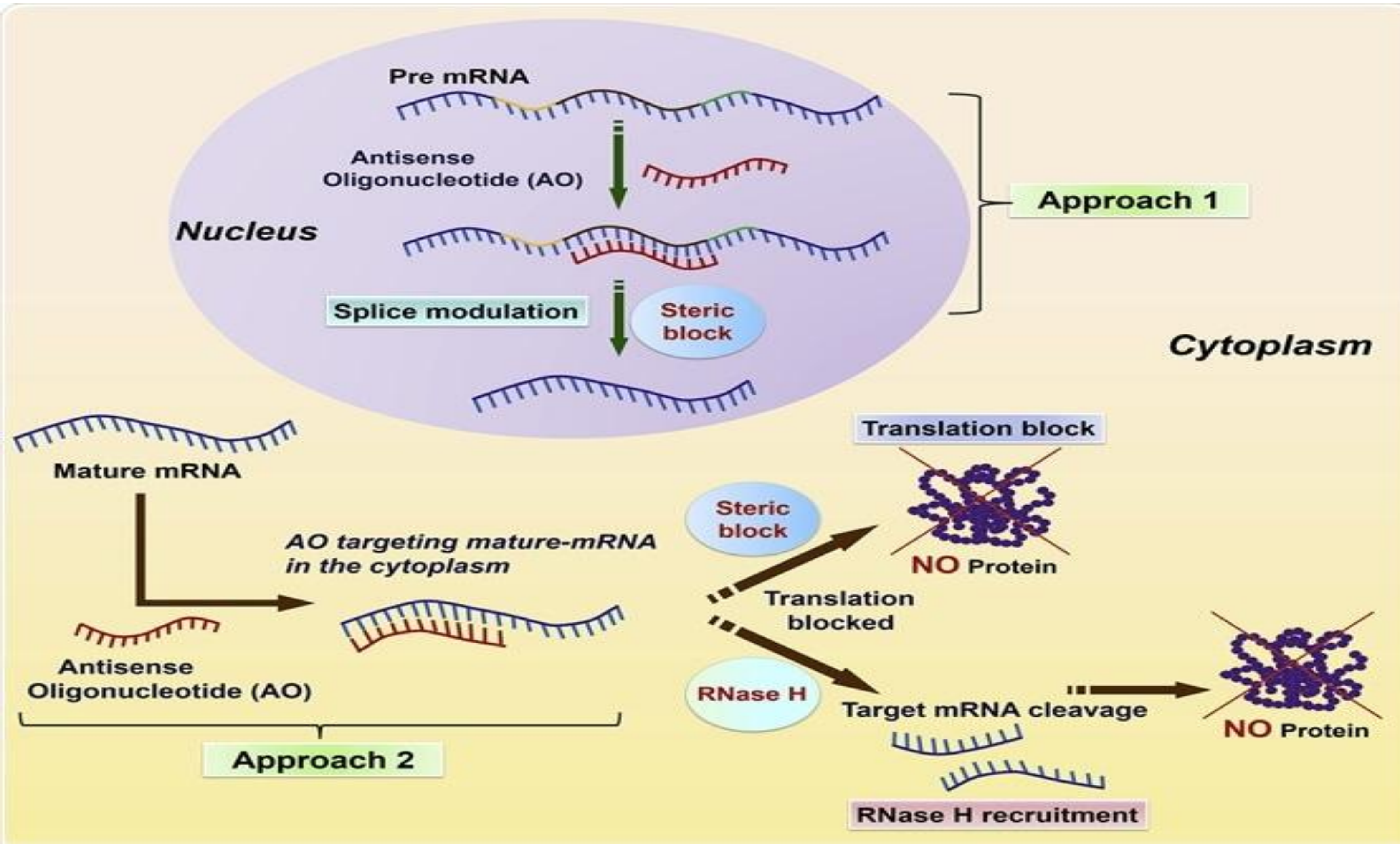
In plants, antisense RNAs are mainly used in the inhibition of fruit maturation, virus resistance, flower coloration, starch synthesis, male sterility, and fertility .Furthermore, antisense RNAs also play a key role in the inhibiting the expression of genes involved in the synthesis of harmful substances in food.

1- Ethylene can be used to regulate the expression of genes involved in metabolic processes, and thus control the time of maturation and extend the preservation of fruit . antisense RNA of 1-aminocyclopropane-1-carboxylate (ACC) oxidase from tomato was shown to be capable of inhibiting the expression of the rate-limiting enzymes in the biosynthetic pathways of ethylene, and thus postpone the maturation of fruit. studies are ongoing and have been extended to fruits such as pears, apples, bananas, and mangoes..

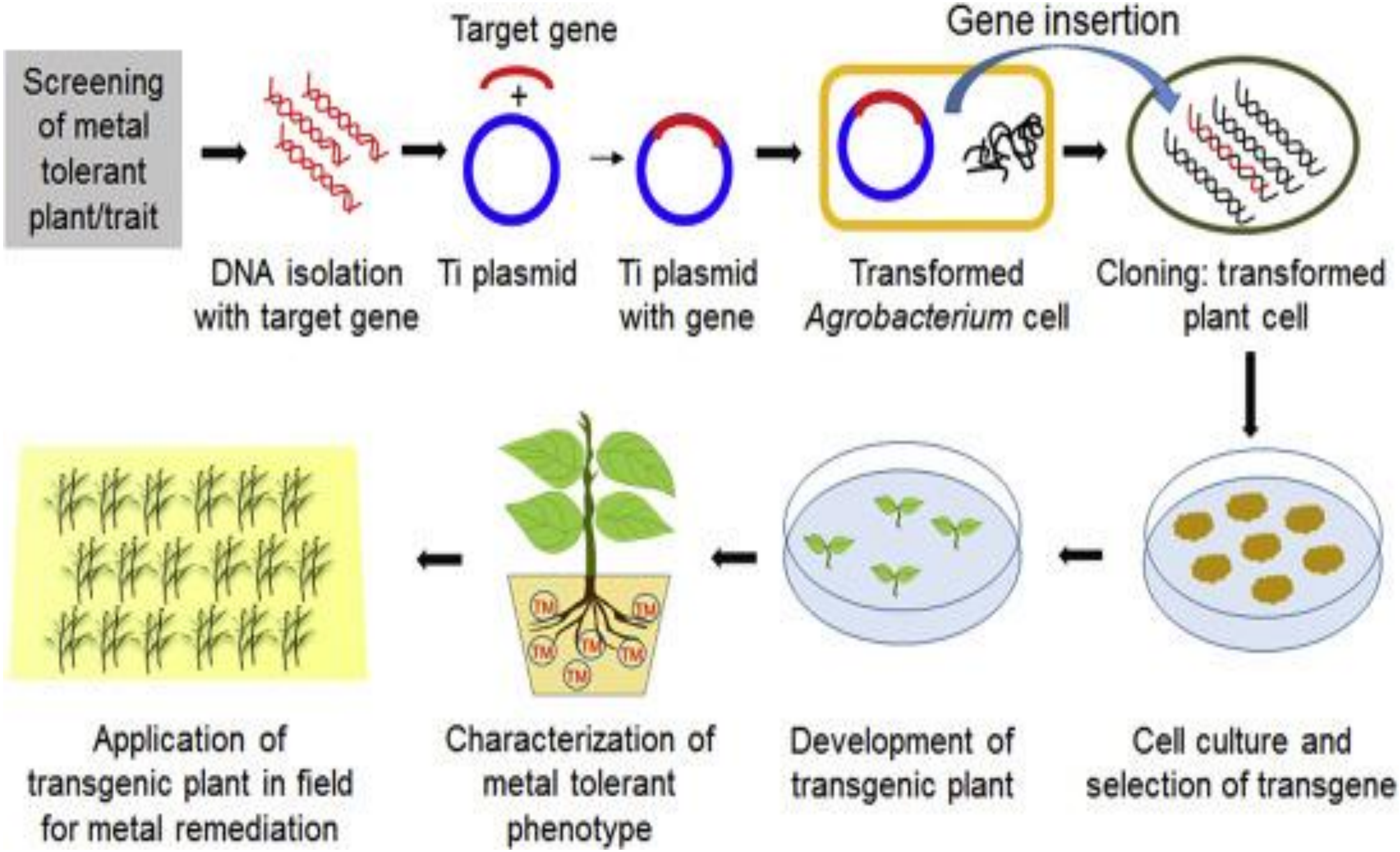
2- plant viruses represent one of the critical factors, because they influence the crop yield and quality , Antisense RNA can be used in plant virus resistance because antisense sequence inhibits RNA biosynthesis. first reported on the use of antisense RNA to inhibit DNA viruses, and results indicated that antisense DNA of the AL1-coding gene from tomato golden mosaic virus (TGMV) was used to inhibiting TGMV replication.

3- Starches include amylose and amylopectin, but amylose is considered undesirable in the starch industry. However, we can use antisense RNA to improve the starch components in plants. For example, used the endogenous granule-bound starch synthase (*GBSS*) antisense gene to inhibit *GBSS* gene expression for the first time. This led to the absence of GBSS protein and the production of amylose-free potato starch.

4- Antisense RNA can also be used to change flower colors of petunia



Pre mRNA
Antisense Oligonucleotide (AO)
Nucleus
Approach 1
Splice modulation
Steric block
Cytoplasm
Mature mRNA
Translation block
Steric block
NO Protein
AO targeting mature-mRNA in the cytoplasm
Translation blocked
Antisense Oligonucleotide (AO)
RNase H
Target mRNA cleavage
NO Protein
Approach 2
RNase H recruitment


Screening of metal tolerant plant/trait
Target gene
+
Gene insertion
DNA isolation with target gene
Ti plasmid
Ti plasmid with gene
Transformed *Agrobacterium* cell
Cloning: transformed plant cell
Cell culture and selection of transgene
Development of transgenic plant
TM
Characterization of metal tolerant phenotype
Application of transgenic plant in field for metal remediation