RAMA UNIVERSITY

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FACULTY OF ENGINEERING &TECHNOLOGY

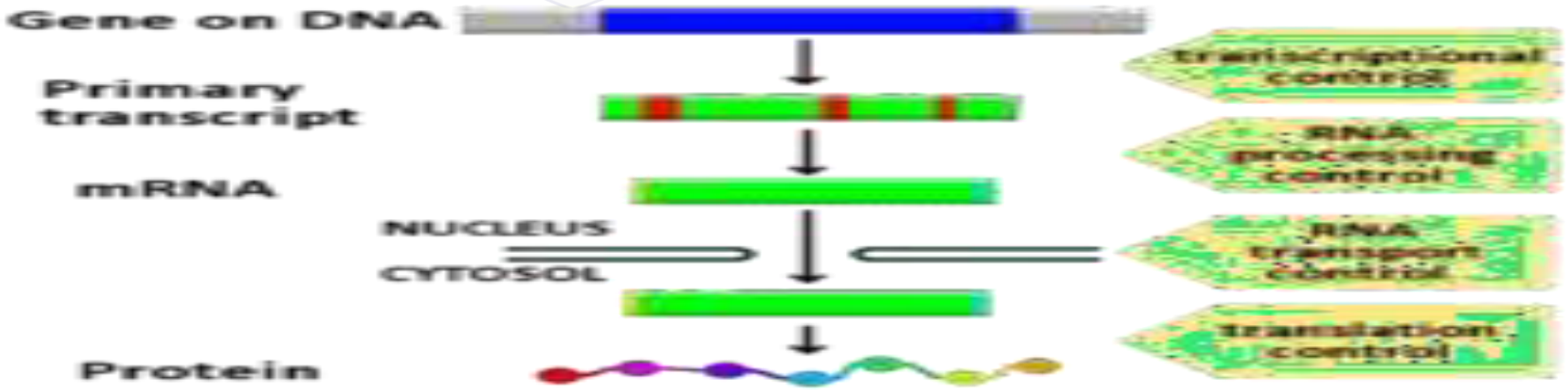
DEPARTMENT OF BIOTECHNOLOGY

Gene Expression:

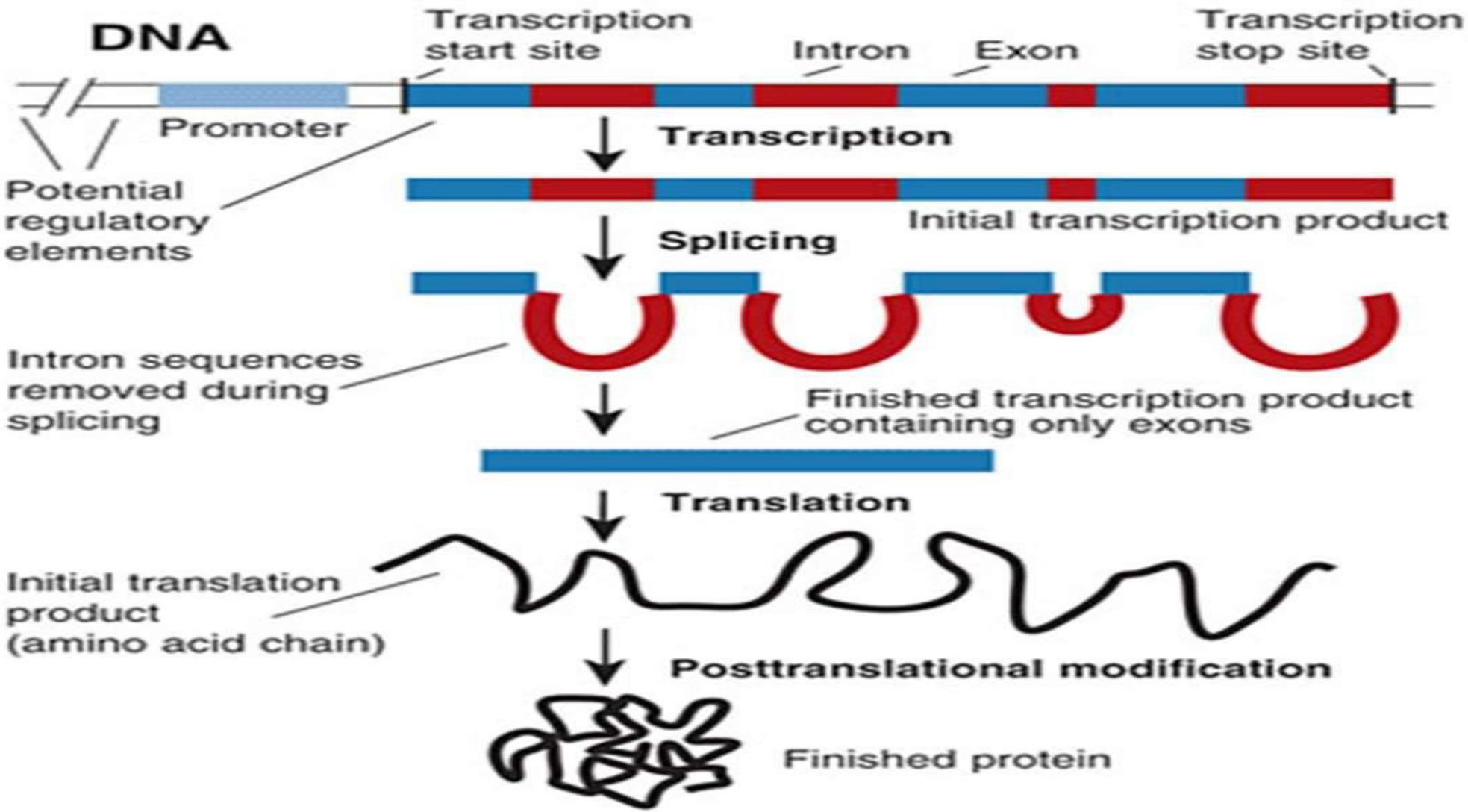
- Gene expression is the process by which the information encoded in a gene is used to direct the assembly of a protein molecule.

  Gene expression is explored through a study of protein structure and function, transcription and translation, differentiation and stem cells.
- It is the process by which information from a gene is used in the synthesis of a functional gene product.
- These products are often proteins, but in non-protein coding genes such as ribosomal RNA (rRNA), transfer RNA (tRNA) or small nuclear RNA (snRNA) genes, the product is a functional RNA.
- The process of gene expression is used by all known life - eukaryotes (including multicellular organisms), prokaryotes (bacteria and archaea)

- Regulation of gene expression includes a wide range of mechanisms that are used by cells to increase or decrease the production of specific gene products (protein or RNA).
- Gene regulation is essential for viruses, prokaryotes and eukaryotes as it increases the versatility and adaptability of an organism by allowing the cell to express protein when needed.



- Although a functional gene product may be an RNA or a protein, the majority of known mechanisms regulate protein coding genes.
- Any step of the gene's expression may be modulated, from DNA-RNA transcription to the post-translational modification of a protein.
- The first discovered example of a gene regulation system was the lac operon, discovered by Jacques Monod, in which protein involved in lactose metabolism are expressed by E.coli only in the presence of lactose and absence of glucose.
- Gene regulation drives the processes of cellular differentiation and morphogenesis, leading to the creation of different cell types in multicellular organisms where the different types of cells may possess different gene expression profile.

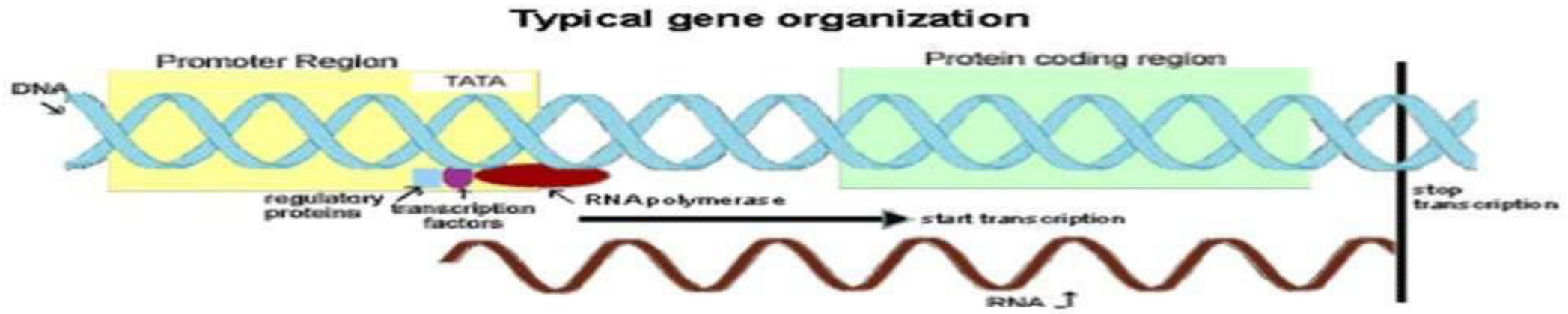

DNA
Transcription start site
Intron
Exon
Transcription stop site
Promoter
Transcription
Potential regulatory elements
Initial transcription product
Splicing
Intron sequences removed during splicing
Finished transcription product containing only exons
Translation
Initial translation product (amino acid chain)
Posttranslational modification
Finished protein

Gene

Genes are subunits of DNA, the information database of a cell that is contained inside the cell nucleus.

This DNA carries the genetic blueprint that is used to make all the proteins the cell needs.

Every gene contains a particular set of instructions that code for a specific protein



Constitutive (house keeping) genes:

Are expressed at a fixed rate, irrespective to the condition.

Their structure is simpler.

Controllable genes:

Are expressed only as needed. Their amount may increase or decrease with respect to their basal level in different condition.

Their structure is relatively complicated with response elements

POSITIVE REGULATION :

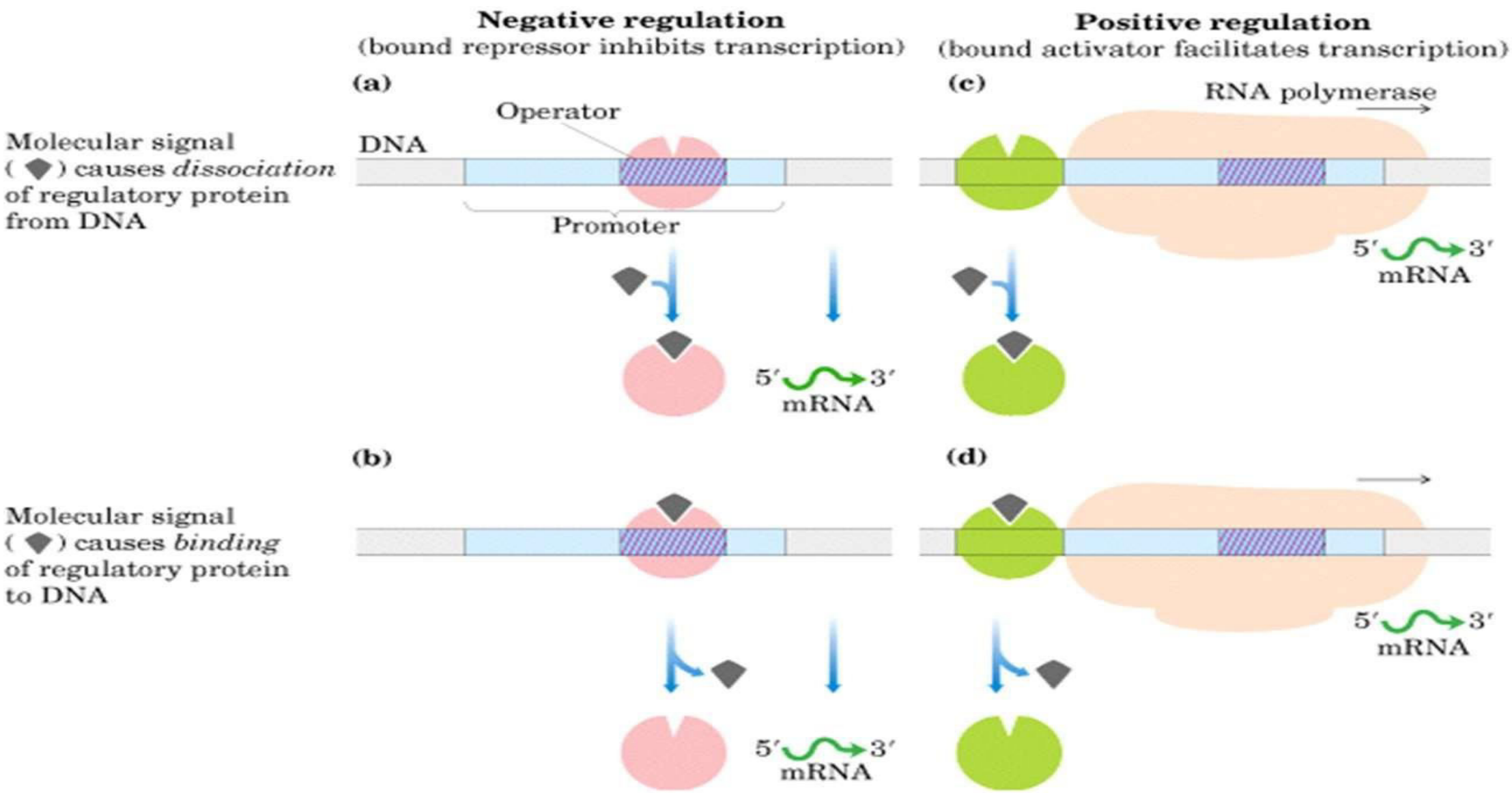
When the expression of genetic information is quantitatively increased by the presence of specific regulatory element is known as positive regulation.

Element modulating positive regulation is known as activator or positive regulator.

NEGATIVE REGUATION:

- When the expression of genetic information is diminished by the presence of specific regulatory element is known as negative regulation.
  The element or molecule mediating the negative regulation is said to be repressor.

Positive and negative regulation


Negative regulation
(bound repressor inhibits transcription)
Positive regulation
(bound activator facilitates transcription)
(a)
(c)
Operator
RNA polymerase
DNA
Molecular signal
(◆) causes *dissociation*
of regulatory protein
from DNA
Promoter
5′ 3′
mRNA
5′ 3′
mRNA
(b)
(d)
Molecular signal
(◆) causes *binding*
of regulatory protein
to DNA
5′ 3′
mRNA
5′ 3′
mRNA

Types of temporal Response

Type A response:

- Increased extent of gene expression is continued in presence of inducing signal.
- This is commonly observed in prokaryotes in response to intracellular conc. of nutrient.

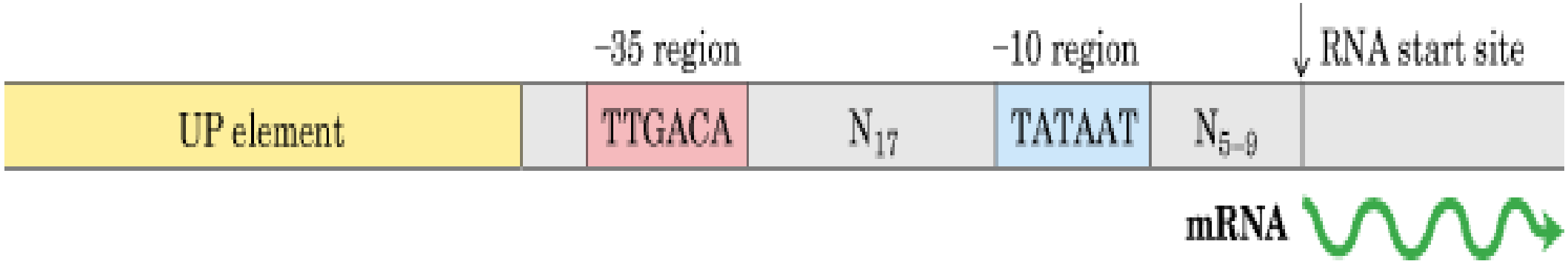
Type B response:

- Increased amount of gene expression Is transient even in presence of regulatory signal.
- This is seen in commonly during development of organism.

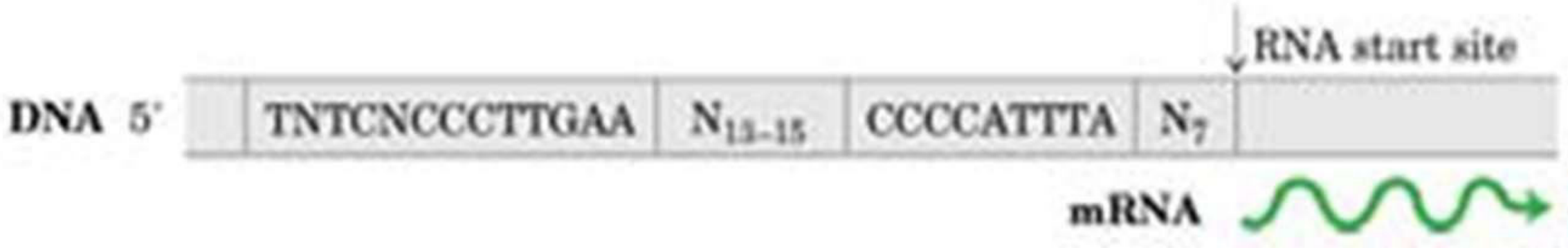
Type C response:

- Increased gene expression that persists even after termination of signal.
- It is seen in development of tissur or organ.

1) RNA polymerase binds to DNA at promoters.



2)Transcription initiation is regulated by proteins that bind to or near promoters.



Steps involving Regulation of gene Expression:

Synthesis of the primary RNA transcript (transcription)

↓

Posttranscriptional modification of mRNA

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Messenger RNA degradation

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Protein synthesis (translation) Posttranslational

↓

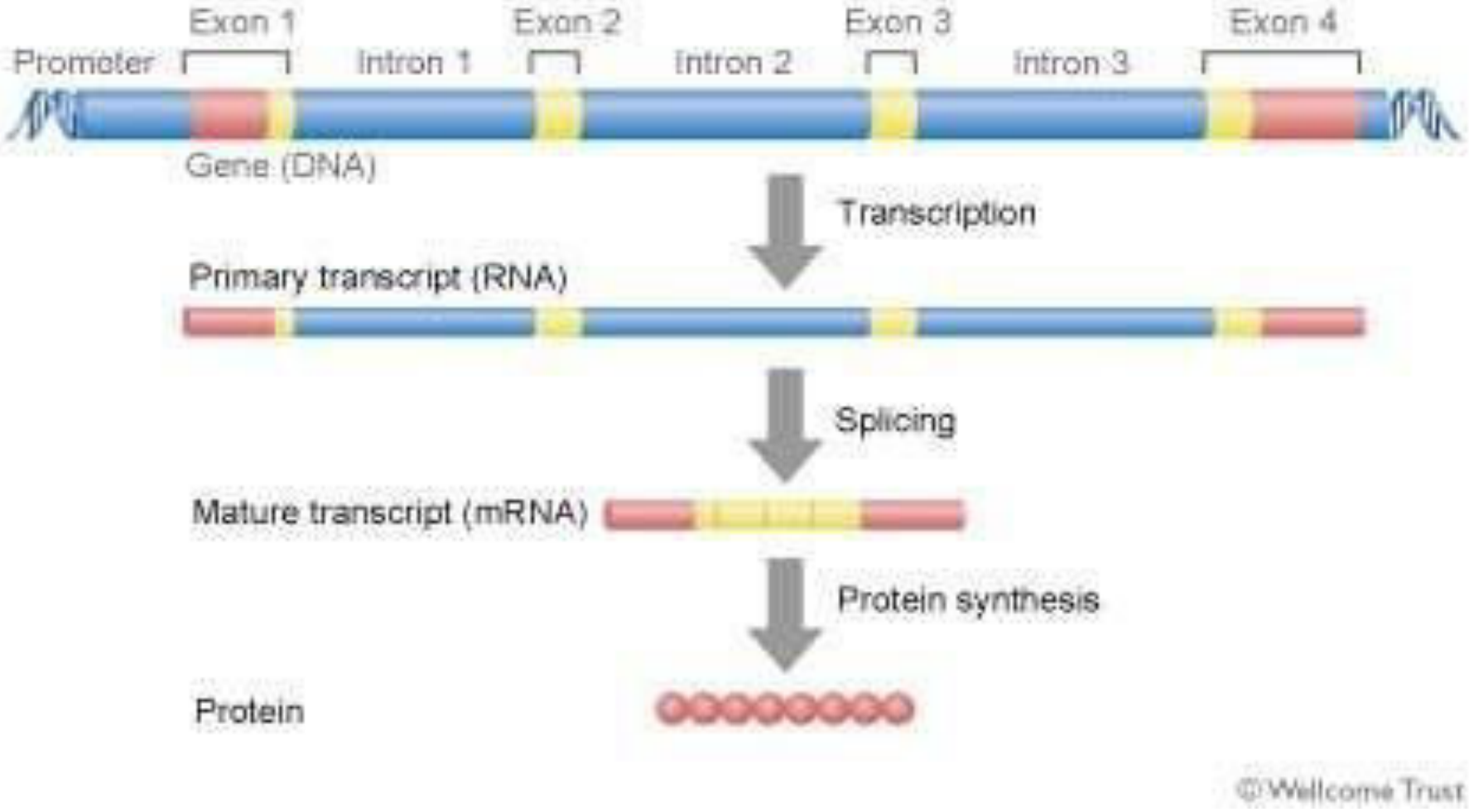
modification of proteins Protein targeting & transport

↓

↓

Protein degradation

Gene Expression



- In prokaryotes the primary control point is the process of transcription initiation .
- Different ways for regulation of gene expression in bacteria:
  - 1- Promoter recognition.
  - 2-Transcription elongation(Attenuation).

- Regulation of gene expression can be done by some operon pathways such as
  1. lac operon.
  2. tryptophan operon.

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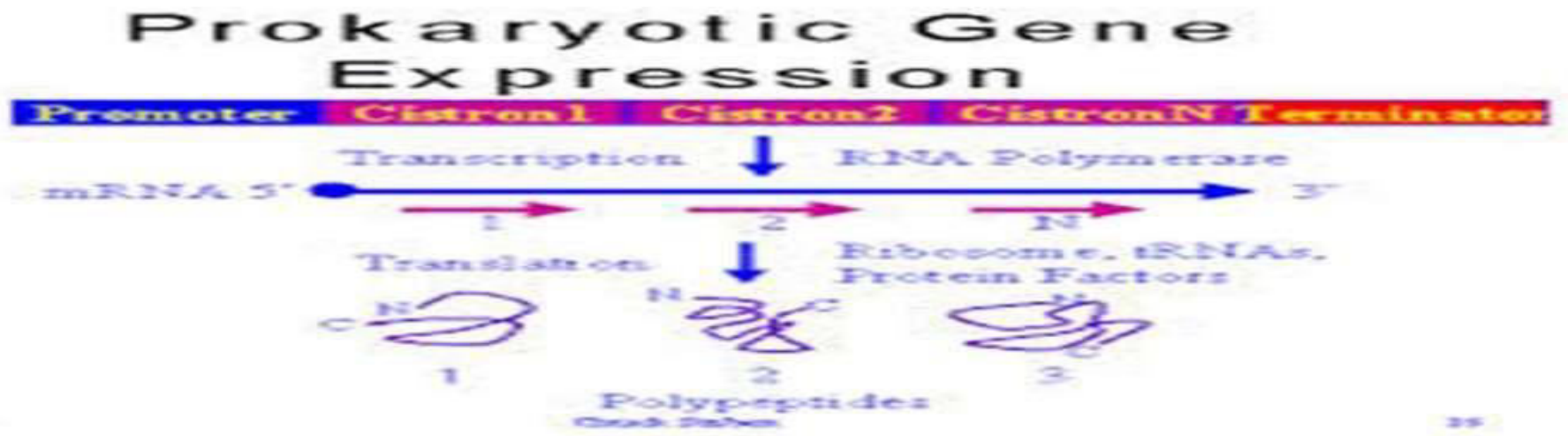

Transcriptional control

Translational control Post translational control